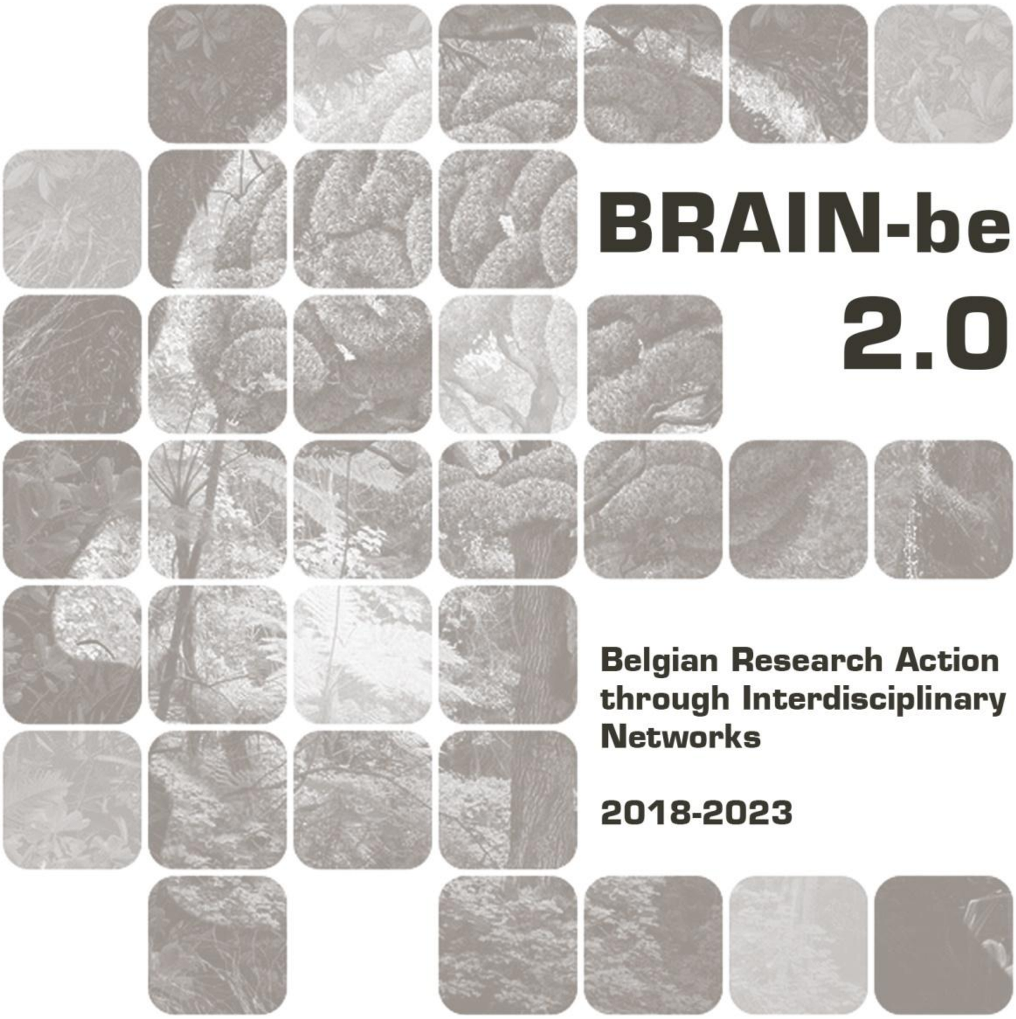

CAMBIUM

CirculAr Material flows in BelgIUM

Material flow framework and data architecture, identification of inconsistencies and data gaps

Final report

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Pillar 3: Federal societal challenges

BRAIN-be 2.0

Belgian Research Action through Interdisciplinary Networks

2018-2023

NETWORK PROJECT

CAMBIUM

CirculAr Material flows in BelgIUM

Contract - B2/223/P3/CAMBIUM

WP1: Material flow framework and data architecture, identifying inconsistencies and data gaps

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ABSTRACT

CONTEXT

Belgium's transition towards a circular economy requires a robust and transparent understanding of material flows across the economy. Building on existing economy-wide material flow accounting frameworks, this report situates itself within ongoing efforts to monitor material use, circularity and resource dependency at the national level. It responds to the need for greater consistency, completeness and policy relevance in material flow indicators by critically examining current data sources, methodologies and accounting practices applied in the Belgian context.

OBJECTIVES

The report aims to develop a structured material flow framework and accompanying data architecture for Belgium that enables a systematic mapping of material inputs, transformations and outputs. It seeks to identify inconsistencies, uncertainties and blind spots in existing indicator sets, while assessing their implications for monitoring material footprint and circularity. In addition, the report explores opportunities to refine existing indicators and to develop complementary metrics that better capture circular material flows, trade-related dependencies and data gaps specific to Belgium.

CONCLUSIONS

The analysis demonstrates that while Belgium benefits from relatively comprehensive data availability through official statistics, important limitations persist in terms of system boundaries, treatment of waste and secondary materials, and representation of upstream material requirements. Trade-related indicators and footprint-based metrics reveal significant dependencies and uncertainties that are not visible in conventional material flow indicators alone. Addressing these challenges requires clearer conceptual distinctions, improved data integration across statistical domains, and cautious interpretation of derived indicators. The proposed framework provides a consistent basis for identifying priority data gaps and for supporting more informed monitoring of circular economy performance in Belgium.

KEYWORDS

Material flow analysis; circular economy; data gaps; material footprint

1. INTRODUCTION

Building further on the overview of state-of-the-art methodologies with a focus on frameworks, data sources, metrics and indicators available for Belgium, we aim to:

1. To provide a structured overview of existing indicator and blind spots in existing indicator sets to monitor material footprint and circularity of material flows, while identifying any gaps or shortcomings.
2. To investigate and develop several new indicators specific to the Belgian context, aiming to address some of the identified gaps.

The mapping exercise starts from the framework and methodology developed by Mayer et al. (2018) (see Figure 1). This framework and linked indicator sets is further enhanced based on state-of-the-art methodologies and data sources.

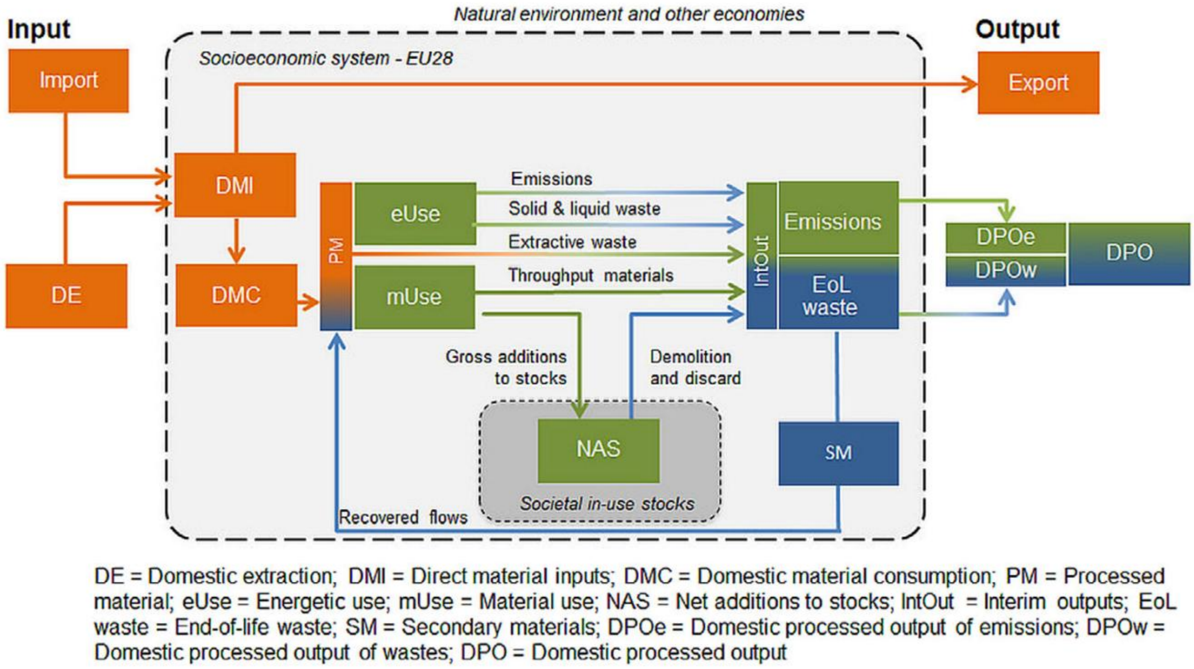

Figure 1: Framework and throughput indicators for an economy-wide CE assessment. Colours indicate data sources used: orange = official data from economy-wide material flow accounts, blue = official waste and emissions statistics, green = mass-balanced modelling. Please note that a shift from green to blue colour indicates a combination of statistical data and modelling. Source: Mayer et al. (2018).

The framework, based on the mass balancing principle, encompasses material flows include domestic extraction used (DE), trade flows, throughput materials (such as dispersed and dissipated materials), stock additions and stock depletions (e.g., demolition and discard). They also encompass end-of-life waste (EoL waste), secondary materials (SM), emissions (DPOe) and losses (DPOw). Physical stocks include natural resource stocks (preceding DE), socioeconomic stocks of products (in-use societal stocks), and domestic processed output (DPO).

This methodology deploys a mass-balancing approach, meaning that if no statistical data are available, the corresponding flows are calculated or modelled based on literature. This allows for the compensation of differences in reported input and output flows. In these cases, a potential discrepancy or uncertainty is hidden. This task aims to provide an overview of the relevant information currently available, to identify areas of uncertainty, explore new or alternative data sources where possible, and support the analysis of circular material flows with additional indicators.

In addition to these actual material flows that enter and leave the territory, virtual material flows are accounted for, such as the raw material equivalents of import and export flows. In a framework that presents actual material flows, imports and exports are quantified by their weight, whereas the raw perspective converts trade flows into raw material equivalents. This conversion takes into account all upstream resources required to produce and distribute the product, i.e. the material rucksack.

The material flow analysis framework provides a refined overview of state-of-the-art indicators and required data sources, providing a basis to further explore and tackle uncertainties, inconsistencies and gaps.

Similar to Mayer's framework, the primary physical stages of material flows through the entire system are structured following throughput indicators. These material flow stages encompass the source of material inputs (e.g., domestic extraction, imports), the key material transformation processes within the system (e.g., processed materials, energetic use, material use, in-use material stocks, waste treatment, and end-of-life waste), and the destination of outflows (e.g., exports, and domestic processed output to the environment).

Throughout this task, several frameworks, methodologies, and indicator sets were consulted. The initial refinement was based on the economy-wide circularity framework for Flanders, which builds on Eurostat's Economy-Wide Material Flow Analysis (EW-MFA). Additionally, indicators relevant to monitoring the performance, trends, and challenges in raw material supply—along with their impact on the EU's economy, environment, and society—were explored using the EU monitoring framework for the circular economy and the Raw Materials Scoreboard.

The structure of the report follows the logic of the material flow framework. Starting with the input indicators (Section 2.1), followed by indicators on use and transformation (Section 2.2) and the indicators on output (Section 2.3). A section on the circularity indicators concludes Chapter 2.

2. MAPPING EXERCISE

2.1 Input indicators

Imports (IMP)

According to Eurostat's EW-MFA, imports are defined as flows of products entering the domestic economy from the rest of the world. This category also **includes waste imported for treatment and secondary materials**, as can be seen in Figure 2, which shows a snapshot of the composition of direct material inputs as displayed in the Sankey Diagram of Material Flows for Belgium in 2023. The imports of waste for recycling can be separately consulted through Eurostat.

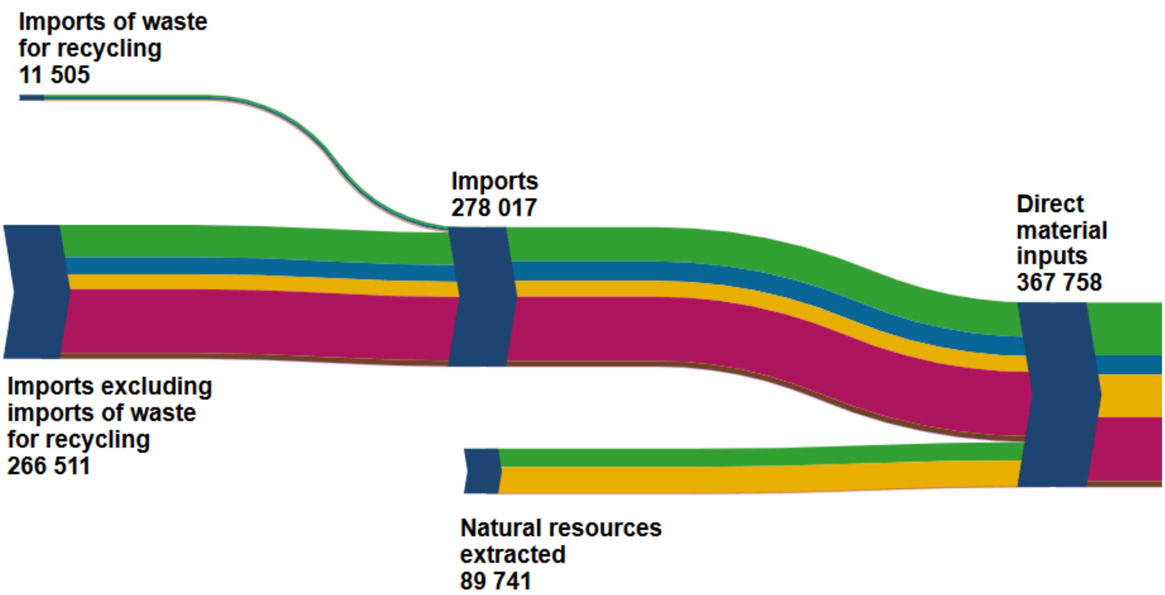

Figure 2: Screenshot of the Material Flow Diagram (Sankey Diagram) of Eurostat for Belgium in 2023.

Uncertainties or inconsistencies

As indicated by Circular Economy Monitor Flanders[1] , a major inconsistency arises from including trade in waste and secondary materials (SM) in overall imports and exports. This creates a disconnection between the waste management system and the trade flows of waste and secondary materials. To address this, waste imports (IMPw) are separately allocated to a new step in our proposed framework, the "waste management system (WMS)", while trade in SM (IMPsm) is directly integrated into the SM feedback loop. Consequently, trade in waste and secondary materials are excluded from general trade statistics to avoid double counting. It is important to note, however, that trade in products containing secondary materials remains included in general imports and exports statistics and that only official waste and recyclable raw materials are separately monitored. Examples of products classified as waste for recycling are discussed in this section below, and examples of products classified as recyclable raw materials can be found under the section "Secondary materials".

A possible inconsistency is the concept used in compiling trade statistics. In trade data statistics, the national concept and the residential concept differ in how they define who is considered part of an

[1] OVAM. (n.d.). *Circular Economy Monitor Flanders.* https://cemonitor.be/en/home-english/

economy. Under the national concept, trade activity is attributed based on nationality or ownership, for example, goods and services traded by enterprises that are nationally owned, even if those enterprises operate abroad. In contrast, the residential concept follows the principles of the Balance of Payments and System of National Accounts, attributing trade to entities that reside within an economy, regardless of their nationality or ownership. This means that foreign-owned firms operating domestically are included in a country's trade statistics, while domestically owned firms operating abroad are not. As a result, the residential concept generally provides a more accurate picture of economic activity within a country's borders, while the national concept reflects the global activity of nationally affiliated enterprises.

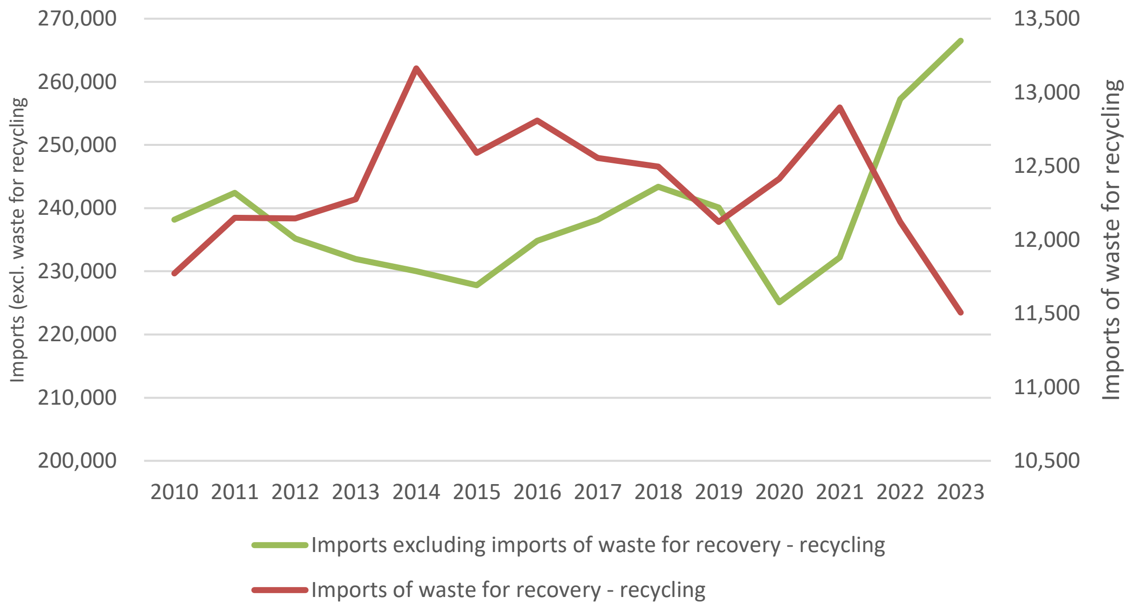

Figure 3: Flows going into imports in Belgium from 2010 to 2023, in thousand tonnes.
Source: Eurostat (env_ac_mfa, env_ac_sd, env_wassd)

Figure 3 shows the composition of the material imports in Belgium from 2010 to 2023, which includes imported waste for recovery and recycling on the one hand, and all other materials on the other. Imports of waste and secondary materials have remained relatively stable in the period from 2010 to 2020, to than experience a steep surge since 2020. Other material imports, however, declined by 5.3% in 2020 compared to 2010 due to the economic impact of COVID-19, and then increased sharply in the period from 2020 to 2023. This makes the total material imports excluding waste destined for recycling in Belgium in 2023 9.9% higher than in 2010.

The following two sections zoom in on both imports of waste for recycling, and imports excluding imports of waste for recycling. They then discuss the weight of materials going through these imports into the economy and explore which specific products account for these material flows. It is important to note that imports of secondary raw materials are not included in these calculations; these will be discussed later in the report.

Imports of waste for recycling

Figure 4 zooms in on the materials that are going through imports of waste for recycling in Belgium from 2010 to 2023. We find that biomass and metal ores have consistently accounted for the largest share of material imports of waste for recycling over the past decade, while fossil energy materials/carriers, and non-metallic minerals account for the lowest share.

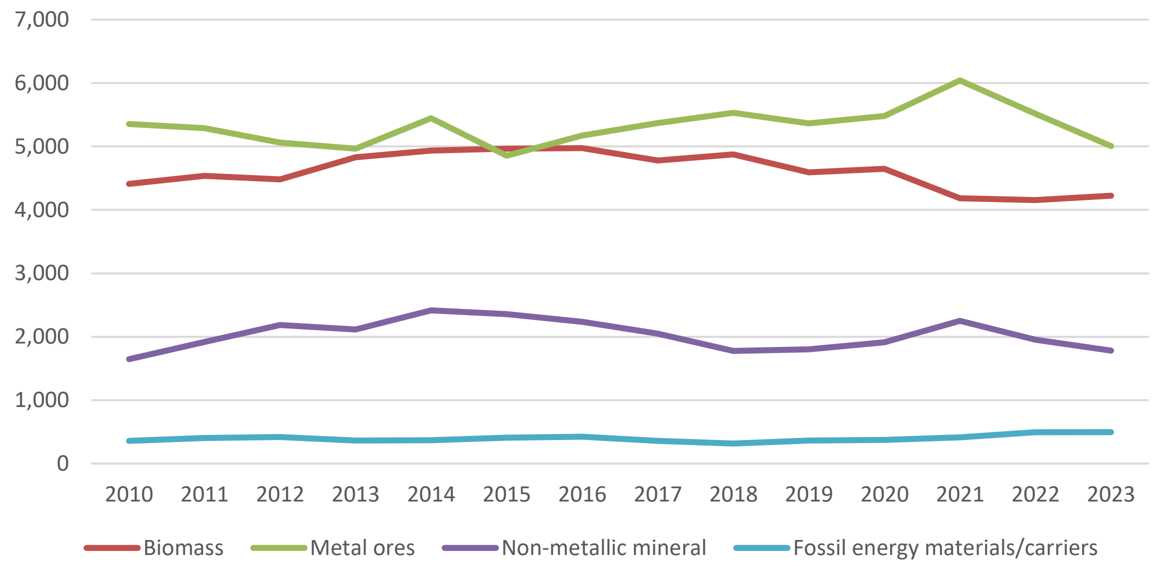

Figure 4: Materials going through imports of waste for recycling in Belgium from 2010 to 2023,in thousand tonnes. Source: Eurostat (env_ac_mfa, env_ac_sd, env_wassd)

Eurostat calculates these numbers using Combined Nomenclature (CN) codes to identify types of waste products destined for recycling[2]. Using Eurostat's database on international trade in goods statistics[3], developed by Eurostat, the weight of waste products for recycling imported can be calculated. These products are then classified according to their material content (biomass, metal ores, fossil energy materials/carriers or non-metallic minerals) and their weight is adjusted with a Material Flow (MF) factor to represent the actual material content of a product[4]. Using these datasets, the weight of products accounting for these material imports could be calculated per material category.

The products that are imported into Belgium in 2023, containing biomass and metal ores, are shown in **Error! Reference source not found.** and **Error! Reference source not found.**, respectively. This fi gure shows the share that these products account for in the total weight of biomass and metal ores imported. For example, almost half of metal ores imported into Belgium, that go through waste destined for recycling, go through "waste and scrap of iron and steel, not fragmentised "shredded", not in bundles" products (47.9%). Products containing biomass that account for the largest share in its total imports are products such as "Old and unsold newspapers and magazines, telephone directories, brochures and printed advertising material" (25.7%), "Wood waste and scrap (excl. sawdust)" (14.6%) and recovered "waste and scrap paper or paperboard of unbleached kraft paper, corrugated paper or corrugated paperboard" (14.23%).

[2] Eurostat. (2024). *List of CN codes used to approximate imports and exports of waste destined for recycling* (Annex). Retrieved from https://ec.europa.eu/eurostat/cache/metadata/Annexes/env_ac_sd_esms_an_1.pdf
[3] Eurostat. (n.d.). *COMEXT database: International trade in goods statistics*. Retrieved from https://ec.europa.eu/eurostat/comext
[4] European Commission. (2018). *Economy-wide Material Flow Accounts Handbook*. Publications Office of the European Union. https://doi.org/10.2762/26244

CN code	Description of CN-code (label)	% of total biomass imported
47073010	Old and unsold newspapers and magazines, telephone directories, brochures and printed advertising material	25.65 %
44014900	Wood waste and scrap, not agglomerated (excl. sawdust)	14.57 %
47071000	Recovered "waste and scrap" paper or paperboard	14.23 %
47079010	Unsorted, recovered "waste and scrap" paper or paperboard (excl. paper wool)	9.34 %
47073090	Waste and scrap of paper or paperboard made mainly of mechanical pulp	7.41 %
53013000	Flax tow and waste, incl. yarn waste and garneted stock	6.16 %
5119910	Sinews or tendons of animal origin, parings and similar waste of raw hides or skins	5.50 %
47079090	Sorted, recovered "waste and scrap" paper or paperboard	5.13 %
44014100	Sawdust, not agglomerated	3.07 %
/	Other	8.95 %

Table 1: Percentage of total biomass imported into Belgium for waste and recycling expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

CN code	Description of CN-code (label)	% of total metal ores imported
47073010	Old and unsold newspapers and magazines, telephone directories, brochures and printed advertising material	25.65 %
44014900	Wood waste and scrap, not agglomerated (excl. sawdust)	14.57 %
47071000	Recovered "waste and scrap" paper or paperboard	14.23 %
47079010	Unsorted, recovered "waste and scrap" paper or paperboard (excl. paper wool)	9.34 %
47073090	Waste and scrap of paper or paperboard made mainly of mechanical pulp	7.41 %
53013000	Flax tow and waste, incl. yarn waste and garneted stock	6.16 %
5119910	Sinews or tendons of animal origin, parings and similar waste of raw hides or skins	5.50 %
47079090	Sorted, recovered "waste and scrap" paper or paperboard	5.13 %
44014100	Sawdust, not agglomerated	3.07 %
/	Other	8.95 %

Table 2: Percentage of total metal ores imported into Belgium for waste and recycling expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Concerning non-metallic minerals, Belgium's import of these materials in 2023 mainly consisted of cullet and other waste and scrap of glass (40.3%), followed by slags and ashes containing lead, copper, tin, aluminium and other metals. Fossil energy materials and carriers accounted for the smallest share of total material imports over the past decade in Belgium. In 2023, Belgium's import of this material mainly consisted of plastic and oil-derived waste. The largest flows were waste and scrap of polymers of ethylene, propylene, and other plastics, as well as waste oils from petroleum and bituminous minerals. Smaller import streams included worn clothing and textile products, used rubber tyres, and waste from acrylic and polypropylene fibres.

Imports excluding waste destined for recycling

When examining imports excluding imports of waste destined for recycling, the largest share consists of fossil energy materials or carriers, as shown in Figure 5. Biomass is the second largest category and has increased since 2015. The imported weight of metal ores, non-metallic materials, and other products has remained relatively stable over the years, despite a slight decline over the past decade. Imports categorising as waste for final treatment and disposal only made up a minor part of total material imports, with imports ranging from 9 thousand tonnes to 107 thousand tonnes per year. The imports of fossil energy materials/carriers have increased steeply since 2021, compared to the trend lines of other materials being imported. The imported products containing these different materials are shown in tables Table 3 to Table 6.

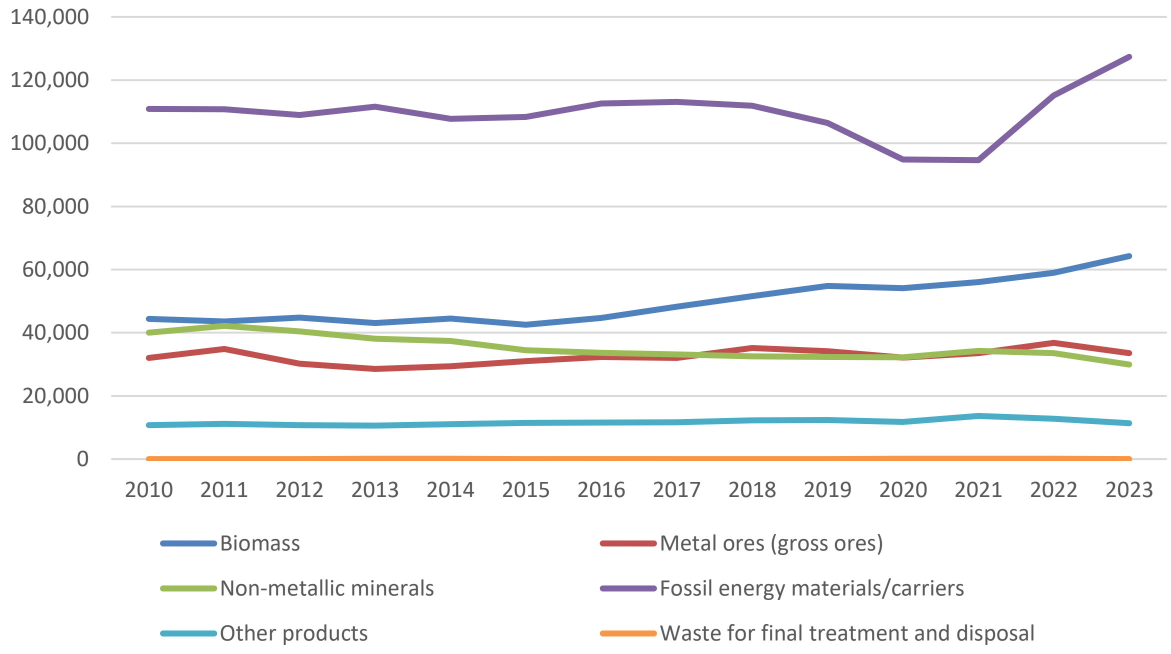

Figure 5: Materials going through imports, excluding imports of waste for recycling in BE from 2010 to 2023, in thousand tonnes.
Source: Eurostat (env_ac_mfa, env_ac_sd, env_wassd)

The tables below present, for each material category, the nine products that together account for the largest share of the total weight of imports, excluding imports of waste destined for recycling. These figures were calculated using the same methodology discussed in the previous subsection on imports of waste destined for recycling.

Biomass imports

The largest share of imports containing biomass is accounted for by the category "Other products" (72.4%), indicating that there is a wide variety of different products containing biomass. The largest identifiable product groups are "Potatoes, fresh or chilled" (6.6%), "Low erucic rape or colza seeds" (4%) and "Wheat and meslin (excl. seed for sowing, and durum wheat)" (3.8%).

CN code	Description of CN-code (label)	% of total biomass imported

7019090	Potatoes, fresh or chilled (excl. new potatoes from 1 January to 30 June, seed potatoes and potatoes for manufacture of starch)	6.61 %
12051090	Low erucic rape or colza seeds	4.01 %
10019900	Wheat and meslin (excl. seed for sowing, and durum wheat)	3.77 %
10039000	Barley (excl. seed for sowing)	2.76 %
10059000	Maize (excl. seed for sowing)	2.69 %
22019000	Ordinary natural water, not containing added sugar, other sweetening matter or flavoured; ice and snow	2.23 %
23040000	Oilcake and other solid residues, whether ground or in the form of pellets, resulting from the extraction of soya-bean oil	2.12 %
8039010	Bananas, fresh (excl. plantains)	1.78 %
44032310	Sawlogs of fir "Abies spp." and spruce "Picea spp."	1.69 %
/	Other	72.35 %

Table 3: Percentage of total biomass imported into Belgium, excluding imports of waste for recycling, expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Metal ores imports

The largest share of imports containing metal ores consists of non-agglomerated iron ores and concentrates (13.2%), followed by agglomerated iron ores (5.8%) and semi-finished products of iron or non-alloy steel (5.3%). Other significant import flows are flat-rolled steel products (4.0%) and zinc ores and concentrates (2.9%). Imports of electric motor vehicles also make up a small part of total metal imports (2.2%). The category "Other products" accounts for 62.1% of total metal ore imports, indicating that similarly to imports containing biomass, the products imported containing metal ores are also fragmented.

CN code	**Description of CN-code (label)**	**% of total metal ores imported**
26011100	Non-agglomerated iron ores and concentrates (excl. roasted iron pyrites)	13.20 %
26011200	Agglomerated iron ores and concentrates (excl. roasted iron pyrites)	5.75 %
72071210	Semi-finished products of iron or non-alloy steel, containing by weight < 0,25 of carbon	5.29 %
72104900	Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, hot-rolled or cold-rolled "cold-reduced"	3.97 %
26080000	Zinc ores and concentrates	2.87 %
87038010	Motor cars and other motor vehicles principally designed for the transport of <10 persons, incl. station wagons and racing cars, with only electric motor for propulsion, new	2.22 %
72091690	Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, in coils	1.68 %
72139149	Bars and rods, hot-rolled, of iron or non-alloy steel, in irregularly wound coils, containing by weight > 0,06% and < 0,25% of carbon	1.53 %
87034010	Motor cars and other motor vehicles principally designed for the transport of <10 persons, incl. station wagons and racing cars	1.38 %
/	Other products	62.11 %

Table 4: Percentage of total metal ores imported into Belgium, excluding imports of waste for recycling, expressed in products in 2023.

Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Non-metallic minerals imports

When looking at non-metallic minerals, the largest share of imports consists of natural sands (30.2%) followed by pebbles and gravel (8.4%). Products accounting for a smaller share in imports include cement clinkers (4.3%), silica and quartz sands (3.4%) and granulated slag from steel manufacturing (2.7%). Fertilisers such as urea (2.4%) and ammonium sulphate (2.3%) also play a role in mineral imports. A large share (41.7%) of imports falls again under "Other products".

CN code	**Description of CN-code (label)**	**% of total minerals imported**
25059000	Natural sands of all kinds, whether or not coloured	30.19 %
25171010	Pebbles and gravel for concrete aggregates, for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated	8.38 %
25231000	Cement clinkers	4.26 %
25051000	Silica sands and quartz sands, whether or not coloured	3.42 %
26180000	Granulated slag "slag sand" from the manufacture of iron or steel	2.73 %
31021010	Urea, whether or not in aqueous solution, containing > 45% nitrogen in relation to the weight of the dry product	2.44 %
31022100	Ammonium sulphate	2.32 %
25084000	Clays (excl. fireclay, bentonite, kaolin and other kaolinic clays and expanded clay)	2.28 %
25171080	Broken or crushed stone, for concrete aggregates, for road metalling or for railway or other ballast, whether or not heat-treated	2.28 %
/	Other products	41.69 %

Table 5: Percentage of total non-metallic minerals imported into Belgium, excluding imports of waste for recycling, expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Fossil energy materials/carriers imports

Fossil energy imports mainly consist of petroleum oils and oils obtained from bituminous minerals, crude (23.2%) and natural gas in gaseous state (17.8%). Other major import flows include gas oils (7.5%), liquefied natural gas (5.5%) and light oils and preparations (4.1%). Imports of special spirits from petroleum, coal tar distillation oils, and jet fuel together make up around 6% of total fossil energy imports. The "Other" category represents 34.4% of the total.

CN code	**Description of CN-code (label)**	**% of total fossil energy imported**
27090090	Petroleum oils and oils obtained from bituminous minerals, crude (excl. natural gas condensates)	23.15 %
27112100	Natural gas in gaseous state	17.80 %
27101943	Gas oils of petroleum or bituminous minerals, with a sulphur content of <= 0,001% by weight	7.48 %
27111100	Natural gas, liquefied	5.54 %

27101290	Light oils and preparations, of petroleum or bituminous minerals, n.e.s.	4.08 %
27101225	Special spirits (excl. white spirit) of petroleum or bituminous minerals	2.49 %
27079999	Oils and other products of the distillation of high temperature coal tars and similar products in which the weight of the aromatic constituents exceeds that of the non-aromatic constituents, n.e.s.	1.88 %
27101211	Light oils of petroleum or bituminous minerals for undergoing a specific process	1.62 %
27101921	Jet fuel, kerosene type	1.55 %
/	Other products	34.40 %

Table 6: Percentage of total fossil energy materials/carriers imported into Belgium, excluding imports of waste for recycling, expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

"Other products" and "waste for final treatment and disposal" imports

The "other products" category mainly consists of a wide variety of chemical and industrial products that include multiple material categories. These include for example, industrial chemicals, cleaning and personal care products, pharmaceuticals and other various substances. They do not fall under specific material categories such as biomass, metal ores, non-metallic minerals or fossil energy materials/carriers because they are composed of multiple materials. Although this is common issue for most manufactured products, still many products can be allocated to a single material category based on material composition in which one material category clearly jumps out. For some products this is not the case, and these are allocated to this "other products" category.

Lastly, the imports of waste for final treatment and disposal account for a relatively small share in material imports in Belgium. This category was in 2023 dominated by municipal waste, which makes up over half of total imports. Sewage sludge and chemical industry wastes follow, together accounting for most of the imports. Other streams, such as residual chemical products, solvents and clinical waste, represent only a small share.

EXPORTS (EXP)

Figure 6 shows the evolution of exports from Belgium from 2010 to 2024, distinguishing between exports excluding waste for recycling and exports of waste for recovery/recycling. Exports excluding waste for recycling remain relatively stable over time, with a temporary decline around 2020 followed by a recovery and a peak around 2023. Exports of waste for recovery/recycling account for a much smaller share of total exports but vary more year to year, increasing until around 2020–2021 before declining slightly.

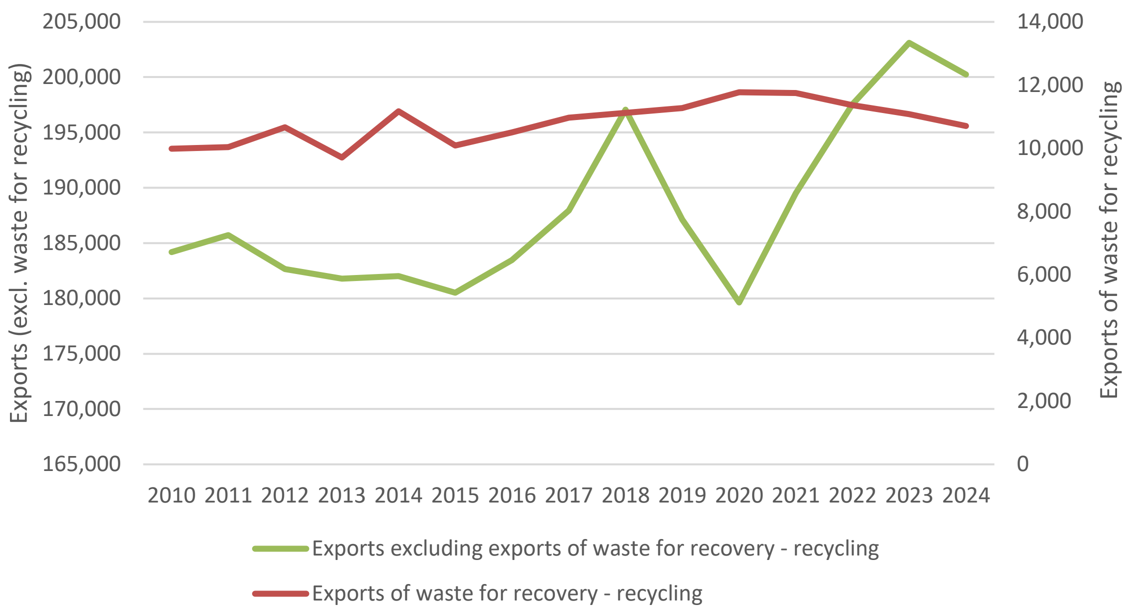

Figure 6: Flows going into exports in Belgium from 2010 to 2024, in thousand tonnes.
Source: Eurostat (env_ac_mfa, env_ac_sd, env_wassd)

Exports of waste for recycling

Figure 7 zooms in on the materials that are going through exports of waste for recycling in Belgium from 2010 to 2024. Similar to imports, biomass and metal ores consistently account for the largest share of exported waste for recycling over the observed period. Export volumes of these two material categories vary over time but remain higher than those of non-metallic minerals and fossil energy materials/carriers throughout the entire period. Biomass exports remain relatively stable over time, while exports of metal ores fluctuate more strongly, with declines around 2013 and 2015 followed by a recovery and peak around 2021, after which volumes decrease slightly. By contrast, exports of non-metallic minerals and fossil energy materials/carriers are considerably lower, with non-metallic minerals showing a gradual upward trend since 2010, while fossil energy materials/carriers consistently account for the smallest share of waste exports for recycling.

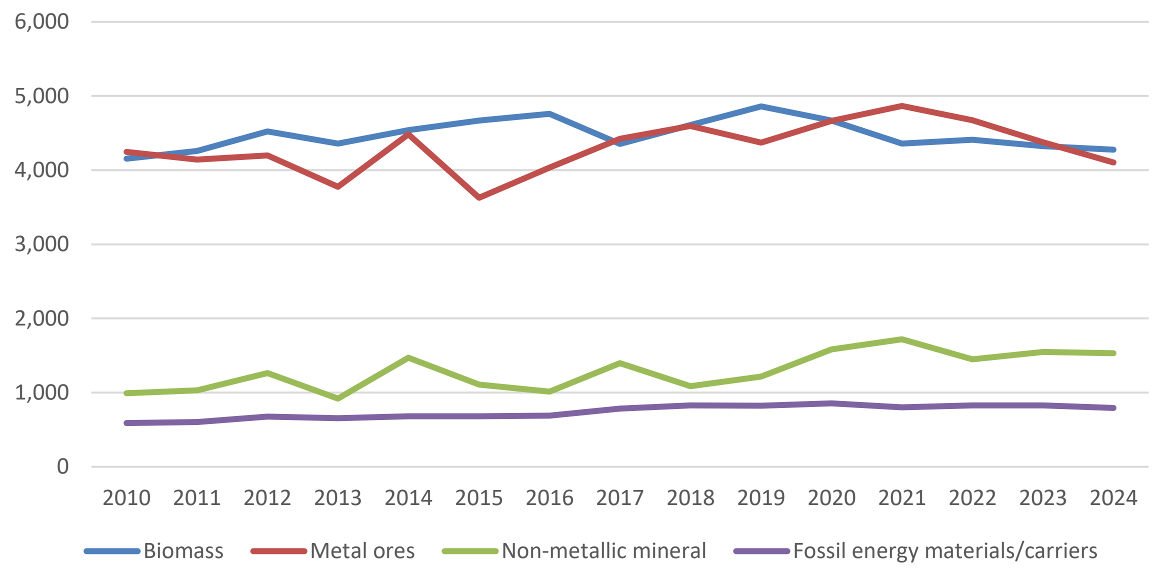

Figure 7: Materials going through exports of waste for recycling in Belgium from 2010 to 2024, in thousand tonnes. Source: Eurostat (env_ac_mfa, env_ac_sd, env_wassd)

Similar to the analysis of materials going through imports (both excluding exports of waste for recycling and only exports of waste for recycling), a deep dive on what products contain the exported materials that are presented in Figure 7 was done for the two largest exported material categories, namely biomass and metal ore products. The same methodology was applied as described in the *Imports (IMP)* section.

The products exported from Belgium in 2023 containing biomass and metal ores are presented in Table 7 and Table 8, respectively, showing their share in the total weight of waste exported for recycling. Exports of metal ores are highly concentrated, with more than half consisting of waste and scrap of iron or steel, not fragmentised ("shredded"), not in bundles (54.61%), followed by waste and scrap of stainless-steel containing ≥ 8% nickel (18.88%), while all other metal-containing products account for relatively small shares. Biomass exports are more diversified but are dominated by paper- and cardboard-based materials, with recovered waste and scrap paper or paperboard of unbleached kraft or corrugated paper representing 41.37% of total biomass exports, followed by sorted recovered paper and paperboard (16.94%), and smaller contributions from mechanical pulp-based paper waste, flax tow and waste, and wood waste and scrap.

CN code	**Description of CN-code (label)**	**% of total biomass exported**
47071000	Recovered "waste and scrap" paper or paperboard of unbleached kraft paper, corrugated paper or corrugated paperboard	41.37 %
47079090	Sorted, recovered "waste and scrap" paper or paperboard	16.94 %
26190020	Waste from the manufacture of iron or steel suitable for the recovery of iron or manganese	8.43 %
47073090	Waste and scrap of paper or paperboard made mainly of mechanical pulp	7.92 %
53013000	Flax tow and waste, incl. yarn waste and garnetted stock	6.15 %

44014900	Wood waste and scrap, not agglomerated (excl. sawdust)	5.60 %
47072000	Recovered "waste and scrap" paper or paperboard made mainly of bleached chemical pulp, not coloured in the mass	2.43 %
47073010	Old and unsold newspapers and magazines, telephone directories, brochures and printed advertising material	2.29 %
47079010	Unsorted, recovered "waste and scrap" paper or paperboard (excl. paper wool)	2.21 %
/	Other	6.65 %

Table 7: Percentage of total biomass exported from Belgium for waste and recycling expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes

CN code	Description of CN-code (label)	% of total metal ores exported
72044990	Waste and scrap of iron or steel, not fragmentised "shredded", not in bundles	54.61 %
72044910	Waste and scrap of stainless steel, containing by weight >= 8% nickel	18.88 %
76020090	Waste and scrap of iron or steel, fragmentised "shredded"	6.25 %
72043000	Waste and scrap of tinned iron or steel	4.63 %
72044110	Scrap of aluminium	2.65 %
76020019	Waste and scrap of alloy steel	1.73 %
72042900	Waste and scrap of stainless steel (not containing >= 8%)	1.67 %
72042190	Waste and scrap, of copper alloys	1.34 %
74040099	Trimmings and stampings, of iron or steel, not in bundles	1.24 %
/	Other	7.00 %

Table 8: Percentage of total metal ores exported from Belgium for waste and recycling expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes

Exports of non-metallic minerals in 2023 are dominated by a small number of large industrial waste streams, notably waste and scrap of polymers of ethylene (38.5%), followed by slags and residues from metallurgical processes, including zinc- and lead-containing residues and waste from iron and steel manufacturing. Exports of fossil energy materials and carriers mainly consist of glass waste, which represents the largest single stream (54.3%), followed by textile waste, used rubber tyres, and various plastic waste fractions. Overall, these exports are largely composed of polymer-, rubber-, and textile-based materials.

Exports excluding waste destined for recycling

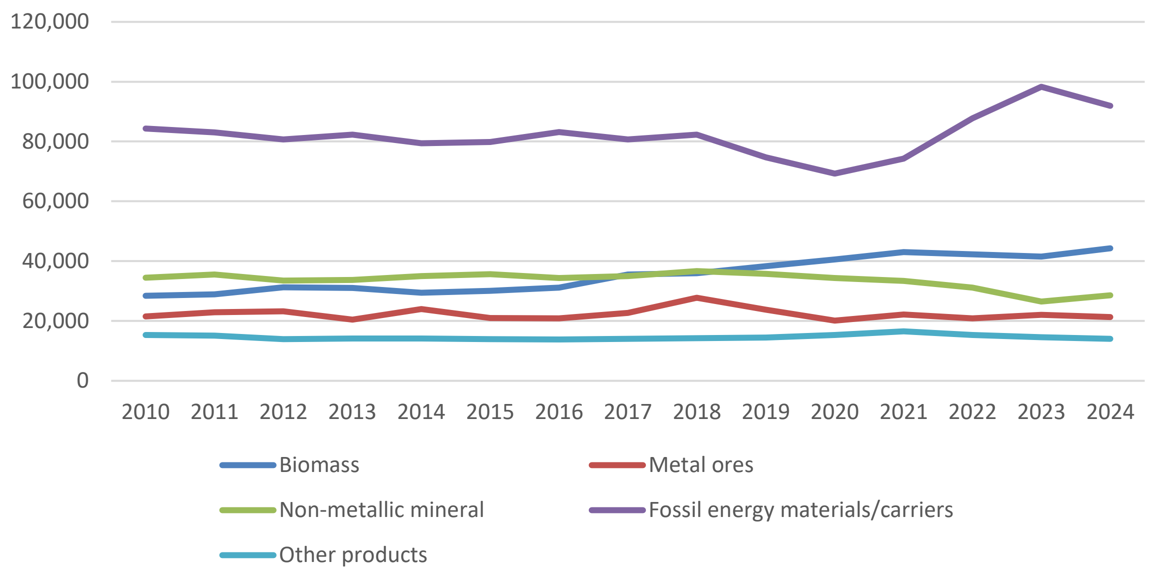

Figure 8: Materials going through exports, excluding exports of waste for recycling in BE from 2010 to 2024, in thousand tonnes.
Source: Eurostat (env_ac_mfa, env_ac_sd, env_wassd)

Figure 8 shows the evolution of material exports from Belgium from 2010 to 2024, excluding exports of waste destined for recycling. Fossil energy materials and carriers consistently account for the largest share of exports over the entire period, despite a decline from 2018 to 2020 followed by a strong rebound after 2021. Biomass and non-metallic minerals form the second and third largest export categories, respectively, with biomass exports showing a gradual upward trend, while non-metallic mineral exports remain relatively stable before declining slightly in since 2020. Exports of metal ores are lower and more volatile, while other products represent the smallest export category. The overall material composition of exports is broadly similar to that for imports (Figure 5), although export volumes are consistently lower. The exported products containing these different materials are shown in Table 9 to Table 12.

Biomass exports

Table 9 presents the composition of biomass exports from Belgium in 2023, excluding waste destined for recycling. Biomass exports are highly fragmented, with no single product accounting for the dominant share, as reflected by the large share the category "Other" (72.35%) has. Among the identified products, cooked frozen potatoes (6.61%), animal or vegetable fertilisers (4.01%), and low erucic rapeseed or colza seeds (3.77%) represent the largest individual shares, indicating that exports of biomass products are diverse and dominated by agricultural and food-related products.

CN code	**Description of CN-code (label)**	**% of total biomass exported**
20041010	Cooked potatoes, frozen	6.61 %
31010000	Animal or vegetable fertilisers	4.01 %
12051090	Low erucic rape or colza seeds	3.77 %
7019090	Potatoes, fresh or chilled (excl. new potatoes from 1 January to 30 June, seed potatoes and potatoes for manufacture of starch)	2.76 %
11071099	Malt (excl. roasted, wheat and flour)	2.69 %
8039010	Bananas, fresh (excl. plantains)	2.23 %

44013100	Wood pellets	2.12 %
23064100	Oilcake and other solid residues, resulting from the extraction of low erucic acid rape or colza seeds	1.78 %
22030001	Beer made from malt, in bottles holding <= 10 l	1.69 %
/	Other	72.35 %

Table 9: Percentage of biomass exported from Belgium, excluding imports of waste for recycling, expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Metal ore exports

Table 10 shows the composition of metal ores exported from Belgium in 2023, excluding waste destined for recycling. Similar to biomass exports, metal ores exports are highly fragmented across product categories, with the "Other" category accounting for 71.21% of total exports. Flat-rolled iron or non-alloy steel products represent the largest individual shares (each below 8%) in metal ore exports, followed by smaller contributions from machinery, vehicles, and zinc-related products.

CN code	**Description of CN-code (label)**	**% of total metal ores exported**
72104900	Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, hot-rolled or cold-rolled "cold-reduced", not corrugated, plated or coated with zinc	7.77 %
84243008	Water cleaning appliances with built-in motor, without heating device	4.20 %
87038010	Motor cars and other motor vehicles principally designed for the transport of <10 persons, incl. station wagons and racing cars, with only electric motor for propulsion, new	3.03 %
72259200	Flat-rolled products of alloy steel other than stainless, of a width of >= 600 mm, hot-rolled or cold-rolled "cold-reduced" and plated or coated with zinc	2.77 %
72091690	Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, in coils, simply cold-rolled "cold-reduced", not clad, plated or coated, of a thickness of > 1 mm but < 3 mm	2.55 %
72107080	Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, hot-rolled or cold-rolled "cold-reduced", painted, varnished or plastic coated	2.20 %
26080000	Zinc ores and concentrates	2.17 %
72082700	Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, in coils, simply hot-rolled, not clad, plated or coated, of a thickness of < 3 mm, pickled, without patterns in relief	2.15 %
72091790	Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, in coils, simply cold-rolled "cold-reduced", not clad, plated or coated, of a thickness of >= 0,5 mm but <= 1 mm (excl. electrical)	1.95 %
/	Other	71.21 %

Table 10: Percentage of metal ores exported from Belgium, excluding imports of waste for recycling, expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Non-metallic mineral exports

Table 11 presents the composition of non-metallic mineral exports from Belgium in 2023, excluding waste destined for recycling. Compared to biomass and metal ores, non-metallic mineral exports are somewhat more concentrated, with construction-related materials such as broken or crushed dolomite and limestone (11.68%), aggregates and gravel (6.58%), and granules and powders of natural stone (6.10%) accounting for the largest individual shares. Nevertheless, nearly half of total exports fall under the "Other" category (46.27%), indicating a still relatively diverse export structure.

CN code	**Description of CN-code (label)**	**% of total minerals exported**
25171020	Broken or crushed dolomite and limestone flux, for concrete aggregates, for road metalling or for railway or other ballast	11.68 %
25171010	Pebbles and gravel for concrete aggregates, for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated	6.58 %
25174900	Granules, chippings and powder, whether or not heat-treated, of travertine, ecaussine, alabaster, basalt, granite, sandstone, porphyry, syenite, lava, gneiss, trachyte and other rocks of heading 2515 and 2516 (excl. marble)	6.10 %
25232900	Portland cement (excl. white, whether or not artificially coloured)	5.82 %
31024010	Mixtures of ammonium nitrate with calcium carbonate or other inorganic non-fertilising substances, for use as fertilisers	5.49 %
31022100	Ammonium sulphate (excl. that in tablets or similar forms, or in packages with a gross weight of <= 10 kg)	5.22 %
25059000	Natural sands of all kinds, whether or not coloured (excl. silica sands, quartz sands, gold- and platinum-bearing sands, zircon, rutile and ilmenite sands, monazite sands, and tar or asphalt sands)	4.74 %
25051000	Silica sands and quartz sands, whether or not coloured	4.16 %
31052010	Mineral or chemical fertilisers containing phosphorus and potassium	3.95 %
/	Other	46.27 %

Table 11: Percentage of non-metallic minerals exported from Belgium, excluding imports of waste for recycling, expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Fossil energy material/carrier exports

Table 12 shows the composition of fossil energy materials and carriers exported from Belgium in 2023, excluding waste destined for recycling. Exports are dominated by refined petroleum products, with petroleum oils obtained from bituminous minerals (20.92%) and natural gas in gaseous state (10.52%) accounting for the largest individual shares. Additional contributions come from various petroleum oils and liquefied gases, while the residual "Other" category still represents a substantial share (39.08%), indicating a relatively diversified export portfolio within fossil energy materials.

CN code	**Description of CN-code (label)**	**% of total fossil energy exported**

27112100	Petroleum oils and oils obtained from bituminous minerals, crude (excl. natural gas condensates)	20.92 %
27101943	Natural gas in gaseous state	10.52 %
27101290	Gas oils of petroleum or bituminous minerals, with a sulphur content of <= 0,001% by weight (excl. containing biodiesel, and for undergoing chemical transformation)	9.10 %
27079999	Natural gas, liquefied	5.34 %
27101241	Light oils and preparations, of petroleum or bituminous minerals, n.e.s. (excl. containing biodiesel, for undergoing chemical transformation, and special spirits, motor spirit and spirit type jet fuel)	4.08 %
27101947	Special spirits (excl. white spirit) of petroleum or bituminous minerals	3.36 %
27101962	Oils and other products of the distillation of high temperature coal tars and similar products in which the weight of the aromatic constituents exceeds that of the non-aromatic constituents, n.e.s.	3.01 %
27101921	Light oils of petroleum or bituminous minerals for undergoing a specific process	2.70 %
27101245	Jet fuel, kerosene type	1.88 %
/	Other	39.08 %

Table 12: Percentage of fossil energy materials/carriers exported from Belgium, excluding imports of waste for recycling, expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes.

Data sources and data gaps

Data regarding the import of materials is well documented and is mainly available through Eurostat's Economy-Wide Material Flow Accounts (EW-MFA). The composition and evolution of material imports to Belgium can be consulted, distinguishing between imports of waste for recycling and other imports. Available data shows import flows by material type (biomass, metals, non-metallic minerals and fossil energy materials/carriers). Linking Eurostat's list of CN codes classified by material type with import data from Eurostat's COMEXT database, we were able to see what products accounted for the most imported weight per material category.

It is important to note, however, to use caution when using the most recent data, as errors may still be present and corrections are often made in the following years. Moreover, the use of CN codes and applying MF factors to classify products according to their material content can be limiting, as these do not always correspond directly to the full material composition of products. For example, a car is classified as a single material category (metal ores), but it consists of many different materials beyond metals, such as non-metallic minerals (glass for windows and mirrors) or fossil-based materials (plastics and rubbers). This could possibly result in an over- or underestimation of material import.

Additionally, the import data only covers international statistics. For Belgium, there are no interregional statistics available to assess trade between regions. Interregional input-output models developed by the Federal Planning Bureau of Belgium provides an estimation, but much detail is lost due to the aggregation of products and sectors.

Additional indicators and alternative data sources

Material import dependency

The material import dependency, as calculated by Eurostat, expresses the share of import in total direct material inputs in percentage. The indicator reflects the degree to which an economy depends on imported materials to satisfy its overall material needs. Its values range from 0% to 100%, with values equal to 100% indicating a complete reliance on imports and no domestic extractions of the material. Figure 9 shows the material import dependency for Belgium from 2010 to 2023. As can be seen, the indicator has a value of 100% for metal ores and fossil energy materials/carriers, indicating no domestic extraction of these materials. The domestic extraction of materials will be discussed in more detail in the following section. The import dependency of non-metallic minerals decreased slightly over the years, from 41.7% in 2010 to 38.6% in 2023, which can be attributed to the decreasing imports of this material as depicted in Figure 5, or a decreasing societal or industrial need. The import dependency of biomass, on the other hand, increased from 57.3% in 2010 to 64.8% in 2023, showing an increased dependency. This increased dependency is strengthened by the 60.4% increase in imports of the material between 2010 and 2023 (Figure 5).

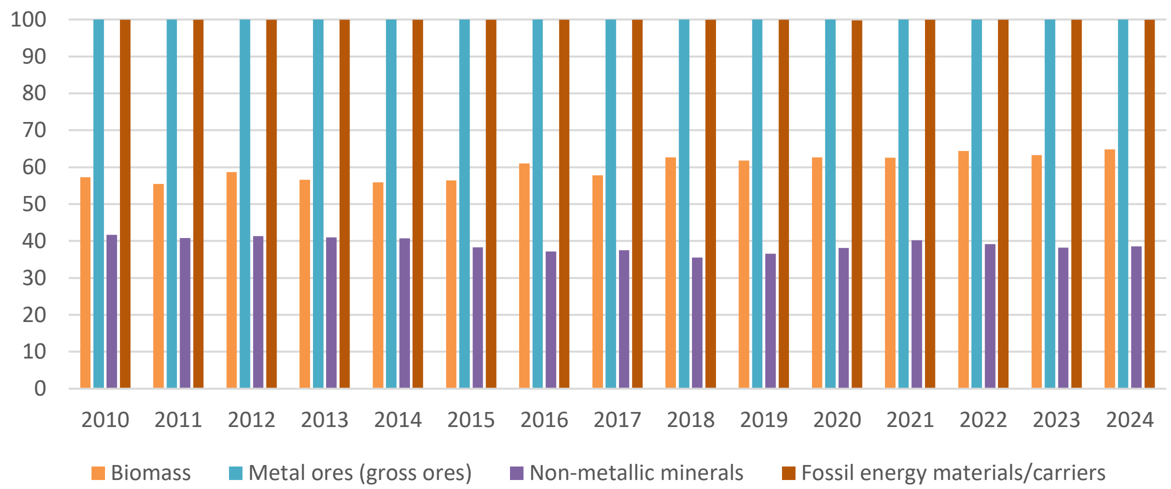

Figure 9: Material import dependency indicator for Belgium from 2010 to 2024 (%).
Source: Eurostat (env_ac_mid)

Herfindahl-Hirschman Index (HHI)

Another interesting and widely used indicator for measuring the import dependency of a nation for each good is the Herfindahl-Hirschman Index (HHI). To calculate the HHI for each good, the sum of the squares of the shares of the countries in Belgian imports (expressed as a fraction of 1) is taken. In the most extreme case, the good is imported from only one country (n=1), and the HHI will be equal to 1. The more concentrated the imports are, the closer the HHI will be to 1, and the greater the dependency on a limited number of countries.

$$HHI = \sum_{i=1}^{n} (share\ in\ imports_n)^2 \qquad (countries: 1 \ldots n) \qquad 0 \leq HHI \ \leq 1$$

The Federal Planning bureau of Belgium calculated these numbers for the period between 2014 and 2023[5] and determined for each good how dependent they are on import. The report finds that Belgium's trade dependency on non-EU countries remained relatively stable between 2014 and 2023. However, a notable shift occurred, China emerged as the primary source for the highest number of goods with a strong import dependency, surpassing the United States (US). The US still comes in second, followed by the United Kingdom (UK). Belgium is especially reliant on China for the imports of electronics and machinery, and on the US for pharmaceuticals and chemicals.

A possibility would be to use the results from this report to assess the import dependency per material category rather than per product. This could be done by classifying each product (expressed in CN codes) according to their material content and adjusting their imported weight with a Material Flow (MF) factor to represent the actual material content of a product, according to the methodology developed by Eurostat[6].

DOMESTIC EXTRACTION (DE)

Domestic Extraction (DE) refers to the quantity of material resources extracted from the natural environment by resident production units, encompassing the use of natural resources.

Biomass

Domestic extraction of biomass tracks the flow of cultivated and non-cultivated biomass from the environment to the economy. Non-cultivated biomass (e.g., wild fish catch, hunting, logging from natural forests) is measured directly at the boundary between the environment and economy. For cultivated biomass, the "harvest approach" is used, treating cultivated forests and agricultural plants as part of the environment. In the EW-MFA framework, biomass is recorded at the point of harvest, not during growth, indicating that the cultivation of animals and fish is not regarded as domestic extraction.

[5] Dumont, M., Michel, B., & Rayp, G. (2024, December). *De Belgische in- en uitvoerafhankelijkheid van niet-EU-landen* (Working Paper 2024/13). Federaal Planbureau. https://www.plan.be/sites/default/files/documents/WP202413_13021_NL.pdf

[6] European Commission. (2018). *Economy-wide Material Flow Accounts Handbook*. Publications Office of the European Union. https://doi.org/10.2762/26244

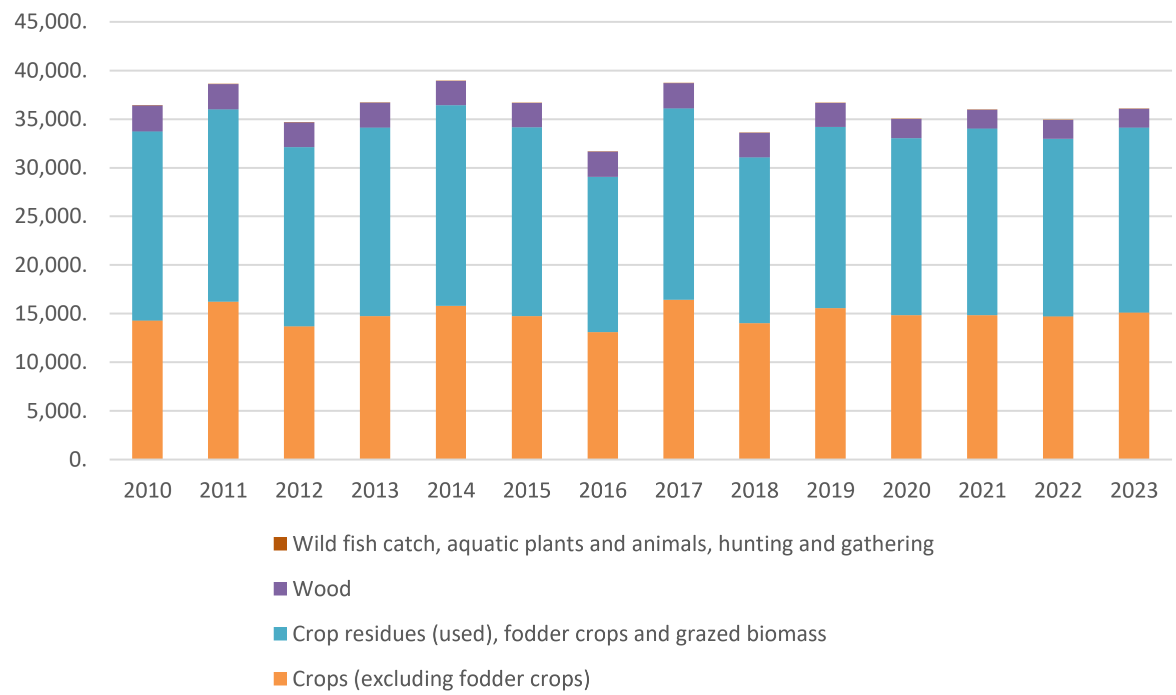

Figure 10: Domestic extraction of biomass in Belgium between 2010 and 2023, in thousand tonnes. Source: Eurostat (env_ac_mfa)

Figure 10 shows the domestic extraction of the different biomass categories for Belgium from the period of 2010 to 2023. It remained relatively stable over the years, fluctuating between 31,000 and 39,000 thousand tonnes per year. The largest share consistently comes from crop residues, fodder crops and grazed biomass, followed by crops (excluding fodder crops) while wood and wild fish catch only contribute marginally.

Uncertainties or inconsistencies

Biomass produced by households for own consumption and biomass waste from parks, infrastructure areas, and gardens cannot be included due to a lack of data. While these streams should be part of DEU if used in the economy (e.g., for food or energy production), no data is currently available to account for them.

Note that cultivated livestock (e.g. cows, pigs) is not a natural input and hence excluded from the economy-wide material flow accounts domestic extraction. In economy-wide material flow accounts, the category biomass deliberately excludes cultivated livestock to prevent double counting, consistent with the harvest approach. Under this approach, only the primary biomass harvested from the environment—such as crops, wood, or grazed biomass—is recorded as an input. Livestock, on the other hand, is considered a stock within the economy, not a direct extraction from nature. Including animals themselves as biomass inputs would lead to double counting because the feed they consume (crops, grazed biomass, or other biomass inputs) is already captured as harvested biomass. By counting only the biomass actually taken from the environment, economy-wide material flow accounts ensure that material inputs reflect real ecological extractions rather than internal transformations within the economic system.

Data sources

The annual crop production in Belgium is determined based on agricultural data reported by STATBEL. Specifically, the following resources are used: "Definitieve raming van de productie van de landbouwteelten – 2002-2018" and "Tab A: landbouwcijfers 2018 - Resultaten volgens uitgebreide lijst van variabelen: voor België, de Gewesten, de Provincies, de Landbouwstreken." These datasets provide detailed insights into crop production across Belgium, broken down by regions, provinces, and agricultural zones.

The first dataset provides production data for approximately 20 crops, allowing it to be used directly. In contrast, the second dataset requires a conversion step (based on yield figures), as it represents cultivated land area (in acres) for approximately 200 crops. Approximately 60-70% of the total crop production volume (in tonnes) is covered by the first source, as it includes the most significant crops in terms of production volume. Similarly, for fodder crops and grazed biomass, a supply-side approach is applied, utilizing pasture area, provided by STATBEL, multiplied by pasture yield.

Data on non-cultivated biomass, such as wild fish catch, aquatic plants/animals and hunting and gathering is made available via the Federal Planning Bureau of Belgium and accessible via Eurostat. However, these figures are calculated separately by each Belgian regional entity's environmental institute: Research Institute for Nature and Forest (INBO) for the Flemish region, the 'Institut de Conseil et D'études en Dévelopment Durable' (ICEDD) for the Walloon region and 'Leefmilieu Brussel' for the Brussels-Capital region.

Domestic extraction in relation to wood considers the biomass harvested from cultivated (and non-cultivated) forest. The domestic extraction of wood is **estimated** using the total forest area (in ha), a harvest factor and a density factor. The forest area in Belgium can derived from STATBEL (land use according to cadastral area).

Non-metallic minerals

The EW-MFA aims to measure the domestic extraction of non-metallic minerals based on the run-of-mine amount, at the point where the material transitions from the natural environment to the national economy. This refers to the total quantity of material extracted directly from a mine or quarry before any processing, sorting or beneficiation. In terms of non-metallic minerals, it is assumed that the quantities extracted and those leaving the quarry as ready-to-sale products differ only slightly. Since official statistics often only reflect quarrying production output, these can be used as an approximation for run-of-mine amounts[7].

[7] Christis, M., Vercalsteren, A. (2020). *Macro-economic material flow indicators for Flanders 2002-2018.* CE Centre Publication No. 11. VITO. https://publicaties.vlaanderen.be/view-file/47476

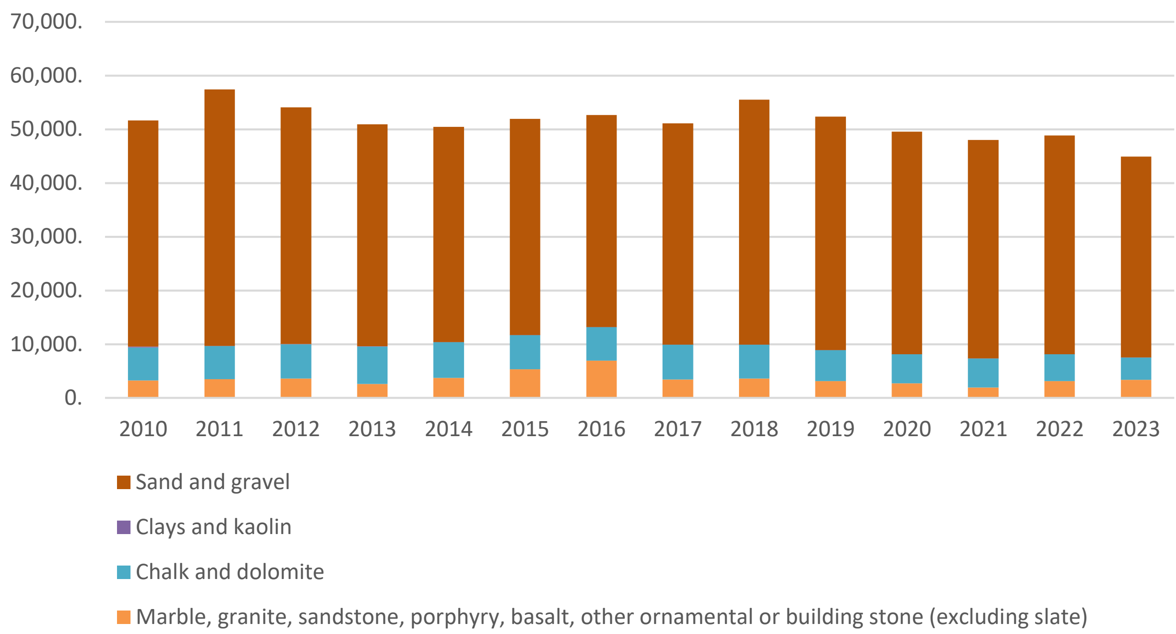

Figure 11: Domestic extraction of non-metallic minerals in Belgium between 2010 and 2023, in thousand tonnes. Source: Eurostat (env_ac_mfa)

Belgium's domestic extraction of non-metallic minerals between 2010 to 2023 ranged from roughly 44,900 thousand tonnes in 2023 to 57,400 thousand tonnes in 2011, as depicted in Figure 11. It fluctuated over time, but it shows a decreasing trend since 2018. Most of this extraction comes from sand and gravel, while chalk and dolomite, ornamental or building stones (e.g. marble and granite), and clays and kaolin make smaller contributions. Slate, limestone and gypsum, salt, as well as chemical and fertilizer minerals are not extracted in Belgium.

Data sources

At the Belgian level, STATBEL annually reports production data representing the production values by the main activity of the establishments. This data is structured according to the NACE, CPA and Prodcom classifications[8].

Primary non-metallic minerals extracted in Flanders[9] include sands, quartz sand, clay, loam and gravel. Additionally, a limited amount of Balegem stone (a type of natural stone) is extracted in a single quarry in Flanders. Quartz sand is also mined by a single company, albeit at multiple locations. Due to data limitations, Balegem stone is not included and for quartz sand the available data is provided by consumers but should be considered incomplete. Data is provided by the annual reports on MDO 'monitoringsysteem duurzaam oppervlaktedelfstoffenbeleid'. These reports include data for most years, missing years are estimated through intra- and extrapolation.

In Walloon, aggregates (limestone, dolomite, sandstone and porphyry), marble, granite, basalt, chalk, and sand are mined[10].

[8] https://statbel.fgov.be/nl/themas/ondernemingen/industriele-productie#fig
[9] https://omgeving.vlaanderen.be/nl/primaire-delfstoffen
[10] Indicateurs de flux de matières - État de l'environnement wallon

Additional indicators and alternative data sources

As an additional indicator, the VBO (Verbond van Belgische Ondernemingen) proposed including an indicator for the sustainable extraction of primary materials within Belgium and to assess the extent to which Belgium reserves their own primary raw materials for applications for which no (secondary) alternative raw materials are available. However, due to the absence of data at the national level, this indicator was excluded from their indicator dashboard for the monitoring of circular economy in Belgium.

Indicators that should also be considered when looking at Domestic Extraction, are indicators on import reliance. These have already been addressed under the "Import" section of this report.

Metals and fossil-based energy carriers

The extraction of metal ores and fossil-based energy carriers is non-existent in Belgium.

DIRECT MATERIAL INPUT AND RAW MATERIAL INPUT

According to Eurostat, Direct Material Input (DMI) represents the total material directly introduced into the economy. It is calculated as the sum of domestic extraction and imports. DMI encompasses all materials of economic value that are available for use in production (e.g., manufacturing) and consumption (e.g., the purchase of manufactured goods). Figure 12 presents the composition of Belgium's DMI between 2010 and 2023. It shows that imports constitute the largest share of DMI, while domestic extraction remains comparatively little and stable over time. However, direct material input does not account for the consumption of raw materials and resources throughout the supply chain, making it less robust against outsourcing.

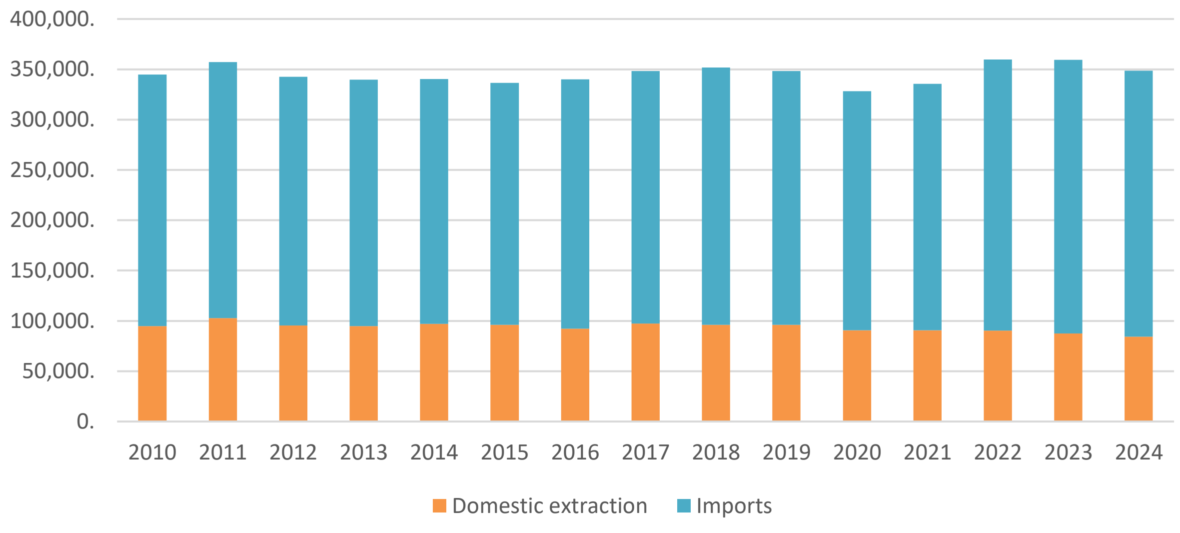

Figure 12: Composition of Belgium's Direct Material Input between 2010 and 2023, in thousand tonnes.
Source: Eurostat (env_ac_mfa)

For this reason, the Raw Material Input (RMI) is considered which represents the material footprint of the national economy, capturing its complete material basis, including upstream supply chains abroad. This footprint allows for an assessment of the global material impact of the economy and highlights the extent to which its material basis is outsourced to other countries. Figure 13 presents the RMI of Belgium from the period of 2010 to 2020, which is calculated by the Belgian Federal Planning Bureau and can be consulted on the Eurostat's database. After 2020, the bureau did not calculate the RMI for Belgian anymore.

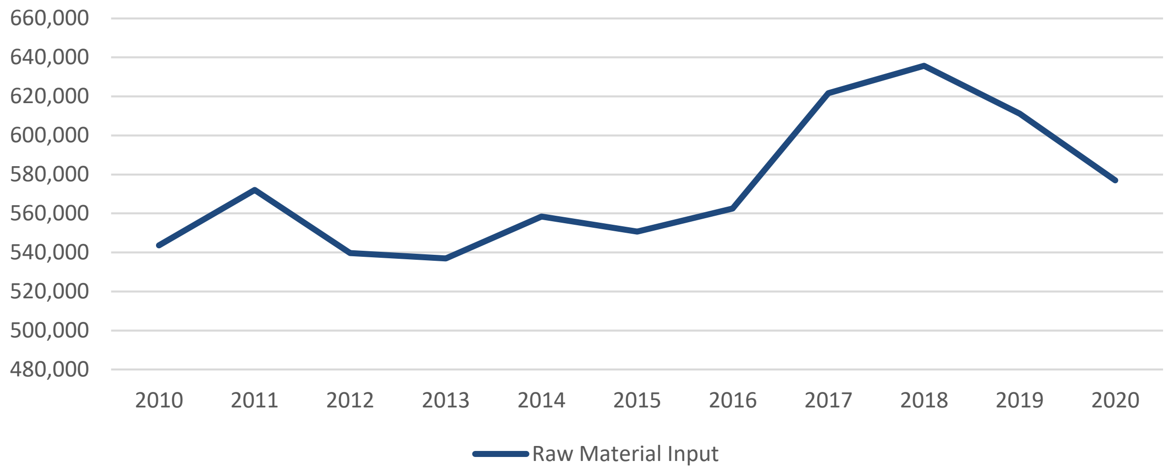

Figure 13: Raw Material Input of Belgium from 2010 to 2020 in thousand tonnes.
Source: Eurostat (env_ac_rme)

Notably, the RMI follows a less stable path than the DMI, showing a steep increase from 2016 (+/- 562,500 thousand tonnes) to 2018 (+/- 635,700 thousand tonnes), to then decrease sharply to 577,000 thousand tonnes in 2020. This indicates that even though domestic extraction and physical imports did not change much from 2010 to 2020, as can be seen in Figure 12, the change in the composition of imports, global supply chains or trade partners influenced the global resource footprints of the Belgian material inputs.

Uncertainties or inconsistencies

Direct Material Input (DMI) is calculated by adding the quantities of imported products to the quantities of domestic extraction (DEU). As such, this indicator is a derived metric and not directly based on statistical data.

To estimate RMI, the direct material inputs are expressed in tons of Raw Material Equivalent (RME) and thus include the indirect use of raw materials (i.e. the rucksack of materials required in the production of the product). The RME-coefficients are estimated by combining national and Eurostat data and enable the conversion of trade flows to RME's. More specifically, Belgian import and export statistics, including trade with EU and non-EU partners, are supplemented with trade in services from the Belgian interregional input-output model (extrapolated from 2010) and specific data from Belgian and European input-output models. The conversion to RME uses 182 aggregated product group coefficients, not individual product-level coefficients, which reduces the reliability of the RMI indicator compared to DMI, as the latter is calculated using more detailed data. The same applies for the domestic and raw material consumption indicators described in the next section.

As the footprint approach inserts many over- and underestimations, the RMI indicators are best expressed using the moving average. This emphasises the trend and not the year-to-year fluctuations in the data of conversion factors.

Data sources and data gaps

Data on Belgium's Direct Material Input is accessible via Eurostat and is calculated by the Federal Planning Bureau. Data on the DMI expressed in raw material equivalents (RMI) is no longer available for Belgium since 2020, as the Federal Planning Bureau does not calculate these numbers anymore. The necessary data to compile these statistics are available from Eurostat economy-wide material flow analysis methodology documentation.

Additional indicators and alternative data sources

Resource productivity

An interesting measure of how well a region is decoupling the use of natural resources with its economic growth is resource productivity. This indicator is traditionally defined as gross domestic product (GDP) relative to domestic material consumption (DMC). The DMC is defined as Direct Material Input minus exports, and even though materials used to produce exported goods are included in the DMC, this indicator does not fully account for the material consumption associated with exports. Therefore, it is also relevant to consider an adjusted resource productivity indicator, with GDP as its numerator but the DMI as denominator. Figure 14 shows the indicator for Belgium in comparison with GDP and DMI, indexed at the year 2010. It demonstrates how the Belgian economy grew with 22.6% between 2010 and 2024, while its material input remained roughly stable. As a result, GDP/DMI nearly doubled, indicating a significant improvement in how efficiently material input, including those that later become exports, are used to generate economic output.

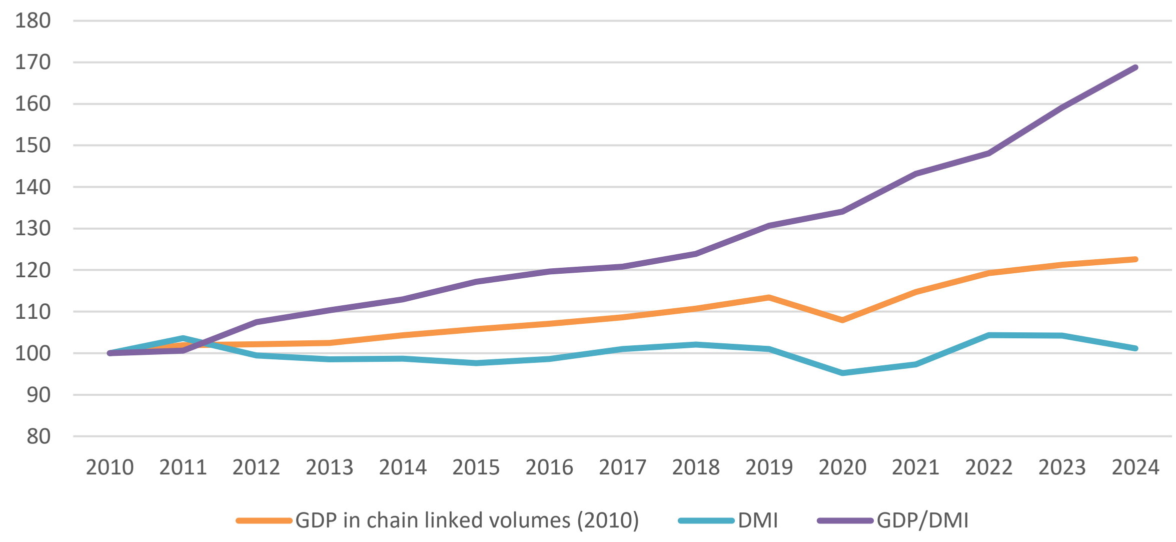

Figure 14: Belgian resource productivity with DMI as denominator, in comparison with GDP and DMI from 2010 to 2024 (Index 2010 = 100).
Source: Eurostat (nama_10_gdp) (env_ac_mfa) (env_ac_rp)

Imports expressed in raw material equivalents

The share of total raw material equivalents relative to directly imported materials (IMP_RME/IMP) represents the material footprint of imported goods, including all raw materials used globally to produce them, compared to their direct physical weight. Intuitively, this indicator shows how many raw materials are needed globally for every kilogram of imports. A high ratio (e.g. close to 2) would represent an economy that mainly imports highly processed goods, thereby outsourcing a large part of its material footprint abroad. A lower ratio would indicate that the country mainly imports raw materials or unprocessed goods, so that the material footprint of the imports more closely reflects the actual physical weight of its imports. Figure 15 shows this indicator for Belgium between 2010 and 2020. Over the decade, the ratio declined from 1.81 to 1.67, reaching its lowest point around 2015 before stabilising. This confirms Belgium’s tendency to import highly processed goods, which is typical for advanced, service-oriented economies.

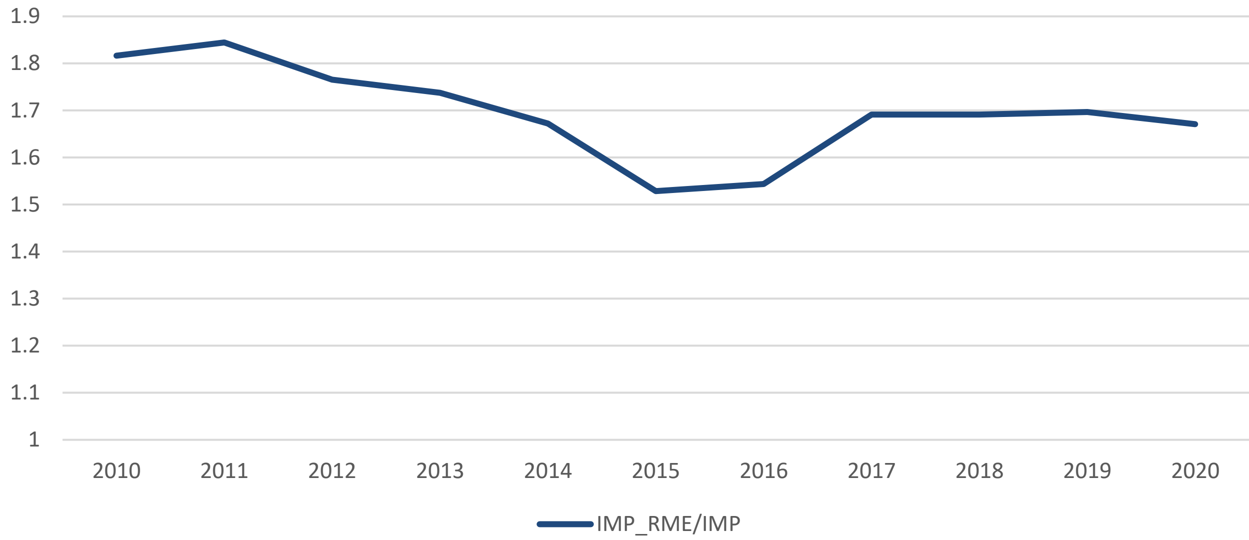

Figure 15: Imports expressed in RME relative to physical imports, from 2010 to 2020, in Belgium.
Source: Eurostat (env_ac_rme, ds-059341)

Exports expressed in raw material equivalents

The share of total raw material equivalents relative to directly exported materials (EXP_RME/EXP) shows how the material footprint of exported goods, including all raw materials used globally to produce them, compares to their direct physical weight. Similar to the IMP_RME/IMP indicator, this ratio indicates how many kilograms of raw materials (globally, but mostly domestically) are required to produce each kilogram of exported goods. A high ratio means that exports require a lot of raw materials to produce before turning into actual exports, while a lower ratio indicates that the economy mainly exports raw materials or less material intensive products. Figure 16 shows this indicator for Belgium between 2010 and 2020. The ratio declined from above 2.0 to around 1.75, reaching its lowest point in 2015 before stabilising. This indicates that Belgium primarily exports processed products, typical of an economy focused on manufacturing and added-value production rather than raw material extraction.

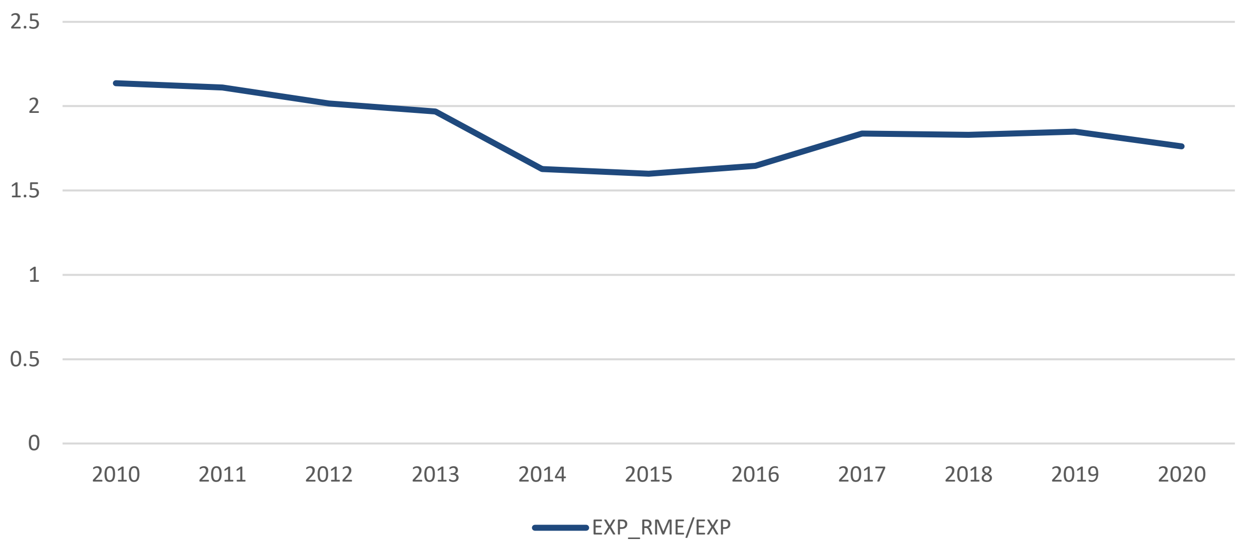

Figure 16: Exports over exports expressed in RME, from 2010 to 2020, in Belgium.
Source: Eurostat (env_ac_rme, ds-059341)

2.2 Use and transformation indicators

Domestic material consumption and raw material consumption

Domestic material consumption (DMC) represents the total quantity of materials directly used within an economy, including biomass, metal ores, fossil energy carriers, and non-metallic minerals. It is calculated as domestic extraction used plus imports minus exports, reflecting the direct apparent consumption of materials while excluding indirect flows. Figure 17 visually represents this composition from 2010 to 2024. Exports of materials are shown as negative values, and domestic extraction and imports as positive. The total domestic material consumption is represented as a line. As can be seen, Belgium’s DMI remained relatively stable over the years despite a small drop in 2020.

Figure 17: Composition of Belgium's Domestic Material Consumption from 2010 to 2024, in thousand tonnes.
Source: Eurostat (env_ac_mfa)

In contrast, the raw material consumption considers indirect flows and measures the total global material use linked to domestic production and consumption activities. More specifically, this indicator includes indirect flows associated with imports while excluding exports and their related indirect flows. Raw material consumption is calculated as DMC plus imports minus exports, all expressed in raw material equivalents (RME). It does not account for hidden flows or unused extraction, such as mining overburden or harvesting losses. Thus, RMC reflects the global quantity of used extraction required to meet domestic final demand.

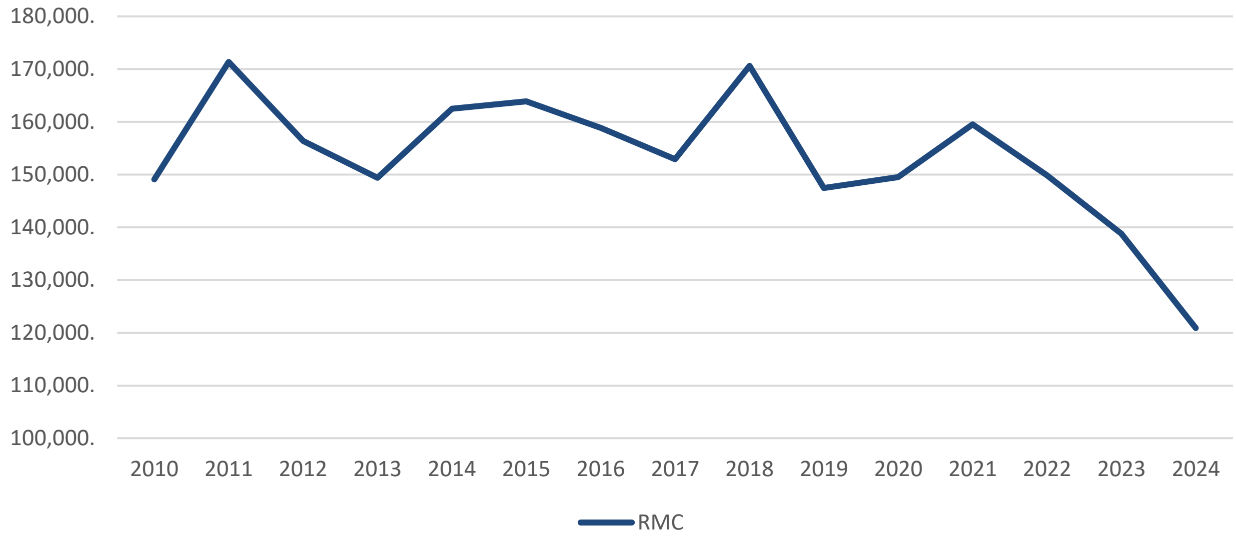

Figure 18: Belgium's Raw Material Consumption (RMC) between 2010 and 2024, in thousand tonnes.
Source: Eurostat (env_ac_rme)

Uncertainties or inconsistencies

Similar to the RMI, the use of RME coefficients to determine the material footprint of trade flows to calculate the RMC introduces some uncertainties as described above.

Data sources and data gaps

The results are available from the Federal Planning Bureau under the theme of material flow accounts for the entire economy, as well as from Eurostat under the theme of economy-wide material flow accounts.

Additional indicators and data sources

Ratio MC/DMC

The RMC/DMC ratio compares a country's total material footprint, expressed in raw material equivalents, to its direct domestic material consumption. It serves as an indicator for the degree of externalisation of an economy because it indicates the degree to which a country's consumption depends on foreign material extraction rather than domestic, showing how dependent its economy is on foreign resources. For Belgium (Figure 19), the ratio fluctuated around or slightly above 1 between 2010 and 2021, suggesting that the country's material footprint was largely driven by imported materials and not domestic extraction. After peaking in 2018 and 2021, the ratio gradually declined to below 0.9 in 2024, pointing to a relative decrease in import-related material use. This reflects Belgium's open and trade-intensive economy, which relies strongly on imported goods.

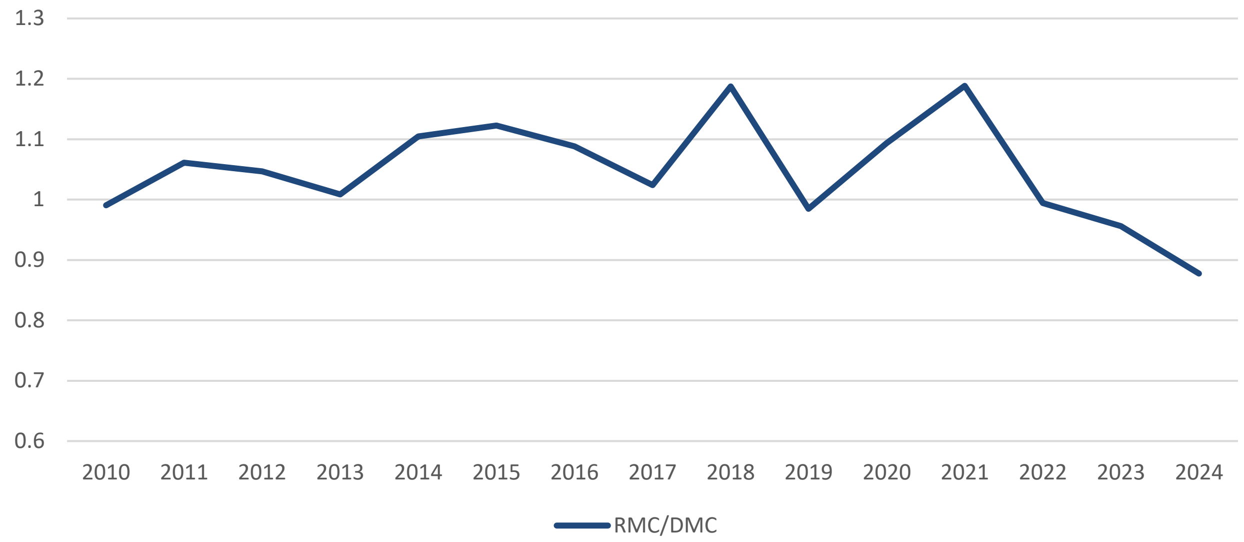

Figure 19: Belgium's RMC/DMC ratio from 2010 to 2024.
Source: Eurostat (env_ac_rme, env_ac_mfa)

Note that the denominator (physical import) is incomplete (except for the total ratio) as material categories other products (A.5) and waste imported for final treatment and disposal (A.6) are excluded." "Physical trade flows are allocated to their main material component, while expressed in RME they consist out of multiple material categories.

Resource productivity

As discussed in the "Direct Material Input" section of this report, a country's resource productivity is typically measured via the ratio of its GDP over DMC. It reflects how efficiently an economy utilises material inputs to generate economic output. It can assess the decoupling between economic growth and material consumption, that is, whether economies can grow using fewer natural resources. Figure 20 shows this indicator for Belgium between 2010 and 2024, indexed in 2010. Compared to 2010, Belgium's GDP (in chain-linked volumes) increased with 22.6%, while its Domestic Material Consumption dropped by 8.5%. As a result, resource productivity rose substantially, by 86.6% compared to 2010 levels. This trend suggests a decoupling of economic growth to material consumption.

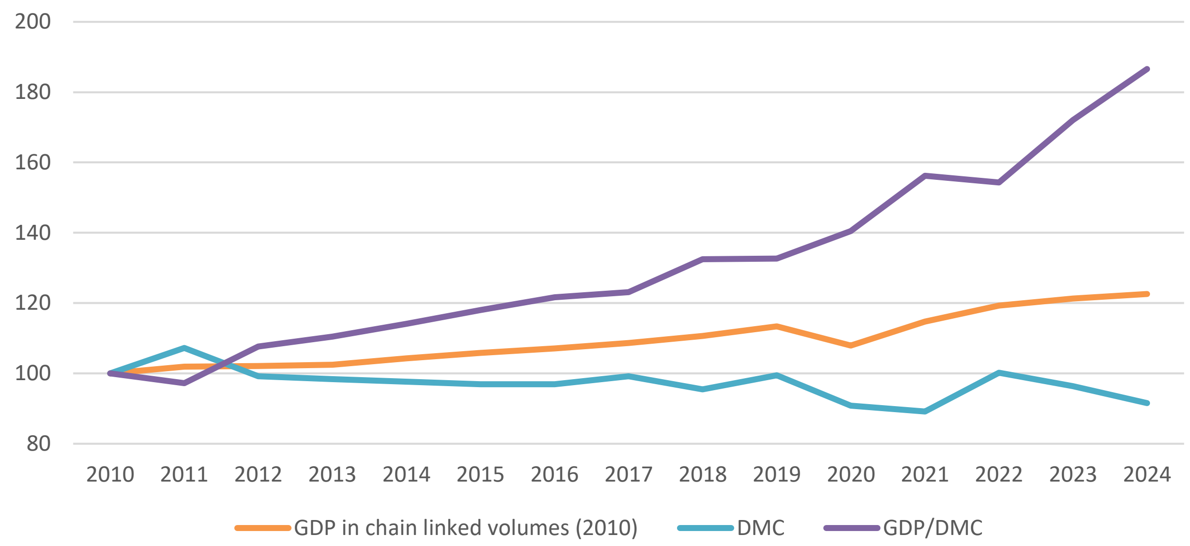

Figure 20: Belgian resource productivity with DMC as denominator, in comparison with GDP and DMC from 2010 to 2024 (Index 2010 = 100).
Source: Eurostat (nama_10_gdp) (env_ac_mfa) (env_ac_rp)

Physical trade by stage of manufacturing

Based on Eurostat's database on international trade in goods statistics[11], it is possible to calculate the physical imports and exports expressed in their stages of manufacturing. Annex 5 of the EW-MFA questionnaire developed by Eurostat[12] links products expressed in CN codes at the 8-digit level to their relevant stage of manufacturing (raw, semi-finished and finished products). By linking this list to import and export data from the COMEXT database, it becomes possible to assess imported and exported products according to their stage of manufacturing.

Figure 21 shows the breakdown of physical imports and exports by stage of manufacturing for Belgium in 2023. Belgium's physical imports are dominated by raw and semi-finished products, whereas the physical exports are dominated by semi-finished products. This is typical for highly industrialised and manufacturing-oriented economies that mainly import raw materials and intermediate goods for processing and production. These findings are also consistent with the previously discussed RMC/DMC indicator (Figure 19) of around one, indicating that a large share of Belgium's material consumption stems from imports rather than domestic extraction.

[11] Eurostat. (n.d.). *COMEXT database: International trade in goods statistics*. Retrieved from https://ec.europa.eu/eurostat/comext
[12] European Commission. (2023). EW-MFA questionnaire: Annexes. https://ec.europa.eu/eurostat/web/environment/methodology#Material%20flows%20and%20resource%20productivity

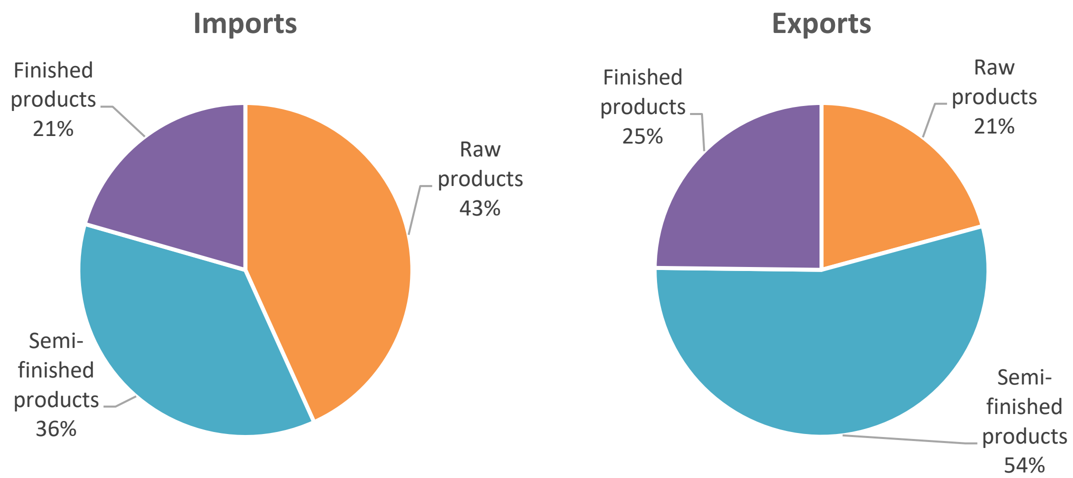

Figure 21: Physical imports and exports by stage of manufacturing, Belgium, in 2023 (kg).
Source: Own calculations based on data from COMEXT, Eurostat.
Methodology: Linking of trade statistics (CN codes) with stages of manufacturing based on Annex 5 of EW-MFA questionnaire.

PROCESSED MATERIALS

The total volume of domestically processed materials (PM) is calculated as the sum of Domestic Material Consumption (DMC) and the feedback loop of secondary materials (SM). These materials are utilised for either energy-related purposes (eUse) or material-based applications (mUse).

The processed material indicator is defined as the sum of domestic material consumption (DMC) and secondary material input. More specifically, trade in secondary materials (SM) should also be taken into account. Thus, the calculation is the sum of DMC and SM, plus SM imports, minus SM exports.

Uncertainties or inconsistencies

Since the processed materials indicator is an estimate derived from other flow indicators, any uncertainties in these defining indicators are transferred to this indicator.

By-products are not accounted for in processed materials as these residual materials fall outside the legal waste management system. These materials are either internally recycled within the same processes (intra) or sold and processed by external entities through economic transactions. Official statistics do not capture this flow.

Data sources and data gaps

Similarly to Eurostat's List of CN codes used to approximate imports and exports of waste destined for recycling, a list of CN codes is available to identify recyclable raw materials. Linking this to international trade data allows for an estimation of the SM feedback loop. The imports and exports of recyclable raw materials are discussed in detail in the Secondary materials section of this report. However, as mentioned above, data on by-products is not included in official statistics.

A gap is that some regions, particularly Flanders, have been able to calculate the waste used by businesses as raw materials, depending on whether it is pre-consumer or post-consumer waste. However, it appears to be challenging to calculate this on a national scale for all of Belgium.

EUSE AND MUSE

The product flow originating from processed materials is split over energetic use (eUse) or material use (mUse). eUse includes materials used for technical energy production (e.g., fossil fuels, fuelwood, and biofuels) as well as for feed and food, which serve as primary energy sources for humans and livestock. The distinction between eUse and mUse follows the methodologies and allocations outlined by Mayer *et al.* (2018) and Haas *et al.* (2015).

Uncertainties and inconsistencies

As noted above, the allocation of processed materials between mUse and eUse relies on literature, FAOstat food balance sheets, and assumptions, which inevitably introduces some uncertainties. Additionally, as highlighted by Christis et al. (2021), the values derived from the EW-MFA methodology do not align with Flanders' energy balance data.

Data sources and data gaps

No specific data is available. Here we rely on literature.

SOLID AND LIQUID WASTE

Mayer et al. (2018) employed a mass-balancing approach, presuming that all materials utilised for energy production were transformed into DPO emissions (including water vapor) and solid waste during the same year they were extracted. To estimate the solid waste from combustion, they relied on waste statistics, while the solid waste generated from human and animal metabolism (excreta) was calculated using coefficients that represent the indigestible portion of consumed food and feed.

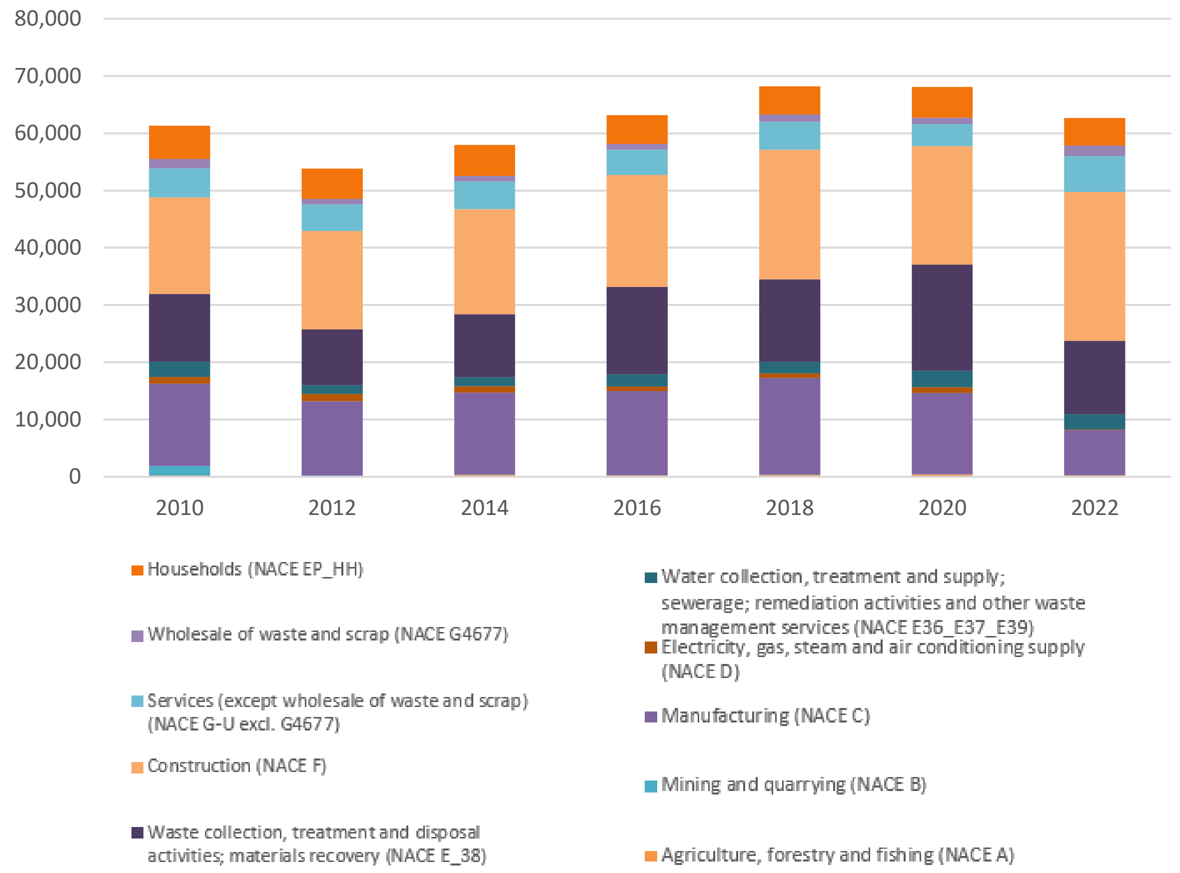

Figure 22: Belgium's bi-annual generation of waste per economic activity (NACE) between 2010 and 2022, in tonne. Source: Eurostat (env_wasgen)

Figure 22 shows a deep dive on Belgium's waste generation (solid and liquid) between 2010 and 2022. Eurostat's data on waste generated is available every two years per economic activity (based on NACE codes) and the households. Manufacturing and construction account for the largest shares of total waste generation, followed by mining and quarrying, while household waste remains comparatively limited. Between 2010 and 2022, total waste generation fluctuates but shows a gradual increase until around 2018, after which levels decline slightly.

The same dataset also provides information on waste generation by waste category between 2010 to 2020, which is represented in Figure 23. Waste generation is dominated by mineral and solidified waste, which increases steadily from 2010 until 2018 and then declines slightly. Recyclable waste represents the second largest category, decreasing in volumes from 2010 to 2012 and increasing again towards 2020. Mixed ordinary waste and animal and vegetal waste show moderate growth over time, while chemical and medical waste fluctuates at lower levels. Common sludges and equipment-related waste remain relatively small and stable throughout the period.

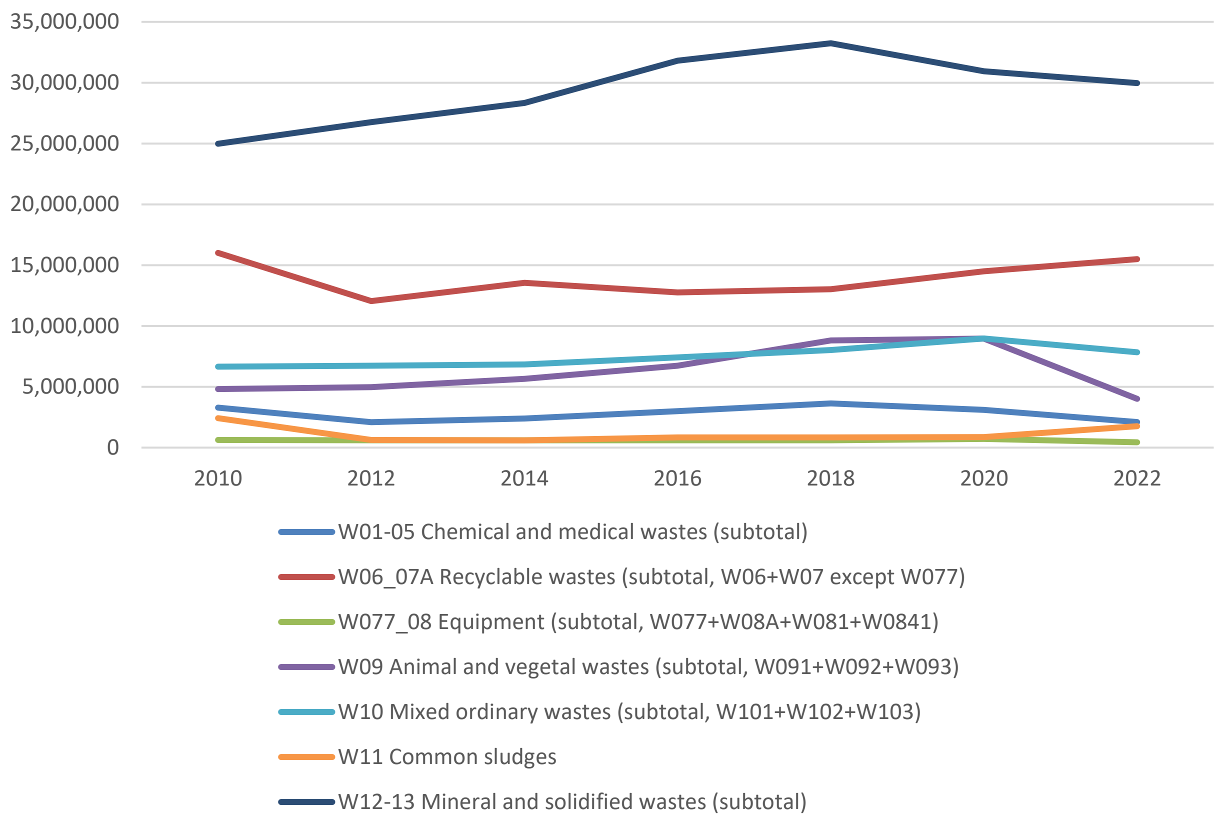

Figure 23: Belgium's generation of waste, by waste category from 2010 to 2022, in tonne.
Source: Eurostat (env_wasgen)

Eurostat also allows for the two datasets to be combined and to represent the waste generated per economic activity, by waste category. Figure 24 presents this breakdown for 2022, expressed as the percentage of total waste generated within each economic activity. The composition of waste differs across sectors. Construction is dominated by mineral and solidified wastes, which account for most of the waste generated in this sector. Electricity, gas, steam and air conditioning supply is also characterised by a high share of mineral and solidified wastes. In contrast, agriculture, forestry and fishing generate a more mixed waste profile, with substantial shares of animal and vegetal wastes and mixed ordinary wastes. Manufacturing and mining and quarrying show more diversified waste compositions, combining recyclable wastes, mineral wastes and mixed ordinary wastes. Services and wholesale of waste and scrap are characterised by a relatively high share of recyclable wastes, while households generate a combination of recyclable wastes, mixed ordinary wastes and animal and vegetal wastes.

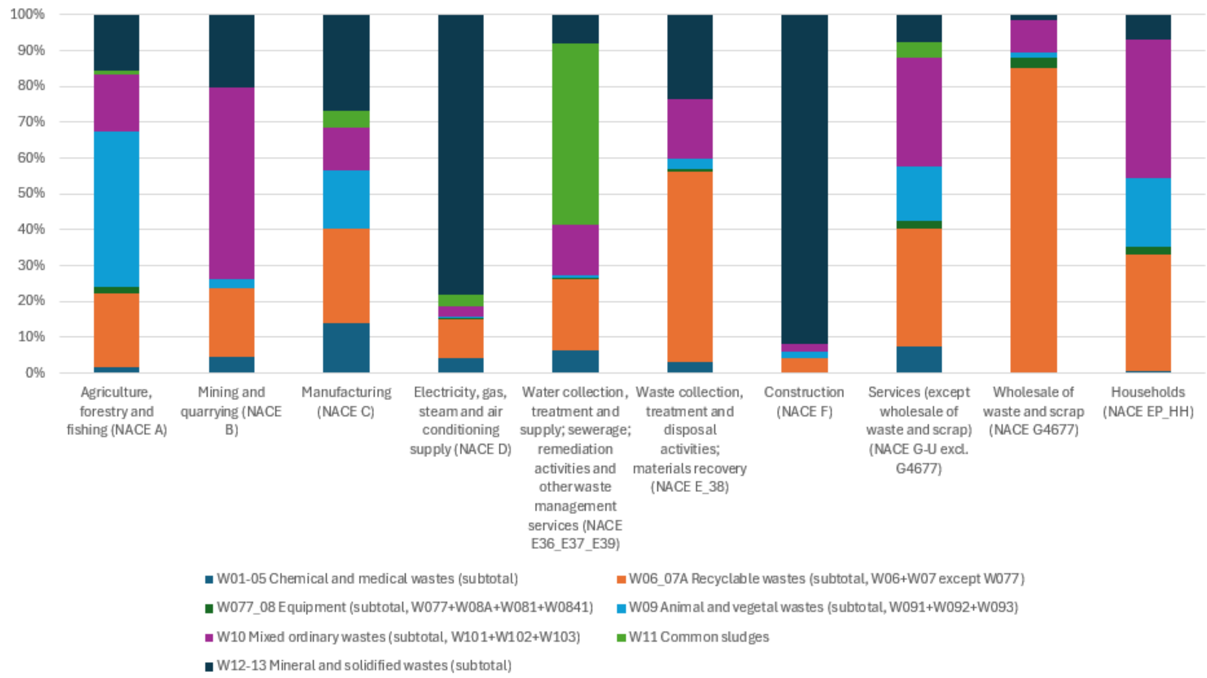

Figure 24: Belgium's generation of waste per economic activity (NACE), by waste category in 2022, as a percentage of total waste generated per economic activity.
Source: Eurostat (env_wasgen)

Data sources & data gaps

The main data source is Eurostat providing statistics on waste generation, collection and treatment, and data on specific waste streams.

Additional indicators

The commission adopted delegated decision (EU) 2019/159 of 3 May 2019, which establishes a common methodology and minimum quality requirements for the standardised measurement of levels of food waste. The European definition of food waste encompasses all food products that have become waste. It does not distinguish between edible and inedible parts (e.g., bones, peels). Consequently, inedible parts are also included as food waste.

Food loss, on the other hand, specifically refers to the edible fraction of raw materials or products, spanning from harvest through to the consumption phase, intended for human consumption but ultimately not consumed by people. Food items lost for human consumption but redirected to animal feed are considered as food loss but not as food waste. Conversely, inedible fractions, such as those used for fermentation, are counted as food waste but not as food loss. (VBO)

Belgium reports to Eurostat following the European definition, "food loss" as reported by FEVIA, the federation of the Belgian food industry, highlights inefficiencies in resource use. These inefficiencies can serve as an indicator for areas where organizational and policy measures can improve resource efficiency and minimize waste.

THROUGHPUT MATERIALS, EXTRACTIVE WASTE AND STOCK

Based on Mayer's framework mUse is split into extractive waste, materials used for stock building and throughput materials. Throughput materials are materials that do not accumulate in in-use stocks and encompass (1) materials that are used in a dissipative way such as fertilizer minerals and losses that occur during material processing (wastage, not reported in waste statistics) and (2) short-lived products such as packaging, newspapers, manufacturing waste and food waste (reported in waste statistics). Extractive waste refers to material discarded during the extraction stage such as overburden and tailings. This extractive waste is generated before the ore is processed into refined metals. Stock-building materials include all materials that accumulate in buildings, infrastructure, or durable goods with a lifespan exceeding one year.

Whitin the context of MFA, gross additions to stock (+stock, GAS), net additions to stock (NAS) and demolition and discard (-stock) are considered. More specifically, the gross additions to stock represent the total amount of material added to a stock in a given period without considering any outflows or removals. This emphasizes material demand and the inflow towards new stock creations. Net additions to stock (NAS) reflect the net change in stocks and are typically calculated as the difference between GAS and materials leaving the stock (-Stock, demolition and discard). Demolition and discard (-stock) refers to the material that is removed from the socioeconomic stock. (Mayer)

Uncertainties and inconsistencies

Mayer et al. allocated a share of mUse to throughput materials across the different categories. As biomass makes up a large portion of throughput materials in mUse because it is predominantly used for consumption as food, feed, or bio-based products 50% is allocated to throughput materials. For metal ores this percentage is 21%. Metals have a high functional importance and a long lifespan in durable goods (e.g., machinery, vehicles, and infrastructure). However, during the production process (e.g. refining and smelting) significant losses occur as metal ores are processed into refined metals, and these losses (waste streams) are accounted for in throughput materials. Examples include slags, dross (consists of oxidized impurities and metal oxides - often contains recoverable metals) or scrap (are widely repurposed in construction, metal recovery and environmental applications). Industrial minerals, such as limestone, gypsum, phosphates and other non-metallic minerals, are for a significant portion allocated to throughput materials, namely 47%. Construction minerals such as sand, gravel and stone are typically used in long-lived application like building and infrastructure. Since these materials accumulate in the stock of the economy and are only released slowly (e.g., during demolition), their share in throughput materials is only 5% and much smaller compared to fast-cycling materials like biomass and fossil-based energy carriers. For the latter 39% is allocated to TM. Fossil energy carriers include coal, oil, and natural gas, which are primarily used for energy production (combustion) but also to produce plastics and other petrochemical products. A significant portion of fossil-based energy carriers is allocated to plastic packaging, which has a short lifespan and contributes heavily to throughput materials. Overall, these allocation percentages, derived from Mayer et al. (2018), are based on estimates and should be interpreted as approximations, which inherently introduce some uncertainties.

Stock-building materials include all materials that are incorporated into buildings, infrastructure, or durable goods with a lifespan exceeding one year. The proportion of these materials in mUse is approximated using a combination of industry data, production statistics, findings from material flow analyses, and informed assumptions. While the framework does not allow to calculate the stock in Belgium, it does enable the estimation of -Stock and +Stock from which NAS can be derived. The +Stock can be estimated by multiplying the share of mUse that becomes a part long-lived goods by mUse. The -Stock is estimated by subtracting throughput materials (TM) and solid and liquid waste in a given year from end-of-life waste (EoLw).

$$+Stock = mUse * added\ share\ of\ stock\ building\ materials\ (\%)$$
$$-Stock = EoLw - TM - Solid\ \&\ Liquid\ waste\ (-extractive\ waste?)$$

Stock-related flows are primarily estimated as a net mass balance between inputs and outputs, implying a fully closed system. However, this approach often absorbs inconsistencies and uncertainties present in the data.

Data sources and gaps

Additions to stock (+Stock) refer to materials or products introduced into a system that are not immediately consumed or discarded. Based on literature[13] the allocation factors are derived:

- ➔ 10% of the fodder crops and 90% of the roundwood is allocated to +Stock;
- ➔ Salt and 5% of the other non-metallic minerals are allocated to TM;
- ➔ 50% of the fossil energy carriers to +Stock; and
- ➔ 47% of iron, 75% of aluminium and 64% of other metal products allocated to +Stock.

Uncertainties and inconsistencies

As the stock creates a substantial time gap between the input and output of materials. Materials in mUse will eventually flow to EoLw, but a time gap between both should be considered.

In an economy-wide material flow diagram, the **stock** represents all materials that remain within society for longer periods in the form of buildings, infrastructure, consumer goods, and equipment. This stock plays a crucial role in fulfilling societal needs—providing housing, mobility, communication, and countless services. In a more circular economy, the goal is to preserve materials in this stock for as long as possible, thereby reducing the need for new material inputs. Strategies such as maintenance, repair, reuse, and high-quality recycling extend the lifespan of products and slow down material throughput. Statistically, however, estimating the size and evolution of this stock is challenging because detailed, continuous data are often lacking. Still, several indicators shed light on stock dynamics: reuse volumes via reuse centres (kg per capita), including separate data for textiles, furniture, and electrical and electronic appliances; total reuse estimates for Flanders, including informal channels; repair expenditure indicators from household budget surveys; the share of reusable packaging in business-to-business streams; and the percentage of industrial waste that is reused, used as secondary materials, or recycled/composted. Even hibernating stocks, such as vacant buildings or materials stored in landfills, are relevant for understanding potential future resource recovery. Together, these elements help illustrate how the stock functions both as a reservoir of materials and as a key lever for advancing circularity.

SECONDARY MATERIALS

As defined by Mayer et al. (2018) secondary materials refer to materials recovered through all forms of recycling, reuse, and remanufacturing but also downcycling (e.g., backfilling) or cascadic use. Data

[13] Mayer et al. (2019) – Table S2, Wang et al. (2007) – Fig. 2, Cullen et al. (2016) – Fig. 2 and Allwood et al (2010) – Table 4

on the stock of secondary materials is sparsely available, but Eurostat offers data on trade in recyclable raw materials per European country, both intra- and extra-EU. Below you will find a deep dive on both imports and exports of recyclable raw materials in and from Belgium.

Imported recyclable raw materials

Figure 25 shows the total imports of recyclable raw materials per category in Belgium over the period of 2010-2023. Metals have consistently accounted for the largest share in the import of recyclable raw materials into Belgium over the past decade, with its imported weight ranging from 5 to 6 million tonnes annually. Organic recyclable raw materials make up the second largest category in the total import of recyclable raw materials, with an annual imported weight of around 3 million tonnes, followed by minerals and paper and cardboard at a much lower volume.

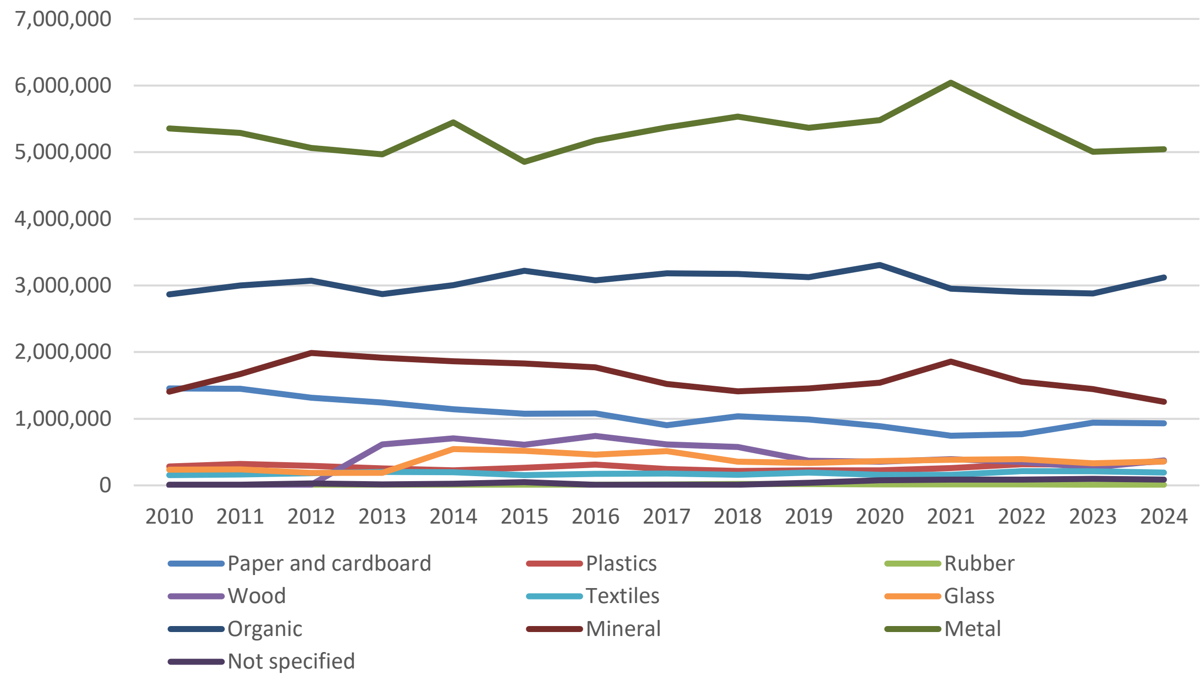

Figure 25: Import of recyclable raw materials into Belgium from 2010 to 2024 by category, in tonne (intra- and extra-EU). Source: Eurostat (cei_srm020)

Eurostat provides an overview of the products, expressed in CN codes, that are associated with each raw material category[14]. Linking these CN codes with trade data from Eurostat's database on international trade in goods statistics trade, COMEXT[15], the weight of the separate imported and exported products per recyclable raw material category can be calculated. This methodology follows the one discussed in the "IMPORTS" section of this report. Table 13 and Table 14 show the composition of imported products for the two categories that account for the largest share in recyclable raw materials, namely, recyclable metals and organic material.

[14] Eurostat. (2024). *Trade in recyclable raw materials: Metadata and methodology* (Annex – List of CN codes used for the calculation of Trade in recyclable raw materials). Retrieved from https://ec.europa.eu/eurostat/cache/metadata/en/cei_srm020_esmsip2.htm

[15] Eurostat. (n.d.). *COMEXT database: International trade in goods statistics*. Retrieved from https://ec.europa.eu/eurostat/comex

For metals, the bulk of imports consist of waste and scrap of iron or steel, not fragmented (47.9%). Other significant flows are waste and scrap of stainless-steel containing ≥8% nickel (12.8%) and waste and scrap of iron or steel, fragmented (6.8%). Smaller categories include waste and scrap of tinned iron or steel, scrap of aluminium, and waste and scrap of alloy steel. For organic materials, imports are more diversified. The largest category is oilcake and other solid residues from the extraction of soya-bean oil (42.8%), followed by beet-pulp (10.3%) and oilcake and residues from the extraction of sunflower seeds (8.6%). Other contributions come from bagasse and other sugar-manufacturing waste, residues of starch manufacture, and maize stalks, fruit peel, and other vegetable residues. Smaller fractions include by-products of brewing and distilling and animal-origin waste such as sinews and hides.

CN code	Description of CN-code (label)	% of total recyclable metals imported
72044990	Waste and scrap of iron or steel, not fragmentised "shredded", not in bundles	47.89 %
72042110	Waste and scrap of stainless steel, containing by weight >= 8% nickel	12.79 %
72044910	Waste and scrap of iron or steel, fragmentised "shredded"	6.84 %
72043000	Waste and scrap of tinned iron or steel	4.18 %
76020090	Scrap of aluminium	3.61 %
72042900	Waste and scrap of alloy steel	2.81 %
72042190	Waste and scrap of stainless steel (not containing >= 8% nickel, radioactive, or waste and scrap from batteries and electric accumulators)	2.70 %
74040099	Waste and scrap, of copper alloys	2.67 %
72044199	Trimmings and stampings, of iron or steel, not in bundles	2.50 %
/	Other	14.01 %

Table 13: Percentage of total recyclable metal materials imported into Belgium expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes

CN code	Description of CN-code (label)	% of total recyclable organics imported
23040000	Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of soya-bean oil	42.85 %
23032010	Beet-pulp	10.30 %
23063000	Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of sunflower seeds	8.64 %
23032090	Bagasse and other waste of sugar manufacture (excl. beet pulp)	6.39 %
23031090	Residues of starch manufacture and similar residues, incl. concentrated steeping liquors (excl. of starch from maize)	4.79 %
23080090	Maize stalks, maize leaves, fruit peel and other vegetable materials, waste, residues and by-products for animal feeding, whether or not in the form of pellets, n.e.s.	4.56 %

23066000	Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of palm nuts or kernels	4.20 %
5119910	Sinews or tendons of animal origin, parings and similar waste of raw hides or skins	2.85 %
23033000	Brewing or distilling dregs and waste	2.65 %
/	Other	12.76 %

Table 14: Percentage of total recyclable organic materials imported into Belgium expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from import statistics based on ESTAT CN codes

Exported recyclable raw materials

Figure 26 shows the export of recyclable raw materials from Belgium by materials category between 2010 and 2024. Metals have consistently accounted for by far the largest share of recyclable raw material exported, with annual volumes ranging from 2.1 million to 2.7 million tonnes. From 2010 to 2021, paper and carboard made up the second-largest category and represented a substantial share in exports with its exported weight exceeding 1 million tonnes in 2011. However, its volumes sharply declined over the years to levels similar to the share of the other material categories such as plastics and textiles. This can most likely be attributed to restrictions regarding waste paper imports by trade partners such as China. In 2023 and 2024, the second largest material category was organic material, with export volumes fluctuating between 0.15 and 0.25 million tonnes per year. Exports of rubber, glass, minerals and woods remain relatively minor in comparison.

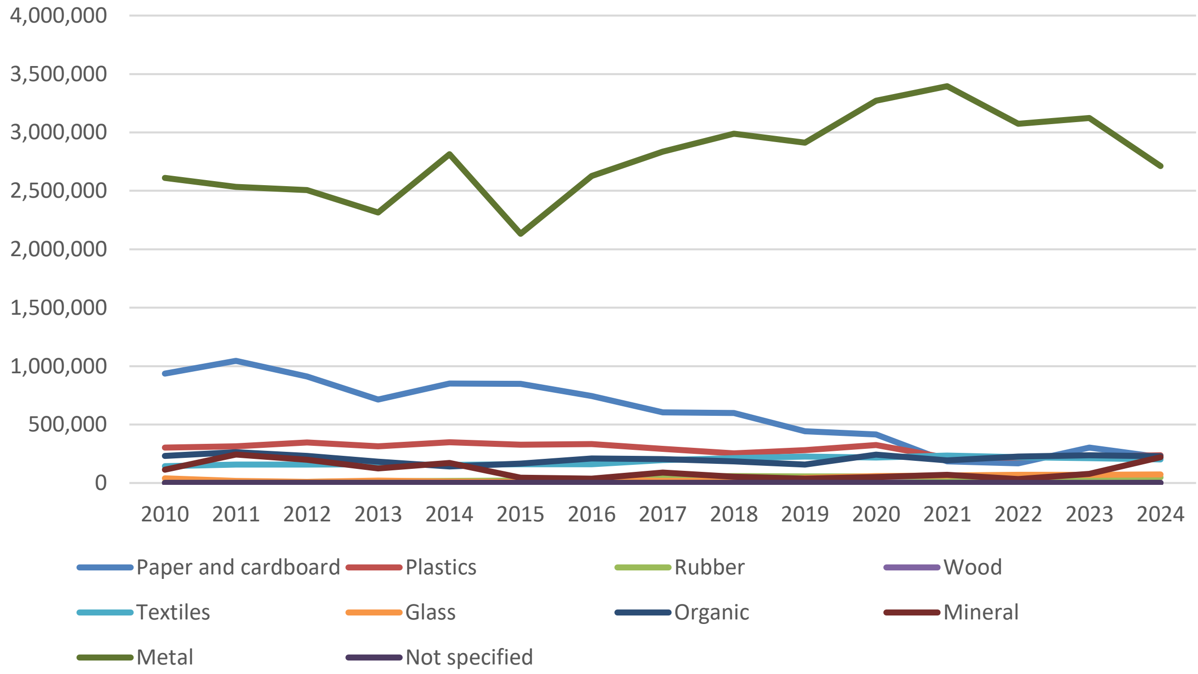

Figure 26: Export of recyclable raw materials into Belgium from 2010 to 2024 by category, in tonne (intra- and extra-EU).
Source: Eurostat (cei_srm020)

Similar to the analysis made for the imports of recyclable raw materials, a deep dive was done on the two largest materials categories exported in 2023, namely metals and organic materials. Table 15 and Table 16 present, for each material category, the nine products that together account for the largest share of the total weight of exports. These figures were calculated using the same methodology discussed in the previous subsection on imports of recyclable raw materials.

For metals, exports are dominated by waste and scrap of iron or steel that are not fragmented or bundled, which together make up more than half of all exported recyclable metals (52.4%). The second-largest flow consists of fragmented or shredded waste and scrap of iron or steel (18.1%). This shows Belgium's strong position in the steel recycling and processing industry, where large volumes of waste and scrap of iron and steel are being prepared for export. Other large shares include scrap of aluminium (6.0%), waste and scrap of cast iron (4.7%), and tinned iron or steel (4.4%), that together make up the other significant portion of exported recyclable metal. Smaller shares come from residues such as turnings and shavings (2.5%), as well as alloy and stainless-steel scrap (around 3% combined). The remaining 7.4% consists of various other metal waste streams exported in smaller quantities.

CN code	**Description of CN-code (label)**	**% of total recyclable metals exported**
72044990	Waste and scrap of iron or steel, not fragmentised "shredded", not in bundles	52.35 %
72044910	Waste and scrap of iron or steel, fragmentised "shredded"	18.10 %
76020090	Scrap of aluminium	5.99 %
72041000	Waste and scrap, of cast iron (excl. radioactive)	4.65 %
72043000	Waste and scrap of tinned iron or steel (excl. radioactive, and waste and scrap of batteries and electric accumulators)	4.44 %
72044110	Turnings, shavings, chips, milling waste, sawdust and filings, of iron or steel, whether or not in bundles	2.54 %
76020019	Waste of aluminium, incl. faulty workpieces and workpieces which have become unusable in the course of production or processing	1.66 %
72042900	Waste and scrap of alloy steel	1.60 %
72042190	Waste and scrap of stainless steel (not containing >= 8% nickel, radioactive, or waste and scrap from batteries and electric accumulators)	1.29 %
	Other	7.39 %

Table 15: Percentage of total recyclable metals exported from Belgium expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from export statistics based on ESTAT CN codes

Regarding organic material, exports are more diverse. The largest category is oilcake and other solid residues from the extraction of low-erucic acid rapeseed or colza oil (25.8%), followed by residues from starch manufacturing (20.7%) and oilcake from soya-bean oil extraction (16.2%). Brewing and distilling dregs and waste account for about 10% of total organic exports, while flours and meals of meat or offal make up 5.4%. Smaller fractions include maize stalks and other vegetable residues (4.3%) and oilcakes from linseed (4.2%) and sunflower seeds (3.9%). A minor share (1.4%) is made up of bird skins and feathers and other similar residues. These products show that Belgium's organic exports consist mainly of agricultural by-products and residues from the food and feed industries, which are repurposed into secondary materials exported abroad.

CN code	Description of CN-code (label)	% of total recyclable organics exported
23064100	Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of low erucic acid rape or colza seeds "yielding a fixed oil which has an erucic acid content of < 2% and yielding a solid component of glucosinolates of < 30 micromoles/g"	25.79 %
23031090	Residues of starch manufacture and similar residues, incl. concentrated steeping liquors (excl. of starch from maize)	20.70 %
23040000	Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of soya-bean oil	16.21 %
23033000	Brewing or distilling dregs and waste	10.02 %
23011000	Flours, meals and pellets, of meat or offal, unfit for human consumption; greaves	5.44 %
23080090	Maize stalks, maize leaves, fruit peel and other vegetable materials, waste, residues and by-products for animal feeding, whether or not in the form of pellets, n.e.s.	4.30 %
23062000	Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of linseed	4.23 %
23063000	Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of sunflower seeds	3.89 %
5059000	Skins and other parts of birds, with their feathers or down, feathers and parts of feathers, whether or not with trimmed edges, not further worked than cleaned, disinfected or treated for preservation; powder and waste...	1.39 %
	Other	8.04 %

Table 16: Percentage of total recyclable organic materials exported from Belgium expressed in products in 2023.
Source: own calculations based on data from COMEXT, Eurostat.
Methodology: Selection from export statistics based on ESTAT CN codes

Uncertainties and inconsistencies

Secondary materials can be approached from different perspectives. More specifically, the scope of the SM flow can focus on the collection of waste for recovery and recycling or the use of secondary materials recovered from former waste. In case of the latter, SM are defined as the output of recycling facilities, however this poses the risk of double-counting because both primary and secondary waste are included.

According to Mayer et al. (2018), the flow of secondary materials can be quantified using Eurostat's treatment statistics (env_wastrt) by means of the reported amounts that are recovered, excluding energy recovery. Note that these statistics show the amount of input material to recovery and not he actual output of secondary materials[16]. However, differing views exists on whether all backfilling

[16] Discrepancies between the amount of recovered and actually recycled materials replacing primary material are not well understood and reported and lead to an overestimation of socioeconomic cycling rates. Schiller and colleagues (2017) conclude that for Germany, only 48% of outflows of concrete and bricks are suitable for high-quality recycling, reducing the recycling share in fresh concrete to a maximum of 32%. A Swiss study of polyethylene terephthalate (PET) bottles, tinplate, aluminium, paper and cardboard, and glass reveals that

operations can be considered as 'genuine' recovery and the distinction between recycling and backfilling varies across member states. For these reasons backfilling and recovery of construction and demolition waste should be presented separately to ensure clarity and consistency.

Data sources and gaps

OVAM (Flanders), IBGE-BIM (Brussels Capital Ragion), SPW Agriculture, Ressources naturelles et Environnement (Wallonia), Statbel (Belgium) and Eurostat.

Additional indicators and data sources

Additional indicators relevant to secondary materials include the WEEE collection rate of electrical and electronic equipment waste (WEEE) and the WEEE recycling rate. These indicators offer insight into resource efficiency, as WEEE contains a relatively high percentage of critical raw materials. The recycling rate is calculated within the European framework, expressed as the amount of recycled WEEE relative to the amount of WEEE collected within the same year. (VBO)

EEE recycling

Data sources for these indicators are available through Eurostat. This dataset provides information on waste generated from the separate collection of EEE (categorised into at least the six groups defined by the WEEE Directive) and includes data on various waste management operations: waste generated, products put on market, waste collected, waste treatment, recovery, recycling and preparing for reuse. Figure 27 shows the recycling rate of WEEE in Belgium between 2019 and 2023, broken down by the six product groups. The recycling rate means the total quantity of recycled EEE waste divided by the total quantity of generated EEE waste. Overall, the figure shows growth in recycling rates for each of the product groups between 2019 and 2023. Most categories, such as large equipment and temperature change equipment show steady annual increases, while other categories such screens, monitors, and equipment and small IT and telecommunications equipment show fluctuations over the years.

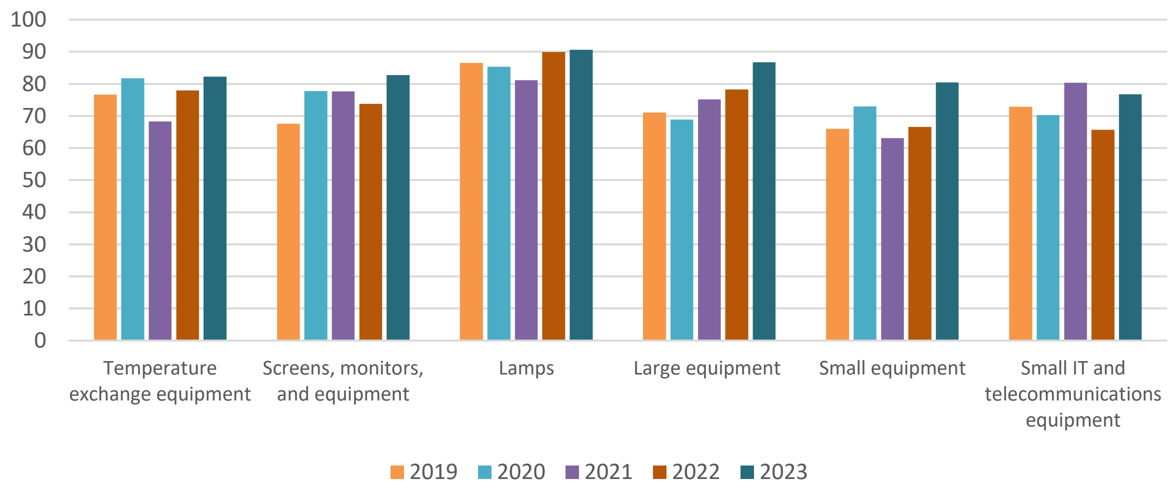

Figure 27: Recycling rate of WEEE in Belgium, broken down by product groups, from 2019 to 2023.

Actual recycling rates are substantially lower than reported in official statistics (Haupt et al. 2017), and the authors expect similar differences in other countries.

Source: Eurostat (env_waseleeos)

Figure 28 presents the put on market (POM), waste collected, and various waste management operations for electrical and electronic equipment (WEEE) in Belgium in 2023, together with the corresponding collection rates. A gap is visible across categories between POM and the amount of waste collected, which is expected given the time lag between products being placed on the market and reaching end of life, as well as changes in market size and the effectiveness of collection systems, which can lead to losses. In growing markets, POM is typically higher than waste collected, whereas in declining markets the opposite may occur. However, in this dataset POM remains consistently higher than collected waste for all categories. That said, the discrepancy is relatively small for Small IT and telecommunications equipment and for screens, monitors and equipment containing screens, where collected volumes are relatively close to the amounts put on the market. By contrast, the difference is much larger for categories such as large equipment and small equipment, pointing to stronger collection losses or longer/less predictable product lifetimes in these waste streams. Overall, the main bottleneck appears to lie in the collection phase rather than in downstream treatment, seeing as most collected WEEE is directed towards preparing for reuse and recycling. Differences between categories may also reflect qualitative aspects of the waste management system, such as WEEE being discarded via residual waste streams, leading to uncollected losses. The collection rate, shown as a percentage, is calculated as waste collected in 2023 divided by the average POM over the previous three years, which is intended to account for product lifetimes. Nevertheless, this proxy may not always align with the actual lifespan of all product categories, which can contribute to variation in observed collection rates.

Figure 28: Put on market, waste and collection rate of electrical and electronic equipment (WEEE) by waste management operations, Belgium, 2023, in million tonnes.
Collection rates are calculated as waste collected in year 2023 divided by the put on market in the previous 3 years (2020-2022).
Source: ESTAT [env_waseleeos], last update 29/10/2025.

End-of-life vehicles waste

Similar data can be obtained for end-of-life vehicles (ELV) on Eurostat. This also includes data on various waste management operations and can be broken down into different waste categories of the end-of-life vehicles (such as its tires, metal components, ferrous scrap, etc.). Figure 29 shows the waste arising from end-of-life vehicles of type passenger cars (M1), light commercial vehicles (N1) and three wheeled moped vehicles (ELV directive), broken down into the different waste management operations from 2010 to 2023 in tonne.

Waste generated is defined by Eurostat as the total quantity of waste, which means any substance or object which the holder discards or intends or is required to discard, that is generated in a given year[17]. Recovery of waste encompasses operations where waste serves a useful purpose by replacing other

[17] Eurostat. (n.d.). *Information on data – Waste*. Retrieved October 31, 2025, from https://ec.europa.eu/eurostat/web/waste/information-data

materials, either directly or after processing[18]. Recycling of waste can be seen as a subset of recovery, which is any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes[19]. The reuse of waste entails any operation in which products or components that are not classified as waste are used again for the same purpose for which they were originally designed[20].

The graph reveals that total waste generated from ELVs start at around 180,000 tonnes in 2010 and shows a declining trend since then, with a generated waste stream of around 80,000 tonnes in 2023, indicating a significant reduction in total waste generated from ELVs over time. The recovery and recycling follow an almost identical trend over the years, they both fluctuate over time but decline in line with the reduction in total waste. The reuse of EVLs hold much smaller volumes, ranging between 15,700 to 44,000 tonnes, and shows less variation over the years in line with the previously discussed waste management operations. Overall, these figures show that recovery and recycling dominate EVL waste management in Belgium, while reuse plays a relatively smaller role.

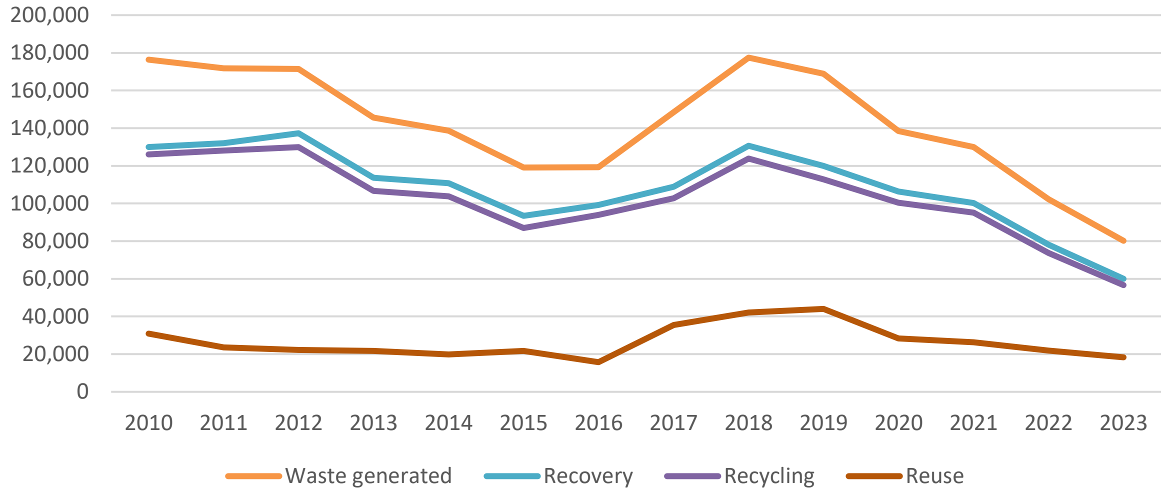

Figure 29: Waste arising only from end-of-life vehicles of type passenger cars (M1), light commercial vehicles (N1) and three wheeled moped vehicles (ELV directive), from 2010 to 2023 in Belgium, in tonne.
Source: Eurostat (env_waselv)

End-of-life packaging recycling

Data on the recycling rate of end-of-life packaging waste can also be found on Eurostat, by type of packaging waste. Figure 30 depicts this rate for Belgium from 2010 to 2023. It shows that paper and cardboard packaging consistently achieves the highest recycling rates, remaining close to 100% throughout the period. Glass and metallic packaging also maintain high and stable rates above 85%, with only minor fluctuations. The recycling rate of wooden packaging shows more fluctuations over time, with values ranging between 63.3% and 90.6%, peaking around 2017 and then declines slightly. Plastic packaging, however, remains much lower than the other packaging categories, starting at

[18] Eurostat. (n.d.). Glossary: Recovery of waste. Statistics Explained. Retrieved October 31, 2025, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Recovery_of_waste

[19] Eurostat. (n.d.). Glossary: Recycling of waste. Statistics Explained. Retrieved October 31, 2025, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Recycling_of_waste

[20] Eurostat. (n.d.). Glossary: Reuse of waste. Statistics Explained. Retrieved October 31, 2025, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Reuse_of_waste

41.5% in 2010 and gradually rising to 59.9% in 2023. Overall, recycling performance in Belgium is quite high for most packaging categories, though plastics still lag behind.

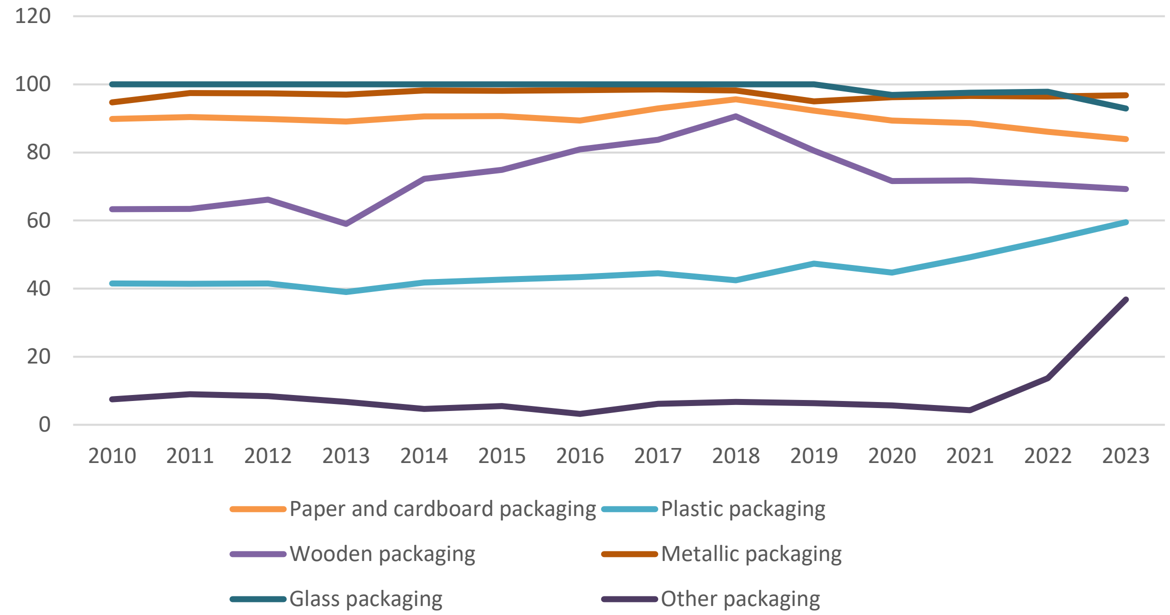

Figure 30: Recycling rates of packaging waste for monitoring compliance with policy targets, by type of packaging, from 2010 to 2023 in Belgium, in %.
Source: Eurostat (env_waspacr)

Batteries and accumulators waste

Additionally, Eurostat provides insights into the recycling volumes of batteries and accumulators by type of battery. Figure 31 provides an overview of these volumes for Belgium between 2014 and 2023, as no data is available before 2014. The figure shows that most recycled batteries are lead-based, as they consistently make up for the largest share of total recycling volumes. Overall recycling volumes remained relatively stable between 2015 and 2023, and the recycling of Ni-Cd batteries and other batteries and accumulators represents only a small fraction of total recycled batteries and accumulators.

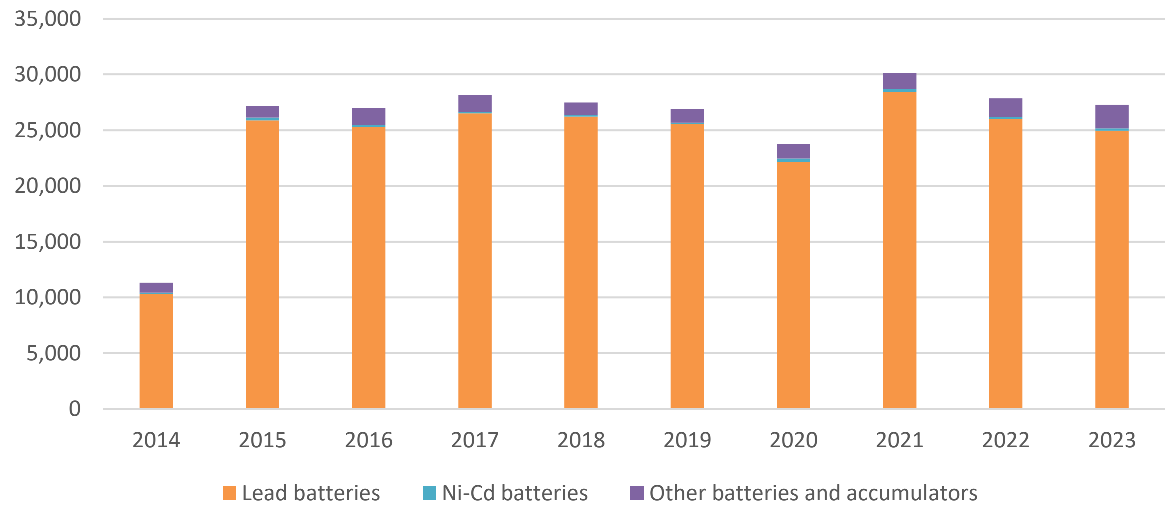

Figure 31: Recycling volumes of batteries and accumulators, by type of battery, from 2010 to 2023, in Belgium, in tonne.
Source: Eurostat (env_wasbat)

Looking into more detail, Eurostat provides data on the products put on market and the total waste collected of portable batteries, which are defined as: any battery, button cell, battery pack or accumulator that is sealed; and can be hand-carried; and is neither an industrial battery or accumulator nor an automotive battery or accumulator. Figure 32 shows the evolution of portable batteries and accumulators put on market and collected as waste in Belgium between 2010 and 2023. The number of batteries put on market has gradually increased over time, with a sharper rise since 2018. Waste collection has also grown but remains consistently lower than the quantities placed on the market. This suggests that a considerable share of portable batteries still escapes official recycling streams.

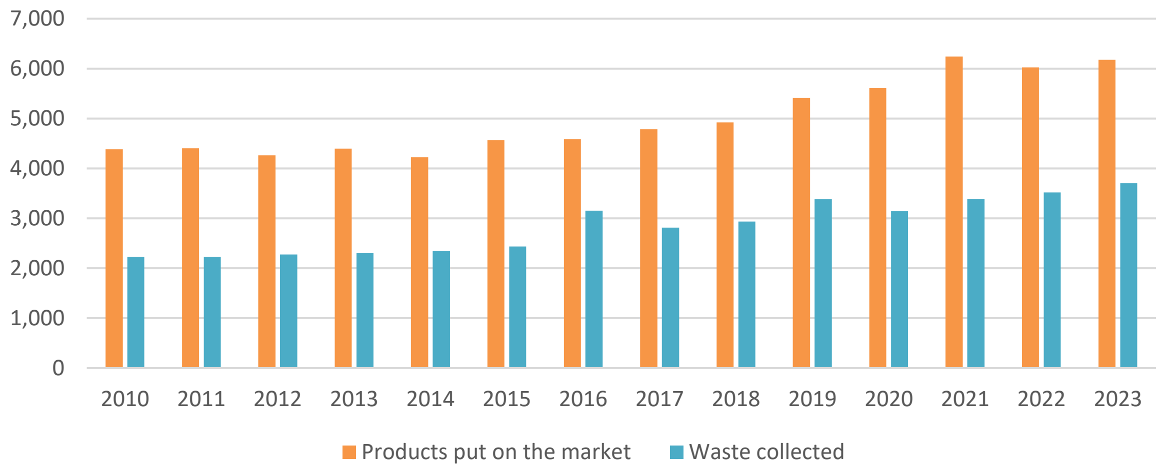

Figure 32: Sales and collection of portable batteries and accumulators, from 2010 to 2023, in Belgium, in tonne. Source: Eurostat (env_wasbat)

Recycling performance at end-of-life

Two indicators are often used to assess the contribution of recycled materials to overall material inputs in an economy: the End-of-Life Recycling Rate (EoL-RR) and the End-of-Life Recycling Input Rate (EoL-RIR)[21]. The EoL-RIR measures the share of recycled materials stemming from recycling of post-consumer scrap entering the economy as a fraction of total material inputs. The EoL-RR, on the other hand, captures the number of secondary materials recovered at end-of-life compared to the total waste generated. The latter provides insight into the performance of the collection and recycling sectors in recovering materials at end-of-life, making it a useful indicator from a recyclers' perspective. Looking at the difference between these two indicators can be interesting to assess whether or not efficient recovery of materials at end-of-life translates in a contribution of recycled materials to overall material demand.

Other concepts related to these two are:

- **Recycling rate**: The recycling rate is the share of recycled waste out of the total amount of waste generated.
- **Functional recycling**: Functional recycling, also known as closed-loop recycling, is a type of recycling where waste is reprocessed into products of the same or similar quality, unlike open-loop recycling where quality degrades over time.

[21] Talens, L., Nuss, P., Mathieux, F. and Blengini, G.A., Towards Recycling Indicators based on EU flows and Raw Materials System Analysis data. JRC technical report JRC112720, 2018.

- **Circular material use rate**: The indicator measures the share of material recycled and fed back into the economy – thus avoiding the extraction of primary raw materials – in overall material use. The circular material use rate, also known as the circularity rate, is defined as the ratio of circular use of materials to overall material use. Note that circular material use rate also included non-functional recycling.
- **Recycling input rate**: The RIR shows the fraction of secondary material in the total material demand (including ‘old scrap’ and ‘process scrap’.
- **End-of-life collection rate**: The end-of-life collection rate measures the efficiency with which end-of-life material is collected.

Data on the EoL-RIR rate is publicly available via Eurostat, but only on the EU27 aggregate level per raw material category, the EoL-RR rate is not yet publicly available. The Joint Research centre (JRC) of the European Commission published its Raw Materials Scoreboard biannually, with its latest report stemming from 2021[22]. In this report, the two indicators are analysed and discussed.

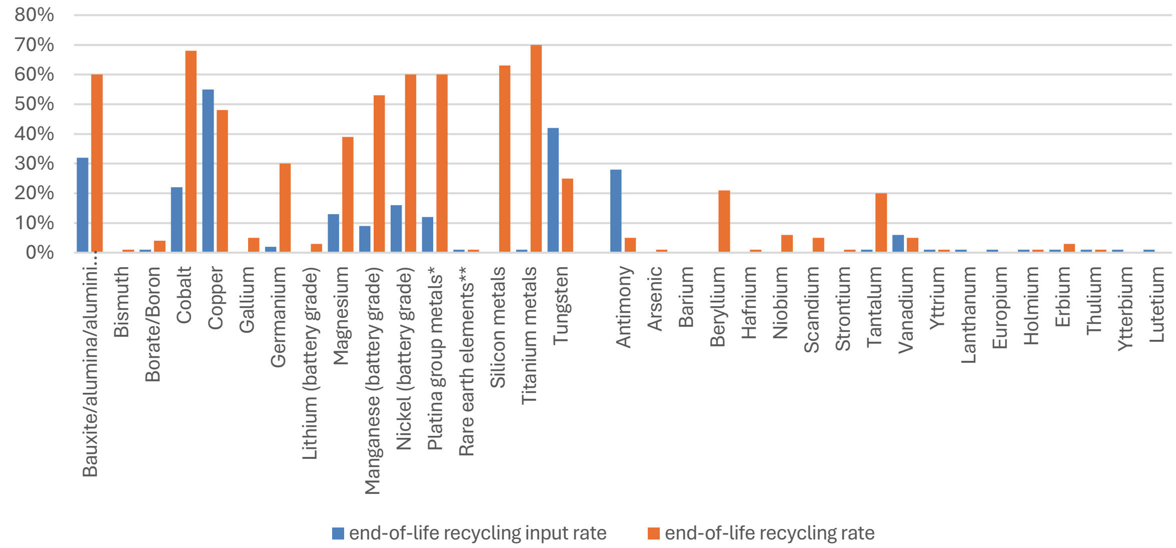

Figure 33: End-of-life recycling input rate and end-of-life recycling rate of selected materials.
Note: First set is the list of strategic raw materials; and second set is the list of critical (non-strategic) raw materials. The benchmark in the Critical Raw Materials Act only refers to the strategic raw materials.
**Platina group metals: platinum, palladium, rhodium, ruthenium, osmium, and iridium.*
***Rare earth elements: neodymium, praseodymium, gadolinium, samarium, cerium, terbium, and dysprosium.*
Source end-of-life recycling input rate: ESTAT, [cei_srm010], last update: 11/05/2023 (2022-data) and Grohol and Veeh (2023).
Source end-of-life recycling rate: Graedel, T. E., Reck, B. K. & Miatto, A. (2022). Alloy information helps prioritize material criticality lists. Nat. Commun. 13, 1–8 (2022).

2.3 Outflow indicators

Interim outputs

Materials that are not added to stocks or recycled are transformed into gaseous, solid, or liquid outputs during the same year they are extracted. Along with materials from demolition or discarded

[22] European Commission, Joint Research Centre. (2021). *Raw Materials Scoreboard 2021*. European Union. https://rmis.jrc.ec.europa.eu/scoreboard2021

in-use stocks that have reached the end of their service life, these outputs are classified as interim outputs (IntOut). Interim outputs comprise all waste and emissions after the use pahse IntOuts are further categorized into emissions, which include all gaseous outputs (e.g., carbon dioxide [CO2], sulfur dioxide [SO2], methane [CH4]) and water vapor, and End-of-Life (EoL) waste, encompassing all solid and liquid outputs. (Mayer 2019)

Uncertainties and inconsistencies
Interim outputs are derived via the sum of TM, -Stock and eUse.

EoLw and waste management system

As mentioned previously, and proposed by Christis et al. (2021), the waste management system is considered as a separate step to which imported waste is added. In this way the disconnection with trade in waste is partly resolved. The WMS processes both the domestic waste and imported waste, part of this volume ends up as DPOw or might be exported.

Emissions

DPOe
The emissions (DPOe) comprise all gaseous emissions (e.g. carbon dioxide [CO2], sulphur dioxide [SO2], methane [CH4]) including water vapor from combustion and human and animal respiration. The oxygen input from air is excluded. DPOe is cacluated by the eUse minus solid & liquid waste. Three methods can be used to estimate the emissions related to the use of fossil energy carriers:

- First, the import minus export of fossil energy carriers resulting from the EW-MFA calculations.
- Second, using emission statistics in the greenhouse gas emissions. Considering an average vapor, including vapor from combustion, and an excess H2 of 24% (from Mayer et al. (2019) - Table S5) the emission excluding oxygen from air can be estimated.
- Third, based on the energy balance.

DPOw
Domestic processed output (waste; DPOw) is all EoLw excluding materials recovered for re- and downcycling. All liquid and solid outputs including moisture content as included in extracted material but excluding extra added water. DPOw is calculated as EoLw minus SM.

After subtracting SM, the remaining waste is returned to the environment as DPO waste (DPOw) and either landfilled, incinerated, or deliberately applied (e.g., manure, fertilizer) (Mayer). For incineration with energy recovery (RCV_E) a feedback loop is added to eUse. While waste incineration without recovery (DSP_I) flows to DPOe.

2.4 Circular economy indicators

Circularity rates

Within the framework of Mayer et al. (2018) three pairs of circularity indicators are defined to estimate socioeconomic cycling (SC), ecological cycling potential (EC) and non-circularity (NC). The socioeconomic cycling rates measure the contribution of SM to PM (input socioeconomic cycling rate, ISCr) and the share of IntOut that is diverted to be used as secondary materials (output socioeconomic cycling rate (OSCr)). Because there is no clear definition for sustainably produced biomass and an absence of related data, the share of primary biomass (*i.e.* biomass in DMC) in PM is used for the input ecological cycling rate potential (IECrp). The output ecological cycling rate potential (OECrp) represents the proportion of domestic processed output (DPO) derived from biomass. Non-circularity indicators quantify the use of fossil energy carriers in primary materials (PM) and intermediate outputs (intOut), highlighting the share of material flows that do not contribute to either socioeconomic or ecological loop closure. The unexploited potential for socioeconomic cycling can be calculated as the difference between 100% and the combined total of the three circularity rates. (Mayer et. al 2018)

CIRCULAR MATERIAL USE RATE

The circular materials use rate (CMUR) was developed by Eurostat and serves as indicator to monitor progress towards a circular economy with a focus on "secondary materials". The CMUR quantifies the proportion of materials recovered and reintegrated into the economy, reducing the need for primary raw material extraction. The indicator accounts for material flows, including fossil fuels and energy products, but excludes water flows. The CMU rate is defined as the ratio of the circular use of materials (U) to an indicator of the overall material use (M). (Eurostat)

$$CMU = \frac{U}{DMC + U} = \frac{(RCV\_R - IMP_w + EXP_w)}{DMC + (RCV\_R - IMP_W + EXP_w)}$$

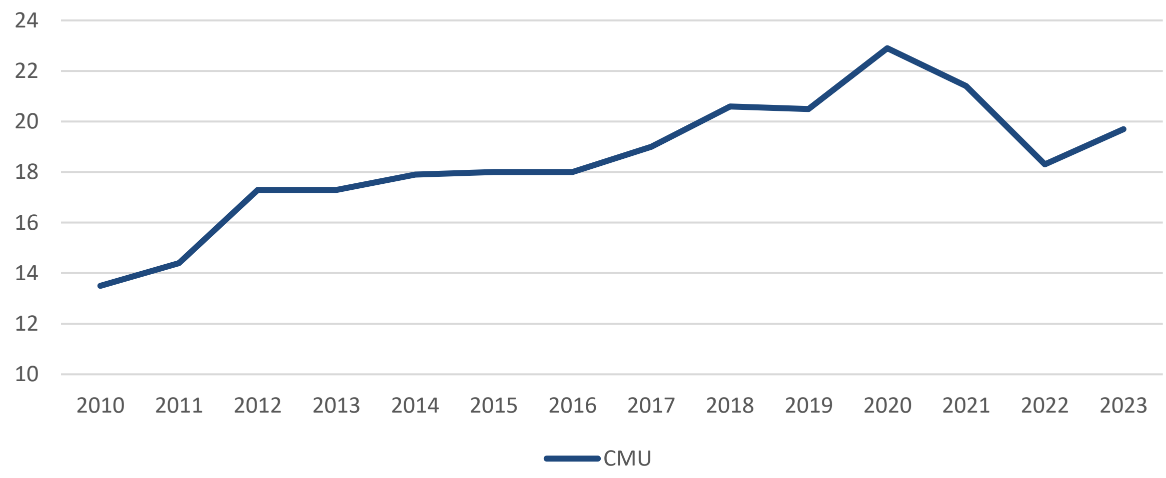

Figure 34: Belgium's circular material use rate (%) between 2010 and 2023.
Source: Eurostat (cei_srm030)

Figure 34 illustrates the evolution of Belgium's circular material use rate between 2010 and 2023. The indicator increased steadily from around 13% in 2010 to 17% in 2012, after which it remained relatively stable at approximately 19–20% until 2018. In 2019 and 2020, the rate reached its highest level of about 22%, before declining slightly in the following years and stabilising just below 20% in 2023.

Recycling rates

Recycling rates measure the share of waste materials that are recycled and fed back into the economy, reflecting how effectively material value is retained. Higher recycling rates indicate fewer material losses and more effective recycling systems. Recycling rates can be calculated for specific product groups, such as electrical and electronic equipment (EEE), or for packaging waste by packaging type; both are discussed under Section 2.2 *Use and transformation indicators*, within the *Secondary materials* indicators of this report. In addition, the recycling rate of all waste (excluding major mineral waste) can be consulted via Eurostat's CE Indicators and is presented in Figure 35. Data is available bi-annually and until 2020. After rising from 2010 to 2014, the recycling rate declines slightly around 2016 before increasing again, reaching its highest level in 2020

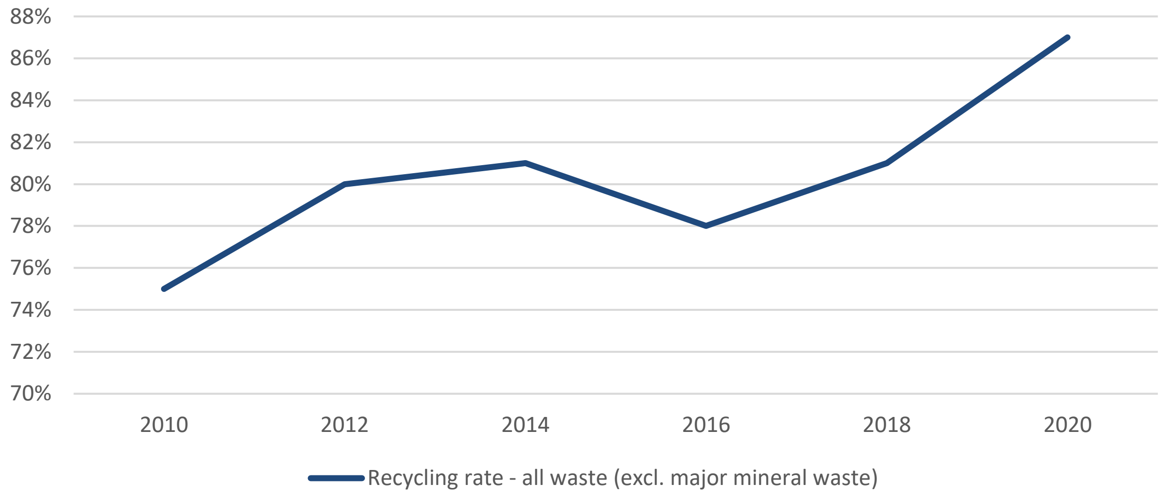

Figure 35: Belgium's recycling rate of all waste excluding major mineral waste from 2010 to 2020.
Source: Eurostat (cei_wm010)

The recycling rate of a country's municipal waste can also be consulted through Eurostat. This indicator measures the share of recycled municipal waste in total municipal waste generation and gives a good indication of the quality of a country's overall waste management system. Municipal waste mainly reflects the waste generated by households or waste from other sources that is similar in composition of household waste. Figure 36 shows this rate from Belgium from 2010 to 2023, which remained relatively stable over the period. The recycling rate of municipal waste fluctuated around 54% over the past decade, with a sharp drop in 2020. It rebounded again the following year and reached its highest level in 2023 of 55.8%.

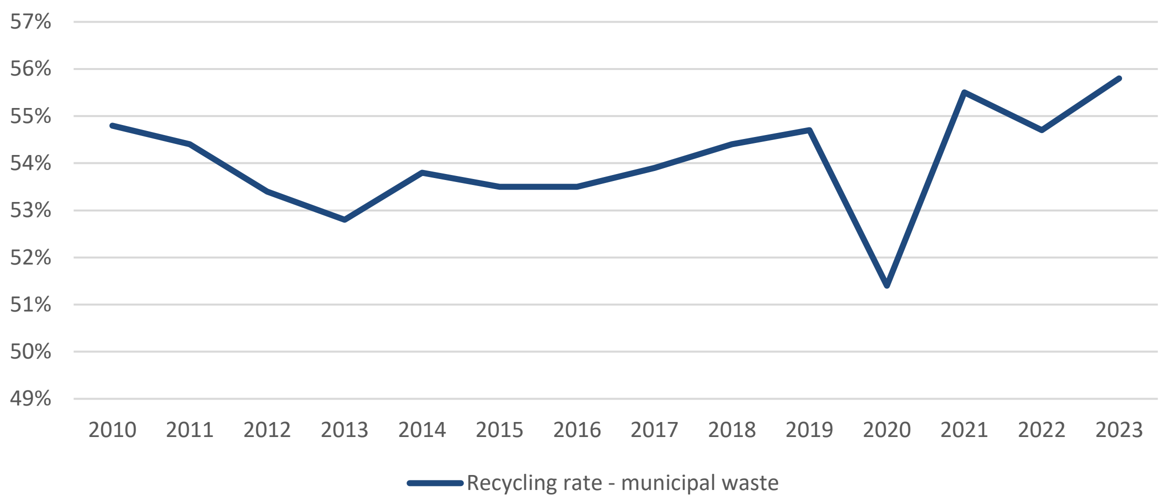

Figure 36:Belgium's recycling rate of municipal waste from 2010 to 2023.
Source: Eurostat (cei_wm011)

Uncertainties and inconsistencies

Like the secondary material (SM) flow, the circular material use rate (CMUR) can be approached from different perspectives. In principle this indicator measures both the capacity of a country to produce secondary materials and its effort to collect waste for recovery. However, countries have open economies with trade of waste collected in one country and treated and recycled in another. In that case, the production (of secondary raw materials) and collection effort (of waste for recycling) in one country may not be the same. Therefore, the CMUR must focus on either production or collection, a design choice that affects its specification. The first perspective gives a fair indication of the circularity of a country but does not measure the use of secondary materials in that country and has the risk of 'not considering' the export of waste to countries where recycling is less qualitative.

The disconnection with the trade in products containing secondary materials persists. Secondary materials extracted, recovered, or processed in products within Belgium but subsequently exported are not included. Consequently, the use of secondary materials by Belgian companies in exported products is not recognized. Only the portion of secondary materials used in products consumed domestically within Belgium is credited. As a result, the circularity rate does not fully reflect the complete use of secondary materials in the Belgian industry.

Preferably the CMUR should also be calculated for the material categories, to show differences between categories and have a better understanding of the effects on categories with a smaller share. However, an important consideration is that data with the same classification breakdown are required for all components of the indicator. While this poses no issues for DMC, it can be challenging for the SM flow due to potential spill-over effects between material categories when flows are reported separately as the categorization of SM is based on correspondence tables. However, it is important to recognize that the circularity degree largely depends on the type of materials, such as biomass for food versus minerals or metals, making direct comparisons between material categories less meaningful. Additionally, circular economy strategies may lead to substitutions between material categories. For instance, product-service systems may require more durable products, thereby increasing the demand for metals.

CMUR does not explicitly take into account the effect of CE strategies such as remanufacturing or life time extension. These strategies extend the functional life of products, preventing waste generation and reducing material demand for new products. Moreover, the indicator does not account for the quality loss of recycled materials; it only measures the quantity of materials that are cycled.

Data sources and gaps

Eurostat publishes the results of the indicator in two data sets: Circular material use rate env_ac_cur and Circular material use rate by material type env_ac_curm.

Data required for the calculation of the CMU rate as currently defined by Eurostat are readily available on country basis:

- Waste statistics (Regulation (EC) No 2150/2002)
- EW-MFA accounts (Regulation (EC) 691/2011)
- International trade in goods stats (COMEXT database)

Residual material that falls outside legal waste coverage—such as by-products from production processes—is either reintegrated into the same production process (intra-use) or sold and processed externally as part of an economic transaction. While this is important to capture especially as the circular use of residual material is expected to increase in the future, this flow is not captured by official statistics and is therefore not considered.

Furthermore, it should be noted that Eurostat's waste recovery data represents the **input** of waste streams into various recovery operations, such as recycling, energy recovery, and backfilling. It reflects the quantity of waste collected and sent for recovery, not the final usable output or its quality. The quality and efficiency of the recovery process (e.g., how much high-quality material is produced after recycling) are not directly reported in Eurostat's standard recovery datasets. Losses during recovery, contamination, or the portion of material that cannot be effectively recycled are not detailed in the recovery data. This approach can lead to overestimations of effective recovery rates, as not all input material results in usable, high-quality secondary resources. For example, not all plastics sent for recycling are converted into new products due to contamination or process inefficiencies. This limitation highlights the importance of complementary indicators or studies to assess recovery efficiency and the actual production of usable secondary materials.

Additional indicators and data sources

Ideally, the overall material use (M) should reflect the total amount of primary raw materials utilised by an economy. From this viewpoint, raw material consumption (RMC) serves as the ideal indicator, as it captures the global quantity of primary raw materials that is both directly and indirectly used by an economy.

An alternative indicator that is often considered within the national context is the National Circularity Index (NCI). This index is derived from the Global Circularity Metric methodology but applied to country level. The main difference from the CMUR is the fact that NCI applies the producers's perspective rather than the collector's perspective. The types of material flows considered differ from those in the Eurostat CMUR indicator. Specifically, backfilling materials are included, as well as materials sent to energy recovery when the Combined Heat and Power (CHP) efficiency exceeds 65%. In contrast to the CMUR indicator, the NCI accounts for the secondary materials in imported products. However, the secondary material import is estimated by means of applying the Global Circularity Index to the net direct import, which introduces a major uncertainty.

Furthermore, an additional indicator, similar to the NCI, is suggested that excludes biomass and fossil fuels for energetic purposes. However, this poses methodological challenges and may result in a distorted interpretation. For example, increasing renewable energy increases demand for non-fossil materials (e.g., metals), which is not captured in this case. A more detailed breakdown of the CMUR by material categories, like plastics and wood, would be valuable once appropriate data and methods are available.

3. CONCLUSIONS

The integrated material flow framework presented in this report highlights the complexity of tracking material use and circularity within a highly open and industrialised economy such as Belgium. By explicitly linking input flows, use phases and output flows, the framework clarifies how conventional indicators capture only part of the underlying material dynamics and where structural blind spots remain. In particular, the distinction between direct material flows and raw material equivalents reveals important mechanisms of externalisation, whereby reductions in domestic material consumption do not necessarily correspond to reductions in the overall material footprint.

The framework demonstrates that key transition points, such as the transformation of materials during use, the generation of by-products, and the management of end-of-life waste, are insufficiently reflected in existing indicator sets. The separation of waste, secondary materials and exports within the system boundary exposes potential double counting and conceptual inconsistencies that affect the interpretation of circularity metrics. This is especially relevant for indicators that rely on domestic material consumption as a denominator, while material losses, interim outputs and stock changes are only partially observed or modelled.

By embedding circularity indicators directly within the material flow structure, the analysis shows that recovery and recycling rates depend not only on waste treatment performance but also on upstream material use, stock accumulation and trade patterns. The interaction between secondary material inflows, waste management systems and exports plays a decisive role in determining observed circular material use rates, yet these interactions are not consistently captured across data sources. The framework therefore underlines the need to distinguish between theoretical circularity potentials and actual recovery outcomes based on available waste supply and stock depletion.

Overall, the framework provides a coherent basis for interpreting material flow and circular economy indicators in a consistent system context. It enables the identification of priority data gaps, notably regarding by-products, material stocks, interim outputs and the regional allocation of waste treatment flows. Addressing these gaps is essential for improving the robustness of circularity monitoring and for ensuring that observed trends reflect real changes in material use rather than artefacts of accounting conventions. The framework thus supports more transparent, policy-relevant assessments of Belgium’s progress towards a circular economy.