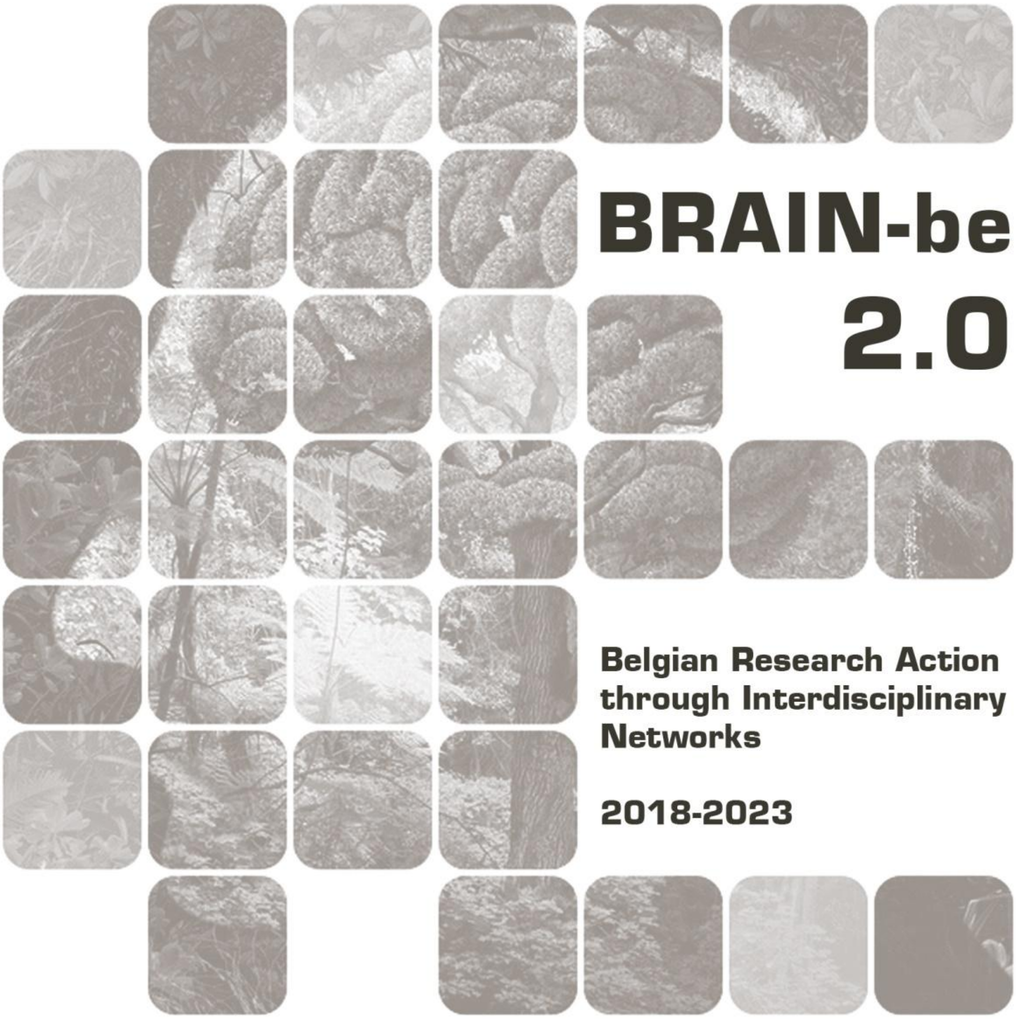

WP2: Material flow metrics and indicators

Task 2.2: Development of waste accounts for Belgium

Louise NOËL (ICEDD) – Alizé CARÊME (ICEDD)

Pillar 3: Federal societal challenges

NETWORK PROJECT

CAMBIUM

CirculAr Material flows in BelgIUM

Contract - B2/223/P3/CAMBIUM

WP2: Material flow metrics and indicators

Task 2.2: Development of waste accounts for Belgium

PROMOTORS: Maarten Christis (VITO)
Marco Orsini (ICEDD)

AUTHORS: Louise Noël (ICEDD)
Alizé Carême (ICEDD)
Dorine Hall (ICEDD)
Jana Deckers (VITO)

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WTCIII
Simon Bolivarlaan 30 bus 7
Boulevard Simon Bolivar 30 bte 7
B-1000 Brussels
Belgium
Tel: +32 (0)2 238 34 11
http://www.belspo.be
http://www.belspo.be/brain-be

Contact person: Alizé Carême aca@icedd.be
Tel: +32 (0)81 25 04 80

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ABSTRACT

Context

Over the past two decades, the transition towards a circular economy has increased the demand for robust and consistent information on secondary raw materials derived from waste. While European waste statistics and material flow accounts provide essential insights into waste generation, treatment and overall material use, they remain insufficient to describe how waste-derived materials are transformed and reintroduced into the economy. In particular, existing statistical frameworks do not allow for a systematic tracing of waste flows through treatment chains nor for a clear identification of secondary materials returning to economic production. This lack of integrated information limits the ability to assess circularity and to support evidence-based policy making.

Objectives

The Waste Accounts project aims to address these information gaps by developing a coherent accounting framework capable of describing waste flows in physical terms, from generation to final use or disposal, while explicitly identifying secondary raw materials and secondary fuels returning to the economy. Building on the System of Environmental-Economic Accounting – Central Framework (SEEA-CF), the project applies the Physical Supply and Use Table (PSUT) framework to waste, relying exclusively on existing European statistical data sources. A central objective is to improve knowledge on secondary material availability at European level without introducing additional reporting obligations for Member States. The project also seeks to provide a methodological basis for the development of new indicators relevant to circular economy monitoring.

Conclusions

The Waste Accounts framework demonstrates that existing waste and material statistics can be combined through modelling to produce new, policy-relevant information on waste treatment chains and secondary material flows. At its current stage, the model delivers a consistent and balanced representation of waste flows at the EU27 aggregate level and supports the derivation of indicators that are not accessible through conventional statistics. Exploratory applications at national level, illustrated through the example of Belgium, confirm both the added value of detailed waste composition data and the sensitivity of results to methodological assumptions, reference years and data heterogeneity. These findings underline that waste accounts are modelling instruments rather than fixed statistical products and that national applications require careful adaptation. Despite remaining limitations, the Waste Accounts project provides a solid methodological foundation for future developments towards country-level implementation and enhanced circular economy monitoring.

Keywords

Waste accounts
Secondary raw materials
circular economy
Material flow accounting

1. INTRODUCTION

Over the last two decades, the transition towards a circular economy has progressively reshaped European environmental and economic policies. This shift has led to a growing interest in **secondary raw materials**, understood as **materials recovered from waste streams and reintroduced into the economy through recycling, recovery or other valorisation processes.** In this context, policymakers increasingly require robust and consistent information on the origin, transformation and final use of waste-derived materials. Beyond the quantities of waste generated or treated, attention has shifted towards understanding **to what extent waste effectively returns to the economy, in which form, and through which economic actors**.

Despite the existence of well-established European statistical frameworks, the information currently available remains insufficient to answer these questions in a comprehensive manner. Waste statistics collected under the Waste Statistics Regulation (WStatR) primarily focus on waste generation and final treatment operations. While these data are essential, they do not provide a detailed representation of the internal processes of waste management, nor do they allow for a systematic identification of secondary material flows that re-enter economic production. In parallel, material flow accounts (MFA) offer a macro-level view of material use within the economy, but they do not explicitly describe waste treatment chains or the transformation of waste into secondary raw materials. As a result, significant information gaps persist at the interface between waste statistics, material flow accounting and environmental-economic analysis.

Addressing these gaps is not straightforward, as existing data sources were not designed to describe waste management as a sequence of interconnected physical flows. Waste generation data reflect gross waste production and may include multiple counting of materials, while treatment data concentrate on final treatment categories and largely exclude intermediate or pre-treatment operations. Moreover, waste statistics do not distinguish systematically between waste residuals and waste products, even though this distinction is fundamental for identifying when waste acquires economic value and re-enters the production boundary. As a consequence, the direct compilation of waste accounts from statistical sources is not feasible without additional modelling.

To overcome these limitations, the Waste Accounts project adopts a modelling-based approach grounded in the accounting principles of the System of Environmental-Economic Accounting – Central Framework (SEEA-CF). In particular, it builds on the framework of Physical Supply and Use Tables (PSUT), which are designed to record physical inputs, outputs and exchanges between the economy and the environment in a balanced and consistent manner. Applied to waste, the PSUT framework makes it possible to describe not only the supply of waste by economic activities and households, but also its use by waste treatment processes, accumulation in landfills or backfilling, exports, dissipation to the environment and reintegration into the economy as products. Figure 1 illustrates the conceptual structure of the waste supply and use tables as implemented in the project, highlighting the distinction between waste residuals and waste products within the accounting framework.

Physical supply table for solid waste

	Generation of solid waste							Rest of the world	Flows from the environment	
	Waste collection, treatment and disposal industry									
		Incineration								
	Landfill	Total	Of which: Incineration to generate energy	Recycling and reuse	Other treat-ment	Other indus-tries	Households	Imports of solid waste	Recovered residuals	Total supply

Physical use table for solid waste

	Intermediate consumption; collection of residuals						Final consumption	Rest of the world		
	Waste collection, treatment and disposal industry									
		Incineration								
	Landfill	Total	Of which: Incineration to generate energy	Recycling and reuse	Other treat-ment	Other indus-tries	Households	Exports of solid waste	Flows to the environ-ment	Total use

FIGURE 1. CONCEPTUAL STRUCTURE OF THE PHYSICAL SUPPLY AND USE TABLES (PSUT) APPLIED TO WASTE ACCOUNTS, ILLUSTRATING THE DISTINCTION BETWEEN WASTE RESIDUALS AND WASTE PRODUCTS, AND THE BALANCING OF SUPPLY AND USE WITHIN THE SEEA-CF FRAMEWORK SOURCE ARGUS AND ICEDD

2. OBJECTIVES

The Waste Accounts project was initiated to address the information gaps identified above. Carried out for Eurostat in collaboration with ARGUS and ICEDD, the project aims to develop a coherent accounting framework capable of describing waste flows in physical terms, from generation to final use or disposal, while explicitly identifying the flows that return to the economy as secondary raw materials or secondary fuels.

A key ambition of the project is to improve knowledge on secondary material availability in the European economy without imposing additional reporting burdens on Member States. Rather than introducing new data collections, the project deliberately relies on existing European datasets and statistical systems, including waste statistics, material flow accounts, trade statistics and the SEEA-CF. This constraint constitutes both a methodological challenge and a defining feature of the project, shaping the choice of methods and the scope of the analysis.

The central objective of the Waste Accounts project is therefore to estimate, in a coherent and transparent way, **the physical flows associated with waste management and secondary material production at the European level.** This includes identifying which flows are exchanged, who supplies them, who uses them, in what quantities and through which treatment pathways. By aligning waste accounts with existing methodologies such as MFA and SEEA-CF, the project seeks to ensure consistency across environmental accounts while extending their analytical capacity. In doing so, it provides a foundation for the development of new indicators capable of supporting circular economy policies and monitoring progress towards European environmental objectives.

At the current stage, the model has been developed and tested at the level of the EU27 aggregate, covering a wide range of waste categories and treatment operations over a multi-year period. The focus on aggregated European data reflects both data availability constraints and the exploratory nature of the approach. Nevertheless, the long-term perspective of the project is to enable country-level implementation, allowing Member States to better understand their own waste treatment systems and secondary material potentials within a harmonised European framework.

The following chapter describes the structure of the Waste Accounts model and the methodological choices underlying its implementation within the PSUT framework.

3. METHODOLOGY

3.1 Description of the Waste Accounts model

Building on the conceptual framework introduced in the previous chapter, the Waste Accounts model was developed to translate the principles of Physical Supply and Use Tables into an operational tool capable of describing waste flows and secondary material production in a coherent and balanced manner. Building on the principles of the SEEA-CF, the model extends the standard PSUT framework to account for the specific characteristics of waste management systems, including the distinction between waste residuals and waste products, the presence of multiple treatment steps and the transformation of waste into materials that re-enter the economy.

At the core of the model are two interlinked physical accounting tables: **the physical supply table** and **the physical use table for waste.** Together, these tables record all physical flows associated with waste generation, treatment, use, accumulation, exports and dissipation to the environment. The accounting structure ensures that, for each flow and at each level of aggregation, total supply equals total use, thereby allowing the identification of secondary material flows without double counting. These tables follow the structure illustrated in Figure 2 and 3, which provides the reference framework for the implementation of the model.

[t]			sector:																
flow type	supplied flow	material class	A	B	…	E38/MECH	E38/BIO	E38/PCT	E38/RCV_E	E38/DSP_I	…	HH	IMP	ACC/DSP_L	ACC/RCV_B	ACC/DSP_OTH	ENV	Total
Natural Input			-	-		-	-	-	-	-		-	-	-	-	-	-	-
	Air, nitrogen		-	-		-	-	-	-	-		-	-	-	-	-	-	-
	Air, oxygen		-	-		-	-	-	-	-		-	-	-	-	-	-	-
	Water		-	-		-	-	-	-	-		-	-	-	-	-	-	-
Residuals/Waste			**20.210.000**	**624.830.000**		**88.059.582**	**40.412.723**	**12.240.438**	**22.016.855**	**3.938.305**		**187.260.000**	**11.684.680**	-	-	-	-	**2.225.202.583**
	R-W011		-	-		-	-	-	-	-		**10.000**	**15.532**	-	-	-	-	**1.975.532**
		4	-	-		-	-	-	-	-		10.000	15.532	-	-	-	-	1.975.532
	…																	
	R-W101		**290.000**	**30.000**		-	-	-	-	-		**109.090.000**	**713.213**	-	-	-	-	**135.963.213**
		1	192.879	19.953		-	-	-	-	-		72.555.759	474.358	-	-	-	-	90.429.133
		2	12.200	1.262		-	-	-	-	-		4.589.416	30.005	-	-	-	-	5.719.972
		3	29.313	3.032		-	-	-	-	-		11.026.817	72.092	-	-	-	-	13.743.162
		4	55.608	5.753		-	-	-	-	-		20.918.008	136.759	-	-	-	-	26.070.946
		5	-	-		-	-	-	-	-		-	-	-	-	-	-	-
	…																	
Residuals/Material dissipation			-	-		-	**37.013.507**	**11.703.985**	**75.613.672**	**10.466.394**		-	-	-	-	-	-	**134.797.558**
	Material dissipation		-	-		-	**37.013.507**	**11.703.985**	**75.613.672**	**10.466.394**		-	-	-	-	-	-	**134.797.558**
		1	-	-		-	37.013.507	2.036.027	58.177.970	6.770.007		-	-	-	-	-	-	103.997.510
		2	-	-		-	-	1.267.388	70.200	-		-	-	-	-	-	-	1.337.588
		3	-	-		-	-	3.540.435	46.800	183.768		-	-	-	-	-	-	3.771.003
		4	-	-		-	-	4.769.150	17.318.671	3.512.619		-	-	-	-	-	-	25.600.440
		5	-	-		-	-	90.985	32	-		-	-	-	-	-	-	91.017
Products			-	-		**581.135.400**	**46.648.456**	**11.864.727**	-	-		-	**9.401.941**	-	-	-	-	**724.200.661**
	P-38.32.2 (excl. 22)		-	-		**6.576.842**	-	-	-	-		-	**1.297.534**	-	-	-	-	**10.054.655**
		1	-	-		-	-	-	-	-		-	-	-	-	-	-	-
		2	-	-		6.576.842	-	-	-	-		-	1.297.534	-	-	-	-	10.054.655
		3	-	-		-	-	-	-	-		-	-	-	-	-	-	-
		4	-	-		-	-	-	-	-		-	-	-	-	-	-	-
		5	-	-		-	-	-	-	-		-	-	-	-	-	-	-
	…																	
Total			**20.210.000**	**624.830.000**		**669.194.982**	**124.074.687**	**35.809.149**	**97.630.528**	**14.404.699**		**187.260.000**	**21.086.622**	-	-	-	-	**3.084.200.802**

FIGURE 2 - SUPPLY TABLE SEPARATES THE GENERATION OF SOLID WASTE RESIDUALS AND SOLID WASTE PRODUCTS. SOURCE: ARGUS AND ICEDD

[t] flow type	used flow	material class	sector: A	B	…	E38/MECH	E38/BIO	E38/PCT	E38/RCV_E	E38/DSP_I	…	HH	EXP	ACC/DSP_L	ACC/RCV_B	ACC/DSP_OTH	ENV	Total
Natural Input			-	-		-	-	-	-	-		-	-	-	-	-	-	-
	Air, nitrogen		-	-		-	-	-	-	-		-	-	-	-	-	-	-
	Air, oxygen		-	-		-	-	-	-	-		-	-	-	-	-	-	-
	Water		-	-		-	-	-	-	-		-	-	-	-	-	-	-
Residuals/Waste			-	-		**669.194.982**	**124.074.687**	**35.809.149**	**97.630.528**	**14.404.699**		-	**6.799.116**	**878.528.868**	**212.245.851**	**132.340.000**	-	**2.225.202.583**
	R-W091		-	-		-	**20.333.218**	-	**1.430.000**	**210.000**		-	**62.765**	**230.000**	-	**140.000**	-	**22.405.982**
		1	-	-		-	20.333.218	-	1.430.000	210.000		-	62.765	230.000	-	140.000	-	22.405.982
	…																	
	R-W101		-	-		**6.137.347**	**37.700.845**	-	**47.460.000**	**6.220.000**		-	**365.022**	**38.030.000**	**40.000**	**10.000**	-	**135.963.213**
		1	-	-		4.081.949	25.074.832	-	31.565.646	4.136.922		-	242.776	25.293.753	26.604	6.651	-	90.429.133
		2	-	-		258.198	1.586.075	-	1.996.642	261.675		-	15.356	1.599.922	1.683	421	-	5.719.972
		3	-	-		620.363	3.810.801	-	4.797.257	628.718		-	36.896	3.844.072	4.043	1.011	-	13.743.162
		4	-	-		1.176.836	7.229.137	-	9.100.455	1.192.685		-	69.993	7.292.253	7.670	1.918	-	26.070.946
		5	-	-		-	-	-	-	-		-	-	-	-	-	-	-
Residuals/Material dissipation			-	-		-	-	-	-	-		-	-	-	-	-	**134.797.558**	**134.797.558**
	Material dissipation		-	-		-	-	-	-	-		-	-	-	-	-	**134.797.558**	**134.797.558**
		1	-	-		-	-	-	-	-		-	-	-	-	-	103.997.510	103.997.510
		2	-	-		-	-	-	-	-		-	-	-	-	-	1.337.588	1.337.588
		3	-	-		-	-	-	-	-		-	-	-	-	-	3.771.003	3.771.003
		4	-	-		-	-	-	-	-		-	-	-	-	-	25.600.440	25.600.440
		5	-	-		-	-	-	-	-		-	-	-	-	-	91.017	91.017
Products			**46.648.456**	-		-	-	-	-	-		-	**22.335.440**	-	-	-	-	**724.200.661**
	…																	
	P-38.32.39/compost		**22.346.370**	-		-	-	-	-	-		-	-	-	-	-	-	**22.346.370**
		1	22.346.370	-		-	-	-	-	-		-	-	-	-	-	-	22.346.370
Total			**46.648.456**	-		**669.194.982**	**124.074.687**	**35.809.149**	**97.630.528**	**14.404.699**		-	**29.134.556**	**878.528.868**	**212.245.851**	**132.340.000**	**134.797.558**	**3.084.200.802**

FIGURE 3 - USE TABLE SEPARATES THE COLLECTION AND DISPOSAL OF SOLID WASTE RESIDUALS FROM THE USE OF SOLID WASTE PRODUCTS. SOURCE: ARGUS AND ICEDD

The physical supply table describes the origin of waste-related flows. It records the generation of primary waste by economic activities and households, the supply of secondary waste arising from waste treatment processes, and the supply of waste products that acquire economic value and are exchanged between economic units. A key feature of the model is the explicit separation between waste residuals and waste products at the time of disposal or treatment. Waste residuals correspond to materials that are discarded and require treatment, while waste products refer to discarded materials that are directly supplied to other economic units with a positive value, such as scrap metals. This distinction is essential to correctly identify when waste crosses the production boundary and contributes to economic activity.

The physical use table complements the supply table by describing how waste flows are used within the economy and beyond. It records the collection and treatment of waste residuals by the waste management sector, the use of waste products by economic activities, exports of waste, accumulation in landfills or backfilling sites, and flows to the environment resulting from dissipation during treatment. In the model, waste treatment activities are represented as intermediate consumption processes that transform waste residuals into secondary waste, waste products or dissipated materials, depending on the type of treatment applied.

The waste management sector, corresponding primarily to NACE Rev.2 division E38, plays a central role in the model. To reflect the diversity of waste treatment operations, this sector is further disaggregated by treatment type. The model distinguishes between mechanical treatment, biological treatment, physico-chemical treatment, energy recovery, incineration, landfilling, backfilling and other disposal operations. These treatment types are consistent with the categories used in waste statistics, while allowing for a more detailed representation of the internal structure of waste management processes. Treatments that do not result in outputs supplied to the economy, such as landfilling or certain disposal operations, are treated as final uses within the accounting framework.

One of the defining characteristics of the Waste Accounts model is its representation of waste treatment as a sequence of treatment steps rather than as a single final operation. For each waste category, the treatment chain is modelled as a succession of up to five steps, starting from the generation of primary waste and ending with final disposal, accumulation or reintegration into the economy. This approach reflects the reality of waste management systems, where waste often undergoes pre-treatment operations such as sorting or stabilisation before being recycled, recovered or disposed of. By modelling these sequences explicitly, the model captures intermediate flows that are not visible in conventional waste statistics.

The modelling is performed at the level of waste categories as defined by the EWC-Stat classification. Each waste category is treated as a distinct waste stream, for which a specific treatment pathway is defined. The starting point of the modelling is the amount of primary waste generated within the EU, including waste subsequently exported for treatment and waste imported from outside the EU. Secondary waste generated during treatment processes is accounted for as output from one treatment step and input to subsequent steps, ensuring mass balance throughout the treatment chain.

To ensure compatibility with material flow accounting, all waste flows are decomposed into material components and allocated to the five MFA material classes: biomass, metal ores, non-metallic minerals, fossil energy materials and carriers, and other materials. This requirement implies that even mixed waste categories must be represented as combinations of material components. In the model, transformations of matter during treatment processes are not represented as chemical conversions between materials, but as physical reallocations that preserve mass balance at the component level. For instance, materials entering incineration are represented as generating both residual outputs, such as slag or ash, and material dissipation to the environment, while maintaining the original material composition for accounting purposes.

Several assumptions are required to operationalise the model, given the limitations of existing data. These assumptions concern, among others, the allocation of waste flows to treatment types, the distribution of outputs from one treatment step to subsequent steps, and the composition of mixed waste categories. While these assumptions introduce uncertainty at the level of individual flows, they are applied consistently across all waste categories and treatment chains, ensuring coherence at the aggregated level. The objective of the model is not to reproduce specific national waste management systems in detail, but to provide a harmonised and transparent representation of waste flows at the European level.

The scope of the model corresponds to EU27 aggregates and covers the period from 2004 to 2020, with the possibility of extension to subsequent years. The choice of an aggregated European scope reflects both data availability and the exploratory nature of the project. At this stage, the model is not intended to be applied directly at the level of individual Member States without adaptation, as national waste management structures may differ significantly and require country-specific assumptions.

While the Waste Accounts model provides a coherent framework to represent waste flows and treatment chains, its operational implementation requires waste categories to be expressed in material terms compatible with material flow accounting. Many waste categories used in waste statistics are heterogeneous and cannot be directly linked to material classes or components. To address this limitation, the Waste Accounts methodology relies on correspondence tables that translate waste categories into consistent material breakdowns, enabling the balancing of flows across treatment steps. The following chapter describes the construction and application of these correspondence tables and their role in waste decomposition.

3.2 Correspondence tables and waste decomposition

A central methodological challenge of the Waste Accounts project lies in the treatment of waste categories that are heterogeneous by nature. As presented on the table below, most waste flows reported in European waste statistics, and in particular those defined under the EWC-Stat classification, do not correspond to single materials but rather to mixtures of different material components (mixed). This heterogeneity prevents a direct integration of waste statistics into a Physical Supply and Use Table framework that is compatible with material flow accounting. To overcome this limitation, the Waste Accounts model relies on correspondence tables that decompose waste categories into material components and material classes.

TABLE 1 - CATEGORISATION OF EWC-STAT CATEGORIES BY WASTE COMPOSITION. SOURCE: ARGUS AND ICEDD

Item #	WASTE Code (EWC-Stat)	WASTE Description	Pure / Mixed / Non-disaggregated
1	W011	Spent solvents	Non-disaggregated
2 & 3	W012	Acid, alkaline or saline wastes	Non-disaggregated
4	W013	Used oils	Non-disaggregated
5 & 6	W02A	Chemical wastes	Non-disaggregated
7 & 8	W032	Industrial effluent sludges	Non-disaggregated
9 & 10	*W033*	*Sludges and liquid wastes from waste treatment*	*Not applicable (second. waste)*
11 & 12	W05	Health care and biological wastes	**Mixed**
13	W061	Metal wastes, ferrous	**Pure**
14	W062	Metal wastes, non-ferrous	**Pure**
15	W063	Metal wastes, mixed ferrous and non-ferrous	**Mixed**
16 & 17	W071	Glass wastes	**Pure**
18	W072	Paper and cardboard wastes	**Pure**
19	W073	Rubber wastes	**Mixed**
20	W074	Plastic wastes	**Mixed**
21 & 22	W075	Wood wastes	**Pure**
23	W076	Textile wastes	**Mixed**
24	W077	Waste containing PCB	Non-disaggregated
25 & 26	W08A	Discarded equipment (except discarded vehicles and batteries and accumulators waste)	**Mixed**
27 & 28	W081	Discarded vehicles	**Mixed**
29 & 30	W0841	Batteries and accumulators wastes	**Mixed**
31	W091	Animal and mixed food waste	**Pure**
32	W092	Vegetal wastes	**Pure**
33	W093	Animal faeces, urine and manure	**Pure**
34	W101	Household and similar wastes	**Mixed**
35 & 36	W102	Mixed and undifferentiated materials	**Mixed**
37 & 38	*W103*	*Sorting residues*	*Not applicable (second. waste)*
39	W11	Common sludges	Non-disaggregated
40 & 41	W121	Mineral waste from construction and demolition	**Mixed**
42 & 43	W12B	Other mineral wastes (W122+W123+W125)	**Pure**
44 & 45	W124	Combustion wastes	**Pure**
46 & 47	W126	Soils	Non-disaggregated
48 & 49	W127	Dredging spoils	Non-disaggregated
50 & 51	*W128_13*	*Mineral wastes from waste treatment and stabilised wastes*	*Not applicable (second. waste)*

The correspondence tables establish a systematic link between waste categories as reported in waste statistics and the material composition required for accounting purposes. For each waste category, the table specifies the share of different material components, which are subsequently allocated to the five material classes used in material flow accounts. This step is essential to ensure consistency between waste accounts and MFA, as all waste-related flows must ultimately be attributable to biomass, metal ores, non-metallic minerals, fossil energy materials and carriers, or other materials. Without this decomposition, it would not be possible to trace secondary raw materials derived from waste through the economy in a manner that is compatible with existing accounting frameworks.

The methodological role of the correspondence tables extends beyond classification. By translating waste categories into material components, they enable the modelling of waste treatment chains at a level of detail that is not available in waste statistics. In the model, waste flows are balanced at the component level across treatment steps, which allows the identification of material dissipation, accumulation and reintegration into the economy. Figure 4, which presents the different levels of breakdown applied to the rows of the physical supply and use tables, illustrates how waste categories are progressively decomposed into residuals, products, material classes and components within the accounting framework.

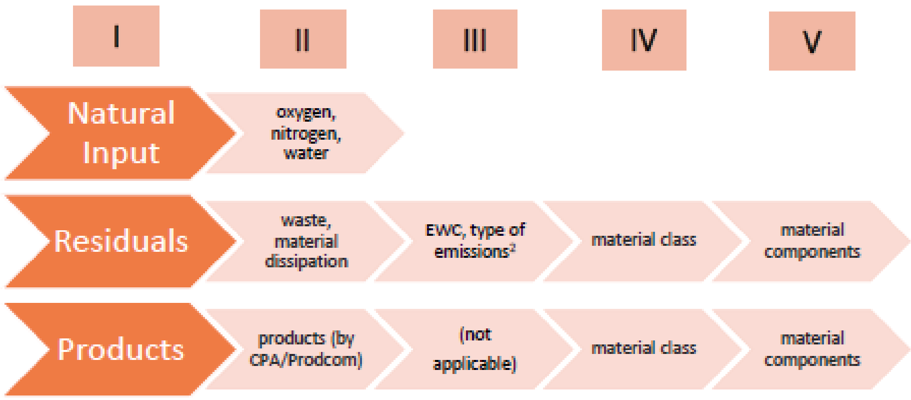

FIGURE 4 - OVERVIEW OF THE DIFFERENT LEVELS OF BREAKDOWN USED IN THE SUT ROWS. SOURCE: ARGUS AND ICEDD

In order to understand the logic of the Waste Accounts model and the central role played by correspondence tables, it is useful to start with a concrete example. Household and similar waste, classified as W101 under EWC-Stat, provides an illustrative case to demonstrate why waste decomposition is necessary and how it is implemented in practice.

W101 represents one of the largest waste flows in the European Union and is characterised by a highly heterogeneous composition. It typically includes organic material, paper and cardboard, plastics, metals, glass, textiles and other minor fractions, whose relative shares vary across countries and collection systems. From a statistical perspective, W101 is reported as a single waste category in waste generation and treatment statistics. However, from an accounting perspective, such an aggregated category cannot be directly integrated into a Physical Supply and Use Table framework that aims to trace materials and identify secondary raw material flows.

Within the Waste Accounts model, the treatment of W101 illustrates the need to decompose mixed waste categories into material components (see Figure 5). The modelling starts from the total amount of W101 generated at EU level and follows this flow through successive waste treatment operations. At each treatment step, the input flow is split into outputs according to the material composition of the waste and the technical characteristics of the treatment. Mechanical treatment, for instance, redistributes the input into segregated material flows, while incineration produces residual outputs such as slag and ash, as well as material dissipation to the environment. Throughout the process, mass balance is maintained at the level of material components, ensuring consistency between inputs and outputs.

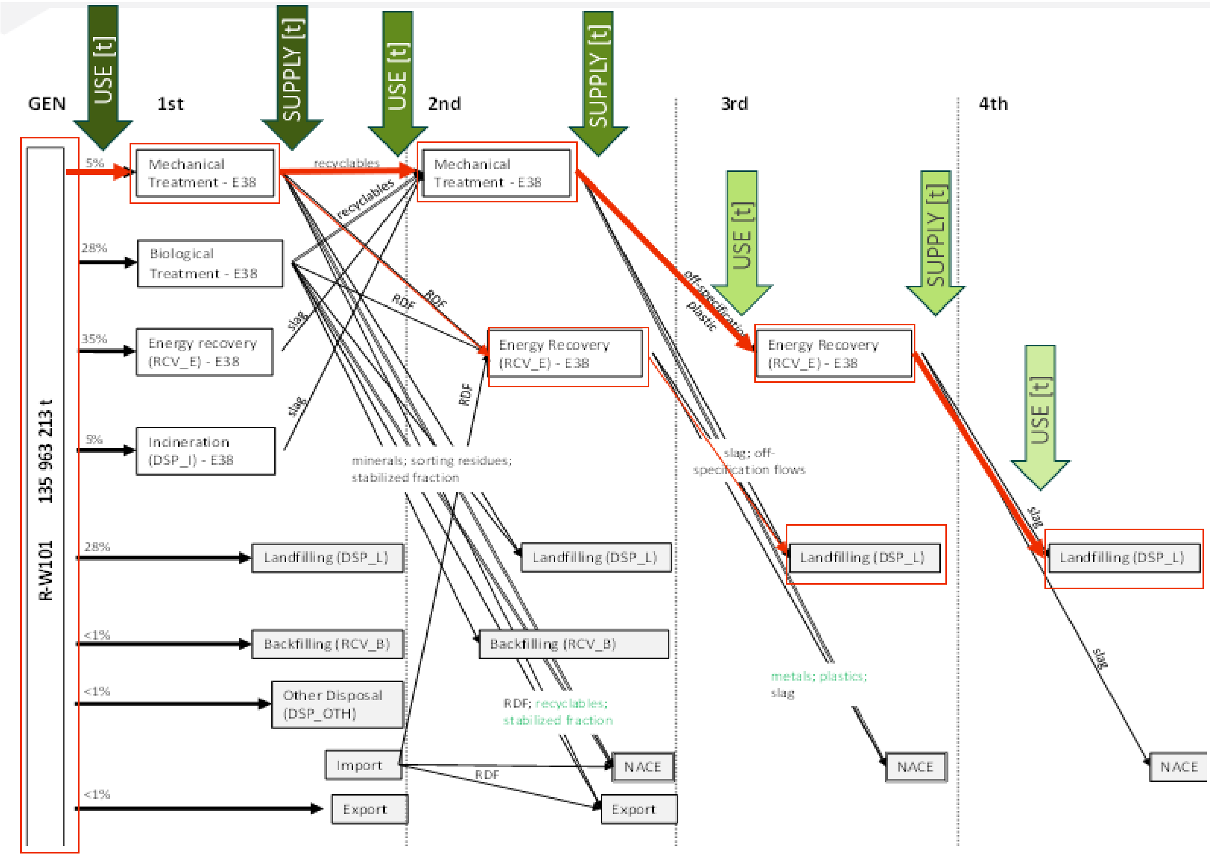

FIGURE 5– EXAMPLE OF THE MODELISATION OF TREATMENT OF W101. SOURCE: ARGUS

To enable this modelling, the primary waste flow must first be expressed in terms of material components. For W101, this requires an estimation of its composition based on existing information sources. At EU level, the composition used in the model is derived primarily from the European Environment Agency's municipal waste model, complemented by waste characterisation studies and literature sources. These data provide estimates for the relative shares of organic material, paper, plastics, metals, glass and other components within household waste. Once defined, this composition becomes a key input to the model, as it determines how the waste flow is transformed across treatment steps and which materials ultimately re-enter the economy as secondary raw materials.

To improve the robustness of the correspondence tables and to account for national specificities in waste composition, Member States were invited to contribute to the process by providing information on the material breakdown of selected waste categories. This exercise was designed as a targeted and limited request, focusing on expert knowledge and existing national studies rather than on new data collection.

Responses were received from 8 Member States, 6 of which provided sufficiently detailed information to allow the correspondence tables to be adapted to their national context. Although the participation was limited, the contributions provided valuable insights into the variability of waste composition across countries and waste management systems. In some cases, the responses confirmed the assumptions used in the initial correspondence tables, while in others they highlighted significant differences linked to collection systems, consumption patterns or industrial structures. These inputs were used to refine the correspondence tables and to assess the sensitivity of the model to changes in waste composition.

Overall, the use of correspondence tables is a cornerstone of the Waste Accounts project. By enabling the decomposition of waste categories into material components, they make it possible to trace secondary raw materials throughout waste treatment chains and to integrate waste statistics into a coherent accounting framework. At the same time, the experience gained from the W101 example and from the consultation of Member States highlights the need for continued refinement of waste composition data, particularly if the model is to be applied at national level in the future.

The following chapter presents an exploratory application of the correspondence tables for Belgium. Using detailed waste composition studies available for Flanders and Wallonia, this example demonstrates how the same methodological framework can be applied to different regional contexts and how resulting correspondence tables may differ from the EU average. The exercise provides insight into the added value of national data for waste accounts, while also underlining the limits of comparability arising from differences in methodologies, reference years and underlying assumptions.

3.3 Example for Belgium

In order to illustrate how the correspondence tables can be adapted at national or sub-national level, an exploratory exercise was carried out for Belgium. This exercise relies on detailed waste composition studies available for 2 regions, Flanders and Wallonia, and applies the same methodological principles as those used for the EU-level correspondence table. The objective is not to produce definitive national waste accounts, but to demonstrate how existing composition data can be translated into the Waste Accounts framework and to highlight the sensitivity of results to underlying assumptions.

For Flanders, the exercise is based on the report “Eindrapport Sorteeranalyse huisvuil 2019-2021”, published by OVAM and covering waste composition data collected between 2019 and 2021. For Wallonia, the analysis relies on the report “Analyse de la composition des ordures ménagères brutes et des déchets organiques collectés sélectivement en Wallonie - Année 2017-2018”, published in 2019 and based on measurement campaigns carried out in 2017 and 2018. It is important to note from the outset that these studies do not cover the same reference years and that differences in results must therefore be interpreted with caution.

<u>Flanders</u>

The Flemish exercise focuses on the composition of household residual waste, as analysed in the OVAM sorting study. The starting point is the mass-based composition of the residual waste stream, which reflects what remains in the waste bin after the operation of existing selective collection systems. This composition was translated into the flow components used in the Waste Accounts correspondence table by allocating each reported fraction to material components and, subsequently, to material classes.

The allocation relies on a set of transparent assumptions. Paper and cardboard, glass, metals and wood are directly assigned to their corresponding material components. Plastics are assumed to be predominantly synthetic, while textiles are divided between synthetic and natural fibres. Organic waste is allocated to the biomass material class. Fractions described as inerts or fines are mainly assigned to non-metallic minerals, while mixed or poorly identifiable fractions are allocated to unspecified components.

Two fractions required particular attention. Sanitary and hygienic waste represents a significant share of the Flemish residual waste and is characterised by a multi-material composition combining cellulose, synthetic polymers and absorbent materials, often contaminated by biological residues. Due to this complexity, it cannot be meaningfully attributed to a single material component. In the correspondence table, this fraction is therefore split between biomass, fossil-based materials and unspecified components, with the assumption that it does not contribute to material recycling and is primarily oriented towards incineration.

The category labelled “other combustible and inert fractions” poses similar challenges. It aggregates heterogeneous residues such as composites, degraded plastics, textiles, small fragments and mineral fines. These materials are difficult to identify and separate during sorting and are partly combustible and partly inert. In the correspondence table, this fraction is distributed across fossil materials, non-metallic minerals, biomass and unspecified components, reflecting both its physical heterogeneity and the uncertainty associated with its classification.

Wallonia

For Wallonia, the exercise is based on the detailed composition analysis of household residual waste presented in the 2019 RDC Environment and ICEDD report, using data collected in 2017 and 2018. The study provides a fine-grained breakdown of waste categories, including organic waste, plastics, textiles, textiles sanitaires, inerts, fines, composites and various minor fractions. As for Flanders, the analysis focuses on the residual waste stream, excluding selectively collected fractions.

The translation into the Waste Accounts correspondence table follows the same principles as for Flanders. Material fractions that are clearly identifiable are allocated directly to corresponding components, while mixed or composite categories are distributed across several components based on their typical material content. Organic waste is assigned to biomass, plastics to fossil-based materials, and inerts and fines to non-metallic minerals.

Specific complications arise from the high share of inerts in the Walloon residual waste, which is largely explained by the presence of mineral-based cat litter and fine fractions. These materials increase the weight of the mineral component and contribute little to material recovery. As in the Flemish case, sanitary textiles represent a structurally important fraction that cannot be easily decomposed into pure materials. Their allocation therefore relies on assumptions similar to those used for Flanders, with a significant share assigned to unspecified components to reflect uncertainty and heterogeneity.

Comparison of results

When comparing the three correspondence tables (see Table 2), namely the EU average, the Flemish case and the Walloon case, several differences become apparent. Compared to the EU-level table, both Belgian regions show a lower share of traditionally recyclable materials such as paper, glass and metals in the residual waste stream, reflecting relatively well-developed selective collection systems. At the same time, both regions display a higher relative importance of organic waste that show the importance and the potential of the selective collection of this waste.

TABLE 2 - CORRESPONDENCE TABLE FOR HOUSEHOLD AND SIMILAR WASTE (W101): COMPARISON BETWEEN EU27, FLANDERS AND WALLONIA

Flow component	EU27 (2016)	Flanders (2019–2021)	Wallonia (2017–2018)
Paper and cardboard	14	9	7,5
Glass	5	2	3,6
Plastics, synthetic	13	14	12
Plastics, natural	0	1	0,8
Rubber, synthetic	–	1	0,8
Rubber, natural	–	0	0
Metals, ferrous	2	1	1
Metals, non-ferrous	1	1	0,9
Wood	3	1	0,3
Textiles, synthetic	4	3,5	2,7
Textiles, natural	2	1,5	1,1
Organic (animal / vegetal origin)	37	42	41,7
Mineral	3	6	12
Unspecified / MFA1 (mainly biogenic)	11	8	6
Unspecified / MFA2 (mixed / composites)	1	2	3
Unspecified / MFA3 (miscellaneous)	2	2	3,5
Unspecified / MFA4 (mainly fossil)	3	2	2,1
Unspecified / MFA5 (balancing item)	–	3	0,7
Total	**100**	**100**	**100**

Differences between Flanders and Wallonia are also significant. The Flemish residual waste contains a higher proportion of organic material, while the Walloon residual waste shows a much larger mineral fraction, mainly due to inerts. The relative importance of sanitary and hygienic waste is comparable in both regions, but its impact on the correspondence table is amplified by differences in the surrounding waste composition. These contrasts illustrate how regional waste management practices, consumption patterns and collection systems shape the structure of residual waste and, consequently, the results of waste accounts.

However, these comparisons must be interpreted with care. The underlying composition studies do not refer to the same reference years, and waste management systems have evolved since the data were collected. In particular, the selective collection of organic waste has expanded in recent years in both regions, which is likely to have reduced the share of organics in the residual waste stream. As a result, the correspondence tables derived from these studies represent snapshots in time rather than current conditions.

Discussion and perspectives

This Belgian example highlights the fundamental difficulty of comparing waste accounts across countries or regions. Composition studies are based on different methodologies, sampling strategies, levels of detail and classification systems. Even when they target similar waste streams, differences in definitions and measurement protocols inevitably lead to differences in results. The construction of correspondence tables therefore always involves assumptions, and these assumptions vary depending on data availability and quality.

At the same time, the exercise demonstrates the value of detailed composition studies for improving waste accounts. They provide empirical evidence that can be used to refine correspondence tables, reduce uncertainty and better reflect national or regional specificities. From a methodological perspective, the Belgian case confirms that the Waste Accounts framework is flexible enough to accommodate such adaptations, while also making explicit the limits of comparability.

As a perspective, it is worth noting that a new waste composition study is currently underway in Wallonia. Once completed, it will provide more recent data that can be used to update the correspondence table and to assess changes in the structure of household residual waste over time. Such updates will be essential for moving towards more robust national applications of the Waste Accounts model and for improving the relevance of the indicators derived from it.

3.4 Indicators derived from the Waste Accounts

The primary objective of the Waste Accounts project is not limited to the compilation of a new dataset, but rather to the production of information that cannot be derived from existing waste statistics or material flow accounts taken separately. By integrating waste statistics into a Physical Supply and Use Table framework and by explicitly modelling waste treatment chains and material compositions, the project creates the conditions for the development of new indicators addressing key questions of the circular economy. These indicators are designed to provide insights into the availability, transformation and use of secondary raw materials within the economy, while remaining fully consistent with existing accounting frameworks.

The indicators proposed within the project are derived directly from the waste accounts results and rely on the balanced structure of the PSUT. This structure makes it possible to distinguish between waste residuals and waste products, to identify the economic actors supplying and using waste-derived materials, and to avoid double counting caused by multiple treatment steps. As a result, the indicators capture physical realities that are not visible in conventional statistics, such as the dispersion of waste flows across treatment chains or the extent to which waste re-enters the economy in material or energy form.

A first group of indicators focuses on the extent to which waste-derived materials are fed back into the economy. These indicators quantify the share of waste flows that, after treatment, results in products used by economic activities, either as secondary raw materials or as secondary fuels. By distinguishing between different material classes and waste categories, they provide a more nuanced picture of circularity than aggregate recycling rates. In particular, they allow an assessment of which waste streams contribute most to material recovery and which remain largely dissipated or disposed of.

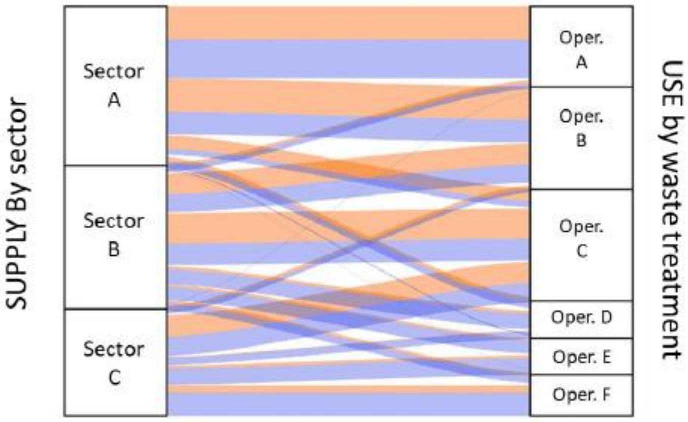

FIGURE 6. CONCEPTUAL REPRESENTATION OF WASTE FLOWS RETURNING TO THE ECONOMY THROUGH MATERIAL AND ENERGY RECOVERY, AS DERIVED FROM WASTE ACCOUNTS. SOURCE: ARGUS AND ICEDD

A second set of indicators addresses the distribution of waste flows across treatment pathways. Using the information embedded in the waste accounts, it becomes possible to describe how waste is allocated between mechanical, biological, physico-chemical and thermal treatments, as well as final disposal operations. These indicators reflect the structure of waste management systems and allow comparisons over time or between waste categories. They also provide a basis for analysing the relative importance of pre-treatment operations, which are largely invisible in waste statistics but play a crucial role in determining the final outcome of waste processing.

The waste accounts further support indicators that distinguish between mixed and pure waste flows. Through the correspondence tables, waste categories can be characterised according to their degree of heterogeneity, which has direct implications for recyclability and treatment efficiency. Indicators derived from this information highlight the role of mixed waste streams in limiting material recovery and underline the potential benefits of improved separate collection and sorting. Such indicators are particularly relevant for policy discussions on waste prevention and collection systems.

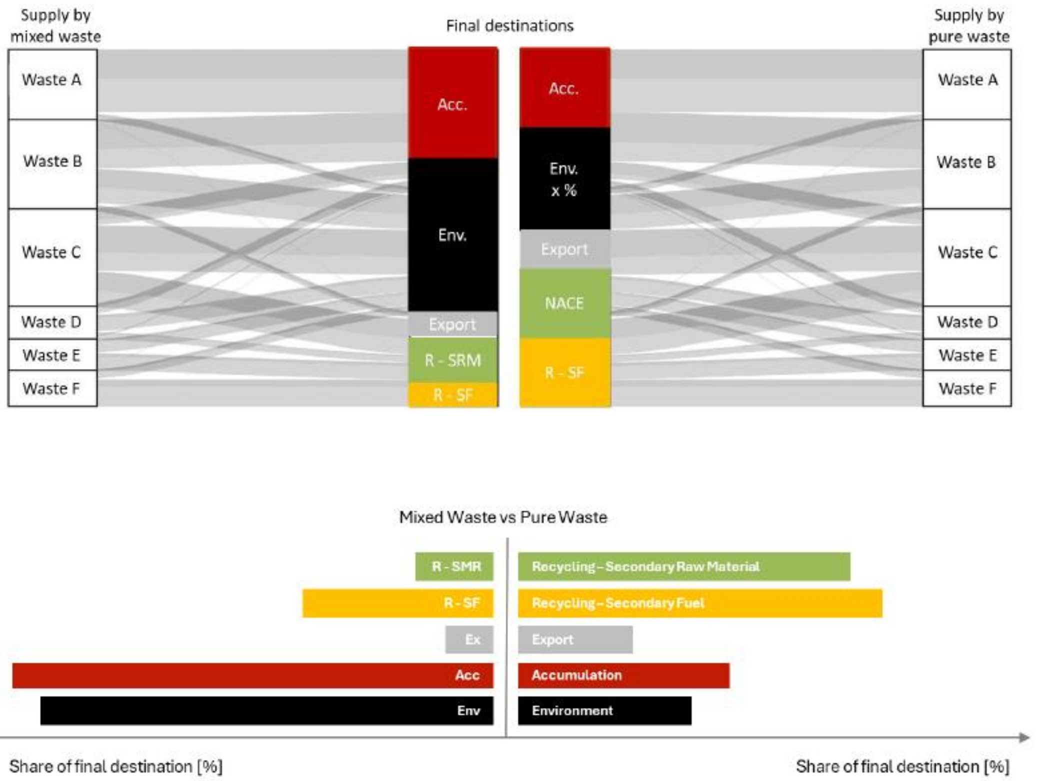

FIGURE 7. ILLUSTRATION OF THE DISTINCTION BETWEEN PURE AND MIXED WASTE STREAMS AND ITS IMPLICATIONS FOR WASTE ACCOUNTS INDICATORS. SOURCE: ARGUS AND ICEDD

Another important dimension captured by the proposed indicators concerns the balance between material recovery, energy recovery and disposal. By tracking waste flows across treatment chains and final uses, the waste accounts make it possible to assess the relative weight of these outcomes for different waste categories and material classes. This information can be used to derive indicators related to the hierarchy of waste treatment options, providing a quantitative basis for evaluating alignment with policy objectives such as those expressed in the waste hierarchy and the circular economy action plan.

The waste accounts also enable the estimation of indicators related to domestic capacities and dependencies. By combining information on waste generation, treatment and trade, it is possible to assess the extent to which secondary raw materials generated within the EU are used domestically or exported, and conversely, to what extent the EU relies on imports of waste for recycling or recovery. These indicators contribute to a better understanding of strategic dependencies and the role of waste trade in the circular economy.

Finally, the project explores the use of waste accounts to support refined circularity indicators that complement existing headline indicators, such as the circular material use rate. By providing a detailed representation of waste-derived material flows, the waste accounts offer the possibility to compute alternative measures of circularity that focus specifically on waste treatment outcomes rather than on economy-wide material balances. While these indicators are still under development, they illustrate the added value of waste accounts as an analytical tool rather than merely a statistical compilation exercise.

Overall, the indicators derived from the Waste Accounts project demonstrate how the integration of waste statistics, correspondence tables and PSUT-based modelling can generate new insights into the functioning of the circular economy. They are designed to be transparent, reproducible and adaptable to future improvements in data quality. At the same time, their interpretation must take into account the assumptions underlying the model, particularly with respect to waste composition and treatment allocation. These limitations are discussed further in the concluding chapter, together with perspectives for future development and potential country-level applications.

CONCLUSION

The Waste Accounts project represents an important methodological step towards a more comprehensive description of waste flows and secondary raw material availability within the European economy. By integrating waste statistics into a Physical Supply and Use Table framework and by explicitly modelling waste treatment chains and material compositions, the project demonstrates how existing data sources can be combined to produce new and policy-relevant information without introducing additional reporting obligations for Member States.

At the current stage of development, the model provides a consistent and balanced representation of waste flows at the level of the EU27 aggregate. This aggregated approach has made it possible to test the feasibility of the methodology, to identify key data gaps and to assess the robustness of the modelling assumptions. It has also enabled the derivation of indicators that shed light on aspects of waste management and circularity that are not visible in conventional waste statistics or material flow accounts.

The exploratory application of the correspondence tables to Belgium further illustrates both the potential and the limitations of the approach. The examples for Flanders and Wallonia show how detailed national or regional waste composition studies can be used to adapt the correspondence tables and to better reflect local waste management systems. At the same time, they highlight the sensitivity of results to differences in waste composition, selective collection systems, reference years and methodological choices. These differences underline the fact that correspondence tables are not fixed statistical objects, but modelling instruments that must be interpreted in the light of their underlying assumptions.

The project has also revealed important limitations that currently constrain the application of the model at national level. The modelling of waste flows relies on a significant number of assumptions, particularly with respect to waste composition, the allocation of waste to treatment pathways and the distribution of outputs across successive treatment steps. While these assumptions are applied consistently and documented transparently, they introduce uncertainty at the level of individual waste streams and treatment operations. As demonstrated by the Belgian example, this uncertainty can become particularly significant when attempting to compare results across countries or regions.

Overall, the Waste Accounts project illustrates the potential of accounting-based approaches to bridge the gap between waste statistics and circular economy policy needs. The results obtained so far confirm the relevance of the approach while clearly identifying the methodological challenges that remain to be addressed, thereby providing a solid and transparent foundation for further development.

RECOMMANDATIONS

Despite the identified limitations, the ambition of the European Union remains to move progressively towards country-level waste accounts that would allow Member States to analyse their own waste management systems and secondary raw material potentials within a harmonised accounting framework. Achieving this objective requires a gradual and iterative approach, building on existing national expertise while acknowledging data heterogeneity.

Future developments of the Waste Accounts project should therefore focus on improving data quality and reducing uncertainty in key components of the model. Priority should be given to the refinement of correspondence tables using up-to-date national waste characterisation studies, administrative data and information from waste treatment facilities. In parallel, assumptions related to treatment chains, material losses and dissipation should be progressively reviewed and improved as new information becomes available.

Methodological enhancements, including improved calculation tools and greater automation, are also recommended in order to facilitate regular updates, sensitivity analyses and scenario testing. Such developments would support a more systematic use of waste accounts over time and improve their robustness for analytical and policy purposes.

Finally, the continued development of indicators derived from waste accounts should remain a central objective. As data quality improves and country-level implementations become more feasible, these indicators can provide increasingly relevant support for monitoring circular economy policies, assessing progress towards waste hierarchy objectives and identifying strategic opportunities for secondary raw material use. In this perspective, waste accounts should be further promoted as a complementary analytical layer that enhances existing statistical frameworks rather than as a replacement for them.

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