

**(W)EEE 2016 Mass balance  
and market structure in  
Belgium**



Final report

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## List of definitions

- Agoria: Federation for Belgian companies in the technological industry
- BeWeee: a tool hosted by OVAM through which actors involved in the collection and treatment of WEEE yearly have to comply with their reporting obligation for WEEE.
- BIM: Brussels Instituut voor Milieubeheer – the Brussels institute for environmental protection. In French: IBGE – Institut Bruxellois pour la Gestion de l’Environnement.
- C&F: Cooling and freezing appliances – domestic refrigerators and freezers
- COBEREC: Confédération Belge de la Récupération - the Belgian steel industry federation.
- DSD: Département du Sol et des Déchets – the new Walloon waste agency that has taken over the responsibilities of the former OWD.
- DSO: Distribution System Operators – operating managers of energy distribution networks.
- EEE: Electrical and Electronic Equipment – equipment which is dependent on electric currents or electromagnetic fields in order to work properly, and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current.
- EERA: European Electronics Recyclers Association – a non-profit organization that represents and promotes the interest of recycling companies that are treating waste from electrical and electronic equipment (WEEE).
- EU Directive 1013/2006: waste shipment regulation - Defines different regimes that apply to shipments of wastes for disposal and for recovery, as well as to hazardous and "green-listed" non-hazardous wastes.
- Export of EEE: collected used electronics that have been exported as whole units.
- Export of WEEE: collected WEEE that has been exported as whole units.
- FEE: Federatie van de Elektriciteit en Electronica / Fédération de l'Electricité et de l'Electronique - the association of companies active on the Belgian market as a manufacturer, importer, distributor or service provider in the field of electrical installation materials, plumbing and heating, electrical household appliances, lighting applications, test and measuring equipment, batteries, electric heating, information carriers and technical maintenance.
- Go4Circle: the umbrella association for circular economy.
- Household EEE: EEE intended for use in private households and similar use in commercial, industrial, institutional and other environments.
- Individual Plan: a manufacturer of EEE that has chosen to organize and report its own individual collection system of WEEE via an individual waste prevention and waste management plan.
- Integrated Annual Environmental Report: a collection of data on the production of industrial waste in Flanders (Integraal Milieujaarverslag)
- KOMOSIE: Koepel van Milieuondernemers in de Sociale Economie – umbrella association for Flemish re-use centers.

- LHA: Large household appliances -washing machines, dishwashers, dryers ...
- Lamps: all gas discharge lamps and LED lamps, excluding the luminaires.
- Manufacturer: For the purpose of this study we define manufacturer as a manufacturer of EEE.
- Mass balance: a tool used for the identification of material entering and leaving a system.
- OOM: Out of market.
- OVAM: Openbare Vlaamse Afvalstoffenmaatschappij – the Flemish waste agency.
- Open scope: redefinition of the scope of Directive 2012/19/EU, in which all EEE must be collected and treated unless it falls under one of the exclusions explicitly mentioned in Article 2, paragraphs (3) and (4).
- OWD: Office Wallon des Déchets – the Walloon waste agency.
- POM: Put on market - the first making available of a product on the market within the territory of a Member State on a professional basis.
- PROF: Professional appliances - dedicated professional and special equipment including large IT network equipment, large medical equipment for hospitals and large professional tools.
- Recupel: a non-profit organization that organizes the collection and recycling system in Belgium for WEEE.
- Recupel Approved Recycler: operators that have signed a charter agreement with Recupel to collect and process WEEE.
- Recupel charter agreement: agreement in which collectors and processors engage to collect and/or process discarded electrical and electronic equipment.
- Recupel member: importers and manufacturers affiliated to the Recupel collective system that are subject to the take-back obligation for waste electrical and electronic appliances and do not have an Individual Plan.
- Recupel contracted processor: companies that process WEEE on behalf of Recupel.
- Regional authorities: For the purpose of this study we define regions as the regional government instances responsible for waste management; In Belgium, the instances are BIM, DSD and OVAM.
- Ressources: the association of non-profit organizations involved in recovery and recycling in Wallonia and Brussels.
- Screens: CRT and flat panel display TV's and Monitors.
- SHA (incl. IT): Small household appliances - small IT and CE products, handheld tools, toys and other small items.
- Waste register: a register in which companies keep track of their waste streams.
- WEEE: Waste Electrical and Electronic Equipment – electrical and electronic equipment which is waste within the meaning of Article 3(1) of Directive 2008/98/EC, including all components, sub-assemblies and consumables which are part of the product at the time of discarding.
- WEEE in residual waste: For the purpose of this study we define WEEE in residual waste as the WEEE found in residual waste as consequence of incorrect disposal.

- WEEE in scrap: For the purpose of this study we define WEEE in scrap as the WEEE found in scrap as a consequence of unauthorized dismantling.
- WEEE generated: used EEE that has been discarded by the end-user and is subject for collection and treatment.

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## 0. Introduction

In 2012, the European Parliament approved the new WEEE directive 2012/19/EU. One of the main changes introduced by the directive concerns the re-definition of the collection targets for WEEE.

The directive entails that appropriate measures have to be adopted by the member state in order to:

- Minimize disposal of WEEE in unsorted municipal waste
- Ensure correct treatment of collected WEEE
- Achieve high level of separate collection of WEEE

The re-definition of collection targets is a gradual evolution with the final minimum collection rate of 65% of *POM* (placed on the market)<sup>1</sup> or 85% of *WEEE generated*<sup>2</sup> to be reached in 2019. We note that *Recupel* currently applies a collection rate expressed as a percentage of the average of the POM of the past three years (i.e. 2014, 2015 and 2016). This in accordance with the guidelines in the directive. Consequently, in this report, all relative collection rates are expressed as a percentage of this average POM.



Figure 1 - Evolution of WEEE collection target

The three Belgian *regional authorities* have transposed this EU guideline to local regulation<sup>3</sup>. They are jointly responsible for achieving the collection target at member state level. *Recupel* is running an operational collective system of Extended Producer Responsibility for WEEE in Belgium, next to producers with an individual waste plan.

This study aims to fulfill the following objectives:

- Map the market structure in which distributors, collectors and recyclers play a key role in the collection of WEEE.
- Objectively quantify the different registered and unregistered streams of *OOM* WEEE and summarize them in a *mass balance*.

<sup>1</sup> Collection rate expressed as a percentage of the average weight of EEE placed on the market (POM) in the three preceding years in the member state concerned

<sup>2</sup> Collection rate expressed as a percentage of WEEE Generated on the territory of that member state

<sup>3</sup> Brussels: 2016/3180, published on 13 January 2017, Flanders: VLAREMA 4, published on 1 July 2014, Wallonia: 2017/202097, published on 26 April 2017 in the official journal

- Create a fact-based starting point that can enable discussions between the regional authorities, the different actors in the value chain and Recupel on the improvement opportunities to meet the EU collection target.

In section 1, you will find the executive summary of the report. A description of the market structure is given in section 2. Section 3 and 4 describe the registered and the unregistered streams. In section 5 you will find a comparison with the previous study, and in section 6 we discuss further potential of the unregistered documented streams. Finally, conclusions and recommendations can be found in section 7. In annex (section 8), we discuss the different calculation methods and the corresponding uncertainty of the data.

Recupel was supported in the execution of this study by the Sustainability Team of Deloitte Belgium, the three Belgian regional authorities, the Belgian steel industry federation *Coberec*, the umbrella association for circular economy *Go4Circle* and the European Electronics Recyclers Association (*EERA*). All these parties frequently attended sounding board group meetings to discuss the observations, methodologies and results of this study.

## Executive summary



## 1. Executive summary

In 2012, the European Parliament approved the new WEEE directive 2012/19/EU, which includes a redefinition of the collection targets for WEEE. The directive entails that appropriate measures should be adopted by the member state in order to:

- Minimize the disposal of WEEE in unsorted residual waste
- Ensure the correct treatment of collected WEEE
- Achieve a high level of separate collection of WEEE

The three Belgian regional authorities, who are jointly responsible for achieving the collection target at member state level, have transposed this EU guideline to local regulation. Recupel, who organizes the collection and recycling in system in Belgium for WEEE requested Deloitte to update and refine the mass balance of WEEE. Based on different data gathering and calculation methods, we obtained a total collection figure for 2016.

The mass balance that shows the different streams for each fraction is summarized below.

<i>Weight in kton</i>	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	TOTAL	
POM	52,73	37,68	117,51	13,55	3,27	41,48	<b>266,21</b>	<b>100,00%</b>
Target	34,27	24,49	76,38	8,81	2,13	26,96	<b>173,04</b>	<b>65,00%</b>
--> Registered	28,23	19,70	57,94	15,92	1,51	5,63	<b>128,94</b>	48,44%
--> Recupel	27,11	19,04	51,95	15,39	1,46	4,10	<b>119,05</b>	44,72%
--> Individual plans	0,00		0,29			1,41	<b>1,70</b>	0,64%
--> Complement BeWeee	0,33	0,11	4,20	0,09	0,01	0,00	<b>4,74</b>	1,78%
--> Waste registers	0,79	0,55	1,51	0,45	0,04	0,12	<b>3,45</b>	1,30%
--> Not registered	24,50	17,98	59,57	-2,38	1,76	35,84	<b>137,27</b>	51,56%
--> Documented	15,14	3,90	21,93	4,21	0,01	7,58	<b>52,78</b>	19,83%
---> WEEE in scrap	14,48	1,21	4,83	0,00	0,00	3,62	<b>24,13</b>	9,06%
---> Export EEE			13,54			3,74	<b>17,29</b>	6,49%
---> Export WEEE	0,46	2,69	0,80	3,29	0,01	0,22	<b>7,48</b>	2,81%
----> Notified export	0,46	0,82	0,12	1,42	0,01	0,20	<b>3,04</b>	1,14%
----> Unnotified export	0,00	1,87	0,68	1,87	0,00	0,02	<b>4,44</b>	1,67%
---> WEEE in municipal waste	0,20	0,00	2,76	0,92	0,00	0,00	<b>3,89</b>	1,46%
--> Undocumented	9,35	14,08	37,63	-6,59	1,75	28,26	<b>84,49</b>	31,74%

Table 1 - Belgian WEEE mass balance 2016

The mass balance consists of four main parts, the put on market (POM) figure, the registered streams, the unregistered documented streams and the unregistered undocumented streams. Resulting weights for each of the parts have been distributed over the different reporting categories (fractions): *LHA*, *C&F*, *SHA* (incl. IT), *Screens*, *Lamps* and *Professional equipment*. For more context on the categories see section 3.

### POM

The weight reported as POM comes from Recupel<sup>4</sup>, the *individual plans* and *BeWeee*. In accordance with the legislation, we took the average weight for 2014, 2015 and 2016. Ink cartridges, cables, solar panels<sup>5</sup> and veterinary devices are out of scope of this study and

<sup>4</sup> Recupel Board of Directors confirmed methodology (January 2018) but certain weights of categories are subject to further refining. For the categories under review, we use the preliminary weights as best estimate.

<sup>5</sup> Solar panels are EEE but are not under the responsibility of Recupel. A separate management organization, PV Cycle Belgium, has been set up for the collection and processing of solar panels.

hence excluded from the POM figure. This is due to the fact that these streams only were in scope as of 2016 and therefore only limited information is available for these types of WEEE. Taking this into account, in 2016 266,21 kton<sup>6</sup> of *EEE* has been placed on the market in Belgium. We note that the POM figure used was subject to a Recupel study in which the methodology to determine the POM has been refined.

### *Registered streams*

The *EEE* that is put on market eventually becomes *WEEE* and must be collected and recycled. 128,94 kton (48,44% of POM) of the *WEEE* has been registered as collected and/or recycled through Recupel, individual plans, *BeWEEE* and the waste registers.

In total 119,05 kton (44,72% of POM) has been collected and recycled via the licensed **Recupel** channels. The biggest fraction reported is SHA (51,94 kton).

In total 1,70 kton (0,64% of POM) can be added to the collection figure through 10 companies that report their **individual plans**. The biggest fraction is professional equipment (1,41 kton), the smallest is SHA (0,29 kton). Currently, there are no individual plans related to the fractions C&F, screens and lamps. We note that the discrepancy between the POM and OOM figure reported by the individual plans is quite large (2,55 kton).

Companies involved in the collection and treatment of *WEEE* that are not a *Recupel Approved Recycler*, can comply with their reporting obligation via the **BeWEEE tool**. Based on the *BeWEEE tool*, we were able to add an additional 4,74 kton (1,78% of POM) to the Recupel collection figure and the individual plans. The category SHA (4,20 kton) represents the biggest fraction. For the professional category, no *WEEE* was reported in *BeWEEE*. The *OVAM* manages *BeWEEE*. In addition, for 2016, there is no reporting duty for Brussels and Wallonia. Therefore, mainly Flemish companies report into the *BeWEEE tool*.

Finally, collection and treatment of *WEEE* can also be captured in the **waste registers** of companies. Based on the information received, we identified 3,45 kton (1,30% of POM) as collected and treated in addition to the aforementioned registered streams. Small household appliances represent with 1,51 kton the biggest fraction. We note that these waste registers are currently not used by the regional authorities for the reporting of *WEEE* at national level.

As a general conclusion on the registered streams we can state that a lot of information on *WEEE* is currently available but the full potential of the *BeWEEE tool* and the data reported in the waste registers is not used.

### *Unregistered documented streams*

Unregistered documented streams are data sources available complementary to the registered streams. Of these unregistered streams, we were able to document 52,78 kton (19,83% of POM).

A significant part of the documented stream can be found in **WEEE in scrap**. This stream represents 24,13 kton (9,06% of POM) on the mass balance. *WEEE* captured in this data source mainly comes from the unauthorized dismantling of equipment by (local) scrap dealers. Based on interviews with four national scrap dealers and Coberec, we could estimate the weight of *WEEE* in scrap. These interviews also provided us with insights regarding the split up over the different fractions: large household appliances (14,48 kton) are most present in scrap. The fractions lamps and screens are not present in metal scrap.

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<sup>6</sup> European number format is used in the whole report.

Another large documented stream is the **export of EEE**. IT equipment more specifically is often exported for second-hand use abroad. Although the devices are not end-of-life yet, they cannot be collected and treated in Belgium as they were exported. After inquiries with brokers and leasing companies, we estimated the flow export EEE at 17,29 kton (6,49% of POM). We only investigated the main flow that concerns IT equipment. Consequently, we allocated the weight over the fractions small household appliances (incl. IT) and the professional category. Regarding this stream there are quite some challenges. Firstly, brokers are not identified as companies involved in the collection and treatment of WEEE and therefore do not report through any of the registered streams (with the exception of two brokers that report to Recupel). Secondly, we noted that several re-use centers collect, refurbish and resell IT equipment, whereas they are not entitled to. In addition, some of those that are member of Ressources or KOMOSIE do not report to Recupel.

Regarding the **export of WEEE** (7,48 kton and 2,81% of POM), we must distinguish notified export from unnotified export. Notified export concerns WEEE that is legally exported according to the waste shipment regulation and represents 3,04 kton (1,14% of POM) of the mass balance. Unnotified export is illegally shipped WEEE and represents 4,44 kton (1,67% of POM). Mainly screens (3,29 kton) are exported. We see different opportunities to enhance the reported weight of the exported WEEE as currently there is no central registration of the export notifications and subsequently they are not used in the reported figures on WEEE. Additionally, in practice, export of WEEE is rarely notified to the regional authorities. Finally, with the cooperation of customs we would be able to identify road transport of WEEE.

The last flow of WEEE that is unregistered but that we have documented is **WEEE in municipal waste**. This stream represents 3,89 kton (1,46% of POM). In this flow, smaller WEEE is thrown in garbage bins and eventually incinerated. We did not conduct further research on this stream as currently all regional authorities are conducting a composition study of the residual waste, of which final results are expected by the end of 2018. We based ourselves on studies performed in the past for our calculation and for the allocation over the different fractions. Studies report that small household appliances (2,76 kton) represent the biggest part of WEEE in municipal waste. C&F, lamps and professional equipment are very rarely found in municipal waste.

#### *Unregistered undocumented streams*

Based on a collection figure through registered streams of 128,94 kton and a documented collection figure of 52,78 kton, we identified an undocumented stream of 84,49 kton (31,74% of POM).

We conducted research on the possible components of the undocumented streams and made estimations on their size. We did not include these estimations in the documented streams due to a lack of reliable data or the insignificance of the stream. The undocumented streams we estimated are luminaires in scrap, export of medical devices and export of WEEE through repair centers.

Based on interviews with DSOs (Distribution System Operators), governmental agencies, manufacturers and installation firms we conclude the size of **luminaires that are recycled in scrap** to be relevant. However, in order to quantify this stream, further research is necessary.

From interviews with hospitals and laboratories, we understood that occasionally some hospitals and laboratories **donate** their used equipment to foreign countries. We estimated that donation of medical equipment could have a potential of less than 0,05% of POM.

Given the insignificant size of the stream, we did not conduct any further research on this subject.

A last stream of WEEE identified as an undocumented stream in the mass balance, is the **WEEE exported by repair centers**. This flow could represent less than 0,05% of POM on the mass balance. WEEE from repair centers have the potential to be a leakage if the non-repairable items are sent back to *manufacturers* abroad. We perceive this stream to be insignificant and as a result, we did not further investigate it.

We note that from the total weight of the unregistered undocumented streams in the mass balance, a part is still in use. Consequently, this equipment cannot be collected. We did not quantify this part of the mass balance as in our study we focus on the out-of-market streams.

**In conclusion, the total collection rate of 2016 amounts to 181,72 kton or 68,26% of POM**

- **Total collection rate based on registered streams: 128,94 kton or 48,44% of POM**
- **Total documented streams: 52,78 kton or 19,83% of POM**
- **Total undocumented streams: 84,49 kton or 31,74% of POM**

In the following parts of this report, we will elaborate on the different topics discussed above. All information regarding the registered streams is discussed in section 3. In section 4.1 we go into detail on the unregistered documented streams and section 4.2 discusses the unregistered undocumented streams. Section 5 compares the result of this study with the previous study, and in section 6 we discuss further potential of the unregistered documented streams. Finally, conclusions and recommendations can be found in section 7. In annex (section 8), we discuss the different calculation methods and the corresponding uncertainty of the data and the calculations.

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## Market structure





## 2. Market structure

### 2.1 Holistic market structure

In an earlier study (FFact Management Consultants, 2013), the market structure of actors involved in the production, usage, collection, treatment and recycling of *WEEE* was perceived as follows:

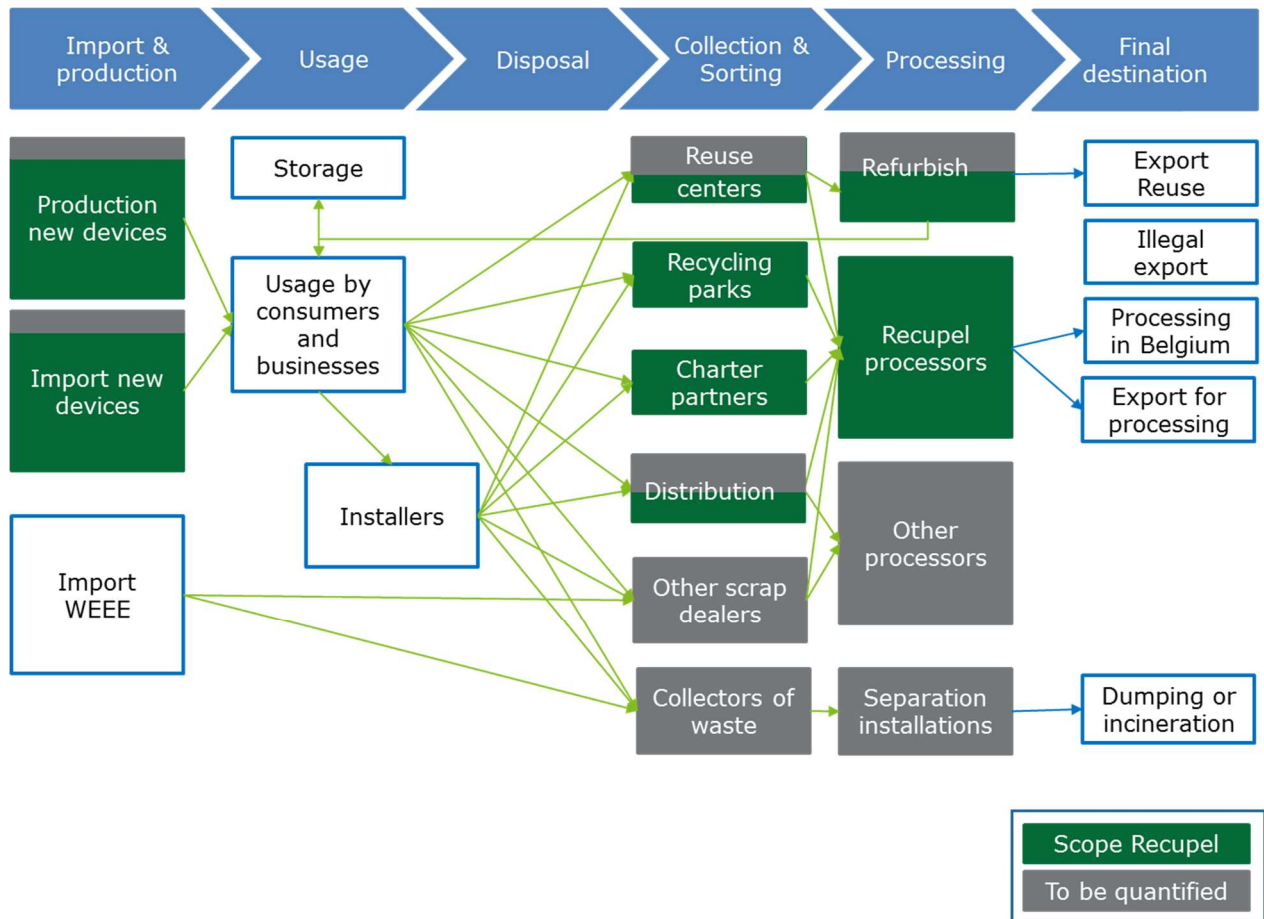


Figure 2 - Market structure as perceived in the past (FFact Management Consultants, 2013)

The above representation of the market structure focuses on the different subsequent actors in the value chain, the possible different interactions between these actors and whether or not the activities of the actors with regard to the collection of WEEE is captured in the Recupel reporting.

It visualizes the potential routes a device can follow from production to final destination.

## 2.2 Focused market structure

Throughout this study, we interviewed the following actors that are involved in the collection and recycling of WEEE:

- Collectors and recyclers
- Brokers
- Re-use centers and refurbishers
- Repair centers
- Scrap dealers and metal recyclers
- Hospitals and laboratories

In addition, we conducted a survey with 46 respondents among Belgian collectors and recyclers in order to identify the different components of the total collection rate of WEEE in Belgium. Based on the survey results and the interviews with the above actors, we concluded that in order to determine a total collection figure for WEEE it is most relevant to focus on the moment where the (W)EEE goes out of market. In the following paragraphs, we describe the market structure around the moment that WEEE goes out of market. We do this separately for the registered and non-registered streams as the market situations are different.

### *Registered streams*

Parties involved in the regulation and registration of WEEE in Belgium are Recupel and the Belgian regional authorities. They are responsible for gathering the data on the moment that the equipment goes out of market and becomes waste. We identified the following registered data sources where WEEE goes out of market. We note that all data sources will be extensively discussed in the following sections.

- *Recupel (R)*: Recupel receives data regarding WEEE collected and treated in their own collection, as well as data reported to Recupel by the *Recupel Approved Recyclers*.
- *BeWEEE (B)*: BeWEEE is a tool hosted by *OVAM* through which actors involved in the collection and treatment of WEEE can yearly comply with their reporting obligation for WEEE.
- *Waste registers (W)*: All companies that produce business residual waste are obliged to keep a register of the waste streams produced in their company. The waste producing companies are also obliged to report these waste registers to their respective regional authority.
- *Individual plans (IP)*: A limited number of companies opt to report their individual waste management plans to their respective regional authorities.

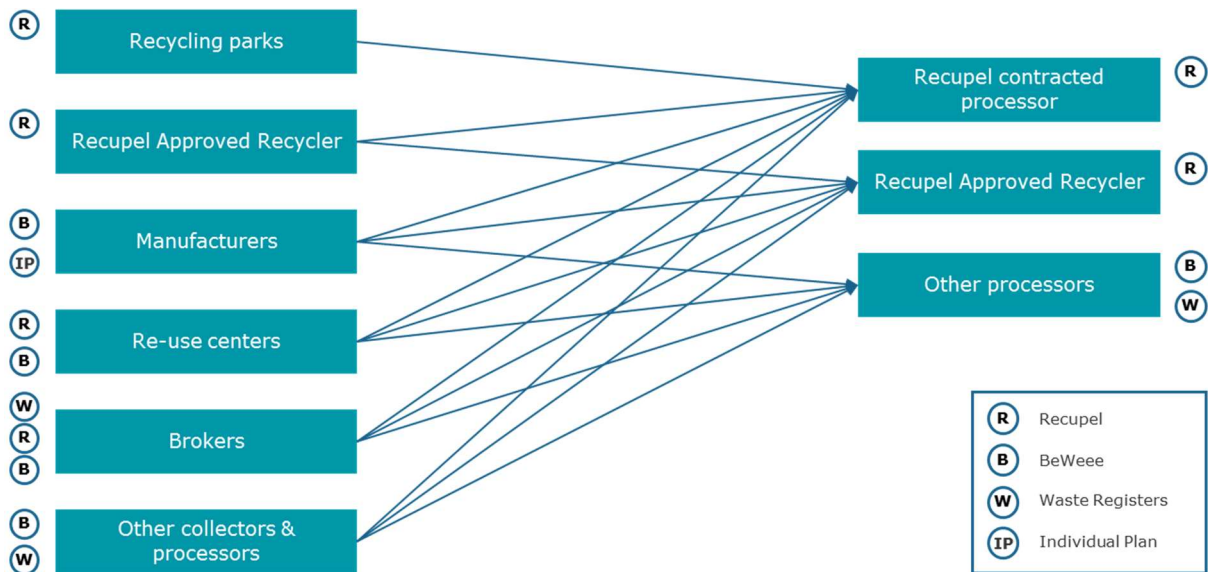


Figure 3 - Representation of registered streams

In the following paragraphs, we will shortly discuss all WEEE streams that are registered. We will also discuss in which data source the stream is captured.

The stream of WEEE gathered at **recycling parks** is fully maintained by Recupel, implying that all WEEE that is collected at the recycling park eventually ends up at a *Recupel contracted processor*. Note that we do not take into account the possibility of theft at recycling parks. Possible leakages from the incorrect sorting of WEEE are captured in the flow of WEEE that is recycled through scrap (section 4.1.1).

**Recupel Approved Recyclers** are operators that have signed a *charter agreement* with Recupel to collect and process WEEE. In this stream, we must make the distinction between collectors and processors.

- In total Recupel has 59 collectors (status on December 1, 2017). These companies transport WEEE to the approved processors.
- As for processors, 14 are approved by Recupel. They can either process the WEEE themselves or choose to bring the WEEE to another (more specialized) approved processor.

For these actors we only take into account figures reported to Recupel in order to avoid double counting. We also assume that there are no leakages in this stream.

Closely related to the Recupel Approved Recyclers are the **Recupel contracted processors**. These companies are processors who have a contractual agreement with Recupel for the processing of the WEEE that Recupel collects. In total there are 10 Recupel contracted processors (status on December 1, 2017). As they cooperate with Recupel, we assume that there are no leakages in this stream.

A fourth stream of registered WEEE comes from manufacturers. Some **manufacturers of EEE** opt to manage their waste streams themselves and therefore have an individual plan that they report to the respective regional authority. Manufacturers that do not have an individual plan are obliged to become a member of Recupel to report their POM and OOM figures. Possible leakages in this stream are captured in other flows of WEEE, namely *WEEE in scrap* (section 4.1.1) and *export of EEE* via brokers (section 4.1.2).

WEEE in **re-use centers** can go out-of-market in two different ways:

1. The equipment is refurbished and put back on the market.
2. The equipment is not repairable and is collected and treated.

We identified that around 30 re-use centers report to Recupel. Others report in BeWeee and for the remainder we were able to extract figures out of the waste registers. Next to those reported streams, we also identified leakages that will be discussed later on in section 4.1.3.

**Brokers**, companies specialized in buying, refurbishing and selling second-hand EEE, operate in the same way as re-use centers. However, the devices going out of market at brokers are not captured in the waste registers as brokers are not labeled as a waste producing company. Information on the processed WEEE of brokers is included in the Recupel figure or in BeWeee. As is the case for re-use centers, we also identified leakages in the reporting of brokers. These are discussed in section 4.1.2.

Besides the Recupel Approved Recyclers, there are also **companies collecting and processing waste that are not collaborating with Recupel**. These companies can either transport the WEEE to a Recupel Approved Recycler, an unlicensed processor (in Belgium or abroad) or recycle the WEEE themselves. Figures on this stream can be found in BeWeee and in the waste registers. This flow of WEEE has quite some leakages, which we will discuss in the unregistered yet documented streams in section 4.1.1.

#### *Unregistered streams*

As mentioned in the previous paragraphs, there are leakages in the registration of WEEE. We define leakages as WEEE that can no longer be registered. This occurs when the equipment is subject to non-compliant recycling or when the WEEE is exported. Non-compliant recycling occurs when WEEE is recycled with scrap or when it is disposed in residual waste. In figure 5, we visualize the different flows of the unregistered WEEE.

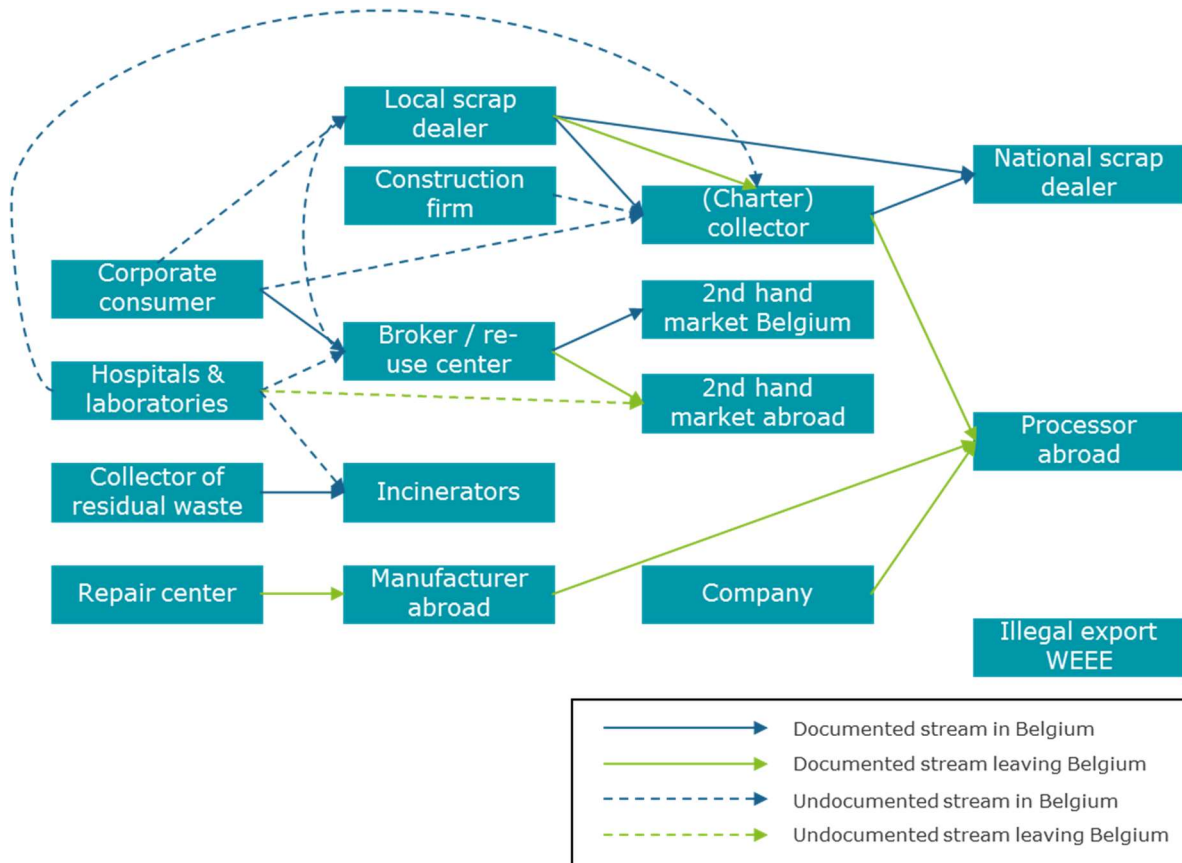


Figure 4 - Representation of unregistered streams

In our representation, we distinguish the documented from the undocumented streams, and the flows that stay within the country from those that are exported. **Documented streams** are unregistered streams that we were able to quantify based on data complementary to the registered streams of data. **Undocumented streams** are streams where the data was too unreliable to document or that we identified to be insignificant. Hence, we did not further investigate these streams.

A significant part of the documented streams consists of leakages at **local scrap dealers**. WEEE is often recycled through scrap. At the local scrap dealer, the equipment is regularly dismantled in order to recuperate the metal parts of the equipment. From the local scrap dealer the dismantled WEEE flows directly, or via **(Recupel Approved) collectors**, to **national scrap dealers**. As this WEEE cannot be sorted out of the metal scrap, this stream is considered to be a leakage. Note that in our representation we define local scrap dealer as the first scrap dealer that dismantles the equipment, regardless whether the equipment came from another scrap dealer or not. We discuss this stream in section 4.1.1.

Regarding WEEE dismantled by local scrap dealers, we identified that luminaires are often discarded together with metal waste by **construction firms**. Eventually they end up at national scrap dealers via (Recupel Approved) collectors. We were not able to capture the whole picture of this flow, hence we consider this stream to be undocumented. We discuss this stream in section 4.2.2.

It occurs that a small part of the WEEE recycled with scrap metal concerns the metal case of IT equipment coming from **brokers**. During our interviews, we understood that IT equipment is sometimes dismantled to recuperate parts. The metal case of the IT equipment is then brought to local scrap dealers. However, we did not conduct any

research on this subject as we believe these are exceptional cases. As described earlier, a more relevant leakage is the **export of second-hand IT equipment** conducted by brokers and re-use centers. We understood that brokers and re-use centers mostly sell their IT equipment outside of Belgium. Only a smaller part is distributed again on the Belgian market. As second-hand EEE leaving the country can no longer be collected and recycled in Belgium, this stream must be considered as a leakage. Based on interviews with the sector we were able to document the size of this flow. See section 4.1.3.

Another stream of WEEE leaving the country is the one of **medical and laboratory devices**. Hospitals and laboratories often donate their equipment to developing countries. In addition, hospitals and laboratories are approached by brokers for their end-of-life medical and laboratory devices. A smaller part of the medical and laboratory devices are subject to non-compliant recycling:

- They end up at a local scrap dealer,
- Or they are incinerated together with hazardous medical waste.

Nevertheless, we identified these streams to be irrelevant in size. Hence, we decided not to further investigate the OOM movements of medical equipment. See section 4.2.1.

Smaller WEEE is sometimes discarded in garbage bins and via collectors of **residual waste** it is eventually incinerated. Based on residual waste composition analyses we were able to document this stream in section 4.1.4.

Another way WEEE can leave the country is via **repair centers**. If the equipment cannot be repaired, it is often returned to the manufacturer who will then either cannibalize the device or recycle it. When the manufacturer is not located in Belgium and does not report to Recupel or BeWEEE this flow must be considered as a leakage. Due to the fact that this stream appeared to be relatively low in volume, we did not further investigate it. See section 4.2.3.

Besides through repair centers, WEEE can also leave the country via waste collectors and **companies**, in the capacity of end-user, that are located close to the national border or that have other activities located abroad. Based on export notifications we were able to document streams going from waste collectors and general companies to (specialized) processors abroad, this is mainly the case for companies located at the national border. See section 4.1.3.

A last flow of WEEE leaving the country is **illegal export**. Although the parties involved in this stream are very diverse, we were able to document the weight of WEEE that is illegally exported. See section 4.1.3.

In the sections 3 and 4, we describe more in detail the registered and unregistered streams, the actors involved, the method used for quantifying the OOM stream and the challenges in capturing this data stream.

**Registered streams**



### 3. Registered streams

In the following sections, the quantification method and underlying data sources to estimate the total collection figure of WEEE in 2016 for Belgium will be discussed. Summarized, these sources concern the following:

1. Official reporting streams, the **registered streams**. The registered streams consist of four data sources:
  - a. The collection of WEEE gathered through the *Recupel* network
  - b. The WEEE collection reported through the *individual plans*
  - c. The collection of WEEE reported in *BeWEEE*
  - d. The WEEE collection reported in the waste registers that are gathered by the Belgian *regional authorities*.
2. Data sources that were identified in the course of this study and that can be considered as a reliable data source – based on market insights obtained by interviewing relevant actors - to document the unregistered part in the mass balance, the **documented** streams:
  - a. WEEE recycled in *scrap* metal
  - b. *Second-hand EEE exported*
  - c. *Export of WEEE* is captured through the notifications made to the regional authorities. In addition, an estimation is made of the export that was not notified to the regional authorities.
  - d. *WEEE* that is discarded together with household *municipal waste*
3. Adding the above two streams together, gives the collection rate of WEEE for Belgium. The discrepancy between this collection rate and the average of the POM of the three preceding years gives the **undocumented** part of the mass balance.

We note that in general, all the different data sources, official sources as well as documented sources, were checked for overlapping data and potential double counting among the different sources. The elimination of double counted values was performed to the extent that it was possible to link different data sources based on reporting actors.

In each section, the following subjects are discussed:



First the **context** of the data source is described: who is involved in the reporting, which reporting system is used, what is the role of this data source in the total of all data sources ...



In a second part we elaborate on the **market analysis and investigation** performed to obtain a collection figure.



Thirdly, the **challenges** in the collection of the data or general challenges with regard to the data source are described.



In the **result**, an overview is given of the total tonnage of registered or estimated OOM as well as the split between the different fractions. Below the different fractions applied and a non-exhaustive description of the concerned equipment is given:

- *LHA* (Large household appliances): washing machines, dishwashers, dryers...
- *C&F* (Cooling and freezing appliances): domestic refrigerators and freezers
- *SHA* (incl. IT) (Small household appliances): small IT and CE products, handheld tools, toys and other small items
- *Screens*: CRT and flat panel display TV's and Monitors
- *Lamps*: all gas-discharge lamps and LED lamps, excluding luminaires



- *Professional appliances*: dedicated professional and special equipment including large IT network equipment, large medical equipment for hospitals and large professional tools

The uncertainty of the data and the calculation methods is discussed in annex (section 8). In short, the different streams discussed in the following paragraphs differ in terms of data and calculation uncertainty as described below:

- Registered streams: the underlying uncertainty of the calculation method and data varies between <20% and <2%.
- Unregistered streams:
  - Documented: the uncertainty of calculation methods and data on average is higher (between <30% and <2%) but sufficiently reliable.
  - Undocumented: the underlying uncertainty of the calculation method and data is >40%. Hence, we either did not quantify the stream, or we defined an upper and lower limit. Nevertheless, we believe these streams offer an opportunity for quantification in future research.

### 3.1 Recupel collection



#### Context

Recupel is a non-profit organization that organizes the collection and recycling system in Belgium for WEEE. It was founded in 2001 by the federations *FEE* and *Agoria*. Recupel works closely together with distributors, (inter)municipalities, reuse centers, regional authorities and recyclers to set up a sustainable and cost efficient network of manufacturers, distributors, collectors and recyclers.

Currently, Recupel organizes the collection of WEEE through the following channels:

- Recycling parks where consumers can dispose of their WEEE (1 for 0 principle<sup>7</sup>)
- Recycling points at retail stores and supermarkets (1 for 1 or 0 for 1 principle<sup>8</sup> if surface >400 m<sup>2</sup>)
- EEE distributors that are obliged to accept WEEE (1 for 1 or 0 for 1 principle)
- Reuse centers that process some of the used EEE as second-hand devices (1 for 1 or 0 for 1 principle)
- Recupel Approved Recyclers (collectors and recyclers) that have a charter agreement with Recupel (1 for 0 principle)

All actors involved with this collection and recycling network report to Recupel, and Recupel provides a detailed annual report to the government.



#### Market analysis and investigation

Recupel gathers the data concerning the (W)EEE collected and/or recycled through the above mentioned network. An external party annually audits the reporting system and the collected reporting data.

<sup>7</sup> Principle related to the acceptance of (W)EEE. 1 for 0 concerns the obligation to accept WEEE without any sale of EEE.

<sup>8</sup> Principle related to the acceptance of (W)EEE. 1 for 1 concerns the obligation to accept WEEE if EEE is sold. 0 for 1 concerns the possibility to sell EEE when no WEEE is handed over.



### Challenges

#### Limited coverage of all collectors and recyclers through Recupel system

As mentioned above, the collection data gathered by Recupel is limited to the companies contracted by Recupel. Though Recupel already coordinates a vast network of collectors and recyclers in Belgium, they do not cover the whole market of collectors and recyclers<sup>9</sup> as there is no obligation for collectors and recyclers to hand over WEEE to Recupel.



### Result

The total weight of (W)EEE collected through the Recupel network in 2016 is 119,05 kton.

Recupel collection							
	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	Total
<b>Tonnage (kton)</b>	27,11	19,04	51,95	15,39	1,46	4,10	119,05
<b>% of total POM per fraction</b>	51,42%	50,53%	44,21%	113,60%	44,67%	9,89%	44,72%

Table 2 - Extract from mass balance: Recupel collection

The division between the different fractions was based on the actual descriptions in the reporting by the different actors in the Recupel network.

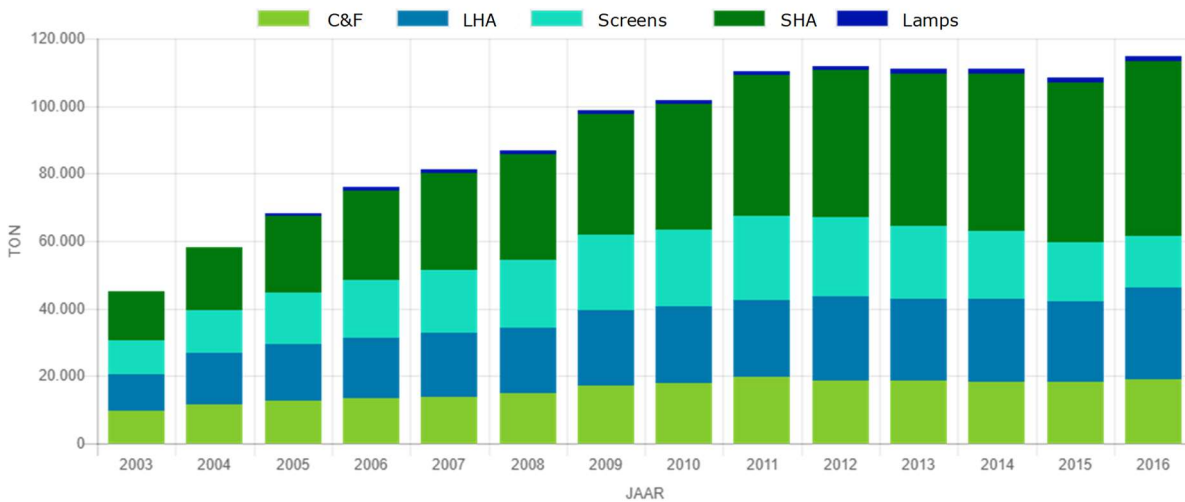


Figure 5 - Evolution of Recupel collection 2003-2016

The collection of WEEE in the Recupel network has never been higher than in 2016 as can be seen in the above figure. More than 32 million devices were collected through the Recupel network, which is an increase of 5,2 million devices compared to 2015.

<sup>9</sup> For example, some re-use centers do not report to Recupel.

## 3.2 Individual plans



### Context

A limited number of Belgian companies – 10 companies in 2016 – opt to organize their own individual system of collection of WEEE. These companies are obliged to yearly report through an individual waste prevention and waste management plan on the weight of EEE they have put on the market and the weight of WEEE they have collected from the market. The individual plans are to be submitted to the relevant regional authorities for approval.



### Market analysis and investigation

We received from each of the regional authorities the total OOM reported by companies with individual plans. This concerns a clearly documented stream of which the results have been shared with us by the three regional authorities for 2014 to 2016.



### Challenges

#### Improvement potential for collection results

In their individual plans, companies also report on the weight of EEE they yearly place on the market. We note that year on year, the weight of WEEE collected is significantly lower than the weight of EEE placed on the market. Below an overview is made of the difference between POM and OOM in the individual plans of 2014 to 2016 in Belgium.

Individual plans			
	2014	2015	2016
<b>POM (kton)</b>	4,49	4,20	4,25
<b>OOM (kton)</b>	1,84	2,11	1,70
<b>OOM/POM</b>	41,04%	50,23%	40,00%

Table 3 - Individual plans - overview POM and OOM - 2014-2016



### Result

In 2016, a total of 1,70 kton OOM was reported in the individual plans.

Individual plans							
	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	Total
<b>Tonnage (kton)</b>			0,29			1,41	1,70
<b>% of total POM per fraction</b>	0,00%	0,00%	0,24%	0,00%	0,00%	3,40%	0,64%

Table 4 - Extract from mass balance: individual plans

The division over the different fractions was made based on the description in the reported individual plans.

### 3.3 BeWeee



#### Context

BeWeee is the Belgian tool through which actors involved in the collection and treatment of WEEE can yearly comply with their reporting obligation for WEEE. BeWeee is currently hosted by OVAM as in Flanders the obligation to report on WEEE reported and WEEE collected is already in place since 2014. Data was made available for reporting years 2014, 2015 and 2016.

In Flanders, the following actors are obliged to yearly report on the tonnages or volume of (W)EEE they have put on the market or taken out of the market:

- POM EEE: manufacturers
- OOM (W)EEE
  - distributors
  - collectors
  - recyclers
  - exporters
  - re-use centers

In Brussels it will be obliged to report on WEEE collected and treated as of 1 January 2018. In Wallonia it is obliged as of May 2017. It has not been specified whether Brussels and Walloon companies will have to fulfill their reporting obligation in BeWeee or through an alternative system.



#### Market analysis and investigation

The total OOM weight reported in 2016 in BeWeee amounts to 127,15 kton. The total weight that can be added to the mass balance amounts to 4,74 kton.

Data source	OOM weight reported in (kton) before elimination of duplicate data	OOM weight reported in (kton) after elimination of duplicate data
BeWeee	127,15	4,74

Table 5 - Data reported in BeWeee before and after elimination of duplicates

The difference between the total reported weight in BeWeee and the addition to the mass balance is due to the fact that a number of amounts reported had to be eliminated to prevent duplication of data:

- 1,24 kton was reported by individual members of Recupel for 2016, while the same weight was also included in the collection figure of Recupel (see section 3.1) in this study.
- 119,05 kton was reported by Recupel on behalf of its members for 2016, while the same weight was also included in the collection figure of Recupel (see section 3.1) in this study.
- 2,12 kton was reported more than once by different actors in the same value chain for 2016 (for more information on the elimination rationale, we refer to Annex 8.2)



#### Challenges

##### **Incomplete coverage of all collectors and recyclers through BeWeee**

The BeWeee tool is not - or not properly - used by all collectors and recyclers in Belgium.

- BeWeee is only used by Flemish companies, but even for Flanders, the reporting in BeWeee does not fully cover all collection and recycling activities in Flanders.
- For 2016, Brussels and Walloon companies did not report in BeWeee because of the fact that the reporting obligation in Brussels will only enter into force as of January 2018 and the reporting obligation in Wallonia only entered into force in May 2017. It is not clarified whether the reporting will have to be fulfilled in BeWeee or in an alternative reporting system.
- In the coming years, a new independent entity will be established which will host and maintain the BeWeee tool.

The below table gives an overview of the number of collectors and recyclers that have reported in BeWeee and the total OOM weight that they reported, after elimination of duplicates.

Year	2014	2015	2016
<b>OOM weight reported (before elimination of duplicates) (kton)</b>	138,24	126,65	127,15
<b>OOM weight reported (after elimination of duplicates) (kton)</b>	4,75	2,66	4,74
<b># actors that have reported</b>	270	224	359
<b># of actors with zero-report</b>	166	74	238

Table 6 - Collectors and recyclers reported in BeWeee before and after elimination

The incomplete coverage of the total reporting potential in Belgium can be compensated by the use of data reported in waste registers (see section 3.4).

### Result



In 2016, an additional amount of 4,74 kton OOM was reported in BeWeee.

BeWeee							
	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	Total
<b>Tonnage (kton)</b>	0,33	0,11	4,20	0,09	0,01	0,00	4,74
<b>% of total POM per fraction</b>	0,63%	0,29%	3,58%	0,65%	0,17%	0,00%	1,78%

Table 7 - Extract from mass balance: BeWeee data

The division between the different fractions was made based on the descriptions in the BeWeee reporting.

### 3.4 Waste registers reported to the regional authority



#### Context

In Belgium, all companies that produce business residual waste are obliged to keep a register of the waste streams produced in their company. This register should include amongst others the amount and type of the waste streams, the treatment method, the name of the company that collects the waste and the name of the company that treats the waste.

The waste producing companies are also obliged to report these waste registers to their respective regional authority. The procedures to report these waste registers are different in each region:

- Brussels: companies that collect, transport and/or treat waste should report their waste register every three months to *BIM*.
- Flanders: only a number of companies that produce and/or treat waste should report a part of their waste register to OVAM.
- Wallonia: companies that produce and/or collect dangerous waste (including WEEE) should yearly report their waste register to *DSD*.

As mentioned in section 3.3, although all Flemish distributors, collectors, recyclers, exporters and re-use centers of WEEE are obliged to report on their WEEE collection, BeWeee is not used by all involved actors. In addition, Brussels and Walloon actors were not yet obliged to report specifically on the WEEE they collected in 2016 (Brussels actors will be obliged as of 2018 and Walloon actors are obliged as of 2017).

That is why the database that is maintained through the waste registers (that contain information concerning WEEE) constitutes an independent source to unveil streams of WEEE that have not been captured through the Recupel network, the BeWeee tool or the individual plans (see sections 3.1 – 3.3). This conclusion is based on a crosscheck with the different parties involved in the reporting of waste registers, being BIM, DSD and OVAM.



#### Market analysis and investigation

We were only able to gather the waste register data from Brussels and Flanders. We were unable to do a complete analysis of the collected and recycled WEEE reported in the waste registers due to the fact that DSD did not share the waste registers reported to them by Walloon collectors and recyclers.

Region	WEEE OOM reported in waste registers (kton)
Brussels	0,87
Flanders	0,30
Wallonia	No data shared

Table 8 - Waste register data received from the Belgian regional authorities

We note that the low tonnage from the Flemish waste registers is due to different reasons:

- The waste registers reported to OVAM concern only a subset of the total population of collectors and recyclers in Flanders.
- OVAM collects the waste registers in the context of the “*Integrated Annual Environmental Report*” (*Integraal Milieujaarverslag*). This report contains not all information included in a waste register.

- In addition, there is great overlap between the data reported in the waste registers and the other registered streams (see next paragraphs).

To estimate the missing data for Wallonia, we performed an extrapolation based on:

- The number of inhabitants in each of the Belgian regions,
- The weight of WEEE per inhabitant in each region.

The extrapolation is documented in the below table.

<b>Extrapolation of registered stream for Wallonia</b>			
<b>1. Inhabitants per region</b>			
<b>Region</b>	<b>#Inhabitants 2016<sup>10</sup></b>		
Brussel	1 187 890		
Flanders	6 477 804		
Wallonia	3 602 216		
<b>2. Weight per inhabitant per region (kg/inhabitant)</b>			
<b>Region</b>	<b>BeWeee</b>	<b>Waste registers</b>	<b>Total</b>
Brussel	0,04	0,74	0,78
Flanders	0,53	0,03	0,57
Wallonia	0,04		0,04
<b>Average weight Flanders and Brussels (kg/inhabitant):</b>			<b>0,68</b>
<b>3. Extrapolation of registered stream for Wallonia</b>			
Expected kg/inhabitant Wallonia			0,68
- Registered kg/inhabitant Wallonia:			0,04
= Kg/inhabitant to be used for extrapolation:			<b>0,63</b>
<b>Extrapolated weight of registered stream Wallonia (kton):</b>			<b>2,28</b>

Table 9 - Extrapolation method to determine missing Walloon data



### Challenges

#### **No systematic crosscheck in place with other official data sources**

As mentioned before, the database that is created at each of the regional authorities through the gathering of the waste registers of the different involved actors in the respective region constitutes a great opportunity to capture collection data of WEEE that is not registered today. There is however no crosscheck in place yet to identify missing data in the other official data sources (see section 3.1 – 3.3).

<sup>10</sup> Source: Statbel – consulted on 17/10/2017



## Result

Based on the above extrapolation, we can add a total of 3,45 kton OOM to the mass balance. This total weight consists of the data reported by Brussels and Flanders and the weight estimated through extrapolation for Wallonia:

Region	WEEE OOM reported in waste registers (kton) before elimination of duplicate data	WEEE OOM reported in waste registers (kton) after elimination of duplicate data
Brussels	0,87	0,87
Flanders	41,91	0,30
Wallonia	Not applicable	2,28
<b>Total</b>		<b>3,45</b>

Table 10 - Final complementary weights of WEEE reported or estimated based on waste registers per regions

Note that the large discrepancy between the above collection figures for Flanders before and after elimination of duplicate data is caused by the fact that we identified a large number of duplicate values in the OVAM waste register data, when comparing to the Recupel collection figure, the BeWEEE data and the individual plans. There is much less overlap for the Brussels data. As the above collection figure for Wallonia was based on an extrapolation, we could not perform an investigation for duplicate values. However, as collection of WEEE from Wallonia is in general much less present in the other registered streams because there was no reporting obligation yet in this region for 2016, the risk to include double counts is not significant.

The division between the different fractions was based on the division between the different fractions of the Recupel collection (see section 3.1).

Regional authorities - Waste registers - complementary WEEE OOM							
	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	Total
<b>Tonnage (kton)</b>	0,79	0,55	1,51	0,45	0,04	0,12	3,45
<b>% of total POM per fraction</b>	1,49%	1,47%	1,28%	3,30%	1,30%	0,29%	1,30%

Table 11 - Extract from mass balance: regional authorities' data - waste registers - complementary WEEE OOM



**Unregistered streams**



## 4. Unregistered streams

### 4.1 Documented unregistered streams

As described in sections 3.1 to 3.4, a considerable portion of the collection rate can be documented based on existing registered streams. Next to these official registration streams, there are complementary data sources that can be used to document streams of WEEE that are not captured in the officially registered streams. The complementary streams that were documented in this study include WEEE in scrap, export of WEEE and export of EEE.

#### 4.1.1 WEEE in scrap



##### Context

Next to the official recycling networks, WEEE is often mixed with metal scrap due to the mainly metallic composition of the electric and electronic equipment. In order to estimate the weight of WEEE that is collected in metal scrap, we first made an overview of the market structure of scrap dealers:

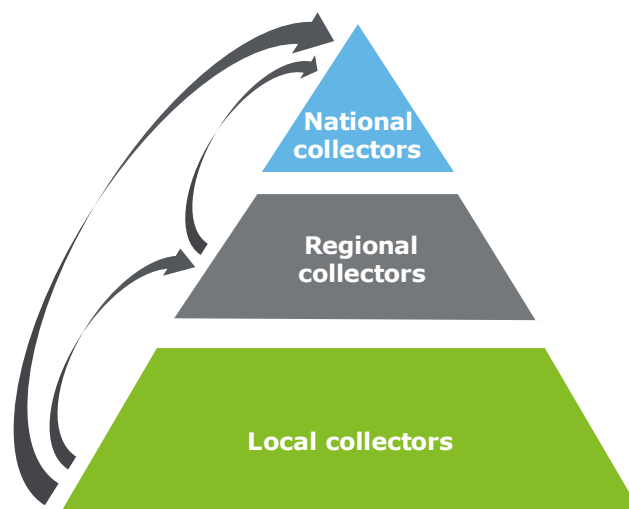


Figure 6 - Market structure WEEE recycling

As the above picture shows, the following are the typical actors in the scrap sector:

- **Local collectors and recyclers:** they collect WEEE included in metal scrap in limited geographical areas and may perform some dismantling activities. They generally sell the (partly dismantled) WEEE and/or scrap to regional recyclers or directly to national recyclers.
- **Regional collectors and recyclers:** they collect WEEE included in metal scrap in regional areas and may perform some dismantling activities. They generally sell the (partly dismantled) WEEE and/or scrap to national recyclers.
- **National collectors and recyclers:** they collect WEEE included in metal scrap on a national level. They possess one or more shredder installations to shred light metal scrap, potentially containing WEEE.

In order to check the above theoretical market structure against the reality in the Belgian market and to gain more insights, we conducted a survey among Belgian collectors and recyclers. We identified and contacted 202 Belgian collectors and recyclers (response rate 24,75%). We came to the following conclusions:

- We asked our respondents to indicate the weight of WEEE they yearly process. Based on the responses, we can conclude that in reality, Belgian collectors and recyclers of WEEE are divided into on the one hand a large pool of local collectors and recyclers, and on the other hand a small pool of national recyclers. This as opposed to three types of players. One of the reason is the limited size of the Belgian scrap industry.
- In addition, we asked the respondents to describe their business activity. Based on the responses and crosscheck with a list of all licensed WEEE collectors and recyclers per region, we note that two thirds of the respondents dismantle or recycle WEEE but are not licensed to do so.

The above observation leads to a revised market structure for Belgium:

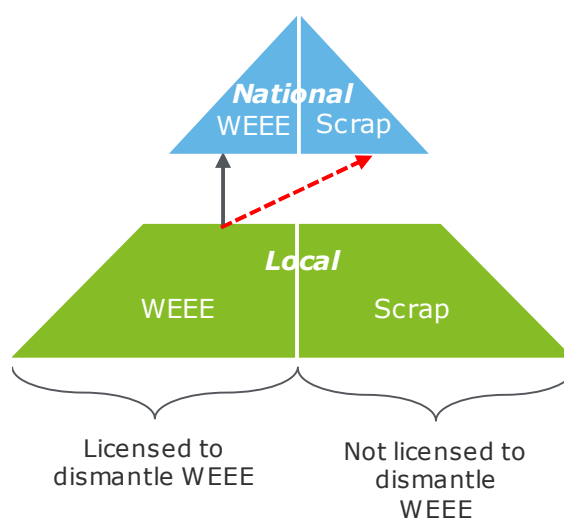


Figure 7 - Adjusted market structure scrap dealers WEEE recycling

Starting from this structure, we made an estimation of the total weight of WEEE that is not collected through the official network but ends up in scrap. This will be described in the following sections.



### Market analysis and investigation

As explained in the sections above, Belgian scrap dealers collect and process a significant portion of WEEE together with metal scrap. Given the pyramid structure of the market, most of the metal scrap (containing WEEE) ends up at a limited number of large national scrap dealers. In order to estimate the tonnage of WEEE in scrap at the top of the pyramid, we used the calculation method depicted in the figure below.

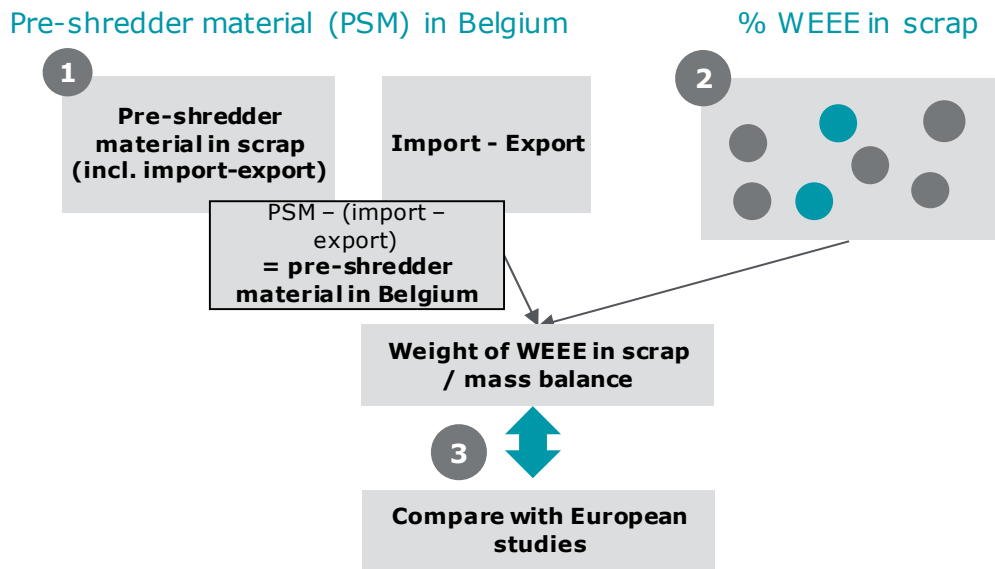


Figure 8 - Calculation method WEEE in scrap

1. Determine total weight of pre-shredder material treated in Belgium

Based on discussions with Coberec, a professional association specialized in the Belgian iron and steel sector, we understood that WEEE is most likely to be found in pre-shredder material. Pre-shredder material is the light iron scrap that can be shredded, as opposed to heavy metal fractions. Consequently, we exclude heavy iron scrap, such as steel production waste in which WEEE is very unlikely to be present. We estimated the total weight of pre-shredder material yearly treated in Belgium based on extrapolation of the weight of pre-shredder material that is treated by individual shredder installations in Belgium. This total weight has been corrected for import and export of pre-shredder material in and out of Belgium.

2. Determine percentage of WEEE in scrap

In a next step, we determined the average share of WEEE in pre-shredder material. We performed a survey with four of the largest scrap dealers in Belgium, covering 31,25% of the shredder installations in Belgium. Three of these scrap dealers made an estimation of the percentage of WEEE that is present in the pre-shredder material they treat. We obtained the below ranges. We note that our respondents only made an estimation of WEEE that is visibly present in the metal scrap they treat. Luminaires for instance are not included in their estimation. We return to the stream of luminaires in scrap in section 4.2.2.

WEEE in pre-shredder material in Belgium		
	Min. percentage	Max. percentage
Scrap dealer 1	3%	5%
Scrap dealer 2	2%	4%
Scrap dealer 3	1%	5%

Table 12 - Percentage of WEEE present in the pre-shredder material treated by Belgian scrap dealers

We took the average of the above 6 percentages in order to obtain a general average of the share of WEEE present in pre-shredder material in Belgium.

3. Determine total weight of pre-shredder material treated in Belgium

We received from two Belgian scrap dealers the total weight of pre-shredder material that is annually treated at their company. These scrap dealers operate four shredder installations in total. Knowing that there are 16 shredder installations in Belgium, the scrap

treated by these companies represents 25% of the total amount of pre-shredder material treated in Belgium.

<b>Weight pre-shredder material generated and treated in Belgium (kton)</b>	
<b>Scrap dealer 1</b>	0,04
<b>Scrap dealer 5</b>	0,28
<b>Extrapolated total weight for Belgium</b>	<b>1,27</b>

Table 13 - Total estimated weight of pre-shredder material generated and treated in Belgium

#### 4. Determine total weight of WEEE in pre-shredder material treated in Belgium

Multiplying the total weight of pre-shredder material yearly treated in Belgium with the general average percentage of WEEE in pre-shredder material in Belgium, gives the total weight of WEEE in scrap in Belgium.

#### 5. Cross-check weight of WEEE in pre-shredder material as % of POM with other studies

In a last step, we expressed the total weight of WEEE in scrap in Belgium as a percentage of the total WEEE generated in Belgium. We compared this percentage to the same ratio for other countries:

<b>WEEE in pre-shredder material in Belgium as a percentage of POM - 2016</b>	
<b>Country (year of calculation)</b>	<b>WEEE in scrap/POM</b>
<b>Belgium (2016)</b>	9,07%
<b>Belgium (FFact Management Consultants, 2013)</b>	10,10%
<b>The Netherlands (Huisman, 2015)</b>	25,00%
<b>France (BIO, 2012)</b>	21,36%

Table 14 - Cross-check WEEE in pre-shredder material in Belgium as a percentage of POM with other studies

Comparing the percentage obtained in this study to the percentages of WEEE in scrap as a share of the total weight of WEEE generated in other countries and/or studies, shows us that the current percentage is a conservative estimation. Additionally, this has been confirmed by EERA.



### Challenges

#### Difficult identification of WEEE in scrap

Based on our interviews with national scrap dealers, we understood that it is hard to identify WEEE in scrap and consequently labor-intensive to extract WEEE from scrap and dismantle and recycle the devices separately. Only one of the four national scrap dealers interviewed extracts the WEEE from the metal scrap they treat and reports this fraction separately to Recupel.

Although this is already a very good example that it is possible for scrap dealers to treat WEEE separately from metal scrap, we were also informed by the same scrap dealer that very small WEEE or WEEE that is hard to recognize such as luminaires are not extracted from the scrap metal.

#### Unofficial dismantling of WEEE

The most valuable components of WEEE are the ones containing metal. As shown in figure 7, WEEE is often (partially) dismantled by small, local recyclers that extract these metal fractions from an electronic or electric device and sell them with other metal scrap

to scrap dealers. These local recyclers are not licensed by the regional authorities nor are they a member of the Recupel network, which makes it hard to track this leakage of WEEE.



### Result

Based on the above calculations, we were able to quantify 24,13 kton of WEEE in scrap. WEEE in scrap is one of the largest complementary streams to the officially registered streams. Due to the limited number of players in the market that treat pre-shredder material, this can be considered a reliable estimation.

WEEE in scrap							
	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	Total
<b>Tonnage (kton)</b>	14,48	1,21	4,83	0,00	0,00	3,62	24,13
<b>% of total POM per fraction</b>	27,46%	3,20%	4,11%	0,00%	0,00%	8,73%	9,06%

Table 15 - Extract from mass balance: WEEE in scrap in kton and as a percentage of OOM

Based on our interviews with national scrap dealers, we understood that WEEE in scrap mostly concerns large household appliances and small household appliances. Other devices present in scrap are cooling and freezing devices and professional devices such as boilers. Consequently, we divided the total documented weight over the fractions as follows (Ffact Management consultants, 2013):

- LHA: 60%
- C&F: 5%
- SHA (incl. IT): 20%
- PROF: 15%

We also verified this allocation with one of the scrap dealers interviewed.

## 4.1.2 Export EEE



### *Context*

In Belgium, companies buy or lease IT devices such as laptops, tablets and smartphones. After the end of lease or after the device has been fully depreciated, the devices are mainly sold or donated to respectively brokers or re-use centers. These brokers and re-use centers will refurbish the devices that are still usable. The majority is exported and only a small part is sold in Belgium. This stream of exported second-hand IT devices is not properly registered in the systems described in section 3. Consequently, we documented this stream based on alternative source data and performed crosschecks with the existing official reporting streams.

We note that we make abstraction of other streams of exported second-hand EEE such as *household EEE* sold on online platforms and export of second-hand medical devices. We return to these streams in section 4.2.1.



### *Market analysis and investigation*

We used a method in which we start from the put-on-market weight of relevant IT devices that are likely to reach the end of their first life in 2016. Gradually, we refine this total weight in order to estimate the weight of devices that are exported by brokers or re-use centers.

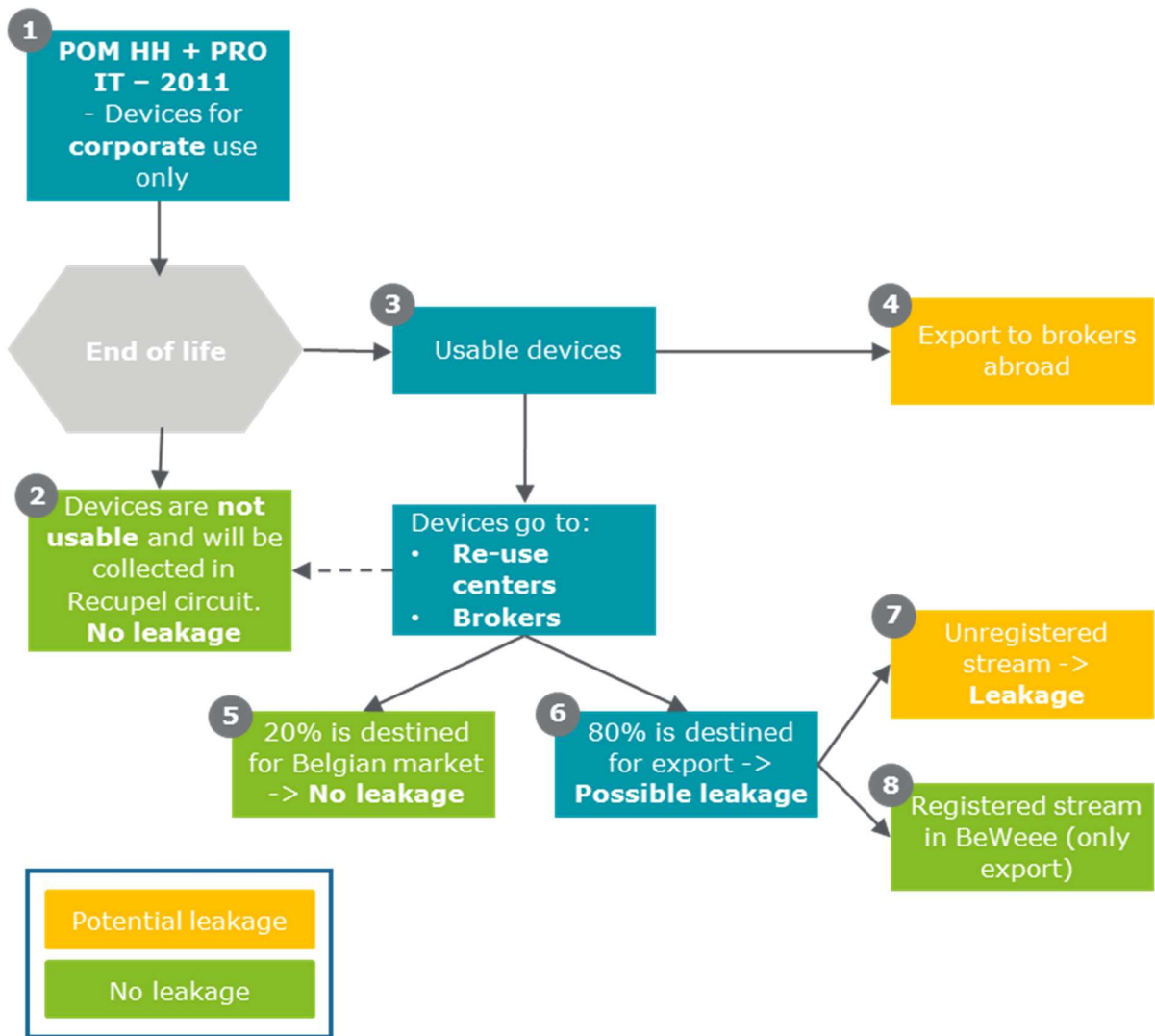


Figure 9 - Calculation method export IT EEE

### 1. Determine relevant POM weight

The starting point of the calculation is the total put-on-market weight of 2011 of household and professional devices (see step 1 in the above figure). We assume an economic lifetime of 5 years. In addition, we only consider the product categories that are used in a corporate environment and are consequently likely to be sold or donated to brokers and re-use centers.

	POM HH +PRO IT - 2011 - all	POM HH +PRO IT - 2011 - devices for corporate use only
<b>Weight of POM (kton)</b>	68,48	38,07

Table 16 - POM HH + PRO IT - 2011 - division between corporate use and others

### 2. Correct for overlapping and/or irrelevant data

We performed the following consistency checks on the data:

- We take into account the collection that is already performed by Recupel of household and professional IT devices that are not re-usable (see step 2 in the above figure).



- Based on interviews with brokers and leasing companies, we understood that only 80% of the IT devices that are refurbished by brokers or re-use centers are exported. Consequently, we subtract the weight of devices destined for the Belgian market (see step 5 in the above figure).
- Lastly, the export for re-use registered in BeWeee is deducted (see step 8 in the above figure).

### 3. Identify all export of EEE

Based on this calculation, we obtain a total weight of exported EEE of 17,29 kton. Note that this export figure consists of direct export of usable devices to foreign brokers (see step 4 in the above figure) and export of second hand devices by Belgian brokers and re-use centers (step 7 in the above figure). Note that we eliminated overlap with registered out of market streams of re-use centers (see step 8).

Complementary data stream	Total weight of export EEE 2016 <i>before</i> data elimination (kton)	Total weight of export EEE 2016 <i>after</i> data elimination (kton)
Export EEE	17,84	17,29

Table 17 - Export EEE: elimination of duplicate data



### Challenges

#### No clear reporting

- Despite that **brokers** centrally collect the IT devices, there is no registration of this collection (e.g. in a waste register or in an alternative central register).
- Not all **re-use centers** that collect, refurbish and resell second-hand IT devices are licensed to do so. Consequently, for these re-use centers there is no collection registration. In addition, a number of re-use centers have a license but do not report to the regional authorities or Recupel.
- Besides the re-use centers, companies such as brokers, can also perform re-use activities. However, these companies are legally not perceived as re-use centers. Consequently, they are not obliged to report on the WEEE they collect and treat, and as a result slip through the cracks of the registered streams.



### Result

For 2016, we quantified a total of 17,29 kton export of EEE. As was expected based on current market trends and interviews with brokers and leasing companies, the stream exported second-hand IT devices concerns a significant part of the collection figure.

Export EEE							
	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	Total
Tonnage (kton)			13,54			3,74	17,29
% of total POM per fraction	0,00%	0,00%	11,53%	0,00%	0,00%	9,02%	6,49%

Table 18 - Extract from mass balance: export EEE in kton and as a percentage of POM

The division over the different fractions of second-hand household IT devices and second-hand professional IT devices is limited to the fraction SHA (incl. IT) and the fraction PROF, respectively.

### 4.1.3 Export WEEE



#### Context

Export of WEEE to “non-OECD Decision” countries is prohibited (cfr. *EU directive 1013/2006*). Export to any country of used EEE that still functions is authorized, provided that the device is accompanied by a test certificate. All export of WEEE from any of the three Belgian regions should be notified to the government of the respective originating regional authority. In addition, every shipment should be accompanied by a document as prescribed in article 18 of the EU directive 1013/2006. This document includes amongst others a specific description of the content of the shipment.

When we translate the before defined export of WEEE to available data streams, the OOM figure can be based on the following subsets of data (see also figure below), complementary to the aforementioned registered streams:

- Notified export: the volume of legally exported WEEE that is taken out of the Belgian market and has been notified to one of Belgium’s regional authorities as export of WEEE. We note that in theory, this stream can be considered as a registered stream. We, however, included this registered stream in this section for clarity purposes.
- Not-notified export: export of WEEE that has not been notified to one of Belgium’s regional authorities.

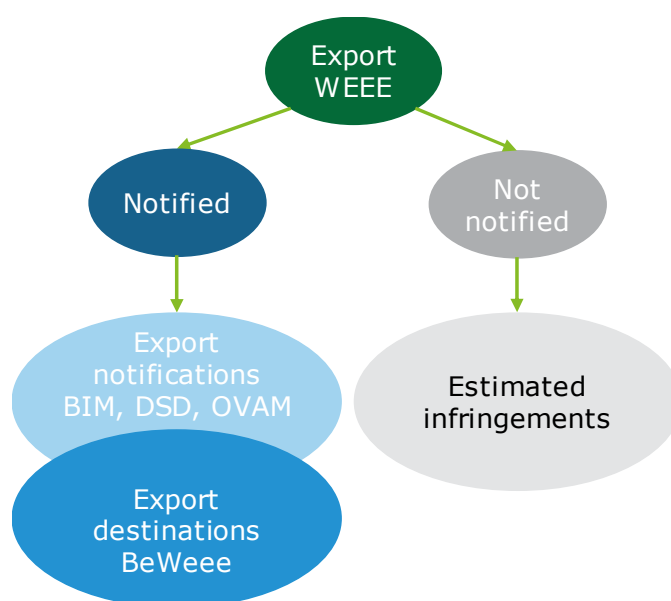


Figure 10 - Complementary data sources for the documentation of export of WEEE



#### Market analysis and investigation

We conducted three interviews with the persons responsible for the notifications as well as the environmental inspection of BIM, DSD and OVAM.

- *Notified export*

The weight of notified export was based on actual export notifications of WEEE to the relevant departments of the three regional authorities (BIM, DSD and OVAM) for 2016. We selected the relevant export notifications based on the following EURAL codes.

EURAL code	Description
<b>Under 09 01 - wastes from the photographic industry</b>	
09 01 11	single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03
<b>Under 16 02 - wastes from electrical and electronic equipment</b>	
16 02 10*	discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09
16 02 11*	discarded equipment containing chlorofluorocarbons, HCFC, HFC
16 02 12*	discarded equipment containing free asbestos
16 02 13*	discarded equipment containing hazardous components ( 2 ) other than those mentioned in 16 02 09 to 16 02 12
16 02 14	discarded equipment other than those mentioned in 16 02 09 to 16 02 13
16 02 16	components removed from discarded equipment other than those mentioned in 16 02 15
<b>Under 20 01 - municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions, separately collected fractions</b>	
20 01 21*	fluorescent tubes and other mercury-containing waste
20 01 23*	discarded equipment containing chlorofluorocarbons
20 01 35*	discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components ( 6 )
20 01 36	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35

Table 19 - Relevant EURAL codes for notified export of WEEE

In addition, we filtered out notifying companies that are Recupel Approved Recyclers to avoid double counting. This results in the following overview:

Source data legal export	Total weight of notifications 2016 before data elimination (kton)	Total weight of notifications 2016 after data elimination (kton)
<b>DSD (Wallonia)</b>	0,74	0,74
<b>BIM (Brussels)</b>	0,08	0,08
<b>OVAM (Flanders)</b>	4,00	2,22
<b>Total</b>	<b>4,82</b>	<b>3,04</b>

Table 20 - Total notified weight of exported WEEE 2016

- *Not-notified export*

We understood from the Flemish environmental inspection and the persons responsible for the export of WEEE at the three regional authorities that the largest stream of export of not-notified WEEE leaves Belgium through the port of Antwerp. The weights of exported WEEE that leave Belgium via the ports of Ghent and Zeebrugge are not significant. That is why in our estimation of the total weight of not-notified exported WEEE, we focus on estimating the weight of WEEE that yearly leaves the port of Antwerp.

We used the following methodology:

1. *Identify number of seized infractions in the port of Antwerp*

In the context of the export of WEEE from the port of Antwerp, infractions are defined as shipments of WEEE to non-OECD countries that are not accompanied by a testing document.

The environmental inspection and customs inspected in 2016 381 shipments that were likely to concern infractions. 69 of these inspected shipments were loaded in Belgium. 40 of these Belgian shipments – or 58% - concerned actual infractions and are thus categorized as seized illegal export.

2. *Determine average weight of a WEEE shipment*

We determined the average weight of a shipment containing WEEE based on a sample of testing papers of one month (20 testing papers). The sample concerns container shipments that were selected by the environmental inspection. In order to determine whether these shipments are compliant with the law, i.e. that they do not contain WEEE, the environmental inspection asks a testing company to verify whether the devices are working and to issue a test certificate for each device. The resulting testing papers contain a description of the exact composition of a shipment that was selected for inspection by customs or the environmental inspection. The resulting average weight of WEEE in a shipment is about 766 kg.

3. *Determine the estimated weight of seized infractions*

Multiplying the number of seized infractions (1) with this average weight (2), results in the weight of seized infractions of shipments of WEEE exported from Belgium (3). The “CWIT study” (Huisman, 2015) estimates that seized illegal export makes up 0,02% of WEEE generated (5). Total illegal export for Belgium amounts to 3,10% of WEEE Generated (4). Extrapolating the weight of seized illegal export based on the aforementioned percentages gives us a total weight of not notified export of 4,44 kton.

The calculation is summarized in the below table.

Component description	Calculation	Result
Number of inspected shipments, loaded in Belgium, containing (W)EEE		69
Number of infractions seized	(1)	40
Average weight of (W)EEE in one shipment (kg)	(2)	716
Weight of seized infractions (kg)	(3)=(1)X(2)	28 640
Estimation of total illegal export (CWIT, 2012) (as % of WEEE Generated)	(4)	3,10%
Seized illegal export (CWIT, 2012) (as % of WEEE Generated)	(5)	0,02%
<b>Total not notified export (kg)</b>	<b>(3)X(4)/(5)</b>	<b>4 439 200</b>

Table 21 - Calculation of total weight of not notified export



## Challenges

### No view on data available at customs

As described in the previous section, we based our calculation for the not notified part of exported WEEE on interviews and data exchange with the Flemish environmental inspection. The Flemish environmental inspection, however, is not the only authority involved with the control of the correct application of the legislation concerning export of WEEE. Customs plays an important role in the inspection of shipments too. In addition, they are also active in the inspection of road transport, which could give additional insights and help frame the global picture of export of WEEE from Belgium. Unfortunately, customs did not respond to our queries.

### No central registration of WEEE export

All export of WEEE from Belgium should be accompanied by a document including a description of the content of the shipment (the "Annex 7" of the Waste Shipment Regulation). A central registration of this document would provide us with a reliable data source.



## Result

The below table gives an overview of the total estimated weight for notified and not-notified export: respectively 3,04 kton and 4,44 kton. Compared to the other documented stream, the resulting total weight is rather limited.

Export of WEEE								
Sub-component	Value displayed	LHA	C&F	SHA (incl. IT)	SCREENS	LAMPS	PROF	Total
Notified export	Tonnage (kton)	0,46	0,82	0,12	1,42	0,01	0,20	3,04
	% of total POM per fraction	0,88%	2,18%	0,11%	10,47%	0,26%	0,49%	1,14%
Not notified export	Tonnage (kton)	0,00	1,87	0,68	1,87	0,00	0,02	4,44
	% of total POM per fraction	0,00%	4,97%	0,58%	13,81%	0,00%	0,04%	1,67%

Table 22 - Extract from mass balance: export of WEEE in kton and as a percentage of POM

The estimated weights are conservative. In addition, we expect the weight of not-notified export to be significantly higher in reality. Based on our conversations with the environmental inspection, the responsible persons at the regional authorities and exportation companies in and around the port of Antwerp, we understood that this stream is not to be underestimated. In addition, we were not able to conduct an analysis of not-notified road export due to lack of cooperation from customs and due to the fact that there is no central registration of the "Annex 7" document.

The division over the different fractions was performed as follows:

- Notified export: we divided the total notified weight based on the description of the content of the shipment in the notification.
- Not-notified export: we divided the total estimated weight based on the description of the composition of the inspected shipments in the testing papers used in step 2 of the calculation.

#### 4.1.4 WEEE in municipal waste



##### Context

In Belgian households and in Belgian companies, small and middle-sized WEEE are sometimes discarded via the residual waste fraction, i.e. the standard garbage bin. This is certainly the case in areas where recycling parks and collection points do not have a strong presence.



##### Market analysis and investigation

The total weight of WEEE that is discarded together with the household residual fraction in Belgium can be estimated based on different studies that investigated the composition of residual waste in Belgium. For WEEE discarded with the business residual fraction, it is more complicated as there are only limited studies on this for Belgium.

In 2017, each of the Belgian regional authorities are performing a composition study. All three studies are still ongoing. One study investigates the composition of household residual waste, the other two focus on business residual waste. As the results of these ongoing studies are preliminary at the time of the writing of this report, we refrain from drawing any conclusions. That is why we based our calculations for WEEE in household residual waste on a sorting analysis from the past, performed by *OWD* in 2010 (*RDC-Environment S.A.*, 2010). This analysis concludes that 0,30% of the household residual waste in Wallonia is WEEE. Although the results of the ongoing study concerning the composition of household residual waste are still preliminary, we note that this percentage is in line with the first findings of the current study. We applied this percentage to the total weight of residual waste in each of the regions (1 295,72 kton). We obtained a total weight of WEEE in residual household waste of 3,89 kton.

We note that a recent study (*Rijkswaterstaat, Ministerie van Infrastructuur en Milieu, 2017*) in the Netherlands estimated the percentage of WEEE in household residual waste to be 1,18%. Given the fact that the sorting and collection system of household residual waste in the Netherlands is quite similar to the Belgian system, we can state that using 0,3% is a conservative approach.

Regarding WEEE in business residual waste, there are no recent studies available for Belgium. Along with the fact that the Flemish and Brussels region are conducting a composition analysis on business residual waste, we withhold from estimating the size of this stream.



##### Challenges

###### **More recent sorting analyses are ongoing**

As mentioned in the previous paragraph, each of the Belgian regional authorities were still working on a composition study of the residual waste fraction at the moment of the issuance of this report. We are confident that in the future, calculations of the total weight of *WEEE in residual waste (both for household and businesses)* can rely on the results of these studies.



##### Result

Based on the aforementioned data, we only quantified the WEEE in municipal waste to be 3,89 kton. Due to the prudent estimation of the percentage of WEEE in the municipal residual waste fraction, the stream WEEE in municipal waste is the smallest unregistered stream in the total collection figure.

<b>WEEE in municipal waste</b>							
	<b>LHA</b>	<b>C&amp;F</b>	<b>SHA (incl. IT)</b>	<b>SCREENS</b>	<b>LAMPS</b>	<b>PROF</b>	<b>Total</b>
<b>Tonnage (kton)</b>	0,20	0,00	2,76	0,92	0,00	0,00	3,89
<b>% of total POM per fraction</b>	0,38%	0,00%	2,35%	6,82%	0,00%	0,00%	1,46%

*Table 23 - Extract from mass balance: WEEE in municipal waste in kton and as a percentage of POM*

The repartition between the different fractions was based on the description of the total weight per fraction identified in municipal waste in a UK study of 2010 by Defra (Resource Futures, 2013).



## 4.2 Undocumented unregistered streams

As explained in section 1, 31,74% of POM is not contained in officially registered streams nor documented based on complementary data sources. Based on interviews with the different parties active in the collection and recycling of WEEE, we could make an estimation of the different streams underlying the undocumented part of the POM. In the following sections, we describe the different streams of WEEE that go out of the Belgian market and are not captured in the registered or documented streams.

We also made an estimation of the magnitude of these undocumented streams. We note that these estimations should be interpreted with appropriate prudence as they are based on source data and calculations that are more uncertain than the source data and calculations used to quantify the registered and documented streams in sections 3 and 4.

We remark that from the total weight of the unregistered undocumented streams, a part of the equipment is still in use and therefore cannot be collected at the time being. We did not estimate this part of the mass balance as in our study we focus on the out-of-market streams. In order to identify the quantity of the equipment still in use, Recupel is currently conducting a study on this.

### 4.2.1 Medical and laboratory devices



#### *Context*

In order to understand the process of how medical and laboratory EEE are put on the Belgian market and taken out of the market, we interviewed several parties that are involved in different steps of the process:

- three Belgian manufacturers of medical devices,
- two Flemish hospitals, one Walloon hospital and one Brussels hospital,
- one volunteer organization,
- one broker of laboratory EEE,
- two umbrella organizations of respectively manufacturers of medical devices and manufacturers of laboratory devices

These interviews gave us the following insight in the general POM and OOM situation for medical EEE in Belgium:

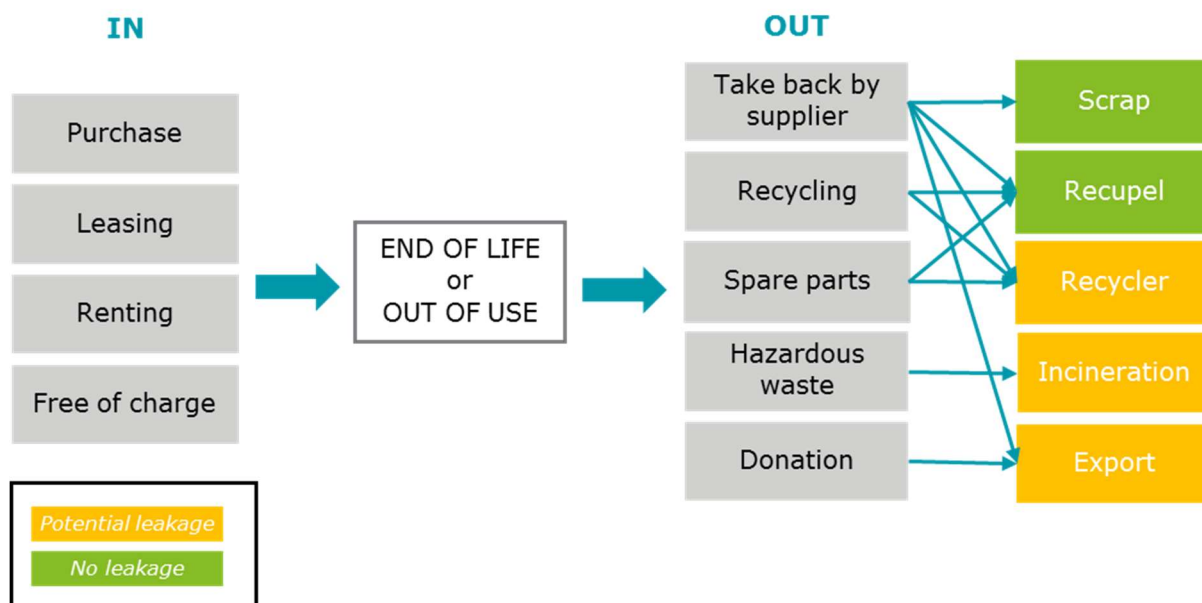


Figure 11 - POM and OOM of medical laboratory EEE

New medical and laboratory EEE in general are put on the market by selling, leasing, renting and giving them free of charge to hospitals and laboratories. The latter is most often combined with usage of components of or disposables related to the device, which is paid for.

The devices reach the end of their (first) life after an average of 5 to 20 years. The lifetime depends on different factors such as the frequency of usage of the device, the decision of the hospital or laboratory to invest in a newer technology before the end of the lifetime of the device in use, whether the device is either frequently moved or used on a fixed location, ...

The medical and laboratory (W)EEE can be operationally withdrawn in five different ways:

- The **supplier** that installs the replacement device takes back the old one. If the device is still usable, the supplier will refurbish the device and export it. In case it is not usable anymore, the device is recycled through the Recupel network or discarded as scrap.
- A **recycler** or a **collector** picks up the device.
- The hospital or laboratory keeps the old device as a source of **spare parts** for similar devices that are still in use. Alternatively, the hospital or laboratory donates the device for (academic) research to a university. In both cases, the device is recycled afterwards through the Recupel network.
- In case the device is contaminated, it is disposed of together with other **hazardous** non-electronic medical waste and incinerated.
- Some hospitals **donate** usable devices to other hospitals in overseas or other European countries. These exportations are notified to customs.

We note that in hospitals as well as in laboratories, devices that are considered end-of-life by one department are sometimes transferred to another department that can still use the device. We consider this case deferred disposal: the device is eventually disposed of through one of the channels shown in figure 11.



### Market analysis and investigation

As it is depicted in the flow chart above, the exported medical and laboratory (W)EEE and the incinerated WEEE represent leakages which are not included in the Recupel network. However, we understood through interviews with the hospitals that these streams represent a minority of the tonnage of medical (W)EEE they yearly dispose of. The magnitude of the different streams is further explained in the following paragraphs.

#### 1. Export of EEE through donation

Out of the four hospitals we contacted, two engaged in donation activities. For one of these hospitals, we estimated the total weight of the used EEE they donated in 2015 to be around 850 kg.

Based on this average weight and an optimistic hypothesis that the number of Belgian hospitals that engage in donation activities lies between half of the Belgian hospitals and all hospitals, the total weight of unregistered export of used EEE lies between 0,12 kton and 0,24 kton:

Region	Number of hospitals	Donated weight of used EEE (kton)	
		50% of the hospitals	All hospitals
<b>Flanders</b>	147	0,06	0,13
<b>Brussels</b>	37	0,02	0,03
<b>Wallonia</b>	90	0,04	0,08
	<b>274</b>	<b>0,12</b>	<b>0,24</b>

Table 24 - Estimation of total weight of donated medical and laboratory EEE

#### 2. Export of EEE by brokers

Another way in which used medical EEE can be exported, is by brokers who buy the (refurbished) device from the supplier that took it back at the hospital or laboratory. A Recupel study of 2011 (Dedicated Research, 2011) shows that using the supplier to take back the end-of-life device is much less frequently done than reaching out to a Recupel Approved Recycler. The study mentions that suppliers were used in less than 10% of the cases. In addition, manufacturers of both medical and laboratory devices and a broker of laboratory second-hand devices confirmed to us that export of second-hand EEE happens but is not significant.

#### 3. Incineration of contaminated WEEE

We were informed by a large Flemish hospital that the yearly volume of contaminated WEEE in their hospital only amounts to a bucket of 30L. Another Flemish hospital confirmed the range of this volume. In addition, implants such as pacemakers, the biggest part of contaminated WEEE, are out of scope for this study.



### Challenges

#### No view on data available at customs

As described in this section, export of EEE through donation is notified to customs. However, customs did not respond to our queries. Consequently, we were not able to make accurate calculations for the stream of donated devices.



### *Result*

We can conclude that in the hospitals and laboratories we interviewed, the largest part of OOM from medical devices is registered through the Recupel network or documented in other streams of the mass balance. An insignificant minority of the outgoing stream is incinerated or exported.

## 4.2.2 Luminaires in scrap



### Context

When we compared the POM and OOM figures from Recupel for all different WEEE categories for 2016, we noted that there is a large discrepancy between POM and OOM for household and professional luminaires:

Luminaire type	POM 2016 (kton)	Recupel collection 2016 (kton)	Δ POM-OOM 2016 (kton)
Household luminaires	19,10	2,35	16,75
Professional luminaires	10,56	0,12	10,44
<b>Total</b>	<b>29,66</b>	<b>2,47</b>	<b>27,19</b>

Table 25 - Luminaires - discrepancy between POM and OOM

We investigated what the underlying causes could be of the large discrepancy between POM and OOM 2016.



### Market analysis and investigation

The starting point of our investigation was the market of public lighting, which could give us insight in the discrepancy for professional luminaires. Luminaires used in public lighting on average have a lifetime of 15 to 25 years, for luminaires with LED and gas-discharge lamps respectively. This means that comparing the POM with the OOM of the same year as we do in the above table is not an entirely correct analysis. The comparison can however give an idea of the magnitude of the discrepancy.

We performed interviews with four DSOs and one governmental agency managing public lighting in all Belgian regions. They shared with us the following insights:

- All of the interviewed organizations work with subcontractors for (a part of) the replacements of luminaires.
- Two companies confirmed that for large replacements (i.e. 50 to 70 luminaires), the luminaires are sorted separately but for maintenance replacements, the luminaires are sorted together with the main component of the lamppost (being plastics or metal).
- Three out of the four interviewed parties does not know whether the luminaires are recycled as WEEE or as scrap. The fourth company stated that only 10% of the luminaires that they replace themselves are recycled as WEEE. The other 90% and the luminaires replaced by their subcontractors are recycled together with scrap.

Given the recent technologies, luminaires that are put on the market in 2016 are significantly lighter than luminaires that are taken out of the market in 2016. The use of LED resulted in replacement waves in most regions: before the start date of the wave, less than average replacements of lamps and luminaires are performed and during the wave, more than average replacements are made. In some regions, these replacement waves have already begun and in others not. This can also have an impact on the POM and OOM figure.

We interviewed 4 manufacturers of other professional and household luminaires. 3 of these manufacturers also perform the removal of old luminaires and installation of new luminaires. All of these manufacturers collaborate with a Recupel Approved Recycler or a Recupel contracted processor for the collection of the end-of-life luminaires. Consequently, based on our interviews, we identified no leakage in this stream.



## Challenges

### Mixed sorting of luminaires

As explained above, when replacing a lamppost, the luminaire is only a fraction of the components that are discarded. Consequently, in some cases, less attention is paid to the way this component is collected, sorted and recycled.

### LED replacements

Although we did not perform an extensive market research, we did perceive that at the moment of the writing of this report, it is unclear for most of the interviewed parties how the collection and recycling of LED luminaires can be organized in a compliant and efficient way.



## Result

Based on the OOM data (estimations) received from the four parties we interviewed, we calculated the potential OOM weight of luminaires that are recycled with scrap.

Luminaire type	POM 2016 (kton)	Recupel collection 2016 (kton)	Δ POM-OOM 2016 (kton)	Public lighting luminaires recycled in scrap 2016 (kton)
HH luminaires	19,10	2,35	16,75	NA
PROF luminaires	10,56	0,12	10,44	0,20
<b>Total</b>	<b>29,66</b>	<b>2,47</b>	<b>27,19</b>	<b>0,20</b>

Table 26 - Luminaires - potential weight of OOM recycled in scrap 2016

Note that the above calculation does not take into account the whole market of public luminaires. The result shows that the stream of professional luminaires that are not registered through the Recupel network can only be traced back for a very small part (0,76% of the discrepancy between POM and OOM 2016) to luminaires from public lighting that end up in scrap.

### 4.2.3 EEE exported via repair centers



#### Context

Repair centers are companies that repair household EEE. Most of the repair centers are specialized in a certain category of devices and some of the Belgian repair centers are a dedicated partner of particular electro brands.

A part of the devices that cannot be repaired, are not directly registered through one of the official streams that are described in section 3. This is due to the fact that some manufacturers of electric and electronic devices request that repair centers return irreparable devices from their particular brand to them. When this manufacturer is located abroad, this OOM stream is not documented in one of the registered streams.



#### Market analysis and investigation

We contacted two repair centers in Belgium that cover, based on their gross margin, approximately 64% of the market. They confirmed that the procedures at repair centers for the collection and recycling of irreparable (components of) electronic and electric devices is as described in the below figure.

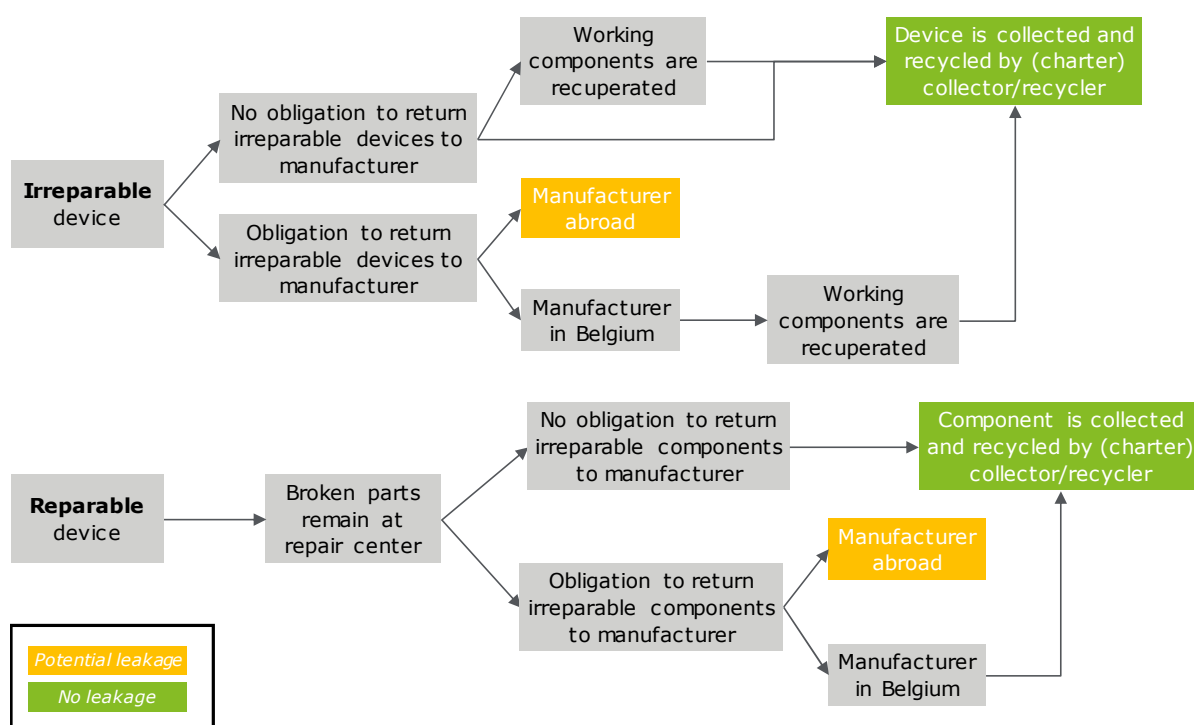


Figure 12 - Repair centers - collection and recycling procedures

As can be seen in the above figure, the fact that some manufacturers request the return of irreparable devices entails two possible unregistered streams in the recycling of irreparable devices at repair centers:

- Irreparable devices that have to be returned to a foreign manufacturer go out of the Belgian market, but are not registered in any of the official streams.
- Irreparable components that have been removed to repair a device may also be returned to a foreign manufacturer. In the same way as the integral devices, these

components go out of the Belgian market, but this OOM movement is not registered in one of the official streams.

Based on estimations provided by the two repair centers we interviewed, we could make the following rough calculation of the above two leakages:

Take back by manufacturers	Investigation (64% of the market)	Extrapolated result (100% of the market)
# items treated annually	164 000	256 450
# irreparable items	9 400	14 626
# take back by manufacturer	7 520	11 701
Average weight of a device (kg)	9,30	
Potential leakage via take back (kton)	0,07	0,11

Table 27 - Repair centers - potential leakage via take back by manufacturers of EEE

The calculation of the potential leakage is an upper limit as it assumes that all manufacturers that take back devices are located abroad. Note that when a manufacturer in Belgium takes back an irreparable device, we assume that the device is included in one of the registered or unregistered streams as described before in section 3 and 4.



### Challenges

#### **No registration of devices returned to manufacturer**

As explained in the previous paragraphs, devices that cannot be repaired by repair centers or broken components taken out of repaired devices can both be returned to the manufacturer (in case of their specific request). If this manufacturer is located abroad, this might be notified to customs or the regional authority. However, we did not find any trace of such notification in the notifications to the regional authorities (see section 4.1.3) and we do not have insight in the notifications to customs.



### Result

Based on the above calculation, we estimated the leakage of devices taken back by foreign manufacturers to be 0,11 kton. We stress that this calculation is an upper limit. Consequently, we considered this weight insignificant and did not perform any further investigations.



**Comparison with previous study**



## 5. Comparison with previous study

In this section, the results of this study are compared with those of the previous study concerning the mass balance of WEEE in Belgium (in this section referred to as the "Ffact study") (Ffact Management Consultants, 2013).

We note that we have made a recalculation to the WEEE mass balance of 2011 for Belgium in order to make it comparable to the mass balance resulting from this study. In the Ffact study, the WEEE generated was calculated as a separate stream in the mass balance. The calculation of the WEEE generated was however not in scope of this study and therefore is included in our undocumented stream.

In order to obtain a comparable situation, we performed a recalculation on the undocumented stream of the 2011 mass balance such that it includes the WEEE generated. To do this, we subtracted the registered and documented stream from the total POM weight.

Applying this amendment, we obtain the following WEEE mass balance for Belgium of 2011 (right table), which now can be compared to the current mass balance (left table).

<i>Weight in kton</i>	CURRENT		FFACT	
	Total	Relative	Total	Relative
POM	<b>266,21</b>	<b>100,00%</b>	<b>287,00</b>	<b>100,00%</b>
Target	<b>173,04</b>	<b>65,00%</b>	<b>186,55</b>	<b>65,00%</b>
-> Registered	<b>128,94</b>	48,44%	<b>115,00</b>	40,07%
--> Recupel	<b>119,05</b>	44,72%		
--> Individual plans	<b>1,70</b>	0,64%		
--> Complement BeWeee	<b>4,74</b>	1,78%		
--> Waste registers	<b>3,45</b>	1,30%		
-> Not registered	<b>137,27</b>	51,56%	<b>172,00</b>	59,93%
--> Documented	<b>52,78</b>	19,83%	<b>55,00</b>	19,16%
---> WEEE in scrap	<b>24,13</b>	9,06%	<b>29,00</b>	10,10%
---> Export EEE	<b>17,29</b>	6,49%	<b>6,00</b>	2,09%
---> Export WEEE	<b>7,48</b>	2,81%	<b>3,00</b>	1,05%
----> Notified export	<b>3,04</b>	1,14%		0,00%
----> Unnotified export	<b>4,44</b>	1,67%		0,00%
---> WEEE in municipal waste	<b>3,89</b>	1,46%	<b>17,00</b>	5,92%
--> Undocumented	<b>84,49</b>	31,74%	<b>117,00</b>	40,77%

Table 28 - Comparison current WEEE mass balance with WEEE mass balance of 2011

When comparing the current mass balance with the 2011 mass balance, we note several differences.

### POM

We note a difference of 20,79 kton between our current POM and the POM of 2011. One of the reasons for this discrepancy is the different methodology for calculating the POM. We based ourselves on the weights provided by Recupel, whereas the Ffact study based the POM weight on the UNU model. Another reason could be the market trend of decreasing weights for devices. However, we did not conduct further analysis, as this is not in scope of our study.

### *Registered streams*

When analyzing the registered streams, the total collection of WEEE is 13,94 kton higher compared to 2011. Besides the fact that the collection by the Recupel network is now higher than in 2011, the difference is particularly due to the flows identified in **BeWEEE** and the **waste registers**. In 2011, the BeWEEE tool did not yet exist and the previous study did not analyze the waste registers.

### *Unregistered documented streams*

The total weight of the unregistered documented streams is more or less equal in both this study and the Ffact study. Nevertheless, we noted differences in the underlying streams.

Although the weight of **WEEE in scrap** has the approximately same size (difference of 4,87 kton), there is a difference in the applied methodology. This study only takes into account WEEE generated and shredded in Belgium, whereas the Ffact study takes into account WEEE generated and shredded in Belgium as well as WEEE generated in Belgium and shredded abroad as part of exported scrap metal.

For the **export of EEE**, we apply a different methodology, resulting in an estimation that is 11,29 kton higher compared to the Ffact study. The reason for this is that we focus on export streams of EEE via the IT brokerage market, while Ffact only took into account export of EEE together with WEEE through shipment.

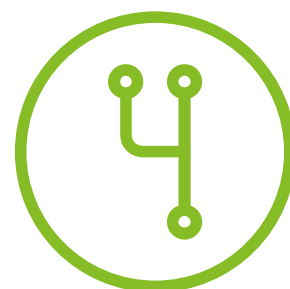
Regarding **export of WEEE**, we note a discrepancy of 4,48 kton, which is due to the fact that besides unnotified export, we also investigated notified export of WEEE. However, we come to the same conclusion as Ffact: additional research is required concerning flows of WEEE exported through road transportation.

We also note a large gap (13,11 kton) between our weight of **WEEE in residual waste** and the weight reported by Ffact. The reason for this is twofold: firstly we apply a lower percentage of WEEE discarded in garbage bins. Secondly, in our study we do not take into account WEEE in business residual waste as at the moment of the writing of this study (winter 2017) two of the Belgian regional authorities are conducting a composition analysis on WEEE in business residual waste. Consequently, an accurate and actual calculation of WEEE in business residual waste can be made in 2018.

### *Unregistered undocumented streams*

Finally, for the unregistered undocumented streams, we report a weight that is 32,51 kton lower compared to the 2011 WEEE mass balance for Belgium. As has been indicated above, the difference is mainly due to the discrepancy in the POM figure and the registered streams.

**Unregistered documented streams:  
further potential**



## 6. Unregistered documented streams: further potential

In the previous chapters, we estimated the size of the unregistered documented streams on the mass balance. When making assumptions in these calculations, we consistently used the most conservative approach, applying a principle of precaution. In this chapter, we calculated for each of the unregistered documented streams what their value would be if we applied alternative, less stringent assumptions, identified in other European studies. The impact of using these available assumptions in the calculation of the size of an unregistered stream shows the further potential of this stream. The adapted mass balance can be found below.

<i>Weight in kton</i>	<b>Conservative estimate</b>		<b>Alternative estimate</b>	
	<b>TOTAL</b>	<b>% of POM</b>	<b>TOTAL</b>	<b>% of POM</b>
<b>POM</b>	<b>266,21</b>	<b>100,00%</b>	<b>266,21</b>	<b>100,00%</b>
-> Registered	<b>128,94</b>	48,44%	<b>128,94</b>	48,44%
--> Recupel	<b>119,05</b>	44,72%	<b>119,05</b>	44,72%
--> Individual plans	<b>1,70</b>	0,64%	<b>1,70</b>	0,64%
--> Complement BeWeee	<b>4,74</b>	1,78%	<b>4,74</b>	1,78%
--> Waste registers	<b>3,45</b>	1,30%	<b>3,45</b>	1,30%
-> Not registered	<b>137,27</b>	51,56%	<b>137,27</b>	51,56%
--> Documented	<b>52,78</b>	19,83%	<b>87,47</b>	32,86%
---> WEEE in scrap	<b>24,13</b>	9,06%	<b>43,08</b>	16,18%
---> Export used EEE	<b>17,29</b>	6,49%	<b>20,55</b>	7,72%
---> Export WEEE	<b>7,48</b>	2,81%	<b>9,58</b>	3,60%
----> Notified export	<b>3,04</b>	1,14%	<b>3,04</b>	1,14%
----> Unnotified export	<b>4,44</b>	1,67%	<b>6,55</b>	2,46%
---> WEEE in municipal waste	<b>3,89</b>	1,46%	<b>14,25</b>	5,35%
--> Undocumented	<b>84,49</b>	31,74%	<b>49,80</b>	18,71%

Table 29 - Belgian WEEE mass balance - conservative and alternative estimate

In general, we could state that using these available assumptions, an additional potential weight of 34,69 kton (13,03% of POM) of the unregistered documented streams can be documented. In the next paragraphs we explain in detail on how we defined the alternative values.

### *WEEE in scrap*

For WEEE in scrap, the alternative estimation amounts to 43,08 kton (16,18% of POM), which is 18,95 kton higher than the conservative result used in this study. To define the alternative value, we adjusted one parameter in the calculation method (we refer to section 4.1.1. for the detailed calculation method): the percentage of WEEE in scrap. We multiply this percentage with the total weight of scrap generated in Belgium (corrected for import and export of scrap) to obtain the weight of WEEE in scrap.

In our precautionary approach we estimate the percentage of WEEE in scrap to be 3,46%, based on interviews with the largest scrap dealers in Belgium. However, when analyzing other European studies<sup>11</sup>, we identified that the average percentage of WEEE in scrap is

<sup>11</sup> Studies included in the benchmark: Ffact (2012), Dutch WEEE flows (2012), CWIT (2012), DEFRA (2016)

6%. When applying this to our calculation, the alternative estimation for WEEE in scrap is 43,08 kton, holding all other parameters equal.

#### *Export used EEE*

In order to define an alternative value for the export of used EEE, we benchmarked our estimation with other European studies<sup>12</sup>. On average, export of used EEE amounts to 7,72% of the total mass balance in these European studies, which is 1,23% more than on the Belgian mass balance. When applying 7,72% instead of 6,49%, the total weight of used EEE that is exported increases with 3,26 kton to 20,55 kton.

#### *Export WEEE*

For export of WEEE, the discrepancy between the conservative estimation (7,48 kton or 2,81% of POM) and the alternative estimation from the port inspection (9,58 kton or 3,60%) is 2,10 kton (0,79% of POM).

We note that for export of WEEE, we only defined an alternative estimation for the unnotified export. The weight of notified export was based on actual notifications. Consequently we didn't use any assumptions or parameters for the calculation.

To calculate the alternative estimation for unnotified export, we changed the parameter of the number of inspections in the methodology (for the detailed calculation we refer to section 4.1.3 table 21). In our conservative approach, we applied the number of inspections conducted by the environmental inspection and customs (69 inspected shipments, 40 infractions seized, thus 58% seized). However, we also received alternative information on the number of inspections conducted by the port inspection (74 inspected shipments, 59 infractions seized, thus 80% seized). When applying the higher interception rate received by the port inspection, we are able to quantify 6,55 kton (2,46% of POM), keeping all other parameters equal.

#### *WEEE in municipal waste*

The difference between the conservative estimation used in this study (3,89 kton or 1,46% of POM) and the alternative estimation (14,25 kton or 5,35% of POM) is 10,36 kton (3,89% of POM).

To calculate the alternative estimation, we changed the parameter of the percentage of WEEE in household residual waste in our methodology (for the detailed calculation we refer to section 4.1.4). In our precautionary estimate we have applied the 0,30% of the 2010 OWD study, for the alternative estimate we used the 1,10% of the Netherlands (Rijkswaterstaat, 2016).

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<sup>12</sup> Studies included in the benchmark: Ffact (2012), Dutch WEEE flows (2012), CWIT (2012), Global E-waste monitor (2014)

## Conclusions & recommendations



## 7. Conclusions and recommendations

In this section of the report, we discuss the key conclusions that we have drawn and make recommendations to tackle the issues identified and encountered during our study.

### 7.1 POM

When declaring EEE as POM to Recupel, the distributors of this EEE pay a contribution per device put on the market.

Based on conversations with Recupel, we understood that often, a part of the EEE declared as POM is not actually distributed on the Belgian market. Some of these devices are directly exported. In this particular case the distributors can claim back their contribution. In that way, this correction to the POM figure is captured by Recupel. However, it occurs that the contribution is not claimed back. In this way, the part of EEE that leaves the country is not corrected in the POM figure. Hence, we recommend to:

- Conduct a study on the total weight of EEE that is exported after it has been reported as POM
- Inform distributors of EEE about the possibility to claim back their contribution if they directly export the EEE

### 7.2 Registered streams

We note that a lot of information about the registered streams is available through central registration. However, there is still potential to enlarge the amount of registered streams. In this context, there could be a role for the independent non-profit organization that will operate the **BeWeeee** tool in the future. This organization will be founded in 2018 by Recupel, at the request of the regional authorities. As it will operate independently from Recupel, the organization could also be fit to perform the following tasks:

- Monitor actors in the WEEE chain that currently do not report in BeWeeee and make them aware of their reporting duty
- Stimulate all of the actors involved in the recycling of WEEE to report their WEEE flows in BeWeeee

Digging deeper in the registered streams, we noticed that there was a significant discrepancy between the POM and OOM figures of the **Individual Plans**. As maintaining the Individual Plans will also be one of the tasks of the organization that will operate BeWeeee, we recommend that this organization investigates the cause of this discrepancy in order to increase the collection of WEEE.

Finally, we experienced that a lot of information is incorporated in the **waste registers** of collectors, recyclers and distributors of WEEE. These waste registers are gathered by the regional authorities. Unfortunately, to date, this source of information is unused. Therefore, in the short term we recommend to:

- Provide the waste registers to the independent organization operating BeWeeee
- Or encourage the regions to analyze and report the flows of WEEE in the waste registers to Recupel or in the BeWeeee tool.

In the long term, Recupel, the organization operating BeWeeee and the regional authorities could simplify the reporting process for the collectors, recyclers and distributors of WEEE. This could be done by eliminating the obligation to report in BeWeeee, provided that the actor reports his waste register to the organization operating BeWeeee.



### 7.3 Unregistered documented streams

For the unregistered documented streams, we see opportunities in the fields of WEEE in scrap, export of WEEE and EEE, and WEEE in residual waste. Based on our investigation, we noted that **local scrap dealers** often dismantle WEEE without proper licenses. To address this issue we recommend to:

- Conduct a thorough analysis on scrap metal to identify the exact amount of WEEE recycled together with scrap
- Conduct more stringent controls on the unauthorized processing of WEEE and take necessary actions when infractions are encountered

Another unregistered documented stream for which we see an opportunity to enlarge the collection rate, is **export of WEEE**. We noted a significant amount of WEEE is (il)legally transported via ports and roads. Based on our interviews, we understood that many of these flows are reported to customs or are captured in the formalized transportation guidance document 'Annex 7'.

Nonetheless, customs did not cooperate with this study, and the 'Annex 7' form is not centrally registered. Hence, we were not able to quantify these streams. As a result, we would encourage customs to cooperate with Recupel in order to enhance their common insight in the export of WEEE via ports and road. In addition, it could be investigated whether the 'Annex 7' document can be centrally registered by the regional authorities. The insights of customs and the central registration of the 'Annex 7' document can provide us with valuable information on the flows of (W)EEE arising from brokers and re-use centers, export companies, donation of medical devices and export by repair centers to manufacturers.

Closely related to the export of WEEE is the **export of EEE** by re-use centers. We noted that not all re-use centers report to Recupel even though they are member of *Ressources* or *KOMOSIE*, two federations of social economy enterprises. Therefore, we strongly recommend the regional authorities to stimulate re-use centers to report to *Ressources* or *KOMOSIE*, or directly to Recupel.

Another part of the export of EEE that shows room for improvement of registration, is the flow arising from **brokers**. We noticed that the line between the definition of WEEE and second-hand EEE is very thin and that brokers are not always aware that they are exporting waste or performing re-use activities and therefore are submitted to the reporting duty of WEEE. Hence, we recommend the regional authorities to create awareness among brokers concerning this reporting duty and to encourage them to report their flows of (W)EEE.

In our study, we mainly focused on brokerage activities in the IT sector. However, we recommend to further investigate if other product categories are also subject to brokerage activities, such as EEE used in the catering sector.

A last conclusion we can draw for the documented streams, is that at the moment there is limited information on the WEEE found in **residual waste**. Nevertheless, each of the Belgian regional authorities are currently conducting waste composition analyses. Therefore we recommend Recupel to analyze the results of the study and take necessary actions depending on the outcome.

## 7.4 Unregistered undocumented streams

Although we were not able to quantify the unregistered undocumented streams with full certainty, we do have recommendations in order to increase the transparency on these flows.

Concerning flows of **medical devices**, we understood that as of February 2016<sup>13</sup>, Belgian hospitals and laboratories are obliged to maintain a register of their heavy medical devices. Therefore, we encourage the sector to report their medical register to Recupel such that these streams can be fully captured.

With regards to the amount of **luminaires in scrap**, we note that limited information is available in the sector. Therefore, we recommend to set-up a study to further investigate the flows of luminaires in scrap.

We also understood during interviews with DSOs that there is uncertainty on how to organize the collection and sorting of LED luminaires. Hence, we advise Recupel to inform DSOs and their subcontractors on this matter.

Finally, we note that a lot of (W)EEE is in use or stored at households. Currently, Recupel is conducting a study on the **possession of (W)EEE at households**. The results of this study will be available in the second quarter of 2018 and will clarify a part of the undocumented streams.

As a last remark to the report, we want to mention that as of August 2018 an *open scope* will be applicable for the definition of devices that fall under the legislation for collection and treatment of WEEE<sup>14</sup>. Consequently, it will be of increasing importance to centrally align registration and control the collection and treatment of WEEE. This requires a commitment of companies, including brokers and re-use centers, on the registration of (W)EEE. In addition, there should be a focus on non-compliant recycling as this represents the largest leakage on the mass balance.

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<sup>13</sup> K.B./A.R. of 19/01/16

<sup>14</sup> Directive 2012/19/EU Article 2 (b)

## Annex



## 8. Annex

### 8.1 Annex 1 – Uncertainty of the documented data

In order to give insight in the data and calculation methods used to document the tonnages of the unregistered streams, we include in this section an overview of the different data and methods used and the corresponding uncertainty of the resulting documented data. The uncertainty of the documented data is split in two components:

- Uncertainty concerning the calculation method
- Uncertainty concerning the data used






The main sources of uncertainty concerning the data used are:

- Completeness: the data used concerns the whole reporting year (i.e. 2016).
  - o Sampling: taking a sample of the whole population instead of considering the whole population decreases the reliability of the data and consequently increases the uncertainty of the final result.
  - o Extrapolation: extrapolating sample data to reach a result that is similar to the complete population diminishes the certainty of the final result.
- Precision: the data used concerns the activity to be quantified and the timeliness of the reporting year (i.e. 2016).
- Geographical representativeness: the data used is representative for the activities in Belgium.

The main source of uncertainty concerning the calculation method is:

- Assumptions

The uncertainty of the calculation method and the data used is measured as follows:

Uncertainty indicator	Underlying uncertainty
	< 2%
	< 10%
	< 20%
	< 30%
	> 40%

"< 2%" meaning that there is almost no uncertainty and "> 40%" meaning that the data and calculation method used are too uncertain to be included in the final collection figure. Note that we have not used data in the mass balance of which we estimate the uncertainty to be higher than 40% as this would diminish the report quality. Only in section 4.2 we did a few high level estimations to roughly classify the different potential components of the undocumented data stream of the mass balance.

## 8.1.1 Registered streams

### 8.1.1.1 Recupel collection

#### Data uncertainty

WEEE OOM reported in Recupel system	
Data uncertainty	Calculation uncertainty
	Not applicable

#### Calculation steps

WEEE OOM reported in Recupel system	
Calculation steps	Comment
The data was gathered by Recupel, based on the reporting of their members and their own collection network. This data is yearly audited by a certified company.	<ul style="list-style-type: none"> <li>- Calculation: we did not perform calculations on the source data</li> <li>- Data: as the data is based on the actual weight of WEEE collected through the Recupel network, the data uncertainty is low.</li> </ul>

### 8.1.1.2 Individual plans

#### Data uncertainty



WEEE OOM reported in individual plans	
Data uncertainty	Calculation uncertainty

#### Calculation steps

WEEE OOM reported in individual plans	
Calculation steps	Comment
Companies reporting through individual plans report the weights they collected in a fixed format to each of the regional authorities. The regional authority summarized the reported weights and provided this information to Deloitte.	<ul style="list-style-type: none"> <li>- Calculation: the weights reported are manually summarized by the regional authorities per WEEE category.</li> <li>- Data: no risks identified.</li> </ul>
The reported weights are summarized according to 10 WEEE categories that can be used during the transitional period defined by Directive 2012/19/EU, while in the individual plans another definition is used. Consequently a conversion is necessary.	<ul style="list-style-type: none"> <li>- Calculation: <ul style="list-style-type: none"> <li>o As the data is adapted manually, it can be subject to human errors.</li> <li>o We mapped the categories with the fractions according to our understandings of the content of each category and fraction.</li> </ul> </li> <li>- Data: No risks detected.</li> </ul>

### 8.1.1.3 BeWeee

#### Data uncertainty



WEEE OOM reported in BeWeee	
Data uncertainty	Calculation uncertainty
	

#### Calculation steps

WEEE OOM reported in BeWeee	
Calculation steps	Comment
The data gathered in the BeWeee tool is entered by the different actors in the collection system.	<ul style="list-style-type: none"> <li>- Calculation: no calculation is performed at this stage.</li> <li>- Data: as the BeWeee data is entered manually, it can be subject to human errors.</li> </ul>
Inconsistent names in the data are adapted (capital letters, abbreviations, ... in the names of the actors are not consistently used by the BeWeee users)	<ul style="list-style-type: none"> <li>- Data: as the BeWeee data is entered manually, it can be subject to human errors.</li> </ul>
<p>The following eliminations of data are made:</p> <ol style="list-style-type: none"> <li>a. Duplicate reported weights (different players in one chain report the same batch of WEEE)</li> <li>b. Recupel members: they are already included in the figures reported by Recupel (see section 3.1)</li> <li>c. Reporting companies that also report through an individual plan (see section 3.2)</li> <li>d. Weights reported in the fraction solar panels. The collection of WEEE for solar panels is part of a separate ERP System, PV Cycle</li> </ol>	<ul style="list-style-type: none"> <li>- Calculation: data is reviewed through the use of filters. The eliminations are performed manually.</li> <li>- Data: <ul style="list-style-type: none"> <li>o As the BeWeee data is entered manually, it can be subject to human errors.</li> <li>o Comparisons are made with lists of companies provided by Recupel and the regional authorities (individual plans). This data is extracted from their database. No human intervention.</li> </ul> </li> </ul>

### 8.1.1.4 Waste registers reported to the regional authority

#### Data uncertainty

WEEE OOM reported in waste registers	
Data uncertainty	Calculation uncertainty
	



### Calculation steps

WEEE OOM reported in waste registers	
Calculation steps	Comment
We gathered data from BIM and OVAM that was directly linked to the reported waste registers.	<ul style="list-style-type: none"> <li>- Calculation: the weights reported are manually summarized by the regional authorities per WEEE category.</li> <li>- Data: we don't have information on how the companies gather their data.</li> </ul>
We eliminated – if possible – the data linked to Recupel members, companies reporting through an individual plan and companies reporting in BeWeee.	<ul style="list-style-type: none"> <li>- Calculation: data is reviewed through the use of filters. The eliminations are performed manually.</li> <li>- Data: <ul style="list-style-type: none"> <li>o We don't have information on how the companies gather their data.</li> <li>o Comparisons are made with lists of companies provided by Recupel and the regional authorities (individual plans). This data is extracted from their database. No human intervention.</li> </ul> </li> </ul>
Through extrapolation, we made an estimation of the waste register data reported to DSD.	<ul style="list-style-type: none"> <li>- The extrapolation was based on the number of inhabitants in each region (data source: Statbel). Consequently, we assume that the collection of WEEE per inhabitant is similar in the three Belgian regions.</li> </ul>

## 8.1.2 Unregistered streams - documented

### 8.1.2.1 WEEE in scrap

#### Data uncertainty

WEEE in scrap	
Data uncertainty	Calculation uncertainty
	

### Calculation steps

We based the level of uncertainty on the following use of data and calculation method:

WEEE in scrap	
Calculation steps	Comment
Determination of total weight of pre-shredder material yearly treated in Belgium through extrapolation of weight of pre-shredder material yearly treated by individual shredder installations. We used the data of 5 shredder installations and extrapolated this to 16, as there are 16 shredder installations in Belgium.	<ul style="list-style-type: none"> <li>- Data: the weight of pre-shredder material treated by the individual shredder installations is extracted from the monitoring systems of the scrap dealers.</li> <li>- Calculation: Assumption that all shredder installations in Belgium yearly treat the same weight of pre-shredder material.</li> <li>- Calculation: We used the data of 5 shredder installation for the extrapolation to 16 shredder installations</li> </ul>
Determination of percentage of WEEE in pre-shredder material by taking the average of estimations of three scrap dealers.	<ul style="list-style-type: none"> <li>- Data: the percentages are estimated by the scrap dealers based on their knowledge of the composition of the scrap they treat.</li> <li>- Calculation: we took the average of the different percentages the scrap dealers shared with us. We assume that the scrap dealers treat scrap with similar composition.</li> </ul>
Multiplication of the total weight of pre-shredder material treated in Belgium with the average percentage of WEEE in pre-shredder material	<ul style="list-style-type: none"> <li>- Data: see above for uncertainty of data</li> <li>- Calculation: the multiplication assumes that all pre-shredder material yearly treated in Belgium has the same composition.</li> </ul>

### 8.1.2.2 Export WEEE

- **Notified export**

*Data uncertainty*

Export WEEE – notified export	
Data uncertainty	Calculation uncertainty
█	█





*Calculation steps*

Export WEEE – notified export	
Calculation steps	Comment
Selection of relevant EURAL codes from actual export notifications to BIM, DSD and OVAM, filtering out actors from the Recupel network.	The data represents the actual notifications made in 2016 for all regions.

• **Not notified export**

*Data uncertainty*

Export WEEE – not notified export	
Data uncertainty	Calculation uncertainty
	









*Calculation steps*

Export WEEE – not notified export	
Calculation steps	Comment
Determination of average weight of one shipment of exported WEEE: <ol style="list-style-type: none"> <li>Composition of one shipment based on a sample of 20 test papers (May 2017)</li> <li>Weight per fraction based on average weight of fractions reported in BeWEEE 2015-2016 data (844 reports).</li> </ol>	<ul style="list-style-type: none"> <li>- Data: sample of one month (May 2017) for composition of shipments</li> <li>- Data: average weight used, however, based on a sample of BeWEEE reportings of 2 years</li> <li>- Calculation: assumption that composition of shipments does not vary over the year</li> </ul>
Determination of weight of infringements seized in 2016: multiplied the weight calculated in step 1. with the number of infringements of shipments seized in a random sample of 300 shipments.	<ul style="list-style-type: none"> <li>- Data: use of actual number of seized infringements in the port of Antwerp in 2016</li> <li>- Calculation: Assumption that no shipments concerning WEEE were seized in other ports in Belgium is acceptable.</li> </ul>
Calculation of total illegal export of WEEE based on estimation of seized illegal export in the EU and total illegal export for Belgium. (Huisman, 2015).	<ul style="list-style-type: none"> <li>- Data: geographical representation - use of percentage of seized illegal export in EU instead of Belgium.</li> <li>- Calculation: Assumption that percentages used in CWIT study (Huisman, 2015) are representative for situation in 2016.</li> </ul>

### 8.1.2.3 Export EEE

#### *Data uncertainty*

Because of the fact that the data and calculation uncertainty of export of EEE vary significantly between the different calculation steps, we indicated the data and calculation uncertainty separately for each calculation step:



Calculation step (see below)	Export EEE	
	Data uncertainty	Calculation uncertainty
Total POM weight 2011 of IT HH and PROF used in a corporate environment		
Substraction Recupel collection figure		
Split between export and Belgian market		
Correction for registration in BeWeee		

### Calculation steps

Export EEE	
Calculation steps	Comment
<p>Starting point is the total POM weight 2011 of IT HH and PROF used in a corporate environment.</p> <ul style="list-style-type: none"> <li>- Assumption: average depreciation period or leasing period of WEEE going out of the market in 2016 is 5 years.</li> <li>- The POM data is based on the reporting and sales data of Recupel members.</li> <li>- Division of IT product types typically used in a corporate environment on the one hand or used by private consumers on the other hand was done together with Recupel and based on interviews with brokers.</li> </ul>	<ul style="list-style-type: none"> <li>- Data: the division between IT devices generally used in a corporate environment versus devices used by private consumers was made based on interviews with brokers and Recupel knowledge.</li> <li>- Data: the POM data is based on reported units and average weight per product type</li> <li>- Calculation: the POM data is based on number of units reported by Recupel members, average weight per product type and sales data.</li> </ul>
<p>The collection in the Recupel network of IT devices in 2016 is subtracted.</p>	<ul style="list-style-type: none"> <li>- Data: as the data is based on the actual weight of WEEE collected through the Recupel network, data uncertainty is low.</li> <li>- Calculation: no extrapolations or assumptions were made.</li> </ul>
<p>The remaining weight is split between devices that are exported (80%) and devices that are sold on the Belgian market (20%)</p>	<ul style="list-style-type: none"> <li>- Data: the 80/20-split was based on interviews with a sample of Belgian brokers and leasing companies.</li> <li>- Calculation: making a division between exported EEE and EEE sold on the Belgian market is a representation of the actual situation for Belgium</li> </ul>
<p>Lastly, a correction is made for IT devices registered as export in BeWeee and re-use registered in the regional authority's data.</p>	<ul style="list-style-type: none"> <li>- Data: as the data is based on the actual weight of WEEE collected by actors reporting in BeWeee or to the regional authorities, data uncertainty is low.</li> <li>- Calculation: the correction is necessary to double-counted data.</li> </ul>

### 8.1.3 WEEE in municipal waste

#### Data uncertainty

WEEE in municipal waste	
Data uncertainty	Calculation uncertainty
	



### Calculation steps

WEEE in municipal waste	
Calculation steps	Comment
<p>The total weight of household residual waste yearly generated in Belgium was calculated based on a sorting analysis of 2010 (RDC-Environment S.A., 2010).</p> <p>As described in section 4.1.4, no recent data is available. However, in 2018, new sorting analyses will be published in each region.</p>	<ul style="list-style-type: none"> <li>- Data: waste generation data of used studies can potentially be outdated</li> <li>- Calculation: assumption that waste generation in Brussels is equal to average of Flanders and Wallonia</li> </ul>
<p>We used one percentage of WEEE in household residual waste for the three regions. We consulted the sorting analysis held in 2009 in Wallonia (RDC-Environment S.A., 2010) for this percentage.</p>	<ul style="list-style-type: none"> <li>- Data: percentage of WEEE in household residual waste can potentially be outdated</li> <li>- Calculation: assumption that percentage of WEEE in household residual waste in Wallonia is equal to Flanders and Brussels.</li> <li>- Calculation: use of percentage instead of actual figures</li> </ul>

## 8.1.4 Unregistered streams - undocumented

### 8.1.4.1 Medical devices – donation

#### Data uncertainty

Medical devices - donation	
Data uncertainty	Calculation uncertainty
	



#### Calculation steps

Calculation steps	Comment
<p>Determination of total weight of used EEE donated by 1 Flemish hospital:</p> <p>a. The composition of used EEE donated was determined by consulting the annual report of the concerned Flemish hospital: it describes the types of devices donated. However, no number is mentioned.</p> <ul style="list-style-type: none"> <li>Prudent assumption: a device described in the singular counts as one device, a device described in the plural counts as two devices.</li> </ul> <p>b. The average weight of the devices donated was determined after desk research</p>	<p>- Data: the description of the devices donated by a Flemish hospital in the annual report are combined with the average weight of the devices mentioned. This average weight is determined based on investigation on internet.</p> <p>- Calculation: we assume that devices described in plural concern 2 devices. In addition, we determine the weight based on the weight of a similar device.</p>
<p>The determination of the upper (100%) and lower limit (50%) of the total donation weight of used medical EEE in Belgium was based on the number of hospitals in Belgium. This number can be found on the website of the federal government<sup>15</sup>.</p>	<p>- Data: the number of Belgian hospitals was based on a source of the federal government.</p> <p>- Calculation: by extrapolating the average weight of devices donated by one hospital to a number of hospitals in Belgium, we assume that all hospitals donate the same weight of devices.</p>

<sup>15</sup> [https://www.belgium.be/nl/gezondheid/gezondheidszorg/medische\\_diensten/ziekenhuizen](https://www.belgium.be/nl/gezondheid/gezondheidszorg/medische_diensten/ziekenhuizen)

### 8.1.4.2 Luminaires in scrap

#### Data uncertainty



Luminaires in scrap	
Data uncertainty	Calculation uncertainty
	

#### Calculation steps

Calculation steps	Comment
The starting point for the estimation of the potential OOM weight of street luminaires that are recycled with scrap was the number of replacements performed by each of the interviewed companies.	<ul style="list-style-type: none"> <li>- Data: the data delivered by the SDOs and governmental agency came from different sources: some companies let their subcontractors complete an overview of the removed components and request a confirmation of the waste collector of this number. Other companies do not possess such a data management system and made an estimation.</li> <li>- Calculation: we limited our interviews to all parties replacing street luminaires in Belgium. Consequently, the total weight is not representative for the Belgian market</li> </ul>
We multiplied the estimated number with an average weight of a street luminaire. This weight was determined based on objective measurements by technologists from one of the interviewed companies.	<ul style="list-style-type: none"> <li>- Data: the average weight of street luminaires was based on objective measurements by technologists of from one of the interviewed companies.</li> <li>- Calculation: We assume that the weight of luminaires used in public lighting is equal for the different regions.</li> </ul>

### 8.1.4.3 EEE exported via repair centers

#### Data uncertainty

Repair centers	
Data uncertainty	Calculation uncertainty
	

#### Calculation steps

Calculation steps	Comment
We interviewed 2 repair centers, covering 64% of the market. These companies gave us information on the number of devices that are yearly returned to the manufacturer. In addition, they provided us with an average weight of devices repaired at their center.	<ul style="list-style-type: none"> <li>- Data: the number of devices and the average weight determined by the repair centers are estimations.</li> <li>- Calculation: using an average weight to determine the total weight of returned devices, implies the assumption that all devices have the same average weight.</li> </ul>
Based on the fact that the interviewed repair centers have a market share of 64%, we extrapolated the potential leakage weight determined in the previous step to 100% of the market.	<ul style="list-style-type: none"> <li>- Data: the determination of the market size and the market share of the two interviewed parties was based on desk research. We made a list of all Belgian repair centers and their respective gross margin. The interviewed companies are the two largest repair centers in Belgium based on gross margin.</li> <li>- Calculation: extrapolating the weight of returned devices of the two interviewed companies over the whole market, implies the assumption that the return rate to manufacturers is equal for all repair centers.</li> </ul>

## 8.2 Annex 2 – BeWeee – Elimination rationale

In BeWeee, companies can report on the weight of WEEE they have collected and can also destine the weight of WEEE they collect to a certain company, the next actor in the value chain. In an “ideal world”, where all collectors and processors of WEEE report their flows, all of these destined streams should be eliminated, as they are duplicates of one OOM reported by the first actor in the value chain.

The situation in which two subsequent actors in a value chain treat the same amount of WEEE and both report in BeWeee is shown in the below picture:

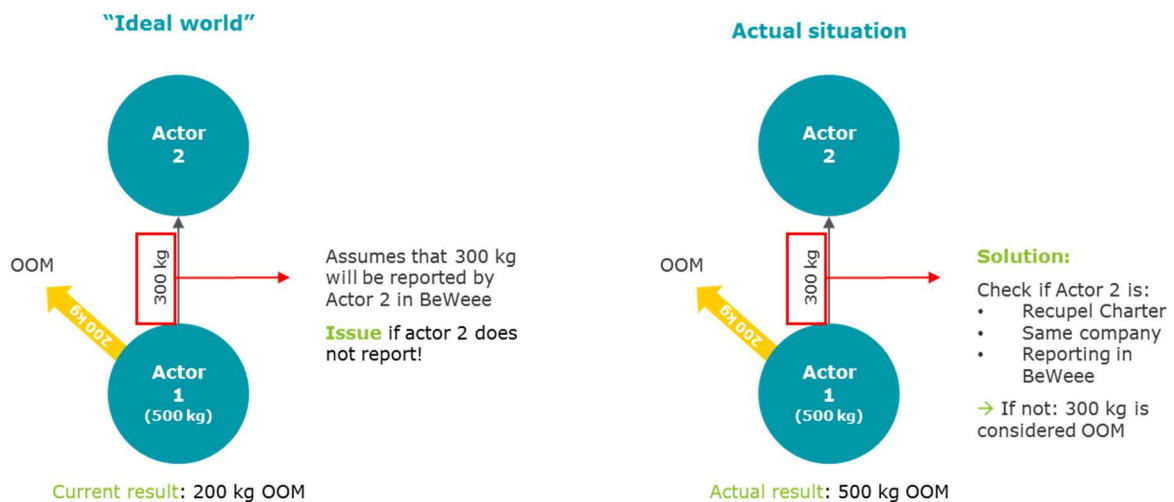


Figure 13 - BeWeee logic of reporting of OOM

In the example above, actor 1 is a collector and actor 2 a recycler. Actor 1 reports a total of 500 kg in BeWeee of which 300 kg is destined to actor 2. Following the “Ideal World” logic, 200 kg will be considered as OOM by actor 1. The remaining 300 kg will be considered as OOM by actor 2.

However, not all companies involved in the value chain report their waste streams. Hence, we first performed the check whether actor 2 is a Recupel member, is the same company as actor 1 or reports in BeWeee. If none of these conditions is fulfilled, the entire weight (i.e. 500 kg) is considered OOM. If one of these conditions is met, the weight that was destined by actor 1 is eliminated, as it should not be double counted in the mass balance.