THE DUTCH WEEE FLOWS

WHERE DO WEEE GO FROM HERE

2011 DUTCH E-WASTE QUANTIFICATION

STUDY COMMISSIONED BY

wecycle

NVMP

ICT-MILIEU

THE DUTCH WEEE FLOWS

STUDY CONDUCTED BY

UNITED NATIONS UNIVERSITY

UNU-ISP

Institute for Sustainability and Peace

Statistics Netherlands

FFact

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INDEX

SUMMARY

In 2010, around 7.5 kg per inhabitant of WEEE is reported on a national level as being collected and treated by Wecycle and ICT~Milieu, the two main organisations that implement WEEE producer responsibility in the Netherlands. This is 28% compared to the new WEEE recast level that targets at 65% collection of three previous years of EEE sales. It is known that there are substantial complementary recycling streams. Therefore the aim of this research is to provide a factual basis for the upcoming WEEE recast collection target definition in the Netherlands and to provide a more detailed and complete quantitative assessment of the WEEE flows. The outcomes are visualised on page 5.

THE KEY FINDINGS ARE:

1. Based on methodology that uses production, import and export data for EEE from Statistics Netherlands, combined and validated with other sources, it is calculated that 26.5 kg/inh (440 kton) of EEE was put on the market in 2010. The average for 2007-2009 is 26.8 kg/inh. The method is easily transferable to other EU countries.
2. A new and unprecedentedly accurate WEEE generated model developed by UNU, calculates WEEE amounts based on interrelated historic sales data, average residence times and stocks in households and businesses.
3. It calculates the amount of WEEE plus export of used EEE generated in the Netherlands at 23.7 kg/inh (+/- 0.4) or 392 kton. The ratio of WEEE + used EEE versus the same year POM is 89% in weight.
4. Export of used EEE is documented as 2.7 kg/inh, (44 kton or 9% of POM); from this 1.7 kg/inh is from households and 0,9 kg/inh is of B2B origin.
5. Export of used EEE reduces the WEEE potential that can be collected and treated in the Netherlands to 21.0 kg/inh (349 kton). The ratio of WEEE Generated NL over (same year) POM is 79% in weight.
6. Of this, Wecycle and ICT~Milieu collected and treated 7.5 kg/inh (125 kton, 28% of POM).
7. Parallel to this, the total complementary recycling stream is 6.6 kg/inh (110 kton, 25% of same year POM). From the complementary recycling stream, 60% is a so-called mono-flow, the remaining is present in a mixed stream with other metals and a small percentage of WEEE (derived parts). Around half of the WEEE is recognisable as mono-flows, the other half is present in a larger mixed stream with other metal products and a small percentage of WEEE (derived parts).
8. In total 2.3 kg/inh, mainly small household appliances, is ending up in residual waste (38 kton, 9% of POM).
9. The project started at around 30% being documented and ended at roughly 80% of all WEEE flows now being documented (19.1 kg/inh, 316 kton). The documented amounts are validated by using an advanced WEEE chain model detailed information, mass balances per actor and logical constraints. Moreover, the model allocates the amounts to the individual collection categories more precisely.
10. In addition clear indications are derived on the likely destinations of the not yet documented remainder, being 3.9 - 5.1 kg/inh (64 - 85 kton, 15% - 19% of POM). For several reasons, roughly half of this, 2.2 kg/inh, (+/- 37 kton), is estimated to be structurally non-identifiable.

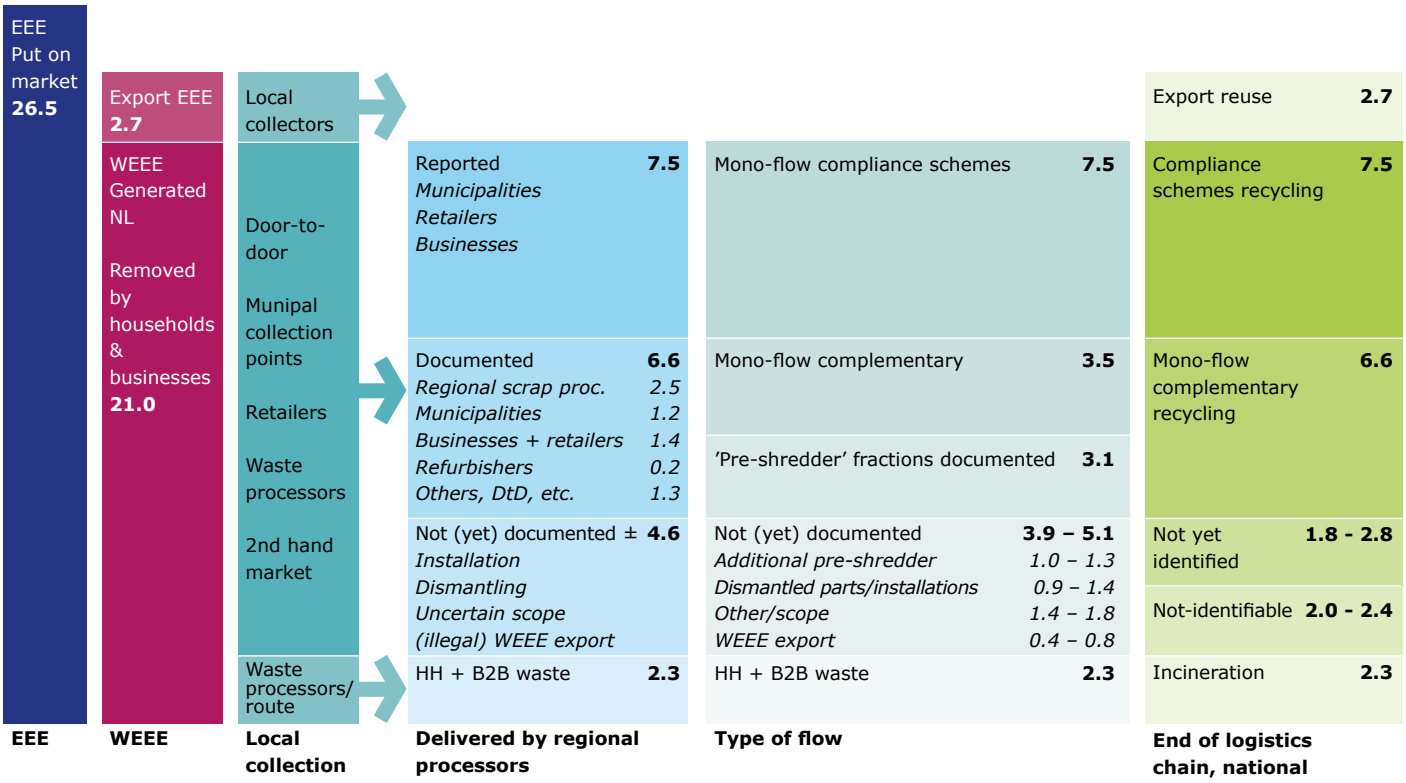


Figure 1 The Dutch WEEE flows 2010

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
EEE POM 2010	**7.88**	**3.88**	**7.50**	**3.03**	**0.76**	**1.74**	**0.27**	**1.46**	**26.5**	**440**
WEEE + used EEE Generated	**6.39**	**2.95**	**6.44**	**3.00**	**1.80**	**1.85**	**0.22**	**1.03**	**23.7**	**392**
WEEE + used EEE / EEE ratio	81%	76%	86%	99%	237%	106%	80%	71%	89%	89%
Export used EEE	**0.26**	**0.60**	**0.24**	**0.60**	**0.26**	**0.49**	**0.00**	**0.20**	**2.7**	**44**
Export used EEE HH whole appliances	0.23	0.54	0.22	0.22	0.04	0.49	0.00	0.00	1.7	29
Export used EEE B2B incl. refurbishing	0.03	0.06	0.02	0.38	0.23	0.00	0.00	0.20	0.9	15
WEEE Generated 2010 NL	**6.13**	**2.36**	**6.20**	**2.40**	**1.53**	**1.36**	**0.22**	**0.83**	**21.0**	**349**
WEEE / EEE ratio (excl. export)	78%	61%	83%	79%	202%	78%	80%	57%	79%	79%
Documented + export used EEE	**4.93**	**2.52**	**4.93**	**2.44**	**1.43**	**1.78**	**0.22**	**0.83**	**19.1**	**316**
Households										
Wecycle/ICT~Milieu	1.86	1.53	1.60	0.61	0.61	1.25	0.10	0.00	7.5	125
Complementary	2.29	0.00	1.22	0.29	0.12	0.00	0.00	0.00	3.9	65
Businesses										
Complementary	0.52	0.39	0.23	0.41	0.45	0.04	0.01	0.63	2.7	44
Compl. recycling B2B + HH	**2.81**	**0.39**	**1.45**	**0.70**	**0.56**	**0.05**	**0.01**	**0.63**	**6.6**	**110**
Waste/incineration	**0.00**	**0.00**	**1.64**	**0.54**	**0.00**	**0.00**	**0.11**	**0.00**	**2.3**	**38**
Not (yet) documented	**1.2 – 1.7**	**0.4 – 0.5**	**1.4-1.6**	**0.5 – 0.6**	**0.4 – 0.4**	**0.1 – 0.1**	**N/A**	**0.2 – 0.2**	**3.9 – 5.1**	**64 – 85**
Potentially identifiable min/max	0.7 – 1.0	0.2 – 0.4	0.6 – 1.0	0.1 – 0.2	0.1 – 0.1	0.0 – 0.0		0.1 – 0.1	1.8 - 2.8	31 – 46
Unidentifiable, min/max	0.5 – 0.6	0.1 – 0.2	0.6 – 0.8	0.4 – 0.5	0.2 – 0.3	0.0 – 0.1		0.1 – 0.1	2.0 – 2.4	34 – 40

Figure 2 Summary table (small differences due to rounding)

1 INTRODUCTION

Traditionally, waste electrical and electronic equipment (WEEE or e-waste) has been a complex waste stream to get a grip on. Due to its own heterogeneous nature and many actors involved compared to other waste streams, it is difficult to determine how much electrical and electronic equipment (EEE) is put on the market (POM), how much becomes WEEE and how much is collected and treated (C&T) on a national level by the compliance schemes (Wecycle and ICT~Milieu) versus complementary recycling (reported by national recyclers to local or provincial authorities) and how much other complementary streams are there, like small door-to-door trade, 2nd hand shops, WEEE in residual waste from households (HH) or businesses (B2B) and/or exported (illegally) out of sight.

1.1 HISTORY OF DUTCH WEEE STUDIES

In 2007, the UNU WEEE Review study (Huisman, J., Magalini, F., et al., 2008) formed a major share of the scientific basis for the recast of the WEEE Directive (European Commission, 2003). Amongst many other contributions, this extended study led to a fundamentally altered WEEE Directive recast proposal (Council of the European Union, 2011). The WEEE recast was finally agreed upon and voted for by the European Parliament at the end of 2011 after extensive negotiations. One of the factors delaying the process was agreeing on the collection target level and basic definition (POM or WEEE) which was troubled by high uncertainty in POM and WEEE amounts. The Netherlands as one of the countries with traditionally extensive complementary recycling, trading and distribution of EEE and WEEE, conducted a follow up of the UNU study in 2007. This led to the unique GfK/Witteveen + Bos reports, (Hendriksen, 2009), (Hendriksen, 2010), (Eijsbouts, 2008) and the first insights in the significance of complementary WEEE flow. This subsequently formed important input for the collection target in the new WEEE Directive.

The new collection target of 65% of three previous years POM or alternatively upon choice by the Member States of 85% of WEEE, requires substantial work in developing criteria and methodology to determine independent, meaningful and practical levels per collection category for the future. Implementation of the new targets is complicated by many factors. This includes both gradual and abrupt changes in materials composition, product design, sales volumes, average weight per appliance, market saturation, residence times, etc. of EEE and WEEE entering and leaving households (HH) versus businesses, institutions and public space (B2B). For assessing the Dutch recycling streams this is further complicated by substantial import and export, reuse flows and dismantling for reusable parts or valuable fractions.

1.2 A COMPLEX WASTE STREAM

The aim of this research is to provide the fact finding basis that could support this future target setting definition by means of a more detailed and complete quantitative assessment of the WEEE flows. Secondly, it aims at qualitative insights in the mechanisms and pathways of collection, recycling, disposal and import plus export of WEEE in the Netherlands. This helps to appoint practical intervention options where needed from an environmental, economic, organisational or enforcement point of view.

On behalf of Wecycle/NVMP and ICT~Milieu, the initiators and donors of this comprehensive research, UNU, Witteveen + Bos (W+B), FFact and the Statistics Netherlands (CBS) aligned all their national and international knowledge and expertise in this project's research group. In addition, a feedback group with all relevant actors from the Dutch WEEE chain is frequently consulted and substantial data input is delivered by:

1. Wecycle and ICT~Milieu (POM in pieces, weights per appliances, benchmark of collection points, plus GfK data on past complementary streams studies, consumer surveys for 2008 for HH and 2010 for SME's, raw lifetime and stocks data);
2. The European Electronics Recyclers Association (EERA), (data for recycling, import and export of all members operating in the Dutch market) and the Dutch Metaal Recycling Federatie (MRF) who both cooperated to the same market survey and questionnaires;
3. The I&M Inspectorate, (extended support in analysing chain, combined analysis export flows);
4. The Ministry of Infrastructure and Environment (I&M) policy department responsible for WEEE;

5. Eureco provided a large number of sorting analyses of residual household waste via Wecycle, containing detailed WEEE sampling on appliance level. Agency NL, the executing agency for waste related issues also assisted here. (WEEE sorting analysis in HH waste 2000-2010);
6. The Dutch association for residual household waste collectors (NVRD).

The scope of this research includes all EEE and WEEE products (see UNU-58, Technical Report for details).

A. Large Household Appliances (LHA), incl. professional luminaires and other professional large steel dominated products, excl. Central Heating ('CV's' in Dutch, boilers and geysers);
B. Cooling and Freezing (C&F), incl. air conditioners and – installations, cooling displays and cooled vending machines;
C. Small Household Appliances (SHA), incl. small IT and CE products, handheld tools, toys and other small items from category 1-10. In this category are items included which were uncertain whether they will fall under the WEEE recast scope: consumer luminaires and small toys with light or sound functions;
D. IT equipment (IT), laptops and desktops incl. accessories, phones, printers and game consoles;
E. Screens (Screens): CRT and flat panel display TV's and Monitors (FPD: Plasma, LCD and LED);
F. Lamps (Lamps), excluding luminaires;
G. Professional Appliances (PROF): dedicated professional and special equipment including large IT network equipment, large medical equipment for hospitals and large professional tools and toys.

1.3 READERS GUIDE

As illustrated in Figure 3, the structure of the report is aligned according to the research steps needed to quantify all WEEE flows. The idea is to start from the 'outside' with total EEE and WEEE amounts and well-known flows, towards the 'inside' being lesser known flows. After introducing the WEEE market structure in Chapter 2, it discusses past and current EEE sales in Chapter 3 and the connected UNU WEEE Generated model in Chapter 4 in order to provide a starting point for the total size of the WEEE flows. Past results and future trends in EEE and WEEE amounts are also discussed here. In Chapter 5, the influence of import and export of EEE and WEEE on the total WEEE potential in the Netherlands is presented. In addition, also the influence of other import and export flows on WEEE Generated is discussed. Chapter 6 explains the size and nature of the well-known compliance scheme part of the WEEE flows of Wecycle and ICT~Milieu. Chapter 7 presents the findings of the market survey aiming to document the complementary recycling flows. This is followed by Chapter 8 where findings on other WEEE flows are presented, including an analysis of WEEE ending up in the waste bin as residual waste for incineration. Finally, Chapter 9 describes the advanced chain model used to integrate, link and validate all information. By definition, at the end of the chain due to the heterogeneous nature of the WEEE flow, the original 'identity' or 'origin' of equipment is sometimes unclear or overlapping. Therefore, it is important to note, that although explained later, the chain model of Chapter 9 not only validates but also confirms and allocates the documented WEEE totals (as found in Chapter 5-8) to the individual collection categories. Chapter 10 contains conclusions and recommendations.

READERS GUIDE	CHAPTER
WEEE Market Structure	2
EEE put-on-market (POM) **Past EEE sales** **POM from National Statistics** **POM NL 2010**	3 3.1 3.2 3.3
WEEE + used EEE Generated **WEEE Generated** **POM and WEEE trends**	4 4.1,2 4.3
Import, Export and WEEE NL **Export used EEE for reuse** **Import and Export of WEEE**	5 5.1 5.2
Compliance Scheme Flows **Container parks** **Retail collection**	6 6.1 6.2
Complementary WEEE Flows **National recyclers** **Regional processors** **2nd hand and charity**	7 7.1 7.2 7.3
WEEE in Residual Waste	8
WEEE Chain Model **Validation of all flows** **2010 NL WEEE mass balance**	9 9.1 9.2
Conclusions & recommendations **Conclusions** **Recommendations** **The future Flows continued**	10 10.1 10.2 10.3

Figure 3 Readers Guide

1.4 RESEARCH TERMINOLOGY

For better comprehension of this report, the following is used as a research terminology:
Documented amounts are those quantities that are validated and for which sufficient evidence is gathered. This does not necessary mean these flows are also reported on a national or regional level (and vice versa). The documented amounts are always displayed as a minimum value when uncertainty is involved. The uncertainty range is included in the size of the not (yet) documented flows. This does also not necessarily mean they are not reported somewhere (out of our research sight). In Chapter 9, the not (yet) documented flows are split into two parts: Firstly, a part which potentially, with (much) more effort could be identified and secondly, a part that is structurally hard or impossible to be documented like dismantling fractions/parts, WEEE unrecognisable as WEEE and additional (illegal) export (see Chapter 9).

WEEE: A DIVERSE WASTE STREAM

Due to the complex and heterogeneous character of the WEEE stream, a consistent classification of products is needed to enable compatibility and clear scoping of WEEE products. Therefore, a new set-up of a product categorisation is drafted. It is constructed in such a way that it supports two angles: a product (functionality perspective) and a legal and recycling perspective. The list categorises various products in such a way that both high level (per collection category) and detailed analyses (per appliance type) are made compatible. The detailed list (See Technical Report) is based on 58 subcategories. This UNU-58 links and divides all possible EEE and WEEE products (about 900 products) into B2B/B2C, in the 5 to 7 collection categories often used in practice, the 10 WEEE Directive product categories, the 17 UNU subcategories used by the WEEE Forum (WEEE Forum, 2010) and the 2007 WEEE Review study, the classification used by Wecycle and ICT~Milieu (> 700 products). The UNU-58 is made to be able to group similar products with identical functionality and, or same return stream characteristics. The most relevant, or Top 25 are listed below.
The 'Top 25' products are selected based on weight, economic value and/or environmental relevancy.
The need of this list in later modelling is to be able construct lifetime profiles per UNU key instead of for all 900 products individually. In addition, the UNU keys are also linked with all EEE related Prodcom (PCC) and Combined Nomenclature (CN) codes used for national statistics and customs allowing future international comparison and thus comparable POM and WEEE assessments. A tool for other EU countries will be made available.

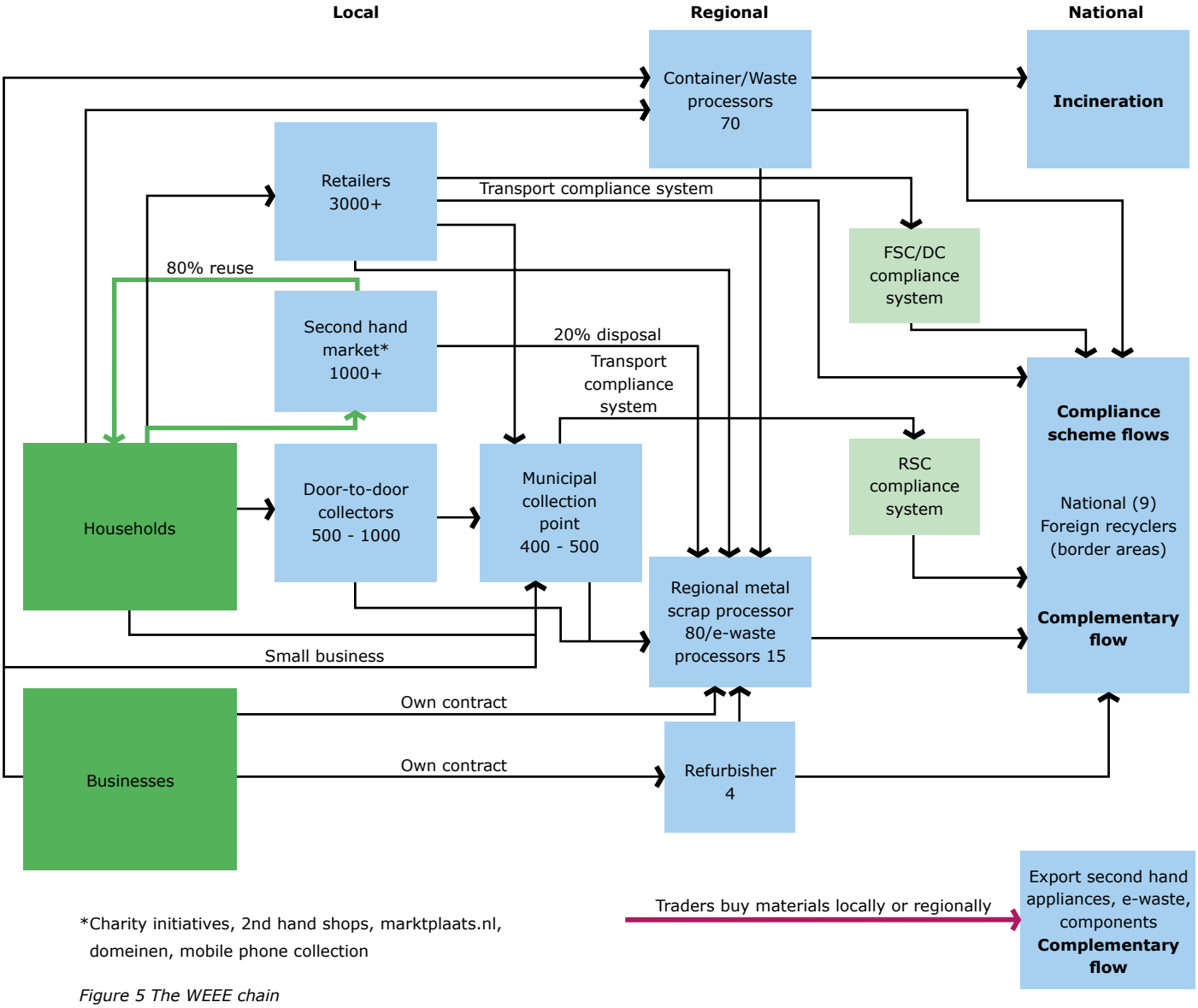
UNU KEY	PRODUCTS	ABBREVIATION	COLLECTION CATEGORY
1-02	Dishwashers	1A2 Dishes	A LHA
1-03	Furnaces and ovens	1A3 Kitchen	A LHA
1-04	Washing machines	1A4 Wash	A LHA
1-05	Wash dryers + centrifuges	1A5 Dry	A LHA
1-08	Fridges (single door)	1B1 Fridge	B C&F
1-09	Freezers	1B2 Freezer	B C&F
1-10	Combi-fridges (double door)	1B3 Combi	B C&F
1-14	Microwaves	1C1 Micro	C SHA
2-01	Mixed SHA: ventilators, irons, etc.	2.1 Small HH	C SHA
2-04	Vacuum cleaners	2.4 Vacuum	C SHA
3-02	Desktop PC's	3A2 Desktops	D IT
3-03	Laptops, incl. tablets + netbooks	3A2 Laptops	D IT
3-04	Printers, scanners and MFP's	3A4 Printers	C SHA
3-06	Mobile phones	3A6 Mobiles	D IT
3-08	CRT monitors	3B CRT	E1 CRT
3-09	FDP Monitors (LCD, LED)	3C FDP	E2 FDP
4-02	MP3, e-readers, car nav., etc.	4A2 Portable	C SHA
4-03	Hifi components	4A3 Hifi	C SHA
4-04	VCR and DVD(R)	4A4 VDVD	C SHA
4-07	CRT TV's	4B CRT	E1 CRT
4-08	FDP TV's (LCD, LED, Plasma)	4C FDP	E2 FDP
5-02	CFL (i + non-i), LED lamps (retro)	5A2 CFL	F Lamps
5-04	TL: straight tube fluorescent lamps (B2B part)	5A4 TL B2B	F Lamps
5-07	HH Luminaires	5B1 LUM	C SHA
6-01	Small Tools (power and garden tools)	6.1 Small tools	C SHA

Figure 4 The UNU 58 – WEEE Classification, Top 25 products

2 THE WEEE MARKET STRUCTURE

There are many actors involved in the WEEE collection, trading and recycling. In Figure 5 a simplified structure shows the main actors and relationships between them. WEEE flows start with consumers (HH) and businesses (B2B): they decide in first instance if WEEE moves into the direction of the collection system of Wecycle and ICT~Milieu (the compliance schemes) or not. Households can for example deliver WEEE at a municipal collection point (or container park) or retail collection point.

By law, municipalities are obligated to have at least one location where households can discard waste like furniture, chemical waste and also WEEE. The compliance schemes have contracts in place with basically all municipalities to collect and recycle all WEEE obtained.
Alternatively, households can also give WEEE to local scrap processors or door-to-door (DtD) collectors. Some of this DtD is also taken care of by large waste collectors. Obviously, these last options lead to complementary WEEE flows as it is sold to other parties than the compliance schemes. Last but not least, small equipment is thrown away with residual HH waste, which is sent to incineration plants. Like consumers, businesses (B2B) also discard WEEE, but through



*Charity initiatives, 2nd hand shops, marktplaats.nl, domeinen, mobile phone collection

Figure 5 The WEEE chain

different channels. B2B WEEE primarily flows via waste processors, refurbishers, regional scrap processors or goes directly to national recyclers. In general, one can say that almost 100% of WEEE originating from businesses results in complementary streams.
To get a better understanding, the market structure of the actors and companies involved is simplified in three levels in Figure 6 to illustrate the difference between collection, processing and recycling, after WEEE is discarded: local, regional and national. It is important to note that in reality there are many loops between the actors in the chain. This is taken into account in this research to avoid double-counting.

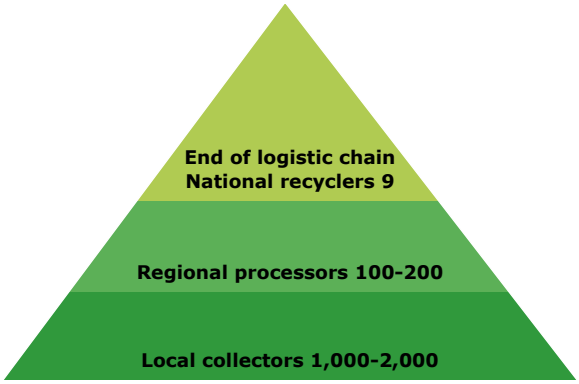


Figure 6 The WEEE pyramid

The base of Figure 6 represents the first actors to receive WEEE. These actors mainly trade with companies at a regional level. Only small amounts of import and export of second hand products for reuse or WEEE for recycling takes place at this level. The middle level represents the sorting and trading by around 100 to 200 companies. Regional processors sell WEEE for recycling purposes to companies at the national level. Furthermore regional processors import and export WEEE to Belgium and Germany and are involved in trade with countries inside and outside EU for higher value streams. The top or national level represents the end of the (logistic) chain with 9 recyclers with some of them having multiple branches and locations as displayed in Figure 6. It is important to note that these national recyclers receive WEEE both from the Wecycle system and at the same time receive complementary WEEE from other actors, especially from the regional processors at the middle of the pyramid.

WHO IS DOING WHAT?

BASE: 1,000 – 2,000 LOCAL COLLECTORS

Municipal collection point
Also called 'waste transfer station' or 'container park'. Households discard bulky household waste like furniture, hazardous waste and also WEEE at these container parks. Almost every municipality has one or more collection points. From these collection points, most WEEE is handed over to the system of the compliance schemes. Another possibility is that municipalities sell WEEE or dismantled fractions like copper cables to metal scrap processors to receive more money than the reimbursement per ton collected from the compliance schemes.

Retailers
When households buy new equipment, they can hand in the old item ('old for new'). About 3,000 retailers have a contract with the compliance schemes so that received equipment will be handed over to recyclers that are under contract of the compliance schemes. Some of the contracted retailers, however still deliver such equipment outside the compliance scheme. Moreover, retailers without a contract can still legally sell WEEE to local or regional metal scrap processors.

Door-to-door collection
Households can also choose to give or sell WEEE to door-to-door collection which mainly happens in cities or being announced by local collectors collecting metals and used EEE. Driven by high metal prizes informal collection pathways exist and obviously the collected WEEE will never be handed over to the system of the compliance schemes.

Charity initiatives
Charity initiatives often work in close cooperation with municipalities and businesses. Their main function is to sell 2nd hand furniture, cloths, books and also used EEE to other consumers. Some of this equipment may be exported. Unfortunately, some equipment cannot be sold because it is broken beyond repair or too old.

Non-functioning or old equipment can follow different channels: a contract with Wecycle, to a collection point of the municipality, to the metal trade or - in some cases – they act as a waste processor (break down equipment, sell valuable parts to traders).

2nd hand/internet market
Usable equipment will be sent from one household to another. Strictly speaking, this is not WEEE but it affects the amounts of WEEE since the equipment can be used for a longer period. In order to prevent double counting of equipment, it is necessary to exclude the 2nd hand market from the WEEE prediction model.

MIDDLE: 100 – 200 REGIONAL PROCESSORS

Metal scrap processors
These companies have a strong focus on metal recycling, sorting and trading into different parts like copper, cables, RVS or scrap materials. A few hundred metal scrap processors are active in the Netherlands. From the 150 MRF members among them, around 80 receive WEEE from local scrap yards, door-to-door trade, waste transfer station or charity initiatives, but also directly form householders and businesses that discard their WEEE. From the B2B and PROF flow, they specifically collect heating and electrical installations, B2B communication and IT equipment and additionally also quite some LHA.

Waste processors
These companies collect waste principally from businesses, but sometimes also from households under contract by municipal authorities. The wastes they collect can either be mixed wastes or specific waste streams. Some of these wastes, e.g. monostreams of certain types of equipment, are sold for recycling without processing. For some mixed wastes streams the waste processors use their sorting facilities to separate recyclables. Residues from sorting and wastes that are unsuitable for sorting are landfilled or incinerated. Equipment can be part of all these flows.

Refurbishers
These companies collect equipment with the purpose to resell the product in the Netherlands or abroad for reuse or recycling.
If the equipment is not suitable to sell as complete units, an option is to strip the equipment into parts (like hard disks) that are sold separately in the Netherlands or abroad. Refurbishers mainly receive IT equipment from businesses (offices) and together with NGO's offer support to donation programmes for educational institutes in developing countries.

RSC/DC
WEEE from the collection points of the municipalities or the retail (via distribution centres, DC) within the collection system of Wecycle is - for logistical reasons - transported to a regional sorting station (RSC). From these stations it is transported to specialized WEEE processors at the national level.

TOP: 9 NATIONAL RECYCLERS
National recyclers, consisting of metal shredders and specialists (in recycling of special often hazardous WEEE, for example C&F and CRT), receive sorted appliances, mono-flows and 'pre-shredder' material. Mono-flows are sorted materials that consist of one or two categories of WEEE e.g. professional appliances, IT desktops and cooling and freezing appliances. The 'pre-shredder' materials are bought from regional metal scrap processors and consist of a metal mix with a certain percentage of WEEE (parts from professional and large household appliances, small household appliances, Central Heating and IT appliances). Furthermore, these companies import WEEE for recycling purposes in the Netherlands.

WEEE that it is discarded via the normal waste bin will enter the regular system of residual household waste management in the Netherlands. This means that this waste will go to an incineration plant for municipal solid waste. Some of these incinerators have a separation step for metals prior to incineration.
The metal fraction that is separated contains a mixture of metals including e.g. tin cans and also WEEE (not recognisable as WEEE anymore).

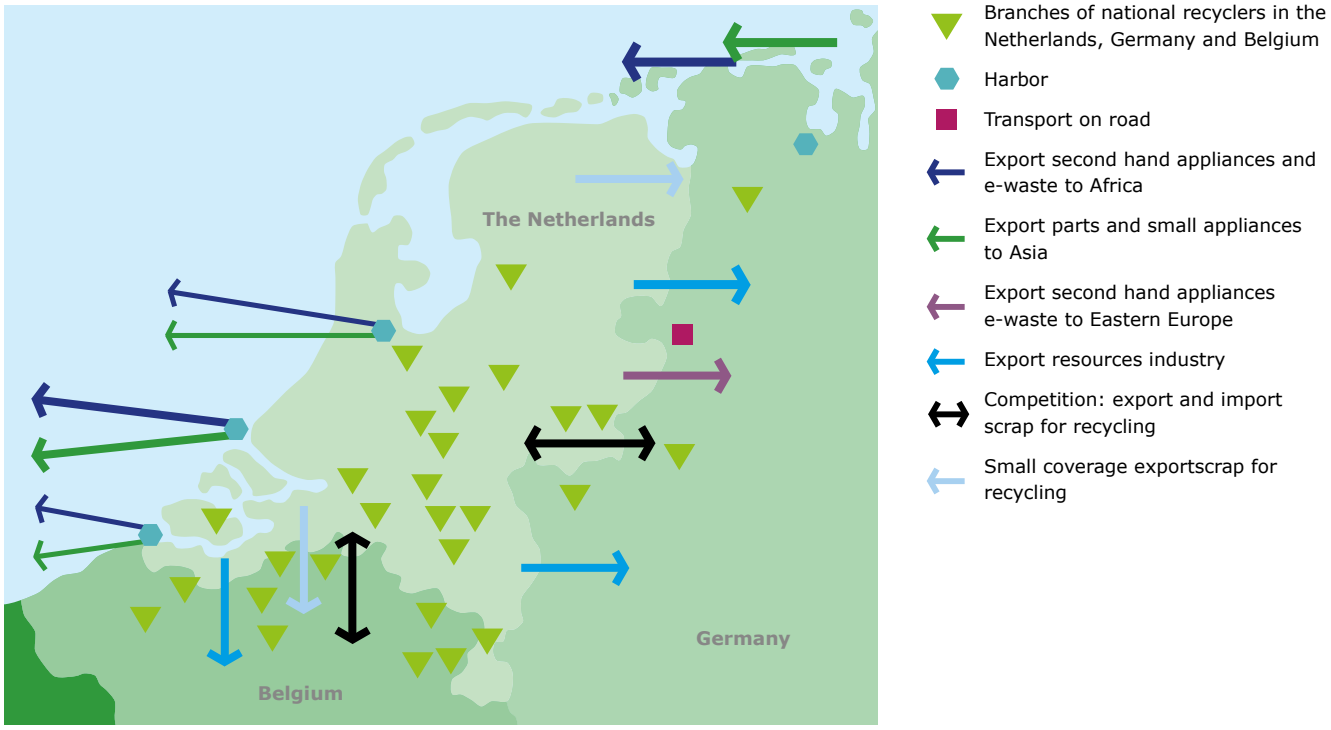


Figure 7 Locations of national recyclers

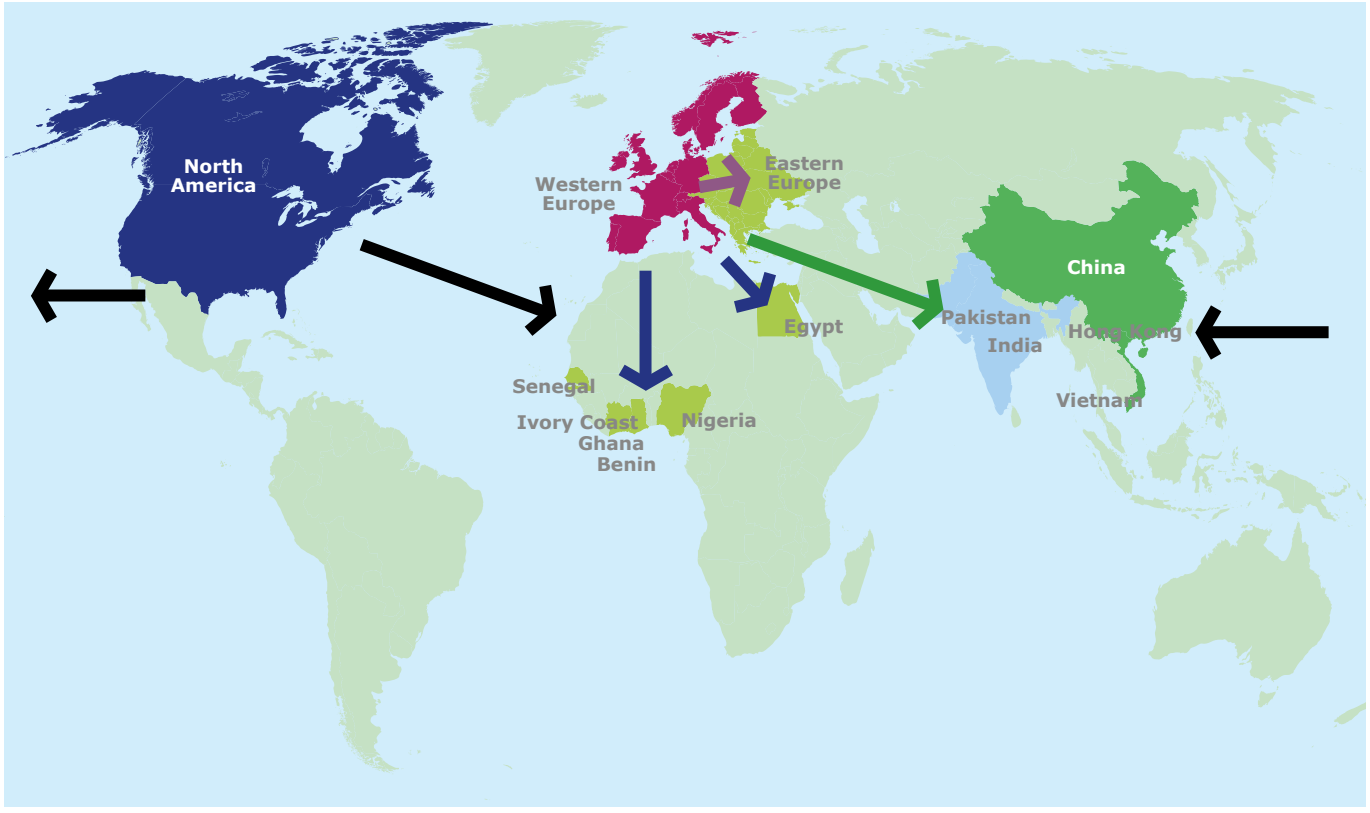


Figure 8 Export flows

3 EEE PUT ON MARKET

In order to determine current WEEE flows, it is essential to figure out past EEE sales. In Chapter 3.1 the approach and modelling is discussed. In 3.2 the cooperation with Statistics Netherlands to validate other sales data sources and the results for the 2010 Dutch POM is presented in 3.3.

3.1 QUANTIFYING WEEE FLOWS

There are different data sources: being primarily producer (WEEE) registers, national producer association sales data, (commercial) market surveys determining saturation levels and year-on-year sales development and national statistics describing national production and international trade. Based on these data sources, a robust, consistent and comprehensive method is needed that covers all the relevant product types described with the UNU keys. The UNU WEEE Generated model is based on combining national statistics as an independent source to check completeness of register and sales data from the various industry associations in pieces.

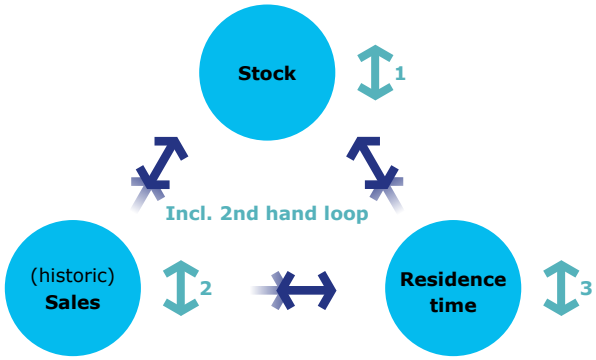


Figure 9 Structure of the UNU WEEE Generated Model

Special interest is given to linking the sales component to two other components determining WEEE generation: being GfK measured stocks in HH and B2B and residence times in HH and B2B. This enhances the accuracy of WEEE generated considerably. The term 'residence time' is preferred to describe the age of products rather than 'lifetime' as the time of non-functioning or un-used appliances in stock is included (Oguchi, 2010). The 'residence times' are obtained from the 2007 HH and 2010 B2B market surveys from GfK. This data is highly detailed and comprises two 'residence time' data sets:

1. The number of appliances as well as their age (incl. the 2nd hand loop) when discarded.
2. The age composition of the stock of appliances not yet discarded. The latter helps to fine-tune lifespans independent of increasing or decreasing sales in the past. The age distribution of the GfK data is used as a basis for the statistical model described in the example of Figure 11-17.

In addition, a 'first-year-failure rate' is added as many electronic products see a small peak discarded in the first year due to 'dead-on-arrival' or consumers just disliking what they bought.

3.2 POM DATA AND STATISTICS NETHERLANDS

The commodity registrations from the national statistics are the prime source to validate all Dutch sales data. The registrations are a very comprehensive data source that covers all EEE categories. Due to several statistical laws in the EU, similar registrations are available for other EU countries. Often, (historic) registrations from industry associations or compliance schemes are incomplete. For this project, data from Statistics Netherlands is used to check all available sales data. This is very advantageous, as the micro data is mandatory collected through confidential surveys towards all main producers, importers and distributors in the Dutch society since 1995. This has been performed under the strict confidentiality regulations that apply to Statistics Netherlands. For the data from the Dutch national statistics, annual domestic production and import/export volume of specific product are registered respectively under the EU nomenclatures of Prodcom (PCC) codes (EU's statistical classifications of national production of commodities) and Combined Nomenclature codes (CN, EU's statistics of national import and export of commodities). Most of the PCC codes correspond to one or multiple CN codes in the external trade classification. By using the EU coding system, each country registers their data according to these codes on the company and shipment batch level.

Data is aggregated on a national or product category level before publishing, which ensures that the sales of individual company cannot be derived. The plausibility of the Statistics Netherlands data is compared with the sales data after modelling from the UNU WEEE Generated

model of the previous section. Here sales data before 1995 is retrieved from the industry associations VLEHAN (for whitegoods), FIAR CE (for browngoods) and ICT~Milieu (ICT) as complementary data sources. Finally, the estimate from the GfK possession study in the year 2007 is used to calibrate the previous two sources. The database and model are accompanied with a standard procedure to track and eliminate errors and differences.

In Figure 18, a comparison is made between the Statistics Netherlands data and POM assessment and the UNU model outcomes (combining all sales data sources). It shows a very good correlation, specifically for the two most recent years due to most effort in updating the micro data here. The deviations in previous years might be caused by some unnoticed mistakes in the raw data. However, the deviations are ostensibly more pronounced as the output of the UNU model based on year of sales is considerably smoothed due to being a model outcome that does dampen economic fluctuations. The statistical data, based on production, import and export contrarily, is not smoothed, thus is expected to display these year-on-year economic fluctuations. In the Technical Report a full comparison is made per collection category and appliance type. The annual EEE prediction matches very well for C&F, LHA, SHA and IT equipment and less for more complex scope categories PROF and Lamps. For lamps in particular, it is difficult to separate lamps from luminaires with lamps and luminaires without lamps. Also for LED (retrofit) lamps no codes exist yet up to 2010.

COLLECTION CATEGORY		NUMBER OF CN CODES	NUMBER OF PRC CODES
A	LHA	18	10
B	CF	19	9
C	SHA	202	96
D	IT	27	18
E	Screens	19	8
F	Lamps	14	9
G	PROF	22	12
	Total	**321**	**162**

Figure 10 Number of good codes per collection category

STATISTICS NETHERLANDS EEE GOOD CODES

There are 4,000 to 6,000 goods codes covering most of the commodities in the economy. The main challenge is to select the relevant codes corresponding to EEE. In order to complete the calculation, the following items are solved:

1. Different units are used depending on specific codes (pieces, 1,000 pieces, or kg etc.), so a unit conversion table with detailed weight information per specific product type is used to align the data. Based on the product list, the associated weights over time have been collected from various sources.
2. Import and export of products includes both new and 2nd hand equipment under the same CN code. This is solved by checking the price difference between import and export of the same goods and filtering out low value data (which do not correspond with new product price levels).

For the project, around 200-300 EEE related codes are filtered for each statistic year. Linked to each UNU key, its annual quantity of put on the market is calculated through the following formula. The data is retrieved from the statistic registration under the specific codes.

Put on market = Domestic production
+ Import – Export

THE UNU WEEE GENERATED MODEL

The blue line is the original data of appliances discarded in 2007 with the age horizontally and the percentage of the total sample vertically. The red line is the data after statistical modeling (for statistical experts: it is a fitted Weibull function with a 'first year' failure rate added (see peak in first year).
The green line is the alternative normal distribution.

The red line is captured by only three parameters and used as the starting value for residence time for this type of appliances in the model.
After adding data on sales, stock age and stock size the model calculates the most plausible set of sales, age and stock connections to describe past and future sales, stock age and stock size (extrapolation long term trend):

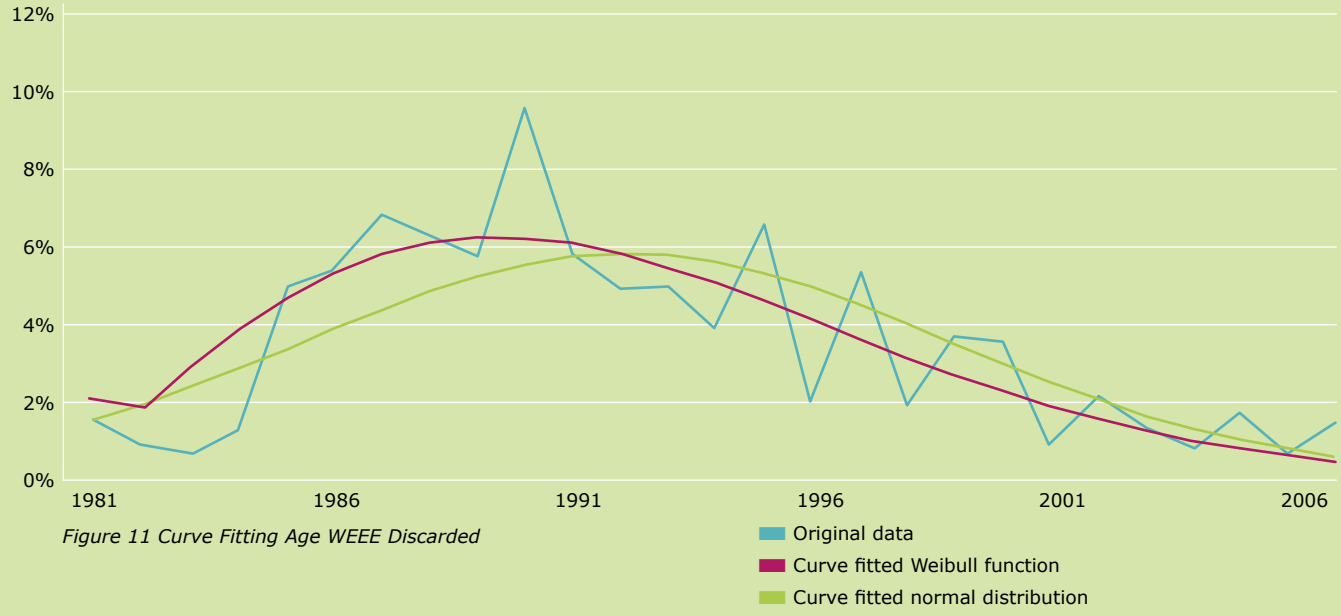


Figure 11 Curve Fitting Age WEEE Discarded

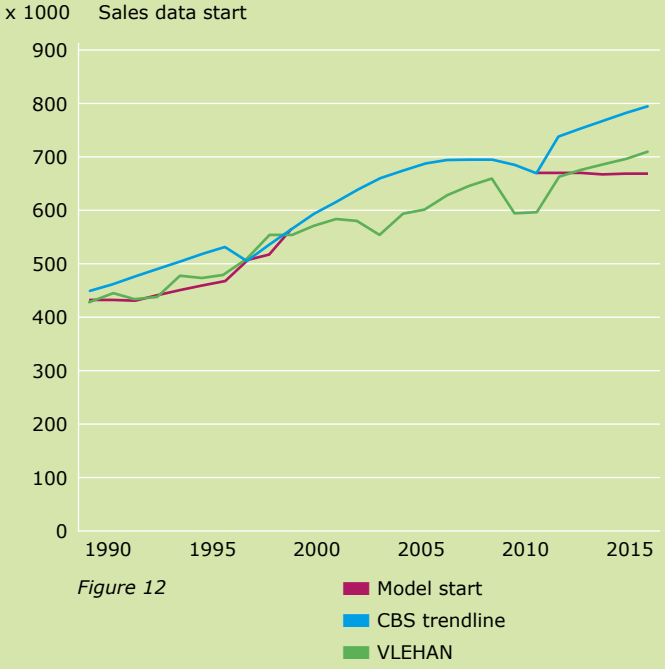


Figure 12

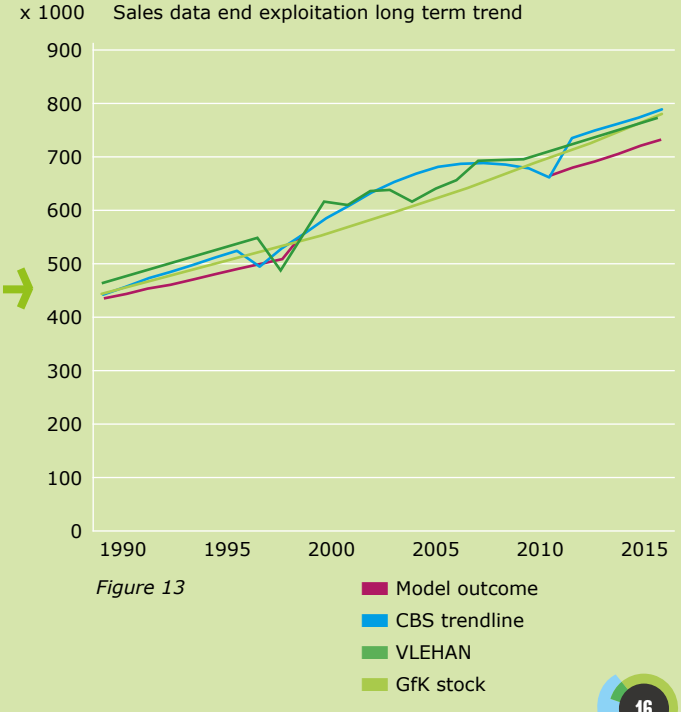


Figure 13

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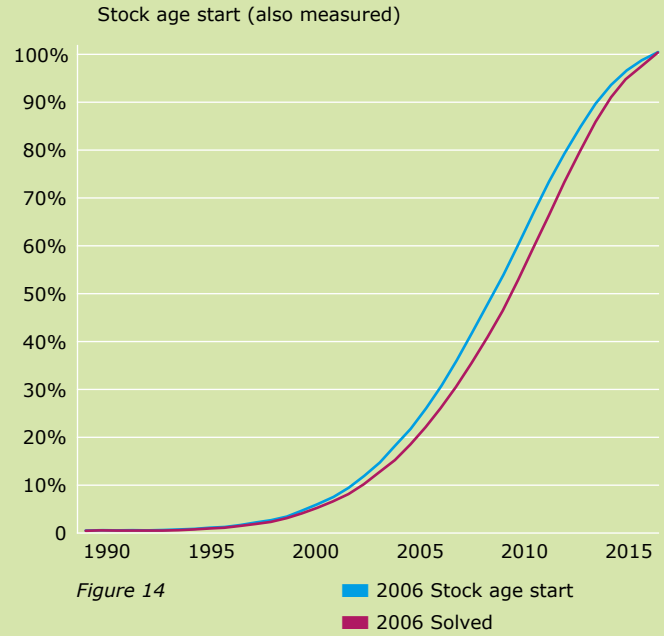


Figure 14

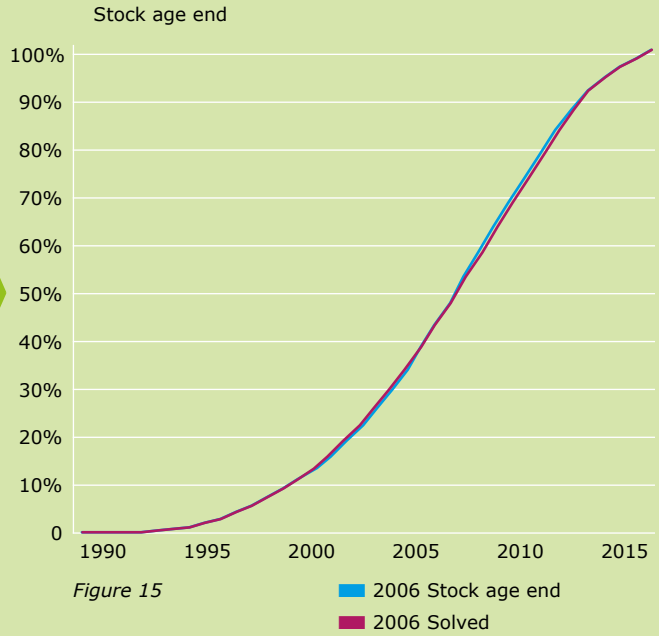


Figure 15

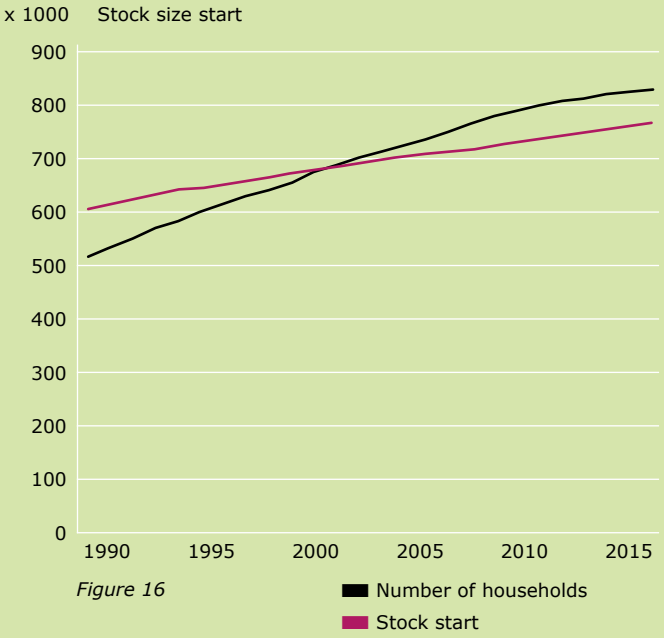


Figure 16

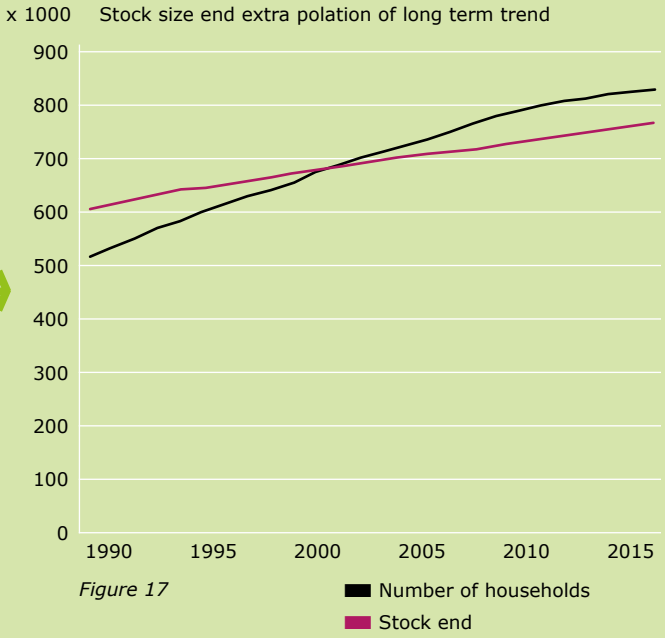


Figure 17

To summarize, the use of statistical data to calculate EEE put on the market can provide the most complete and detailed registration information about electronic products. The method is not necessarily limited to the Dutch context, and can be further extended to the other European countries because the same principle and coding systems are applied. Furthermore, the EU CN code is also correlated to the United Nations' HS codes, thus has the potential to achieve a streamlined calculation and comparison at a global level.

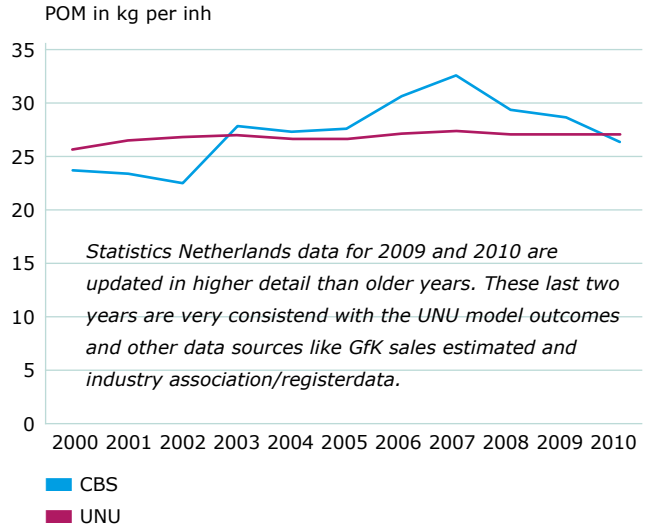


Figure 18 Statistics Netherlands (CBS) vs. model outcome all sources (UNU)

3.3 EEE PLACED ON MARKET 2010

By combining all previous sales data, Statistics Netherlands and UNU model outcomes with the Wecycle and ICT~Milieu registers for 2009 and 2010, the total Dutch EEE POM of the last two years is estimated to be 4.5 kg higher than previously reported: being 26.5 kg per inhabitant.

This more complete and accurate Dutch POM amount (compared for 2009 and 2010 on average) is deviating from previous reported amounts. It is of course not possible, nor allowed due to data confidentiality issues, to do a 'free-rider check'. However, it is possible to identify the total weight per UNU-key and thus whether seems to be amounts missing. The following explanations are likely for the deviation of the totals:

- Unclear classification of products do cause a shift from one UNU-key/collection category to another, but can also lead to errors when pieces are multiplied with a different average weight. This is contributing to roughly 1.4 kg/inh;
- Missing appliances contribute to roughly 1.3 kg/inh. From this, around 0.9 kg/inh are B2B/PROF appliances. Here, by means of a so-called 'WOB' request (Wet Openbaarheid Bestuur), the notifications of producers outside the Wecycle/ICT~Milieu compliance schemes are evaluated for 2006-2009. This resulted in 56 additional producers plus those reporting through small compliance schemes like RTA (professional WEEE). The additional amounts found cover 0.4 kg/inh, which indicates around 0.5 kg/inh is missing.
- Some HH appliances could be regarded out of the scope of the WEEE Directive/WEEE Recast. This specifically includes HH luminaires (around 0.6 kg) and IT accessories (0.4 kg) for which it is difficult to separate product parts from products, with some small amount of toys this added up to 0.9 kg in total; Errors and mislabelling roughly account for 0.4 kg in total (0.9 too little plus 0.5 kg too much).

UNU KEY	DESCRIPTION	AVERAGE 2009-2010	MAIN REASON
1-05	Drying (wash dryers, centrifuges)	0.69	Mislabeled: in POM sheet with 1-02 dishwashers
1-13	B2B C&F (aircons, cooling displays, etc.)	0.68	Missing/scope: PROF equipment via installation comp.
5-07	HH Luminaires	0.60	Scope: HH Luminaires incl. in this research
3-07	B2B IT (large servers, routers, copiers)	0.41	Classification: In ICTM all appliance > 35kg are regarded B2B
1-04	Washing machines	0.41	Misc: Av. weight pp x some deviation long-term trend x most heavy product
1-08	Fridges	0.37	Classification: overlap w. combi-fridges and other C&F, combined diff. is 0.25
3-01	IT accessoiries	0.37	Scope: Parts or small appliances
6-02	Small tools (power and garden tools)	0.33	Missing: handheld tools in B2B
2-02	Kitchen equipment	0.28	Misc: Scope, av. weight, classification
2-01	Small HH, ventilators, irons, sewing mach.	0.27	Misc: ventilators, classification, incl. sewing machines from cat. 6.
1-07	Sunbeds	0.26	Missing in Wecycle POM
4-08	Flat panel display TV's (LCD, LED, Plasma)	0.23	Mislabeling combi-TV's, av. weight pp
4-05	Speakers	0.18	Classification: overlap with 4-02, 4-04
2-03	Hot water, coffee makers, water cooker	0.16	Includes more appliances than Wecycle POM
10-1	Dispensers (not cooled)	0.14	WOB: Partly in Individual Notifications
10-2	Dispensers (cooled)	0.13	WOB: Partly in Individual Notifications, two large comp. are: 0.22 kg/inh
	… etc …	…etc…	…etc…
1-10	Combi-fridges	-0.12	Classification: overlap fridges, combi-fridges and other C&F
8-02	PROF medical equipment	-0.12	WOB: Due to individual notifications
3-09	Flat panel display monitors (LCD, LED)	-0.40	Lower weight than estimate from ICTM, miniaturisation
4-03	Hifi components	-0.41	Scope issue with 4-02, 4-04
1-02	Dishwashers	-0.54	See 1-05, together deviation is 0.22 kg/inh
	Total difference	**4.5 kg/inh**	

FROM WHICH:		
A	LHA	0.93
B	C&F	0.86
C	SHA	1.84
D	IT	0.97
E	Screens	-0.21
F	Lamps	0.02
G	PROF	0.14
	Total	**4.5 kg/inh**

Figure 19 Deviations from 'official' POM 2010

Some of the above explanations are overlapping. A more detailed explanation by means of a 'free-rider check' on individual company level is neither possible nor allowed due to data confidentiality. Many of the 'wrong classifications', errors and more accurate average weights are incorporated in recent Wecycle product list updates used for registration.

3.4 SUMMARY

Although there is some uncertainty in the above reasons for the deviations, the new total EEE POM is far more accurate compared to the previous 'official' numbers due to integrating all available data sources and the effort at Statistics Netherlands. In the Technical Report a more elaborate description of the UNU WEEE Generated model and all detailed outcomes for all 58 appliance types is presented.

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E SCREENS	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
EEE POM 2010	7.88	3.88	7.50	3.03	2.50	0.27	1.46	26.5	440
Incl. deviations from previous sources	0.93	0.86	1.84	0.97	-0.21	0.02	0.15	4.6	76

Figure 20 Summary EEE POM 2010, incl. deviations

4 WEEE + USED EEE GENERATED

Besides the validation of sales and POM data within the UNU model, obviously the residence times and stocks that determine WEEE generated are important input parameters as well as relevant market outcomes.

4.1 'SPAGHETTI': SHORTER LIFESPANS

In Figure 21, the residence time for different types of equipment is displayed. The graph illustrates what percentage of new products placed on the market in 2005 is becoming obsolete in the following years. Due to the highly detailed data and UNU WEEE Generated model, these graphs are available for all POM years between 1990 and 2010 for almost all appliance types. More information and graphs for other POM years are available in the Technical Report. On the left side of the residence time spectrum are mobile phones, digital camera's and laptops. On the right side with the longest lifetimes are small tools (kept in garages for a long time) and freezers.

Shorter lifespans of EEE

From the analysis, basically all appliances show decreasing residence times. Generally speaking, the residence time of equipment POM in 2000 versus 2010 declined with approximately:

- 17% for Screens
- 12% for SHA
- 10% for IT
- 10% for Lamps
- 7% for LHA
- 4% for C&F
- 4% for PROF

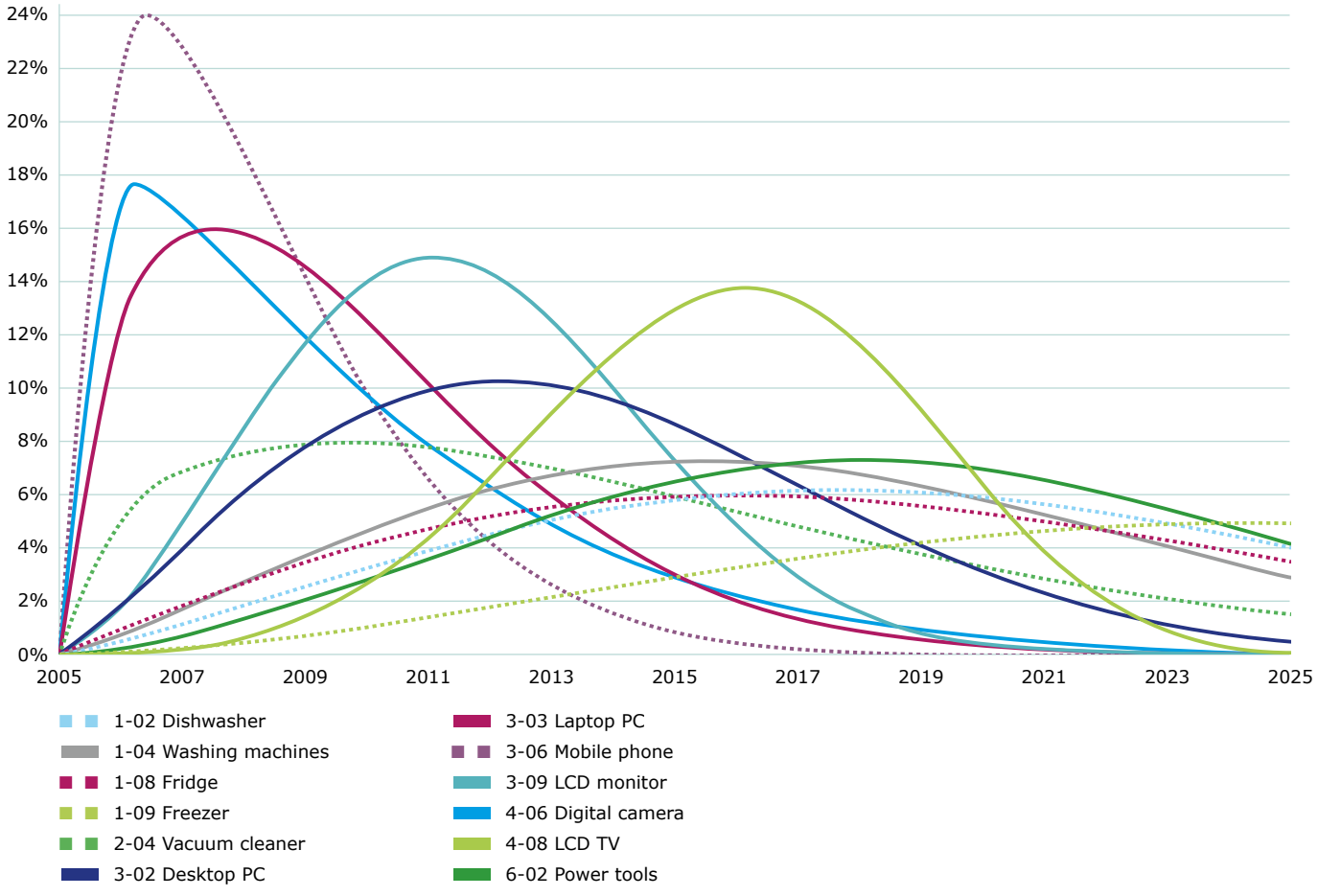


Figure 21 Residence times of EEE POM in 2005 (% discarded per year)

4.2 MORE PRODUCTS IN HOUSEHOLDS

In Figure 22, the number of EEE pieces in stock is displayed (incl. 'hibernated' products that are already out of use but not yet removed from the household). As expected, the number of products present in both households and businesses increased. The increases and differences in trends are interesting for C&F (not much change in pieces per HH) in contrast to SHA, Screens and Lamps (Hendriksen, 2009). Note: the luminaires of TL and energy saving lamps and the TL/ energy saving lamps itself are counted as 2 items each (or more when there are more lamps per luminaire).

2000	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL	TOTAL EXCL. LAMPS, LUM.
EEE in stock (million items)	**24**	**17**	**360**	**152**	**14**	**13**	**736**	**4.8**	**1321**	**585**
Households	22	15	341	116	8	13	503		1018	515
Businesses	2	2	19	36	5	0	233	4.8	303	70
HH EEE in stock (items)										
Per HH	3.2	2.1	50	17	1.2	1.9	74		150	76
per person (excl. B2B)	1.4	0.9	22	7.3	0.5	0.8	32		64	32
per person (incl. B2B)	1.5	1.0	23	9.6	0.9	0.8	46	0.3	83	37

2010	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL	TOTAL EXCL. LAMPS, LUM.
EEE in stock (million items)	**29**	**18**	**489**	**190**	**16**	**16**	**984**	**5.1**	**1747**	**763**
Households	26	16	468	153	10	16	735		1424	689
Businesses	2	2	21	38	6	0	250	5.1	323	73
HH EEE in stock (items)										
per HH	3.6	2.2	63	21	1.3	2.1	99		193	93
per person	1.6	1.0	28	9.2	0.6	0.9	44		86	42
per person (incl. B2B)	1.7	1.1	29.5	11	0.9	1.0	59	0.31	105	46
Growth 2000-2010 total	**19%**	**10%**	**36%**	**25%**	**15%**	**23%**	**34%**	**5%**	**32%**	**30%**
Growth 2000-2010 per HH	**10%**	**2%**	**26%**	**21%**	**10%**	**13%**	**34%**		**29%**	**23%**
Average decrease in lifetime	**+/- 7%**	**+/- 4%**	**+/- 12%**	**+/- 10%**	**+/- 17%**	**+/- 17%**	**+/- 10%**	**+/- 4%**	**+/- 8%**	**+/- 8%**

Figure 22 Stock development in households, a comparison between 2000 and 2010
2000: 6.801 million households; 15.864 million persons
2010: 7.386 million households; 16.575 million persons

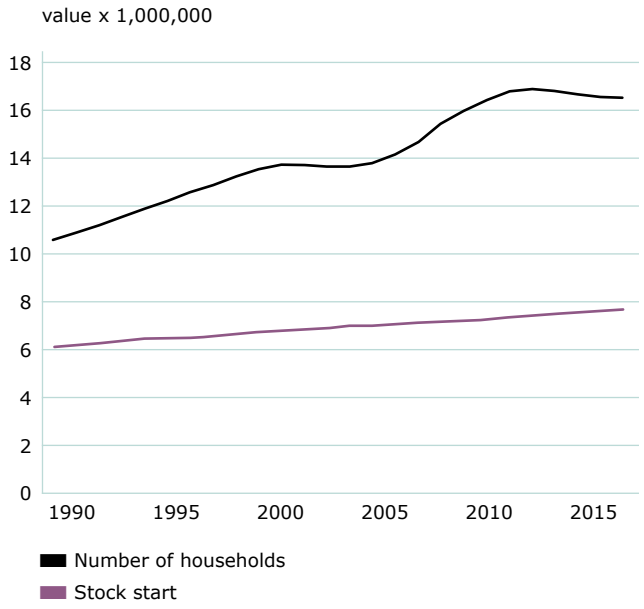


Figure 23 Stock development for TV's 1990-2015

From CRT to LCD TV
To the left, the total stock of TV's is illustrated. Due to the shift from CRT to LCD TV's between 2003 and 2008, the number of TV's per household increased from 1.9 to 2.3 and a new 'saturation' level is achieved.
Obviously, the weight per appliance decreased rapidly, followed by much more miniaturisation of LCD screens. However, the decrease is mitigated by growth in average screen sizes.

4.3 TRENDS IN EEE AND WEEE

One would expect with more appliances and lower residence times that the total amount of WEEE is rapidly increasing. This did occur until around 2003, however, the average product weight per piece substantially declined after 2003. This is especially the case for screens (from heavy CRT's to LCD from 2003 – 2006 for TV's) but also for IT and SHA (incl. CE appliances like mp3-players). In addition, the global financial crisis at the end of 2008 did significantly reduce the growth rate in the number of pieces being sold. Therefore one can observe a net stabilisation of the EEE POM amounts around 26-28 kg/inh since 2003. Figure 24 shows the trends per collection category.

The number of pieces of C&F steadily increased, but here the average weight per appliance increased (more and larger double door fridges). For SHA (kitchen and CE equipment combined), the increase in pieces sold is very high (2000 – 2010: +29%), but due to lower weights, mainly for small CE appliances (like mp3 players, camera's and the change from VCR to DVD), the increase in weight is only +17%. The same effect is even more obvious for IT equipment (2000 – 2010: +40% in pieces, only +6% in weight) and obviously more extreme for screens (see from CRT to LCD). Here the number of pieces sold increased with 29%, but the total market input weight lowered with 40%.

Due to residence times of often more than 10 to 15 years before EEE becomes WEEE (incl. used EEE exported), the 'stabilisation' in the total market input weight will only become visible around 10 years later for the WEEE return stream. The WEEE amounts are still increasing, but this growth rate will decline the coming 5 years. As a consequence the ratio of WEEE versus EEE will increase. Note that export of used EEE is included in the next graph.

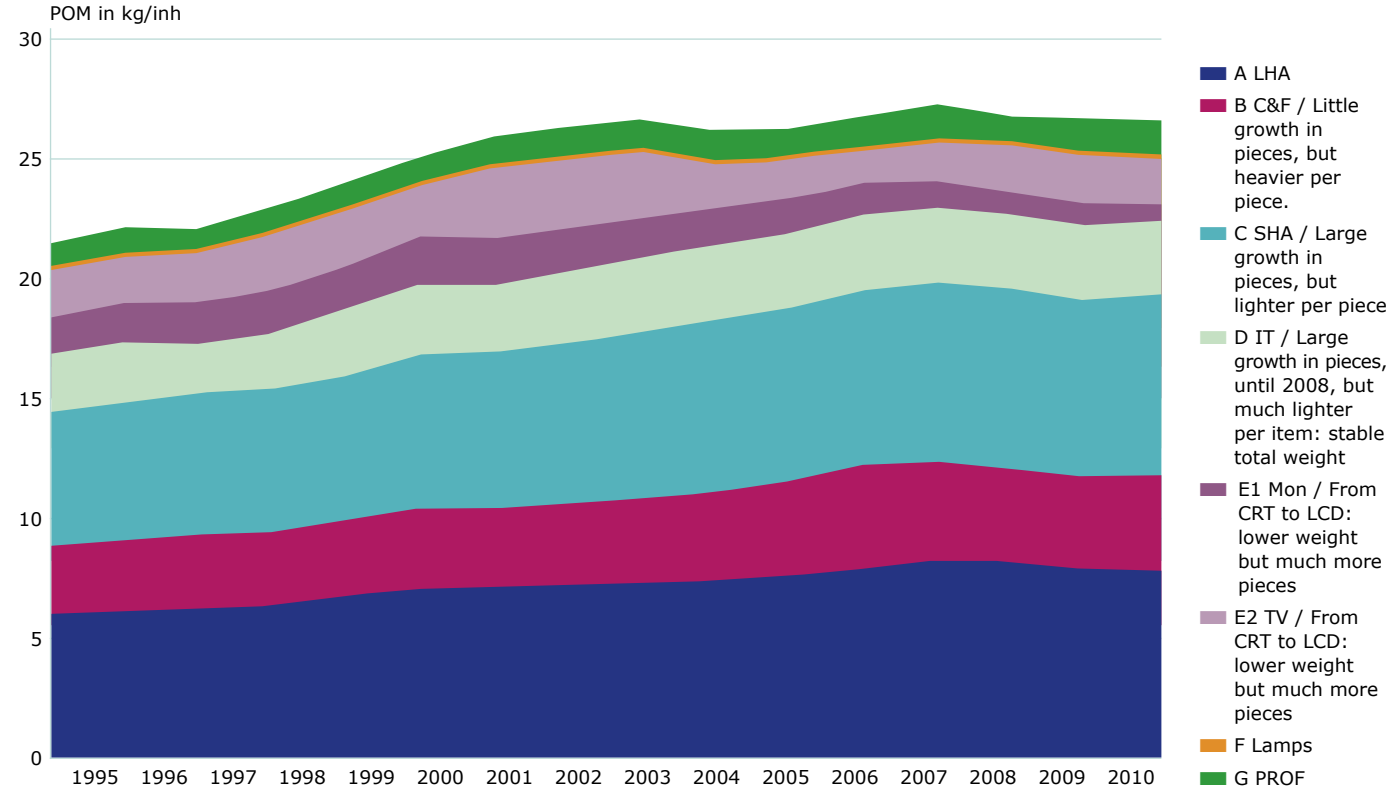


Figure 24 Historic development of EEE POM in kg/inh

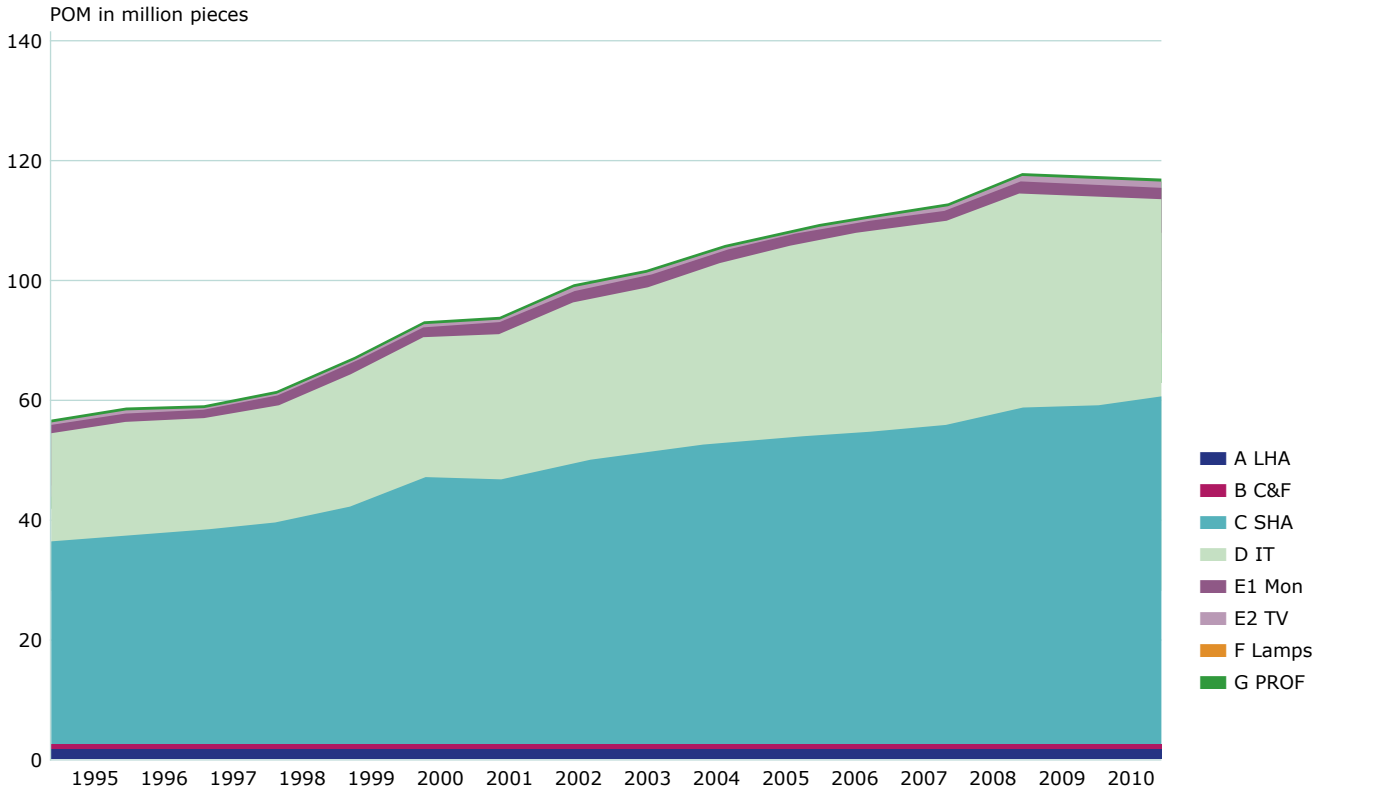
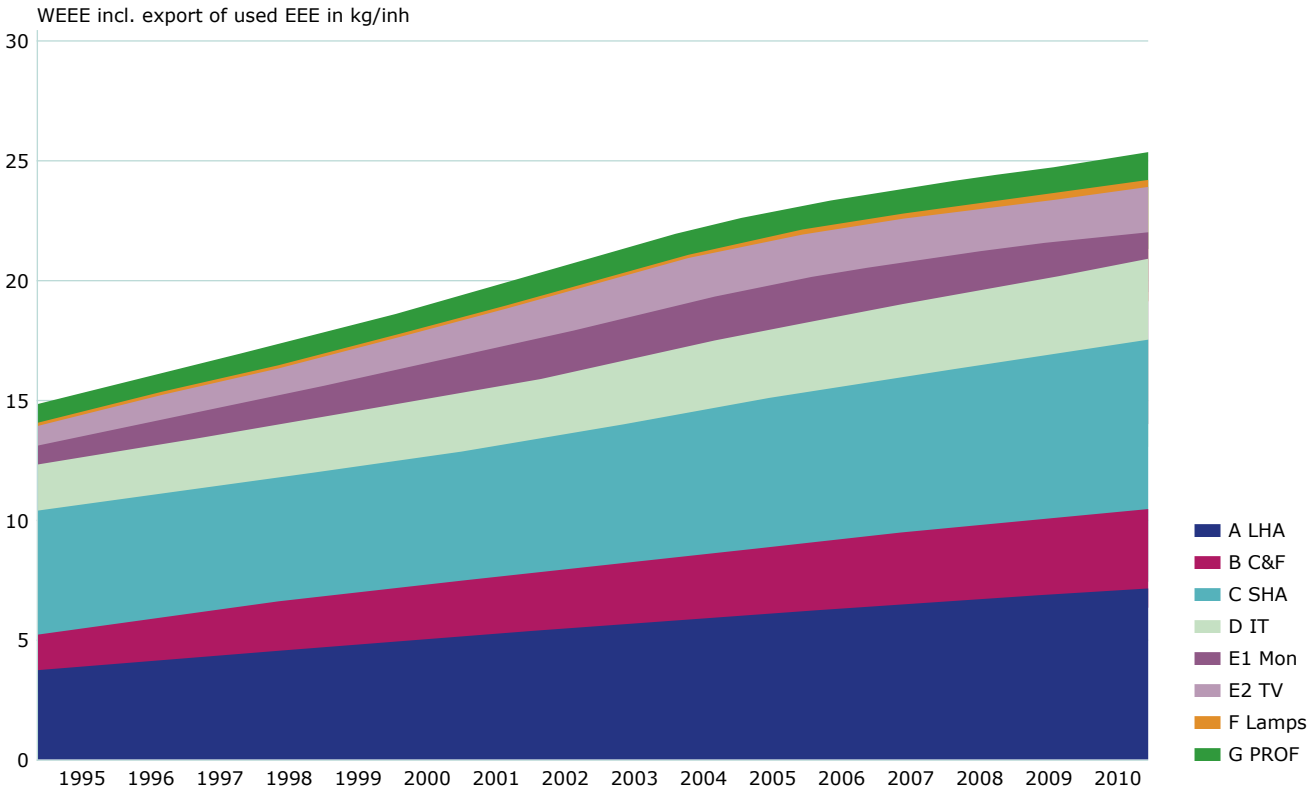


Figure 25 Historic development of EEE POM in million pieces



year	WEEE kg/inh
1995	14.8
2000	17.7
2005	20.9
2010	23.7
2015	25.4

Figure 26 Historic development of WEEE incl. used EEE Generated

4.4 SUMMARY

The POM and WEEE Generated amounts are summarised below. More information regarding the influence of import and export is given in the next Chapter.

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
EEE POM 2010	**7.88**	**3.88**	**7.50**	**3.03**	**0.76**	**1.74**	**0.27**	**1.46**	**26.5**	**440**
WEEE + used EEE Generated	**6.39**	**2.95**	**6.44**	**3.00**	**1.80**	**1.85**	**0.22**	**1.03**	**23.7**	**392**
HH	5.05	2.38	6.07	2.02	1.10	1.80	0.22	0.00	18.6	309
B2B	1.34	0.58	0.37	0.98	0.69	0.04	in HH	1.03	5.0	84
WEEE + used EEE / EEE ratio	**81%**	**76%**	**86%**	**99%**	**237%**	**106%**	**80%**	**71%**	**89%**	**89%**

Figure 27 WEEE + used EEE generated 2010

5 IMPORT, EXPORT AND WEEE GENERATED NL

Export for reuse can substantially influence the total WEEE Generated amounts in the Netherlands as these appliances have permanently left the country and are not available for collection and recycling anymore.

5.1 EXPORT FOR REUSE

5.1.1 EXPORT FOR REUSE

For most HH appliances, the high quality of the sales, stock and lifetime data in the WEEE generated model allow calculation of the amount of appliances exported for continued use. This is done by describing the loop of 2nd hand products to other households (which usually increases the residence times) versus appliances not ending up at other households. The analysis is made possible via detailed data on the amount of products discarded with the intention of 2nd hand use in the GfK analyses (Hendriksen, 2009) as well the measurement of how many products in stock are obtained new versus 2nd hand. The lifetime of these appliances that remain within households as well as those not ending up in other households is determined (see Technical Report for more details). Being in between 45% to 70% of the total residence time ensures that they have too much value to end up in the WEEE flows. It is calculated that 1.9 kg/inh (31 kton) is being exported as a minimum, mainly consisting of fridges, IT and flat panel displays. Regardless the legal status of these appliances (is it WEEE or used EEE?), in both cases the amounts leave the Netherlands permanently and cannot be collected and recycled here anymore.

5.1.2 VALIDATION EXPORT FOR REUSE

Independent from the UNU analysis, the export of second hand HH appliances to Africa and Eastern Europe is also estimated using experience of the VROM Inspectorate, other market operators and analysis of data from customs. This leads to and estimation of approximately 1.9 kg/inh or 31 kton exported (see Technical Report from more background information). Figure 29 shows this amount of export of second hand appliances to Africa and Eastern Europe and the breakdown in collection categories.

The export to Africa consists mainly of C&F and CRT Monitors (included in E1) and CRT TV's (included in E2). Cooling and freezing appliances could be repaired relatively easily in Africa. Also CRT's are reused or parts are used to repair other appliances. The export to Eastern Europe has relatively speaking more LHA including dishwashers and dryers, SHA and IT. The results from the UNU WEEE Generated model and Inspectorate experience match very well and the 31 kton as a minimum quantified amount is regarded as validated. The remaining uncertainty is discussed with the WEEE chain model of Chapter 9.

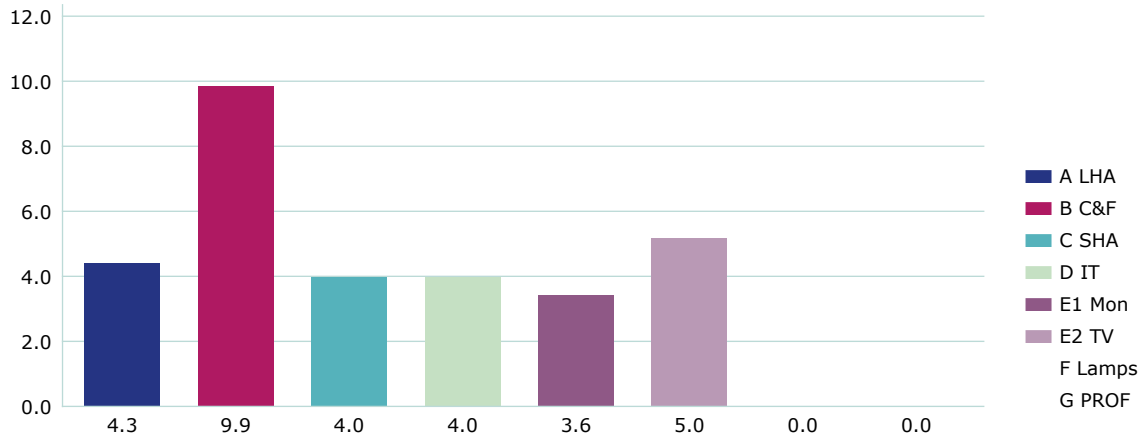


Figure 28 Breakdown of 31 kton of export of 2nd hand appliances

5.1.3 REFURBISHMENT

The above analysis is applicable for HH appliances. Export of B2B appliances and specifically PROF appliances needs to be taken into account as well. Refurbishment involves several activities: product and parts recovery; upgrading of old equipment (IT and PROF) after which it is sold as a working product; dismantling of old equipment into parts, which are sold separately; dismantling of old equipment not suitable for refurbishing for material recovery purposes. Due to the nature of products like specialised medical hospital equipment and high values of parts like harddisks, they are treated differently and sometimes can be reused, repaired or upgraded cost-effectively in other countries. The net effect of refurbishment is that used EEE and parts are reused in other countries. Around 5 kton mainly being IT equipment and monitors is identified directly, another 8 kton including 4 kton of PROF follows from the chain model (see Chapter 9 later).

5.2 IMPORT AND EXPORT OF WEEE

Traditionally, the Netherlands is a trading country. This is also the case for EEE, used EEE and WEEE. The contribution of the various types of export to the total flows is:

1. Traders export 2nd hand appliances including some non-functioning appliances, so mixed used EEE and WEEE amounts. These are mainly C&F, LHA and CRT TV and monitors to Africa via the ports of Amsterdam, Rotterdam, Antwerp and Hamburg (dark blue arrow in Figure 29). Ports located further away are out of scope. Long distance transport by road is commercially not viable for large WEEE appliances in WEEE.
2. Traders and workers from Eastern Europe where markets are less saturated, export second hand appliances including some WEEE, mainly LHA and SHA and IT to Eastern Europe by road (red arrow of Figure 29). Here, long transport distance is not limiting export of appliances like dryers and dishwashers.
3. Traders export parts, fractions and small appliances to Asia via mentioned harbours (green arrow of Figure 29).
4. Regional metal scrap processors export WEEE to large recyclers abroad (blue arrow to border areas), which is estimated at 16 kton of WEEE (this will be explained further in the next Chapter).

The Dutch national recyclers import large amounts of WEEE from border areas (black double arrow in Figure 29). Additionally, businesses that use centralised recycling facilities in Western Europe may import WEEE to Dutch recyclers too. The national recyclers have imported 200 kton WEEE as a minimum. The import consists of 50% mono-flows and 50% 'pre-shredder' material. If the share of WEEE in 'pre-shredder' material is higher than 3,5%, the import will even be higher. The imported flows are much larger than the complementary flows of WEEE from Dutch origin. Contrary to the expectations at the start of the investigations, the import exceeds the export with at least 100 kton. Since the imported WEEE is not part of the WEEE generated of the Netherlands, it is excluded from the chain model. More information on the flows to various destinations is available in the Technical Report. The large amount of import can be explained by the large recycling capacity in the Netherlands. Figure 30 displays the findings for all import and export flows at a national level.

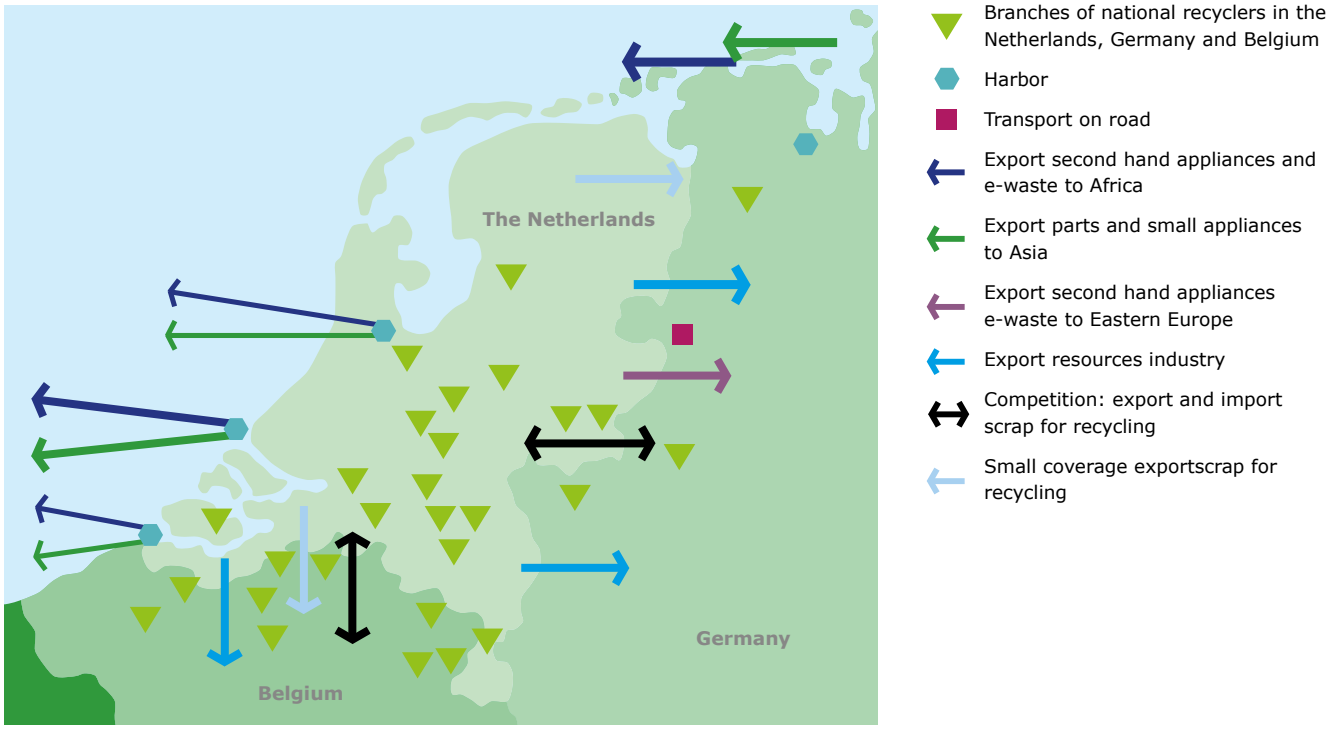


Figure 29 Import and export flows

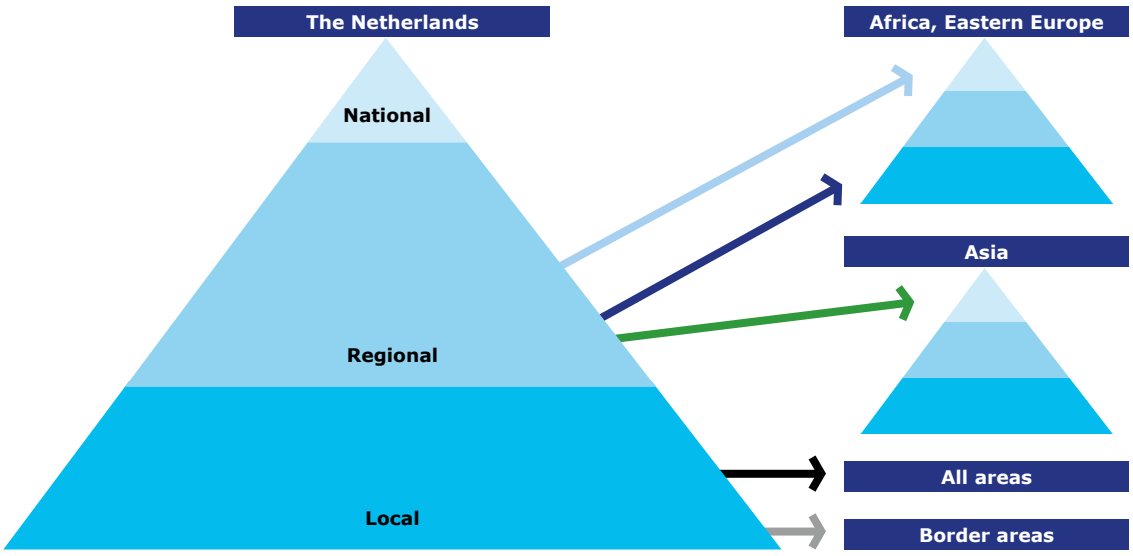


Figure 30 Import and export flows

Export second hand appliances 31 - 33 kton
Export e-waste 3 - 9 kton
Export reuse and e-waste at minimum 4 kton
Export professional appliances 1 - 2 kton
Export mono-flows border areas: non-identifiable kton

5.3 SUMMARY

From the chain model allocation of the export amounts, as a minimum, the export of used EEE is 1.7 kg/inh, 29 kton for HH equipment and 0.9 kg/inh, 15 kton for EEE from B2B origin. This means that in total 44 kton will not become WEEE in the Netherlands. Therefore, these amounts lead to 21.0 kg or 349 kton available as WEEE generated in the Netherlands (further referred to as WEEE NL). This is the starting point for further analysis in the next Chapters. For the export of EEE itself, it cannot be determined whether this is to be classified as export of 2nd hand working appliances solely or mixed with non-functioning items and thus as WEEE. The ratios of EEE versus WEEE are displayed both including and excluding export of whole appliances. As expected, the ratio of EEE versus WEEE is particularly high for screens due to the shift from LCD to CRT. The total ratio for WEEE NL vs. EEE in weight is around 79%. Validation of the amounts exported per collection category in the WEEE chain model is discussed in Chapter 9.

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
EEE POM 2010	**7.88**	**3.88**	**7.5**	**3.03**	**0.76**	**1.74**	**0.27**	**1.46**	**26.5**	**440**
WEEE + used EEE Generated	**6.39**	**2.95**	**6.44**	**3.00**	**1.80**	**1.85**	**0.22**	**1.03**	**23.7**	**392**
WEEE + used EEE/EEE ratio	81%	76%	86%	99%	237%	106%	80%	71%	89%	89%
Export used EEE	**0.26**	**0.60**	**0.24**	**0.60**	**0.26**	**0.49**	**0.00**	**0.20**	**2.7**	**44**
Export used EEE HH, whole appliances	0.23	0.54	0.22	0.22	0.04	0.49	0.00	0.00	1.7	29
Export used EEE B2B, incl. refurbishing	0.03	0.06	0.02	0.38	0.23	0.00	0.00	0.20	0.9	15
WEEE Generated 2010 NL	**6.13**	**2.36**	**6.20**	**2.40**	**1.53**	**1.36**	**0.22**	**0.83**	**21.0**	**349**
WEEE/EEE ratio (excl. export)	78%	61%	83%	79%	202%	78%	80%	57%	79%	79%

Figure 31 Summary export used EEE

6 COMPLIANCE SCHEME FLOWS

From the total of 349 kton potentially available WEEE in the Netherlands, the Wecycle and ICT~Milieu compliance schemes take care of 125 kton or 7.5 kg/inh. The key question is of course where the rest ends up. In order to understand the complementary system of Chapter 7, in this Chapter, the role of the 'public collection' points via municipalities and retailers is discussed first.

6.1 MUNICIPAL COLLECTION POINTS

The Netherlands has a long tradition of separate waste collection. Municipal container parks collecting any large household waste including WEEE, play an important role. An average inhabitant produces 560 kg of waste every year. Approximately 25% of this waste is collected via these container parks (140 kg per inhabitant per year with a total volume of 2.3 million tons per year) and separated into different fractions like garden waste, wood, metal, broken bricks, chemical waste and WEEE. Almost every Dutch community has one of these collection points. In the past a part of WEEE, predominantly LHA, was discarded of as metal waste and sold to local or regional scrap processors. Another part was discarded as residual waste. Today, the municipalities have contracts with Wecycle (except one) to ensure that WEEE received from households is treated according to national law and regional permits. Thus these collection points play a vital role in the Wecycle system and collect about two thirds of the compliance scheme flows as displayed in Figure 32.

When the results of these collection points are studied in more detail, one finds large differences per municipality which can vary between 0.7 kg and 20.0 kg/inh with an average of 5.2 kg/inh. These differences are displayed in Figure 33. A field study (100 locations) and benchmark is done to obtain more information. This included two questions: Is the collected WEEE handed over to Wecycle? Does WEEE reach the municipal collection points as expected or are others actors able to collect significant amounts of WEEE before it reaches these container parks? The extended field survey shows that a small part of the collection points don't follow the contract in a strict manner. When this happens, it mainly concerns LHA, SHA and SHA-IT sold to other parties. The bottom part of Figure 32 shows the correlation between the percentage of municipalities in compliance with the contract to hand over all WEEE and their total collection result.

	A	B	C	D	E1	E2	
COLLECTION RESULTS	LHA	C&F	SHA	IT + MON		TV	TOTAL
2009 (ton)	10,705	18,380	20,247	21,998		16,121	87,451
2009 (kg/inh)	0.65	1.11	1.23	1.33		0.98	5.3
2010 (ton)	8,248	15,994	24,606	19,733		16,788	85,369
2010 (kg/inh)	0.50	0.96	1.48	1.19		1.01	5.2

	A		C	D
COLLECTION RESULTS	LHA		SHA	IT
Municipalities collecting < 4.0 kg/inh	73%		88%	87%
Municipalities collecting > 4.0 kg/inh	94%		97%	98%

Figuur 32 Top: Collection results municipalities 2009 and 2010; Bottom: % collection points compliant versus collection result

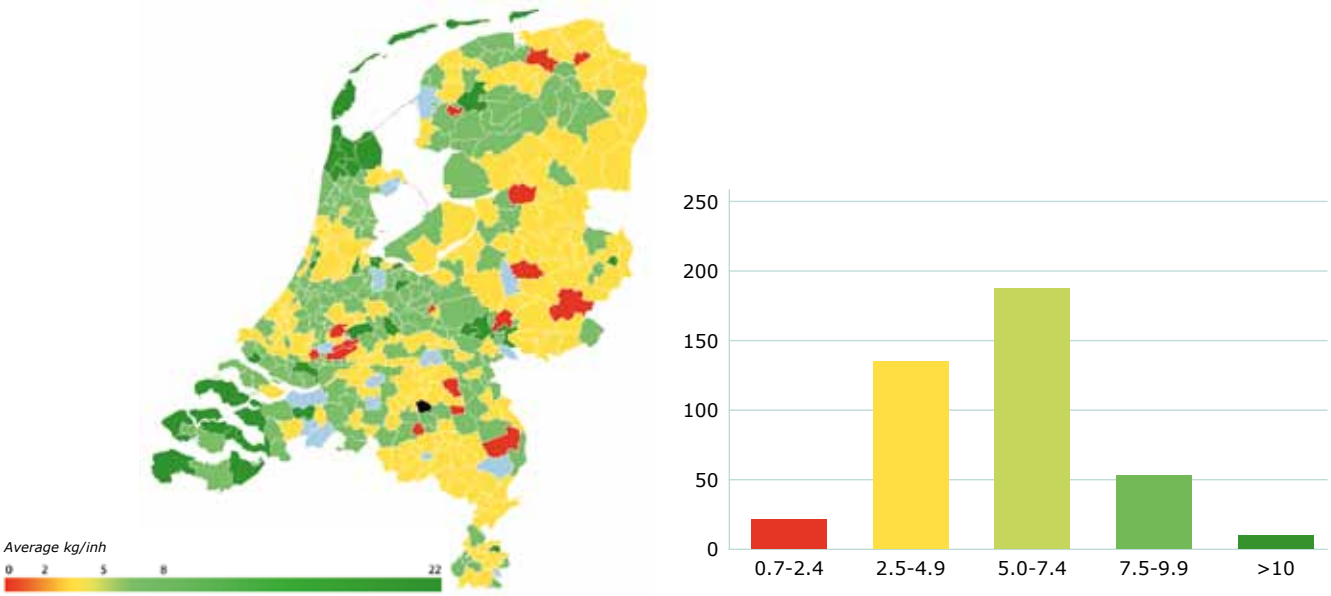


Figure 33 Benchmark WEEE from Municipalities

Trade also occurs for special products like mobile phones often given to charity organisations or cables separated from equipment and sold to traders because of high copper prices. Based upon these results, it is calculated that 7 kton of WEEE is sent to the local or regional metal scrap processors. Later during the investigations, via the market survey discussed in the next Chapter, another 19 kton of WEEE is sent directly to the national recyclers. Another interesting result is that the collection point benchmark showed that substantial amounts do not reach the collection points at all. Local scrap processors are willing to pay for used equipment. The field survey also gives evidence to the fact that door-to-door collection and trade is responsible for obtaining WEEE directly from households towards complementary flows.

6.2 RETAIL

From 2009 to 2010 Wecycle (excl. ICT~Milieu) changed the contracts with retailers in order to receive more WEEE. This increased the formally reported WEEE collection as illustrated in the next table:

	A	B	C	D	E1	E2	
COLLECTION RESULTS	LHA	C&F	SHA	IT + MON		TV	TOTAL
2009 (ton)	5,857	6,839	963	2,243		213	16,115
2009 (kg/inh)	0.36	0.41	0.06	0.14		0.01	1.0
2010 (ton)	22,535	9,286	1,869	3,793		213	37,696
2010 (kg/inh)	1.36	0.56	0.11	0.23		0.01	2.3

Figure 34 Collection results retail 2009 and 2010

The results of 2010 more than doubled compared to 2009. Very interesting is the ratio of LHA versus C&F. Based on the WEEE Generated model, this ratio should be approximately 2.1 which only became the case in 2010. This indicates that when WEEE is collected at the retailers with a contract with Wecycle, almost all WEEE they received in 2010 is handed over to Wecycle including LHA (which was often sold separately before 2010). Retail shops with a contract behave as expected and it is not likely that these retail shops are responsible for large complementary flows. Nevertheless there are retail shops that don't have a contract with Wecycle although the most important retail shops work together with Wecycle. As a result an estimate 20-30% of WEEE or 15 – 20 kton received at retailers becomes a complementary stream.
These flows potentially become part of the flows of local or regional metal scrap processors and are discussed in the next Chapter and validated in Chapter 9.

6.3 SUMMARY

From 349 kton, 21.0 kg/inh of WEEE Generated NL, 125 kton, 7.5 kg/inh is reported by the compliance schemes, which leaves a potential of 223 kton available for complementary recycling.
Validation of the amounts reported per collection category is done in Chapter 9 via the WEEE chain model.

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
WEEE Generated NL	**6.13**	**2.36**	**6.20**	**2.40**	**1.53**	**1.36**	**0.22**	**0.83**	**21.0**	**349**
Wecycle/ICT~Milieu	1.86	1.53	1.60	0.61	0.61	1.25	0.10	0.00	7.5	125
Not (yet) documented WEEE	**4.27**	**0.83**	**4.60**	**1.80**	**0.93**	**0.11**	**0.12**	**0.83**	**13.5**	**223**

Figure 35 Summary compliance scheme flows

7 COMPLEMENTARY RECYCLING FLOWS

Data on complementary recycling flows is obtained through an extended market survey of MRF and EERA recyclers on national and regional level, followed by interviews to understand the outcomes. The recyclers interviewed include all national recyclers, the most relevant ones on a regional level and some foreign recyclers. They were all very cooperative and made a lot of effort to provide and validate the required data.

7.1 NATIONAL RECYCLERS

National recyclers receive sorted appliances, mono-flows and 'pre-shredder' material. Mono-flows are sorted materials that consist of one or two categories of WEEE e.g. professional appliances, IT desktops and cooling and freezing appliances. The 'pre-shredder' materials are bought from regional metal scrap processors and consist of a metal mix with a certain percentage of WEEE (parts from professional and large household appliances, small household appliances, Central Heating and IT appliances). Furthermore, national recyclers import WEEE for recycling purposes in the Netherlands. WEEE from the compliance schemes is also processed by the national recyclers, but strictly kept separate of the analysis of the complementary flows.

The most relevant findings from the survey of MRF and EERA recyclers are:

- Around 88 kton of Dutch WEEE is recycled by the 9 recyclers in the Netherlands parallel to the 125 kton of WEEE collected by the compliance schemes.
- The 88 kton consists of 60% mono-flows and 40% WEEE mixed with other metals in 'pre-shredder' material. The national recyclers remove materials from WEEE, shredder and sort the materials and sell separated materials like metal, plastic and glass to the industry as raw materials, mainly abroad.
- The share of WEEE in 'pre-shredder' material is determined to be at least 3.5%. However, some recyclers indicate that the share of WEEE is higher in their input and may be as high as 7% of the total input. When applying the higher estimate, the amount of complementary Dutch WEEE, recycled in the Netherlands would be 110 kton instead of 88 kton.
- The amount recycled in neighbouring countries is 16 kton, mainly being pre-shredder materials. When the 7% higher estimate is used, the amount would be 20 kton instead of 16 kton.

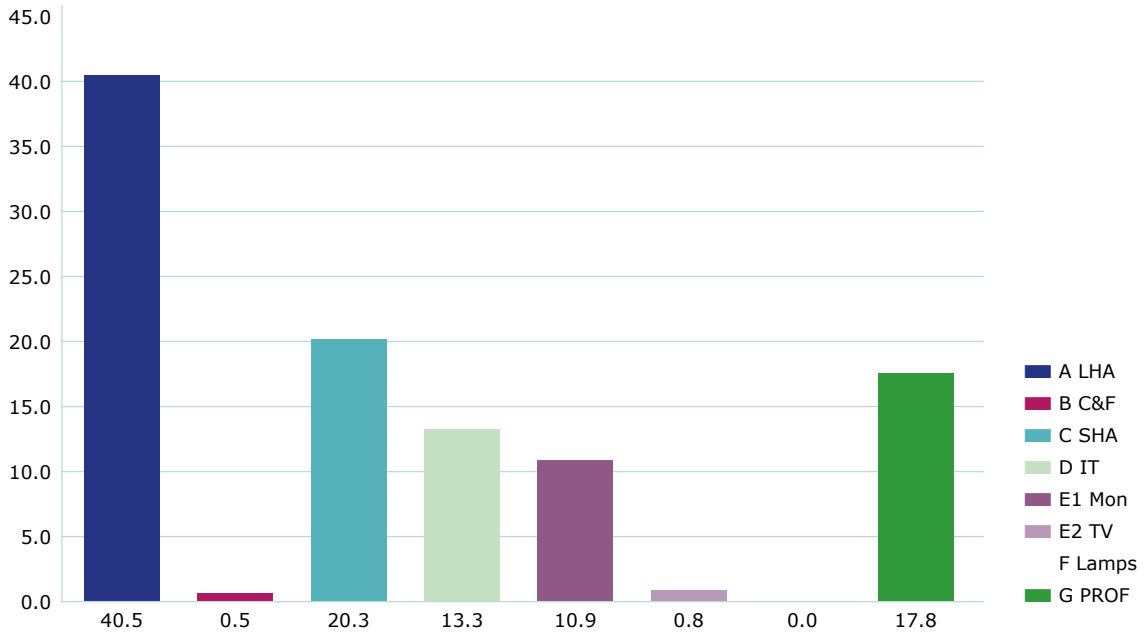


Figure 36 Breakdown of documented complementary recycling

The estimation of the total complementary recycling flow of Dutch WEEE of 104 kton (88 + 16) is a conservative estimation and could be 130 kton (110 + 20) as a maximum and is illustrated in Chapter 5.2. As expected, the majority consists of large household appliances. However, categories like small household appliances, professional and IT are important as well. The identified 104 kton is validated in Chapter 9 (and slightly corrected upward to 110 kton).

7.2 REGIONAL AND LOCAL TRADERS

The amounts documented at the national level are also validated from the data of their suppliers on a regional level. Regional metal scrap processors receive ferro and non-ferro flows including WEEE from Dutch local collectors. The origin of WEEE consists of consumers and businesses. They also receive WEEE that is directly brought to them by households. This WEEE mainly consists of large household appliances with a high metal content, e.g. washing machines. To a lesser extent they also directly receive ICT from households. The regional metal scrap processors also play an important role for WEEE from businesses. In particular, companies installing electrical installations and heating systems deliver WEEE to those traders and they also receive professional communication and IT equipment. A small part of the scrap originates from foreign border areas. Almost none of the regional metal scrap processors have a permit to process hazardous WEEE like cooling and freezing appliances, CRT screens and flat panels. Therefore these categories should not be part of their input streams. Regional metal scrap processors have as an input: LHA and SHA from households, PROF appliances like automatic dispensers from B2B, Central Heating installations both from HH and installation companies (modelled, but excluded from the scope of this research) and IT excluding monitors. Some input like IT is already dismantled in parts. Parts often have a higher market value than complete equipment. More qualitative details on the regional processors and local collectors are included in the Technical Report.

When foreign recyclers are closer located than Dutch recyclers (small coverage in the Netherlands) and/ or prices are competitive, regional processors export 'pre-shredder' materials to recyclers in Germany and Belgium. Based upon market information of these regional recyclers, it is determined that 16 kton of Dutch WEEE is recycled by 12 recyclers across the border in Germany and Belgium. The total amount of WEEE that is received at the regional metal scrap processors from municipalities, businesses, waste processors, retail shops and local collectors, is about 104 – 115 kilotons of WEEE. This matches the size of the complementary recycling flow displayed in Figure 36 and confirms the amounts documented.

7.3 OTHER

Strictly speaking, 2nd hand goods don't belong to WEEE. Eventually these goods become WEEE and have to be taken care of when they become waste. As long as the goods are still in use, the average lifespan of these 2nd hand goods is extended. This is included in the residence times of the WEEE Generated model as well as in the WEEE chain model of Chapter 9 to avoid double counting.

Charity initiatives however, can behave slightly differently. When 2nd hand goods are broken and cannot be repaired it becomes WEEE. Options for the charity initiatives for this WEEE are:

- WEEE is directed to the compliance scheme system, based upon a contract with the compliance schemes;
- WEEE is given to the collection point of the municipality since charity initiatives and municipalities often work together and a significant part are physically located next to each other;
- WEEE is sold to local or regional metal scrap processors;
- In some cases, sometimes in combination with social work places, WEEE is dismantled and sold as parts or recycling fractions.

Professional charity initiatives can handle 0.8 kg of WEEE per inhabitant of the municipality when they work in close cooperation with the municipal collection point and when they are well organized. In case they use the first two options, they are included in the compliance scheme flows. The second option means WEEE is added into the administration of the municipalities. The branch organisation BKN cooperates with the compliance schemes, but this is not the case for all the charity initiatives. The third and fourth option leads to complementary recycling flows. Not every municipality has a charity initiative and less professional charity initiatives generate less WEEE. In total, an estimated 0.2 – 0.3 kg/inh (3 – 5 kton) leads to complementary recycling flows towards to local or regional metal scrap processors.

7.4 SUMMARY

The findings for the complementary recycling flows of Chapter 7 are summarised below: from the 349 kton, 235 kton is now documented and 114 kton remains not yet documented. Again, validation of these flows per collection category and by B2B or HH origin is discussed in Chapter 9.

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
WEEE Generated NL	**6.13**	**2.36**	**6.20**	**2.40**	**1.53**	**1.36**	**0.22**	**0.83**	**21.0**	**349**
Documented WEEE (excl. export)	**4.67**	**1.92**	**3.05**	**1.30**	**1.17**	**1.30**	**0.11**	**0.63**	**14.2**	**235**
Wecycle/ICT~Milieu	1.86	1.53	1.60	0.61	0.61	1.25	0.10	0.00	7.5	125
Complementary recycling	**2.81**	**0.39**	**1.45**	**0.70**	**0.56**	**0.05**	**0.01**	**0.63**	**6.6**	**110**
Not (yet) documented	**1.45**	**0.43**	**3.15**	**1.10**	**0.37**	**0.06**	**0.11**	**0.20**	**6.9**	**114**

Figure 37 Summary complementary flows

8 WEEE IN RESIDUAL WASTE

As smaller WEEE is easily discarded via the normal standard garbage bins, substantial analysis is done regarding the WEEE content of residual waste. The research is based on a large amount of individual surveys originally issued by municipalities and made available mainly via Eureco and partly via Agency NL. Several hundred surveys are investigated to calculate the amount of WEEE ending up in incineration more accurately.

8.1 PAY-AS-YOU-THROW

Since information of individual municipalities was available, additional analysis are made to explain possible relationships between the amounts of WEEE and differences between local waste policies. The two most important waste collecting configurations are:

- **Flat tax:** regardless of the amounts of waste an individual household discards of every year, a fixed price is paid for the waste collecting services;
- **Pay-as-you-throw (PAYT).** In a substantial amount of municipalities a household must pay more taxes if they discard more household waste. In these "PAYT" communities (in Dutch: DIFTAR) payment is calculated on the basis of kilogram, frequency or by means of special (taxed) litter bags. For those households there is more incentive to discard WEEE in the appropriate channels (via retail or municipal container parks) and not with residual household waste.

The key finding is that on average 0.88% of residual household waste is WEEE which means that 2.1 kg/inh of WEEE in 2010 is not available for collection. Due to the high number of data points, the uncertainty in these amounts is very low. The amounts of WEEE in residual waste from HH are fairly consistent over the years. In PAYT municipalities the average amount of WEEE in residual waste is around 1 kg/inh or 50% lower. This suggests that PAYT is a strong supporter for the collection of WEEE.

8.2 SMALL APPLIANCES

In the surveys and database of Eureco extra information is available regarding the type of appliances that were discarded as WEEE, the frequency and the weight of these individual appliances. This made it possible to conduct a frequency analysis in which individual appliances are linked to the UNU keys.

Local waste policies can affect the amounts of WEEE that is discarded of as household waste as shown in below table. The average amount of WEEE for PAYT communities per inhabitant is about 1 kilogram less compared to the average in the Netherlands. This suggests that PAYT is successful in reducing the amounts of WEEE that otherwise would be discarded with residual household waste. The main results are displayed in the table below.
The table shows that inhabitants living in rural and urban areas behave similarly: the amounts of WEEE discarded of as household waste are comparable.

SORTING ANALYSES, WEEE IN HH WASTE (KG/INH)					
	2006	**2007**	**2008**	**2009**	**2010**
Flat tax, urban area	**2.3**	**2.5**	**2.3**	**2.6**	**2.2**
Flat tax, rural area	**1.8**	**2.7**	**2.0**	**2.4**	**2.1**
PAYT, vol. freq.	1.0	1.4	1.3	1.0	1.7
PAYT, other	0.9	0.9	1.2	0.7	0.9
Total per inh	1.9	2.4	1.9	2.2	2.1
Total in kton	30.8	38.9	32.1	35.9	32.7
PAYT of total	**17%**			**19%**	**19%**

Figure 38 Results WEEE in residual waste 2006 - 2010

The complete list with 273 different appliance types is presented in the Technical Report. Small WEEE items, as expected, are the major part, predominantly being small household appliances, IT and telecom appliances and HH luminaries. All appliances above 1%, together 50% of the total WEEE are presented in the table below.

The overall results show that small white and browngood appliances account for 37% of the WEEE that is discarded with residual waste. With respect to ICT, in particularly the smaller parts are discarded as residual waste like keyboards. Medium sized IT-equipment like desktops or laptops are rarely found. Due the large average weight of these appliances however, they contribute substantially. More hazardous waste like energy saving lamps is also discarded with residual household waste. These numbers are small (2% of the total number of appliances). In weight their importance is even less: about 0.4% to the total weight of WEEE consists of energy saving lamps since the weight of an average energy saving lamp is between 80 and 110 grams.

APPLIANCE TYPE	COLLECTION CATEGORY	UNU KEY	ITEMS FOUND	WEIGHT (GRAMS)	AVERAGE WEIGHT (G)	WEIGHT (%)	CUMULATIVE (%)
Household luminaires	C SHA	5-07	278	94,395	340	9.1%	9.1%
Loudspeakers	C SHA	4-05	65	58,953	907	5.7%	14.7%
Adapter	all CAT	all CAT	185	51,986	281	5.0%	19.7%
Desktop PC	SHA IT	3-02	4	44,844	11,211	4.3%	24.0%
Frying pan	C-SHA	2-02	21	44,311	2,110	4.3%	28.3%
Vacuum cleaner	C SHA	2-04	7	35,427	5,061	3.4%	31.7%
Coffee maker	C SHA	2-03	27	32,175	1,192	3.1%	34.8%
Christmas lamps	C SHA	5-01	5	26,307	5,261	2.5%	37.3%
Toaster	C SHA	2-02	10	21,479	2,148	2.1%	39.4%
Telephone	C SHA	3-05	74	18,957	256	1.8%	41.2%
Water cooker	C SHA	2-03	31	16,188	522	1.6%	42.8%
PC keyboard	SHA IT	3-01	16	13,923	870	1.3%	44.1%
Laptop PC	SHA IT	3-03	7	13,822	1,975	1.3%	45.4%
Iron	C SHA	2-01	13	13,561	1,043	1.3%	46.7%
Drill	C SHA	6-01	8	13,302	1,663	1.3%	48.0%
DVD-player	C SHA	4-04	7	12,529	1,790	1.2%	49.2%
Sander	C SHA	6-01	8	11,854	1,482	1.1%	50.4%
Subtotal			**766**		**2.2 kg**	**50.4%**	
Total (100% of the items)			**2,074**	**1,041 kg**	**502 kg**		

Figure 39 Weight and pieces of WEEE in residual household waste

Unfortunately, the same level of detail in the information on how much WEEE is found in residual waste from businesses is not available. Nevertheless one can expect that businesses also discard WEEE via residual waste, especially for small equipment. From the chain model explained in Chapter 9 follows that if one combines the information regarding POM/WEEE for businesses, around 3 to 4 kton of B2B WEEE is likely present in residual waste from businesses. This value is validated in Chapter 9.

8.3 SUMMARY

The average amount of WEEE in residual household waste, is 2.1 kg/inh per year. This is roughly 10% of the total volume of WEEE generated by households. Including B2B residual waste, in total 38 ktons of WEEE is not in line with the WEEE Directive requirement of separate collection. For the total mass balance this means that from the 349 kton of WEEE Generated NL, 272 kton is now documented.

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
WEEE Generated NL	**6.13**	**2.36**	**6.20**	**2.40**	**1.53**	**1.36**	**0.22**	**0.83**	**21.0**	**349**
Documented WEEE (excl. export)	**4.67**	**1.92**	**4.69**	**1.84**	**1.17**	**1.30**	**0.22**	**0.63**	**16.4**	**272**
Wecycle/ICT~Milieu	1.86	1.53	1.60	0.61	0.61	1.25	0.10	0.00	7.5	125
Complementary recycling	2.81	0.39	1.45	0.70	0.56	0.05	0.01	0.63	6.6	110
Waste/incineration	0.00	0.00	1.64	0.54	0.00	0.00	0.11	0.00	2.3	38
Not (yet) documented	**1.45**	**0.43**	**1.51**	**0.56**	**0.37**	**0.06**	**0.00**	**0.20**	**4.6**	**76**

Figure 40 Summary documented flows incl. WEEE in Residual Waste

9 THE WEEE CHAIN MODEL

From the analysis so far, 76 kton out of 349 remains not yet documented. However, substantial market information is now available as well as an advanced chain model available that can validate all findings and indicate where the remaining 76 kton or 4.6 kg/inh can be found.

9.1 VALIDATION OF ALL FLOWS

The difficulty with the heterogeneous nature of the WEEE flows and the many actors involved (see Figure 5 in Chapter 2) is that in the middle section of Figure 41, the 'identity' or 'origin' of equipment is 'lost'. This means that it is often unclear whether WEEE originated in businesses or households and to which collection category it originally belonged. In the field work of Chapter 5 and the market survey of Chapter 6, there is overlap in the amounts per collection category. This is specifically the case for: SHA and IT appliances, SHA-IT and IT Monitors sometimes documented as IT in general for B2B IT and PROF equipment and for (pre-shredder materials from) steel dominated LHA and PROF appliances. Only when all the information is linked together into the WEEE chain model of Figure 41, a complete and validated picture emerges per collection category. This chain model is developed in the course of this project to avoid time consuming manual calculations of several hours by hand. In addition, the results are more accurate and free from interpretation. Another necessity is to prevent double counting on various levels:

- To avoid 'return loops' for output from the regional to the national level;
- To split Dutch derived WEEE from imported recycling streams;
- To distinguish types and origins of export of used EEE and WEEE;
- To distinguish B2B and HH flows.

The exact structure of this WEEE chain model is explained in the Technical Report. In short, with the help of a number of logical constraints, like equipment and materials mass balances and maximum and minimum values identified in the previous Chapters, different scenarios are evaluated. Through this, deviation to the most reliable data points is minimised very strictly and the deviations from less reliable data is done less strictly. It results in WEEE amounts per collection category, including material recovery outside the first line of WEEE treatment. Here, the field survey did not investigate the flows of dismantling fractions like plastics and parts for reuse. The chain model however, has sufficient data to predict the bandwidth of these very disperse material flows. This enables characterising the total not yet documented flows without performing extremely costly and likely impossible surveys on every single local actor in the chain. In addition, it provides lower and upper limits and thus the uncertainty range for these amounts. The chain model could not be applied on lamps, due to insufficient data on the B2B channels and stocks in public space and offices.

9.2 WEEE MASS BALANCE NL 2010

From applying the advanced chain model and analysing different scenarios, the following is derived: Documented and validated amounts include the minimum export of used EEE of 31 kton/1.9 kg/inh for HH appliances, the reported amounts on a national level by Wecycle and ICT~Milieu (125 kton, 7.5 kg/inh), the complementary recycling amounts (110 ktons, 6.6 kg/inh) and the WEEE in residual waste (38 kton, 2.3 kg/inh). The model validated the total WEEE amounts and allocated the amounts of HH and B2B per WEEE per collection category as already presented in the previous chapters.

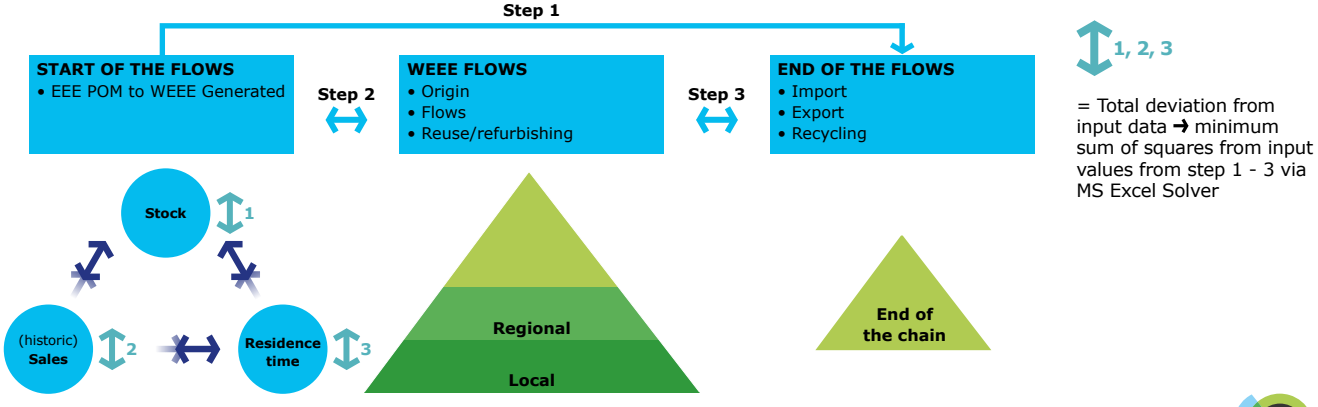


Figure 41 WEEE chain model and research approach

2010 IN KG/INH	A LHA	B C&F	C SHA	D IT	E1 MON	E2 TV	F LAMPS	G PROF	TOTAL (KG/INH)	TOTAL (KTON)
EEE POM 2010	**7.88**	**3.88**	**7.50**	**3.03**	**0.76**	**1.74**	**0.27**	**1.46**	**26.5**	**440**
WEEE + used EEE Generated	**6.39**	**2.95**	**6.44**	**3.00**	**1.80**	**1.85**	**0.22**	**1.03**	**23.7**	**392**
WEEE + used EEE/EEE ratio	81%	76%	86%	99%	237%	106%	80%	71%	89%	89%
Export used EEE	**0.26**	**0.60**	**0.24**	**0.60**	**0.26**	**0.49**	**0.00**	**0.20**	**2.7**	**44**
Export used EEE HH, whole appliances	0.23	0.54	0.22	0.22	0.04	0.49	0.00	0.00	1.7	29
Export used EEE B2B, incl. refurbishing	0.03	0.06	0.02	0.38	0.23	0.00	0.00	0.20	0.9	15
WEEE Generated 2010 NL	**6.13**	**2.36**	**6.20**	**2.40**	**1.53**	**1.36**	**0.22**	**0.83**	**21.0**	**349**
WEEE/EEE ratio (excl. export)	78%	61%	83%	79%	202%	78%	80%	57%	79%	79%
Documented + export used EEE	**4.93**	**2.52**	**4.93**	**2.44**	**1.43**	**1.78**	**0.22**	**0.83**	**19.1**	**316**
Households										
Wecycle/ICT~Milieu	1.86	1.53	1.60	0.61	0.61	1.25	0.10	0.00	7.5	125
Complementary	2.29	0.00	1.22	0.29	0.12	0.00	0.00	0.00	3.9	65
Businesses										
Complementary	0.52	0.39	0.23	0.41	0.45	0.04	0.01	0.63	2.7	44
Compl. recycling B2B + HH	**2.81**	**0.39**	**1.45**	**0.70**	**0.56**	**0.05**	**0.01**	**0.63**	**6.6**	**110**
Waste/incineration	**0.00**	**0.00**	**1.64**	**0.54**	**0.00**	**0.00**	**0.11**	**0.00**	**2.3**	**38**
Not (yet) documented	**1.2 – 1.7**	**0.4 – 0.5**	**1.4-1.6**	**0.5 – 0.6**	**0.4 – 0.4**	**0.1 – 0.1**	**N/A**	**0.2 – 0.2**	**3.9 – 5.1**	**64 – 85**
Potentially identifiable min/max	0.7 – 1.0	0.2 – 0.4	0.6 – 1.0	0.1 – 0.2	0.1 – 0.1	0.0 – 0.0		0.1 – 0.1	1.8 - 2.8	31 – 46
Unidentifiable, min/max	0.5 – 0.6	0.1 – 0.2	0.6 – 0.8	0.4 – 0.5	0.2 – 0.3	0.0 – 0.1		0.1 – 0.1	2.0 – 2.4	34 – 40
from which: max add. Illegal export	**0.0 – 0.1**	**0.1-0.1**	**0.1 – 0.3**	**0.1 – 0.2**	**0.1 – 0.2**	**0.0 – 0.0**		**0.0 – 0.0**	**0.4 – 0.8**	**8 – 14**
from which add.: pre-shredder	**0.6 – 0.8**	**0.0 – 0.0**	**0.2 – 0.4**	**0.0 – 0.0**	**0.0 – 0.0**	**0.0 – 0.0**		**0.1 – 0.1**	**1.0 – 1.3**	**16 – 22**

Figure 42 Dutch WEEE Flows 2010

The chain model calculates the not (yet) documented WEEE at varying between 64 and 85 kton, or 3.9 to 5.1 kg/inh. This is split in two parts: those amounts that could potentially be reported by more effort and those that cannot be identified:

1. The potentially identifiable part is estimated at around 1.8 to 2.8 kg/inh. Specifically LHA, between 0.7 – 1.0 kg might be documented by means of dedicated pre-shredder fraction sampling and/or more separation of WEEE before shredding. For SHA, an additional 0.6 – 1.0 kg might be found in the form of WEEE derived (non-metal) recycling fractions at larger traders.
2. The non-identifiable part consists of WEEE or WEEE derived fractions that are structurally difficult to be documented like (non-metal) dismantling fractions for reuse or recycling at local levels, WEEE unrecognisable as WEEE and a maximum potential for (illegal) export from qualitative assessment per collection category. It also includes around 0.5 kg of uncertainty in POM and WEEE amounts partly due to year-on-year economic fluctuations. For a small portion (0.1 - 0.2 kg) it remains unclear in the WEEE flows whether the materials should be regarded as WEEE on non-WEEE, a larger portion of around 1.1 – 1.6 kg can be addressed to local dismantling of parts for reuse of for example IT components like drives, motherboards and memory and of separating adapters, cables and compressors and remaining non-metal recycling fractions like large plastic parts at local processors. A remaining upper limit of 0.4 – 0.8 kg might possibly be additional illegal export still appearing out of sight. This value should be regarded as a maximum based on the type of products involved and the analyses made in Chapter 5.1 and 5.2.

10 THE FUTURE FLOWS

This research is based on an 'all-actors-involved' cooperation which provided for high quality information sets regarding:

- **EEE POM and product weight distributions from Wecycle/ICT~Milieu and Statistics Netherlands on micro-data level;**
- **WEEE residence times of appliances discarded and in stock at HH and B2B from consumer surveys;**
- **Many sorting analyses of WEEE in residual waste;**
- **Extensive field work at regional and national recyclers;**
- **Extensive field work at municipal collection points.**

Combined with sophisticated scientific modelling, the outcome is a highly detailed and more accurate view on the whereabouts of the EEE and WEEE flows in the Netherlands. Before the start of this project, two thirds of the WEEE flows were unaccounted for. Now, in total, including the export for reuse amounts, 80% of the WEEE plus used EEE potential is documented.

10.1 CONCLUSIONS

The main conclusions are:

1. The amount of EEE POM in 2010 is 26.5 kg/inh for the chosen WEEE scope (see Chapter 1.2). The WEEE recast 65% target basis of the average POM 2007-2009 (POM 3 yrs.) is 26.8 kg/inh.
2. In comparison with previous annual reporting, the more accurate determination of POM amounts resulted in 4.5 kg/inh not being identified previously, which is obviously relevant for substantiating the POM target basis. A dedicated and transferable method is developed for analysing a country's POM independently.
3. The amount of WEEE Generated incl. used EEE is 23.7 kg/inh, 392 kton, or 88% of POM 3 yrs.
4. Export of used EEE is at least 1.9 kg/inh for HH appliances and 0.8 kg for B2B appliances, (9% of POM 3 yrs.).
5. The amount of WEEE Generated in the Netherlands is 21.0 kg/inh or 349 kton/78% of POM 3 yrs.
6. The ratios WEEE/POM are above the long term trend from the past. From analysis of the long term trend it is expected that the ratio WEEE+ used EEE/POM will remain around 90% for the coming years.
7. Currently, the compliance schemes flow is 7.5 kg/inh which is 28% compared to POM 3 yrs.
8. The total complementary recycling flow is in the same order of magnitude as the compliance schemes flow: 6.6 kg/inh which is 25% POM 3 yrs.
9. The collection rate would be 53% in case all complementary streams documented in this research would also be reported on a national level. Note the differences per collection category. In addition, all collection categories, except screens, are below the WEEE recast target level of 65% of POM 3 yrs.
10. Compared to the alternative 85% WEEE Generated target, the combined compliance schemes and complementary recycling flows are 67% resp. 60% dependent whether export of used EEE is included (basis is 23.7 kg/inh) or not (basis is 21.0 kg/inh) in the WEEE Generated definition.
11. In total 2.3 kg/inh (2.1 from HH), mainly SHA, ends up in residual waste. This is 9% of POM 3 yrs.
12. Around 17% of POM 3 yrs. remains not (yet) documented. Roughly half of this structurally and permanently difficult to identify due to fractions not being recognisable as WEEE derived, dismantling for parts and (non-metal) fractions, economic fluctuations in POM and WEEE. The other half can in theory be documented e.g. by better sampling or separation beforehand of WEEE in pre-shredder materials.

COLLECTION RATE vs. POM 3 YRS.	A LHA	B C&F	C SHA	D IT	E SCREENS	F LAMPS	G PROF	TOTAL (KG/INH)	WEEE RECAST LEVEL
EEE POM 2010	**7.88**	**3.88**	**7.50**	**3.03**	**2.50**	**0.27**	**1.46**	**26.5**	
Av. POM 2007-2009: 100% is 26.8 kg	**8.13**	**3.95**	**7.41**	**3.04**	**2.72**	**0.27**	**1.31**	**26.8**	
Export used EEE	3%	15%	3%	20%	28%	0%	15%	10%	
Formal collection	23%	39%	22%	20%	68%	37%	0%	28%	
Complementary	35%	10%	20%	23%	22%	5%	48%	25%	
Waste	0%	0%	22%	18%	0%	40%	0%	9%	
Not (yet) documented	18%	11%	20%	19%	16%	N/A%	15%	17%	
from which approx. identifiable	10%	7%	11%	5%	5%		8%	9%	
from which approx. unidentifiable	7%	4%	10%	14%	11%		6%	8%	
Total Wecycle/ICT~Milieu + Complementary	**58%**	**49%**	**41%**	**43%**	**91%**	**42%**	**48%**	**53%**	**65%**
Alt. target 1: WEEE Gen. NL (100% = 21.0 kg -- >)	76%	82%	49%	54%	85%	51%	76%	67%	85%
Alt. target 2: WEEE + used EEE (100% = 23.7 kg -- >)	73%	65%	47%	43%	68%	51%	61%	60%	85%

Figure 43 WEEE Flows as % of the POM 3 yrs. collection target level

10.2 RESEARCH RECOMMENDATIONS

An important contribution in this research is the analysis of historic EEE sales at Statistics Netherlands. This method is potentially available for other EU countries to perform similar analysis. A list is available to find and relate PCC and CN codes to individual EEE products. The database constructed currently runs until 2010 and needs to be updated annually as the goods change annually. For the purpose of this research, a lot of information including the distribution of product weights is exchanged to tune the POM list and vice versa the UNU WEEE Generated model. A document with all good codes from 1996 to 2010 including weights will be provided.

The UNU WEEE generated model provides for a very detailed prediction of the WEEE Generated amounts, also for the coming years. For most appliances present in substantial numbers in households the data quality is extremely high. However for some less relevant and less common products from the old WEEE categories 6-10, the data can be improved further. It is advised to repeat the HH and B2B possession studies roughly every five years to update and correct for ongoing decreases in residence time and maybe more frequent or dedicated to include new products entering the market (like the recent growth in smartphones and tablets) and to fine-tune the residence time profiles of products that are just newly appearing in the recycling stream (LCD TV's).

A large part of the complementary flow is managed by the national recyclers. In particular the share of WEEE in pre-shredder material is not having a high accuracy during the research and additional research might improve the data for this flow. It is therefore advised, if possible, to sample the pre-shredder streams on the fraction of WEEE derived materials. In addition, the data related to export flows can be updated when similar research is done in neighbouring countries like Belgium. Alternatively one could try to involve those companies in Belgium and Germany into a reporting system in the Netherlands and vice-versa.

The research showed a rather good verification of the size of the complementary streams that flow via national recyclers and for the export flows with data on the amounts that are collected via local and regional actors. From a research point of view it is advised to repeat the monitoring of these flows regularly in cooperation with the compliance schemes and MRF and EERA members.

Based on ongoing export inspection work, new findings can be incorporated in the chain model in the future. Regarding export of whole appliances by road towards Eastern Europe it is advised to take further sampling effort to reduce the current bandwidth and uncertainty in destinations of export of whole appliances.

10.3 THE FUTURE FLOWS CONTINUED

The benefits of extensive research like this for the future are manifold:

1. The reliability of the total POM amounts is fundamentally improved and determined independently using existing data at Statistics Netherlands. However, a more detailed analysis through a 'free-rider check' on individual company level is and never will be possible nor allowed due to data confidentiality at Statistics Netherlands and the compliance scheme registers themselves. It is however possible to determine for which type of appliances there is a high likelihood of errors, unclear classification or a chance of having 'free-riders'. The improved classification of products is recommended for implementation in the coming years. The new UNU compatibility lists can be shared with other countries to enable detailed comparisons.
2. The WEEE Generated information does support more detailed financial and organisational planning. Also technical and/or recycling capacity planning at recyclers can be based on more accurate prediction on the age and nature of the return streams.
3. The extensive market research and identification of non-reported WEEE streams helps to understand how and where these can be found. The factual basis provides an important starting point for assessing different options to raise the Dutch WEEE collection amounts in practice.
4. The detailed insights on the size and nature of exports of used, mixed used and non-functioning EEE and of WEEE derived fractions and illegal shipments can assist in more targeted interventions.
5. In the future, combined with composition data, better environmental and resource recovery focus can be substantiated, e.g. through follow-up research on WEEE related critical materials mass balances for the Netherlands and to further prioritise which of the WEEE flows are more environmentally relevant.
6. Finally, the outcomes provide key insights to build the factual basis for this years planned development of the criteria and methodology to convert the generic collection targets of the WEEE recast in more practical terms. Furthermore, assistance to other countries with far less information available is possible in order to streamline and enhance WEEE quantification research.

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ABBREVIATIONS

EEE	Electrical and Electronic Equipment
WEEE	Waste Electrical and Electronic Equipment (generated)
WEEE NL	WEEE Generated in the Netherlands, excluding export of used EEE
C&T	Collected and treated
Used EEE	EEE appliances intended for 2nd hand use or reuse
POM	Put-on-Market
B2B	Business to Business, small, medium and large enterprises, including institutions and public space
CN	Combined Nomenclature, EU statistics of national import and export of commodities
DC	Distribution Centre
DtD	Door-to-door trade
HH	Households
RSC	Regional Sorting Center
kg/inh	kilogram per inhabitant
PCC	Prodcom, EU statistical classifications of national production of commodities
SME	Small and Medium sized Enterprises
UNU-58	Classification list of all EEE and WEEE in 58 categories/ appliance types
WOB	Wet Openbaarheid Bestuur ('Law Transparency Public policy')

COLLECTION CATEGORIES AND APPLIANCES

LHA	Large Household Appliances
C&F	Cooling and Freezing
SHA	Small Household Appliances
IT	IT and Telecom Appliances
CRT	Cathode Ray Tube
FPD	Flat Panel Display
Mon	Monitors
TV	Televisions
LCD	Liquid Crystal Displays
Lamps	Lamps
PROF	Professional Appliances
CE	Consumer Electronics
CFL	Compact Fluorescent Lamps
CH	Central Heating Appliances (incl. boilers and geysers)
DVD	Digital Video Disk
LED	Light-Emitting Diodes (displays)
TL	Straight Tube Fluorescent Lamp
VCR	Video Cassette Recorder

INSTITUTES

Agency NL	Executing agency for government policy - waste field
CBS	Centraal Bureau voor de Statistiek (Statistics Netherlands: see: www.cbs.nl/en-GB/menu/home/default.htm)
EERA	European Electronics Recyclers Association
FFact	FFact (see: www.ffact.nl)
FIAR	Vereniging van Fabrikanten, Importeurs en Agenten op Radiogebied (producer association CE products)
ICTM	ICT~Milieu (producer association recycling ICT equipment)
I&M	Ministry of Infrastructure and Environment policy department responsible for WEEE
Lightrec	Producer association for lamps
MRF	Metaal Recycling Federatie
NVRD	The Dutch association for residual household waste collectors
RTA	Stichting Recycling Technologische Apparatuur (small compliance scheme for PROF equipment)
UNU	United Nations University (see: isp.unu.edu/about/organization/scycle/)
VLEHAN	Vereniging Leveranciers Huishoudelijke Apparaten Nederland ('producer association for whitegoods')
Wecycle	Wecycle (compliance scheme for all WEEE categories, except IT)
W+B	Witteveen+Bos (see: www.witteveenbos.nl)

RESEARCH TERMINOLOGY

Documented amounts are those quantities that are validated as a minimum and for which sufficient evidence is gathered. This does not necessary mean these flows are also reported on a national or regional level (and vice versa). The documented amounts are always displayed as a minimum value when uncertainty is involved.
The not (yet) documented flows include the uncertainty range on top of the documented amounts and those flows not yet identified. This does also does not necessarily mean they are not reported somewhere (out of our research sight). The not (yet) documented flows are split into two parts:

- Potentially identifiable flows could be identified with (much) more effort.
- Unidentifiable flows are structurally impossible to be documented like dismantling fractions/parts, WEEE that is commonly not recognised as WEEE and additional (illegal) export.

Complementary flows are those flows not reported on a national level.

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