

**White goods foundation  
Brown goods foundation  
IT~Environment foundation  
Metalektro Recycling foundation  
LightRec foundation  
Recycling Centre Ventilators  
foundation  
Removal Electrical Appliances  
foundation**

**Research into complementary  
waste streams for e-waste in the  
Netherlands**

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\*Regional Sorting Centre

## MANAGEMENT SUMMARY

In accordance with the EU-guideline, 2002/96/EG (WEEE-Directive), manufacturers and importers must collect and recycle used electrical and electronic equipment (hereafter referred to as e-waste). The WEEE-Directive has been documented in the *Besluit beheer elektrische en elektronische apparatuur* (BEA Act) and the *Regeling beheer elektrische en elektronische apparatuur* (BEA Regulation). The manufacturers and importers involved are responsible for the environmentally friendly collection and recycling of products they have sold on the Dutch market. The White goods, Brown goods, SMR, LightRec, SVCV and SVEG foundations have centred all their activities concerning collection and recycling in the *Nederlandse Verwijdering Metalektro Producten* (Dutch Removal of Metal-electrical Products) foundation, hereafter referred to as NVMP. The manufacturers and importers collect the used products from the retail trade and the municipalities. The collected products are then sent to the recyclers contracted by the NVMP and the *IT-Environment* foundation. IT-Environment has set up a similar system for IT-equipment.

Witteveen+Bos has carried out field research at environmental waste areas, recycling companies, RSC locations, and completed a structured phone questionnaire at shops as well as the collection of additional data from distribution centres and final recyclers to achieve an accurate estimate of the amount of e-waste that is generated in the Netherlands and the resulting complementary streams. E-waste refers to all household waste electrical and electronic equipment. Complementary e-waste is defined as e-waste that is not collected by NVP and IT-Environment but is disposed of through other channels. The table gives a summary of the results.

### Mass balance household e-waste in the Netherlands (kilos/ residents/ year)

Product categories	Collection foundations	Environmental disposal area complement.	Recycling/in stallation companies	Mini-container	Retail trade & undefined	e-waste (total)
1. large household appliances	0.82	1.25	3.3	-	2.64	8.0
1 B. household fridge/freezer	1.55	-	-	-	0.28	1.8
3 A. IT and telecom	<i>in 3b-</i>	-	-	-	-	-
3 B personal computer use	1.25	0.95	-	0.30	0.19	2.7
5. lighting (energy saving bulb)	0.02	-	-	0.07	-	0.1
2. small household appliances	<i>in 4</i>	-	-	-	-	-
4. consumer appliances	1.73	0.30	0.3	1.11	1.58	5.1
6. electrical appliances	0.35	-	-	0.37	-	0.7
7. toys, sports, relaxation	0.02	-	-	0.18	-	0.2

The most important data for determining the volume of the annual e-waste comes from the ownership measurements of GfK Panel Services Benelux, located in Dongen. The average weight per machine and the estimated total life span (including 'second hand use') per machine is based on the average ownership per household. The total amount of e-waste generated in the Netherlands can then be estimated. In total an estimated 18.5 kilos of e-waste per citizen per year is generated, this is shown in the last column of table 4.5. This estimate strongly resembles the estimation of the United Nations University (UNU)<sup>1</sup>. The UNU-study showed that a maximum estimated 16 to 18 kilos of e-waste per citizen per year is generated in the 27 member states of the EU.

<sup>1</sup> 2008 Review of Directive 2002/96 on Waste Electrical and Electronic Equipment, 5 August 2007

This includes 5.7 kilos collected and recycled for the NVMP and IT-Environment as indicated in the second column of table 4.5. 85% of the 5.7 kilos comes from environmental waste areas, 14% comes from shops as part of the "old for new" regulation and 1% comes via various smaller channels.

With regards to the complementary e-waste streams, it is estimated that a further 2.5 kilos is disposed of through scrap dealers. An additional 3.6 kilos, mainly central heating boilers and boilers, are brought to scrap dealers. This means that at least 11.8 kilos is recycled, of which 6.1 kilos should be considered as complementary. This is significantly more than previously assumed; the reason for this is that a lot of e-waste is not mentioned separately as e-waste by the administrations. In total, two thirds of the e-waste in the Netherlands is recycled in this way.

Two kilos is disposed of by way of the household mini-container. Finally, there remains 4.7 kilos as indicated in the last but one column. This e-waste originates mainly from shops, where it is received from customers as part of the "old for new" regulation. Three kilos of this e-waste consists of ferrous large white appliances and other white and brown appliances, which are probably recycled in the Netherlands, just like any other metal material. The remaining 0.7 kilo consists of televisions, monitors, refrigerators (limited) and other small appliances.

## 1. INTRODUCTION

### 1.1. Background

In accordance with the EU-guideline, 2002/96/EG (WEEE-Directive), manufacturers and importers must collect and recycle used electrical and electronic equipment (hereafter referred to as e-waste). The WEEE-Directive has been documented in the *Besluit beheer elektrische en elektronische apparatuur* (BEA Act) and the *Regeling beheer elektrische en elektronische apparatuur* (BEA Regulation). The manufacturers and importers involved are responsible for the environmentally friendly collection and recycling of products they have sold on the Dutch market. Any manufacturer and/importer can join the system developed for this purpose. This is done by joining one of the following foundations:

- White goods foundation;
- Brown goods foundation;
- Metalektro Recycling (SMR) foundation;
- LightRec Netherlands foundation;
- Recycling Centre Ventilators (SVCV) foundation;
- Removal Electrical Appliances (SVEG) foundation;
- IT-Environment foundation.

The White goods, Brown goods, SMR, LightRec, SVCV and SVEG foundations have centred all their activities concerning collection and recycling in the *Nederlandse Verwijdering Metalektro Producten* (Dutch Removal of Metal-electrical Products) foundation, hereafter referred to as the NVMP. The manufacturers and importers collect used products from the retail trade and the municipalities. The collected products are then sent to recyclers contracted by the NVMP and the *IT-Environment* (IT environmental) foundation. The IT-Environment has set up a similar system for IT-equipment. The NVMP foundations cover the operational costs from the recycling charges received, which are visibly charged to the consumer. The IT-Environment covers these costs, by imposing a charge on the manufacturers/importers based on their market share.

The WEEE-Directive includes collection and recycling targets. Member states are compelled to collect 4 kilos of e-waste per citizen per year and to recycle it in an environmentally friendly way. For the Netherlands this would mean 65,000 tons per year (with 16.4 million citizens: source CBS-Statline 2007). The foundations look after the collection and recycling of 5.7 kilos of e-waste per year, easily meeting the EU-target. However, there are indications that more e-waste is generated per citizen per year. In comparison: Norway, Sweden and Switzerland collect 13.4 kilos, 12.2 kilos and 11.4 kilos respectively per citizen per year.

### 1.2. Assignment

In the light of this the White goods, Brown goods, Metalektro Recycling, LightRec, Removal Electrical Appliances, Central Recycling Ventilators and - finally – the IT-Environment foundations (hereafter referred to as the foundations) have commissioned Witteveen+Bos to map the Dutch situation with respect to household e-waste<sup>2</sup>. In order to achieve this, the following questions have been studied:

- a) How much household e-waste is generated in the Netherlands in total each year?
- b) Where any redundant appliances are collected and recycled, which are not currently included in the collection structure of the foundations (so-called complementary e-waste streams, which are not included in the collective waste registration of the foundations). Which product categories does it concern and what is the annual amount, divided into product categories?
- c) Which mechanisms and organisations/persons can give rise to the complementary streams?

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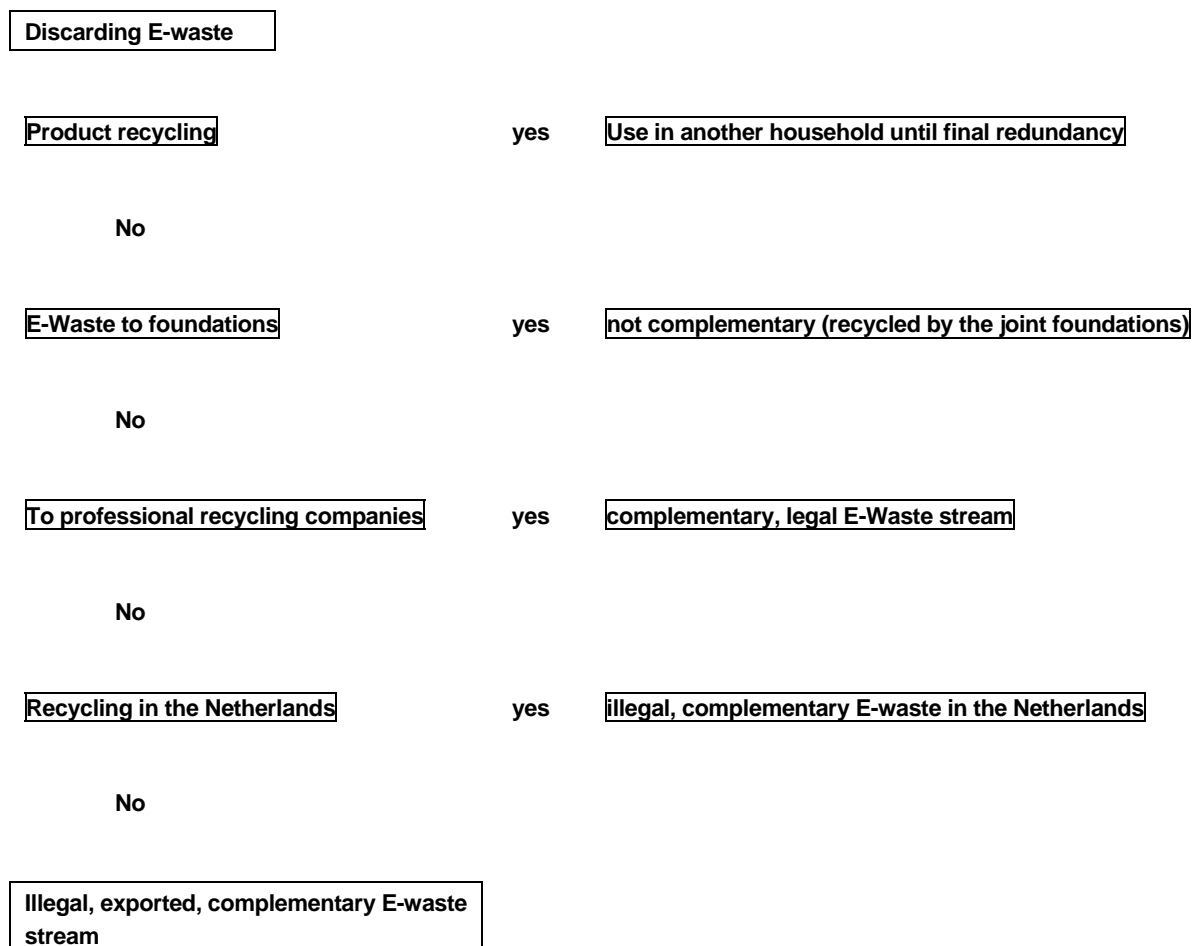
<sup>2</sup>

Appendix 1A and 1B of the WEEE-Directive indicates the scope of the regulation. It concerns 10 product categories, including approx 110 separate products. For this study, most of the WEEE-Directive product categories apply for the foundations. With the exception of the product categories 'Medical aids', 'Measurement- and control-equipment' and 'Vending machines' (for money, drinks, bottles, food).

### 1.3. Research scope

The following picture illustrates the scope of the research graphically. The research does not cover further information on the illegal streams.

**Image 1.1. Research scope**



### 1.4. Bookmarks

The report is built up as follows:

Chapter 2 describes the current collection structure as organised by the foundations. Chapter 3 describes the research setup. Chapter 4 explains the results.

An additional management summary has been added to the report.

## 2. DESCRIPTION OF THE COLLECTION STRUCTURE FOR E-WASTE

### 2.1. Introduction

The separate collection and recycling of e-waste is the result of the European laws concerning product responsibility, the EU-guideline 2002/96/EG (WEEE-Directive). In the table below, the categories in appendix 1A of the WEEE-Directive are listed; these categories are further specified by subcategories in appendix 1B of the Directive to include approx 110 different appliances (see appendix I of the separate appendix report).

#### **WEEE-Directive categories electrical and electronic appliances**

1. large household appliances;
2. small household appliances;
3. IT and telecommunication equipment;
4. consumer appliances;
5. lighting appliances;
6. electrical and electronic equipment (except large non-moveable industrial installations);
7. toys, appliances for sports and relaxation;
8. medical aids (except all implanted and infected products);
9. measuring and verifying machines
10. vending machines.

The collection structure organized by the manufacturers is aimed at collecting and recycling the devices in categories 1 up to and including 7, the consumer categories. E-waste is collected and offered through various channels, after which it is eventually sent to various (contracted) recyclers. This is explained further in the following paragraphs.

### 2.2. The collection route

The collection route starts with a consumer who wishes to dispose of an appliance as waste. The consumer has the following options for disposing of the unwanted appliance<sup>3</sup>:

in the shop during a sale, in accordance with the 'old for new' regulation. When a new appliance is bought, the old, similar appliance can be left at the shop where the new appliance is purchased without any extra charge. This 'old for new' regulation also applies to electrical household appliances for which no removal charge is paid; the waste disposal of the municipality. Often there is a location (environmental waste area) available, where e-waste can be taken without charge. Some municipalities also have a collection route for e-waste, sometimes with a charge to cover transport costs.

### 2.3. Transport and sorting circuit

After the consumer has disposed of the appliance, the following outline transport and sorting circuits are available:

- environmental waste area -> Regional Sorting Centre (RSC) -> recycling;
- retail trade -> recycling.

According to the records of the NVMP and IT-Environment, approx. 85% of e-waste is forwarded to the foundations through the first circuit, this is further explained in chapter 3. The second circuit takes care of 14% of the e-waste that is collected and recycled within the system.

<sup>3</sup> Apart from the possibilities indicated, appliances are often left at recycling companies. This is the case for appliances which are not broken and are still usable and have not entered the circuits mentioned in this research. The recycling companies sell these appliances to second hand companies, unless the appliances are no longer suitable for use.

The remainder (1 %) enters the collection structure of NVMP and IT~Environment through other ways, for example special collection drives at schools. This is not specified further.

### 2.3.1. Circuit 'environmental disposal area – RSC\* - recycling'

There are 443 municipalities in the Netherlands (source VNG) that have environmental waste areas. These environmental waste areas are operated by the municipalities or by third parties on behalf of the municipality. The citizens can leave oversized refuse which almost always includes e-waste. At the environmental waste areas, the e-waste is collected in walk-in containers without windows. Normally, two containers are needed per area to manage the e-waste in an orderly fashion. Larger appliances, such as washing machines, are stacked in one of the containers. Smaller appliances are pre-sorted into pallet boxes, the full pallet boxes are then placed in the second container by using a hand truck. Full containers are removed, by various transport companies, to one of the 17 RSC locations in the Netherlands. See the table below for all the RSC locations:

**Table 2.1. Locations of Regional Sorting Centres Netherlands**

Oudehaske	Schiedam (2 locations)	Tilburg	Nijmegen
Vijfhuizen	Rotterdam	Breda	Venlo
Amsterdam	Dordrecht	Bergen op Zoom	Weert
's-Gravenland	Den Bosch	Goes	Kerkrade

Generally, a RSC operates as follows:

- full containers from municipalities are weighed, at the RSC or at another site, when the RSC does not have a weighing bridge;
- these full containers are emptied at the RSC, partly by hand and partly with the use of a fork-lift truck;
- it is then sorted and placed in other containers;
- the sorted containers are transported to the contracted recycling companies.

### 2.3.2. Circuit 'retail trade - recycling'

A shop has the follow options for disposing of used electrical household appliances (obtained through the 'old for new' regulation):

- at the municipality's environmental waste area; in quantities of a maximum of 7 items per visit;
- at a RSC; large quantities of e-waste can be sorted directly here, as is done for the e-waste from the environmental waste areas;
- chain stores with a distribution centre (DC) can transport used appliances, via the return logistics, to the distribution centre. The DC can then send the e-waste to the final recycling company;
- using a collection service of the NVMP foundation or a collection service of the IT~Environment foundation, whereby the appliances are collected from the shop, following a specific collection structure.

### 2.3.3. Recycling

NVMP and IT~Environment have entered into contracts with selected recycling companies for the collection and recycling system. These contract partners are introduced below.

#### Coolrec

Coolrec is a 100% subsidiary of the Van Gansewinkel organisation. Coolrec has two sites in the Netherlands. In Eindhoven and Dordrecht refrigerators, freezers, professional refrigerators and TV-screens and computer monitors are recycled.

#### Sims Mirec

Sims Mirec is part of Sims Recycling Solutions. There are two sites available in the Netherlands: Sims Recycling Solutions in Eindhoven and Mirec BV in Echt (cathode ray tube recycling).

**Recydur**

Recydur is a Dutch recycling company specialized in recycling used electrical and electronic appliances. Recydur is an independent company and has a recycling site in Apeldoorn.

**HKS Metals**

HKS Metals has sites in Amersfoort, Amsterdam, Eindhoven, Hengelo, and Zwartsluis. HKS Metals annually recycles more than 1 million tons of ferrous scrap and 100,000 tons of non-ferrous scrap.

**De Ruiter Schroot**

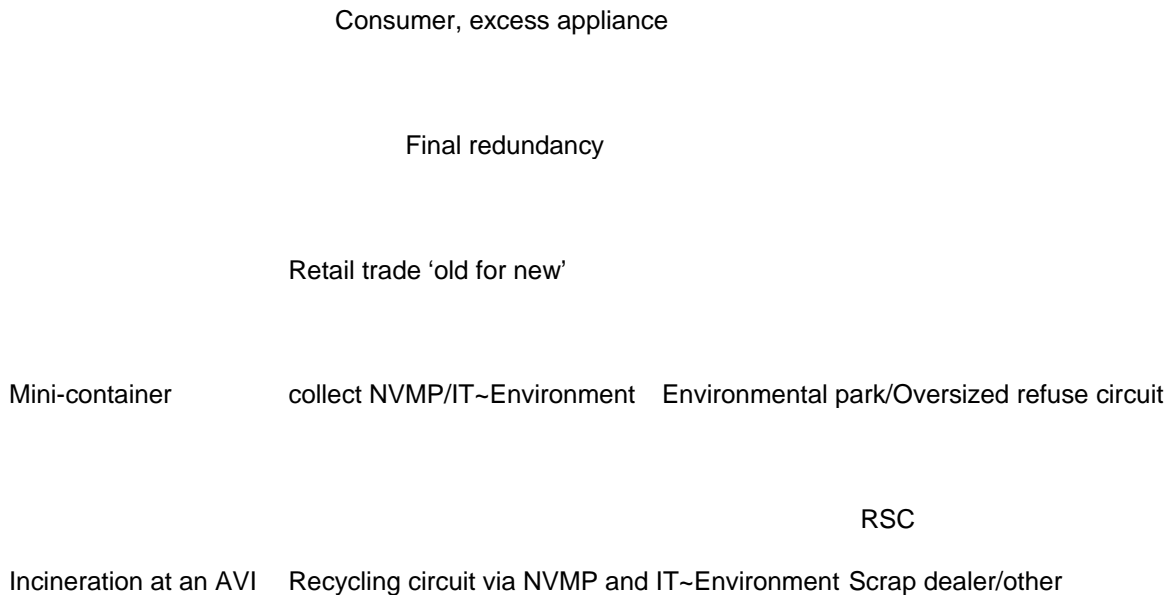
Ruiter Schroot has been contracted to recycle large white goods. De Ruiter Schroot is part of van Dalen Metals, Recycling & Trading. Together they have several sites.

### 3. RESEARCH JUSTIFICATION

#### 3.1. Defining the problem

With respect to the amount of e-waste collected in the Netherlands, we only know how much is recycled through the collection structure organized by the NVMP and IT~Environment. In order to estimate the volume of any complementary streams, the diagram below was used. The dotted lines indicate potential complementary circuits.

**Image 3.1: Diagram for the research design for complementary streams of e-waste**



The diagram is explained further below. It was then determined in which way the missing data could be collected to give a total overview of the amounts of e-waste, including the complementary streams.

#### **Consumer and complementary streams**

The consumer determines the amount and the content of the e-waste by what he or she buys and what he or she throws away. It is very important for the present research into complementary e-waste streams to have an indication of the total amount of the e-waste generated by households. Furthermore, the consumer determines a number of complementary streams when the e-waste is disposed of by way of the mini container or by selling it to a scrap dealer.

In addition, the division within the product categories is important because some product categories still generate money as e-waste, especially metal e-waste. It is presumed that a complementary stream is more likely to arise when the e-waste has value compared to when the e-waste is considered to be useless.

## **Recycling circuit NVMP and IT-Environment**

The records of the NVMP and the IT-Environment show the quantities for the product groups large white appliances, refrigerators and freezers (KV), televisions (TV), other white and brown appliances and IT. It also shows that 85% of the total amount of collected and recycled e-waste is disposed of by way of the environmental waste areas. An additional 10% is collected by the retail trade by a collection network and approximately 4% is collected at the distribution centres (return logistics from chain stores). The remainder is limited in size and is divided into various channels.

### **environmental waste areas and complementary streams**

Much of the e-waste is disposed of at environmental waste areas, which is why it is important to discover whether e-waste is disposed of through other channels than the collection systems of the NVMP and IT-Environment. As indicated in image 3.1, the most important option is the disposal of metal e-waste to a scrap dealer, for example by using an iron container.

In principle, image 3.1 should also show the e-waste stream for the RSC sites, recycling companies and second hand shops, where e-waste could potentially be received from households when it is no longer suitable for use. Research has shown that these streams are very limited; these streams have not been included in the diagram because it would complicate it unnecessarily.

### **Retail business and complementary streams**

A rounded off percentage of 14 % of the total amount of registered e-waste is collected through the retail business, as part of the 'old for new' regulation. Also here, it is important to investigate whether certain e-waste streams are going through other channels than the structure that was set up for this purpose. Not much is known of the size and the content of these potential complementary streams.

## **3.2. Applied research methods**

Based on image 3.1 and the explanatory statement, the scope of the questions covered the following issues:

- a) how much e-waste is disposed of per year and what does it consist of?
- b) do complementary e-waste streams originate from consumers and if so, what is the volume?
- c) do complementary e-waste streams originate from environmental waste areas and if so, what is the volume?
- d) Do complementary e-waste streams originate at retail businesses and if so, what is the volume?

In order to be able to answer these questions we investigated what information is available and usable. The actual research is aimed at the unknown remainder. Additional interviews have clarified the situation. See more information below.

### **3.2.1. Method for determining the total content e-waste**

In order to estimate the amount of e-waste generated by all the households and to determine the potential complementary streams at source (the consumer) it is important to get insight into:

- a) the number of appliances owned per household, divided into the separate products for the product categories 1 to 7 in the WEEE-Directive, also known as white goods, brown goods and grey goods (IT);
- b) the ways the products are disposed of;
- c) the weight per appliance;
- d) the average life span per appliance.

The data available for answering these questions is given below:

### **Measurement of possession and way of disposal**

To answer the first two questions, the measurement of possessions, carried out by GfK Panel Services Benelux in 2007, was used. This research was based on a large sample survey. The sample survey was n=6136 for white goods appliances, n=5780 for brown goods appliances and n=5780 for grey goods appliances. As an extra quality control, GfK visited a couple of hundred households personally, after the online and written survey was completed, to determine whether all the appliances were registered correctly and to see whether any appliances were forgotten. The information from the face-to-face check was used to correct the results of the online and offline measurements, where necessary. For heavy appliances such as washing machines, televisions and such, plus most of the smaller appliances, possession was determined per household. Additionally, it was determined in which way appliances are disposed of, partly on the appliance level and partly on the appliance group level.

### **weight and life span**

In the GfK Panel Services Benelux report, the lifespan of the appliances, which are disposed of, was determined. The GfK research made the following distinction:

- disposal with intent of final removal;
- disposal with intent of second life (with second consumer, for example by giving it to another household or by disposing it at a recycling company).

With respect to the re-use part, which means the life span is extended, the second owner will use the appliance for some time, after which it will be disposed of definitely. Witteveen+Bos have made a correction on the GfK data, in order to determine the average life span per appliance. This average life span was verified within the advisory group.

Concerning the average weight per appliance, various sources have been used: the records of the NVMP and IT~Environment, wherein an average weight has been determined per product category; the report of the United Nations University (UNU)<sup>5</sup>, in which the average weight is given for a number of products; the appendix of weights taken from the GfK questionnaire; a weight analysis carried out by UK CEED and the European Recycling Platform<sup>6</sup>.

By using these sources, it is possible to provide a weight for approx 70% of the appliances. The remainder, approx 30 mainly smaller, light appliances, such as battery drilling machines, was looked up on Google, to obtain the weight of the particular appliance, as indicated by the manufacturer.

### **3.2.2. Research on the complementary e-waste streams from environmental disposal areas**

The available data from the NVMP and IT~Environment records does not provide insight into the actual supply per product category per environmental waste area. The RSC only weighs products in a container, without further specification of the individual product categories concerned, per environmental waste area. Then – after the sorting process at the RSC has been completed – the products are weighed

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<sup>4</sup> Possession, disposal and obtaining white goods, brown goods and grey goods, *Dongen*, October 2007

<sup>5</sup> 2008 Review of Directive 2002/96 on Waste Electrical and Electronic Equipment, 5 August 2007

<sup>6</sup> Arisings, Collection and Handling of Waste Electrical and Electronic Equipment in Peterborough, 2004

for the following categories large white appliances, KV, TV, other white and brown appliances and IT, whereby the totals per category represent the total for all the municipalities delivering to that particular RSC.

This is why the records from the RSC are not useful for determining where complementary streams originate, when certain categories are not available. In order to find out which method is actually being used, research in the field was carried out at 36 environmental waste areas and recycling companies. The WEEE product list was used as a base. By carrying out interviews and observations on site, it was recorded how appliances such as washing machines, IT appliances, refrigerators, televisions and similar appliances are recycled. Finally, the relevant RSC sites were visited to see whether part of the e-waste was being traded from the RSC sites. It became clear that this does not occur.

Concerning the sites visited, we must state that this also included co-operations representing a number of environmental waste areas. Often this concerned regional operational governmental companies, with possibly a linked recycling company. The areas investigated are in the South-East Netherlands, Central Netherlands and the North-East Netherlands. The total service area, covered by the organisations investigated, amounts to 4 million citizens, approximately 25% of the total Dutch population.

The collection results from the areas researched are consistent with the average collection results as registered by SenterNovem (in 2005):

**Table 3.1. E-waste from collections at municipalities in 2005 (kilos/inhabitant/year)**

Province	kilos per inhabitant	province	kilos per citizen
Drenthe	4.4	Noord-Brabant	4.6
Flevoland	4.9	Noord-Holland	4.2
Friesland	4.7	Overijssel	3.8
Gelderland	4.6	Utrecht	4.3
Groningen	4.7	Zeeland	6.2
Limburg	4.6	Zuid-Holland	4.0
<b>Average per citizen</b>			<b>4.4</b>

The overview per province shows that the amounts of e-waste per citizen per province are very similar. Only Zeeland deviates markedly, with an average 6.2 kilos per citizen per year (in 2005). It is therefore concluded that a sufficiently accurate indication can be given for the Netherlands, based on the sample survey researched.

### 3.2.3. Research into complementary e-waste streams from the retail trade

The initial investigation into the subject of potential complementary e-waste streams from retail businesses included a meeting with the Inspectorate of the Department of Housing, Regional Development and the Environment concerning their research into discarded electrical and electronic appliances. It became apparent that discovering data would be difficult. For this reason, this part of the research has been carried out based on a broad questionnaire by phone. Apart from questions regarding the product categories sold, whether appliances are returned and where they are stored, it also included questions on service improvement.

Every 10<sup>th</sup> company from the NVMP administration has been placed in a separate database and handed over to Witteveen+Bos. Some of the addresses could not be used, for example because the company no longer existed. Before the telephone questionnaire was carried out, an announcement letter was sent to approximately 1,100 companies. Should they not wish to take part

<sup>7</sup> The department of Housing, Regional Development and the Environment- *Inspectie, Het beeld verhelderd, Handhavingsactie 2006 op de export van afgedankte elektrische en elektronische apparaten*, Eindhoven 8 March 2007.

in this research, the option was available of being removed from the call sheet. Further, companies were removed where the letters could not be delivered. Finally 1,011 companies were rung and 164 companies took part in the questionnaire.

#### **3.2.4. Other sources of information**

Apart from discussions with the advisory group, wherein all foundations were represented, which has extensive knowledge on the present subject, additional information was obtained from:

- the Inspectorate of the Department of Housing, Regional Development and the Environment;
- de Nederlandse Vereniging voor afval- en reinigingsmanagement *Dutch Association for waste and Cleaning management* (NVRD);
- the National Research Information Service;
- the department of Housing, Regional Development and the Environment Intelligence and Investigation service;
- The contracted final recycling companies;
- A few scrap dealers, not contracted;
- Dealers in broken appliances (through Markplaats.nl);
- Distribution centres connected with large chain stores and kitchen suppliers.

## 4. RESULTS

This chapter initially covers the overall impressions. Thereafter, the estimate for the total amount of household e-waste in the Netherlands, and finally the volume of the complementary streams and the locations where they originate, is estimated per product category. For easy reading, most of the quantities have been converted into kilos per citizen per year. The conversion factor of 16,400 tons of e-waste total per citizen was used (based on 16.4 million citizens; source CBS-Statline 2007).

### 4.1. General findings

#### 4.1.1. Environmental waste areas

Most of the visits were made after making an appointment by phone (approx 2/3); the remaining visits to environmental waste areas were carried out unannounced. 85% of the e-waste collected by the NVMP and IT~Environment is collected at environmental waste areas. The table below shows the total amount of e-waste collected at environmental waste areas and registered by the NVMP and IT~Environment, divided into the separate categories:

**Table 4.1. Collection results at the environmental waste areas**

Environmental waste areas through RSC locations (results 2007)	IT-app.	LARGE WHITE APPLIANCES	KV	OTHER WHITE AND BROWN APPLIANCES	TV	total
total collection (kilos)	20,565,625	9,242,903	19,523,895	18,123,401	12,410,412	79,866,236
kilos/ citizen/year	1.3	0.6	1.2	1.1	0.8	4.9

It is striking that the amount of large white appliances collected lags when compared to the result for the collection of refrigerators (KV). You would expect to see more kilos, as large white appliances are heavier than refrigerators. This last point is made clearer in paragraph 4.2, where the total amount of e-waste generated is divided into product categories.

The separate report in appendix II presents the results of the field research, where a conversion has also been applied, relating to the size of the service area. The results are summarized as follows:

Of the easily traded, large white appliances (washing machines and tumble driers), 58% is disposed of at the environmental waste areas through the (local) scrap dealer and the other 42 % at the RSC; compared to the number of citizens, it is apparent that 65 % of the large white appliances are disposed of through scrap dealers and 35 % via the RSC;

Concerning other white and brown appliances, 17% is disposed of at environmental waste areas to scrap dealers. Compared to the number of citizens, this concerns 23% of the other white and brown appliances; unexpectedly it was found that 24% of IT-appliances are not disposed of at the RSC sites and in those cases external channels were used. For example, the casing is taken apart and sorted per part and is then sold as valuable metal;

In relation to the service area, it became evident that 57% of the IT and telecom appliances that are discarded are sent to the RSC and 43% goes through alternative channels. In other words, when an alternative route is chosen, this occurs at the large environmental waste areas and/or within regional co-operations for environmental waste areas;

- at many environmental waste areas, cables are cut off for security reasons, this is often done at the request of the RSC. These cables are then sold separately, mainly by the environmental waste areas (value for buyer) and are not offered to NVMP and IT~Environment; environmentally damaging e-waste (refrigerators, televisions, monitors, energy saving bulbs, TL-light bulbs) are almost always disposed of through the NVMP and IT~Environment route. The most important reason for this is that the municipalities should set an example.

The most important reasons for not disposing of valuable e-waste via the NVMP and IT~Environment are financial reasons. The municipalities indicate that handling costs are incurred while these are not invoiced. Especially with regards to large white appliances, they feel that these can be recycled in an environmentally friendly way by scrap dealers. By disposing of large white appliances in this way, a source of income is generated, which means the waste tax could be lowered (this is limited). The same consideration can be made for IT. With IT, it is important to have enough volume, which means that this working method hardly occurs at all at small environmental waste areas. Finally, there is also the discussion concerning payment, between the NVRD (on behalf of the municipalities) on the one hand and the foundations on the other hand. At some sites no valuable e-waste is offered to the foundations, instead an alternative source of income is generated.

#### **4.1.2. Recycling companies**

The total complementary e-waste stream is relatively low in comparison to the complementary stream from the environmental waste areas; this will be explained in paragraph 4.3. An important reason for this is that relatively little e-waste reaches the recycling companies because they try to prevent it, which means that only a little e-waste can be moved as a complementary stream.

Recycling companies, as well as second hand shops, give an opportunity for appliances to have a new life and result in a life span extension. This is not possible for all appliances. The important question remains, what proportion of the appliances intended for reuse need to be removed on consideration and become e-waste. There are not any hard figures for this in the research. Field research, and the interviews at recycling companies, did show that they are not keen on appliances that do not work. Unusable appliances take up space, staff need to spend more time on them (pick up, loading it in the shop, check, disposal), resulting in considerable costs. These costs are not or not sufficiently covered when the appliances turn out to be useless and need to be disposed of as e-waste.

Many recycling companies, for this reason, apply a pre-selection by phone, asking about the appliance being offered and whether it still works. Unusable appliances are most often not accepted, they then refer, for example, to an environmental waste area for disposal of the appliance. Furthermore, it is also possible that appliances are offered directly at the recycling company. Also then, a selection takes place, but even so, it is impossible to guarantee to 100% that all the appliances accepted are usable for sale. Based on this consideration, it is thought that 80% of the appliances destined for 're-use' are actually used again and so will be thrown away after a life span extension at the second consumer.

The actual e-waste (the appliances that are not longer usable) is mainly transported to the (local) scrap dealer, if it contains metal. IT is taken apart when there are enough personnel available to dismantle it. Financial arguments are the main reason that e-waste containing metals do not reach the NVMP and IT~Environment. Toxic e-waste (monitors, refrigerators) is generally taken to the local environmental waste area and then to the RSC site, it is rarely directly transported to the NVMP and IT~Environment. The main reason for this is that recycling companies are opposed to e-waste causing damage to the environment.

#### **4.1.3. Retail trade**

The following table shows the registered collection results for e-waste from retail trade, which was forwarded to NVMP and IT~Environment, divided into the separate categories:

**Table 4.2. Collection result at the retail trade**

Retail trade (results 2007)	IT-app.	LARGE WHITE APPLIANCES	KV	OWEG	TV	total
total collection (kilos)	265,000	4,047,240	5,144,848	959,220	1,936,278	12,352,586
kilos/citizen/year	0.02	0.2	0.3	0.1	0.1	0.8

14% of the registered e-waste comes via the retail trade, where appliances were collected as part of the 'old for new regulation', collected by a collection network or through retail distribution centres (return logistics). Considering that e-waste is received, complementary e-waste streams could occur. The first indication that complementary streams exist, becomes clear from the results for the collection of large white appliances, refrigerators and freezers. The number of large white appliances collected is below the result for refrigerators and freezers.

It was asked in the Witteveen+Bos questionnaire which product categories were sold. The next question was whether appliances were received and if so, where they were located. We also asked if they could provide an indication of the percentage of appliances that are returned when a new appliance is purchased. The primary results are indicated in the table below.

**Table 4.3. Questionnaire results product categories retail trade**

Product categories	Large white appliances	KV	TV	IT	Other white and brown appliances
Return percentage for appliances 'old for new' regulation	54	50	64	24	32
<b>Disposal of E-Waste received</b>	<b>Large white appliances</b>	<b>KV</b>	<b>TV</b>	<b>IT</b>	<b>Other white and brown appliances</b>
<b>Through disposal channel (%)</b>					
1 environmental waste area/collection municipality	38	32	35	10	31
2 collection NVMP/IT~Environment	50	65	58	40	61
3 repair & sale	2	0	4	0	6
4 sale dealers	2	0	0	20	0
5 return stream DC	4	0	0	0	0
6 container refuse	2	3	4	10	0
7 container old metal	4	0	0	20	2
<b>total percentage</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

These results show that the questionnaire is not representative of the retail trade as a whole. The results indicate that 50% is recycled through the collection structure of NVMP and IT~Environment and that approx. 30% are disposed of at environmental waste areas or is collected by the municipality. Moreover, half of the e-waste is received when new appliances are delivered. However, based on these figures, the total volume of e-waste collected via the retail trade by NVMP and IT~Environment should be double the registered result for collection. This deviation, and the volume, is too great for any conclusions to be based on the questionnaire's results.

Two reasons can be named for why we can conclude that the questionnaire does not give a true picture of the retail trade as a whole:

- because the questionnaire was set up as a service questionnaire (the reasoning being that better quality research results could be achieved), only companies took part that frequently receive appliances in return and often use the structure for this purpose i.e. companies which benefit from the collection system;
- a relative high number of independent, smaller companies participated in the random check. This influences the result, based on the consideration that larger chain stores are able to dispose of large volumes of (metal) e-waste through other channels

By carrying out an additional, targeted questionnaire by phone with the larger chain stores we hoped to gain a better picture of the volume of e-waste generated and any complementary streams. Unfortunately, it was impossible to collect enough accurate data. However, by using an alternative method we were able to estimate the complementary streams from the retail trade. This also is explained further in paragraph 4.3. We will first explain the determination of the household e-waste generated in the Netherlands.

#### 4.2. Volume of household e-waste in the Netherlands

A recent and extensive study by the United Nations University (UNU)<sup>8</sup> indicates that 21 kilos EEA (electronic and electronic appliances) is bought per citizen per year within the EU27 member states. Because the new member states are rapidly increasing their quantities, it is expected that the quantity of discarded e-waste will be lower than 21 kilos. In this UNU-study, it was estimated between 16 up to a maximum of 18 kilos of e-waste would be generated. This study also investigated various final recycling scenarios of environmental relevance. It is possible that the Netherlands generates a differing quantity of e-waste.

As indicated in paragraph 3.2.1, the most important data for determining the amount of e-waste generated per year was obtained from the measurement of possessions research by GfK Panel Services Benelux in Dongen. An estimate has been made of the amount of e-waste generated per year in the Netherlands, based on the average possession per household, the average weight per appliance and the estimated life span (including 'second use') per appliance. In appendix 3 of the separate appended report, the calculation is presented at the appliance level. The results are summarized below per product category.

**Table 4.4. Amount of e-waste generated, divided into the product categories**

	<b>estimated tonnage per year</b>	<b>per citizen (kilos/year)</b>
1 A large (metal) household appliances	13128	8.0
1 B large household refrigerators/freezers	29941	1.8
2 small household appliances	18948	1.2
3 A IT and telecommunication appliances	11849	0.7
3 B personal computer use	32330	2.0
4 consumer appliances	63341	3.9
5 lighting appliances	1432	0.1
6 electronic and electronic equipment	11802	0.7
7 toys relaxation and sports equipment	3208	0.2
<b>total</b>	<b>304139</b>	<b>18.5</b>

The table shows that the amount of refrigerators and freezers is lower than the amount of large white appliances, while the opposite is shown from the results from the recorded collections. This is an important indicator for the presence of complementary streams and agrees with the belief that large white appliances are recycled through separate channels because this generates revenue.

The accuracy of the aforementioned estimate depends on the spread of the average weights per appliance, the estimated life span (including second life) and the number of appliances being used per household. For the 'average weight' section, the aforementioned English study analyzed the weight deviation (spread) per appliance. The result showed that the average deviation per appliance amounts to 30%. The total weight deviation, over all products concerned, will be considerably lower, but it is evident that there will be some deviation. Taking into consideration the inaccuracy in the possession measurements and the estimated life span, an uncertainty margin of approx 15% should be taken into account.

<sup>8</sup> 2008 Review of Directive 2002/96 on Waste Electrical and Electronic Equipment, 5 August 2007

<sup>9</sup> Arisings, Collection and Handling of Waste Electrical and Electronic Equipment in Peterborough, 2004

Taking into account the uncertainties, the actual amount of generated e-waste from households in the Netherlands will be between 16 and 21 kilos per citizen per year. Calculations in the remainder of the report will be based on 18.5 kilos per citizen per year, this is the average and the best estimate that can be made based on the available data.

### 4.3. Determining the complementary streams

There is a lot of fragmented data available. A method based on a mass balance is a suitable way to use the fragmented data to achieve a picture that is as complete as possible. By using a mass balance, it is also possible to estimate unknown streams, because they are often related to known streams. Step by step, this approach and division is explained. It is based on the following tables, where on the one hand the collection results from the foundations are given (left) and on the other hand the estimated generated e-waste from the households (right); in the columns in between are the complementary streams that are to be determined, this is explained in chapter 3, in diagram 3.1.

#### 4.3.1. Distribution step 1

The table below is the first step, where product categories 2 and 4 have been placed underneath each other for clarity. These categories together, including categories 6 and 7, form the category other white and brown appliances plus TV within the NVMP administration. All the quantities are in kilograms per citizen per year. When the quantities are presented to two decimal places, this not to show high accuracy but because the quantity is so low that it would disappear if it was rounded off. The middle section of the table is not yet known (column 3-6), and the second column is not yet explained. The outer section (column 7) is explained in the next paragraph. We start with the information available.

**Table 4.5. First distribution step e-waste (in kilos/citizen/year)**

Product categories	collection foundations	environmental waste area complement.	recycling/ engineering contractors	mini-container	retail trade & uncertainties	E-waste (total)
1 A large household appliances		0.82				8.00
1 B household fridge/freezer						1.8
3 A. IT and telecom		<i>in 3b</i>				
3 B. personal computer use		1.25				2.7
5. lighting (energy saving lamp)		0.02				0.1
2. small household appliances		<i>in 4</i>				
4. consumer appliances		1.73				5.1
6. electrical equipment		0.35				0.7
7. toys, sports, relaxation		0.02				0.2
<b>total</b>		<b>5.7</b>		<b>2.0</b>		<b>18.5</b>

Below, column 2 (collection foundations) and column 5 (mini-container) are discussed further by using the additional information.

#### Column 2, collection foundations

The collection result achieved in 2007 by the foundations is indicated in column 2. The data for the foundations has been adjusted because the administrative categories deviate from the product categories in the WEEE-Directive. The product categories 3A and 3B have been combined for administrative reasons. Since the records of the IT-Environment places these products in one category, we have done the same. Furthermore, product categories 2 and 4 have been combined, so as to be able to make comparisons with the NVMP category, other white and brown appliances and TV. The NVMP has carried out a sorting analysis on other white and brown appliances

in order to obtain a division into the product categories 'equipment' and 'toys'. In total 2.1 kilos is collected (other white and brown appliances and TV), which is divided between the lower 4 rows belonging to column 2.

### Column 5, mini-container

Consumers have the possibility to take smaller appliances to a mini-container. During the field research, it was asked whether there were any recent sorting analyses, apart from data obtained from the internet. Various municipalities provided data, which had been drawn up by various research bureaus<sup>10</sup>. These show that the amount of e-waste from households is limited and amounts to 0.8% on average. In the Netherlands, this would be equal to approx. 2 kilograms per citizen per year. We would like to point out that it is mainly smaller appliances that are disposed of in this way.

### 4.3.2. Distribution step 2

In the last step, some data is already entered, which means that the other data can now be filled in. This concerns columns 3 and 4, included in table 4.6.

**Table 4.6. Second distributions step e-waste**

Product categories	Collection	environmental	Recycling/	mini-	retail trade &	e-waste
	foundations	waste area complement.	engineering contractors	container	uncertainties	
1 a. large household appliances	0.82	1.25	3.30			8.0
1b. household fridge/freezer	1.55	-	-			1.8
3a. IT and telecom	<i>in 3b</i>	-	-			
3b. personal computer use	1.25	0.95	-			2.7
5. lighting (energy saving lamps)	0.02	-	-			0.1
2. small household appliances	<i>in 4</i>	-	-			
4. consumer appliances	1.73	0.30	0.30			5.1
6. electrical equipment	0.35	-	-			0.7
7. toys, sports, relaxation	0.02	-	-			0.2
<b>Total</b>	5.7	2.5	3.6	2.0		18.5

Below, the figures in columns 3 and 4 are explained.

### Column 3, complementary streams from the environmental waste area

Complementary streams are found for large white appliances, IT and other white and brown appliances, as explained in general terms in paragraph 4.1.1. This is based on the detailed data from appendix II of the separate enclosed report. The field research has shown which complementary streams exist and the percentage. As a result, the amount offered to the NVMP and IT-Environment is known. The percentages for the complementary streams for IT, large white appliances and other white and brown appliances are 43%, 65% and 23 respectively %. The ratio between the streams, multiplied by the actual waste registered shows the size of this complementary stream<sup>11</sup>.

A correction has been applied to other white and brown appliances, with regards to relatively heavy TV sets that are correctly brought to the NVMP. If they were included in this calculation, it would result in an overestimation of the complementary stream. For this reason, televisions have been excluded from the calculation for the complementary stream for other white and brown appliances. The calculated complementary stream for other white and brown appliances is relatively small (0.3 kilos), the calculated complementary stream for large white appliances, as may be expected, is significantly higher and amounts to 1.25 kilos.

<sup>10</sup> Bureau Milieu & Werk BV in Tilburg, Syncera, Eureco BV, CREM BV Amsterdam, SenterNovem

<sup>11</sup> A calculation example to clarify: 57% of IT appliances are offered to IT-Environment and 43% are disposed of through other channels. The ratio amounts to  $43/57 = 0.75$ . The complementary IT-stream amounts to  $0.75 \times 1.25$  kilos (the actual collection) = 0.95 kilos.

#### Column 4, complementary stream for recycling and engineering contractors

A significant complementary stream involves central heating boilers and electrical boilers, which are part of large white appliances, according to the WEEE-Directive. The possession measurement estimated how many central heating boilers and electrical boilers are disposed of each year, and this has been converted into an annual estimate for the expected amount of e-waste (see product category 1 of appendix III of the appendix report). These appliances represent a great weight, which is why a substantial amount of e-waste is generated, 3 kilos per citizen per year.

Field research has shown that these appliances are rarely offered to an environmental waste area or recycling company. In addition, the quantity at the NVMP is marginal (13,000 kilos in 2007). When they are handed over at an environmental waste area (in rare cases), they are transported to a scrap dealer. These appliances are almost always taken away by engineering contractors when they install new central heating or boilers. We have contacted some of the contracting engineers and they confirmed our impression: central heating boilers and boilers are transported to scrap dealers, where they are partly dismantled to obtain useable parts.

There are then two complementary streams, estimated at 0.3 kilos per citizen per year, from recycling companies and from the consumer. These numbers are less 'hard', but deviations will not be serious because the estimated streams are not large. A part comes from the recycling companies. These are appliances that were intended for sale, but are then disposed of as e-waste. The other part is generated by the consumers. In the GfK questionnaire it was possible to state 'destination unknown'. A part of these appliances could have been offered to a scrap dealer or could have been taken abroad, for example, for use in a second home. When we contacted the scrap dealers they confirmed that this occurs, but that it was very limited. The volume of the stream is determined by a chain analysis, as presented in appendix IV in the appendix report.

#### 4.3.3. Distribution step 3

The missing data has been entered in column 5 and 6 of the table below.

**Table 4.7. Third distribution step e-waste**

Product categories	Collection foundations	Environmental waste area complement.	Recycling/ engineering contractors	Mini-container	Retail trade & uncertainties	e-waste (total)
1 a. large household appliances	0.82	1.25	3.3	-	2.64	8.0
1b. household fridge/freezer	1.55	-	-	-	0.28	1.8
3a. IT and telecom	<i>in 3b</i>	-	-	-	-	-
3b. personal computer use	1.25	0.95	-	0.30	0.19	2.7
5. lighting (energy saving lamps)	0.02	-	-	0.07	-	0.1
2. small household appliances	<i>in 4</i>	-	-	-	-	-
4. consumer appliances	1.73	0.30	0.3	1.11	1.58	5.1
6. electrical equipment	0.35	-	-	0.37	-	0.7
7. toys, sports, relaxation	0.02	-	-	0.18	-	0.2
<b>Total</b>	<b>5.7</b>	<b>2.5</b>	<b>3.6</b>	<b>2.0</b>	<b>4.7</b>	<b>18.5</b>

Columns 5 and 6 are explained below.

#### column 5, complementary stream from the mini-container

The sorting analyses showed that 2.0 kilos are discarded using the mini-container. By using a mass balance, we estimated what the division would look like. We assumed that large appliances could not be discarded by using a mini-container. This rules out product category 1. This leads to the division as indicated in column 5. Deviations within the column are balanced: the total always equals 2.0 kilos.

### **Column 6, retail trade and uncertainties**

Column 6 is the missing piece of the puzzle and has been used to close the gap between the sum of column 2 - 5 and column 7 (e-waste total). In other words, if you deduct column 2 to 5 from column 7, the result is column 6.

There is more uncertainty for the figures in column 6 because it expresses the uncertainty margin concerning the yearly amount of e-waste generated (18.5 kilos). If the total quantity of household e-waste, for example, amounts to 17 kilos, only 3.2 kilos would be generated by chain stores. There is also uncertainty because chain stores, in particular, do not have the data required to make a double check. If the exact quantity of e-waste generated by the chain stores was available, the total amount of e-waste (18.5 kilos) could be estimated more exactly.

However, it is clear from the data from the NVMP and IT~Environment that the amount of large white appliances from chain stores is far below expectation, when this is compared to the quantity of fridge/freezers that is offered. The largest proportion of the 4.7 kilos concerns large white appliances. These appliances are transported to scrap dealers because they still have a value. In addition, a proportion of the other white appliances and IT contains metal and therefore is sent to a scrap dealer. This concerns approx  $\frac{2}{3}$ , which represents 3 kilos that is disposed of in this way