Products in household waste

An exploratory study in the Nordic Countries

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Content

Abbreviations

EEE	Electric and Electronic Equipment
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
GDP	Gross Domestic Product
ISAG	Information System for Waste and Recycling in Denmark
KOSTRA	Kommun-Stat-Rapportering (Municipality-State-Reporting in Norway)
PCB	Printed Circuit Board
WEEE	Waste from Electric and Electronic Equipment

Preface

The idea behind this project emerged from a strong feeling that we need to understand more about why the amount of waste keeps on growing, what products constitute the waste and what this will mean for the future of waste management, as well as, a conviction that only such knowledge would allow us to appreciate how the waste policies and product policies must evolve.

When the opportunity to further investigate what is known and what could be derived from existing data, statistics and general knowledge on the issue arose, a Nordic research team was formed consisting of Environice in Iceland, the National Consumer Research Centre (NCRC) in Finland and the International Institute for Industrial Environmental Economics (IIIEE) at Lund University in Sweden as coordinating body.

The project has given interesting insights in the Nordic waste situation and we believe that the participatory work of a number of workshop experts as well as the report as such will disseminate the findings and serve as platform for further investigations in this area.

We would like to thank the Nordic Council of Ministers for the both the financial contribution and scientific input through the reference group, a number of representatives of the Nordic waste management sector that have provided information, comments and directions, and the participants in the project workshops for valuable contribution of knowledge, comments and review of findings. We are very grateful for your help and patience. Finally, we would like to express our appreciation to our project partners in Finland and Iceland. Thank you all.

Lund in the warm July of 2008

The Authors

Summary

This project on products in Nordic household waste was funded by the Nordic council of Ministers and conducted by the International Institute for Industrial Environmental Economics (IIIEE) at Lund University, Sweden in co-operation with a project team consisting of Environice in Iceland and the National Consumer Research Centre (NCRC) in Finland.

Currently, there is an increase in product throughput in the society; more and more products are produced, bought and consumed. This study was triggered by the question “where do all products consumed in the society end up?” as that kind of information is not provided in the commonly presented waste statistics. Thus, the aim of the study is to contribute to if and how existing statistics and data could be used to describe the waste flow composition on a product level and how (necessary) additional information could be collected. The attention of the study is on utility products, which are discharged in a similar shape as when purchased or as parts thereof. We denote these products as our target products. Typical examples are electrical and electronic equipment, furniture, building materials, toys, kitchen utensils, garden tools, hobby tools, books, etc.

The approaches to find the information included examination of waste statistics and pick analyses, consultations with experts in the areas of consumer research, waste management and statistics, workshops with invited practitioners from the waste management sector and waste accounting, etc.

The waste statistics are predominantly reporting total amounts in relation to sources for the waste generation, type of material collected for recovery or in accordance with final treatment methods, such as combustible and compostable. Of the target products of special interest for this study, it is in general only waste from electrical and electronic equipment (WEEE) that is accounted separately. The examined pick analyses support this structure of reporting, providing very few indications on the target products. Our rough indications point to a 5–20% content of target products in the domestic waste, but the uncertainty is considerable.

It should also be mentioned that most such pick analyses address domestic waste – bulky waste is explored to much less extent. Nonetheless, the available information point in the direction that many discharged products end up in the bulky waste.

A separate analysis of packaging material and WEEE demonstrated that it is possible to keep track of product and material flows as they enter the market as well as when they are collected after use. The return rates were however calculated based on collection and estimates on amounts

put on the market a given year, which is a system that appears to give reasonable figures for non-durable products like packaging, but tend to be more difficult for durable goods like electrical and electronic equipment. For the latter products the Nordic countries also show rapid increases in collected amounts, which could be interpreted as there is a substantial accumulation in the society and that consumers today find it more appropriate to dispose of these products to the dedicated collection systems.

Consumer research and statistics can tell to what extent certain products have proliferated to the households, how much they are used etc., but not much about typical lifetimes of the products, nor to where obsolete products are discarded. Commercial marketing research institutes are able to extract such information through their consumer panels.

Waste accounting systems have been developed (and are still under development) in some countries, primarily in Denmark and Norway, for entire societal waste flows as well as for aggregated product segments. The accounts are based on market input-outputs considering estimated product lifetimes (which experiences from the WEEE area say is a difficult task to establish). The current results indicate that there should be more waste from our target products than the waste statistics give account for. This could be explained by several factors, such as export of second hand products, accumulation, errors in estimations and products ending up outside the common waste collection systems. It was concluded that the waste accounts could be further refined in multiple ways and broken down for specific product groups giving statistics for longer time periods and thus decrease the uncertainties related to products' lifetimes and accumulation.

The overall conclusions from the study is that existing data, statistics and experiences from different sources probably could serve as a proper ground for making fair estimations of where consumed products go and to what extent they make up the household waste.

As a result of the study, we propose the following recommendations:

- Policymakers should consider the links between waste, chemicals and product policies in order to strengthen the information flow and feedback loops from the waste management system back to product designers and producers. This issue is highly topical as waste policies tend to shift towards material separation and collection rather than addressing targeted and often complex products, and how to prevent waste problems.
- Policymakers should meet the need to build better knowledge on the product composition in the current and predicted future waste streams through:
    - Supporting the development and application of refined pick analysis methods including specific product categories and measurement standards for domestic waste.

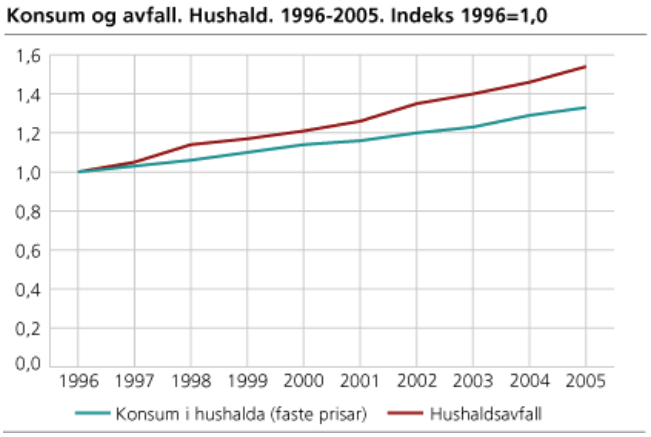
  - Initiating a general approach for mapping and surveying bulky waste. There is a need to develop appropriate analysis methods, supported and complemented by systematic and qualified estimations of the bulky waste composition from practitioners at the recycling centres.
  - There is sufficient Nordic capacity for the development work, but necessary resources for the accomplishment must be allocated.
  - Assigning academia in the sustainable production and consumption area to conduct case studies for selected product categories for better understanding of consumers' purchase and use patterns and product accumulation.
  - Facilitation of further development of waste account approaches.
- Policymakers and IPP expertise should prioritise among the product areas and groups and thus ease the process. The policymaking level has the privilege and duty to initiate the processes both through engagement and allocation of necessary resources.

Introduction

1.1 Background

Despite the proclamations of our countries' commitment to sustainable development during the last decades, we witness an increasing amount of waste being generated in the Nordic countries, as well as in the rest of Europe and beyond. The data figures may vary and there could be a number of causes. In addition, the accuracy of measurements and data is not clear. The trend of increasing waste amounts is, however, a commonly accepted fact. There is also an even more significant increase in the consumption of products of various kinds, as illustrated by the example in Figure 1, the index of Norwegian consumption and waste generation for the period 1996–2005.

Figure 1. Household consumption and waste generation in Norway in 1996–2005.



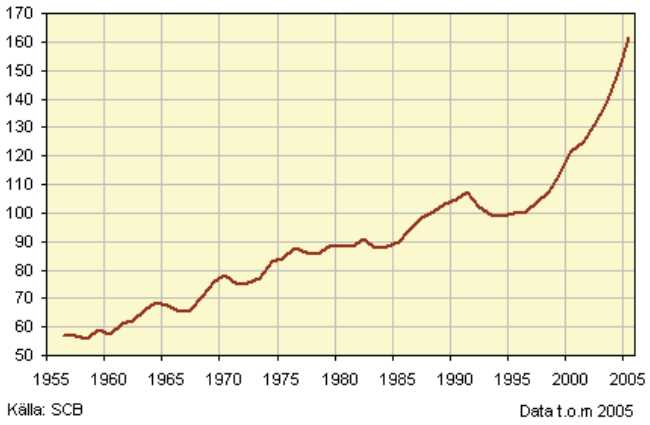
Index 1996=1. Blue line (lower): consumption, Red line (upper): household waste. Source: Statistics Norway.

The Danish waste strategy concludes that the economic growth has a substantial impact for the amounts of waste generated. The more money people have in their hands, the more waste they create.[1] In recent years, the trade has had a steady growth, illustrated in Figure 2 showing the growing turnover of trade and commerce in Sweden from the 1950s until present. New malls for building and garden products, furniture, clothes and confection, electronic goods, white goods, etc. are regularly opening up in the outskirts of our towns and cities. The flow of imported goods and products from low-cost countries is mushrooming.

[1] Regeringen 2003, Affaldsstrategi 2005–2008 *(Danish Government, Waste strategy 2005–2008)*

A relevant question is where all these products end up when used and discarded? Even if some old products are re-used for similar or other purposes, they will all, at some point of time, be discarded as waste. We could expect some kind of accumulation (products in extended use or stored), but eventually they will be rejected and disposed of.

Figure 2. Annual turnover in Swedish retail trade 1957–2006. Index 1995=100.



Source: Statistics Sweden.

Obviously, the discarded products will also be ending up somewhere, but where? The currently available collection systems for source-separated waste are primarily designed for packaging and other homogenous materials. We only have a few exceptions with collections systems dedicated to more complex products, such as for cars and waste electrical and electronic equipment (WEEE). Do all other more or less complex products disappear in the collection system for mixed waste without being especially noted due to the fact that the systems are not built to account for such products? Or do we keep on building up a never before seen stock of products in the houses, and thus a considerable societal environmental debt, while waiting for the saturation of products in the households. Are we already in a wave of wear and tear, where the consumption phase just has begun, while we are still waiting for the "flood to hit us" when the numerous products are to be discarded? If so, do we need to redesign our waste collection systems in order to take better care of the products of the present and future consumption? Is there also a need to more strongly stimulate new producer incentives for designing and marketing more durable and less environmentally harmful products, without hazardous substances, and which are more convenient to separate from the common waste stream, more easily re-used, disassembled and recycled when discarded? Or is the only solution to be found in a radical change of our consumption patterns? The answers to these questions will influence the balance between product and waste policies, and the direction of both.

Frequent measures to address the trend is different extended producer responsibility (EPR) schemes (packaging, cars, batteries, tyres, and waste electronic and electrical equipment (WEEE), etc.) and collection systems for material recovery for different packaging materials, newsprints and organic matter (such as kitchen waste), while we have continued to expand the mass treatment of waste through incineration with energy recovery. That is, we are through the EPR systems and some other policy measures trying to give some signals and incentives to producers for changing the design of products and product systems, but keep on relying on largely traditional waste approaches.

Discussions with experts within the field and representatives of the waste management sector indicate that there is no or very limited knowledge about the composition of household waste in terms of products. When planning for this project, we were typically told by people working with various waste-related issues that the waste amounts have increased considerably and keep on rising, while the composition has remained largely the same. Based on our own experience, rather than any scientific studies, we found the latter difficult to believe. However, continuing our conversations with the various practitioners and experts, we soon realised that when they speak about the waste composition, they refer to the materials in the waste and not the various types of products. This is in line with the fact that there are studies of the waste composition available from the Nordic countries. However, they all give accounts for materials and thus not providing useful answers to many of the above-mentioned questions. Or, maybe the information is already there, but just not compiled to answer our questions?

1.2 Aim and limitations

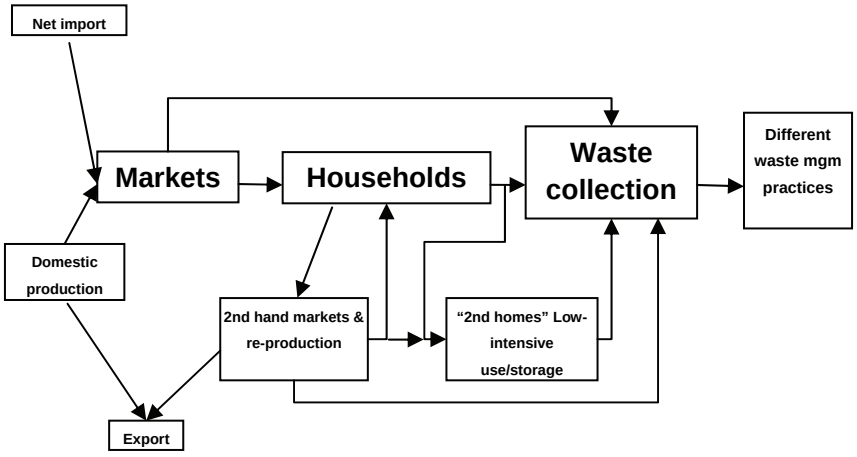
The aim of this study is to search data describing the product composition of household waste, the amounts and trends in the Nordic countries. This implies also to try methods and approaches for finding out rough estimates on the composition, to explore to what extent information could be aggregated, and where the necessary information could be found. The aim of the study is to contribute to the understanding if and how existing statistics and data could be used to describe the waste flow composition on a product level and how (necessary?) additional information could be collected.

In case the data background provides indications of the composition, the information will be reported, but not used for finding the aggregated figures. Thus, this limited first study does not aim to process the possibly existing background information into a full data set directly ready for further analysis.

We have focused the data search on what could be seen as utility products that are discharged in a similar shape as when purchased or at least as parts (as broken). We exclude packaging, newspapers, food and food residues, napkins, tissue paper, foil and similar from our target products, as they are already today to a large extent in the focus of implemented or discussed source separation systems. We will refer to these types of products as "(our) target products" in the following text. The concept of household waste covers in this study both waste[2] collected from or near the households and bulky waste from households. Separately collected garden waste from households is not examined, as no, or only few, target products are expected to end up in this fraction. As is common in the Danish publications[3], we will use the term "domestic waste" to denote the fraction of household waste, which is not bulky waste or separately collected garden waste.

A basic model was developed in order to structure the explorative search for data, statistics and sources of knowledge. The model, portrayed in Figure 3, is not supposed to give the full picture, but should be sufficient for a general analysis. It has further proved to be a good tool for communicating with various informants.

Figure 3. Structure model of the product flux form market to waste.



The Nordic countries have fairly good waste statistics and well-established waste collection and recycling systems and are thus perceived as a suitable choice for the conduct of the study. As a consequence of slightly different approaches and practices in the waste management systems between the countries, it was also expected that we would find somewhat diverse methods, which together may give a more or less appropriate picture of the household waste composition. Hence, it is not a

[2] Including food and other organic wastes, packaging, paper, etc collected in sacks and bins from households by a regular scheme.

[3] The Danish term corresponding to domestic waste is "*dagrenovation*". We have chosen this terminology as we primarily refer to Danish material when we use it.

matter of national comparisons, but rather to exploit and benefit from different conditions and methods for data collection.

1.3 Approach/method

The basic research approach is explorative and multi-dimensional. The approach is also qualitative as the aim is to investigate if and/or how a description of the product composition of the waste flow can be constructed from existing knowledge rather than quantifying the actual material flows. The work procedure was divided into:

- Literature review: extract relevant information from statistics and waste data, primarily pick analyses. This part of the work consisted of information reprocessing and text analysis (i.e. reading between the lines).
- Focused material balance studies for selected product groups: to use a multitude of data sources and estimates to explore to what level reasonable quantities of these product groups in the waste flows could be determined.
- Lessons learned from producer responsibility schemes, with an emphasis on WEEE and packaging materials.
- Consumption of products: could consumer research contribute to the knowledge on the societal input of products (to the market), life/use time of products, and what consumers do with redundant and broken products?
- Waste accounts: follow-up of national waste accounts in Denmark and Norway in order to combine and match data on consumption and waste disposal.
- Workshops and expert interviews: to judge and clarify the potential use and need for information on product composition of household waste and usefulness of any of the identified methods.

The project was conducted by a working group at the International Institute for Industrial Environmental Economics (IIIEE) at Lund University under supervision of Thomas Lindhqvist. In addition, the group included experts from Finland (National Consumer Research Centre (NCRC) – Eva Heiskanen) and from Iceland (Environice – Anne Maria Sparf). They contributed with local contacts and by safeguarding full information from information sources in Finnish and Icelandic. The persons in the project working group and the ones who contributed to the project workshops were:

Project working group

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2 Waste statistics in the Nordic countries

2.1 Introduction

Existing waste statistics is primarily based on pick analyses and measurements of collected waste. The principles are at large the same in all the Nordic countries though approaches and methods may vary in the details, such as sampling and fraction division accounted for. We have noticed, however, a gradual harmonisation in the way to conduct the pick analyses.

The pick analyses have, with a few exceptions, been made on collected mixed household waste. Corresponding studies on bulky waste from households are rare. Despite that, it is, to a certain extent, possible to obtain statistics on received amounts of the different bulky waste fractions – mostly in terms of materials – which, however, does not directly reveal the composition in product terms.

2.2 Denmark

The Danish waste statistics is beyond comparison the most accessible and extensive in the Nordic countries. It appears like the two large programmes for cleaner technology and cleaner products of the Danish EPA have influenced the situation, though waste has been a core issue for many years in Danish environmental policy. Most of the data background described below is extracted from the official waste statistics of 2004 and 2005.[4,5]

The trends in Danish household waste collection by type is summarised in Table 1, indicating that the total amount has increased by more than 30% in the last decade. The annual increases vary, however, between 1 and 10%. The domestic waste has only grown by 3% from 1994 to 2005 but the bulky waste has, on the other hand, increased by about 31% over the same period. Garden waste increased even more but is still smaller in quantities and, which is important in this context, not considered to include any considerable amounts of targeted products. Out of the approximately 3.3 million tonnes of household waste generated in Denmark in 2005, about 1.7 million tonnes was domestic waste and almost 800 000 tonnes bulky waste. Garden waste and others constituted the remaining part.

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[4] Waste statistics 2004, Danish Ministry of the Environment, Environmental Review No 1 2006, Miljøstyrelsen *(Danish EPA)*

[5] Affaldsstatistik 2005 *(Waste statistics 2005)*, Miljøministeriet, Orientering fra Miljøstyrelsen Nr 6 2006, Miljøstyrelsen

The per capita amount of total household waste was 617 kg in 2005, which was 31 kg more than what was generated in 2004 and 58 kg more than in 2003. Out of the total 617 kg household waste that each Dane generated in 2005, the domestic waste part was 316 kg (approx. 50%). The domestic waste fraction include 41 kg of paper, 18 kg of glass and 8 kg of food waste per capita that was collected separately. The bulky waste fraction increased from 118 kg per Dane in 2003 to 146 kg in 2005. The Waste statistics explains the reason to be that people have got more money in their hands, thus replacing a number of products in their homes, remaking or rebuilding the homes, which indicates that targeted products could be an important share of the bulky waste.

Another trend is that more of the waste is sent for incineration despite the fact that more material is separated for recycling. It is in the same publication reported that about 18% of the domestic waste and 12% of the bulky waste was recycled in 2005. Most of the recycled material was glass bottles, paper, ferrous metals and organic garden waste. The same year, 83% of the domestic waste was incinerated and 1% was sent to landfill. Corresponding figures for bulky waste are 52% and 21%. The orders of magnitude have remained for a few years.

Table 1. Waste from households in Denmark 1994–2005 sorted by type ,1000 tonnes. ISAG

Fraction	1994	1996	1998	2000	2002	2004	2005	Increase 1994–2004 (%)
Total Household waste	2 575	2 767	2 796	3 084	3 121	3 164	3 337	30
• Domestic	1 662	1 655	1 702	1 676	1 700	1 692	1 711	3
• Bulky waste	606	639	572	730	655	687	791	31
• Garden waste	286	401	438	519	517	500	563	97
• Other waste *)	21	72	83	158	246	284	272	

Danish Information System for Waste and Recycling, published in Affaldsstatistik 2005 (Waste statistics 2005).

*) Other waste includes separated packaging waste, etc. The figures do not represent the real situation due to insufficient reporting to the Information system for Waste and Recycling ISAG.

Table 2. Waste from households in Denmark 1994–2005 by fraction (tonnes).The amounts of mixed and sorted fractions given to extent registered. Source: ISAG published in Affaldsstatistik 2005 (Waste statistics 2005).

Fraction	1994	1996	1998	2000	2002	2004	2005
Misc. combustible waste	1 797 717	1 800 752	1 775 930	1 985 975	1 956 486	1 959 363	2 039 395
Misc. non-combustible waste	203 430	164 356	146 707	154 482	162 562	150 696	185 538
Paper & cardboard separated for recycling	142 668	160 469	208 486	181 315	204 059	220 739	249 869
Bottles and glass separated for recycling	69 064	64 903	83 033	82 351	110 758	87 599	99 053
Food and organic waste separated for recycling	32 907	45 905	51 926	44 672	37 072	52 805	44 656
Branches, leaves, grass etc separated for recycling	258 574	386 874	408 877	505 113	512 199	495 129	557 268
Hazardous waste	-	16 214	14 395	27 548	19 840	28 130	24 931
Ferrous metal separated for recycling	-	-	11 926	16 768	24 596	25 028	30 225
Other waste	83 456	129 479	94 569	85 362	85 992	144 038	107 133
Total	2 587 816	2 768 952	2 795 849	3 083 586	3 120 564	3 163 527	3 338 068

Note: Tables 1 and 2 are not readily comparable as one concerns waste by fraction and the other by type of waste.

Table 2 provides the figures for household waste generation by fraction for the passed decade (Note that Table 1 and Table 2 are not readily comparable as one concerns waste by fraction and the other by type of waste). There are no leads regarding the target products per se; our assumption is that these products primarily end up in the combustible and non-combustible fractions and in the ferrous metals fraction, consequently, that most of them are likely ending up in the incineration plants.

The national waste plan (Annex D – Sectors)[6] provides some additional breakdowns of fractions of domestic waste for 2001. In total, 1.81 million tonnes of domestic waste including packages was collected that year. Out of that, the municipal collections systems collected about 1.14 million tonnes from all Danish households when recycled paper and source separated packages were excluded. The data was derived from mapping domestic waste from about 2 000 households in different municipalities. The fractions that specifically could consist of targeted products are shown in Table 3.

Table 3. Fractions including target products of the total of 1 141 496 tonnes of domestic waste in 2001 in Denmark.

Fraction	Amount (tonnes)	Relative contribution (%)
Paper, clean and dry	23 456	2.1
Plastics, other	77 865	6.8
Combustible, other	58 887	5.2
Glass, other	3 666	0.3
Metal, other	6 852	0.6
Non-combustible, other	43 410	3.8
Complex products	1 743	0.2
Hazardous waste	1 848	0.3
Total related to products	217 727	19.3

Source: Table derived from Affaldsstrategi 2005–2008, Bilag D Sektorer (Waste strategy 2005–2008, Annex D Sectors).

The result indicates that target products in the domestic waste could be almost 20%. The information about the actual content of the various fractions is insufficient for further analysis.

The result from more in-depth pick analysis study[7] on the composition of domestic waste, which served as background for the above-mentioned aggregated figures, is given in *Table* 4 below. The aim of the study was not to investigate products, but rather amounts and composition from different households (e.g. flats, private houses) collected during one week. Thus, the fractions are not defined based on product content. Some of them, however, give the accounts for specific products, though product content in other fractions cannot be excluded.

[6] Affaldsstrategi 2005-2008, Bilag D Sektorer (Waste strategy 2005–2008, Annex D Sectors)

[7] Claus Pedersen, Ilonka Domela, Sammensætning af dagrenovation og ordninger for hjemmekompostering *(Composition of domestic waste and methods for home composting)*, Miljøprojekt nr 868 2003, Miljøstyrelsen *(Danish EPA)*

Table 4. Detailed accounts for domestic waste generated during one week in 2001 from two different kinds of households in Denmark.

Fraction	Household flat, 1.9 pers.		Whereof target products		Single family home, 2.4 pers.		Whereof target products	
	(kg)	(%)	(kg)	(%)	(kg)	(%)	(kg)	(%)
Non-processed organic waste	1.69	21.2			2.32	23.3		
Organic, other	0.65	8.2			0.93	9.4		
Animal waste	0.77	9.7			1.0	10.1		
Recyclable paper	*0.96*	*12.1*			*0.98*	*9.9*		
- Phone books	*0.02*				-			
- Notes paper	*0.04*				*0.07*			
- Envelopes - large	*0.01*		*0.07*		*0.01*		*0.08*	
Tissue paper	0.32	4			0.29	2.9		
Residual dry and clean paper	0.17	2.1			0.20	2.0		
- Books	0.01				0.02			
- Drawings, etc.	0.01				0.01			
- Misc. paper	0.10		*0.12*		0.02		*0.05*	
Other dirty paper (typical EPR material)	0.45	5.7			0.76	7.6		
Plastic packages	0.19	2.4			0.23	2.3		
Plastics, other (foil, film and package material)	0.54	6.8			0.68	6.8		
Garden waste	0.24	3.0			0.51	5.1		
- Cat litter, etc	0.07		*0.07*		0.04		*0.04*	
Napkins, etc	0.70	8.8			0.52	5.2		
Combustible, other	0.43	5.4			0.5	5		
- Wood small	<0.01				0.02			
- Wood - large	0.07				0.02			
- Textile	0.06				0.16			
- Rugs, carpets	0.01				0.01			
- Shoes	0.01				0.04			
- Office material	<0.01				<0.01			
- Plastic products	0.03		*0.19*		0.03		*0.28*	
Glass package	0.21	2.6			0.25	2.5		
Glass, other	0.03	0.4			0.029	0.3		
- Drinking glass	0.03				0.01			
- Utility goods	-				0.01			
- Window glass	-		*0.03*		-		*0.02*	
Metal packages	0.18	2.3			0.29	2.9		
Metal other	0.07	0.9			0.045	0.5		
- Utility goods	0.03				0.01			
- Nails and screws	0.01				0.01			
- Other metal items	<0.01		*0.04*		0.02		*0.04*	
Other non-combustible	0.33	4.1			0.36	3.6		
- Ceramics and porcelain	0.04				0.06			
- Cat litter	-				0.13			
- Light bulbs and CDs	<0.01		*0.04*		<0.01		*0.19*	
Complex products	0.02	0.3			0.01	0.2		
- Household appliances					0.004			
- Telephones					<0.001			
- Radio, TV, walkman					-			
- PCB					-			
- Magnetic cards					<0.001			
- Other complex products					0.005			
- Misc.	0.02		*0.02*		<0.001		*0.01*	
Hazardous waste	0.01	0.1			0.018	0.1		
- Batteries	0.006				0.013			
- Products w built-in battery					-			
- Light tubes					-			
- Low-energy bulbs					<0.001			
- Misc. printer cartridges	0.001		*0.007*		-		*0.014*	
Total	*7.96*	*100*	*0.59*	*7*	*9.94*	*100*	*0.72*	*7*

Source: Table derived from Pedersen & Domela 2003 Annex B.

The figures indicate that the target product-related fractions consist of more than well defined products, but also that in 2001 the target product content in the domestic waste was in the order of 7%. Yet, most of the large-sized products consumed are not found at all in the study and obviously they occur somewhere else or do not show in this kind of pick analyses.

Bulky waste studies

One possibility is to search for target products in the households' bulky waste fraction, which is substantially smaller as compared to the domestic waste. The bulky waste is described as larger pieces of utility goods (i.e. furniture, prams, white goods, carpets, etc.) from private households. Typically, but not exclusively, it is waste that cannot be handled through the channels for ordinary domestic waste.[8] As seen above (Table 1), the bulky waste fraction from households was about 800 000 tonnes in 2005.

A thorough survey and evaluation of the existing bulky waste arrangements in the period 1996 to 1998 was reported in 1999.[9] It had as purpose to provide useful knowledge for the local and governmental planning, covering an array of issues regarding bulky waste, including amounts and composition. It was demonstrated that there are uncertainties and noticeable variations in registered generated quantities of bulky waste. It was explained by different definitions, different systems for collection in the municipalities, and sets of background information. The official waste register accounted for 620 000 tonnes in 1995, while calculations from the project survey indicated that approximately 980 000 tonnes of bulky waste, corresponding to 421 kg per household annually, was generated that year. There were, however, variations between 274 and 666 kg per household due to different collection arrangements in the examined municipalities. At that time, the forecast for the year 2000 was 400 000 tonnes of bulky waste in total.

The composition of the bulky waste was examined through sorting the content of 19 containers of the fractions "combustible" and "non-combustible" from 6 municipalities. It was found that far from all waste in the containers was bulky waste according to the used definition. The share could vary between 50 and 96%. The remaining content could be garden waste, domestic-like waste, and small amounts of hazardous and special waste. The genuine combustible bulky waste fraction mainly consisted of furniture, household utility goods, building and demolition waste, and packaging. The non-combustible fraction demonstrated variations due to the design of the collection scheme, but consisted mainly of

[8] Claus Pedersen, Henning Jørgensen, Storskraldsordninger – øget genbrug og genanvendelse *(Systems for bulky waste – increased re-use and re-cycling)*. Miljøprojekt nr 894, 2004, Miljøstyrelsen *(Danish EPA)*

[9] Claus Pedersen, Claus Egeris Nielsen, Ole Kaysen – Kortlægning og vurdering af storskrald *(Survey and evaluation of existing bulky waste arrangement)*, Miljøprojekt 426, 1999, Miljøstyrelsen. *(Danish EPA)*

building and demolition waste, WEEE, furniture, and household utility goods. Many of these products, such as pressure-treated preserved wood products and WEEE, may contain heavy metals, such as cadmium, lead, mercury, cupper, and chromium. From this study, we conclude that there is, or at least was, uncertainties about disposed quantities of bulky waste, that it constitutes a mix of different kinds of waste, and that substantial amounts of targeted products do end up in the bulky waste.

Another pick analysis from 2001 for bulky waste explored the content of domestic waste and garden waste fraction in two bulky waste containers labelled "combustible waste".[10] Both containers were mentioned as being representative despite the fact that one of them only consisted of about 40% of genuine bulky waste, while the other had about 90% bulky waste. The bulky fraction was separated, but not further examined. It was however described as containing carpets/rugs, furniture, etc. The sorted fraction of domestic waste contained about 20% of target products such as clothes, shoes and toys.

A study reported in 2004[11] investigated the content of three fractions of bulky waste, namely "small combustible items", "large combustible items", and "small iron and steel items". The aim of the study was to figure out the content of recyclable and reusable materials in the bulky waste fractions. The sample consisted of the content from five containers sorted in 21 fractions in a manner similar to the pick analyses for domestic waste. Products are not accounted per se, but to some extent possible to derive from some of the fractions.

The content of two analysed containers for "*small combustible items*" included about 5% of products considered reusable, such as clothes and bags, furniture, carpets, and textiles, together with a number of identified target products including WEEE. The content of two sampled containers for "*large combustible items*" was more homogenous, 79% of the content was wood and 14% pieces of furniture like sofas, cupboards, etc. A part of the wood fraction actually consisted of target product-related waste such as doors and window frames. The remaining waste included both obvious target products, specified materials and less specified fractions like combustible/non-combustible. In total, about 9% of the content was considered reusable as products (from beer cans to vacuum cleaners). The content of one container of "*small iron and steel items*" was found to be very diverse both in terms of different kinds of metals and products. Out of the total content, 3% was considered as reusable including kitchen utensils, pots and pans and cutlery. The largest fractions were items made from iron (35%) and items made from other metals (30%), both including substantial amounts of target products, though not reusable. Other sub-

[10] Kathe Tønning, Vægtbaserade indsamlingssystemer for dagrenovation *(Weight-based collection schemes for domestic waste)*, Miljøprojekt nr 645 2001, Miljøstyrelsen *(Danish EPA)*

[11] Claus Pedersen, Henning Jørgensen, Storskraldsordninger – øget genbrug og genanvendelse *(Systems for bulky waste – increased re-use and re-cycling).* Miljøprojekt nr 894, 2004, Miljøstyrelsen *(Danish EPA)*

fractions making up from a few per cent to about 10% included utility goods, machines, furniture, cables and cords, etc.

Concluding remarks

The system/method for analysing household waste is not optimised for detecting products in the waste flows. The Danish pick analyses indicate that the domestic waste part of the household waste comprises typical target products in the order of 5% or more. Based on a generation of about 2 million tonnes of domestic waste, that would give about 100 000 tonnes of target products annually in the waste system.

It is obvious that more traditional target products end up in the bulky waste, though the picture for the composition of these waste fractions is not as clear as for domestic waste. Assuming that between 5 to 20% of the bulky waste constitute traditional target products, that would make up 40 000 to 160 000 tonnes of target products annually in Denmark. The bulky waste composition needs to be further investigated.

2.3 Finland

The Finnish waste statistics are built on a division into hazardous waste, materials sorted out for recycling, various EPR fractions (WEEE, packaging, etc.), and residual mixed waste. The latter constitutes by far the predominant fraction. The figures for 2004 are provided in Table *5* below. Thus, it is difficult to draw any accurate conclusions on the composition of products.

Table 5. Breakdown of household waste in Finland by category in 2004..

Category	Annual amount (tonnes) *	Amount per capita (kg)
Chemical waste	1 800	0.3
Metals	14 700	2.8
Glass	54 700	10.5
Paper & board	205 000	39.2
Plastic & rubber	11 500	2.2
Wood	23 700	5.7
Electrical & electronic waste	8 500	1.6
Mixed household waste	779 600	149.2
Total	1 164 500	223

*) includes waste collected separately for recycling or other resource recovery.

Source: Statistics Finland/ Eva Heiskanen, NCRC, Project workshop presentation

A pick analysis from Helsinki of household waste is presented in Table *6*. The waste is sorted in similar fractions as was used in the Danish study, though without examples of products found. The figures given in the table indicate that just a few fractions could be related to the target products – primarily WEEE, textiles and clothing.

A general observation is that the per capita amount of waste is substantially lower in Finland, as compared to Denmark, which may indicate different methods for measurements.

Table 6. Composition of household waste in the Helsinki Metropolitan Area.

Category	Amount (average value) per capita (kg/year)	Per capita (% by weight)
Kitchen waste	42.7	25.2
Garden and other waste	17.9	9.9
Tissue paper	33.6	2.9
Separately collected paper, board and cardboard	33.6	20.2
Other paper, board and cardboard	2.4	1.4
Plastics	22.4	13.4
Glass	6.2	3.7
Metals	6.4	3.8
Electrical & electronic waste	1.2	0.7
Wood	4.7	2.8
Textiles and clothing	7.5	4.5
Napkins and sanitary pads	12.2	7.2
Mixed packaging	0.9	0.5
Other combustible	3.1	1.8
Other non-combustible	2.2	1.3
Mixed waste (non-packaging)	0.8	0.5
Hazardous waste	0.4	0.2
Total	169	100
– of which fine-grained substance	12	7

Source: Eva Heiskanen, NCRC, Project workshop presentation.

In addition, there are product-specific waste registries for collected products targeted by extended producer responsibility legislation:

- electronic and electrical appliances,
- tyres from motor vehicles, etc.,
- cars, vans and comparable vehicles,
- newspapers, magazines, copying paper, and other comparable paper products,
- packaging.

These products are sorted out before reaching the mixed household waste streams.

2.4 Iceland

The major waste management company in Iceland is SORPA, serving the 187 000 inhabitants of the capital area (out of about 300 000 inhabitants in Iceland). The company has conducted annual pick analyses of the household waste for the period 1999 – 2005, dividing the waste stream in

different kinds of materials, primarily packaging materials.[12] The composition described in Table *7* is valid after the newsprint fraction has been sorted out. The fractions marked in italics are considered as those, which may contain the target products.

This was based on information from the homepage of SORPA[13]. The gradual reduction of the fraction "undefined waste" is explained by improved sorting. The pick analyses give information about the amounts of sampled waste, but unfortunately no information about the variations in total waste amounts.

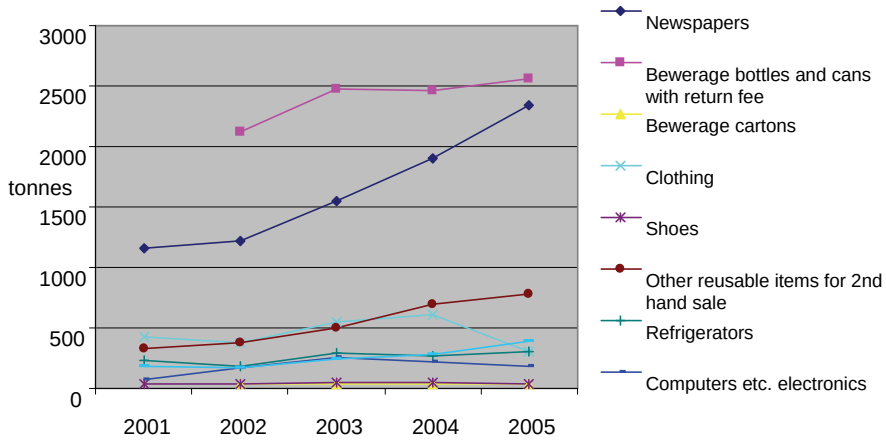
Table 7. Contents of household waste in the Reykjavik area (excluding the newspaper fraction).

Fraction	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)
Clothing	*3.2*	*4.0*	*3.2*	*4.4*	*3.3*
Garden waste	1.5	0.4	2.1	1.0	0.8
Glass (without recycling fee)	2.4	3.5	3.7	3.7	4.6
Glass (with recycling fee)	1.2	1.8	1.4	1.7	1.0
Beverage cans	0.5	0.4	0.4	0.3	0.3
Metals (incl. entire products or parts made from metals)	*2.9*	*3.2*	*3.2*	*3.0*	*3.0*
Milk and beverage cartons	3.9	3.6	3.9	3.6	3.6
Plastic bottles with return fee	0.8	0.6	0.6	0.5	0.6
Electronics (WEEE)	*0.0*	*0.6*	*0.5*	*0.4*	*1.0*
Minerals	0.0	0.0	1.4	0.9	4.5
Timber (incl. products from wood, painted and non-painted wood)	0.5	0.7	0.7	0.5	1.1
Wax	0.0	0.2	0.3	0.3	0.2
Napkins	6.6	8.4	6.2	7.4	7.1
Clear plastic film	0.0	0.0	0.4	0.0	1.2
Cardboard	6.2	7.1	9.5	9.2	9.3
Hard plastics	4.4	1.8	1.9	1.1	0.1
Plastic packaging	8.4	13.9	16.7	17.7	16.1
Food residues	35.6	29.3	28.5	31.0	33.8
Hazardous waste	0.7	0.4	0.5	0.2	0.6
Undefined waste (not packages, paper, carton, minerals, etc.)	*21.1*	*20.0*	*15.0*	*13.0*	*7.8*
Share of waste that may contain products	27.7	28.5	21.6	21.3	16.2

Source: SORPA.

[12] Compiled by SORPA and provided to us by Anne Maria Sparf, Environice.
[13] The Reykjavik Metropolitan Area Waste Management Company (www.sorpa.is)

Figure 4. Trends in collection of specified fractions at recycling centres in the Reykjavik area.



Source: SORPA/Anne Maria Sparf.

Furthermore, SORPA tracks the waste flows into their recycling centres for bulky waste. The waste fraction accounts are in that case to some extent based on products. The company concludes that most fractions increase in amounts received, which is also illustrated in Figure 4. The data from these centres provide a good indication of consumption patterns, although it must be kept in mind that the overall recycling rate is increasing. In addition, Iceland has experienced a period of good economic development which has resulted in increased consumption and thus more throwing away of old things and subsequent increases at recycling centres.

The significant increase in collected newsprints was explained by the fact that one paper with free distribution in the Reykjavik area was introduced during the period. For 2005, it was about 13 kg newsprint paper per capita in the area. The per capita amounts of other product fractions collected at the recycling centres in the Reykjavik area in 2005 were 1.6 kg of clothing, 0.2 kg of shoes, 1.6 kg of refrigerators etc., 1 kg of computers and 2.1 kg of TV sets. In addition, 4.2 kg of reusable products were collected and sold on the second hand market.

- The amount of TV sets and computer screens has increased significantly. The increase in weight was over 10% between 2003 and 2004 and 36% between 2004 and 2005. A comparison of the two specific months January 2005 and January 2006 showed an even more dramatic increase – 80% – due to the popularity of plasma TV sets as Christmas gifts for the family in December 2005. This led to many people abandoning their existing traditional TV sets, even fully functioning ones.

- On the other hand, the proportion of computers decreased around 15% between 2003 and 2004 and almost 20% between 2004 and 2005.
- The amount of refrigerators has also shown an increase of nearly 15% between 2004 and 2005. However, the figure was negative between 2003 and 2004, with a decrease of some 10% in refrigerators that were returned to recycling centres.
- According to staff at SORPA, the general trend at recycling centres has been an increase in all sorts of electronics that are still fully functioning and furniture which is still in good shape.
- The recycled newspaper category has shown a similar increase as in the non-separated household waste. Between 2004 and 2005 the increase was over 20%.
- The amount of clothing returned to recycling centres increased by over 10% between 2003 and 2004 and another 10% between 2004 and 2005.
- The category "reusable products" also increased by over 10% between 2004 and 2005. This includes items such as books and pieces of furniture, as well as decorative items such as vases, mirrors etc. These collected products are sold on the second-hand market for charity.

Concluding remarks

The data give an indication of product content in the range 15 to 20% of the household waste, newsprints excluded. The product fraction excluding "undefined waste" makes about 5% of the total household waste. At the recycling centres, more than 10 kg of target products per capita is collected. Assuming that the total per capita waste generation is about 300 kg and that 5% constitute products add up some 15 kg indicating that 20 to 30 kg of target products are disposed of per capita annually. It is evident that technology shifts and replacement of products shorten the actual lifetime of products below the technical lifetime of the products.

2.5 Norway

Waste Management Norway, the association for municipal waste organisations, reported results from a pick analysis study in April 2004[14] (the actual work was conducted in 2003) based on waste collected from ten municipalities. The study could also compare with previous studies, in some municipalities back to 1995. The main approach was to investigate residual waste, biological waste and paper waste from households in the participating municipalities. The calculations comprised all waste includ-

[14] Britt G. Iversen, Lars B. Pedersen, Sorteringsundersøkelse av husholdningsavfallet i Agder *(Source separation survey of household waste in Agder)*, Renovasjonsselskapet for Kristiansandsregionen, rapport 1/2004

ing the above-mentioned and separately collected plastic waste. The collected waste was sorted into 20 different fractions. The aim of the study, though not explicitly mentioned, was to map out the composition of household waste, content of recyclable materials, present levels of source separation, generated amounts, etc.

The general conclusion from the study was that there were relatively small changes in both composition and amount of the waste. The food waste (37%) and recyclable paper (27%) were the major fractions. Paper is source separated as one fraction, but does also occur in the fractions "others" including office, printer and data paper, books, phone books and paper bags for food stuff.

The fractions defined for the study are not exclusively defined in terms of products or packaging materials. The fractions and their relative contribution to the collected mixed waste from households that relate to products are reported in Table *8* below.

Table 8. Fractions of the residual household waste that may consist of traditional products in Norway in 2003.

Fraction	Description	Share of residual waste (%)	Comment
Paper	Newsprint, magazines, office, printing and computer paper, books, phone books and bags for food stuff	7.7	
Carton, other	Mixed composition including disposable plates	1.9	
Textile	Clothes, carpets, wool, cotton, synthetics	7.4	Increased by 4.8% due to increased consumption
Combustible	Shoes, rubber, leather, wood, ropes	5.3	
Plastics, other	Mixed including toys and binders	2.0	
Glass, other	Window glass, vases, decorative items	0.8	
Metal, other	Items and parts from steel and metal, screws, nails	1.8	
WEEE	Products dependent on electric current, conductive, i.e. electric scissors, mobile phones, hair dryers, light bulbs, load speakers, cables, wrist watches, smoke detectors, etc.	1.8	Order of 2 kg per capita annually. Primarily light sources, fans, smoke detectors, fuses, cables, light bulbs and tubes, keyboards for PCs, telephones, radios, cassettes, records, etc.
Non-combustible, other	Ceramics, porcelain, cement, ash, residual (<10 mm)	5.3	
Hazardous waste	Paints, glues, solvents	0.2	Products: oil filters, ammunition, syringes, pharmaceuticals
Total product-related		34.2	

Source: Derived from Iversen &. Pedersen 2004.

The contribution of the fractions that may include traditional products is about 34% of the waste after source separation. It should be noticed that far from all this waste constitute target products and it is, due to the frac-

tion definitions, difficult to give an accurate figure for the actual target product contribution. A crude estimate would be in the order of 10%.

An older study by Indre Østfold Renovasjon and VBB Samfunnsteknikk from 1997[15] present relative distributions of the fractions in the same orders as the above-mentioned study. Shoes, as a product fraction, were accounted separately and make 0.7% of the total amount of waste.

The waste management company in the Oslo area has conducted analyses of waste amounts and composition every fifth year. The one reported here[16] from 2005 is a pick analysis of domestic waste after source separation of paper, glass and metals. The study concluded that the annual total per capita waste generation (domestic waste and source separated fractions) had increased from 303 kg in 2000 to 323 kg in 2005, which is an increase of 7%. The domestic waste amount, after source separation of paper, packages and textiles, was 237 kg and the largest fraction were food waste and paper of different qualities. The results from the study are provided in table 9. For a comparison between 2000 and 2005, the figures are given as total waste including source separated textiles and packaging material.

Textiles were collected separately and sold for charity. The scheme collected about 3.1 kg per capita, but some 9 kg per capita was found in the domestic waste. In contrast to the situation in most other studies, the WEEE fraction decreased from 2.1 kg per capita in 2000 to 1.5 kg in 2005, which may reflect a more developed collections system for WEEE.

Considering the potentially target product-containing fractions being similar to the ones pointed out in Table *8*, the potential target product composition of the Oslo domestic waste would be up to 29%, which is in line with other studies. The study from 2005 has detailed descriptions of typical content of fractions, which support the assumptions on the selected fractions. Yet, these fractions may not entirely constitute target products and the estimate of the target product content being in order of 10% could be supported.

[15] Kjetil Hansen, Pål M. Ringstad, Indre Østfold Renovasjon – Sorteringsanalyser *(Waste sorting analyses)*, VBB Samfunnsteknikk, 1998

[16] John Geir Østrud, Avfallanalysen 2005, Oslo commune *(The Waste analysis 2005, City of Oslo)*, Renovasjonsetaten, September 2005

Table 9. Amounts and share of sorted fractions in domestic waste (domestic waste.

Fraction	Description	2000		2005			
		Share of fraction (%)	Amount per capita (kg/y)	Share of fraction (%)		Amount per capita (kg/y)	
Kraft paper and carton	Corrugated board, cartons for food, shoes, detergents, toys, bobbins	4.5	13.7	7.6	*3.0*	23.1	*7.0*
Paper/fine paper	Newsprint, magazines, printed matter, brochures, office, printing and computer paper, books, phone books	35.2	106.6	28.5	*12.8*	90.7	*30.2*
Cartons for beverages	Packages for milk, cream, yoghurt, jam, liquid detergents	1.6	4.9	1.4	*1.8*	4.6	*4.2*
Paper, dirty	Used tissue, coffee filters, napkins	2.6	7.8	3.6	*5.0*	14.6	*11.8*
Paper, other/residual	Paper not suited for recycling sorted as wet organic. Food wrapped in paper, Paper plates, cups , bags for dry food				*2.5*		*5.9*
Package foils	Bags, sacks, foil, i.e. packages f food and snacks incl meat f sandwiches, bags f food and coffee, wrap paper, plastic foil < 50% aluminium, etc	4.6	13.9	5.1	*6.9*	16.4	*16.4*
Packages from hard plastic	Beakers f yoghurt, jam, ice-cream, bottles f ketchup, bottles and cans w/wo refund, package f detergents.	2.6	7.7	3.6	*4.9*	11.6	*11.6*
Other plastic	Foil from thin folders, toys, fittings, kitchen utensils, folders, synthetic leather, shoes, styrofoam (incl. package), insulation sheets, cups, plates.	1.0	3.2	0.8	*1.1*	2.6	*2.6*
Food waste	All food residues incl fruit, vegetables, meat, fish, bread, flour products, egg, bones and tea bags	21.6	65.5	22.0	*30.0*	70.9	*70.9*
Compostable	Flowers, plants, soil, garden waste	2.0	6.1	3.0	*4.1*	9.7	*9.7*
Napkins	Incl content, toilet paper	4.5	13.5	4.0	*5.5*	13.0	*13.0*
Combustible	Remains of wooden boxes, ice-cream sticks, wood material, clothes, leather shoes, rubber items, cork, candles, soap, bags f vacuum cleaners w content,	3.0	9.0	3.6	*4.9*	11.5	*11.5*
Textile	Cotton, wool, synthetics, textile carpets	3.5	10.5	3.8	*3.9*	12.3	*9.2*
Packages of glass	Bottles, jars f jam, etc	5.3	16.0	6.0	*4.6*	19.4	*11.0*
Glass, other	Window glass, kitchen glass, vases, decorative items	0.2	0.5	0.4	*0.5*	1.2	*1.2*
Packages from metal	Boxes f food and beverage, caps, lids, tubes, spray cans, foil f meat, fish, coffee, snacks >50% aluminium	2.1	6.4	1.8	*2.1*	6.0	*5.1*
Metal, other	Items and parts from steel and metal, screws, nails, household aluminium foil	0.5	1.6	0.6	0.8	1.9	1.9
Non-combustible, other	Ceramics, porcelain, fuses, stones/ gravel/soil	1.3	4.1	0.6	*0.8*	2.0	*2.0*
WEEE	Misc household products, i.e. radio, phone, hair dryer, light bulbs, loud speakers, cables, cords, etc.	0.7	2.1	0.5	*0.6*	1.5	*1.5*
Hazardous waste	Oil residues, rechargeable batteries, low-energy bulbs, paints, solvents	0.1	0.2	0.2	0.3	0.7	*0.7*
Fines <10 mm	Falls though the sieve, coffee, cat litter, ash, cement, unidentified	3.2	9.6	2.8	*3.9*	9.1	*9.1*
Total		100	303.0	100	*100*	322.9	*237*

Source separated paper, glass, metal and textiles) in Oslo region in 2000 and 2005. The figures in italic for 2005 represent domestic waste after source separation. Source: Østrud, Avfallanalysen 2005.

2.6 Sweden

The search for Swedish background data, not least through a number of individual consultations, gave at hand that there have been several initiatives aiming for investigating the composition of the waste stemming from Swedish households. It seems, however, as the overall picture is lacking. The frequently referred works, both in the individual consultations and in literature sources, were conducted by Reforsk, RVF (now Waste Sweden), and the material companies (producer organisations for EPR materials, that is packaging and newsprint). In these studies, household waste (domestic waste) from six to seven municipalities was sorted in 20 to 29 different fractions. The municipalities were not selected to be representative, but as examples of well functioning collections systems for all fractions under EPR regulation. The main purpose of the studies was to find out how well the source separation of EPR products and materials works on household level. In addition, another purpose was to deepen the knowledge on suitable treatment methods of the waste. Thus, the pick analyses, which was the method applied, do not fully provide the information on product composition. The report gives, nonetheless, some useful indications.

In the investigation from 1997[17], the waste was sorted in the main categories "producer responsibility material" and "non-packaging" and some products could be traced in the latter category. A conclusion from the report was that the per capita collected waste amounts – after voluntary source separation of EPR fractions – was in the range of 3.5 to 4 kg per week. Food waste constituted about 40% of the collected waste. Yet, about one fourth of the collected waste from sacks and bins was material under EPR systems, despite the fact that the municipalities that were subject for the study had well-working collections systems for the EPR waste fraction. The bulk of the EPR waste was newsprint and packaging made from paper and carton. The contributions (in weight) of other fractions, possibly containing typical products, are given in Table 10. Napkins excluded, these fractions make some 0.6 kg per capita per week (approx. 30 kg per year) or about 13% of the waste. Cat litter was mentioned as the dominant product in the fraction "other waste".

A follow-up study to the above-mentioned one was conducted in 2000.[18] On top of the municipalities contributing in the previous study from 1998 one was added. The study found that the waste generation had increased by 20% to 4.6 kg per capita and week. Out of this, 1.5 kg (32%), which is an increase from the previous study, was related to products and materials included in the producer responsibility schemes. It was estimated that more than 600 000 tonnes annually of products and materi-

[17] Tommy Olsson, Lotta Retzner, Plockanalys av hushållens säck- och kärlavfall – En studie i sex svenska kommuner *(Characterization of collected household waste)*, REFORSK FoU 145, 1998

[18] Sanita Vikicevic, Lotta Thomas Törner, Tommy Olsson, Karakterisering av avfallsflödet från svenska hushåll *(Characterization of collected household waste)*, REFORSK FoU 155, 2001

als that should have been sorted out separately was disposed off into the sacks and bins as mixed waste. The fractions including target products, in parallel to the previous study, amounted to 0.6 kg per capita and week (12%) when napkins were excluded. This figure remained stable.

A follow-up study in 2004 sampled waste from the same municipalities as in the previous study. It was found that the per capita waste generation that year was 4.5 kg per week. The food waste fraction was 1.9 kg per capita a week (42%), which is close to the share in the first study, just like the fractions of EPR waste (31% or 1.4 kg). The residual fractions, whereof some constituted target products, were 1.2 kg. The specific fractions described as containing products, napkins excluded, was 0.6 kg per capita a week also in this study.[19] The 2004 study elaborates the content descriptions for some of the individual fractions a bit further and concludes that almost 10 000 tonnes of WEEE could be expected to be found in the residual fractions. Typically, such products were:

- Light bulbs
- Cords and cables
- Remote controls
- Telephones
- Wrist watches
- Light sources/lamps
- Calculators
- Toys
- Computer products
- Cameras
- Hair driers
- Small household equipment
- Shavers
- Tape recorders

Alkaline batteries constituted almost half of the hazardous waste.

[19] Lotta Retzner, Sanita Vikicevic, Per Möller, Trender och variationer i hushållsavfallets sammansättning – Plockanalys a hushållens säck- och kärlavfall i sju svenska *kommuner (Trends and variations in the composition of household waste – Pick analysis of household waste from sacks and bins in seven Swedish municipalities)*, RVF Utveckling 2005:05

Table 10. Product containing fractions from pick analyses in Sweden 1997, 2000 and 2004

Fraction	Description	Share and amount (%)		(kg/capita week)		
		1997 (%)	2000		2004	
Napkins	Napkins for children and adults, tampons, etc	5.8	5.3	0.24	5.5	0.24
Glass, other	Drinking glass, mirrors, window glass, decorative items	0.2	0.3	0.01	0.2	0.01
Plastic, other	Toys, tooth brushes, miscellaneous decorative items	1.1	0.8	0.04	0.9	0.04
Metal, other	Screws, nails, tools, cutlery, items f specific purposes, pans & pots	0.7	1	0.05	0.9	0.04
WEEE	Traditional WEEE: light bulbs, shavers, radios, hair driers, but not cables, cords, etc	0.4	0.3	0.02	0.5	0.02
Textiles	Clothes, rags, etc.	3.0	3.1	0.14	2.3	0.1
Wood	Products from wood, decorative items, ice-cream sticks, etc.	1.3	0.8	0.04	0.5	0.02
Combustible, other	Shoes, kitchen cloths, clean-up waste, wall-paper, tickets, photos, etc	6.2	2.5	0.11	4.2	0.19
Other waste not suited for recy-cling	Cat litter, light bulbs (until 2000), common batter-ies, porcelain, ceramics – residual fraction		3.6	0.17	4.3	0.18
Hazardous waste	Light tubes, special batteries, paint residues, low-energy bulbs, pharmaceuticals, nail varnish, pesticides, etc.	0.2		0.1	0.3	0.01
Total		18.9	17.8	0.82	19.6	0.85

Source: Derived from Olsso &, Retzner 1998, Vikicevic et al 2001, Retzner et al 2005.

The variation in the relative proportion of the different fractions over the three studies is fairly small. Based on the assumption that 10 to 15% of the domestic waste in sacks and bins constitute target products, combined with the estimation from the studies that the annual Swedish waste generation of mixed waste (collected in sacks and bins) is about 2 million tonnes (whereof about 0.6 million tonnes is EPR waste), then approximately 260 000 tonnes of target products would end up as domestic waste.

We have not been able to find any thorough analyses of Swedish bulky waste collected at recycling centres. The waste management company operating in southern Sweden– SYSAV – (Sydskånes Avfallsaktiebolag) provided statistics on bulky waste collected at their recycling centres.[20] The statistics is based on amounts of defined materials or materials suited for specific treatment methods (composting, incineration, etc.) and thus do not provide sufficient information on what share/how much of it that is related to product categories. Nevertheless, the statistics give some indications combined with the SYSAV sorting guide[21] for the recycling centres. In the guide, a large number of products are listed with instructions on what fraction to place them in. The list consists of several chemical products to be sorted as hazardous waste, as well as different kinds

[20] Statistics from Sydskånes Avfallsaktiebolag SYSAV: collected amounts of bulky waste at Recycling centres 2002–05. Provided by Kristofer Kvernes, SYSAV.

[21] SYSAV sorteringsanvisning för grovavfall på Återvinningscentral *(Sorting guide for bulky waste at Recycling Centre)*, 2006 (Susanna Millbäck).

of building materials, furniture, common electrical and electronic equipment, car parts, bikes, textiles, books, compact cassettes, CDs, DVDs, etc. Most of these more or less complex products should, according to the sorting guide, be placed in either of the following fractions: WEEE, metal, other combustible, or other not suited for recycling.

The data compilation for 2005 shows that large amounts of waste end up in the undefined fraction "other" as combustible material. The figures given in Table 11 should be viewed as maximum amounts of products that may end up in the different fractions. In total it would not exceed 3 kg per capita a week (approx. 150 kg per capita annually).

Table 11. Total amounts and per capita a week amounts of bulky waste collected at SYSAV's recycling centres in 2005.

Fraction	Description (our own)	Total amount (tonnes)	Amount (kg/capita week) [22]
Compostable	Garden waste – no or little products	29 071.44	0.9
Wood	Miscellaneous, wood, construction waste, pallets, furniture and other products from wood	16 567.52	0.5
Carton and corrugated paper	Boxes and packaging material, etc – no or little typical products	5 059.09	0.15
Glass	Mixed, windows, mirrors, bottles, etc	569.58	0.02
Scrap metal	Products from metal	6 567.84	0.2
WEEE	Separate collection	5 285.21	0.16
Hazardous waste		1 288	0.04
Other products for 2nd hand sale	Products	799	0.02
Combustible	Misc. (may include products)	21 820.31	0.66
Other bulky waste	Misc. (may include products)	40 527.16	1.23
Total		127 555.15	3.88

Source: SYSAV.

Pick analyses conducted in Eskilstuna municipality in June to September 2007 for the Swedish EPA.[23] This study examined both fractions source-separated as plastic and metal packaging from collection points near the households, and metal and plastic fractions (not necessarily packaging materials) at recycling centres.

It was found that the samples of separated high-density plastic packaging waste contained about 40% non-packaging material from plastics and other materials, such as video tapes, CD covers, buckets, flower pots, plates, etc. The metal packaging samples constituted of between 13 and 26% metal products (non-packaging) and 1 to 3% WEEE.

The two samples from plastic fractions at the recycling centre were constituted of 26 and 65% large plastic products, 21 and 24% of small plastic items, and a small fraction of packaging materials. The samples from the metal fraction also had a small share of packaging material, but primarily

[22] SYSAV works in a region of about 635 000 inhabitants and 6 000 enterprises.

[23] Swedish Environmental Protection Agency (2007) Materialströmmar – ett bätter sätt att samla in hushållsavfall? *(Material streams – a better way for collection of household waste?)*, Report 5752. Appendix 3B.

they were made up of the two categories: other household scrap (about 10%) and large scrap, which apparently was the remaining almost 90%.

Concluding remarks from the waste statistics

The studies used for this data compilation were primarily produced with the aim to build knowledge on total waste amounts, share of waste that should have been source-separated and taken care of by the producer responsibility schemes, etc. The composition studies were rather aimed at finding suitable treatment methods, than for determining the de facto composition of the fractions in product terms. A typical approach for the quantification studies is to measure generated amounts for different kinds of households, implying that the aim is to find the most suitable collections method. Thus, it is difficult to say to what extent the sampling methods provide representative data. There are occasional pieces of information/remarks in the reports giving examples of what could be found in the waste from individual households, such as bags of newspapers, entire computers, etc. that influence the results. The information sources are thus not ideal for the aim of this study. The results could only be viewed as indicative and, probably, providing data in the right order of magnitude.

There is apparently an ongoing development and harmonisation of approaches and methods for pick analyses, which most likely will lead to more accurate and comparable information/data in the future. Waste Management Norway has produced an extensive compilation of sorting methods, waste classifications, sampling and data handling.[24] "Type of product" occurs as one classification of waste, but it is evident that the emphasis is put on classification of materials and treatment methods, primarily the ones accounted for in the text above. Some of these fractions are actually described in terms of target products, despite the facts they are defined in material terms. In addition, the pick analyses are first and foremost dedicated to the bulk of materials contained in the waste. It could thus not be excluded that the data precision is lower for the substantially smaller target product-related fractions.

The domestic waste, collected from or close to the households, is fairly well investigated in the Nordic countries, in particular in comparison to the bulky waste, mostly collected at drop-off points or at recycling centres. This lack of accurate data on bulky waste is a clear deficit for the analysis, not least as there are indications pointing at the bulky waste collection system as the main receiver for discarded target products.

The pick analyses indicate that the domestic waste collected by or near the households could consist of target products to about 10%. Newsprints

[24] Kristian Ohr, Bjørnar Kvinge, Cathrine Lyche, Veileder for plukkanalyser av husholdningsavfall *(Guide to pick analysis of household waste)*, Norsk renholdsverksforening *(Waste Management Norway)*, Rapport nr 7/2005

and packaging material under EPR schemes contribute to about 20 to 30% of the waste. The bulky waste category is smaller in amounts than the domestic waste. It seems like more target products end up in this category.

Table 12. Conservative estimate of target product-related fractions and potential amounts of such products in Nordic household waste.

Country	Products in domestic waste		Product in bulky waste	
	(%)	(tonnes)	(%)	(tonnes)
Denmark	5–10	90 000		40 000–160 000
Finland	5	60 000	No indications	
Iceland	20	15 000	10kg/cap	2 500
Norway	10	135 000	No indications	
Sweden	10–15	260 000		Max 1 350 000

Amounts related to specific waste categories

The aim of this section is both to investigate recycling rates for specific material fractions in the household waste and the methods used for calculating the related input and output material flows the recycling rates are based upon. The section is illustrated by information from Denmark and Sweden only.

3.1 Waste Electrical and Electronic Equipment (WEEE)

Denmark

The following text builds on the Governmental waste plan/strategy from 2003.

The bulk of the WEEE consists of products such as radios, TV-sets, IT products, automatic control devices, white goods, refrigerators and office machines. In 1997 the collected amount of WEEE, excluding refrigerators and freezers, was estimated to 103 000 tonnes. It was divided in 43 000 tonnes of electronic products and 60 000 tonnes of electrical products. The largest contribution (48%) aroused from the municipal collection systems, primarily at the recycling centres for bulky waste. The distribution of the rest is assumed to be from the domestic waste (15%), institutions, commerce and service (20%), and industry (15%). The data account for WEEE may be connected to relatively large uncertainties as a result of “storage chamber” or hoarding effects and extensive second-hand trade. The amount of WEEE is expected to grow due to increased consumption.

In 2001, 21 200 tonnes of WEEE was collected and treated separately and 11 940 tonnes of refrigerators and freezers. In addition, some WEEE was collected separately and sent for shredding and further processing. That fraction is not measured, but was estimated to 64 400 tonnes in 1997. In 2001, it was estimated that 75% of the WEEE was shipped for re-processing and recycling while 15% was incinerated and 10% was traded on the second-hand market. The increase in collected WEEE was explained by increased consumption.

Sweden

The following text is extracted from the report "Samla in, återvinn! – Uppföljning av producentansvaret för 2005"[25].

In Sweden, most of the WEEE is collected by Elretur, a collaboration between the Swedish municipalities, and El-kretsen, which is the producers' organisation for WEEE collection and recycling. In 2005, 126 500 tonnes of WEEE was collected in Sweden, corresponding to 14 kg per capita. This was an increase by 2 kg since 2004. A breakdown of the collection for different fractions of WEEE in 2005 is given in Table *13*.

Table 13. Collected amounts of WEEE in Sweden in 2005.

Product category	Collected amount (tonnes)	Amount per capita (kg)
Large white goods	36 300	4.0
Refrigerators & freezers	25 000	2.8
Other household appliances, hand tools, garden tools	12 300	1.4
IT & office equipment, telecommunication	22 700	2.5
TV, audio & video	21 000	2.3
Cameras, watches, toys	300	0.0
Light sources & lamps	6 700	0.7
Others	2 200	0.2
Total	126 500	14.0

Source: Naturvårdsverket (2006).

Despite the fact that the number of units of large white goods has increased, the accounted weight is lower, which is explained by revised assumptions of the weight per unit. Similarly, the weight of light bulbs was subject for revision.

According to the report, the recycling rates were between 70 and 80% dependent on product category. The recycling rate is, according to Jörgen Schultz (former CEO of El-kretsen), calculated from collected amounts and the amount annually put on the market (same year), an assumption justified by difficulties to make reasonable assumptions of the products lifetime.

In a report on special waste fractions in the Nordic countries[26], statistics on sales of electric and electronic goods in Sweden during the 1990s is displayed. The report provides collection figures for the same period as well (see Figure 5 and Figure 6). The collections system has been developed and improved since then. The report concludes that both the sales and the collection are increasing but does not comment the discrepancy in the orders of the amounts.

[25] Naturvårdsverket (2006) Samla in, återvinn! Uppföljning av producentansvaret för 2005 (Swedish EPA, Collect and recycle! How waste subject to producer responsibility ws dealt with of during 2005), Report 5599

[26] Nordic Council of Ministers. (2004). Survey of special waste fractions in the Nordic countries: legislation, logistics, quantities, treatment and disposal. TemaNord 2005:530. Project conducted by Rambøll

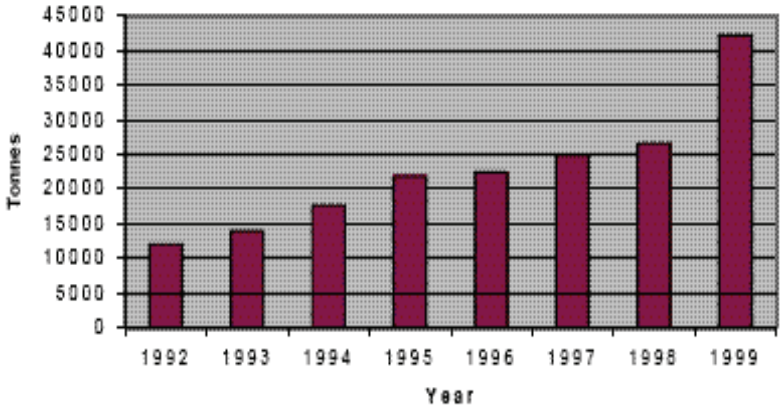


Figure 5. Sales of electric and electronic goods in Sweden, 1992–1999, tonnes per year. Source: Nordic Council of Ministers (2004).

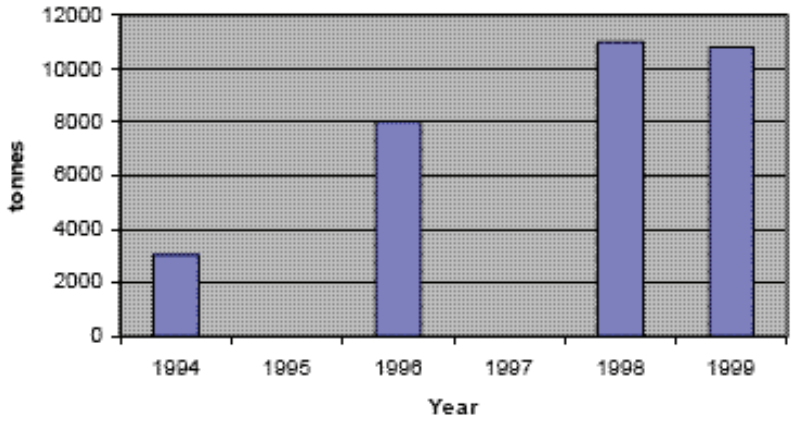


Figure 6. Electric and electronic waste collected in Sweden 1994–1999 in tonnes per year. Source: Nordic Council of Ministers (2004).

The producer responsibility organisation El-kretsen commissioned in 2004 a survey of re-use of IT products in Sweden. The study found a substantial market for second-hand IT products, often based on products replaced when leasing agreements expire. Frequently the products have an expected lifetime of several years beyond the lease period. The professional second-hand market is primarily organised by specialised brokers. The study gives a rough estimation that the brokers were selling about 300 000 units of PC equipment annually. There is also a considerable export of used IT equipment with lower capacity and some of the brokers are connected to international networks for second-hand IT equipment. The amount of exported used equipment is however not given.[27]

The amounts of collected WEEE is dependent on estimations of weight per unit, but it seems like there is a fair precision as of today. The recycling rate is based on amounts placed on the market, indicating that

[27] Carl-Olof Andersson, Bengt-Erik Svensson (2004) Reuse of IT-products, Sevice Management Consulting. Report commissioned for El-kretsen AB

one new product is replacing one old/obsolete. If we accept the method for calculation of recycling rate, some 30 000 to 50 000 tonnes of WEEE would end up outside the official collection schemes. If the residual is a result of hoarding, export of second goods, biases in the statistics or any other reason is difficult to tell.

3.2 Waste paper and packaging materials

Denmark

In 2000, about 1 million tonnes of packaging waste was generated in Denmark, corresponding to 186 kg per capita. It should be noticed that 57% of that waste represent transport packaging, which only to a limited degree reaches the private households. Sales packaging was 43%, but has increased slightly since 1997. Packaging waste is about 8% of the waste collected in Denmark. For the four major packaging material fractions (paper/carton, plastic, metal and glass), the over-all recycling rate was about 56% in 2001.

In 2001, 184 000 tonnes of *glass* packaging (bottles for wine/spirit, food stuff and pharmaceuticals) were put on the Danish market. The private border trade generated an additional 20 000 tonnes of glass. The reuse system for beer and soft drinks generated about 8 000 tonnes of cullet. 140 000 tonnes of collected glass was recycled as cullet for production of new bottles. Thus, the households sent 29 000 tonnes of glass to waste incineration, ending up in the slag.

The packaging made from *steel and metals* amounted in 2001 to about 43 000 tonnes, whereof steel and tin plate was the larges share. In 2000, about 8 400 tonnes was collected and the rest was sent to the waste incineration plants where ferrous metals were separated from the slag. The losses have not been measured. Trials from 2002 indicated that losses are substantial, 76% for tin plate. Most of the metal packaging waste originates from the households.

The *paper and cardboard* consumption was stable at around 1 400 000 tonnes annually between 1997 and 2001. That year, 721 000 tonnes was collected separately corresponding to 53% of the use. The remaining part was incinerated. The households contributed with about 192 000 tonnes of the collected paper waste, but sent about 262 000 tonnes of paper, whereof 46% was considered suited for recycling, to waste incineration.

The Danish consumption of *plastics* was estimated to about 604 000 tonnes for 2000, but only 345 000 tonnes was in the waste. The explanation to the difference was that many of the products produced from plastics are durable and included in for instance infrastructure for water distribution and sewage, telephone systems, district heating, building mate-

rials, and wind mills. Both plastic consumption and the plastic waste fraction have increased by about 40% from 1996 to 2000.

In 2001, the amount of plastic packaging material was about 150 000 tonnes and the level is stable. Some 43 000 tonnes of plastic waste, including both production waste and packaging, was collected and recycled. About half of it, 21 000 tonnes, was plastic packaging.

The plastic fraction of the domestic waste was in 2001 approximately 9% or 155 000 tonnes. Most of it was packaging and about 27 000 tonnes were considered suitable for recycling instead of being incinerated, which was the most common treatment method for plastic waste.

Sweden

The Swedish producer responsibility system for packaging includes both material recycling and energy recovery as means for treating collected material. The energy recovery figures reported also include non-sorted waste going with the ordinary household waste for incineration in waste-to-energy plants. In this text, we only regard the packaging sent for material recycling.

In 1994, before the producer responsibility legislation was introduced, about 40% of the 853 800 tonnes of packaging was material recycled. In 2005, after about ten years of producer responsibility, the recycling rate had increased to about 50% ,but the total amount of packaging had also increased by 75% to 1 797 109 tonnes (according to Swedish EPA information). The amount put on the market was estimated by the producers.

The Swedish producers put 162 700 tonnes of *glass* packaging on the market in 2005. There is in addition a substantial private import of bottled products to Sweden bringing glass packaging estimated to an amount of 50 000 tonnes into the country, that is making up about ¼ of all glass packaging in the country. Regardless of origin, about 155 000 tonnes of glass packaging was collected for material recycling, The official statistics does not consider the private import and can thus show recycling rates exceeding 100%. In 2005, the official rate was 95% and 73% if the estimated privately imported glass is considered. More than 50 000 tonnes of glass packaging are not recycled annually.

It was estimated that 58 200 tonnes of packaging from *steel and aluminium* went to the market in 2005 (packaging for beverages excluded). According to the statistics, 33 700 tonnes or 58% was collected for material recycling. A breakdown shows that steel packaging had a slightly higher recycling rate, 72%, while aluminium was 27% only. About 17 000 tonnes of steel and about 8 000 tonnes of aluminium is lost annually. Only 359 tonnes of packaging from aluminium was estimated to be incinerated and this cannot explain the difference.

A report analysing the waste streams as material flows indicate that the collected metal packaging fraction contains about 10% small products.[28]

The figures for *paper, cardboard* and *corrugated cardboard* packaging are accounted in two groups, as there are two material companies involved. The amount of paper and cardboard packaging put on the market was estimated to about 200 000 tonnes in 2005, whereof 84 464 tonnes or 42% was collected for material recycling (and 1 633 tonnes were incinerated with energy recovery). The input of corrugated paper was 445 000 tonnes that year and 381 000 tonnes or 86% of that was material recycled. Most of the corrugated cardboard, 330 000 tonnes, was collected from businesses. Recycling centres for both households and businesses contributed with 10 000 to 15 000 tonnes and 38 000 tonnes was collected from or near the households.

The high recycling rate could primarily be regarded as emanating from businesses – not households. However, most corrugated cardboard end up in businesses and just little find its way to households.

Out of 158 940 tonnes of *plastic* packaging put on the Swedish market in 2005, only 38 234 tonnes, or 24%, was recycled as material. However, almost 78 000 tonnes (including 48 000 tonnes of low density plastic packaging in the ordinary household waste) went for incineration.

Waste paper collection is organised for newsprints (including newspapers, magazines, advertisements, phone books, catalogues, etc.) and office paper (paper of higher quality). Newsprint like paper amounting to 584 000 tonnes was introduced to the market in 2005. 83% or 483 000 tonnes was collected for material recovery. The share of that collected from or near the households was 37%, with a lower rate in the Stockholm area.

The 2005 consumption of office paper was 378 000 tonnes but 86 000 tonnes was production waste from printshops, etc. and 80 000 tonnes was considered not suited for recycling, including books, labels, envelopes, coated and wet strength paper, etc. Thus the net consumption was adjusted to 212 000 tonnes. Beside the printshop waste about 135 000 tonnes was collected as post-consumer waste paper.

3.3 Concluding remarks from certain waste fractions

Current official WEEE recycling rates do not fully reflect input-output for particular years due to difficulties in knowing how much of a particular product that was put on the market and how is discarded. Sales are calculated either in monetary terms or number of sold units, which have to be re-calculated into weight. There are significant delays for many

[28] Liselott Roth, Anna Björklund, Göran Finnveden (2007) Förutsättningar för ökad insamling och materialåtervinning av hushållens säck- och kärlavfall i materialströmmar *(Conditions for increased collection and material recycling of household waste in material streams)*. Avd för miljöstrategisk analys – fms, KTH Stockholm

products due to the hoarding effect that may distort the statistics. Many replaced products get a new application in the household or in a second home. It is not known how much historic waste there is out there.

Many packagings may not be suited for recycling due to dirt, etc. but it is clear that there is a potential for improvements. According to Swedish EPA, about 20% of the packaging consumed by the households is not source-separated and instead sent for incineration or landfilling together with other household waste.[29] In a reference to one of the background document to the report, it was estimated that about 60% of the theoretically available metal and glass packaging was source-separated and collected. The theoretical amount of plastics and paper in the household waste is somewhat lower. Pick analyses conducted for the same study indicate that the domestic waste only contains 0.5 to 2% of non-packaging related metal and plastics suitable for recycling.

[29] Swedish Environmental Protection Agency (2007) Materialströmmar – ett bättre sätt att samla in hushållsavfall? *(Material streams – a better way for collection of household waste?)*, Report 5752.

4. Waste accounting from production and trade statistics

4.1 Introduction

Our mental model for information search could also be seen as a material balance model, balancing market input (consumption) and output (waste and recycling) leading to search for information on household consumption. Important elements are consumption of new and second-hand products, time of use (instead of lifetime), what happens to the products when used (time of ownership and disposal), etc. There are second-hand market places, but in terms of products in household waste, they represent an extended use/lifetime due to new ownerships. It is relevant, when the products leave the system of investigation (a country or waste collection area). This could in practice be computers, clothes, etc., collected for charity abroad. Many old products are given new functions when replaced with new (for instance, a TV-set in the second home) or simply stored in the households. The approach to quantify waste amounts from consumption may imply an array of uncertainties.

4.2 Consumption statistics and consumer research approach

Consumption statistics for different products were also reviewed. Typically, it is provided according to the international COICOP[30] system, based on purpose of the products. Some of these purposes are given as clear product categories, such as shoes, clothes, furniture, carpets, stoves, ovens and refrigerators, while some could include both products and services. The measures/units are, however, given in monetary terms, requiring estimations of how many products (number of units) or how much of products (weight) the money represents in each category. The Danish statistics on annual consumption between 2002 and 2004 is used as an example and presented in Table *14*.

[30] COICOP, Classification of Individual Consumption According to Purpose (UN, 1999). A point in the classification is the division in non-durable goods (ND), semi-durable goods (SD), durable goods (D) and services (S).

Table 14. Annual Danish household consumption 2002 – 2004. Source: Statistics Denmark, derived from FU5 Household yearly consumption.

Product category	DKK per household per year
Men's wear	2 655.6
Women's wear	4 505.6
Furniture and fittings	4 704.1
Home textiles	1 210.6
Cutlery	52
Kitchen utensils	1 001.2
Bicycles	490.2
TV, video	1 148.2
PC, equipment, etc.	1 929.7
CDs, video tapes, photographic film, etc.	1 206.9
Games, toys and hobby	1 945.2

An alternative accounting is share of households with certain kinds of durable products, as in Table *15*, which just provides indications of the consumption, though nothing is said about how many of each product each household has. In addition, the statistics give indications of how fast different products penetrate the market and, to some extent, the saturation levels and that the households actually have a stock of products that will be replaced within a few years, or that some categories of products, such as fax machines, get out of fashion.

Table 15. Share (in percent) of Danish households in possession of durable consumer goods. Source: Statistics Denmark.

Product category	1999	2000	2001	2002	2003	2004	2005	2006	2007
Tumble dryer	40	40	42	43	50	48	47	51	47
Washing machine	77	76	76	75	82	76	79	80	78
Dishwasher	46	49	48	55	57	60	56	63	61
Microwave oven	49	52	56	58	65	66	68	71	73
Video	82	78	82	82	80	85	84	83	76
CD player	85	84	89	92	91	92	93	94	90
PC	60	65	67	72	79	81	84	85	83
Answering machine	42	42	47	46	48	48	47	50	-
Mobile phone	59	68	73	84	85	90	92	94	95
Fax	17	15	13	13	15	-	-	-	-
DVD player	-	7	9	21	37	54	68	83	84
Video camera	18	20	22	21	24	23	24	32	30
Digital camera	-	-	-	-	-	35	48	61	65
Digital video camera	-	-	-	-	-	10	12	18	21
DVD recorder	-	-	-	-	-	5	8	13	14
Flat screen TV	-	-	-	-	-	-	-	19	29
MP3 player	-	-	-	-	-	-	-	40	47
MP4 player	-	-	-	-	-	-	-	3	8
DAB radio	-	-	-	-	-	-	-	14	20
GPS navigation	-	-	-	-	-	-	-	15	19

Contacts with consumer researchers indicate that the picture of household consumption is weak in terms of what products they buy, duration of use and what happens when products are replaced. So far, most of those kinds of studies have been limited to selected products, such as refrigerators, freezers, TV-sets, stereo, furniture and textiles, and the results do not provide an appropriate background for the input and accumulation of products in the households.

Commercial market research institutes, such as GfK, follow consumption patterns in households for their clients. These institutes use for instance household panels where a number of households keep records of their purchases. This information could probably add knowledge on a more general level on the household consumption. These market research institutes could also add suitable questions to their panels to thereby tailor the output information.

Concluding remarks

Consumption statistics (both official and provided by the trade) clearly show an increase in household consumption of more or less durable products, but provide this information primarily in monetary terms. That kind of information could be used for estimates within defined product groups, which could be aggregated for a more comprehensive picture of product input to the households.

There is also scattered statistics on household ownership of certain durable products. It has though the deficit of not telling anything about the number of products per household or how often they are replaced.

The consumer research has as of yet not studied household consumption and use of durable products or what happens to them when obsolete. Market research institutes could probably provide more such information, if asked and paid.

Yet, another approach is based on macro-level statistics on inputs to the national consumption and making comparisons with the macro-level waste statistics. National offices for statistics collect information on industrial output for industrial and trade statistics. The information is primarily in monetary terms, but could be estimated to the volume. The sources are the domestic manufacturing industries and the custom offices (for import and export). The aim is to produce a balance similar to the one indicated in the model used for this study. Balancing the market input with waste generation introduces biases that need to be considered: the actual weight of products excluding supply-chain waste, packaging etc., conversion of monetary values to weight, and accumulation in the households.

4.3 Waste accounts on product balances in Denmark

Materials on Danish waste accounts were provided to the project group during the project workshop by Ole Gravgård, Statistics Denmark. We have also used two of his publications on the issue.[31, 32] Danish waste

[31] Ole Gravgård Pedersen, Waste, material flows and physical input-output tables – input-output based waste accounts for Denmark 1999. Paper prepared for the 15th international IO conference, Beijing, China, 27 June – 1 July 2005

[32] Ole Gravgård Pedersen, Waste accounts for Denmark 1999, Statistics Denmark, March 2004

accounts have been compiled for 1999. The project was reported in 2004 and had the aim to link the input side of the economy to the output side, thus linking waste flows to certain societal sectors. The idea was to better understand the waste contribution from different sectors that was weakly covered in the conventional waste statistics.

Both method and basic data sources used were more or less the same as the ones used for the regular production of Danish monetary input-output tables: the accounts were built up from material flows derived from physical input-output tables and material flow accounts. The starting point for the calculations was approximately 2 300 product balances from the national accounts. The actual flows of products (weight) could be calculated by combining the monetary values with of the physical quantities.

The waste material balance equals input of products reduced by output of products and accumulation (for instance stock changes, capital formation). The first step towards waste accounts by industries and households is to produce physical balances for different groups of products. In this study, nine groups of products were selected among the total set of product balances in the national accounts. Each group of products builds from an aggregation of balances (product supply and use tables), see Table 16. In this case, about 1 660 balances were used. Thus, the study was based on 26 industries and not the 130 in the classification system. The groups were selected as they are well defined and make up significant waste fractions.

Table 16. Material balances at industrial level from product supply and demand tables. Source: Ole Gravgård Pedersen 2005.

Fraction	Number of product balances
Paper, etc	70
Glass	50
Plastic	80
Food (animal and vegetable products)	300
Iron and metal products	450
Rubber	34
Wood products	25
Lubricating oil	1
Miscellaneous product	650
Total	1 660

Even if the overall material surplus estimations were found sound enough, some uncertainties in the method were mentioned in the report:

- The conversion from monetary terms to weight: there are assumptions that the price per kilo is general within each product category, which is not necessarily the case for heterogeneous products. When the overall weight is known, then the certainty is considered reasonable.
- Accumulation follows the definition of capital formation in the national accounts and some products, such as durable products purchased by households, may fall outside that concept. When old

products, previously accumulated, are discarded, then the amounts of waste generated will be underestimated.

- Complex products, such as household appliances, which are included as iron and metal products in the input-output tables, often include other materials. This means that the material composition could be different.
- The waste statistics include all waste and not only the ones addressed in the material balance calculations, which should be regarded in comparisons.
- Misallocations for some materials when not recorded in the economic statistics and national accounts. This is for instance valid for advertising material, free newspapers, etc provided to households free of charge. This kind of materials is accounted as material surplus at the industries, but end up as waste from households. Packaging follows a similar pattern, which could explain a difference between the calculated and measured amounts of household waste.

The study concludes that the material balances for the selected groups of products address 3.3 million tonnes or 28% of the total amount of waste (11.7 million tonnes). Some of the remaining waste could be addressed if all of approximately 2 300 product balances were included. Much of the remaining waste origin from demolition of old buildings, garden waste, and ashes from energy generation, which are not related to the product input side. It should in this context also be noticed that the households are accounted for 2.96 out of total 11.7 million tonnes of waste generated in Denmark in 1999.

In the study it was further found that the input-output balance give larger estimates of the waste amounts for each of the nine groups of products/waste fractions when compared with the amounts registered in the waste statistics. It was explained by the fact that quite large amounts of specific materials are included in the fraction “waste suitable for incineration”. The comparison for the nine groups of products is given in Table *17*.

The report concludes that in terms of waste fractions most fractions could be explained from input-output material balances, while some have been allocated to specific industries and/or households based on information from the waste statistics. The approach offers an opportunity to replace the large fractions registered in the waste statistics as “waste suitable for incineration”, “waste not suited for incineration” and “non-specified” and allocate them to specific fractions or sources. For instance, the waste account shows that paper, glass, plastic, wood and rubber are more dominant fractions than what is revealed by the waste statistics.

Table 17. Comparison for the input-output based material surplus estimates and corresponding information from waste statistics. Source: Ole Gravgård Pedersen 2005.

Fraction	Input-output based material surplus estimate (1 000 tonnes)	Registered in waste statistics (1 000 tonnes)
Paper, etc	1 363	593
Glass	424	122
Plastic	686	38
Food (animal and vegetable products)	631	218
Iron and metal products	544	441
Rubber	110	27
Wood products	347	27
Lubricating oil	39	60
Miscellaneous product	477	n.a.
Waste suitable for incineration	n.a.	3 057
Other waste from construction	n.a.	546
Others	n.a.	6 571
Total	3 258	11 700

Considering the issue of products in the household waste, a separate analysis was presented at the project workshop. It was based on the figures given in the table above, but figures were adjusted in order to show the household contribution. There are indications of a loss of materials/products that could be reused or recycled that probably end up in the fractions “suitable for incineration” and “not suitable for incineration” in the official waste statistics. Construction waste, garden waste and similar are not included in the waste statistics.

An additional conclusion from the workshop was that the product balances could be used to estimate, with a fair accuracy, the amount of various products that are placed on the market every year. For instance, the group of products “iron and metal products” includes about 450 different product balances for semi-finished of finished products[33]. “Miscellaneous products” consists of more than 650 product balances including textiles, clothes, leather, bags and shoes, as well as, a large number of instruments and appliances. The uncertainties may be less when the product balances are carried out for specific products rather than estimations on material flows. For the economy as a whole the product balances can explain most (85 percent) of the waste, excluding construction waste and garden waste. The main expected potential for improvements would be in addressing product accumulations and scrapping, the construction waste, food products, packing materials, etc.

[33] Doors and windows of iron and steel, cans, steel containers, fittings, cast iron products, household appliances made from iron and steel, tools, pumps, refrigerators, dish washers, engines and machinery, etc. Cars, buses, trains and ships were not included.

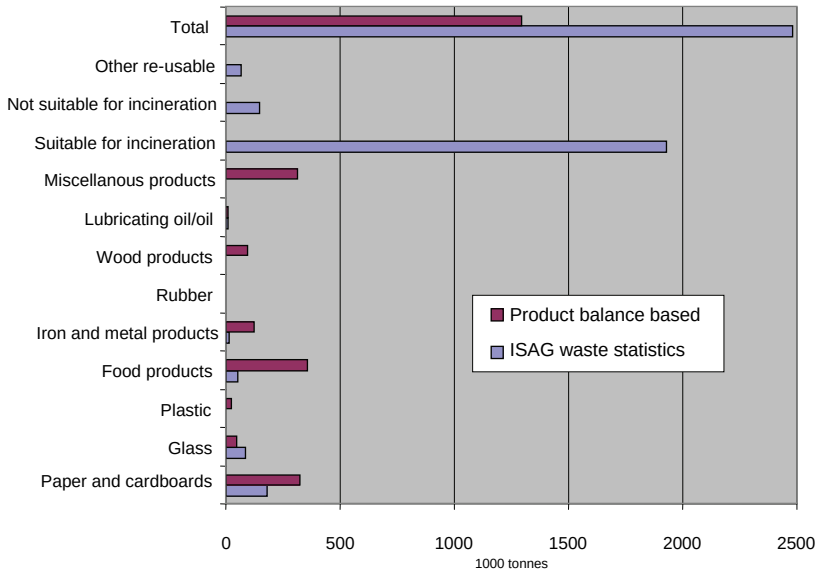


Figure 7. Household waste in Denmark in 1999 (excluding construction and garden waste), comparison of results from waste accounts and waste statistics per fraction. (ISAG: Information system for waste and recycling.). Source: Ole Gravgård Pedersen, Statistics Denmark, Project workshop presentation.

4.4 Waste accounts in Norway – the supply-of-goods method

The material on waste accounts in Norway was provided to the project workshop by Eva Vinju, Statistics Norway. Statistics Norway collects, among others, different kinds of waste data from Norwegian municipalities in the KOSTRA system. One finding from the waste statistics is that the total amount of waste has had a lower increase in relation the GDP growth with the exception of household waste, which is increasing faster. It appears like a higher consumption leads to an even higher waste generation, which is illustrated in Figure 8. According to Statistics Norway, the explanation could be an increase of imported goods for consumption, which means that the production of waste is generated abroad.[34]

[34] Statistics Norway, Waste accounts for Norway. Final figures 1995 to 2005, preliminary figures 2006 (http://www.ssb.no/avfregno_en/)

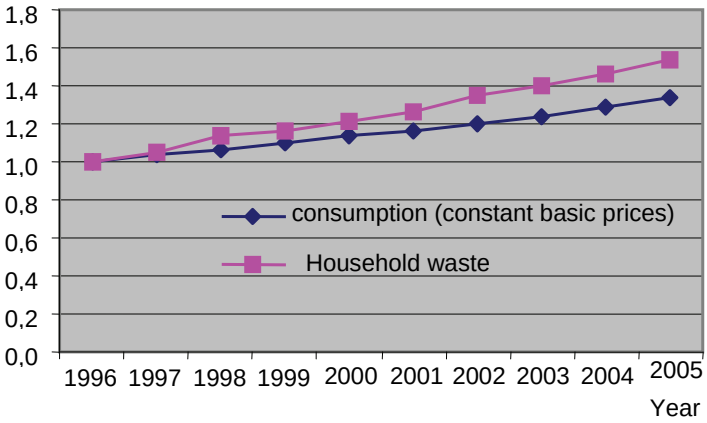


Figure 8. Consumption and household waste 1996 – 2005 in Norway (index 1996=1) Consumption in constant basic prices. Source: Eva Vinju, Statistics Norway, Project workshop presentation.

The waste accounts project begun already in the mid 1990s and the first set of sub-accounts were released in 1997. The first release of a full waste account was published by Statistics Norway in 2002 based on the supply-of-goods method. The accounts provide an overview of Norwegian waste quantities, sources of the waste, the kinds of materials and products it consists of, and how it finally is treated. The Norwegian waste account work has produced a number of reports on specific material flows and been synthesised in the report "Avfallsregnskap for Norge 1993–2000" (Waste Accounts for Norway 1993–2000)[35].

The background is the balance idea that all goods and products will become waste sooner of later. The method gives theoretical quantities of waste a given year and builds on calculated amounts of products consumed and estimations/knowledge about the products' lifetime. The input is based on estimates by the supply-of-goods-method from official import, export and production statistics. The output is based on the official waste statistics. The goods are, just like in the Danish case, allocated to codes and the waste statistics to materials and products. This means that there is a need to know what kind of materials each coded good consists of, allocate them in product groups with similar compositions and lifetimes. The product input according to the codes could be given in different units. Thus, it is necessary to translate the input data into weight units (tonnes), for instance by using reasonable prices per kilo of good.

The model is labour intensive to establish, but easy to use when established. It provides an alternative and independent data source, and allocates the waste to specific product types. It is, on the other hand, not considered suitable for durable goods with a lifetime exceeding about 30 years and does not distribute the materials to specific industries or treatment methods.

[35] Statistics Norway (2003) Avfallsregnskap for Norge 1993–2000 *(Waste accounts for Norway 1993–2000)*

Example: Plastics

The supply-of-goods method estimates the Norwegian plastic waste generation in 1997 to 368 000 tonnes, whereof most from consumption, while the waste statistics accounts that only 296 000 tonnes of plastic were disposed off, which is illustrated in Figure 9.

The difference could be an indication that 19% of the generated plastic waste ended up outside the conventional waste management system. About half of the estimated plastic waste input or 188 000 tonnes originated from households, but also the service industry had a significant contribution of 104 000 tonnes.[36]

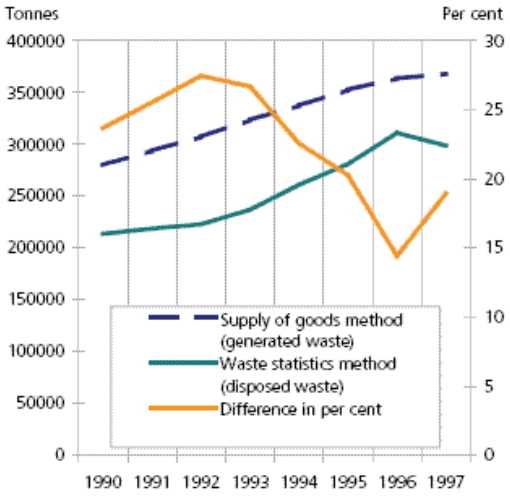


Figure 9. Total quantity of plastic waste in Norway 1990–1997, estimated by both supply-of-goods method and waste statistics. Source: Øystein Skullerud, Svein Erik Stave (2000).

Out of the 322 000 tonnes of consumption-related plastic waste generated in 1997, 23% of 83 000 tonnes came from packaging materials. The origin of the plastic waste is given in Table *18*. Despite the fact that packaging is the larges fraction, a substantial amount of plastics is apparently also used in products that, at least to some extent, were consumed by household and thus either end up in the household waste, accumulate or end up beside the ordinary waste management system.

Example: wood

Both the supply-of-goods method and waste statistics were used to estimate the Norwegian wood waste generation for the period 1990–1997.[37]

[36] Øystein Skullerud, Svein Erik Stave (2000), Avfallsregnskap for Norge - Metoder og resultater for plast *(Waste accounts for Norway – Methods and findings for plastic)*, Statistics Norway

[37] Barbara Kupis Frøyen, Øystein Skullerud (2000), Avfallsregnskap for Norge – Metoder og resultater for treavfall *(Waste accounts for Norway – Methods and findings for wood waste)*, Statistics Norway

Table 18. Norwegian quantities of plastic waste by product type in 1997. Source: Øystein Skullerud, Svein Erik Stave (2000).

Plastic waste: Fraction/product type	Estimated quantity in 1997 (tonnes)
Total	368 318
Total production-related	46 338
Total consumption-related	321 981
Packaging	83 497
Electrical & electronic	44 651
Machinery & tools	6 419
Building & construction products	51 636
Sanitary/household	62 563
Furniture & fittings	16 155
Means of transport (excl. ships)	20 551
Other products	36 509

In 1997 the calculated amount was 1 152 951 tonnes, but the statistics indicated the amount to be 1 032 044 tonnes. The deviation of about 10% was expected due to spill from production and waste from the construction sector, but may also be regarded as incorrect background data for input and output, and/or private combustion and unauthorised handling of the waste. One explanation considered as reasonable in the report is that the sorting analysis used for the waste statistics does not include “furniture and bulky waste” as separate fraction.

The industry was in 1997 the predominant source of wood waste with about 770 000 tonnes (66%) followed by the building and construction sector 226 481 tonnes (20%). The share generated by the households was about 10%, of which a significant part was furniture.

The loss from production is excluded when analysing what products contribute the most to the wood waste, since it cannot be related to specific products. More than half of it was related to the building and construction sector. A detailed account for the wood waste distributed on products is given in

Figure 10. Furniture is the second largest contributor to wood waste. It was estimated that 128 000 tonnes were disposed in 1997, which was an increase by 47% since 1990.

Table 19. Norwegian quantities of wood waste by product type in 1997.

Wood waste: product type	Estimated quantity in 1997 (tonnes)
Spill from production	734 763
Furniture	127 572
Packaging	43 610
Building & construction products	226 481
Other products	20 230

Source: Derived from Barbara Kupis Frøyen, Øystein Skullerud (2000).

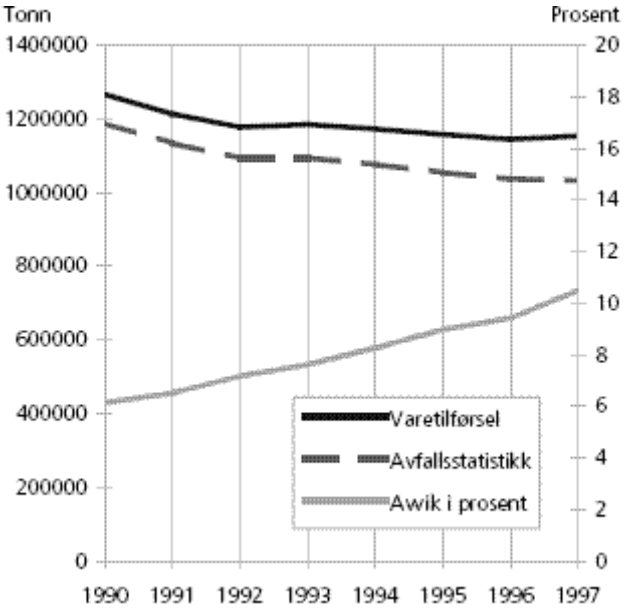


Figure 10. Total amount of wood waste in Norway calculated with supply-of-goods method and from waste statistics in 1990–1997 in tonnes and percent for the deviation. Source: Barbara Kupis Frøyen, Øystein Skullerud (2000).

Example: metals

According to the waste statistics, the Norwegian generation of metal waste in 1996 was slightly more than 700 000 tonnes. The theoretical calculations based on the supply-of-goods method indicate, however, that the input of metals could be three to four times as much[38]*, which is illustrated in*

Figure 11. The source provides several explanations to the discrepancy. Many of the sectors generating the waste are poorly covered by the waste statistics, much of the waste has never entered into the waste management system, and the product lifetime could be underestimated in the theoretical calculations. In addition, some of the metal corrode and "disappear". Nevertheless, the trends for both the calculated input and the registered output are increasing over the studied period of 1992 to 1996.

The most prominent sources of metal waste are industry, households and services. For the latter, the main contribution was from obsolete vehicles, ships and other means of transportation. The contribution from the households is primarily constituted of scrap cars. About 70% of the metal waste was recycled but it was estimated that around 20% was landfilled.

[38] Statistics Norway, Avfallsregnskap for metaller, 1992–1996 *(Waste accounts for metals 1992–1996)* Ukens statistikk nr. 45, 1998 (http://www.ssb.no/ukens_statistikk/utg/9845/2.shtml)

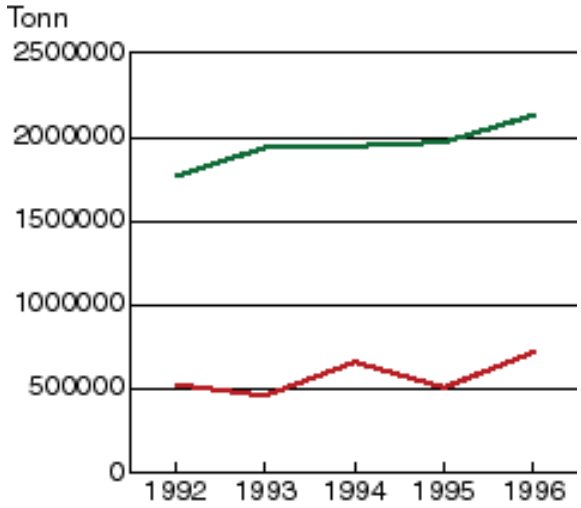


Figure 11. Registered metal waste distributed on sources 1992–1996. (Green line (upper): metal waste from theoretical input calculations Red line (lower): Registered amount of metal waste). Source: Statistics Norway, Avfallsregnskap for metaller 1992–1996.

The main contributing product category in the theoretical input calculations was “tubes and other products”, including a number of products difficult to clearly sort to any particular category. Beside that, the products which generate most metal waste are means of transportation, such as obsolete and scrapped vehicles, ships etc., construction, machinery and tools, and electrical and electronic products. A detailed breakdown is given in Table *20*.

It was acknowledged that there are large uncertainties in connection to the data: there could be errors in the statistics from 50 000 to 150 000 tonnes or 10 to 25%. Some possible reasons for such potential discrepancies are given in the report.

Table 20. Theoretical amounts of metal waste 1996 distributed on categories of products in tonne and per cent.

Category of product	Theoretical amount of metal waste (tonne)	(%)
Tubes and other products	1 007 864	49.5
Means of transportation (excl. ships)	308 887	15.2
Machinery & tools	195 317	9.6
Electric & electronic equipment	156 473	7.7
Ships & large constructions	148 068	7.3
Building	63 803	3.1
Roads etc.	52 969	2.6
Furniture	48 871	2.4
Packaging	40 244	2.0
Sanitation & household	12 728	0.6
Total (consumption related)	2 035 226	100

Source: Derived from Statistics Norway, Avfallsregnskap for metaller 1992–1996.

Example: textiles

The waste accounts also concludes that it was generated 106 000 tonnes of textile waste in 1998. 83 000 tonnes or 78% of is originate from the households.[39] Most of it is clothes, followed by leather wear and shoes. Figure 12 below shows the types of products that constitute the total textile waste in Norway. Even if reuse and recycling is increasing, most of the textile waste was landfilled.

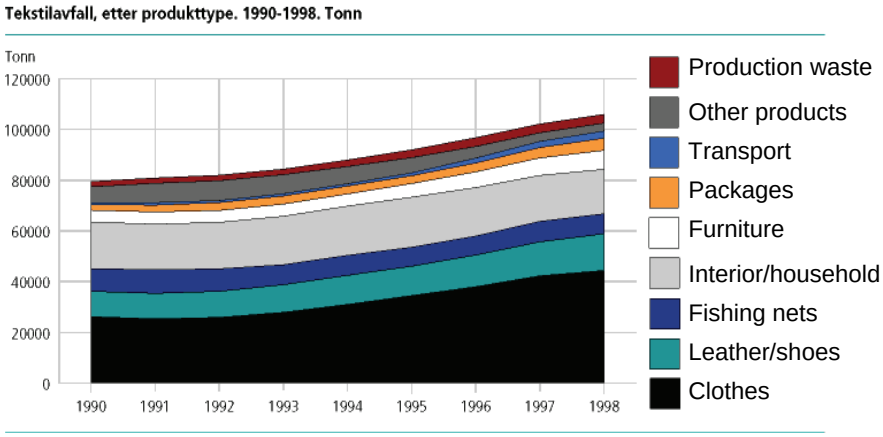


Figure 12. Textile waste distributed on types of products 1990–1998. Source: Statistics Norway, Avfallsregnskap for tekstiler 1990–1998.

[39] Statistics Norway, Avfallregnskap for tekstiler 1990–1998 *(Waste accounts for textiles 1990–1998)*, (http://www.ssb.no/avfregntekstil/)

Conclusions and recommendations

Conclusions

We know that the generation of waste is increasing, but do we know what kind of waste that is mainly contributing to this growth (food, packaging, newspapers, durable goods, etc.)? We also know that the waste amounts are increasing faster than the consumption. Are there trends we have not seen the full results of yet, or have we?

This study was initiated based on the conviction that we need to know more about the composition of household waste than we know today. It seems as if we pay prime attention to the material composition and treatment paths of the waste and have very limited knowledge of what products were discarded. Further, what we were told by experts, that is, that the amount of waste is growing, but the relative composition stays the same, might be true only for the material composition and not for the product composition.

Our curiosity and efforts quickly focused on what we came to call our target products, that is, product groups where the typical products are made of more than one material and durable. Examples of such products are among many others: furniture, electrical and electronic equipment, clothes, construction materials, toys, etc. Are these products an essential part of the growth of the waste generation? Is it possible to answer this question and various related questions about the details of the waste composition in product-terms today and in the future? What statistics are necessary for this? Are we already collecting such figures, or what would be needed to be able to address such questions.

We are convinced that this information could be crucial for developing the waste management systems of the future and to form efficient and sustainable product and waste policies. That is, policies that are not only taking the waste stream, and its potential growth over time, as a given fact, and thus solely focus on finding waste management solutions, but also policies that are giving possibilities for reduction, change of composition and necessary incentives for making that change a reality and a continuous process. To form such product policies and implement them in practice will demand a firm understanding of the trends and details of the consumption and waste generation in product-terms.

We are today measuring the waste in a way that does not give us the full picture. From some studies and observations, we get snapshots of the new type of development. In Iceland there is a clear increase in both

newspapers and electronics. We can recognise that the technology shift to flat screen TVs increased the amount of WEEE substantially, while the introduction of free-of-charge newspapers gave its significant imprint. Also the number of refrigerators went up, but we do not get any clear indication of why.

Waste statistics could be misleading, as they are sometimes reported in weight measures and sometimes in volume. Packaging material has probably reasonably reliable statistics, as well as some other product groups that happen to be singled out in today's statistics: newsprint, WEEE, and food waste. From our target groups, it is WEEE which is today collected in a way that gives us details about amounts and major types of sub-products. Other products that are mixed into the fractions collected kerb-side or in containers close to the residential homes are sometimes noted in pick analyses, but what we manage to get out of available statistics is more a rough estimate of the total amount of such products in these fractions, than details about the various product groups. The analysis of the Nordic waste statistics indicate that targeted products could constitute 5 to 20% of the domestic waste and may be an even larger share of the bulky waste.

There is weak knowledge on bulky waste and to what extent industrial waste gets into the household waste collection systems. There is a huge increase (20 to 40% since 2004) in bulky waste delivered to the recycling centres in Sweden, just like in the other Nordic countries. There are more WEEE and building materials adding to the waste of the recycling centres, but what else? This is most useful information, not least as the recycling centres are expensive to run. There is, however, a lack of consistent sampling methods for bulky waste. For instance, what products and fractions should be sorted and recorded? What sampling periods and how large a sample is needed for reliable data? In one of the examined spot-check studies, bulky waste from 2 000 houses only gave 2 nickel-cadmium batteries. That is, when searching for the less frequent items in the waste stream, we may need very big samples to reach reasonable estimates. It should, however, be possible to make fair "guestimates" of proportions of different fractions of bulky waste from asking people at, for instance, recycling centres.

There are valuable experiences of developing waste accounts in Norway and Denmark. Waste accounts provide an opportunity to estimate, with fair accuracy, the amount of products placed on the market annually. The present attempts of waste accounts indicate that the quantities of waste should be higher than what is reported in the waste statistics. Some accuracy is lost when the data is used for waste calculations because, for instance, industrial waste disposed of as household waste, accumulation (hoarding) is taking place (in the drawers, wardrobes, attics, cellars, summer houses, etc.), amounts of products for recycling and second-hand use abroad are often not well-recorded and the lifetime of durable prod-

ucts is difficult to estimate. The accumulated products will of course sooner or later end up in the waste collection systems.

Waste statistics focus, as mentioned above, mostly on materials with very few data sets on product level. Existing data sets, such as sales/consumption, expected time of use, waste accounts, waste statistics, could be combined to get a fair picture of the quantities of individual products as a cross-section of the waste flow, but much data needs to be "hand-picked", thus there is also a need to point out prioritised products when continuing the work.

We find similar policy objectives related to waste generation and waste management in most countries. An array of different laws and policy instruments, such as extended producer responsibility, different fees and taxes, information, and waste plans are used to address these problems, but the bulk of the problem has primarily been addressed through increased incineration and recycling of packaging materials. Collection of hazardous waste, such as batteries, WEEE, pharmaceuticals, etc. helps reducing the uncontrolled spreading of toxic materials. However, the Swedish EPA states that, despite such efforts, substantial amounts of hazardous waste end up in the sewage system or mixed with other waste and thus contaminate otherwise relatively harmless fractions. It could be as much as half of the hazardous waste generated by households ending up in the common waste system. The Swedish strategic plan for sustainable waste management concludes that "*Pollutants will continue to be a feature of waste management as products containing these substances are manufactured and discarded*" and continues "*Large quantities of the most common heavy metals and pollutants are still present in products that have not yet become waste.*" The preventative approach is also outlined in a similar way as found in other sources "*The amount of waste generated and how hazardous it is are determined as early as the product design phase. It is then that the quantity of materials used to manufacture the product and whether it will contain hazardous substances are decided. … measures taken at the waste stage can be formulated to provide feedback on the products that are difficult to deal with as waste.*"[40] All of this, which in essence could have been quoted from any of the Nordic countries, points to the crucial importance of combining waste policies with preventive product policies. To be able to do this, we need to understand how consumption and waste is composed today and how it will develop in the future.

Available information show that we could in the future expect more combined waste, for instance, WEEE and mixed waste. This may lead to problems in the following processing systems. Incineration is not a good solution for a number of these discarded products and waste fractions.

[40] Swedish Environmental Protection Agency (2005) A strategy for sustainable waste management – Sweden's waste plan.

Some of the main conclusions from the project are:

- Knowledge is needed to address issues on why waste amounts grow, being able to say something about the future waste flows and compositions, to work preventative.
- It is possible to answer much better than today "the question" (on products in household waste) based on current data, but the data has to be further processed (meaning a need of time and resources).
- Current methods need to be elaborated and further applied, but it should also be possible to figure out where the products end up.

Recommendations

As a result of the examination of Nordic waste statistics and consumption-related information, we will propose the following recommendations:

- Policymakers should consider the links between waste, chemicals and product policies in order to strengthen the information flow and feedback loops from the waste management system back to product designers and producers. This issue is highly topical as waste policies tend to shift towards material separation and collection rather than addressing targeted and often complex products, and how to prevent waste problems.
- There is a need to build better knowledge on the product composition in the current and predicted future waste streams. We concluded that current data and information sources could – when further processed and triangulated – form an important stepping stone. First and foremost, policymakers could facilitate a process for reinforcement and broadening of the necessary knowledge base through:

Supporting the development and application of refined pick analysis methods including specific product categories and measurement standards for domestic waste.

Initiating a general approach for mapping and surveying bulky waste, which to a larger share is constituted by target products. The information regarding bulky waste is substantially shallower in comparison to domestic waste. Thus, there is a need to develop appropriate analysis methods, supported and complemented by systematic and qualified estimations of the bulky waste composition from practitioners at the recycling centres.

There is capacity for doing the actual development work in the Nordic waste management and recycling sectors and research institutions but the resources must be allocated for the accomplishment.

Academia in the sustainable production and consumption area should be given the task and the resources to conduct case studies for selected product categories in order to bring better understanding of consumers' purchase and use patterns for selected product categories, not least in order to obtain reasonable estimations of product life/ownership times and thus bring light to the anticipated product accumulation.
The waste account approaches should be further developed and elaborated to trace and explain the discrepancies between expected and registered waste quantities within specified product areas. Both the waste accounts and the case study approaches aim at establishing balances for the specific product categories but through slightly different means and data sources.

- Policymakers and IPP expertise should ease the process through priorities of product areas and groups, based on for instance the products' expected or inherent environmental problems.

The fulfilments of the suggested recommendations require partly new interfaces between policymakers, practitioners in the waste management sector and academia, and not least, among experts and researchers of the related disciplines. The policymaking level has, though, the privilege and duty to initiate the processes both through engagement and allocation of necessary resources.

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6. Sammanfattning på svenska

Detta projekt om produkter i nordiskt hushållsavfall finansierades av Nordiska ministerrådet och utfördes av Internationella institutet för industriell miljöekonomi (IIIEE) vid Lunds universitet (Sverige) i samarbete med en projektgrupp bestående av Environice (Island) och Konsumentforskningscentralen i Finland.

Vi ser idag ett ökat varuflöde i samhället; allt fler produkter produceras, köps och förbrukas. Föreliggande undersökning tog sin utgångspunkt i frågeställningen ”var tar alla de produkter som konsumeras i samhället vägen?” Begreppet “produkter” avser i detta sammanhang varor/prylar, som konsumenter anskaffar för bestämda ändamål och som när de kasseras i allt väsentligt består av samma komponenter som i ursprungligt skick. Typiska fokusprodukter för vår studie är elektrisk och elektronisk utrustning, möbler, köksutrustning, byggmaterial, verktyg, trädgårdsredskap, böcker, leksaker, m.m. Det visade sig i förarbetet till studien att information om olika sådana varugrupper inte finns i avfallsstatistiken. Avsikten med denna undersökning är därmed att bidra till kunskapen om och hur existerande statistik och information kan användas för att beskriva avfallsflödets sammansättning på produktnivå, speciellt för våra fokusprodukter, samt hur och varifrån nödvändig kompletterande information kan samlas in.

Flera tillvägagångssätt användes för att söka relevant information: genomgång av befintlig avfallsstatistik och genomförda plockanalyser, rådfrågning av experter inom konsumentforskning, avfallshantering, återvinning och statistik, workshops med inbjudna experter från avfallssektorn, nationella avfallsräkenskaper, etc.

Avfallsstatistiken rapporterar i huvudsak kvantiteter i relation till var avfallet uppstår (hushåll eller industri, hushållsnära eller vid återvinningsstationer), material insamlade för återvinning eller efter slutbehandlingsmetod (förbränning, deponi, kompostering). Det är i princip endast elektrisk och elektronisk utrustning, s.k. el-avfall, som redovisas separat (vid sidan av förpackningsmaterial som inte faller inom denna undersöknings fokusprodukter). De genomgångna plockanalyserna understryker detta rapporteringsförfarande; de ger väldigt få beskrivningar av vilka produkter avfallet verkligen består av. Grova indikationer vi utläser ur statistiken tyder på ett fokusproduktinnehåll i storleksordningen 5 till 20 procent av hushållens säck- och kärlavfall. Osäkerheten är dock betydande beroende på vilka produkter som kan finnas i avfallskategorierna brännbart, ickebrännbart och deponi. Det ska också nämnas att flertalet plockanalyser genomförts på säck- och kärlavfall. Grovsopor, ofta lämnade i containerar vid s.k. återvinningsstationer, har undersökts i betydligt lägre grad.

Mycket tyder emellertid på att det är just i grovsoporna som många produkter och varor hamnar när de kasseras. Rimliga uppskattningar av grovsopornas sammansättning bör framöver kunna erhållas från personalen vid dessa mottagningsstationer.

En separat analys av information om förpackningsmaterial och elektronikskrot (el-avfall), som följer egna insamlingssystem ofta baserat på producentansvarslagstiftning, visar att det är möjligt att ställa upp materialbalanser och hålla reda på insamlade mängder. Återvinningsgraden beräknas emellertid baserat på insamlat material och uppskattningar av sålda kvantiteter under ett givet år, vilket förefaller ge rimliga resultat för förpackningsmaterial med kort användningstid men är mer komplicerat för långlivade produkter såsom elektrisk och elektronisk utrustning. I detta fall uppvisar de nordiska länderna snabba ökningar av insamlingsresultaten, vilket kan tolkas som att det finns stora ackumulerade mängder i samhället samt att konsumenter vill göra sig av med dessa produkter på ett mer ansvarsfullt sätt.

Konsumentforskning och -statistik kan ge information om i vilken grad olika produkter har spridits i hushållen, i vilken omfattning de används, etc., men saknar i huvudsak data om produkternas typiska livstid (hur länge de finns kvar i hushållen) eller var uttjänta produkter tar vägen när de kastas. Marknadsundersökningsinstitut kan dock genom sina konsumentpaneler ta fram sådan information på kommersiella grunder. Det kan påpekas att den växande andrahandsmarknaden i detta sammanhang fungerar som ”livstidsförlängning” och inte som slutstation för produkterna så länge de stannar inom länderna.

Metoder för avfallsräkenskaper för både samlade avfallsströmmar och enskilda produktområden har utvecklats (och utvecklas) i flera länder, främst i Danmark och Norge. Räkenskaperna bygger på input-output-analyser av marknaderna, beaktande uppskattningar av produkternas bruks-/livstider (vilket erfarenheter från el-avfallsinsamlingen visar är en svår uppgift). Resultaten från avfallsräkenskaperna tyder på att det bör finnas mer fokusprodukter i avfallet än vad avfallsstatistiken visar. Detta förhållande kan ha flera förklaringar såsom export av begagnade produkter, ackumulering i hushållen, felaktigheter i uppskattningar, produkter som hamnar utanför avfallshanteringssystemen, m.m. En slutsats var att avfallsräkenskaperna kan förfinas i flera avseenden samt brytas ner för enskilda produktgrupper för längre tidsintervall. Därigenom minskas osäkerheterna relaterade till produkternas bruks-/livstider och ackumulering.

En övergripande slutsats är att befintlig data, statistik och erfarenhet från olika källor förmodligen kan användas som en utgångspunkt för att göra rimliga uppskattningar av hur stor del av hushållsavfallet utgörs av förbrukade produkter samt vart de tar vägen.

Baserat på undersökningens resultat har vi kommit fram till följande rekommendationer:

- Beslutsfattare bör beakta sambanden mellan avfalls- kemikalie- och produktpolicies med syfte att stärka informationssystem och återkopplingar från avfallshanteringssystemen till produktutvecklare och producenter. Denna problemställning aktualiseras särskilt då avfallspolitiken nu inriktas mot insamling och återvinning av generella materialslag snarare än mot miljömässiga förbättringar av produkterna och att förebygga avfallsproblemen.
- Beslutsfattare bör främja djupare kunskap om produktsammansättningen i dagens och de förväntade framtida avfallsflödena genom att:
  - Stödja utveckling och tillämpning av förbättrade och standardiserade plockanalysmetoder, som även omfattar specifika produktkategorier för hushållens säck- och kärlavfall.
  - Initiera generella metoder för kartläggning och undersökning av grovavfall. Det finns behov av att utveckla ändamålsenliga analysmetoder som kan kompletteras med kvalificerade uppskattningar av grovsopornas sammansättning. Dessa uppskattningar kan hämtas från personalen vid de återvinningscentraler där grovavfallet lämnas.
  - Tilldela nödvändiga resurser; det finns tillräcklig kunskap och kapacitet i de nordiska länderna för att genomföra arbetet.
  - Ge forskare inom området hållbar produktion och konsumtion i uppdrag att genom fallstudier för utvalda produktområden förbättra kunskapen om konsumenters inköps- och användningsvanor samt i vilken omfattning produkter ackumuleras i hushållen.
- Beslutsfattare bör tillsammans med IPP-experter prioritera ett antal produktgrupper och -områden för att underlätta den ovannämnda processen. Beslutsfattarna har både privilegiet och uppgiften att initiera kunskapsuppbyggnadsprocessen både genom engagemang och genom tilldelning av nödvändiga resurser.