



WEEE system setup

a comparison of Sweden, Norway and Denmark

Linea Kjellsdotter Ivert, Hanne L Raadal, Anna Fråne, Hanna Ljungkvist

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Author: Linea Kjellsdotter Ivert, Hanne L Raadal, Anna Fråne, Hanna Ljungkvist

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Photographer: Hanna Ljungkvist

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IVL Swedish Environmental Research Institute Ltd.

P.O. Box 210 60, S-100 31 Stockholm, Sweden

Tel: +46-10-788 65 00, Fax: +46-10.788 65 90

www.ivl.se

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This report is a short summary of the findings from the project WEEE Setup, comparing the legislation and setup of the collection systems for Waste Electrical and Electronic Equipment (WEEE) in Denmark, Norway and Sweden. The setup aspects that have been studied and compared are the practical implementation of legislation, the material flows and financial flows in the systems and the clearing models used between actors in the respective countries.

Electrical and electronic equipment (EEE) such as computers, TV-sets, fridges and cell phones pervades modern lifestyles but its quick obsolescence is resulting in huge quantities of WEEE. The amount of WEEE is growing faster than any other waste category in the world and collection, treatment and recycling of WEEE is essential to improve the environmental management, contribute to circular economy, and enhance resource efficiency.

The project WEEE setup has studied legislation on EU and national levels, consulted scientific literature, conducted interviews with key actors within the WEEE systems in Denmark, Norway and Sweden, and analysed environmental impacts using LCA models. One general conclusion is that the countries, despite being geographically close, are quite different both in terms of legislation and in practical implementation and setup of the WEEE collection systems. The results of the project are not only of interest for the WEEE system actors in Denmark, Norway and Sweden, but may also be used as indications for best practice in Europe and for other products under extended producer responsibility (EPR) obligations.

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Legislation

The first WEEE Directive entered into force in February 2003 (2002/96/EC) and requires producers in the EU member states to take back their products from consumers and ensure their disposal through environmentally sound methods. In December 2008, the European Commission proposed to revise the Directive in order to tackle the rapidly increasing waste stream resulting in a new WEEE directive (2012/19/EU) that became effective on 14th of February 2014. The ten product categories covered by the directive are listed in Table 1.

Table 1: Categories covered by the WEEE directive

Number	WEEE Category
1	Large household appliances
2	Small household appliances
3	IT and telecommunications equipment
4	Consumer equipment
5	Lighting equipment
6	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7	Toys, leisure and sports equipment
8	Medical devices (with the exception of all implanted and infected products)
9	Monitoring and control instruments
10	Automatic dispensers

The WEEE directive is implemented into the national legislation of the three countries in different ways. The new directive has been implemented in Sweden and Denmark, but is expected to be implemented in Norway in the beginning of 2016. The current WEEE directive is implemented into the following national legislations:

- **In Denmark:**
Through an amendment to the Danish Environmental Protection Act and the WEEE Statutory Order (Elektronikaffaldsbekendtgørelsen)
- **In Norway:**
Forskrift om gjenvinning og behandling av avfalla (avfallsforskriften), kapittel 1 om EE-avfall
- **In Sweden:**
Förordningen om producentansvar för elutrustning, 2014:1075 (entered into force on October 15 2014)

The level of legislative detail is higher in Norway and Denmark compared to Sweden, which makes interpretation easier for the system actors. Denmark has the highest level of detail; governing the roles of actors and the terms for cooperation in the system. Since these details have been developed in cooperation with system actors, they are generally accepted as fair and are not seen as a market barrier. In general, clear and detailed legislation seems preferable, especially with regard to roles of actors and ownership of WEEE.

Another difference is the definitions of “WEEE from households”, where Norway stands out by basing this on the origin of the waste rather than the EEE product function. Norway also includes three additional categories (“Cables and conductors”, “Electrotechnical equipment” and “Fixed equipment for heating, air-condition and ventilation”) in its legislation whereas the categories in the WEEE directive are used in Denmark and Sweden. This means that more EEE is covered by producer responsibility in Norway compared to Denmark and Sweden. The requirements on take-back systems are very high in Norway and Sweden, making it difficult for new actors to enter the market and for producers wanting to take individual responsibility without cooperation with PROs.

The legislation does not put much focus on reuse and waste prevention. Some incentives for reuse exist in Norway, where reused volumes are subtracted from the overall collection requirements of the PROs. However, strong promotion of waste prevention and re-use could be improved in all three legislations, since this is key from an environmental point of view. It is also clear that both the WEEE directive and the respective national legislations were written at a time when waste was perceived to have negative economic value. Since the value of WEEE depends on material composition and changing market prices, future legislation should aim to be more flexible.

Implementation

Norway and Sweden have a longer history of producer responsibility than Denmark, which may explain some structural differences like the number of actors and their internal relationships. However, the key actors in the WEEE legislation in Denmark, Norway and Sweden are very similar on an overall level. The main difference is the additional key actor DPA-System in Denmark, a non-governmental, non-profit company working on behalf of the Danish EPA, to which there is no equivalent in Norway and Sweden. DPA-System has many tasks related to allocation of WEEE quantities, post adjustment, guidance, supervision and support to actors within the WEEE system. The allocation made by DPA-System of geographical municipal collection points between producers and PROs is unique for Denmark and eliminates the competition for volumes.

Sweden has only two PROs while Norway and Denmark have five and four PROs, respectively (see Table 2). However, 99% of the Swedish collection is covered by one PRO, making the logistics relatively efficient while reducing the competition in the system. Financial clearing based on market shares of the respective PRO members is used at the end of each period in order to allocate the collection costs. Norway represents the opposite situation, with all five PROs competing for WEEE in the entire country, covering more than 3000 collection points. Sweden and Denmark cover around 1100 and 400 collection points respectively. The number for Denmark only includes municipal and regional collection points, while numbers for Norway and Sweden include distributors, businesses and other types of collection points.

An overview of the PROs in the different countries are summarised in Table 2 below. The type of PRO is based on the PRO's own categorisation.

Table 2: Summary of the PROs in Denmark, Norway and Sweden.

	PRO	Type of PRO	Ownership	Members/producers	Collected** share 2013	Collection points
DK	elretur	Association, non-profit	EEE producers in the board	Not official	Not official	400+20 (municipal collection points + regional collection points)
	ERP	Commercial	Landbell			
	Rene	Commercial				
	LWF*	Association, non-profit	Producers of light sources on the board			
NO	Elretur	Non-profit	Trade association	4981	25%	About 3000***
	Elsirk	Commercial	RagnSells AB		6%	
	ERP	Commercial			25%	
	Eurovironment	Commercial	Elretur		3%	
	RENAS	Non-profit	Trade association		41%	
SE	El-Kretsen	Non-profit	Trade association	1602	99 %	About 1000****
	EÅF	Non-profit	EEE producer	69	1 %	126

* Lyskildebranchens WEEE Forening, only collecting light sources

** 2013 (collected rates, not taking int account cleared/post-allocated volumes)

*** Municipal, distributors and PROs' own

**** Municipal, distributors and businesses

Financial guarantees offered by the PROs

PROs in Denmark, Norway and Sweden have the possibility to fulfill the requirement of financial guarantees, which is done by all PROs. However, in Denmark, all the PROs have applied for exemption of financial guarantees (as they fulfil certain requirements), which have been approved. Thus, in practice neither the PROs nor their connected producers ensure financial guarantees in Denmark. Producers not registered to a PRO must, however, pay a specific management cost per EEE category calculated by DPA-System as basis for financial guarantees.

PROs in Norway and El-Kretsen in Sweden provide a collective financing solution for financial guarantees, included in their fees. In Norway PROs must have the financial resources to fulfill the obligations of their members for a minimum of six months. El-Kretsen has set aside funds to cover WEEE handling for at least one year of operation. At EÅF every product is individually insured and the financial resources set aside depend on the expected lifetime of each product. According to the webpage of EÅF¹ a major risk in a collectively financed solution is that a producer has to take responsibility for someone else's waste. This risk is eliminated by individually insuring each product.

¹ <http://elektronikatervinning.com/producentansvar/ny-producent/>

Clearing models

Clearing between PROs is based on market share in all countries, but can be adjusted based on allocation of WEEE volumes or costs. There are a number of factors that, depending on the characteristics of each country, have varying impact on the operation of PROs and the clearinghouse mechanism. Important influential issues are:

- Distance and geography, with smaller distances reducing costs for transport and logistics.
- Population size and density, where a higher population enables the generation of economic efficiencies and economies of scale.
- Cost of labour, as collection, sorting and treatment are highly labour intensive.
- Length of time in operation as, with time, there are greater opportunities to fine tune the system, negotiate better contracts with suppliers, rationalize overheads and invest in capacity.
- Consumer behaviour, with established PROs owing their success to prevailing consumer recycling behaviour. The level of WEEE recycling awareness in relation to specific product groups is also a key driver of success.

An overview of the respective clearing mechanisms is presented in Table 3. The most important difference is the allocation of physical collection points that is made by DPA-System in Denmark. In Sweden, the clearinghouse allocates the costs for collection and recycling between EÅF and El-Kretsen, but no physical volumes.

Table 3: Schematic overview of the clearing mechanism in the three countries.

Function	Denmark	Norway	Sweden
Organiser of the clearinghouse	DPA-System	Miljødirektoratet/WEEE Register	El-kretsen and EÅF
Who is connected to the clearinghouse	PROs and producers	PROs	PROs
Requirement for entering the clearinghouse	Open for every producer	Only certified PROs	Only certified PROs
Clearing	Volume	Volume	Financial
The decision on how to allocate volumes/costs	Based on the market share of what was put on the market the previous year	Based on the market share of what was put on the market the previous year	Historical WEEE based on current market share Cost for new WEEE is taken when the product is expected to become waste
The decision on how to allocate collection points	DPA-System	PRO must collect in all municipalities	No allocation. El-kretsen collects from municipal collection points.

The Danish model with allocation of collection points may be more difficult in Sweden and Norway due to shifting population densities and larger distances. As long as these differences are compensated for, volume-based clearing seems to be preferable together with allocation of municipal collection points, as this increases the efficiency in the system. However, this requires a strong third party and clear rules that are accepted by the actors. An open question is whether or not differentiation between historic and new WEEE in the system should be made, so that the producers are responsible for their specific products, rather than for a share of the total volumes put on the market.

Environmental impact

The environmental assessment was based on Life Cycle Assessment (LCA) methodology with the aim to answer two main questions:

- Which WEEE fractions are most important to recycle from an environmental perspective?
- How large is the environmental impact from transport compared to other environmental impacts from WEEE?

From a resource efficiency point of view, the fractions of most importance to recycle are the ones that contain material that is “costly” to produce from virgin resources. Scarce materials and materials that require a lot of energy for production (like virgin aluminum) should be given extra attention. The best option from an environmental standpoint is to re-use EEE products for as long as possible before they become waste. This can be achieved through repair and/or upgrading of software, often called remanufacturing, which is the core business of many companies (see for example www.rdc.co.uk).

To answer the second question, a comparison was made of the global warming potential related to material production and transportation of one kg of cargo on a diesel truck (Euro 3, 17,3 ton payload) for 1000 km, with a filling rate of 100% and 50% respectively. The results are presented in Figure 1.

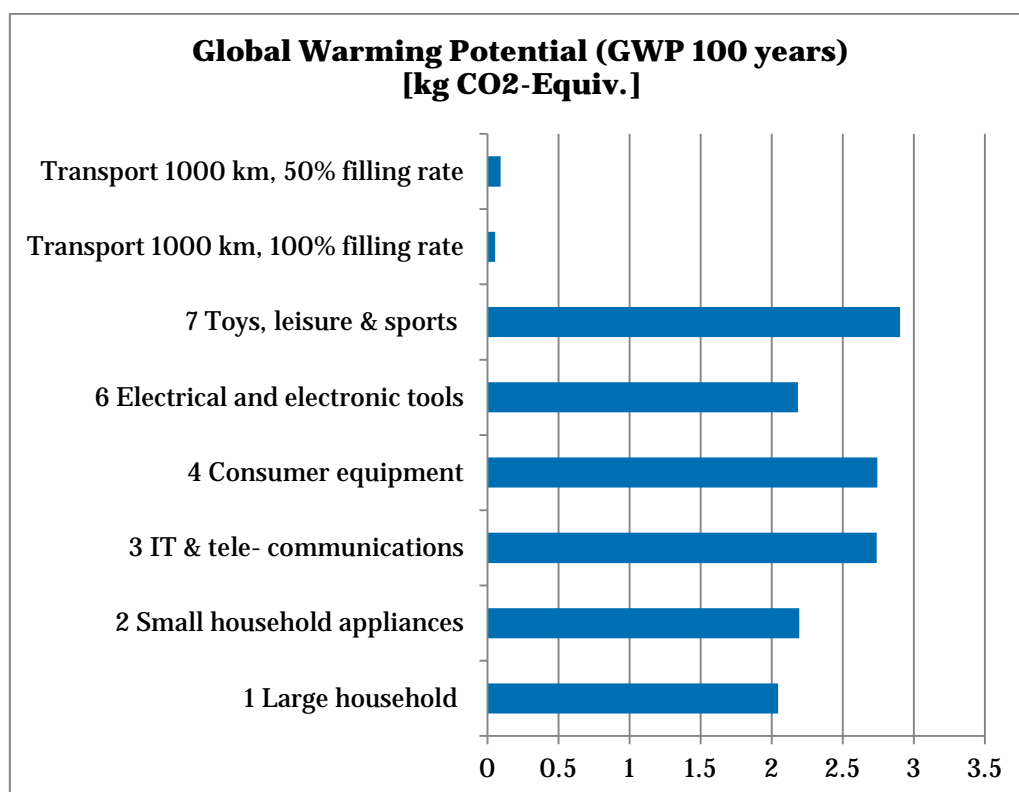


Figure 1: Potential climate impact from material production of one kg of the respective EEE fractions, compared to 1000 km transport of one kg WEEE (50 and 100% filling rate respectively).

The simple conclusion to be drawn from this example is that you can transport WEEE a long distance before the climate impact comes close to the impact from material production. Although transportation of WEEE should be made as efficient as possible, it is not the main issue from an environmental standpoint. As transport is often quite costly, there are economic incentives for efficiency that drive improvements in route planning.

Financial flows and material flows

The financial flows between system actors are summarised in Figure 2. The payment models and fees paid by the EEE producers to the PROs vary to a large extent, both within and between the countries. Fees can be based on value, mass, units, environmental hazard etc. This is part of the competition between the PROs. Also the setup between the municipalities and PROs vary between the countries. In Sweden, the municipalities are financially compensated by the PROs for collecting the WEEE, while in Norway and Denmark this work is supposed to be covered by the municipal waste fees. However, the Norwegian municipalities may be paid a sorting compensation by the PRO in order to sort the WEEE into certain categories.

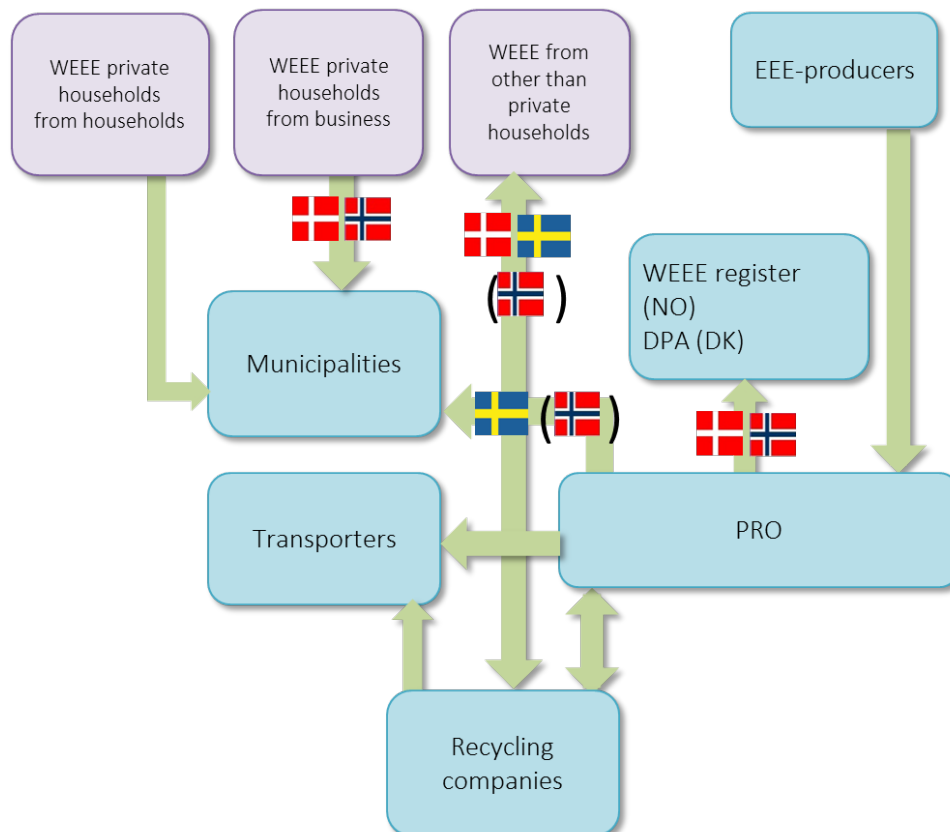


Figure 2: Overview of financial flows in the WEEE system.

In Denmark and Norway, DPA-System and the WEEE register respectively, are financed by the producers. In Denmark, the producers have to pay a one-off registration fee in addition to the annual fee based on EEE put on the market to DPA-System, while in Norway and Sweden the producers only pay fees to their PROs (no administrative fees). However, in Norway the PROs cover the costs for the WEEE register, which means that the producers indirectly pay for the services provided by this register.

The material flows of WEEE differ depending on the origin; WEEE generated by households takes other routes than WEEE generated from businesses. There is also an important distinction between two types of WEEE; from private households and from other than private households. The definitions are presented below:

- **WEEE from private households**
means waste of EEE used by consumers. WEEE from private household could come from private persons as well as commercial, industrial, institutional and other sources. It is the product in itself and not who has used it that matters (in accordance with the WEEE Directive 2012/19/EU).
- **WEEE from other than private households**
means WEEE, originating from EEE intended for professional use.

Figure 3 below shows the major collection routes in the different countries with respect to WEEE from private households from households. In all the following figures, only the main flows are presented bearing in mind that WEEE also can take other routes.

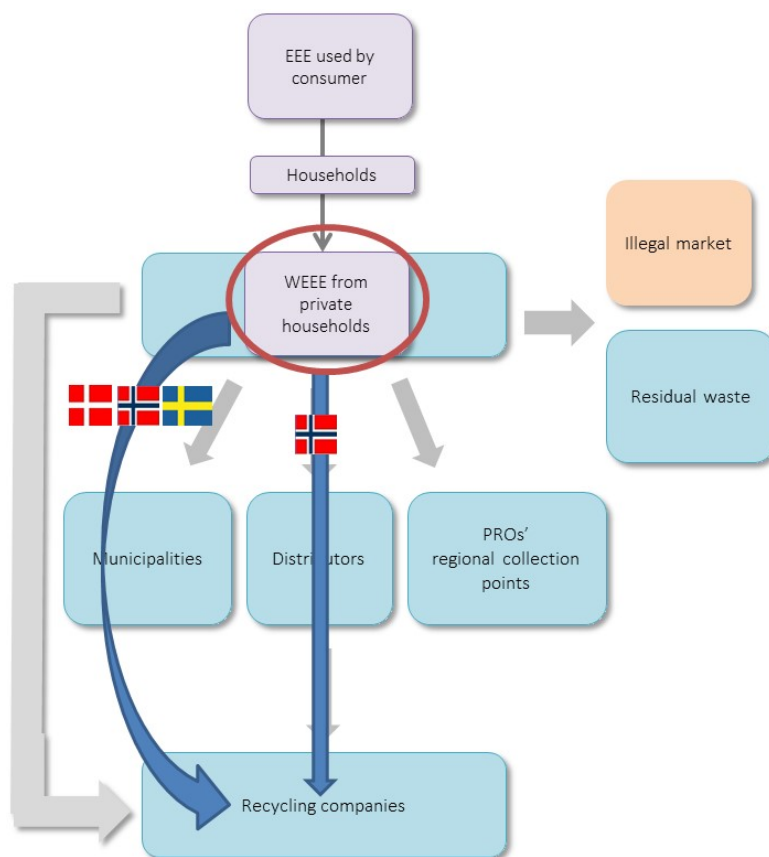


Figure 3: Major material flows for WEEE from private households from households.

The major collection routes for WEEE from private households from households in all the countries are municipal collection points, in particular the recycling centers. However, in Norway, the distributors represent a major collection channel as almost 40% of all collected WEEE from private households are collected through these channels. There is a large variation in the number of collection points in the three countries. In Denmark about 400 registered municipal collection points are operated, in addition to 20 regional collection points, while in Norway and Sweden about 3000 and 1125 collection points, respectively, are operated.

In Figure 4 the major collection routes in the different countries with respect to WEEE from private households from businesses are presented.

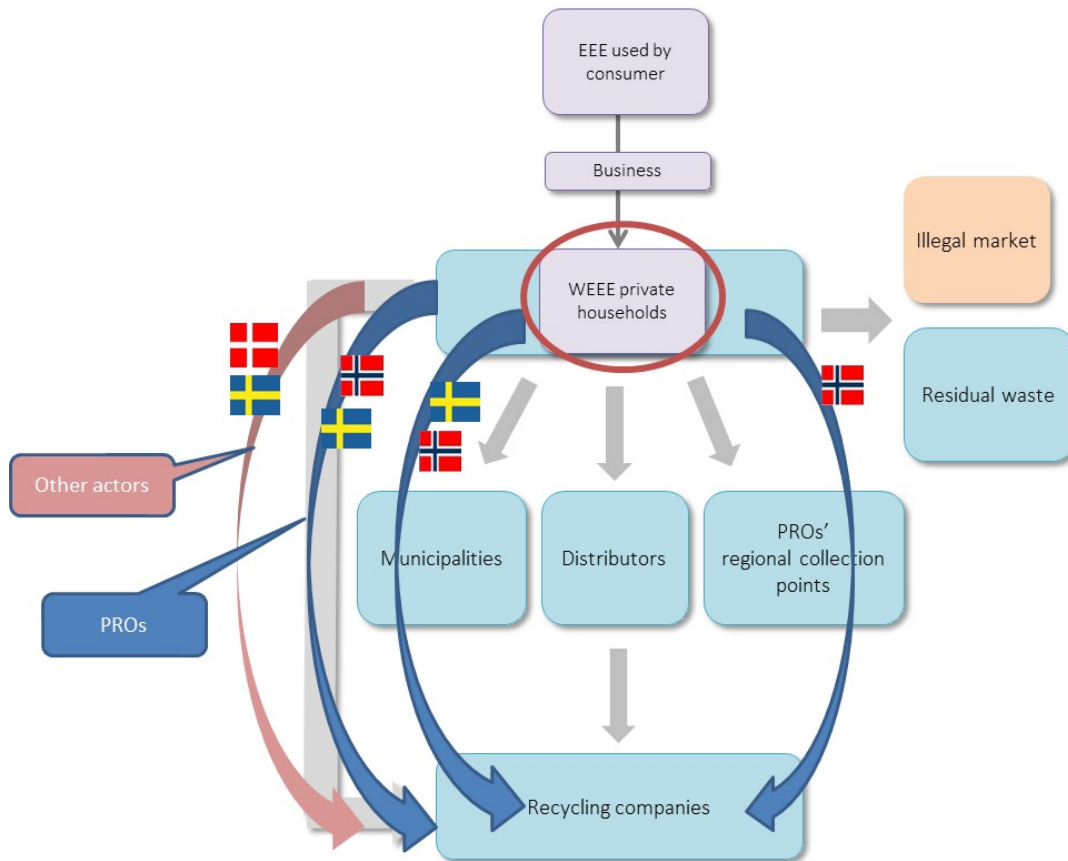


Figure 4. Major material flows for WEEE from private households from business.

The major route in Denmark for these flows is through actors other than PROs transporting the WEEE directly from the companies to recycling sites on a business-to-business level. In Norway, the PROs are the main actors for this flow and a major flow also passes through the municipalities' recycling centers. In Sweden both PROs and other actors are involved in the collection of WEEE from private households from businesses.

Figure 5 below shows the major collection routes in the different countries with respect to WEEE from other than private households.

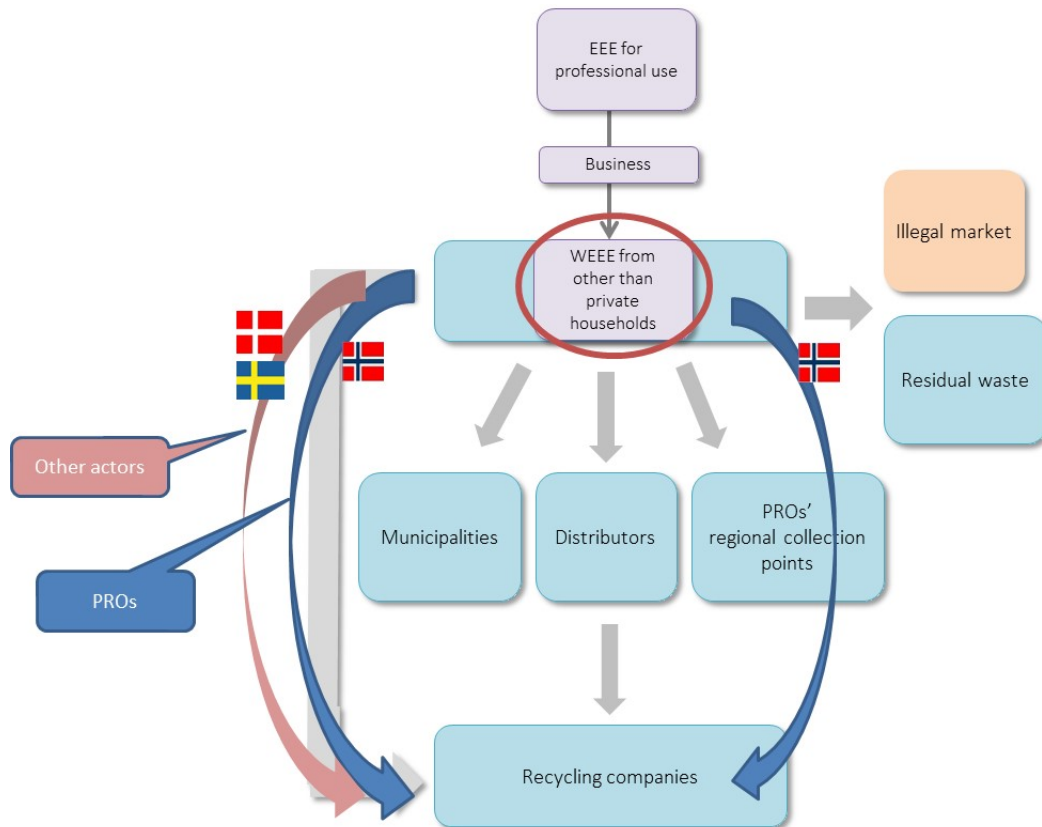


Figure 5. Major material flows for WEEE from other than private households.

The majority of these flows are in Denmark and Sweden collected directly on a business-to-business level by other actors than PROs (transporters/recyclers) while the PROs still are the main actor also for these flows in Norway (either collected directly from the companies or through regional collection points).

In all the three countries, the PROs enter into agreement with transporters and/or recycling companies of collection and treatment of WEEE. In Denmark, after the geographical allocation has been decided, it is up to the municipalities and the transporters to agree on the practicalities of the WEEE collection. If any problem arises, the municipalities turn to the PROs as they are formally responsible for collection. However, the municipalities can order collection at their collection points whenever needed, as this is stated in the WEEE Order. In Sweden, the ordering planning system "Ataio" decides the frequency of WEEE collection at the municipal collection points while, in Norway, this is up to the respective PRO and their agreement with the transporters.

Statistics

According to the official statistics, the collected amounts of WEEE from private households per capita was 12.5 kg in Denmark, 15.6 in Norway and 17.4 kg in Sweden in 2013 (see Table 4). It should, however, be emphasized that the Norwegian figure only includes WEEE generated by private households. When including WEEE from other than households the figure is 22.0 kg per capita.

Table 4: Volumes and collection rates for the three countries in 2013.

Year 2013	Quantities put on the market(ton)		Quantities collected (ton)		Collection rate (%)
	EEE from consumer	EEE for professional use	WEEE from private households	WEEE from other than private households	(WEEE from private households /EEE used by consumer)
Denmark	114 007	24 426	70 845	1 236	62%
Norway	181 650 (sum)		76 015	28 912	58 %*
Sweden	215848	26820	166210	10357	77 %

*Calculated for Norway as: WEEE total collected/EEE total put on market

The total amount of EEE put on market in the ten categories must be reported according to the respective legislation. In Denmark and Sweden the producers/PROs report data to the national register, while Norwegian statistics on EEE put on market are gathered by the customs on a monthly level. This likely improves the quality of the data in Norway. Private import of EEE should also be declared in Norway if the amount exceeds 350 NOK, while private import is not at all covered in the Danish and Swedish statistics. The overall collection rate for WEEE from private households lies around 60 percent for both Denmark and Norway, whereas the collection rate in Sweden was almost 80 percent in 2013.

The collected quantities of WEEE all derive from national registers. It is important to remember that statistics do not cover all WEEE flows, such as business-to-business volumes, and that figures are not readily comparable due to national differences in definitions, reporting procedures etc. In Table 5 the underlying sources for the official statistics on collected quantities of WEEE are summarised. X means that the flow is reported with relatively good coverage, and (X) means that the flow is reported to a limited extent, which is the case for distributors' collection in Denmark and Sweden.

Table 5: Underlying sources for the official collection statistics.

	Denmark	Norway	Sweden
WEEE from private households collected:			
- from municipal collection points	X	X	X
- by distributors	(X)	X	(X)
- from PROs regional collection points	X	X	-
WEEE from other than private households collected:			
- on a business-to-business level	-	-	-
- by distributors	(X)	X	(X)

The gap between EEE put on market and WEEE collected has been rather stable during the latest years in all three countries. The recovery and recycling targets set in the WEEE directive are met for all categories of WEEE in Denmark, Norway and Sweden. The targets are calculated based on the same principles, collected amounts of WEEE divided by the recycled or recovered quantities of WEEE for each category.

Free-riders exist in all countries, but the quantitative impact is difficult to estimate. Norway is assumed to have minor problems with free-riders as the data on EEE put on the Norwegian market is retrieved from customs statistics. Illegal export of WEEE to countries outside Europe also takes place, but seems to be less common in the Nordic countries than on the EU level according to some studies.

Concluding remarks

It is evident that the three studied countries have different legal frameworks and different implementation of their respective WEEE systems. Some conclusions drawn from the project are:

- Legislation does not take into account the value of WEEE in a sufficient way. The economic value of certain fractions leads to competition that can hamper the overall efficiency of the system. Denmark is a good example of where this is dealt with by detailed rules and instructions, developed in collaboration with the system actors.
- Due to differences in legislation, reporting procedure etc., the collection and recycling related statistics are not readily comparable between the countries. The official statistics also lack important flows, such as business-to-business flows and private import.
- Sweden collects more WEEE per capita than Norway and Denmark (although numbers are not readily comparable). This may be due to the few PROs involved and a good planning system which results in a more efficient collection.
- An interesting potential clearing solution may be to combine financial clearing with volume-based clearing, using financial compensation on top of the clearing to achieve a more fair allocation that takes e.g. geography and population density into account. Another solution for financial clearing is to use it for post-adjustment instead of adjusting physical volumes.
- In terms of environmental performance, transport has limited impact. Increasing transport efficiency is mainly driven by cost reductions. Highly complex products containing valuable metals have a higher environmental impact and are therefore very important to recycle.

APPENDIX: Definitions

For the purpose of this report, the following definitions apply.

Clearinghouse is a function that monitors and coordinates allocation of WEEE collection between the producers. It may also include geographical allocation of collection points.

Collection means the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purpose of transport to a waste treatment facility (in accordance with the Directive 2008/98/EC).

Collection point is a point in which WEEE is collected. It covers everything from small cabinets such as the "Röda boxen" and "Samlaren" to recycling centres.

Distributor means any natural or legal person in the supply chain, who makes an EEE available on the market. This definition does not prevent a distributor from being, at the same time, a producer (in accordance with the WEEE Directive 2012/19/EU).

EEE used by consumer means EEE that typically could be used in private household. Still it is not restricted to private persons only as also commercial, industrial, institutional and other sources may use EEE that could be used in private household (e.g. computers, telephones, answering systems, fax, printers etc.).

EEE intended for professional use means EEE that typically not is used in private households, e.g. automatic dispensers, radiotherapy equipment etc..

Electrical and electronic equipment (EEE) means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such current and fields and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1600 volts for direct current. (in accordance with the WEEE Directive 2012/19/EU).

Extended producer responsibility (EPR) is an environmental policy approach in which a producer's responsibility for a product is extended to the post consumer stage of the product's life cycle, including its final disposal" (Widmer et al., 2005).

Financial guarantee: A guarantee that ensures funding to take care of products that have been put on the market when they have become waste.

Free rider is a person or a company who put EEE on the market but is not registered to the EPR system.

Historical WEEE: EEE that has been put on the market before 13 August 2005 and that has become WEEE (Khatriwal et al., 2011).

New WEEE: EEE that has been put on the market after the 13 August 2005 and that has become WEEE (Khatriwal et al., 2011).

Producer means 1) anyone that manufacturers and under his/her own name sell EEE. 2) anyone that under his/her own brand sell EEE. 3) Anyone that import and then sell EEE. 4) Anyone that sells directly to a user in another country in EU (in accordance with the homepage at Elektronikätvervning i Sverige).

Producer responsible organisation (PRO) fulfil the EPR obligations of their members by organizing pick-up of waste from designated public and distributors collection points, ensuring subsequent treatment and recycling, and performing reporting to national governments (Mayers, 2007).

Recovery means any operation primarily using waste for a useful purpose by replacing other materials, which would otherwise have been used to fulfil a particular function, or waste being

prepared to fulfil that function, in the plant or in the wider economy (in accordance with the Directive 2008/98/EC).

Recycling means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations (in accordance with the Directive 2008/98/EC).

Recycling center is a site where waste is collected and often sorted for processing. It is usually open to the public for personal deposit. These facilities usually handle metals, plastics, paper, cardboards, wood, hazardous waste and organic waste.

Recycler company is a company that pre-treats and/or recycles and/or processes waste material.

Re-use means any operations by which products or components that are not waste are used again for the same purpose for which they were conceived. (in accordance with the Directive 2008/98/EC).

Transporter is a company undertaking professional transport of goods.

Waste electrical and electronic equipment (WEEE) means EEE, which is waste, i.e. any substance or object which the holder discards or is required to discard, including all components, sub-assemblies and consumables which are part of the product at the time of discarding (in accordance with the Directive 2012/19/EU and 2008/98/EC).

WEEE from private households means waste of EEE used by consumers. WEEE from private household could come from private persons as well as commercial, industrial, institutional and other sources. It is the product in itself and not who has used it that matters (in accordance with the WEEE Directive 2012/19/EU).

WEEE from other than private households means WEEE, originating from EEE intended for professional use.

CHALMERS INDUSTRITEKNIK



IVL Swedish Environmental Research Institute Ltd., P.O. Box 210 60, S-100 31 Stockholm
Phone: +46-10-788 65 00 Fax: +46-10-788 65 90
www.ivl.se