The Collection and Recycling of Used Mobile Phones: Case studies of selected European Countries

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Case studies of selected European Countries

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Lund, 2011.

Naoko Tojo & PaNate Manomaivibool

Absract

'This study examines the collection and recycling systems in selected countries in Europe – Finland, Germany, Sweden, Switzerland and United Kingdom – where such systems are already in place based on legislation. Based on the review of various written sources as well as interviews with stakeholders (manufacturers, producer responsibility organisations, national government officials, distributors/network providers, municipalities, second shops, refurbishers), we seek to map out the concrete operational mechanisms in the five countries and to find out the perception of actors engaged in such operations. In addition, the overall flow of the mobile phones in five countries is presented in the form of a material flow analysis (MFA).

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1 Introduction

1.1 Mobile phones and the environment

Mobile phones are among the fastest growing information and communication technology (ICT) equipment in terms of both functions they provide and the amount shipped to the market. A modern mobile phone provides so much more than the basic function of a telephone – i.e. means of telecommunication – all the way from alarm clock and games to camera and access to the Internet. As of 2009, more than 1.2 billion mobile phones were sold worldwide (Gartner 2010). The global average mobile phone subscription per 100 inhabitants marked 59 in 2008, with the annual average growth rate of 23% between 2003 and 2008 (ITU 2009a). The subscription rate per 100 inhabitants exceeded 100 in a number of European, Asian and Arabian countries (ITU 2009b; ITU 2009c; ITU 2009d). Accompanied by the aforementioned development of the functions, sales and penetration of mobile phones is their rapid replacement cycle.

The environmental impacts of a mobile phone from life cycle perspective are heavily loaded in the manufacturing phase (Yu et al. 2010). Mobile phones also contain a number of precious metals as well as hazardous substances, although the amount contained in the individual phones has decreased over time. In order to enhance resource efficiency and material recovery while reducing the risk of environment and health impacts from end-of-life phase, it is important to extend the life of mobile phones, as well as to close the material loop. The first important step especially in relation to the latter is to establish an efficient collection system for used mobile phones. However, the collection rate of used mobile phones tends to be very low – the global average being 3-5 %. It is said that significant portion of these phones are hibernating in places such as users' home and offices. For instance, according to the survey that Nokia conducted in 2008 with 6500 people in 13 countries,[1] an average phone user owns five phones, and only only 3% of people recycled their old mobile phones (Nokia 2009).

In Europe, the Directive 2002/96/EC of the waste electrical and electronic equipment (WEEE Directive) provides a legislative framework for the EU Member States to take mandatory measures for – among others – enhancement of collection and recycling of mobile phones. Based on the Directive as well as other national policies, European countries have developed systems to collect used mobile phones for reuse and/or recycling. In contrast, despite the availability of voluntary collection and recycling systems to an extent, no legislative measures have been taken so far in Japan. The existing voluntary system have not achieved satisfactory collection rate.

A growing number of studies started to emerge on the design and implementation of the management of end-of-life management system of electronics in general. However, those focused on mobile phones, especially in developed countries, are scarce.

1.2 Objective

This study aims to examine the collection and recycling systems for used mobile phones in selected countries in Europe where such systems are already in place based on legislation. The overall intention of the study is to contribute the knowledge gained in this study to the development of an appropriate system for the collection and recycling of used mobile phone in Japan. The study consititutes part of the collaborative research between the National Institute for Environmental Studies, Japan and the International Institute for Industrial Environmental Economics at Lund University, Sweden.

Among various stages of the management of post-consumer mobile phones, the study primarily focuses on their collection, due to its

[1] The 13 countries covered in the survey were Finland, Germany, Italy, Russia, Sweden, U.K, United Arab Emirates, USA, Nigeria, India, China, Indonesia and Brazil (Nokia 2009).

critical role for any good reuse/recycling systems. Although discussions related to reuse/recycling of the collected used phones are made when relevant, the detailed description and analysis of the reuse/recycling process per se is not included in the study. Information and analyses about reuse and recycling of mobile phones can be found in Chancerel (2010), Geyer and Doctori Blass (2010) and Regenersis (2009).

1.3 Methodology

1.3.1 Case selection

This study follows a multiple-case design. It starts with a compilation of background information about European countries for the case selection. Table 1-1 presents the telecommunication and waste statistics from the Eurostat and the characterisation of national WEEE systems based on a review of the transposition and implementation of the WEEE Directive by Sanders et al. (2007).

Table 1-1 Background information of European states

Country	Subscriptions, 2006 (in million)	Penetration rate, 2006 (%)	PRO	Collection (physical) [a]	Collection (financial) [b]	Collection WEEE, 2006 (kg/capita)	Collection ICT, 2006 (% of sales)
Austria	9.257	112	Competitive	D/M/P	D/P	7.58	42.17
Belgium	9.383	89	Single	D/M	D	7.25	19.10
Czech Rep	12.753	124	Competitive	D/P	D/P	0.00	n/a
Denmark	5.830	107	Competitive	M	M	11.10	44.11
Estonia	1.579	117	Single	D/P	D/P	4.35	27.48
Finland	5.679	108	Competitive	D/P	P	7.55	38.17
France	51.663	82	Competitive	D/M/P	D/P	0.24	4.20
Germany	85.700	104	Competitive	M	M	9.15	32.50
Greece	10.980	99	Single	P	P	1.02	6.49
Hungary	9.966	99	Competitive	P	P	2.39	21.53
Iceland	0.323	108	Single	D/M	D/M	n/a	n/a
Ireland	4.700	112	Competitive	D/M	D/P	n/a	n/a
Italy	78.571	134	Single	D/M	D/M	n/a	n/a
Lithuania	4.718	139	Competitive	D/M/P	P	2.73	19.50
Netherlands	18.400	113	Single	D/M	D/M	5.78	29.72
Norway	5.041	109	Single	D/M	P	21.90	58.71
Poland	36.758	96	Competitive	D	D	0.45	2.49
Portugal	12.226	116	Competitive	D/M/P	D/P	0.40	6.03
Slovakia	4.893	91	Competitive	D/P	D/P	1.59	14.99
Spain	46.169	106	Competitive	D/M	P	0.00	0.00
Sweden	9.607	106	Single[c]	P	P	14.38	57.24
Switzerland	7.431	100	Single[d]	D/P	P	14 [e]	n/a
United Kingdom	69.657	115	Competitive	D/P	D/P	6.98 [F]	10.21 [f]

Note [a] Actors with the responsibility to provide the collection service by laws: D = distributors, M = municipalities, and P = producers.
[b] Actors with the responsibility to finance the collection service by laws: D = distributors, M = municipalities, and P = producers.
[c] After 2007 a new compliance scheme emerged in Sweden, thus now the country has at least two systems.
[d] Tojo (2004).
[e] Switzerland is not included in the Eurostat's WEEE statistics. This is the figure for 2007 derived from SENS (2008).
[f] No data available for 2006 due to late implementation in the UK. These are the 2007 figures from the Environment Agency.
Source: Eurostat and Sanders et al (2007) unless specified in footnote above.

Five cases are selected for this study: Finland, Germany, Sweden, Switzerland, and the UK. Germany and the UK are examples of populous countries in Europe with a competitive compliance approach. Germany is the only country in this study that municipalities have the statutory responsibility to collect WEEE. Although the UK is the latest to have a national WEEE system with the implementation started in the second half of 2007, it provides

arguably the most prolific and well documented case for the collection of used mobile phones for reuse. Meanwhile, Finland, which also takes competitive compliance approach, is among the less populated countries in Europe. The country enjoys the presence of the biggest manufacturer of mobile phones, Nokia. Sweden also has another major mobile phone manufacturer, Sony Ericsson. It is one of the few EU Member States which introduced producer responsibility system for EEE prior to the coming into force of the WEEE Directive, which was managed by one major compliance scheme until recently. Switzerland unlike the other four does not need to transpose the WEEE Directive but has a well developed system for WEEE with the longest history in Europe. It has a single compliance system for the respective WEEE streams.

1.3.2 Data collection

This research relies on both qualitative and quantitative data. Qualitative data describe the collection and recycling systems in different cases. The main sources of the system description are the legal texts, literature, and websites of relevant actors. With an exception of Switzerland, the other four countries have transposed the EC WEEE Directive. The next chapter thus introduces the Directive and its main provisions related to mobile phones. Under each case study, we then focus on the results of the policy making and implementation at the national level. Qualitative interviews, conducted via telephones and through e-mail correspondence, provide supplementary information about the systems and the actors. The list of interviews and the general interview guide containing key basic questions are found in Appendix I and II. For Sweden, additional interviews and field studies were carried out by eight Swedish MSc students as part of their course assignment on Instruments for Preventative Environmental Protection. Followed by the initial search on the Internet, they contacted four groups of actors involved in the collection of used mobile phones – producers, distributors and network providers, municipalities and second-hand shops and refurbishers – and investigated the activities and attitudes of those actors. The interviewees in the students' field study as well as the names of the students conducting the study of the respective actors are also found in the Appendix I.

Based on the qualitative data, we construct a generic model for a material flow analysis (MFA), as shown in Figure 1-1. The model serves as a point of departure for the collection of quantitative data. This MFA is conducted at the commodity level. It follows the stocks and flows of mobile phones within a national boundary. The determination of stocks and flows relating to the system or a process follows the mass balance principle, expressed in the equation below:

$$\sum M_{input} = \sum M_{output} + \Delta M_{stock}$$

where *M* is the mass of a flow of a stock. MFA is executed with STAN 2.0.1702 (subSTance flow ANalysis), a freeware developed by Institute for Water Quality, Resources and Waste Management at Vienna University of Technology. The results are in "(million) units" and the conversion from weight assumes the average weight of 200 grams per unit, unless stated otherwise. The rest of this chapter describes the processes presented in Figure 1-1 before commenting on the availability and the quality of quantitative data.

1. *Distribution*: New handsets (F1) and second hand handsets (F11) are sold in the domestic market. Data on sales (F2) are obtained from market surveys such as GfK retail surveys. The put-on-the-market data that producers report to the competent authorities under the WEEE legislation are not directly useful in this study because they are reported by weight and aggregated at the category level (in this case, Category 3: IT and telecommunications equipment). To simplify the model, we ignore the stock of phones in the distribution process.

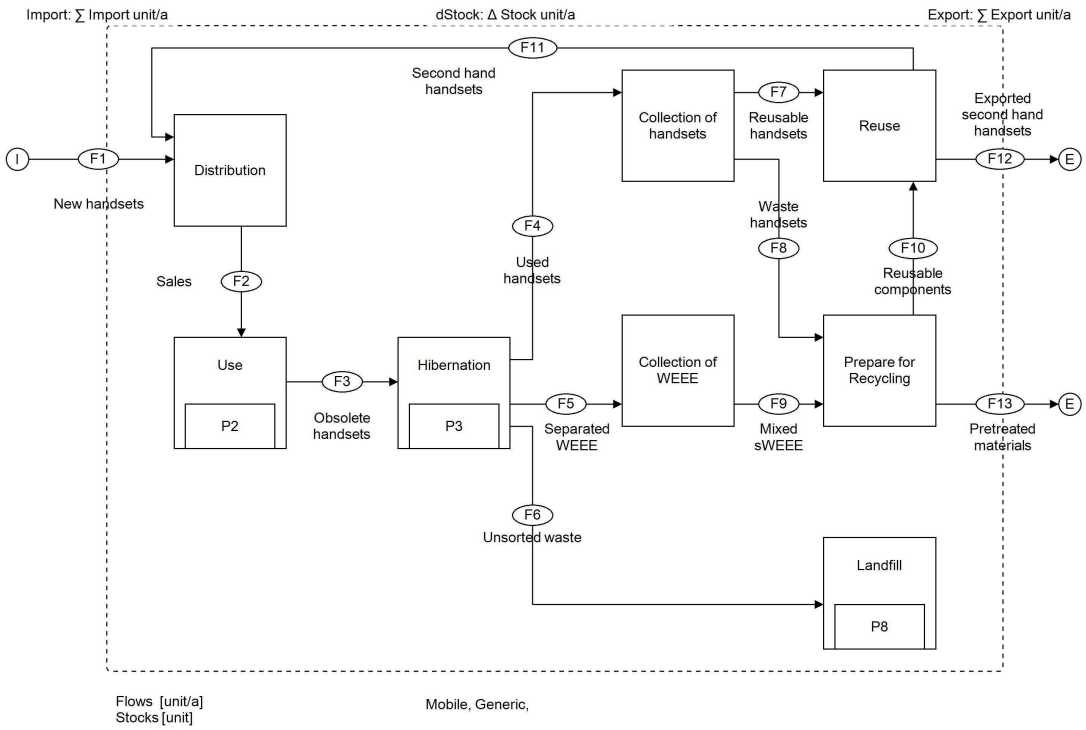


Figure 1-1: A generic model for the material flow analysis used in this study

2. *Use*: The products are used before being replaced. The stock (P2) indicates the number of mobile phones in active services. To quantify the stock in use, we rely on the subscription data published by the telecommunication regulators and network operators in each country. Using subscription data directly can overestimate the number of mobile phones in service where people have more than one subscription to enjoy attractive tariffs within different networks and use multiple SIM cards with one handset. To adjust for this phenomenon, we calculate the factor, "SIM per user", using the formula proposed by Garner (2007):

   $$Y = 1 + 0.32\ X\ \hat{}\ 2.4$$

   where Y is the number of SIM per user and X is reported penetration rate (%). A change in the stock (ΔM_{stock}) can then be calculated to be the difference between the corrected subscriptions at the beginning and at the end of the period. The ΔM_{stock} can also be referred to as the number of first-time users in the period. The difference between total sales and the sales to first-time users is the number of replacement sales. Graphically, STAN will produce a result similar to Figure 1-2. Without the information on the number of handsets a user owns, we assume a 1:1 relationship between replacement sales and obsolete products (F3). This assumption can lead to an overestimation of obsolescence. In reality, some users may actively use more than one handset at a time. To lessen the effect of this overestimation, we create the next process, "hibernation". Replacement is thus not immediately translated into a generation of WEEE. The replacement period, calculated by dividing the stock with the replacement sales, can be defined similarly as the domestic service lifespan.

3. *Hibernation*: After the products become obsolete, they become part of the stock of hibernation (P3) until they are collected for reuse and recycling (F4, F5) or discarded as unsorted waste (F6). This is believed to be the fate of the majority of obsolete handsets. A global survey by Nokia

(2008) indicates that 44% of respondents simply keep their unused phones at home. When this number is corrected to disregard the 25% share of phones given to friends and family members assumed to be within a national boundary which would be classified as part of the stock in active use in this study, the share of retired handsets go to hibernation can be as high as 59%. However, because data regarding the absolute size of hibernation stock is rarely available (unlike time-series subscription data which are well documented), we do not attempt to estimate the hibernation period. Total lifespan reported in previous studies is approximately equal to the combined replacement and hibernation period. In addition, the availability of the data can affect the quantitative MFA. Figure 1-3 compares a normal case (a) with a case where the calculation can only be partially performed: (b) the change can be calculated (beginning with the + or – sign) but the available information is not sufficient to establish the size of the stock at the beginning of the year.

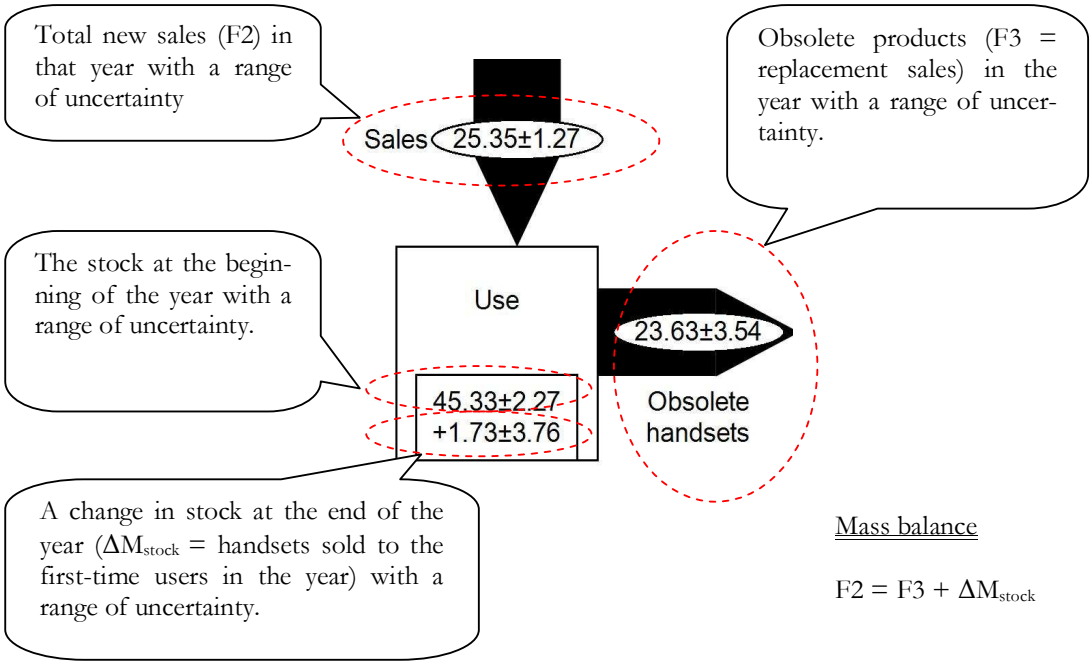
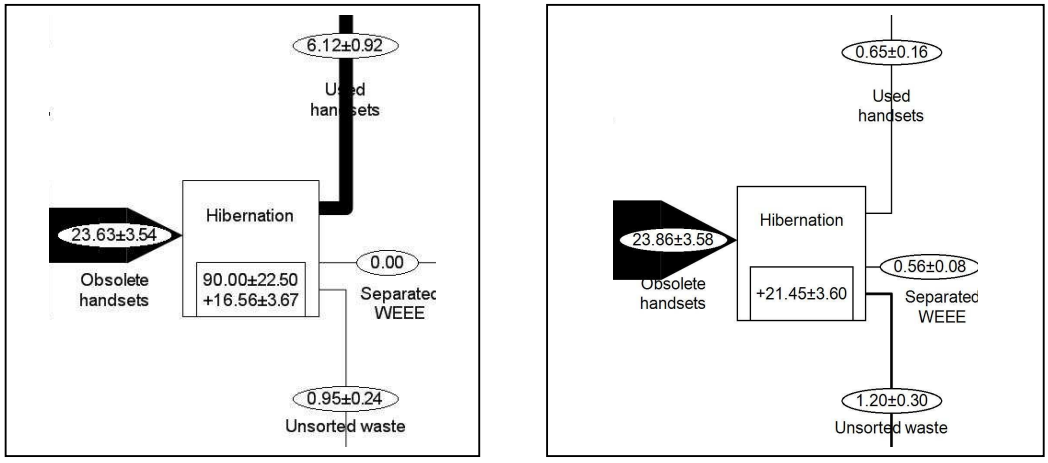


Figure 1-2: An example of the process "use" with a stock

4. *Collection of handsets*: Some obsolete handsets are collected as such (F4) for reuse (F7) and recycling (F8). Trade-in schemes which buy used mobile phones are good examples here. The Nokia (2008) survey finds that 16% of the respondents sell their used devices to emerging markets. When corrected for the stock in use, the share stands at 21%. Anyway, buy back is not a necessary element. Collection of handsets includes also free take back by mobile phone producers and free postal service as long as the collected mobile phones are not immediately mixed with other kinds of WEEE. There is no available statistics that fully capture this type collection but studies on the size of reuse market exist in some countries like in the UK (Metals News 2010; GSMA 2006; Forum for the Future 2004). The reuse rate of this process is often high and can be in the range of 50%-95% depending on how selective the collection is. While some schemes only buy high-end handsets, there are several schemes that accept any types of used mobile phones



(a) UK 2005 (b) Germany 2007

Figure 1-3: Two examples of unknowns about the size of and the change in hibernating stock

5. *Collection of WEEE*: Under the legislation in Europe, mobile phones like the other types of WEEE can be returned free of charge at designated collection points for further reuse and recycling (F5). Typically, these collection points are managed by municipalities. Mobile phones deposited there normally comingle with other small electronics. Because of the reporting infrastructure in the WEEE legislation in Europe, the authorities compile waste collection statistics by weight at the product category level. An exception is the Swiss case where the statistics on the collection quantities are reported at the product level, at least until 2007. To determine the number of mobile phones collected as WEEE, we need information about the share of used mobile phones within the collected Category 3, "IT and telecommunications equipment", and the average weight. The nature of mixed collection decreases the likelihood that mobile phones will be sorted for reuse at this stage. We thus assume that all mobile phones collected as small WEEE (sWEEE) go to the process of preparing materials for recycling (F14).
6. *Reuse*: Under this process, reusable mobile phones (F7) are reconditioned for reselling in the markets as second hand products (F11, F12). Because the inputs come only from organised collections (processes 4.), the reuse process in this study does not include reselling between private persons in the market places (e.g. via ebay). Literature and the advertisements of reuse companies indicate that the majority of reusable products are exported to developing countries (F12), crossing the system boundary. We can also model the flow of products resold in the domestic market (F11) but, unfortunately, only in one case, the UK, the information to roughly estimate the share of domestic reuse is available. Because the reuse market in the UK is markedly different from the others, this estimation is considered non-transferable and, hence, we do not model this flow in the other four cases.

7. *Preparation for recycling*: This process prepares collected sWEEE (F9) for material recycling (F13). During the process, some products and components may be sorted out for reuse (F10). The reuse rate of comingling waste is, however, low: no more than 5%. In addition, mechanical shredding of mobile phones with other low grade small electronics in the preparation for recycling is a main source of loss of precious metals in mobile phones (see Chancerel 2010). We however do not model the process of material recycling. In

this study, material recycling locates outside the system boundary. This cut-off is in line with the practice in Europe where materials are pretreated within countries before shipped for final processes at regional facilities. Another reason for this cut-off is because this process turns the commodities into recyclables and it makes little sense to investigate further using the number of mobile phones as the unit. We do not investigate the flow of waste into the informal recycling sector due to data unavailability. For a pioneer MFA work that employs a life-cycle approach to system boundary, please see Chancerel (2010).

8. *Discard*: Despite being prohibited by the WEEE legislation, some used mobile phones as well as other small WEEE may still find their way to residual waste bins (F6) and eventually to landfill (P8). Although it has long been acknowledged as a problem (Darby and Obara 2005), no statistics available on the extent of this illegal flow and only a few quantitative studies have been done on the topic. In the Nokia (2008)'s global survey, 4% reports to throw away their used phones. When corrected for the stock in use, the share of used handsets destine to landfill is Table 0-1 checks the availability and the quality of data for this study. The following margins of errors are assumed to indicate data uncertainty: ± 5% for high quality data, ± 15% for medium quality data, and ± 25% for low quality data. In the cases where site-specific data are not available or accessible and we have to make assumption, a high level of uncertainties is assumed.

Table 0-1: Data requirement, availability and quality for the material flow analysis

Process	Data requirement	Finland	Germany	Sweden	Switzerland	UK
1.	Sales	High	High	High	Low	High
2.	Subscriptions	High	High	High	High	High
3.	Stock in hibernation	n.a.	n.a.	Medium	Low	Low
4.	Collected handsets	Low	Low	Assumed	Assumed	Medium
5.	Collected Cat.3	Medium	Medium	Medium	n.a.	Medium
5.	Share of handsets in collected Cat.3	Low	Medium	Low	High	Medium
6.	Share of domestic sales	n.a.	n.a.	n.a.	n.a.	Low
8.	Share of handsets in residual waste	Assumed	Low	Medium	Assumed	Assumed

1.4 Structure of the report

Following this introductory chapter, we provide a short description of the two EU Directives related to the subject of this study (Chapter 2). This is due to that except for Switzerland, all the case countries selected are part of the European Union and need to follow the EU legislation. The report subsequently discusses the situations concerning the management of used mobile phones in the five case countries (Chapter 3-7). In light of the main objective of the study, the primary focus of the respective studies is the legal requirements and actual operation related to collection of used mobile phones. In order to avoid repetition, if the mandates of the WEEE Directive are transposed identically in the national legislation, such as collection and recycling targets, they are not described again when the country cases are introduced. It is only the deviation from the Directive as well as items not in the WEEE Directive – such as actors responsible for collection from households – that are described in details in the country studies. Exception is the case of Switzerland which is not an EU Member State. of the handling of batteries is limited to the extent relevant to the focus of this study.

2 European Union

This chapter provides a concise description of parts of the Directive 2002/96/EC on waste electrical and electronic equipment (WEEE Directive) related to the cases. In addition, a concise description of the Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators (Battery Directive) is made, as it governs to the handling batteries contained in WEEE.

2.1 The WEEE Directive

The Directive 2002/96/EC on waste electrical and electronic equipment (WEEE Directive) came into force on 13 February 2003. Member States of the European Union were to transpose the Directive into their national legislation by 13 August 2004. After a review of the transposition and implementation of the Directive, a revision of the Directive was proposed in 2008. As the revision is still under discussion, what is described below is the content of the original Directive. However, some of the proposed changes are mentioned when relevant to the content of this study.

The WEEE Directive is based on Article 175(1) of the EC Treaty which seeks to achieve environmental protection. This means that it sets minimum requirements and allows Member States to set more stringent requirements.

The objectives of the WEEE Directive are:

- To prevent the generation of waste electrical and electronic equipment;
- To increase re-use, recycling and other forms of recovery thereby contributing to a higher level of environmental protection and encouraging resource efficiency; and
- To improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, particularly those involved in the treatment of WEEE (Art. 1).

Article 3 of the WEEE Directive defines electrical and electronic equipment (EEE) as

> …*equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA and designed for use with a voltage rating not exceeding 1000 Volt for alternating current and 1500 Volt for direct current.*

Among the broad range of EEE which are categorised into ten in Annex IA of the Directive, mobile phones belong to Category 3: IT and telecommunications equipment. The waste from EEE (WEEE) covered under the Directive includes all components, subassemblies and consumables which are part of the EEE at the time of discarding.

Regarding some key actors, Article 3 (i) of the Directive defines a producer as:

> *any person who, irrespective of the selling technique used, including by means of distance communication in accordance with Directive 97/7/EC of the European Parliament and of the Council of 20 May 1997 on the protection of consumers in respect of distance contracts:*
>
> *(i) manufactures and sells electrical and electronic equipment under his own brand,*
>
> *(ii) resells under his own brand equipment produced by other suppliers, a reseller not being regarded as the 'producer' if the brand of the producer appears on the equipment, as provided for in subpoint (i), or*
>
> *(iii) imports or exports electrical and electronic equipment on a professional basis into a Member State.*
>
> *Whoever exclusively provides financing under or pursuant to any finance agreement shall not be deemed a 'producer' unless he also acts as a producer within the meaning of subpoints (i) to (iii).*

A distributor is defined as "any person who provides electrical or electronic equipment on a commercial basis to the party who is going to use it"(Article 3 (j)).

Under these definitions, in addition to mobile phone manufacturers, distributors and mobile network providers can be producers, provided that they are the first importer of EEE into the country.

In the WEEE Directive, in terms of distribution of responsibility, activities are broadly divided between a) collection of WEEE from final users, and b) management of WEEE after the collection (i.e. transport of WEEE deposited at the collection sites, treatment, recovery and environmentally sound disposal of WEEE).

Concerning collection, Article 5 of the Directive provides different requirements for 1) WEEE from *private households* and 2) WEEE from *business users* concerning both physical management and financial mechanism.

Regarding WEEE from private households, Member States shall take necessary steps to ensure that systems are set up to enable private households to return WEEE free of charge. Although distributors are to be responsible for accepting WEEE from households on one-for-one, old-for-new basis, Member States can take other measures so long as the alternatives do not make it less convenient for households to return their WEEE. Other than this provision related to distributors, the Directive does not specify which actor should be responsible for collecting WEEE from private households. This has led to diverse solutions taken by Member States in this regard. Regarding WEEE from institutional users, producers or third parties acting on their behalf must provide collection systems.

Member States must achieve the collection target of 4 kg per inhabitant per year of WEEE from private households. The appropriateness of this target is one of the most debated topics for revision. The suggested change is 65% of the average of what is put on the market of the past three years (including the current year).

Once WEEE are collected, it is the responsibility of producers to set up systems for the recovery and treatment of separately collected WEEE. Producers of most of EEE covered by the Directive must meet specified recovery rates by 31 December 2006, (Art. 7). For Category 3 (ICT equipment, including mobile phones), the recovery rate target of 75% is set, within which 65% must meet be met with reuse and recycling of components, materials and substances. The proposed revision increases the respective targets by 5%. The revision also includes reuse of the whole appliance as part of the recovery/recycling target. Article 6 of the Directive – as further specified in Annex II – prescribes the treatment standards which should be followed by the treatment facilities that handle the WEEE coming into the system set up by producers. Removal requirements related to mobile phones include batteries, printed circuit boards, liquid crystal displays and external electric cables (see Appendix III). There is no requirement regarding the information left on the discarded ICT equipment. The revision of the Directive contains a clause that obliges all the separately collected WEEE – instead of limiting the requirement to the facilities accepting the WEEE coming into the Producer Responsibility system – to be treated in accordance with the standard.

From 13 August 2005, producers must finance, at minimum, the collection of WEEE from private households which have been deposited at collection facilities, as well as treatment, recovery and disposal of WEEE. For the *historical waste* (those put on the market before the directive comes into force fully: 13 August 2005), the Directive makes all the existing producers responsible for the activities above collectively. For the *new waste* (those put on the market after 13 August 2005), it is essentially the individual brands that are responsible for their own products (Art. 8).[2]

Regarding WEEE from institutional users, a revision was made in 2003. According to the revision, while the producers finance the end-of-life management of WEEE on one-for-one, old-for-new basis, the rest are to be financed

[2] The deviation from this clause by many of the Member States is one of the problems identified in Sänder et al (2007).

by the end-users. For the new waste, individual brands are responsible for their own waste (Art. 9).

Users in private households must be given certain information, for example on the available return and collection systems. Producers must label equipment indicating that WEEE shall not be disposed together with ordinary waste (Art. 10).

2.2 The Battery Directive

End-of-life management of batteries, an important component of EEE, is complemented by the Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators[3] (Battery Directive). The 2006 Directive repealed an existing Directive 91/157/EEC,[4] which covered specific batteries and accumulators that contain more than certain amount of mercury, cadmium or lead. In addition to the restriction of these substances which was the main scope of the 1991 Directive, the 2006 Directive incorporates all types of batteries (portable, automotive and industrial). In addition, the Directive incorporates the concept of EPR regarding collection, treatment and recycling of waste batteries and accumulators, restricts their disposal in landfills and incinerations, establishes collection targets and requires enhanced information provision to consumers.

Concerning the collection of portable batteries, producers are financially responsible for collection, treatment and recycling as well as conducting public information campaign. The Directive requires distributors to take-back waste batteries and accumulators when supplying a new one, "unless assessment shows that alternative existing schemes are at least as effective in attaining the environmental aims of" the Directive (Art. 8.1 (b)). It also requires free of charge acceptance of portable batteries and accumulators at an accessible collection points. As long as these conditions are met, the decision as to which entity should be in charge of the collection of portable batteries and accumulators is left in the hands of the Member States (Art. 8.2). The Directive contains the minimum collection rate targets of 1) 25% by 26 September 2012 and 2) 45% by 26 September 2016 (Art. 10.2). The denominator of this calculation is the average sale figure of the three years including the year in which the collection rate is calculated. Among the batteries collected, the Directive in its Annex III stipulates differentiated recycling targets for portable batteries differentiated based on the content of the batteries and accumulators (lead-acid, nickel-cadmium and others). Producers are also responsible for treatment and recy- of waste batteries and accumulators in with best available techniques (Article 12.1 (a)).

[3] Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC. OJ L 166, 26.9.2006, p. 0001–0014.

[4] Council Directive 91/157/EEC on batteries and accumulators containing certain dangerous substances. OJ L 078, 26/03/1991 P. 0038-0041.

3 Finland

Finland had the population of 5.30 million on 1 January 2009 (Eurostat 2010). The subscriptions of the mobile phones at the end of 2008 stood at 6.83 million, i.e. 131 connections for every 100 people (FINNET 2010). Figure 3-1 shows the historic trend of mobile subscriptions in Finland between 1995 and 2008. A consumer survey in February 2009 reports that 98.8% of households in Finland had at least one mobile phone (Statistics Finland 2009).

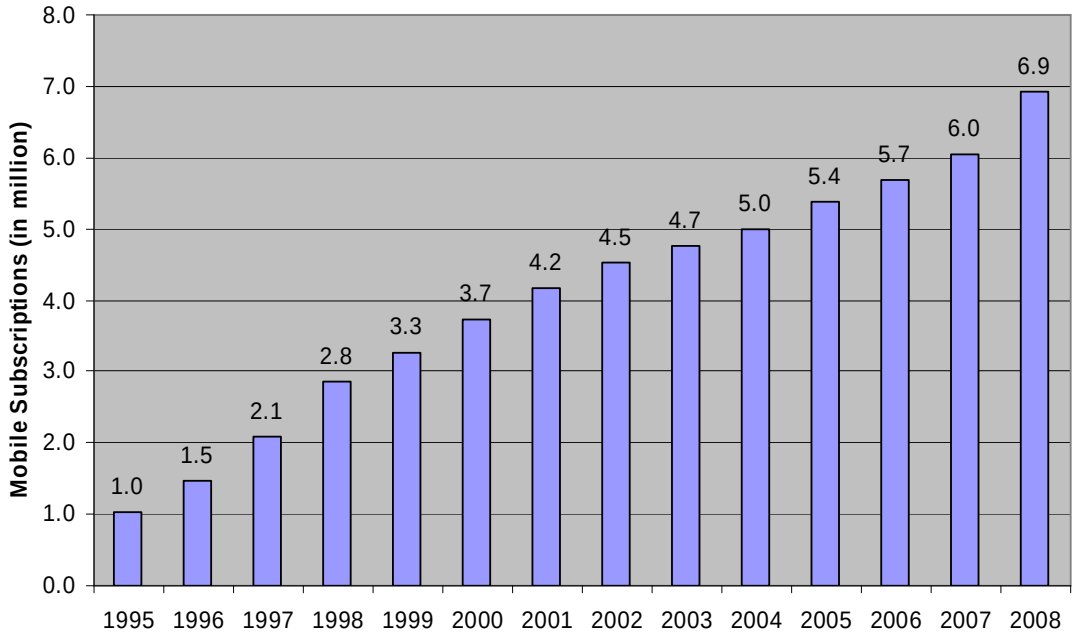


Figure 3-1: Subscription trend in Finland, 1995-2008

Source: Eurostat and FICORA

The Finnish Communications Regulatory Authority (FICORA) is the regulator for the communication industries in Finland. **Error! Reference source not found.** shows the market shares of mobile network operators (MNOs) in Finland at the end of 2008. According to TeliaSonera (2010), the share of post-paid subscriptions remained as high as 90% of its total subscriptions in 2009, despite a continuous decrease since 2005 in which the share was 96%.

Table 3-1 presents a calculation of handset replacement in Finland between 2004 and 2008 2008 based on the market penetration and sale data. Based on this estimation, around 9 million mobile phones were replaced and out of use in Finland between 2004 and 2008.

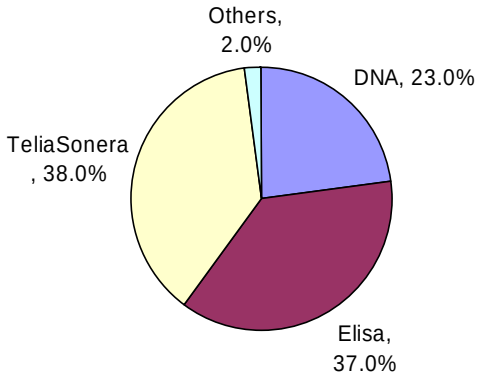


Figure 3-2: Customer bases of mobile network operators in Finland, 31 December 2008.

Source: FICORA as cited in FINNET (2010)

Table 3-1: Subscriptions, sales, and replacement of mobile phones in Finland, 2004-2008.

Year	Penetration rate (connections/inhabitants)	SIMs per user or handset (connections/unit)	Adjusted penetration rate (units/inhabitants)	Population (million inhabitants)	Stock in use (million units)	First-time sales (million units)	Total Sales (million units)	Replacement sales (million units)	Replacement period (years)
2003	0.91	1.26	0.72	5.2	3.78	-	-	-	-
2004	0.96	1.29	0.74	5.2	3.87	0.09	1.48	1.38	2.73
2005	1.03	1.34	0.77	5.2	4.01	0.13	1.80	1.67	2.32
2006	1.08	1.38	0.78	5.3	4.10	0.09	2.01	1.91	2.10
2007	1.14	1.44	0.79	5.3	4.19	0.09	2.05	1.97	2.08
2008	1.30	1.61	0.81	5.3	4.31	0.12	1.99	1.87	2.24

Source: Eurostat (penetration and population) and GfK (total sales)

Finland transposed the WEEE Directive via 1) the Waste Act of 1072/1993, as revised in 2004 (452/2004), and 2) the Government Decree on Waste Electrical and Electronic Equipment (852/2004) – hereafter referred to as WEEE Decree. Interestingly, the Centre for Economic Development, Transport and the Environment for Pirkanmaa, a regional government entity, serves as the national authority responsible for producer responsibility schemes.The Finnish definition of producers as found in Section 3 4) of the WEEE Decree is essentially the same as the one in the WEEE Directive and includes manufacturers, sellers that sell equipment under their own brand and importers and exporters.[5] The Finnish legislation makes producers the primary actor responsible for the WEEE management. Specific mandates given to producers include:

- Establishment of an adequate network of collection facilities in all parts of the country, which allows the last holders of the products with a reasonable opportunity to deliver discarded products. The separate collection should be continued irrespective of the achievement of the collection targets[6] (Section 18d, Waste Act; Section 6, WEEE Decree);

- Fulfillment of collection, reuse and recycling targets as stipulated in the WEEE Directive (Section 5, WEEE Decree);

- Except for cases where collected appliance can be reused as a whole, organisation of delivery of collected WEEE to authorized treatment facilities and their subsequent treatment following the mandate stipulated in the WEEE Directive (Section 6 &7, WEEE Decree);

[5] Noteworthy, however, is that the Finnish definition of importers includes importers to any countries in the European Community, instead of limiting its definition to importers to Finland. How importers are defined have various implications to the practical organizations of WEEE management schemes in Europe – for further discussions on this topic, see, for instance, Sander et al. (2007) and van Rossem (2008).

[6]The interviewee from the government in charge of EPR for WEEE in Finland indicated that the clause "irrespective of whether the collection targets… has been achieved" is included in order to ensure that producers take care of the collection of all the WEEE. This clause became very useful when the collection network was not large enough in 2005-06 and the government forced producers to extend the network. Producers fought against this in court, claiming that the government cannot require the extension of the network as they have met the annual collection target of 4 kg per inhabitants. However, the court ruled in favour of the government due to the aforementioned clause.

- Marking of EEE as stipulated in the WEEE Directive, and provision of information to private households to facilitate collection and recovery of WEEE (Section 10 & 11, WEEE Decree; Section 18e, Waste Act);

- Provision of information to treatment facilities regarding their products to facilitate reuse, treatment and recycling of WEEE (Section 12, WEEE Decree; Section 18e, Waste Act); and

- Reporting of their activities to the authority in charge of producer responsibility (Section 13).

There is no requirement on the aforementioned WEEE-related legislation regarding the treatment of private information remained in discarded equipment, and none of the informants are aware of such requirements. Nor do the schemes interviewed specify any requirements concerning the handling of private information.

In line with existing EPR programmes, the Finnish legislation for EEE allows producers to cooperate in fulfilling their end-of-life related requirements by establishing an organisation that fulfills producers' obligations on their behalf. (Section 18g, Waste Act).[7] As of spring 2010, there are five such organisaitons – broadly referred to as producer responsibility organisations (PROs), and are often referred as "compliance schemes" in the context of WEEE management in Europe – in Finland (Serty, ERP Finland, SELT Association, ICT Producer Co-operative and FLIP Association). Among them, the actual operation of SELT, ICT Cooperative and FLIP are managed by an organisation called Elker, thus there are three operating schemes. All of the three schemes cover all the product groups under the WEEE Directive. Producers decide to which scheme they belong. This means that the share of products covered by the respective schemes could differ depending on the product groups. Regarding Consumer and ICT equipment excluding the monitors, the vast majority is covered by Elker (39%) and ERP (59-60%) while Serty covers very small proportion (2%). According to an interviewee, the fact that Finland has the largest mobile phone manufacturer in the world – Nokia – has not impacted the development of the system per se: they are a member of one of the systems. Meanwhile, Nokia has organised a few major collection campaign, as described further in the latter part of this chapter.

In principle, each of the three schemes organises its collection. According to one informant, the three organisations had been fighting heavily in the past. According to an interviewee, lack of coordination among the schemes created some confusion among consumers regarding the location of collection points, opening hours and the like. This led to some discussions between the government and the organisations. They started to collaborate more in the area of collection lately, due mostly to the economic reasons and also facilitated by some changes in personnel. The collaboration in collection activities is evident from the fact that all the three organisations direct private households who wish to search for local collection points to the same on-line database (www.kierratys.info/). As it stands now, there are over 360 collection points to which private households can return WEEE free of charge (Elker 2010). It should be noted, however, despite this development of collaboration, all the collection points are decided based on collection contract between a scheme and the collection operator.

In most cases, the organisations purchase collection services from municipalities. According to one informant, they have contract with municipal waste management companies covering 95% of the municipalities and 98% of the population.[8] Purchasing collection services from municipalities help producers fulfill legal requirement of establishing a nationwide collection system which are extensive enough to

[7] In addition to rules concerning the establishment and management of the compliance schemes, the Finnish legislation includes an explicit mentioning of the transfer of responsibility from a producer to a compliance scheme when the producer becomes a member of the compliance scheme and the notification concerning the scheme is approved.

[8] In Finland, most of the small municipalities have gathered and created a common regional municipal waste management company.

secure convenience for consumers (see aforementioned list of responsibility). Municipalities have been historically responsible for municipal waste issues and have collection infrastructure in place. It is also the actor whom citizens have the habit to turn to regarding the waste issues. According to one informant, most of these collection points are shared and maintained by all the three schemes. In addition to the municipalities, compliance schemes also use some big private recycling companies for collection of waste. In this case there are more variations: some points are shared by all or many schemes but some points are only for one scheme.

In the absence of clearing house, as found in for instance Germany and Sweden (see Chapter 4 and 5), the allocation of WEEE among the three schemes in Finland are based on negotiations among the three schemes. Currently, the schemes have allocated collection and pick-up responsibility of a single product group[9] from a single collection point to one of the three schemes. The scheme responsible for a collection point provides necessary tools for collection (e.g. containers, cages) and organizes pick-up of the WEEE collected. In many cases, one scheme takes care of all or many of the product groups. These points are allocated among the three schemes based on geography – namely, one scheme collects from collection points located in certain regions in Finland, while another will be in charge of collection in other regions.

In Finland, there is a statutory requirement on municipalities not to disturb the ability of the producers/PROs to carry out their obligations (Section 18h (5), Waste Act). This means, among others, that municipalities cannot sell the articles with positive monetary value they found within WEEE and leave only the WEEE with negative values to producers. The requirement of the municipalities to hand over all the WEEE collected at their collection points is also included in the contracts between municipalities and at least one of the compliance schemes. This makes it easier for compliance schemes in Finland to obtain WEEE with positive values, such as washing machines (under large home appliances). In countries where such mandate for municipalities is absent (e.g. Germany, see Chapter 4), PROs suffer from being left with products with negative value.

In addition to the responsibility given to producers, distributors, including sellers selling the products under their brand, must either accept the discarded EEE which are similar to those bought by purchasers (old-for-new rule), or direct the purchaser to a reception point (Section 18h). The information given by the three schemes indicate that distributors opt for the latter in practice. Consumers do have possibility to request distributors to deliver a new product and transport a similar old product to collection points, but in this case the distributors can charge for the service.

Once the discarded products are collected, the PROs take care of their share at the processors that they have contract with. Although they may have different contractors, one of the informants mentioned that those handled by the PROs are taken care of mostly in Finland in a responsible manner. In contrast, concerns were raised regarding the handling of WEEE collected by actors other than PROs. According to one informant, one of the biggest loopholes of the WEEE Directive is that the requirements related to the treatment of collected WEEE are mandatory only for producers, but they do not cover WEEE collected by actors other than producers. This means that actors other than the producers/PROs do not have to fulfill the same requirements regarding how to handle WEEE. In the case of Finland, these actors need to have environmental permit for the operation required under the Environmental Protection Decree. An informant from private sector indicated that actors other than producers/PROs are not required to fulfill specific requirements set forth for the handling of WEEE laid out under WEEE Decree. He showed concerns concerning the rigidity of the activities in the systems not organised by producers/PROs. Meanwhile, the government official confirmed that fulfillment of these requirements, including the fulfillment of recycling and recovery targets, are part of the conditions for environmental permits for all the actors handling WEEE, thus there is no difference.

[9] The WEEE are grouped into: freezer and refrigerator, other large home appliances, consumer and ICT equipment excluding monitors, TVs/monitors and lamps.

Meanwhile, two of the three schemes let specific operators carry out reuse of collected appliances. In both cases, the operators must sign reuse agreement with the schemes. These operators then start to have access to WEEE collected by the respective schemes. In the case of ERP Finland, the reusers "inspect, repair and sell the equipment to consumers" and report back the outcome of reuse to ERP Finland. The pick up of WEEE could be done via specific web portal or case specific arrangement could be made, including pick up directly from collection points (ERP Finland 2010). In the case of Elker, reuse is carried out in connection with the activities at processing plants, but actors wishing to be engaged in reuse activities can also sign an agreement and pick up WEEE from processing plants (Elker 2010). The reused appliances are counted as collected WEEE, as they have been collected as waste. However, this reuse figure does NOT include reuse of appliances that have NOT been collected by the PROs – namely, those which have been circulated as second hand products without coming into waste stream. The amount of reused mobile phone organised by producers in this way is not known, although one informant suspects that is very small. We slightly modify the generic MFA model presented in Figure 1-1 to accommodate the format of reported data in Finland by having a flow of reuse of whole appliances instead of a flow of reusable components.

Table 3-2 indicates the collection and recycling of IT and telecommunication equipment (category 3 in the WEEE Directive) in Finland between 2006 and 2008. All the figures are based on those reported from the PROs discussed in this chapter. No separate figure is available for mobile phones.

Mobile phones are within the product category of Consumer and ICT equipment and this include a wide range of products. The Finnish legislation follows the same definition for EEE and WEEE as stipulated in the WEEE Directive, thus producers are required to collect not only the device but also components and consumables that are part of products such as batteries. Batteries are under another EPR legislation and in the case of WEEE collected by Elker and ERP are taken care of by the PRO for batteries – Recser Oy. Mobile phones, due to their size and weight and low return rate, constitute a minor flow, which according to one informant do not make the collection of mobile phones a priority. In addition, the mobile phones with positive values – high end, relatively new phones – are hardly coming back to the system, thus those that come back would contribute little, if any, to the economics of the system. All the informants confirmed that none of the schemes conduct separate collection specifically for mobile phones.

Table 3-2: Collection and recycling of IT and telecommunication equipment in Finland: 2006-2008

		2006	2007	2008
1	Put on the market (tonnes)	18 351	24 462	31 039
2	Collected from private households (tonnes)	5 661	8 749	10 328
3	Collected other than private households (tonnes)	1 351	1 625	1 319
4	Total collected (2+3) (tonnes)	7 012	10 375	11 647
5	Treated in Finland (tonnes)	6 674	9 842	11 551
6	Treated in another EU Member States (tonnes)	120	407	96
7	Treated outside of the EU (tonnes)	20	126	0
8	Recovery (tonnes)	5 324	7 844	10 363
9	Reuse and recycling (tonnes)	5 031	7 439	9 816
10	Reuse as whole appliance (tonnes)	282	177	129
11	Collection per capita from private households (kg)*	1.07	1.65	1.94
12	Collection per capita total (kg)*	1.33	1.96	2.19
13	Recovery rate (8/4 x 100) (%)	76	76	89
14	Reuse and recycling (9/4 x 100) (%)	72	72	84

* Calculation done by the author based on the population of the respective year.

Source, Eurostat (2009) for 2006. Information for 2007 and 2008 are obtained from Virtanen.

In addition to PROs, mobile phones are collected by producers, recyclers, companies dealing with second-hand products and collection companies. They directly approach consumers and collect used phones.

Concerning initiatives by producers, Nokia has organised several campaigns over the last several years. For instance, at the end of 2006 the company distributed 200 000 return envelopes, together with the offer that 2 Euro would be donated to WWF for each phone returned. The campaign resulted in the collection of approximately 25 000 phones (Nokia 2010b). Similar attempt was made during April-July 2008, where 13 retail chains representing 80% of the sales of mobile phones were engaged. This resulted in the collection of 13 730 used phones (Nokia 2009). A further trial was made in 2009 where the company works together with the Finnish Post Office. Consumers can receive prepaid envelopes from 150 participating post offices or download it from the Internet. In addition to convenience, consumers can receive some service options when returning an old phone. This resulted in the return of 17 000 phones in two months (Nokia 2010a). In addition to their efforts through these campaigns, Nokia also maintains the collection points in their flagship stores, though according to one informant collection through these stores are very minor. In all cases, the collected phones have been sent for recycling.

Collection of used phones for refurbishment and re-selling as second-hand phones seems to be emerging, although it has not been as prominent as what is found in the UK and its further development can be questioned. According to some informants, some small companies had a marketing campaign. One of them had a big media campaign on TVs and radios in winter 2009, announcing that they would buy back used phones.[10] Depending on the characteristics of the phone (age, model, etc), the phones may be simply taken back free of charge, or consumers can get some money. According to one informant, however, after the campaign it became quiet again. As mentioned earlier, what happens to the phones after the collection by these private actors raised concerns among producers/PROs. Some interviewees stress that it is the role of the authorities to control the other actors' behavior. According to a government official, environmental license inspector has inspected the procedures of these companies, and the authority in charge of supervising the transboundary shipment of waste are aware of these companies. Due to the lack of quantitative data, we assume that the rate of handsets collected for refurbishment and reselling in Finland would be slightly lower than in Germany which is around 3% of the amount of obsolete phones. In the MFA, the value of 2% is assumed with a high degree of uncertainty. This assumption leads to an estimation that less than 40,000 handsets went through the process between 2006 and 2008.

Two of the three manufacturers interviewed expressed the limitation in engaging themselves in the refurbishment of used phones. The cost of quality assurance would be prohibitably high for their participation on business basis. One of the manufacturers commented that their principal strategy is to go for component reuse and recycling. The two manufacturers express their concerns on the limited control on the second hand mobile phones sold in developing countries and the risk on environment and health hazards that can be caused by dumping of waste mobile phones and their parts under the name of reuse/recycling (as discussed further in Chapater 7).

An informant representing a PRO mentioned that the revision of collection targets in the WEEE Directive is a constant discussion topic among the member companies. The life length of the products varies significantly among products, from 2 to 20 years. Some products changed their properties significantly – e.g. TVs with CRT to with plasma, LCD, etc.

Figure 3-3 shows a result of MFA based on the information presented above for the year 2008. Due to a lack of site-specific data on the amount of mobile phones found in mixed municipal solid waste, we assume the rate of unsorted handsets as in Nokia (2008)'s global survey. Despite this, it can be established that only a small fraction of used mobile phones were collected in Finland. The other 91% of handsets expected to be retired in 2008 could

[10] A website of one of such companies is found at: www.kierratakannykka.fi/kannykka-rahaksi/

be either stored at home or disposed improp- erly.

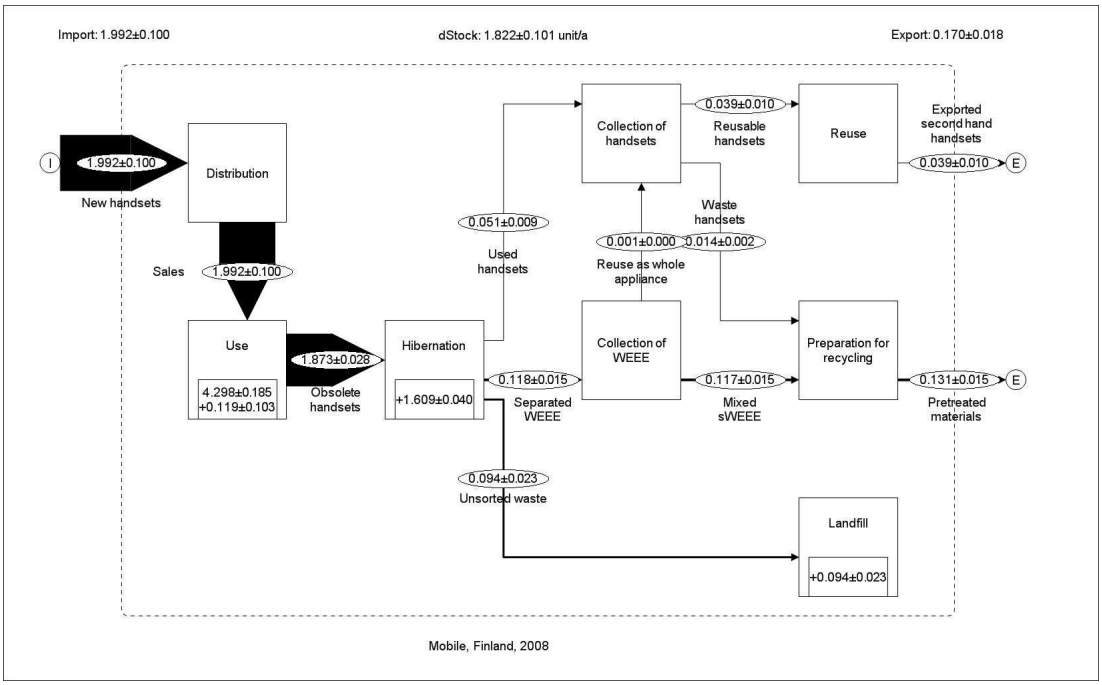


Figure 3-3: Material flows of mobile phones in Finland, 2008 (in million units).

4 Germany

Germany had the population of 82.00 million on 1 January 2009 (Eurostat 2010). The subscriptions at the end of 2008 stood at 107.25 million, i.e. 131 connections for every 100 people (BNA 2009). The split between prepay and post-pay subscriptions was 55:45 in 2007 (BNA 2009). Figure 4-1 shows the historic trend of mobile subscriptions in Germany between 1995 and 2008. A household survey reports that 80.6% of households in Germany had at least one mobile phone in 2006 (destatis 2010).

The Federal Network Agency (Bundesnetzagentur, or BNA) is the regulator for the communication industries in Germany. Figure 4-2 shows the market shares of the four mobile network operators (MNO) in Germany in the first quarter of 2007. T-Mobile is a subsidiary of Deutsche Telekom AG a company which the German Government owns 43% of the share.

Table 4-1 presents a calculation of handset replacement in Germany based on the market penetration and sale data.. Based on this estimation, around 93 million mobile phones were replaced and out of use in Germany between 2004 and 2008. The replacement periods based on this method can be compared with the lifespan figures reported in the literature. For example, the Federal Ministry of Finance in Germany defines the fiscal amotisation time of mobile phones at 5 years while a newer use period figure by GfK stands at 3 years (referred to in Chancerel 2010). Regarding the total lifespan, Chancerel (2010) uses the value of 6 years years for mobile phones in her estimation of 2,273 tonnes of waste mobile phones being generated in Germany for the year 2007.

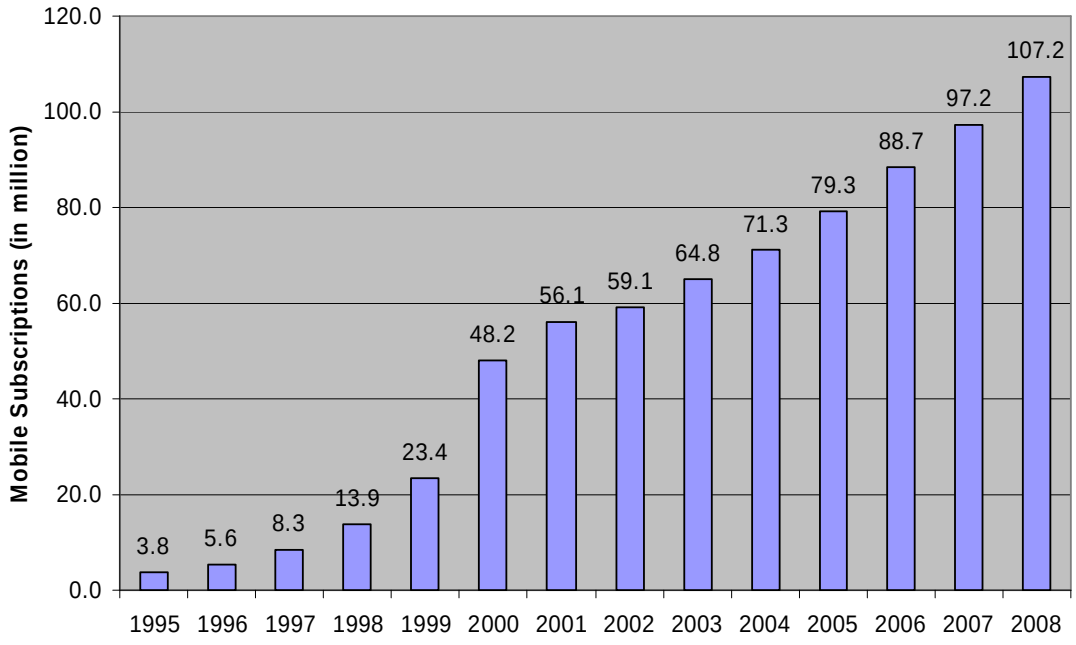


Figure 4-1: Subscription trend in Germany, 1995-2008.

Source: Eurostat and BNA

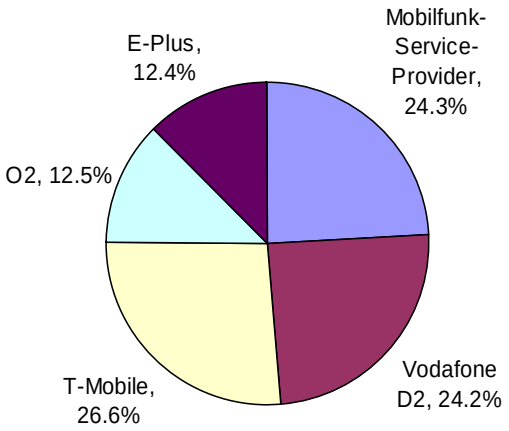


Figure 4-2: Customer bases of mobile network operators in Germany, 2007 (Q1).

Source: BNA

Legally, the collection and recycling of WEEE are now under the provisions of the Act Governing the Sale, Return and Environmentally Sound Disposal of Electrical and Electronic Equipment (Electrical and Electronic Equipment Act – ElektroG) of 16 March 2005. ElektroG is a result of the transposition of the EC WEEE Directive and covers the ten EEE categories of the Directive.

The ElektroG requires source separation for WEEE. Public waste management authorities, i.e. municipalities, are obliged to set up collection points in their district where WEEE from private households (B2C WEEE) can be returned free of charge. Municipalities are required to separate WEEE into the following five groups ready for collection by producers at no cost:

1. Large household appliances, automatic dispensers;
2. Refrigerators and freezers;
3. IT and telecommunications equipment, and consumer electronics;
4. Gas discharge lamps; and,
5. Small household appliances, lighting equipment, tools, toys, sports and leisure equipment, medical products, and monitoring and control instruments.

Table 4-1: Penetration, sales, and replacement of mobile phones in Germany, 2004-2008.

Year	Penetration rate (connections/inhabitants)	SIMs per user or handset (connections/unit)	Adjusted penetration rate (units/inhabitants)	Population (million inhabitants)	Stock in use (million units)	First-time sales (million units)	Total Sales (million units)	Replacement sales (million units)	Replacement period (years)
2003	0.79	1.18	0.67	82.49	54.97	-	-	-	-
2004	0.86	1.23	0.71	82.55	58.21	3.24	19.10	15.86	3.47
2005	0.96	1.29	0.74	82.49	61.41	3.20	20.00	16.80	3.47
2006	1.04	1.35	0.77	85.32	65.63	4.22	20.80	16.58	3.70
2007	1.18	1.48	0.80	82.26	65.77	0.14	24.00	23.86	2.75
2008	1.31	1.61	0.81	81.99	66.63	0.86	20.80	19.94	3.30

Source: Eurostat (penetration and population) and GfK (total sales)

The German legislation defines producers in essentially the same way as the WEEE Directive does. Regarding the distributors, in addition to what is provided by the WEEE Directive, the German definition includes the following: "Any distributor who knowingly sells new electrical and electronic equipment from a non-registered producer is deemed a producer" (Section 3 (12). This would help distributors to push the producer to register, as distributors

would most likely not to assume responsibilities allocated to producers.

Producers and distributors may voluntarily take back WEEE from private households. In addition, producers are required to supply the containers for separate collection for free to the municipalities.

Physical and financial responsibilities from the point of pickup onwards – i.e. transport of WEEE deposited at the collection sites, treatment, recovery and environmentally sound disposal of WEEE – are with the producers unless the municipalities choose to take over the downstream tasks under the Section 9(6) of ElektroG.[11] In both cases, the treatment recovery of WEEE are subject to the same standards and targets prescribed in the law. However, according to some informants, the fact that municipalities have the possibility of retaining the WEEE to themselves have raised the problems where all the valuable WEEE is taken by producers and only non-valuable WEEE are left in the hands of producers.

Each producer also has to provide an annual guarantee for B2C EEE placed on the market after 13 August 2005.

In order to allocate responsibilities and coordinate pickup obligations, producers are also required to set up a clearing house to administer producer registration and allot the quantities of WEEE for each registered producer to collect from municipalities. The Federal Environmental Agency (UBA) acts as the competent authority and can delegate certain enforcement functions to the clearing house. In addition, the protection of personal data that might still be in used mobile phones is under the Federal Data Protection Act (Bundesdatenschutzgesetz, BDSG) of 1990.

[11] Section 9(6) reads: Public waste management authorities may, by providing three months' notice to the Clearing House, choose not to make all WEEE in a specific group under Paragraph 4 vailable for collection for a period of at least one year. In exercising this option, public waste management authorities shall reuse the WEEE or its components or treat it in compliance with Section 11 or dispose of it in compliance with Section 12. Section 13 (1) Nos. 3 to 7, (3) sentence 6 and (4) apply accordingly.

The Stiftung Elektro-Altgeräte Register (EAR Foundation) was established in August 2004 by the industry and was officially designated as the clearing house by UBA in July 2005 (Sanders et al. 2007). The EAR Foundation performs the following tasks:

- Register and assign registration numbers to individual producers;
- Compile and keep records of the quantities of products put on the market;
- Allocate pickup obligations to producers based on an algorithmic calculation method;
- Levy fees as regulated in the Cost Ordinance to the Electrical and Electronic Equipment Act (ElektroG-KostV) of 12 July 2005 (now under a revision) and others associated with its administrative decisions; and,
- Verify the financial guarantees for B2C EEE.

According to the public register, 160 registration numbers were assigned to producers in the Category: "IT and telecommunications equipment, mobile phone" on 31 May 2010 (EAR Foundation 2010). These included the three MNOs: O2, T-Mobile, and Vodafone. This indicates that they are importers or resellers of mobile phones. It is worth noting that in Germany registering and reporting obligations are with individual producers and compliance schemes cannot register on behalf of their members.[12]

In the implementation of producer responsibility provisions, the German Government has adopted the so-called "competitive-oriented compliance approach" (Sanders et al. 2007). The Federal Competition Authority ruled out the possibility of having any take-back

[12] This responsibility of reporting on individual basis is not likely to connect to the implementation of individual responsibility. Meanwhile, it may make it easy for producers to move from one compliance scheme to another, thus may facilitate the sound competition between compliance schemes.

schemes whose members included an entire product sector. This approach results in a multitude of WEEE service providers in Germany including logistic companies, waste management firms, dedicated compliance schemes (such as ERP Deutschland), and loose consortia of individual producers trying to gain economies of scale through collective purchasing. Sanders et al. (2007) lists ProReturn (Philips, Sharp, Siemens), ERP Deutschland (Sony, HP, Samsung, Toshiba), and ENE (Panasonic, Thomson, JVC) as main compliance solutions for the IT and telecommunications sector. However, because the allocation of responsibility is based on weight within each of the five product groups, the significance of mobile phones is rather small. For example, ERP Deutschland charged the producers of WEEE that belongs to the third group 104 Euro/ton. The EAR Foundation determines the level of future guarantee required for for different product types based on the average cost per ton and the expected return rate of each product: 62 Euro/ton for mobile phones. In practice, the availability of collective guarantees based on the principle of reciprocity[13] very much weakens the impact of the provision. For example, two providers of collective guarantees, GSA and ZVEI, only charge the premiums at meager rates of 0.125% and 0.355% per year of required guarantee, respectively (Sanders et al. 2007).

Chancerel (2010) quantifies the collection of six types of small WEEE (sWEEE) including used mobile phones in Germany in 2007. Table 4-2 shows the results of the quantification. The rest of this chapter describes the different collection channels.

Municipalities, as prescribed by ElektroG, are the main collectors of WEEE from private households. In 2007, municipalities requested pickup of 109,680 tonnes of WEEE in Category 3 they collected to producers registered with the EAR Foundation. This was a slight increase from the year 2006 in which 102,336 tonnes were requested to be picked up by producers. Based on unpublished sorting studies at pre-processing facilities, Chancerel (2010) assumes that used mobile phones constitutes about 0.1% by weight of Cat.3 WEEE collected by municipalities. In addition, some municipalities opt to use the provision Section 9(6) of ElektroG and handled the collected WEEE themselves. A conservative estimation of this stream adds another 1,886 tonnes of Cat.3 WEEE to the municipal collection in 2007 (Chancerel 2010). The final tally of used mobile phones collected by municipalities as Cat.3 WEEE stood at 111 tonnes. Because these used mobile phones are collected mixed with other WEEE in the third product group, almost all of them were sent directly to material recycling processes. Chancerel (2010) assumes that the reuse rate here was as low as 1%.

The trade-in market for mobile phones is somewhat developed in Germany. The leading actor in the market is Greener Solutions, a company from the UK, which has operated mobile phone trade-in website, zonzoo, since 2001 (zonzoo 2010). The company has partnered with the likes of Vodafone, E-Plus, O2, and GetMobile in Germany. In 2007, Green Solutions reported to collect some 450,000 handsets for reuse in developing countries. Chancerel (2010) assumes that another 100,000 100,000 used phones were collected by other manufacturers, distributors, and exporting companies. For instance, an industry inmentioned that the company conducted a major collection campaign in Germany a few years ago. Purchasers of new mobile phones are provided with postal parcel in which hibernating phones can be sent back free of charge to the manufacturer. The result of collection was insignificant, however, and the company stopped the campaign. It is worth noting that the EAR Foundation allows the quantities that producers collect themselves to be deducted from their allocated shares. All these added up to 108 tonnes, shown in Table 4-2, assuming that the average weight of 197 grams per unit. It is likely that the market for used mobile phones has expanded since then. Now all the major MNOs have trade-in offers (see Vodafone, T-Mobile, and O2) and some other market players such as Eazyfone Group Ltd. (under the brand "Environfone") have started its operation in Germany (Eazyfone 2010). These trade-in schemes are to a certain extent benefit from a new service of the

[13] Under the principle of reciprocity, the members of a collective agree to shoulder the obligations of insolvent members. The risk of complete insolvency, i.e. all members are out of the market, is thus extremely low as for the premiums for collective guarantees.

Deutsche Post called "Elektroreturn". The service offers a possibility for private households to download shipping label and post sWEEE for free. The Deutsche Post (2010) explains on its website that the advantage of using Elektroreturn over the municipal collection points is higher reuse and recycling rates because different types of sWEEE are not mixed together in the collection. Chancerel (2010) makes a conservative estimation that at least 50% of mobile phones collected by producers and distributors are reused.

Table 4-2: The quantities of used mobile phones in different collection channels in Germany, 2007.

Mobile phones	Separate collection					Non-separate collection (in mixed municipal waste)
	Municipalities		Producers & Distributors' own collection	Other collectors		
	Further treatment by producers through EAR	Further treatment by municipalities based on Section 9(6)		Direct collection from private households by Informal Sector	Others (collection of reusable products and components from collection points)	
In ton	110	1	108 [a]	10	10	979
In unit	558,000 [a]	5,000 [a]	550,000	51,000 [a]	51,000 [a]	4,970,000 [a]

Note [a] Assuming the average weight of 197 gram/unit.
Source: (Chancerel 2010).

Some informal actors collect WEEE directly from households while the others scavenge for reusable products and valuable components from the waste deposited at municipal collection sites. Anecdotal accounts of equipment missing valuable components such as external cables and complaints over damages from scavenging are not uncommon (Sanders et al. 2007). One study estimates that Eastern Europe receives some 120,000 tonnes of WEEE yearly (of which at least 80% are large home appliances) from Germany through informal collection. Besides informal collection, used products are also collected by social organisations, NGOs, special collection events and pilot projects such as "Gelbe Tonne Plus" in Leipzig (Gelbe Tonne Plus 2010). Together informal and other collection channels not prescribed by ElektroG could make up to 20 tonnes of used mobile phones, half of which were expected to be reused (Chancerel 2010).

Last but not least, used mobile phones as well as other sWEEE can end up in the unsorted waste bins. Chancerel (2010) quantifies the amount of non-separately collected mobile phones based on previous sorting studies which indicate that a little less than 1% by weight of residual waste was sWEEE and within this fraction 0.9% could be mobile phones. Under these assumptions, 979 tonnes out of about 14 million tonnes of residual waste collected in Germany in 2007 were used mobile phones equal to 4.97 million handsets. However, this figure seems to be extremely high, accounting for over 20% of estimated 23.9 million replaced units. In this MFA, we, therefore, opt to use the estimate from the Nokia (2008)'s survey that 5% of mobile phones retired from use go to landfill resulting in 1.195 million units.

Figure 4-3 shows a result of MFA based on the information presented above for the year 2007. Using the replacement number of 23.9 million units, the rate of separate collection for used mobile phones in Germany was as low as 5%. Compared to another large country under this study, the UK, the difference is the quantity of used products collected for reuse which was much lower in Germany. This might be because of the replacement period which tends to be considerably higher in Germany than in the UK. Geyer and Doctori Blass (2010) note

the significant time sensitivity of resale values especially for high-end handsets in the reuse market. Around 75% of replaced mobile phones were added to the hibernating stock in 2007; it is not possible with the available information to estimate the size of the stock at the beginning of the year.

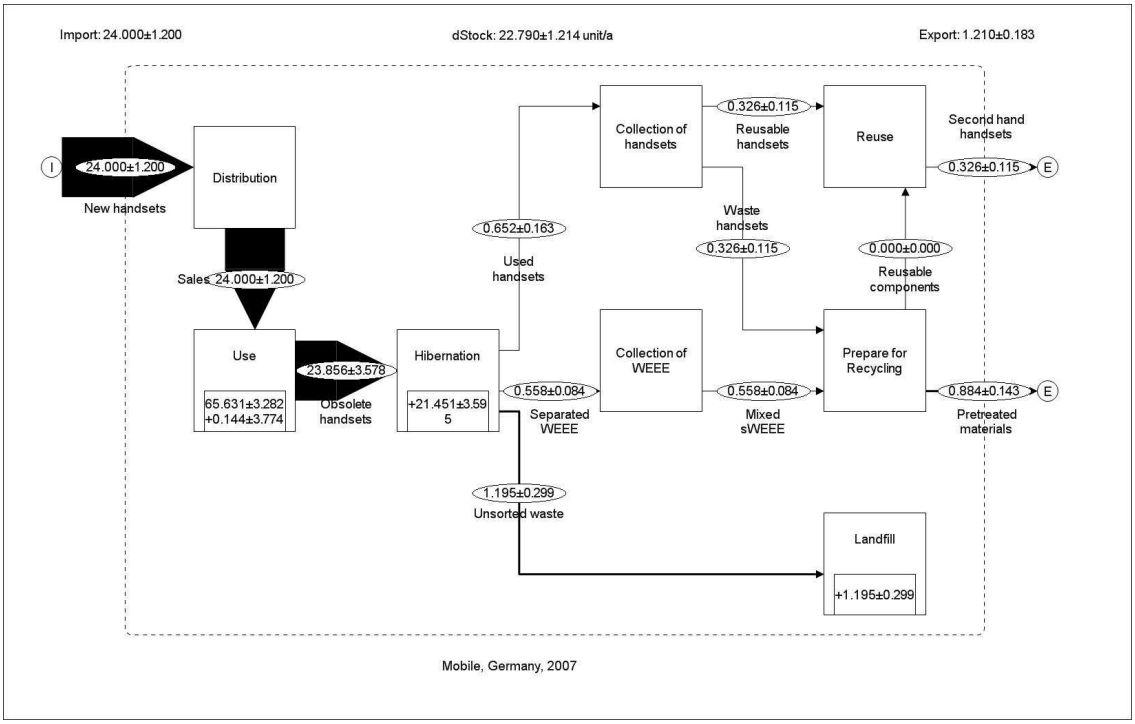


Figure 4-3: Material flows of mobile phones in Germany, 2007 (in million units).

5 Sweden

Sweden had the population of 9.18 million on 1 January 2009 (Eurostat 2010). The subscriptions at the end of 2008 stood at 10.89 million, i.e. 119 connections for every 100 people (PTS 2009). The split between pre-pay and post-pay subscriptions on 31 December 2008 was 40:60 continuing a slight but steady increase in the share of post-pay subscriptions from the level of 42% at the end of 2003 (PTS 2009). Figure 5-2 shows the historic trend of mobile subscriptions in Sweden between 1995 and 2008. A consumer survey reports that 96% of Swedes age 16-74 had at least one mobile phone in 2006 (SCB 2010).

The Swedish Post and Telecom Agency (Post- och telestyrelsen, or PTS) is the regulator for the communication industries in Sweden. **Error! Reference source not found.** shows the market shares of the four mobile network operators (MNO) in Sweden in the first half of 2009.

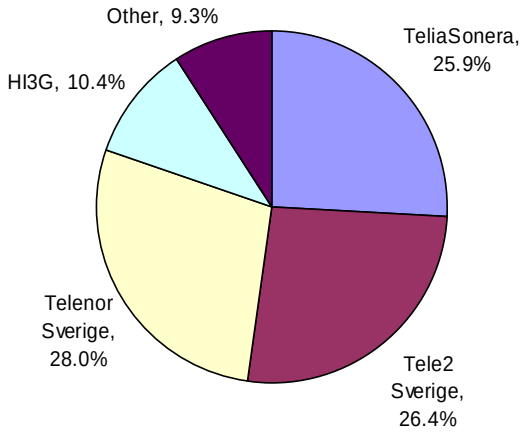


Figure 5-1: Customer bases of mobile network operators in Sweden, 2009 (H1).

Source: PTS

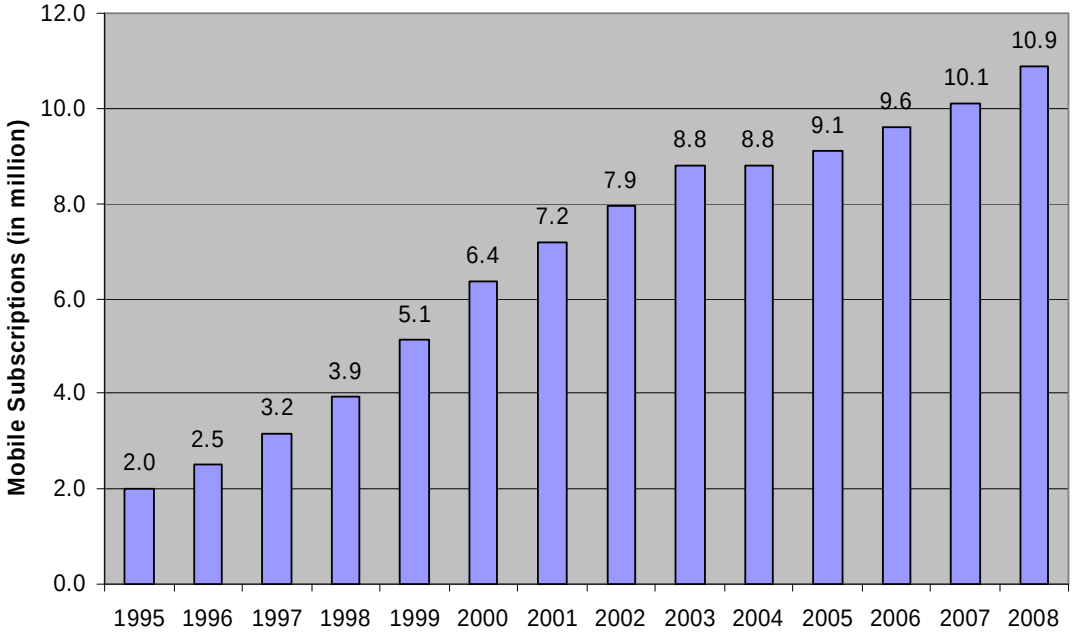


Figure 5-2: Subscription trend in Sweden, 1995-2008.

Source: Eurostat and PTS

Table 5-1: Penetration, sales, and replacement of mobile phones in Sweden, 2004-2008.

Year	Penetration rate (connections/inhabitants)	SIMs per user or handset (connections/unit)	Adjusted penetration rate (units/inhabitants)	Population (million inhabitants)	Stock in use (million units)	First-time sales (million units)	Total Sales (million units)	Replacement sales (million units)	Replacement period (years)
2003	0.98	1.31	0.75	8.94	6.73	-	-	-	-
2004	0.98	1.30	0.75	8.98	6.74	0.01	3.3	3.29	2.05
2005	1.01	1.33	0.76	9.01	6.86	0.12	2.8	2.68	2.51
2006	1.06	1.37	0.78	9.05	7.02	0.16	3.2	3.04	2.26
2007	1.11	1.41	0.79	9.11	7.17	0.15	3.3	3.15	2.23
2008	1.19	1.48	0.80	9.18	7.35	0.18	3.2	3.02	2.37

Source: Eurostat (penetration and population) and MobilTelebranschen (2010) (total sales)

Table 5-1 presents a calculation of handset replacement in Sweden based on the market penetration and sale data. Based on this estimation, around 15 million mobile phones were replaced and out of use in Sweden between 2004 and 2008. The figure corresponds well with the indication given by TeliaSonera in their investigation in spring 2008, which suggests that approximately 15 million mobile phones are left at home without being used. (Avfall Sverige 2008).

Sweden is one of the few EU Member States that introduced EPR legislation for prior to WEEE Directive. The Ordinance on Producer Responsibility for Electrical and Electronic Equipment (SFS 2000:208) was introduced to enhance development of environmentally less burdensome products while improve environmentally appropriate handling (Regeringskansliet 1998). The legislation was revised in 2005 to be in line with the content of the WEEE Directive. The following description related to the content of the legislation is on the revised one (SFS 2005:209), unless otherwise mentioned.[14]

The Swedish legislation provides essentially the same definition of producers as found in the WEEE Directive and includes manufacturers, sellers and importers and exporters (Section 3).[15] The Swedish Ordinance covers essentially the same categories as the WEEE Directive, although the Annex II of the Ordinance lists the functions of products for each category instead of merely listing examples of products. Similarly to the WEEE Directive, it covers components, subassemblies and consumables.

The Ordinance states its purpose as waste prevention via upstream measures, and if waste is nevertheless generated, that producers provide systems for collection of WEEE, that products can be reused and recycled, and recovery and recycling targets as stipulated in the WEEE Directive are met (Section 1). Following this purpose, the legislation assigns responsibility to producers as the primary actors for the management of WEEE. Specific obligation given to the producers in relation to collection and recycling include:

- Ensuring the existence of "one or more appropriate collection system"(s) for WEEE from private households, and that they should be handled free of charge (Section 12, 13, 15 and 16.1);
- Ensuring the possibility for non-household users to deliver WEEE in a simple and

[14] Main changes that took place include: inclusion of collection and recovery targets, expansion of producer responsibility (from old-for-new basis to all the WEEE), adjustment of scope and inclusion of, marking, reporting and registration requirements.

[15] Similar to German definition, the Swedish definition is a so-called National definition. See footnote 5.

practical manner and provision of information to these actors (Section 14, 16.2, 22);

- Consultation with municipalities when setting up collection systems (Section 23, 24, 25);
- Environmentally sound handling of WEEE from collection onwards (Section 16.3);
- Provision of information regarding the content of their products to ensure the handling of WEEE in a sound manner from environment and health point of view (Section 19);
- Reporting to the Swedish Environmental Protection Agency (Naturvårdsverket in Swedish) of the sales figures by weight or numbers, their intention of how to fulfill their responsibility as well as the amount of WEEE 1) collected, 2) reused without pretreatment, 3) pretreated, 4) reused after pre-treatment, 5) material recovery, 6) energy recovery, 7)disposed, and 8) handled outside of Sweden (Section 9, 20, 27); and
- Marking of WEEE in accordance with the WEEE Directive (Section 11).

In addition, Section 8 of the Ordinance restricts the responsibility of municipalities to handle household waste when WEEE are delivered to a responsible producer or collection systems described above. The Swedish legislation does not define distributors and no specific responsibilities are allocated on them. Meanwhile, many of the distributors are in fact importers, thus they are among the producers and have the same responsibilities listed above.

Section 17 of the Ordinance provides detailed accounts as to when a collection system for household is considered appropriate. Among the conditions included are:

- Easy access and good service for households and municipalities and others who are likely to return WEEE, and at least one of the locations should be the one arranged by the municipality, unless otherwise agreed with the municipality;
- WEEE should be easy to sort from other waste streams;
- For new WEEE, appropriate geographical spread "in view of the expected use and service life of products sold and other circumstances";
- For historical WEEE, collection systems should be set up in each municipality;
- The system promotes the reuse of all or parts of the WEEE; and
- The system should not expose personnel handling the WEEE to health and safety risk.

The Swedish implantation of EPR system for WEEE started in 2001 when industry associations comprising of producers of various electronic products established an organisation called El-Kretsen to fulfill their members' responsibility on members' behalf. Although alternative systems emerged over the years – including Eurovironment, Elektronikåtervinning i Sverige ekonomisk Förening: EÅF and some individual solutions, as discussed later – El-Kresten has remained a predominant organisation handling of the responsibility of majority of EEE producers in Sweden.

Under the El-Kretsen system municipalities have been the primary actor for collecting WEEE from households. At the start of the system, SFS 2000:208 allocated physical and financial responsibility for collection and subsequent handling of WEEE to producers (including distributors) on old-for-new, one-for-one basis, while the remaining WEEE – i.e. EEE that a citizen wishes to discard without purchasing an equivalent new one – is left in the hand of municipalities. Implementation of the system in accordance with the legislation would mean having two parallel systems. The distributors did not wish to collect WEEE at the point of sales. Meanwhile, municipalities need to continue to have their collection sites running regardless of the introduction of 2000 legislation. In the end El-Kretsen and the municipalities came to an agreement where the former organise collection from households and pay for the operation, while the latter organise and pay for the recycling and treatment of WEEE (El-Retur 2000). For WEEE gener-

ated from business users, El-Kretsen established separate collection points.

The system has kept this arrangement to date. As of 2008, there are 650 collection points for WEEE generated from households which are manned and financed by the municipalities. In addition, 300 collection points exist nationwide to accept WEEE from business users (El-Kretsen n.d.a). According to an interviewee, the agreement between El-Kretsen and municipalities states that all the WEEE collected by municipalities must be handled by El-Kretsen. Meanwhile, another interviewee stated that the Swedish legislation does not prohibit municipalities to refurbish WEEE and sell it as second hand products.

As mentioned, among the responsibility given to producers is consultation with municipalities concerning the collection points. Annual reports from El-Kretsen indicate a very good collaborative work between them and municipalities. However, a survey conducted in 2010 by the Swedish EPA reveals that only 10% of the municipalities interviewed feel that they have received sufficient information they need from producers.[16] 68% of the municipalities – out of which 86% have less than 20 000 inhabitant – have not been consulted by producers on the collection of WEEE (Swedish EPA 2010). It may be worth checking if the mechanisms of the communication have been functioning as positive as perceived by El-Kretsen. It is especially the case as all the interviewees representing the producers seem to perceive that their responsibility regarding the end-of-life management of their products are well-taken care of by El-Kretsen. A few interviewees indicate some concern regarding the monopolistic behavior of El-Kretsen.

At the collection sites for households, WEEE are sorted into 6-7 categories: 1) refrigerators and freezers, 2) other large home appliances, 3) small and medium-sized EEE, 4) TVs and monitors, 5) fluorescent lighting tubes, 6) low energy light bulbs, and 7) standard light bulbs (El-Kretsen n.d.b). In addition, they started sorting of batteries at the collection station started on 1 January 2009 (El-Kretsen n.d.a).[17] While the portable batteries are sorted here, batteries integrated into WEEE are sorted prior to pre-treatment of WEEE (El-Kretsen n.d.b). Mobile phones are collected within the category of small and medium-sized EEE.

The collected WEEE are transported to recycling facilities which are covering different areas of Sweden. As of 2008, El-Kretsen has contract with 28 transport companies. Small and medium-sized EEE are transported either in mesh pallets which could carry approximately 400 kg of WEEE, or containers sized 35-40 cubic meters. These small and medium-sized EEE are recycled and treated in 13 facilities in 2008 (El-Kretsen n.d.a). There is no legislative requirement as to what to do with the private information remained in WEEE. According to an interviewee, all the WEEE coming under the El-Kretsen system is recycled and treated as waste, thus there is no need to worry about the handling of private information.

El-Kretsen finances its operation via fees collected from producers. The fee consists of one-time entry fee (3500 SEK as of 2005, excluding VAT), yearly fee of 500 SEK (excluding VAT), and fee set for specific products. The fee set for mobile phone is 0.20 SEK per product (excluding VAT).

Table 5-2 indicates the amount of ICT equipment collected in the El-Kretsen system between 2002 and 2008.

Despite the dominance of the El-Kretsen, a few alternative systems have been developed. One of them is Eurovironment. The company was established in Norway in response to the

[16] The interviewees included 91 out of 290 municipalities in Sweden. This includes 12 out of 13 of municipalities with more than 100 000 inhabitants, 23 out of 42 of municipalities with the population of 40 000 to 95000, 22 out of 65 of those with 20 000 – 39 000 inhabitants and 34 out of 170 of those with less than 20 000 inhabitants.

[17] The date of inauguration by El-Kretsen system corresponds to the coming into force of Ordinance of producer responsibility for batteries (SFS 2008: 834), in which Sweden transposed the Battery Directive 2006/66/EC. SFS 208:834 repeals the existing Ordinance on Batteries (SFS 1997:645). It should be noted that sorting of batteries had been practiced in many municipalities prior to the coming into force of the 2008 Ordinance.

frustration of ICT companies towards the operation of EPR scheme in Norway, and expanded its operation to Sweden when the country introduced the EPR legislation (Tojo 2004). Its main operation is the handling of ICT equipment for business users. They promote reuse, and the deletion of information from used equipment is one of their important working areas (Eurovironment 2008). The magnitude of its current operation is not clear.

Table 5-2: Collection of discarded ICT equipment in the El-Kretsen system, Sweden: 2002-2008

	2002	2003	2004	2005	2006	2007	2008
Collection total (el kretsen)	11458	14826	17700	22700	27600	30769	28111
Collection per capita total (kg)	1.29	1.66	1.97	2.52	3.05	3.38	3.06

Source: Naturvårdsverke (2003), Naturvårdsverket (2004), Naturvårdsverket (2008)

Another organisation, ElektroniskÅtervinning I Sverige Ekonomisk Förening (EÅF) was estalbished in 2007. The development of EÅF is related to the establishment of good finanicial gurantee for management of new WEEE in the future. EÅF currently has 8 members, consisting mostly of large distributors (EÅF 2010). They use the members' shops as collection points, and in cases where no shops of their members exist in a municipality, they have agreements with El-Kretsen regarding the financing of collection from these municipalities (Naturvårdsverket 2009). As of 2008 its members put on the market in total 13 292 tonnes of EEE, and collected 6037 tonnes of WEEE. Note that these figures include all the EEE and WEEE and not only ICT equipment.

The report from Naturvårdsverket for 2008 also indicated that additional 10 000 tonnes of WEEE are collected and recycled by recycling industries (Naturvårdsverket 2010).

In addition, distributors such as IKEA, Konica Minolta, On-Off and El-Giganten had their individual operations earlier (Naturvårdsverket 2004). However, at least those companies exemplified in the earlier study have become a member of either El-Kretsen or EÅF.

In Sweden, recyclers, regardless of whether they are taking care of the WEEE from producers/PROs or those collected by other actors, need to be certified to handle WEEE and to follow the same standards.

Similarly to other EU Member States, mobile phones are within the large group of category 3: IT and telecommunication equipment. Although there is no official data, an indicative figure given from an interviewee is 60 000 to 70 000 kilograms/year in El-Kretsen system. Another estimation mentioned in Avfall Sverige (2008) yields comparable result with the estimated figure of 300 000 discarded mobile phones collected in El-Kretsen system in 2007. Our calculation using the average value from the sorting exercises in Germany (0.1%) and in the UK (0.36%) returns the estimates 354 000 and 323 000 mobile phones within the the discarded ICT equipment collected by El-Kretsen in 2007 and in 2008 respectively. Avfall Sverige (2008) further indicates that, despite lack of statistics, the estimation from knowledgeable sources indicate that around 500 000 -600 000 additional mobile phones are are left in the repair shops and are sent directly for recycling.

Interviews with manufacturers in Sweden indicate that they are not particularly active in engaging themselves in the collection of used mobile phones. They tend to leave this to the PROs they belong to. Large manufacturers instead concentrate their efforts in establishing collection sites in countries where no such collection systems exist. An interviewee also pointed to the fact that unlike Germany or Finland, it is not possible to use postal service for the collection of used mobile phones, as that would require postal service to acquire special permit for handling waste.

Interviews with distributors, network providers, producers and municipalities revealed an interesting discrepancy. Three of the retailers and a network provider interviewed indicate that they have been part of an initiative called Mobilkomposten. This was originally an initia-

tive by Nokia and a charity organisation to send used mobile phones to developing countries, and the retailers and the network provider consider themselves to be still part of this. Some of them even have two collection systems, one for reuse which they believe are sent to developing countries for charity and the other for recycle. For the latter they hand the collected used phones to the respective PROs they belong to, or send them directly to recyclers. However, initiative was run for half a year and has been ceased. This means that the used phones for reuse are still somehow collected, but their fate become very vague and none of the retailers know.

Aside from this, several actors – at least one network provider and a few second-hand companies started to buy back used phones. Some of them (such as Varubörsen , Mobilfynd and Mobilvsa) provides some guarantee to the buyers. In some cases, municipalities are also involved in the repair and selling of second hand phones. The magnitude of this activity is unknown, but based on a number of interviewees, it is still quite low. Due to a close proximity in terms of economic, social and environmental aspects between the two Nordic countries, we make the same assumption as in the Finnish case that only around 2% of obsolete handsets were reused as secondhand mobile phones in Sweden.

Low collection of small appliances, including mobile phones have been considered a challenge. The fate of old mobile phones has been debated both in mass media and the government in recent years (Avfall Sverige 2008). In response, several studies have been carried out by actors such as Avfall Sverige (Waste Sweden) and El-Kretsen.

The result of 63 sample analyses of mixed household waste carried out between 2005 and 2008 rarely found mobile phones in this stream. Concerning sorted fractions, plastic packaging waste and metal packaging waste have been looked at. One of the two small samples (75kg) of plastic packaging waste collected at a municipal recycling station includes 0.6% of WEEE (type unknown), while the other sample from kurbside collection did not contain any WEEE. When extrapolating this figure on the collection figure of plastic packaging waste from 2008 – 102 469 tonnes (Naturvårdsverket 2010) – the overall WEEE included in the plastic packaging waste would be 615 tonne. Concerning metal packaging waste, a study of somewhat larger sample (180kg) collected at a municipal recycling station includes 2.6% of WEEE, while the other sample from kurbside collection includes 1.3 % of WEEE (type unknown). A study conducted in 8 places in 2007 (900kg) includes 2% 2% of WEEE, and mobile phone was mentioned as an example (Avfall Sverige 2008). When extrapolating the average of this figure - 2 % - on the metal packaging waste collected in 2008 – 32 447 tonnes (Naturvårdsverket 2010) – the overall WEEE included in the metal packaging waste would be 649 tonne. However, there is no information on the share of used mobile phone within these samples. Therefore, we assume that the portion of discarded ICT equipment within this wrongly sorted WEEE was similar to that in the correctly sorted WEEE in Sweden, i.e. 20%. Then, the same procedure that is used above to calculate the amount of used mobile phones within the collected ICT waste by El-Kretsen returns the figure of wrongly sorted handsets at about 3,000 units. Because most of the wrongly sorted handsets tended to be in the plastic waste stream which would be further sorted at material recovery facilities to screen out contaminants including used mobile phones, we further assume that instead of ending up in the landfill these screened out items would be diverted back to the WEEE system. The range of uncertainties should in this case cover the amount of handsets that might get through the sorting and screening processes and end up in the landfill. In a MFA, we rename F14 and P8 and add a new flow connecting P8 back to P7 accordingly, see Figure 5-3.

The results of the pick analysis of the three municipal waste streams – mixed household waste, plastic packaging waste and metal packaging waste – mentioned above indicate that the overall WEEE found in the municipal waste stream is fairly small. In addition, as mentioned in the aforementioned study of Avfall Sverige from 2008, even when WEEE is is included in other sorted fractions, they be easily resorted to WEEE collection scheme. Interestingly, however, a recent survey by Naturvårdsverket (2010) on 1000 inhabitants indicate that only 34% of the interviewees se-

lected WEEE as among the household products that one should not throw into waste bin. In comparison, 74% selected batteries, followed by glass (60%), metal (54%). Åöastoc (51%), light bulbs (42%) and paper (36%).

A study by TeliaSonera, currently the biggest network provider in Sweden, in spring 2008 indicates that 83% of the 4000 inhabitants aged 18-80 have at least one old mobile phones at home without being used. 22 % have more than 5 old mobile phones. This means that average people of this age range has 2.35 old mobile phones left at home unused. Applying this value to the population aged 15-80 in Sweden in 2008, 7.16 million (Eurostat 2010), returns an estimated stock of hibernated phones of 16.83 million handsets. When asked about the reasons for storage, 47% of those who keep at least one mobile phone mentioned about back up, while 13% mentioned of nostalgic reasons. 7% mentioned they cannot throw them away (TeliaSonera 2008, as cited in Avfall Sverige 2008). Interestingly, none mentioned of the information left on the phones.

Figure 5-3 shows a result of MFA based on the information presented above for the year 2008. Almost 30% of obsolete handsets were recovered. Most of the collected mobile phones either through municipal WEEE collection or repair shops are sent for material recycling. As in the case of the UK (see below), the size of hibernated stock is estimated to be more than double the size of stock in use and growing. On a positive note, the many samplings of other waste streams indicate that the number of handsets wrongly sorted in Sweden tended to be small, comparing to the global survey assumed in the other cases, and even fewer would find their way to a landfill.

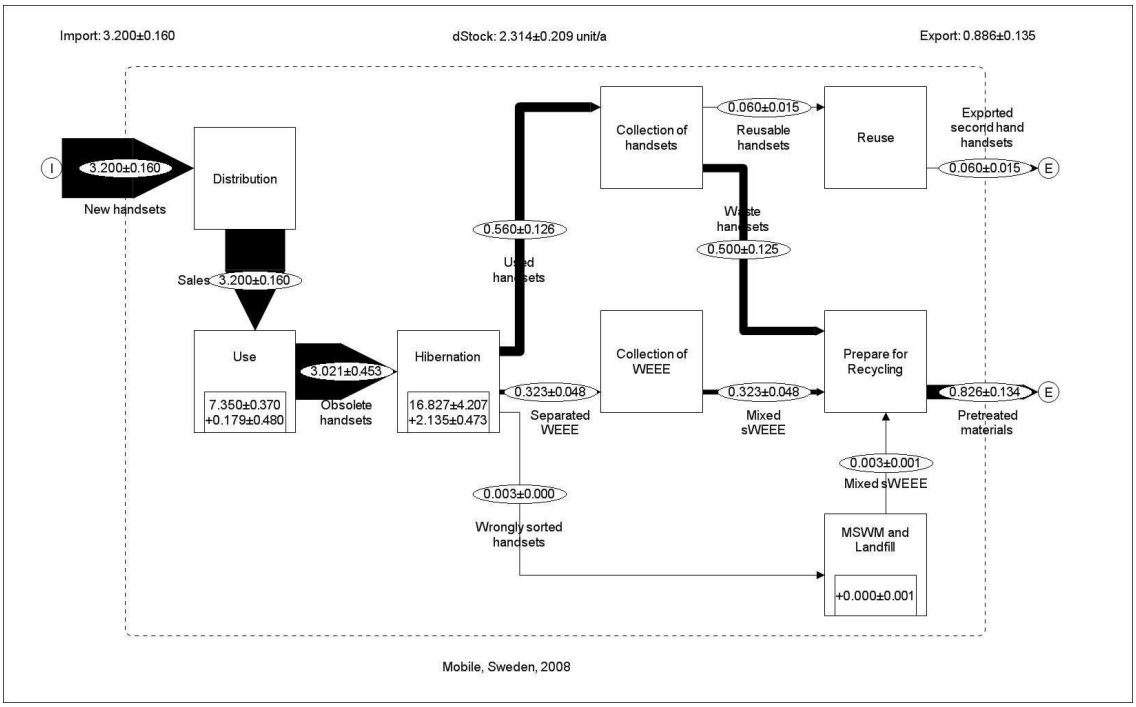


Figure 5-3: Material flows of mobile phones in Sweden, 2008 (in million units).

6 Switzerland

Switzerland had the population of 7.59 million on 1 January 2009 (Eurostat 2010). The subscriptions at the end of 2008 stood at 8.90 million, i.e. 117 connections for every 100 people (OFCOM 2010). The split between pre-pay and post-pay subscriptions in 2008 was 43:57 continuing a slight but steady decrease in the share of post-pay subscriptions from the level of 65% in 1999 (OFCOM 2010). Figure 6-1 shows the historic trend of mobile subscriptions in Switzerland between 1995 and 2008. A A consumer survey reports that 88.9% of Swiss households used mobile phones in 2007 with 48.9% of the households had more than one device (FSO 2009).

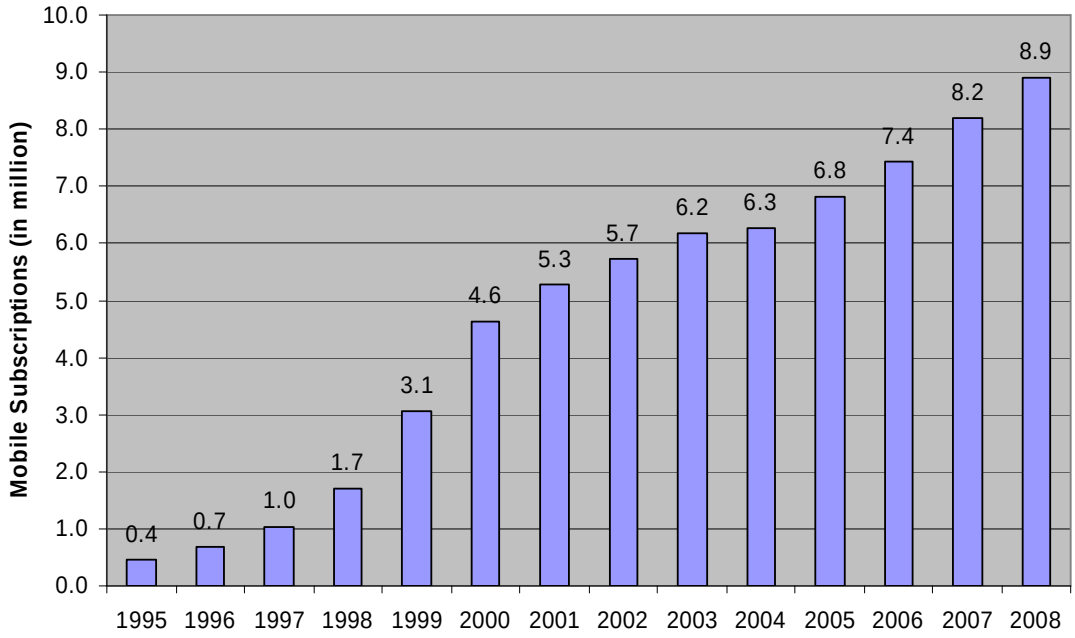


Figure 6-1: Subscription trend in Switzerland, 1995-2008.

Source: Eurostat and OFCOM

The Federal Office of Communications (OFCOM) is the regulator for the communication industries in Switzerland. **Error! Reference source not found.** shows the market shares of the four mobile network operators (MNO) in Switzerland in at the end of 2008.[18]

[18] In late 2009, the second and the third largest MNO in Switzerland – Sunrise and Orange Swizerland – proposed their potential merger (Swissinfo 2009). However, their merger raised criticisms on the creation of duopoly and the Competition Commission put formal halt on the merger in April 2010 (Swissinfo 2010).

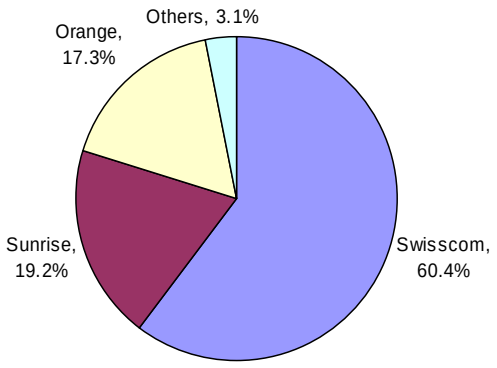


Figure 6-2: Customer bases of mobile network operators in Switzerland.

Source: OFCOM

Table 6-1 presents a calculation of handset replacement in Switzerland based on the market penetration and sale data. Based on this estimation, around 2.5 million mobile phones were replaced and out of use in Switzerland in 2007.

Legally, the collection and recycling of WEEE has been under the provisions of the Ordinance on the Return, the Taking Back and the Disposal of Electrical and Electronic Appliances (SR 814.016, henceforth "ORDEA") since 1998. ORDEA stipulates mandatory take-back and disposal obligations of producers and traders of regulated items. According to its Article 2 amended in 2005, it now covers:

- Consumer electronics equipment;
- Office, IT and communication technology equipment;
- Household appliances;
- Lighting equipment;
- Lamps (without incandescent light bulbs);
- Tools (except large-scale stationary industrial tools); and
- Sport and leisure appliances as well as toys

Table 6-1: Penetration, sales, and replacement of mobile phones in Switzerland, 2004-2008.

Year	Penetration rate (connections/inhabitants)	SIMs per user or handset (connections/unit)	Adjusted penetration rate (units/inhabitants)	Population (million inhabitants)	Stock in use (million units)	First-time sales (million units)	Total Sales (million units)	Replacement sales (million units)	Replacement period (years)
2003	0.85	1.22	0.70	7.28	5.09	-	-	-	-
2004	0.85	1.22	0.70	7.38	5.16	0.07	-	-	-
2005	0.92	1.26	0.73	7.42	5.41	0.25	-	-	-
2006	1.00	1.32	0.76	7.43	5.63	0.22	-	-	-
2007	1.09	1.40	0.78	7.51	5.88	0.25	2.8	2.55	2.21
2008	1.17	1.47	0.80	7.59	6.06	0.18	-	-	-

Source: Eurostat (penetration and population)

Under the Ordinance, take-back must be done free-of-charge (1) by retailers and wholesalers according to the types of products they sell, and (2) by producers according to the brands they placed on the market. ORDEA does not contain detailed rules on how obligations should be carried out. Nor does it prescribe collection or recycling targets. Its implementation is instead laid down in the guidelines (SAEFL 2000). According to the guidelines, registration and authorisation are largely based on existing waste management and environmental laws and regulations, such as the Federal Law Relating to the Protection of the Environment (LPE 1983, SR 814.01), the Ordinance on the Movements of Special Wastes

(OMSW 1986, SR 814.610), the Technical Ordinance on Waste (TOW 1990, SR 814.600), the Ordinance relating to Environmentally Hazardous Substances (Osubst 1986, SR 814.013), the Ordinance on Air Pollution Control (LRV 1985, SR 814.318.142.1), the Water Protection Law (GSchG 1991, SR 814.20), and other cantonal laws and ordinances. The exception is Article 6 of ORDEA that specifies treatment requirements for the disposal of WEEE (see Appendix II). The Federal Law Relating to the Protection of the Environment (LPE) requires waste management entities to apply for a 5-year permit to operate. Its Article 7 6bis specifies the following range of activities: "Waste disposal includes its recycling or placing in a landfill and the preliminary stages of collection, transport, temporary storage and treatment. Treatment means any physical, chemical or biological modification of the wastes". Moreover, those with annual capacity exceeds 1000 tonnes are subjected to the Ordinance on Environmental Impact Assessment (OEIA). However, the SAEFL's guidelines recommend the implementing authorities to exempt entities merely collect and temporarily store WEEE before shipping it to authorised disposal facilities from authorisation (SAEFL 2000).

In practice, the management of WEEE in Switzerland has been organised by PROs representing different industrial branches. As a matter of fact, collective industrial initiatives existed even before the Ordinance which was enacted to strengthen the initiatives upon the request of producers in order to address the problem of free riders. The first of PROs was the Stiftung Entsorgung Schweiz (SENS) established in 1991 for the recycling of refrigerators and freezers. In 1994, the Swiss Association for the Information, Communication and Organisational Technologies (SWICO), established a unit called SWICO Recycling Guarantee for its members to subscribe to the recycling services. Other PROs in Switzerland related to this research are the Interessenorganisation Batterienentsorgung (INOBAT), established in 2001 to replace the BatterieEntsorgungs-Selbsthilfe Organisation (BESO) and the Swiss Lighting Recycling Foundation (SLRS) that was separated from SENS in August 2005. SWICO has a long history of collaborating with INOBAT and PRO for packaging organisation to make it simple and easy for consumers to pay the advance recycling fee (Tojo 2004). Since 2007 the four PROs has had a joint steering board, called VREG, to share experiences and coordinate the work among themselves and also with the authorities. In this study, we focus on the work of SWICO Recycling, which currently consist of 538 member companies in the area of ICT and office equipment, consumer electronics, dental equipment, photographic equipment, and measuring and medical technology (SWICO Recycling 2010).

SWICO Recycling has made agreements with obligatory take-back parties. The mobile phone sector joined the PRO on 1 January 1999. The number of signatories from the sector stood at 18 in 2005. SWICO Recycling raises its operating fund via a pay-as-you-go (PAYG) charge – called advance recycling fees (ARFs) – from their members based on the current market share. Streicher-Porte (2006) provides the following formula for the calculation of SWICO's fees:

$$ARF = (r*O + R)/S,$$

The factors influencing the amount of fees are the reimbursement (r, CHF per unit) to cover all expenditures of the system, the number of obsolete items (O, unit), the amount of reserve (R, CHF), and the estimate of new sales (S, unit). ARFs are adjusted on a yearly basis. The ARF for mobile phones in 2010 is 0.07 CHF per unit (including VAT), the same as in 2009 (SWICO Recycling 2010). It is noted in the 2005 Activity Report that 70% of ARF for mobile phones is actually for their batteries.

Figure 6-3 shows the collection results of SWICO Recycling between 1998 and 2009. At present, the dominating channel is the network of 600 public collection points across the country that contributed to more than half of the collection in 2009. These facilities are shared by SWICO, SENS, and SLRS (for B2C collection) to achieve economy of scale (Streicher-Porte 2006). WEEE collected through the the public collection points and distributors are destined for material recycling. Reuse is allowed for WEEE collected by producers and independent companies. The SWICO sets requirements more stringent than the national legislation for those they have contract with.

They organise third-party audit to ensure the quality of recycling (Tojo 2004).

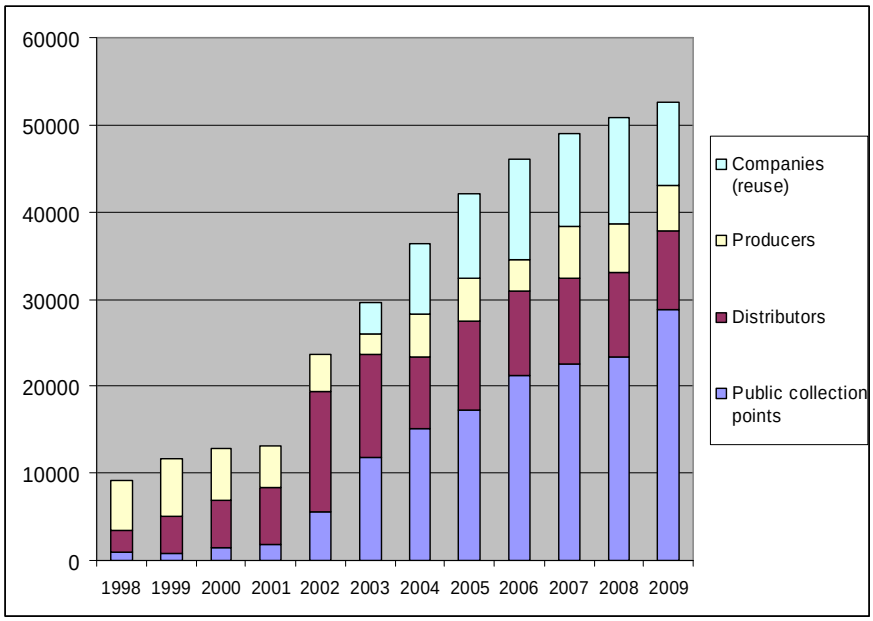


Figure 6-3: Reported collection of WEEE by SWICO Recycling (in tonne).

Source: SWICO Annual Activity Report

Table 6-2 reports the quantities of used mobile phones collected within the umbrella of SWICO Recycling. Mobile phones comprised 0.1-0.2% by weight of its total collection. The conversion from reported tonnage into units assumes a constant average weight of 200 grams/unit. In the 2008 Activity Report, the executive of SWICO Recycling is quoted saying that the return rate of mobile phones, which was around 15% of sales at that time, is "unsatisfactory" with a further estimation that almost 8 million handsets were hibernating in people home (SWICO Recycling 2009). In 2009, the PRO stepped up its collection and awareness raising campaigns targeting used mobile phones and other small devices. The two-day collection initiative with 300 cities, communities, schools, associations and companies during the "True Values" national environmental day in May 2009 was able to collect more than 14,000 mobile phones weighed 1.7 tonnes (SWICO Recycling 2010).

Table 6-2: Reported quantities of used mobile phones collected by SWICO Recycling.

Year	Total quantity (tonne)	Mobile phone (tonne)	Mobile phone (million unit)
2002	23,693	29	0.145
2003	29,623	35	0.175
2004	36,409	57	0.285
2005	42,117	68	0.340
2006	46,083	74	0.370
2007	49,059	69	0.345

Source: SWICO Annual Activity Report[19]

Figure 6-4 shows a result of MFA based on the information presented above for the year 2007. Due to data gaps, the amount of unsorted handsets was assumed based on the survey by Nokia (2008). We also estimate the scale of secondary market for used phones in Switzerland based on the survey result. But

[19] Since 2006, SWICO Recycling has adopted a new reporting format which classifies WEEE into CRT television sets, mixed CE, CRT monitors, LCD monitors, PC/servers, laptops, printers, large-scale copiers, and other equipment. From the 2008 Activity Report onwards, it stops reporting the quantities by products.

since a country of this size would unlikely have have such large market as in the cases of Germany or the UK, the figure is halved and we assume that only 10% of obsolete products were collected for reuse at the reusing rate of 50%. Together with the quantity collected by SWICO, this assumption brings the number of used mobile phones separately collected to around 15.3% of the sales. With the estimation that annually around 2 million obsoletes ended up in the hibernating stock between 2007 and 2009 and the size of the stock was around 8 million at the beginning 2009, the size at the beginning of 2007 can be determined to be around 4 millions. All estimates and assumptions have the ±25% range of errors attached to them.

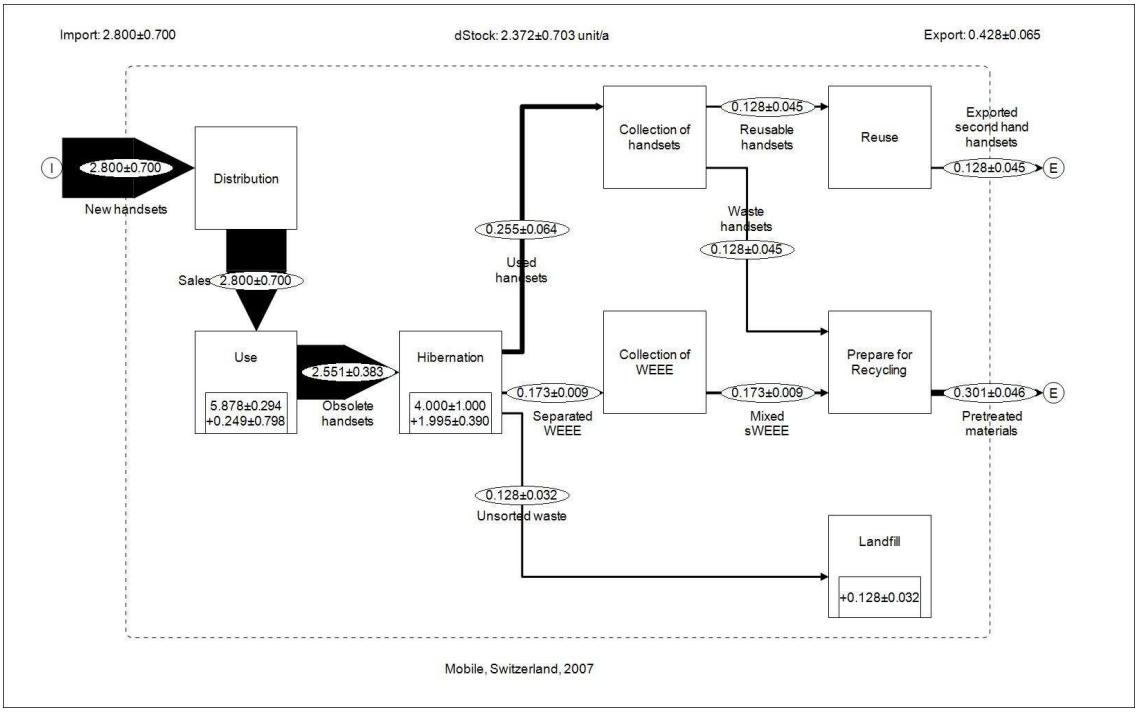


Figure 6-4: Material flows of mobile phones in Switzerland, 2007 (in million units).

7 The United Kingdom

The UK had the population of 61.63 million on 1 January 2009 (Eurostat 2009). The subscriptions of the mobile phones at the end of 2008 stood at 76.83 million, i.e. 125 connections for every 100 people (Ofcom 2009). The split between pre-pay and post-pay subscriptions was 61:39 in 2008 continuing a slight but steady increase in the share of post-pay subscriptions. Figure 7-1 shows the historic trend of mobile subscriptions in the UK between 1995 and 2008. A survey reports that in 2008 only 4% of British adults remained mobile-phone-free while 17% had two or more mobile phones (The Carphone Warehouse 2008).

The Office of Communications (Ofcom) is the regulator for the communication industries in the UK. Figure 7-2 shows the market shares of the five nationwide mobile network operators (MNO) in the UK before the merger of Orange and T-Mobile in 2009. The market shares reported in Figure 7-2 include also the shares of mobile virtual network operators (MVNO) and service providers (SP) that rented the airtime from respective MNO. Virgin Mobile (using T-Mobile's spectrum) was the largest MVNO having the customer base of around 5 million connections at the end of 2008, i.e. almost half of the combined share of all other MVNO and SP (Ofcom 2010).

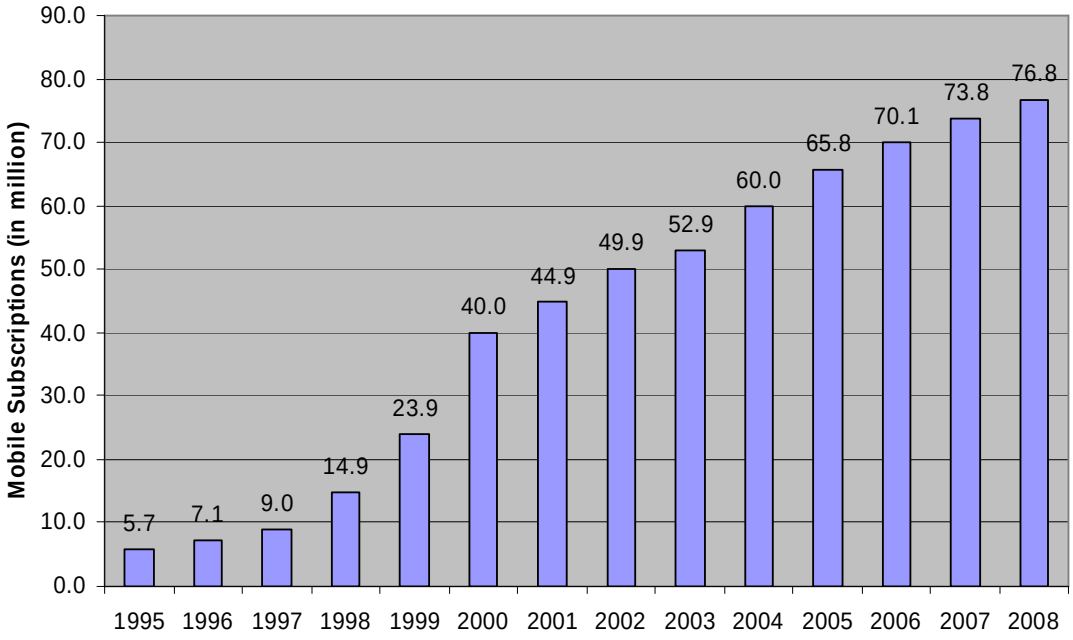


Figure 7-1:Subscription trend in the UK, 1995-2008.

Source: Eurostat and Ofcom

Table 7-1 presents a calculation of handset replacement in the UK based on the market penetration and sale data. The calculated figure of replacement sales in 2004 is higher than the estimation of 15 million obsolete phones per year cited in literature (Vodafone 2010; Orange 2010; Canning 2006; Forum for the Future 2004). Because this is an old estimation, it is likely that the number of obsolete mobile phones in recent years is much higher due to an increase in handset sales and a shortening replacement period. Some sheets (Vodafone 2010; Redeem 2007) estimate the replacement period in the UK at 18 months. One study

(Axion Recycling 2006) reports the age of discard for mobile phones found at collection facilities in London at 2.37 years.

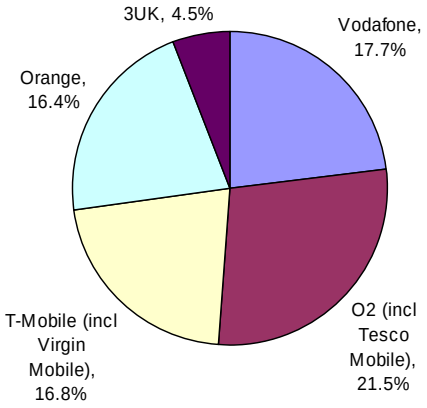


Figure 7-2: Customer bases of five mobile network operators in the UK, 2008.

Source: Ofcom

Legally, the collection and recycling of WEEE are now under the provisions of the Statutory Instruments 2006 No. 3289—the Waste Electrical and Electronic Equipment Regulation 2006 (henceforth "the WEEE Regulation"). The WEEE Regulation is a result of the transposition of the EC WEEE Directive and covers the ten EEE categories of the Directive. The regulation bans unsorted disposal of WEEE and encourages end users to dispose WEEE free of charge at designated collection facilities (DCFs) approved by the government. The Regulation, however, does not oblige any party to operate a DCF. Free take back obligation only exists for distributors who commercially supply new equipment to users on a one-to-one basis but they can discharge the obligation by joining the distributor take back scheme (DTS). The financial responsibility is with the producers who have obligations to join a compliance scheme and to finance the costs of collection, treatment, recovery and environmentally sound disposal of WEEE deposited at DCFs or returned to distributors based on the market-share calculation. The Environment Agency, Scottish Environment Protection Agency (SEPA), and the Northern Ireland Environment Agency (NIEA) are nodal agencies under the Regulation. The Vehicle Certification authority (VCA) is an enforcement authority for the distributors' on-site take-back and consumer information obligations. In addition, the protection of personal data that might still be in used mobile phones is under the Data Protection Act of 1998.

Table 7-1: Penetration, sales, and replacement of mobile phones in the UK, 2004-2008.

Year	Penetration rate (connections/inhabitants)	SIMs per user or handset (connections/unit)	Adjusted penetration rate (units/inhabitants)	Population (million inhabitants)	Stock in use (million units)	First-time sales (million units)	Total Sales (million units)	Replacement sales (million units)	Replacement period (years)
2003	0.89	1.24	0.72	59.44	42.58	-	-	-	-
2004	1.01	1.32	0.76	59.70	45.33	2.75	23.00	20.25	2.10
2005	1.10	1.40	0.78	60.06	47.06	1.72	25.35	23.63	1.92
2006	1.16	1.46	0.80	60.43	48.11	1.05	30.03	28.97	1.62
2007	1.21	1.51	0.80	60.78	48.88	0.77	30.52	29.75	1.62
2008	1.26	1.55	0.81	61.18	49.48	0.60	34.29	33.69	1.45

Source: Eurostat (penetration and population) and GfK (total sales)

Table 7-2 lists the 13 mobile phone producers in the UK (the top five OEMs of handsets, two leading OEMs of smart phones, the five MNOs, and one phone retail chain) according to their compliance schemes as of 2010. Three schemes—ERP UK, REPIC, and Valpak—are

open for all types of WEEE under the Regulation. The three are strictly operators of compliance schemes and do not seek an approval in the physical management of WEEE except Valpak which has been appointed as the DTS (see below) and also an approved exporters. These inclusive schemes mainly arrange WEEE collected by Local Authorities and Councils through competitive tendering for material recycling at contracted approved authotised treatment facilities (AATFs) or approved exporters in order to meet the financial obligation on behalf of their members. The other two—Recycle Telecom Producer Compliance Scheme and Regenersis Environmental Services Ltd (formally known as Fonebak)—are approved schemes exclusively for mobile phones and other portable communication devices. Unlike the first three schemes, the core competence of these selective schemes is in the physical management (collection, reuse and recycling) of used mobile phones. For these schemes, WEEE compliance is an additional value-adding service. Both Recycle Telecom and Regenersis are not only operators of compliance schemes but also DCFs, AATFs and approved exporters in their own right. More information on their roles and activities will be given below.

Table 7-2: Major producers of mobile phones by their compliance schemes.

Producer Name	Obligation Type	Registration Number	Compliance Scheme (Categories of EEE)
Samsung Electronics (UK) Ltd	Both	WEE/FD0076US	ERP UK (All)
Sony Ericsson Mobile Communications AB	B2C	WEE/FC0144QR	ERP UK (All)
The Carphone Warehouse Ltd	B2C	WEE/FD0095VY	Recycle Telecom (IT and Telecoms)
Hutchinson 3G UK Ltd	Both	WEE/AK0171SW	Regenersis (IT and Telecoms)
Orange Personal Communication Services Ltd	Both	WEE/EJ0094VX	Regenersis (IT and Telecoms)
Telefonica O2 UK Ltd	Both	WEE/FK0094VX	Regenersis (IT and Telecoms)
Vodafone Ltd	Both	WEE/FA0094VX	Regenersis (IT and Telecoms)
Apple Sales International	Both	WEE/CE0058TS	REPIC (All)
LG Electronics UK Ltd	Both	WEE/EE0057TS	REPIC (All)
Research In Motion UK Ltd	B2C	WEE/CD0058TS	REPIC (All)
Motorola Ltd	Both	WEE/AD0047SY	Valpak (All)
Nokia UK Ltd	B2C	WEE/HK0044SY	Valpak (All)
T-Mobile (UK) Limited	Both	WEE/DJ0046SY	Valpak (All)

Source: Environment Agency

Table 7-3: Membership fees in the distributor take back scheme.

	Total sales value of EEE of the previous year	Fee payable
Distributor A	Greater than GBP 1.5 m	'Per unit' fee (GBP/unit) Skip 1 (Refrigeration): 1.52 Skip 2 (White non-fridge): 0.62 Skip 3 (CRT): 0.55 Skip 4 (Mixed): 0.02 Skip 5 (Lighting): 0.01
Distributor B	GBP 100,000 – 1.5 m	GBP 1,500 per year
Distributor C	Less than GBP 100,000	GBP 400 per year

Source: Valpak

- The UK Government by the Department Trade and Industry (DTI) has appointed Valpak as the DTS. By the end of the phase one (2007-2009), more than 2,850 distributors representing over 75% of EEE sales in the UK chose to join the DTS in order to be exempted from the on-site free take back obligation (Valpak 2010). The members paid fees to DTS at the rates shown in Table 7-3. The DTS spent most of the GBP 10 million fund raised through the membership fees in supporting 208 Local Authorities in England, Wales, Northern Ireland and Councils in Scotland to set up recycling centres (also known as civic amenity, CA, sites) as DCFs. In the phase one, the DTS paid GBP 6,000 for each recycling centre[20] and, according to Valpak (2010)'s website, the following funding will be available from the DTS to the recycling centres in the phase two of the DTS (2010-2012):

- "GBP 1,000 per eligible site for the maintenance;
- Between GBP 6,000 and 9,000 for new or replacement sites;
- GBP 1,200 per added stream for existing sites that wish to add more skips in their collection;
- Additional funding contingent to the uptake of the DTS by the distributors in the phase two.

In addition, as the DTS, Valpak also assists DTI by compiling and submitting the lists of DCFs for approval. In so doing, Valpak charges the operators of non-CA sites who seek approval a refundable fee of GBP 100 for each site or GBP 500 in total (whichever is lesser). According to communication with Valpak, the registration fee is weaved for no-for-profit or charity organisations. By the end of phase one, there 1,123 recycling centres and the other 420 non-CA sites that are approved as DCFs (Valpak 2010).

The recycling centres of the Local Governments and Councils are the main collectors of WEEE by weight in the UK. Figure 7-3 shows the amount of total WEEE separately collected in the UK, 5-6% by weight of which is from Category 3, IT and Telecommunications Equipment excluding display equipment. About 90% of this quantity was collected by the DCFs. The other 10% was WEEE returned to compliance schemes via distributors or in their own collection systems. For example, Nokia and Motorola offer to take back used mobile phones in the UK via freepost and at their service centres while Sony Ericssons, LG, and Samsung give information about the collection of their respective compliance schemes on their websites. The collection target of 4 kilogram per habitant has been surpassed since 2008. For WEEE in general, the Regulation has had an impact in terms of landfill diversion. Figure 7-3 shows an increase in the collection of Category 3 WEEE. The official data in the UK however are available only at the category level and additional informa-

[20] An additional subsidy of up to GBP 3,000 was payable if deemed necessary for the operational plan Valpak submitted to DTI.

tion is needed to determine the share of used mobile phones in the separately collected WEEE.

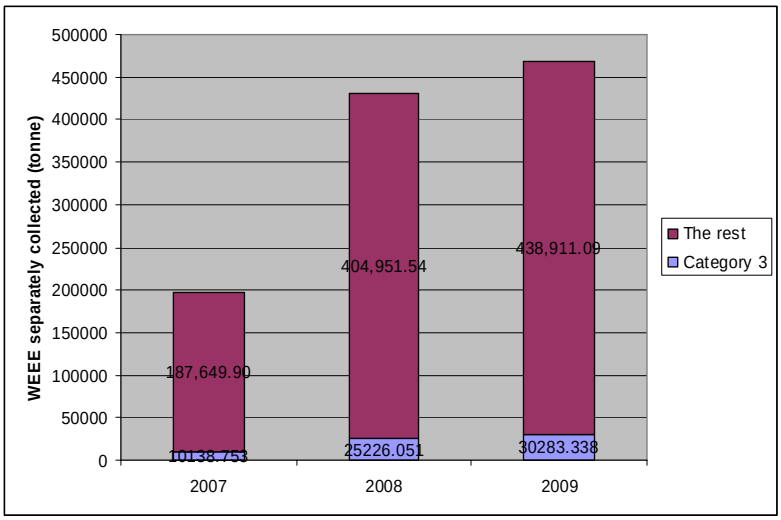


Figure 7-3: Reported collection of WEEE (in tonne).

Note: 2007 covered the period July-December

Source: Environment Agency

At normal DCFs that accept multiple categories of WEEE, used mobile phones are typically collected in a collection skip called "small mixed WEEE" (SMW). Because they constitute a small fraction of SMW, collected used mobile phones are sent to direct recycling together with other SMW. Based on a sorting trial of the 125 tonne sample of SMW (excluding display equipment) arising from several recycling centres, waste from Category 3 amounted to 17,780 kilograms within which 325 items were telephones (Defra 2007). With an average weight of 200 grams per unit, the share of used mobile phones was calculated to be only 0.36% of the Category 3 or 0.05% of SMW. **Error! Reference source not found.** shows the estimated amount of used mobile phones collected as Category 3 that are destined for direct recycling based on the share of mobile phones found within Category 3 at the aforementioned trial and assuming that the share is constant during the period 2007-2009. This estimation might be overstated because the possibility that used mobile phones would be sorted out for reuse was higher for non-household devices and the handsets that were collected by DCFs specialised in phone collection (see below). The margin of error can be estimated by subtracting the amount of reused handsets from collected amount in Category 3 which would give smaller results up to 5% of the figures reported in the last column of **Error! Reference source not found.**.

Table 7-4: Estimated amount of used mobile phones collected as Category 3.

Year	Category 3 (tonne)	Mobile phones (tonne) 0.36% of Cat 3	Mobile phones (unit) 200 g/unit
2007 (July-Dec)	10,138.75	36.50	185,277
2008	25,226.05	90.81	460,984
2009	30,283.34	109.02	553,401

Source: Environment Agency (for Category 3)

Despite being the main contributor in the overall WEEE collection, Local Governments and Councils play a small role in the collection of used mobile phones. Because provisions in the WEEE Regulation are set at the category level and the targets are weight-based, the

management of lightweight mobile phones is marginalised in the system. A manager of one inclusive compliance scheme is quoted saying: "It's all under Category three and, because it's relatively light it is quite marginal to the whole situation of things" (Metals News 2010). Two inclusive compliance schemes we interviewed confirm that they do not go beyond product categories and do not have a special arrangement for used mobile phones. One informant further comments that, despite selling a large volume of valuable products, the share of financial responsibilities of mobile phone producers is as small as the share of their shipments by weight in Category 3. Used handsets discarded at recycling centres are usually old, unfitted for reuse, and hence are sent directly for material recycling together with other devices. In addition, an informant mentions that a contractual condition between his compliance scheme and recyclers preventing the exports of WEEE outside the EU to ensure the integrity of the treatment might not be very encouraging for reuse of mobile phones which have a market in developing countries.

Several other actors have specialised in the collection of used mobile phones and occupied this territory even before the WEEE Regulation. Some are logistics companies that provide reverse logistic services such as product returns, replacements and repairs under warranty to suppliers and distributors. The others which will be the focus of this study have business in collecting used handsets mainly for reuse. These actors have been integrated into the system under the WEEE Regulation to various degrees. At the extreme, actors such as Regenersis and Recycle Telecom become operators of compliance schemes. Others register their collection and/or treatment activities as DCFs, AATFs, and/or approved exporters. Table 7-5 shows the result of the status analysis of the public registers in the UK. It is also possible that some actors prefer to stay clear from the system. Strictly speaking, the trade of used mobile phones does not fall under the scope of the WEEE Regulation and there is no provision compelling the traders to register with the WEEE authority. It is worth noting that the Regulation stipulates the following annual charges for approved operations: GBP 12,174 for each compliance scheme (excluding the charges on individual scheme members), and GBP 2,590 for each ATF or export (will be GBP 500 if one issues evident notes for not more than 400 tonnes of WEEE).

Table 7-5: Status of downstream operators in the UK under the WEEE Regulation.

Operator	Compliance Scheme	Designated Collection Facility	Authorised Treatment Facility	Approved Exporter
A Novo UK Ltd		Approved	Approved	Approved
British Telecomms PLC		Approved		
Cellular Surplus Ltd		Approved		
Eazyfone		Approved	Approved	
Genuine Solutions UK Ltd		Approved	Approved	
Greener Solutions		Approved	Approved	
Mazuma Mobile			Approved	
Mobile Phone Xchange			Approved[1]	
Recycle Telecom Ltd	Approved	Approved	Approved	Approved
Redeem PLC		Approved		
Regenersis Ltd	Approved	Approved	Approved	Approved
S3 Interactive Ltd		Approved		
Unipart Logistics Ltd		Approved	Approved	

[1] The approved operator is Kuehne & Nagel Ltd which is the partner of Mobile Phone Xchange.
Source: Environment Agency

The collection of used mobile phones outside warranty started in the late 1990s as a result of an anticipation of coming legislation. Canning (2006) reports that in 1996/1997 Motorola formed a take back group with Ericsson, Nokia, Alcatel, and Panasonic under the sup-

port from the European Telecommunications Association (ECTEL) to demonstrate the potential of voluntary actions. The trial in the UK initially used communications centres of the British Telecom (BT)[21] as drop-off points. The scheme was joined by Orange, One2One, and Vodafone in 1999 expanding the collection network to almost 400 stores in the later years. End users could also send their obsolete phones with prepaid envelopes. After the batteries were removed, the collected phones recycled to recover precious and base metals. The costs of the scheme were shared among OEMs. According to Canning (2006), the trial only collected a low volume of used mobile phones. This comes as no surprise to informants in the reuse business who label free take back as the least successful collection for used mobile phones.

After the trial, the initiative was taken over by Shields Environmental which was a subcontractor who organised the recycling of collected handsets in the trial scheme. Shields Environmental seeing the potential in the secondary market launched a subsidiary that subsequently became a separate legal entity, Fonebak, in September 2002. The new arrangement saw marked changes both in terms of business orientation and relationships. Fonebak used more aggressive information campaign and offered a wide range of incentives to end users including cash, gift vouchers, and donations to nominated charities in addition to freepost and drop-off services used in the trial scheme. Figure 7-4 shows a continuous increase in the amount of used handsets collected by Fonebak compared to its predecessor. Most of the collected phones were in good conditions and were exported for reuse. Figure 7-5 reproduced the quantification of Fonebak's activities in 2003 based on Forum for the Future (2004). Fonebak gained the support from virtually all major network operators (O2, Vodafone, Orange, T-Mobile, 3, and Virgin Mobile) and several retailer chains. Some of these partners acted as its collection points. On the other hand, OEMs disappeared into the background. After the acquisitions of Intec Cellular Services and Intec Distribution (in 2005), CRC Group (a provider of repair services, in 2007) and Total Repair Solutions (in 2009), and expanding its technical services to other electronic products besides mobile phones, the group was consolidated under the umbrella name "Regenersis." Fonebak is retained as a brand for mobile phone recovery which, according to the interview, accounted for less than half of its operations in the past year. Regenersis now operates in the UK (where the headquarter is located), Germany, Poland, Romania, France, Belgium, Russia, and Hong Kong (where it specilises in trade sales).

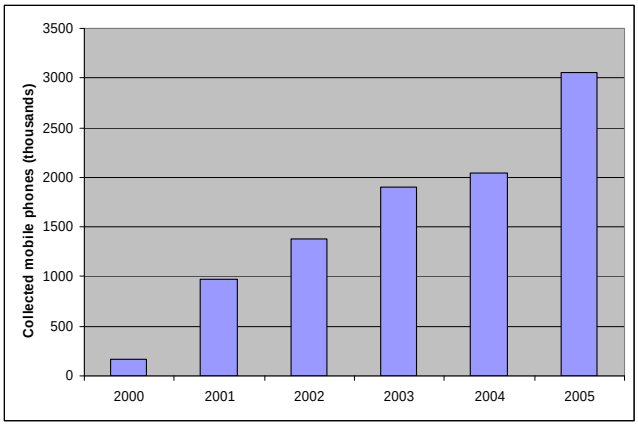


Figure 7-4: Used mobile phones collected by Fonebak and its predecessor, 2000-2005 (in thousands).

Source: Fonebak referred in GSMA (2006)

[21] The mobile business of BT was later taken over by Telefonica O2.

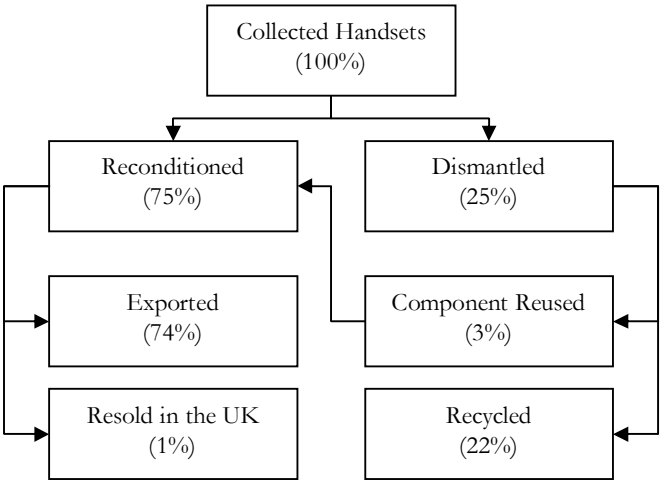


Figure 7-5: Fates of collected mobile phones at Fonebak in 2003.

Besides Fonebak/Regenersis, several other players appeared in the reuse market in the 2000s including the followings:

Redeem PCL was established in 1999. Initially collecting empty ink cartridges, in 2001 it started its collection of used mobile phones which now make up a large part of its business. Redeem (2010) has been working with many charities under its "Recycling Appeal", schools under its "Recycool", youth groups under its "Scouts Appeal" and "Girlguiding UK Recycling Appeal", businesses such as amazon.co.uk, Boots UK, Tesco, Ticketmaster, and recently an MNO, O2, to collected used mobile phones, ink cartridges and other devices and raise funds for their social and environmental causes. It also targets general public in its trade-in programme, "Money 4 UR Mobile." Having the headquarter in Falkirk, Scotland, the firm has its operations in Ireland, Turkey, Italy, and Hong Kong where most of the actual processing and sales are carried out. According to the interview, Redeem currently handle around 100,000 used mobile phones per month in the UK.

- Eazyfone Group Ltd. was established in 2001. It has operated one of the most prominent online trading sites for used mobile phones under a unique brand, "Environfone" (also operates in Germany and Sweden), since 2005. Its other brands are "envirocharities", "envirostudents", "Fones4Schools", and "FoneAid". According to the Eazyfone (2010)'s website, it has been working with 6,500 schools, 900 affiliates, 200 businesses, 600 charities and 1.6 million consumers and supplies refurbished phones to main markets in developing countries as well as independent retailers across Europe.

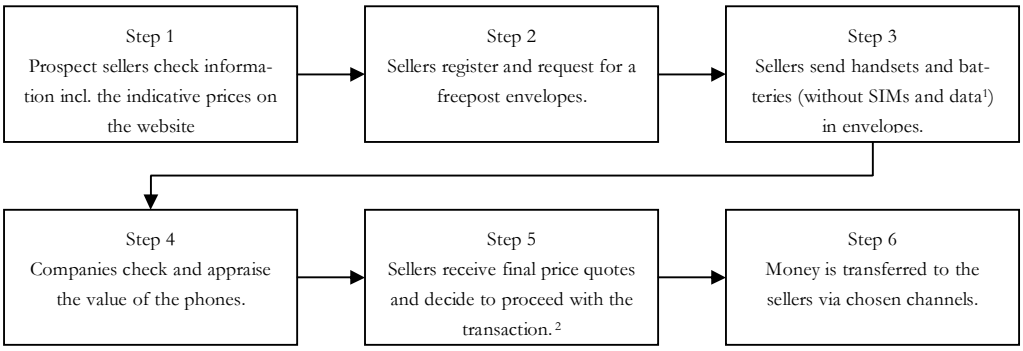
- Ventura Telecom Ltd. was established in 2003 to seize the business opportunity in handset stock grading, stock holding and redistribution in the secondary markets. It has worked with MNOs such as Vodafone, Orange, T-Mobile, and 3. The following is the mission statement of Telecom (2010): "At Ventura we strive to process and hold stock and distribute for the global re-use and recycling of mobile phone handsets. Our way is socially responsible and *ensures that handsets do not conflict or enter into markets occupied by our manufacturing and network partners*" (italic added). Its subsidiary, Mazuma Mobile Ltd. is an operator of a trading website. According

to the Mazuma Mobile (2010)'s website, it resells about 150,000 handsets per month.

- Mobile Phone Xchange Ltd. was established in 2005. It is yet another operator of a high-profile website for trading used mobile phones. It also provides call-centre and on-site services for clients such as Debenhams, Vodafone, News of the World, cashconverters, e2 save mobiles, Ladbrokes.com, Littlewoods, and Media-Saturn, and partners with an AATF, Kuehne & Nagel Ltd. According to the Mobile Phone Xchange (2010)'s website, the company handles tens of thousands of used handsets every month, thousands of which came from the cooperation with Vodafone. It has a branch in Hong Kong to facilitate export sales to countries such as China, India, Pakistan, Nigeria, Australia, Brazil and Mexico.

From the background study and the interviews, we can distinguish three models of mobile phone collection. First, the collection companies can join hands with charities, schools, and other social organisations. What one informant calls an "environmental charity" model is designed to raise people awareness about the desirability of mobile phone reuse and recycling by appealing to the social and environmental causes that they have already supported. Social organisations with their motivated supporters are ideal partners. One informant mentions that the activism of the organisations is the key to the success of this model. In addition, the charities can serve as transfer stations in the programmes and the bulk deliveries help keeping the logistic costs low. On the other hand, there seems to be a limit on what types of phones people are willing to "donate". One informant comments that the schemes with charities and schools normally get low-to mid-range handsets.

The second business model appeals directly to the value of used mobile phones. In this model, the information about the value of handsets and the nature of the transaction is conveyed to individuals. To avoid the costs of erecting physical shops, a common format is build an online trading site as an information outlet and to use freepost as a logistic solution. It is worth noting that the Royal Mail (2009) itself has a recycling service called Simply Drop® allowing users to trade used electronics for cash. Figure 7-6 depicts steps in a typical transaction. Because the trading schemes high-end handsets, it should come as no surprise that they did not buy low-range mobile phones. However, on their own, the reuse companies face a challenge in gaining trust from prospect buyers in the faceless transactions in which they have to hand in their priced mobile phones and wait for the valuation. This barrier can be considerable for first-time sellers who are not familiar with the schemes and the reuse companies. The challenge can be overcome easier when the companies partner with other trustworthy businesses that have their customer bases. Not only this strategy taps on the brand loyalty of the partners but extra benefits such as gift vouchers, special discounts, free air times, etc. in connection to the partnering businesses can also be bestowed on the consumers on the top of the remaining values of handsets. The ideal partners in this "commercial partnership" model are the network operators because they are the closest to the point where people make replacement decisions. Network operators also have budget for acquiring post-pay contracts and can use that to offer premium trade-in prices to customers who upgrade their handsets in the process of buying or renewing their contracts. In addition, network operators are able to provide a drop-off service with immediate valuation and cash back at their shops furthering enhance the peace of mind in the transaction. The obligation as producers in the WEEE Regulation also makes the network operators more open to this kind of partnership. Or as one informant puts it: "Before they should do it, but now they have to do it." This institutional change also provides an incentive for reuse companies to register under the WEEE system so they are in the position to report the quantity and issue evident notes. In this way, not only can network operators make the money from the profit-sharing in trade-in schemes but they can also count the activities toward their market-share responsibility.



[1] SIMs and data in the phones will be destroyed.

[2] If the sellers choose not to proceed with the transaction, the handsets can usually be sent back at their expenses.

Figure 7-6: Typical steps in online trading of mobile phones.

The three models are often combined in practice. Most of the commercial partnering schemes have appeals to social and environmental causes where a fixed sum of money is given to nominated charities for each phone collected. Similarly some trading websites while not buy low-range phones are willing to accept them free of charge for recycling and vow to make a small contribution such as planting a tree or donating a small amount of money to charities. On the other hand, schemes affiliated with social organisations can also give some cash back to their supporters. A price analysis shows that, while giving somewhat discounted prices for high-range phones, schemes with charities and schools for still offered nominal values for low-range products that would not otherwise be traded in the commercial websites.

Meanwhile, according to an informant, partnership with charities and schools can be used as a way to divert public attention from somewhat dubious fate of the used phones.

In addition, regardless of business models, two issues remain important in the reuse business: data protection and a safeguard against stolen handsets. Regenersis (2010) checked a random sample of over 2,000 handsets received in December 2008 and found that 99% still contained personal data. Therefore, one of the fixed costs in the business is an investment in breach the Data Protection Act. Regarding stolen handsets, most, if not all, schemes subscribe to CheckMEND which provides a database of stolen and counterfeit goods and disabled mobile phones with more than 40 billion serial numbered items (CheckMEND 2010).

The majority of separately collected used mobile phones have been reused. Forum for the Future (2004) estimates that in 2003 around 3.7 million handsets were separately collected for reuse in the UK. A new study (referred to in Metals News 2010) estimates that the collection reached 8 million handsets in 2009. The same report attributes this increase to the tightening competition between reuse companies and people awareness of the value of used mobile phones. Informants in the business remark on aggressive PR campaigns among competitors in the UK market in recent years. One informant makes a further comment that this can be attributed to the introduction of smart phones. Figure 7-7shows the uptake of smart phones in the UK which had been facilitated to some extent by handset subsidies in post-pay contracts. When these smart phones were replaced in subsequent years (to recoup the cost of subsidised handsets the post-pay contracts in the UK are typically 12, 18, or 24 months) which happened to coincide with the recent economic recession, consumers could not help but to see the remaining value in the replaced handsets.

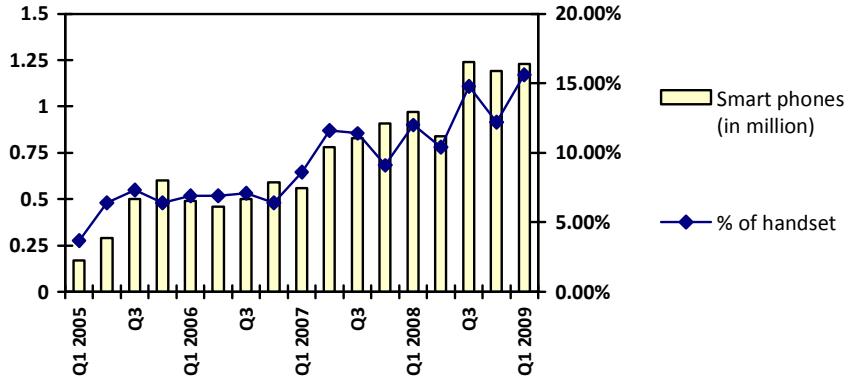
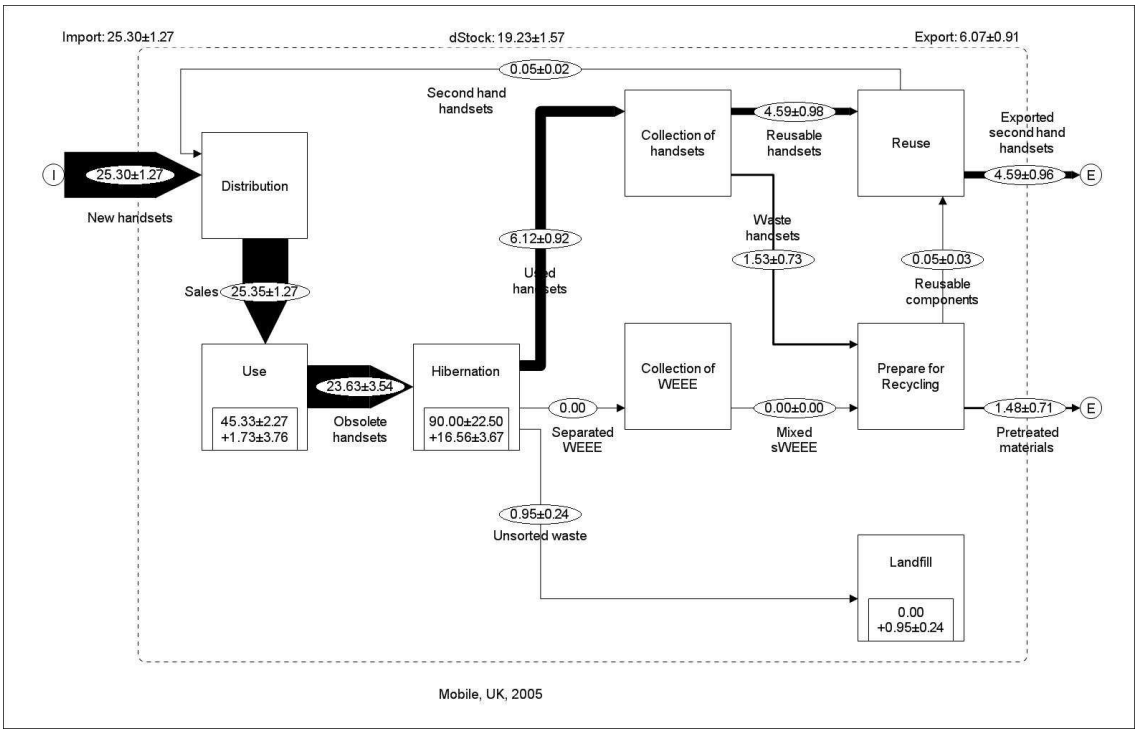


Figure 7-7: Sales and shares of smart phones, Q1 2005-Q1 2009.

Source: GfK (referred in Ofcom 2009)

Most of the collected phones are recondi- and exported to developing countries. Although there is an increase in a demand for second hand high-end handsets in the UK among pre-pay and SIM-only post-pay subscribers, the domestic market does not constitute a significant amount of reselling by reuse companies. Literature identifies that Hong Kong is the trading hub of used mobile phones. This is confirmed by all informants and is evident from the fact that several reuse companies have their sale unit in Hong Kong. Little information exists however on the ultimate end-of-life fates of exported handsets whether they are going to the formal or informal recycling sectors or simply be discarded (see the discussion in Chancerel 2010; Geyer and Doctori Blass 2010). This has become a dubious face of the business. While the reuse business criticises the environmental and social benefits to directly recycle used mobile phones (see Regenersis 2009), one manufacturer of mobile phones interviewed is vocal in questioning the operational integrity and responsibility of *some* reuse companies in terms of actual data protection and a possibility to covertly export WEEE as reusable products to developing countries. Only one reuse company, Regenersis, have offered local distributors in importing countries to collect unwanted handsets and batteries for recycling (GSMA 2006). The interview with the company however reveals that the take up of the offer among its clients has been so far zero because of the existence of "natural recycling" in these countries.

Figure 7-8 shows a result of MFA based on the information presented above for the year 2005 and 2008. Despite an increase in separately collection of used mobile phones (for reuse), the size of hibernating stock grew even more. This stock tended to be comprised of old, low-value handsets. It is unlikely that the collection models built around reuse would work in their management financially speaking. Geyer and Doctori Blass (2010) calculate based on the data in the UK in 2003 that, while on average the profit from refurbishment (USD 21.24 per phone) could easily offset the reverse logistic cost (USD 11 of which USD 6.2 was return incentive), the recovered value of mobile phone recycling was only marginal (USD 0.68). The informants in reuse businesses make similar remarks. The system installed after the WEEE Regulation could provide a physical and financial solution for the separate collection of WEEE but so far did little and did not have instrument to drive up the collection of used mobile phones. Due to a lack of site-specific data on the amount of mobile phones found in mixed municipal solid waste, we assume the rate of unsorted handsets as in Nokia (2008)'s global survey.



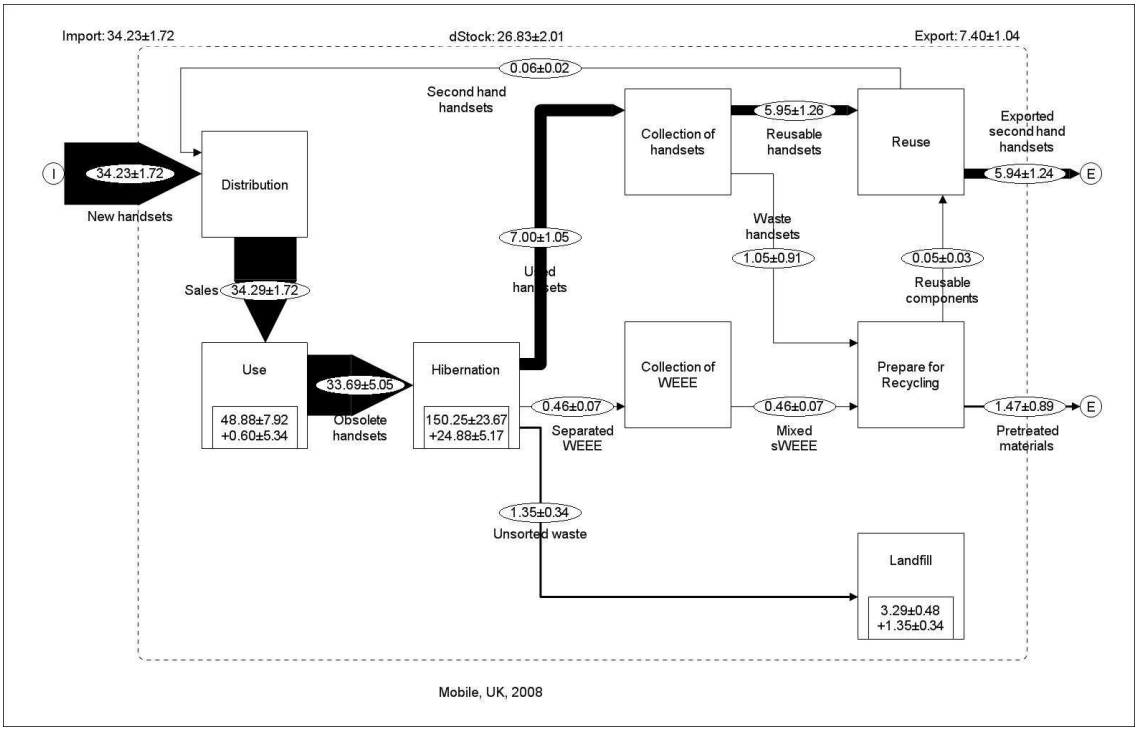


Figure 7-8: Material flows of mobile phones in the UK, 2005 and 2008 (in million units).

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Appendix I: list of interviewees

The first table lists interviewees that the authors of the report contacted directly. Countries are listed in alphabetical order, and interviewees in chronological order within the country. As manufacturers have their operations in all five countries, they are listed independent of the country of origin.

For Sweden, additional interviews and field studies were carried out by eight Swedish MSc students as part of their course assignment on Instruments for Preventative Environmental Protection. Followed by the initial search on the Internet, they contacted four groups of actors involved in the collection of used mobile phones – producers, distributors and network providers, municipalities and second-hand shops and refurbishers – and investigated the activities and attitudes of those actors. The interviewees in the students' field study as well as the names of the students conducting the study of the respective actors are presented in Table II.

Table I: list of interviewees contacted by the authors of the report

Country	Type of the organisation	Name of the Organisation	Timing (in Swedish time) /mode	Name & position of the interviewees
	Manufacturer	Nokia	9h00-11h00, 30 April	Helena Castren, tbc
	Manufacturer	Sony Ericsson	10h00-12h00, 3 May	Pontus Alexandersson, Agnieszka Domanska, Daniel Paska, Kazumi Ichiba, tbc
	Manufacturer	Samsung	10h30-12h00 11 May	David Scuderi European Recycling Manager
Finland	Research Institute	Finnish Environment Institute (SYKE)	9h30-10h00, 29 April	Petrus Kautus, Researcher, environmental policy
	PRO	ERP Finland	10h00-11h00, 4 May	Timo Hämäläinen Country General Manager
	PRO	Elker Oy	E-mail exchanges	Kari Poikela. Operative Manager
	Government	Pirkanmaa Economic Development, Transport and the Environment Centre / Producer responsibility	E-mail exchanges	Teemu Virtanen, Senior Advisor
Sweden	Government	Swedish Environmental Protection Agency	10h00-12h00, 10 May	Jon Engström, Desk Officer, Implementation and enforcement department
	PRO	El Kretsen	E-mail exchanges	
U.K.	Collection	Redeem	10h30-11h30 20 April	Simon Dunn, Director of Sales & Marketing
	PRO, collection, treatment, export	Regenersis	11h00-12h00 10 May	Sarah Bond, Head of Marketing and Communication
	PRO	ERP Europe	14h00-14h30 10 May	Scott Butler, General Manager
	PRO, DTS	Valpak	E-mail exchanges	Matt Baller, Sales Support Co-ordinator

Table II. List of interviewees contacted by MSc students

Type of the actors	**Mode of communication**	**Name of the organisations interviewed**	**Number interviewed**	**Interviewers**
Producers/PROs	Telephone & E-mail	Apple, Sony Ericsson, Nokia, Doro, El-Kretsen	4	Ida Ström, Venus Krantz
Distributors, Network providers	Telephone & E-mail	Experts, Kjell & Co, Media Markt, SIBA, Teknikmagasinet, 3, Tele 2, Telia Sonera	8	Malvina hagbjörk, Jakob Sahlén
	Personal interview	The Phonehouse	1	
Municipalities/municipal waste company	E-mail	Bollnäs, hudiksvall, Ljusdal, Lund, Malmö, Söderhamn, Sysav	7	Niels Boman, Gustav Larsson
Second hand shops, refurbishers	E-mail & Telephone	Mobilevasa, Varubörsen	2	Sara Jarmakowski, Jeanette Witten

Appendix II: General interview guide

The following interview guides were used as a general framework as to which information we seek to find from the respective actors (found in parentheses after each heading below). The questions are modified for each interviewee depending on the knowledge acquired by the authors by the time the interviews were conducted.

1. Background

1.1 Profile of the industry (literature complemented by manufacturers)

- Overall trend and market share
- What are the emerging developments (new competing products, development of technology, new types of actors – in developing countries, a new type of actors that put new unbranded products (called "shanzhai" in Chinese) has rapidly taking up the market; is the same thing happening in Europe?)?
- What are the implications of these trends and developments for the collection and recycling of used mobile phones?

1.2 Rationale for mobile phone collection and recycling (regulators, manufacturers, PROs)

- In addition to the coming into force of the WEEE Directive, any specific reasons to introduce mobile phone collection and recycling in the country?

1.3 Existing systems prior to the introduction of the system based on the legislation (regulators, manufacturers, PRO, NW providers, municipalities)

- Any existing systems/pilot programs prior to the introduction of the system based on legislation in the following five countries – Finland, Sweden, Switzerland, Germany, U.K?
- If yes, Who (e.g. producers/NW providers/municipalities/charities) were involved in such existing systems/pilot programs? What were the roles of the respective actors? Rationales behind the allocation of roles?
- What are your views on the existing systems/pilot programs? What went well and what went wrong?

1.4 Second-hand products and societal perception (regulators, manufacturers (at least for the last question), second-hand/refurbishers)

- Trend and development of the second-hand market for mobile phones. If possible, quantitative data.Why do actors come into mobile phone business? If the phones cannot be exported, would they still stay in business?
- What are the perception of people on second-hand mobile phones? What are your views/strategies?

2. Distribution system (regulators, NW providers and manufacturers)

- Overview of the distribution channel
- Network providers (historical development and current situation: ownership, big players)
- Actors involved in selling mobile phones to end-users, volume of subscription
- Manners of subscription and the number of subscription for respective channels

3. Collection: legal mandate, implementation and views (regulators, manufacturers, retailers, NW providers and PRO, partly second hand/refurbishers)

- How are producers defined (especially in light of if they may include NW operators)?
- Scope of the legislation: any accessories and parts (e.g. batteries and chargers) covered by the legislation? Compatibility with other legislation? Any sorting requirement at the collection points?
- What are the collection options that have been trailed (different return channels and

different incentives)? What are the achievements and lessons learnt?

- Collection targets: anything beyond the EU level? Discussion? Views? Implication to implementation? How has the 4 kg per capita target affected the collection of mobile phones? Is the collection target relevant? View on the new target (65%) discussed? The achieved collection rate for mobile phones, and methods of calculation?
- Actors responsible for collection from households: national legislation, reality, voluntary activities? Any national legislation mandate NW operators to collect? Views and issues? Amount (units and/or kg) collected by the respective responsible actors
- In case of voluntary collection, which legal requirements do they need to follow?
- Any legal requirements related to the handling of private information (in light of the facts that according to the consumers survey in Japan, the main reason for hoarding is consumers' fear of the leakage of private information)? In reality (what do retailers/second hand/refurbishers do)? Any views?
- Any consumer surveys on the place where they discarded/handed in their end-of-life mobile phones, if they receive any money back etc. (and their preference regarding such routes)
- Any other issues?

4. Recycling (regulators, PROs, manufacturers, refurbishers/second hand)

- Recycling targets: anything beyond the EU level? Views? Achievement so far? How have the 75% recovery and 65% material recycling targets for Category 3 affected the recycling of mobile phones? Are the category-based targets relevant? Do they lead to any changes in product design, treatment procedures, or recycling technologies?
- How has the selective treatment stipulated in Annex II of the WEEE Directive affected the recycling of mobile phones? Is it relevant? Does it lead to any changes in product design, treatment procedures, or recycling technologies? Any treatment requirements for refurbishers?
- Who conduct recycling and treatment in reality? voluntary activities? Amount (units and/or kg) recycled by the respective responsible actors
- Financial management within the PRO: How do you pay? How are the size of the fee decided? Any views of the members on this issue?

Appendix III: Treatment requirements stipulated in the WEEE Directive and legislation in Switzerland

Requirements	Targeted substances, preparations and components
Removal from separately collected WEEE	• polychlorinated biphenyls (PCB) containing capacitors in accordance with Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT)(1), • mercury containing components, such as switches or backlighting lamps, • batteries, • printed circuit boards of mobile phones generally, and of other devices if the surface of the printed circuit board is greater than 10 square centimetres, • toner cartridges, liquid and pasty, as well as colour toner, • plastic containing brominated flame retardants, • asbestos waste and components which contain asbestos, • cathode ray tubes, • chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC) or hydrofluorocarbons (HFC), hydrocarbons (HC), • gas discharge lamps, • liquid crystal displays (together with their casing where appropriate) of a surface greater than 100 square centimetres and all those back-lighted with gas discharge lamps, • external electric cables, • components containing refractory ceramic fibres as described in Commission Directive 97/69/EC of 5 December 1997 adapting to technical progress Council Directive 67/548/EEC relating to the classification, packaging and labelling of dangerous substances(2), • components containing radioactive substances with the exception of components that are below the exemption thresholds set in Article 3 of and Annex I to Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation(3), • electrolyte capacitors containing substances of concern (height > 25 mm, diameter > 25 mm or proportionately similar volume)
Separate treatment as indicated	• cathode ray tubes: The fluorescent coating has to be removed, • equipment containing gases that are ozone depleting or have a global warming potential (GWP) above 15, such as those contained in foams and refrigeration circuits: the gases must be properly extracted and properly treated. Ozone-depleting gases must be treated in accordance with Regulation (EC) No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer(4). • gas discharge lamps: The mercury shall be removed.

(Source: Annex II, WEEE Directive)

Table B Components required separate treatment and treatment technologies in Switzerland

Product	Components required separate treatment
General requirements for disposal • Remove manually; appliances must not be broken/shredded unless hazardous substances are previously removed • Dispose as specified under the Ordinance on Movements of Special Wastes (OMSW)	• Batteries and accumulators (Ni-Cd, Hg-containing, Li-ion) • Condensers and ballasts (pre-switches) • Hg switches/relays/valour lamps • Parts containing CFCs (cooling agents, insulation materials) • Selenium drums in copiers • Components releasing asbestos fibres
Electronic appliances	• Batteries and accumulators • Hg switches/relays • Condensers containing PCBs • Selenium drums in copiers • Cathode ray tubes • Printed circuit boards • Wood with paints, varnishes and preservatives • Plastics containing halogenated flame retardants • Valuable constituents, gold, nickel, copper, iron, aluminium, and permanent magnets • Plastic-sheathed cables
Large electrical appliances	• Batteries and accumulators (Ni-Cd, Hg-containing, Li-ion) • Condensers and ballasts containing PCBs • Hg switches/relays • Inorganic insulation materials • Printed circuit boards • Components releasing asbestos fibres (ovens) • Plastic-sheathed cables
Refrigeration and air-conditioning appliances	• Refrigerants: CFCs • Refrigerants: pentane (flammable) • Insulation: polyurethane (PU) and polystyrene (PS) • Condensers containing PCBs • Hg switches/relays • Caustic solutions of ammonia from absorber refrigerators • Chrome-plated ferrous scrap • Other components: compressors, cooling coils, glass, cables and switches
Printed circuit boards	• Batteries and accumulators • Condensers containing PCBs • Hg switches/relays • Base-plate materials containing halogenated flame retardants • Gallium arsenide semiconductors • Lead solders • Conductors and connectors containing gold, silver, palladium, copper
Cathode ray tubes	• Panel glass: barium-strontium glass coated with a fluorescent material • Funnel glass: leaded glass • Emitter containing tungsten, rhenium, barium or strontium • Scanning coils containing copper • Shadow mask: sheet iron • Neck: nickel

Source: (SAEFL 2000)

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The Collection and Recycling of Used Mobile Phones

Case studies of selected European Countries

IIIEE Report 2011:06

The International Institute for Industrial Environmental Economics has since 2008 have a research collaboration agreement with the National Institute for Environmental Studies, Japan, in the area of on Product and Waste Oriented Environmental Management and Policy. Based on this agreement, researchers in the two institutions have been engaged in variuos research projects, bridging the knowledge between Europe and Japan.

It is under this research collaboration agreement that the project entitled Collection and Recdycling of Used Mobile Phones and Actors Engaged in Such Systems was carried out. The content of this report constitutes one part of this joint research project. By examining the collection and recycling systems for used mobile phones in selected countries in Europe, we seek to contribute to the development of an appropriate system addressing the same in Japan.