UNITED NATIONS UNIVERSITY

2008 Review of Directive 2002/96 on

Waste Electrical and Electronic Equipment (WEEE)

Final Report

Contract No: 07010401/2006/442493/ETU/G4
ENV.G.4/ETU/2006/0032

05 August 2007

United Nations University, Bonn, GERMANY · AEA Technology, Didcot, UNITED KINGDOM
GAIKER, Bilbao, SPAIN · Regional Environmental Center for Central and Eastern Europe, Szentendre, HUNGARY
TU Delft - Design for Sustainability, Delft, THE NETHERLANDS

Authors

United Nations University (UNU)
Huisman, Jaco (lead author)
Magalini, Federico
Kuehr, Ruediger
Maurer, Claudia

AEA Technology (AEA)
Ogilvie, Steve
Poll, Jim

Gaiker
Delgado, Clara

Regional Environmental Centre for Central and Eastern Europe
Artim, Eniko
Szlezak, Josef

Delft University of Technology (TUD)
Stevels, Ab

Management

Kuehr, Ruediger
UNITED NATIONS UNIVERSITY
UN Campus
Hermann-Ehlers-Str. 10
D-53113 Bonn, Germany

Tel.:+49-228-815-0213/4
Fax: +49-288-815-0299
Email: WEEEreview@step-initiative.org

United Nations University (UNU) is an autonomous organ of the UN General Assembly dedicated to generating and transferring knowledge and strengthening capacities relevant to global issues of human security, development, and welfare. The University operates through a worldwide network of research and training centres and programmes, coordinated by UNU Centre in Tokyo.

Disclaimer

EXECUTIVE SUMMARY

The Assignment

For the review of the WEEE Directive the European Commission (EC) has launched three research studies analysing the impact and implementation of the WEEE Directive and potential changes that might be required. This study is focusing on the total environmental, economic and social impacts of the WEEE Directive. Secondly, it aims at generating options that can improve environmental effectiveness, cost efficiency and simplification of the legal framework. This study aims to complete the information needed for review of the WEEE Directive in 2008. The information gathered and analysis made, is intended to form the basis for the legislative impact assessment of options for review of the WEEE Directive.

The primary aim of the study is to contribute to this review by listing and evaluating potential options with a two-step approach:

1. The evaluation of the current implementation of the Directive in the EU Member States, with particular attention to the societal aspects of environmental, economic and social impacts of the WEEE Directive,
2. Translation of the information gathered in step one into legislative and non-legislative options, in order to improve, further develop and simplify the WEEE Directive.

This work was conducted from September 2006 until August 2007 in accordance with the Terms of Reference set by the European Commission's Tender Invitation.

Data Gathering and Methodology

Over 183 different contacts were approached for interviews, questionnaires and specific data to gather a very complete data overview. The more than 183 contacts are a fair representation of the Member States (TAC members), Producers, Compliance Schemes, Industry Associations, NGO's, National Registers, Recyclers, Recycler Organisations, Refurbishers and Universities and are covering all relevant stakeholders involved in electronics take-back and recycling. This also includes 15 Member State outcomes of an SME panel procedure. This includes determining:

1. Quantities of WEEE put on the EU market, the amount of WEEE arising as waste and the amounts collected and treated (which are 3 different levels),
2. The technologies used with specific focus on plastics recycling,
3. The environmental parameters over the total recycling chain,
4. The costs of collection, transport, treatment and recycling as well as overhead and administrative burden of the Directive. This includes also an overview of the implementation status in the EU27.

As a result a large database with over 350 literature sources is derived as well as a fully updated environmental and economic assessment model that describes the 64 most relevant substances, their detailed fate over the recycling chain and the respective Life-Cycle Inventories and material prices over time, 15 different environmental impact indicators from the latest LCA methods available, the 31 most relevant recycling, recovery and final waste disposal processes and the main costs over the recycling chain for all individual stages from collection until all final destinations.

WEEE Amounts

Predictions made during the 1990's estimated the tonnage of EEE put on the EU15 market at 7 million tonnes. With the expansion from EU15 to EU27 and based on many sources and different estimation techyniques, this study points out that the amount of new EEE put on the EU27 market in 2005 is estimated at 10.3 million tonnes per year.

In the explanatory memorandum of the WEEE Directive, the amount of EEE arising as waste was estimated in 1998 for the EU15 at 6 million tonnes. The new estimate of the current WEEE arisings across the EU27 is between 8.3 and 9.1 million tonnes per year for 2005. This increase is due to expansion of the EU, growth in the number of households and inclusion of items that may have been excluded previously (B2B). A number of forecasting assumptions were applied which predict that by 2020, total WEEE arisings will grow annually between 2.5% and 2.7% reaching about 12.3 million tonnes. The average compositional breakdown for the EU has been calculated and shown in the figure below:

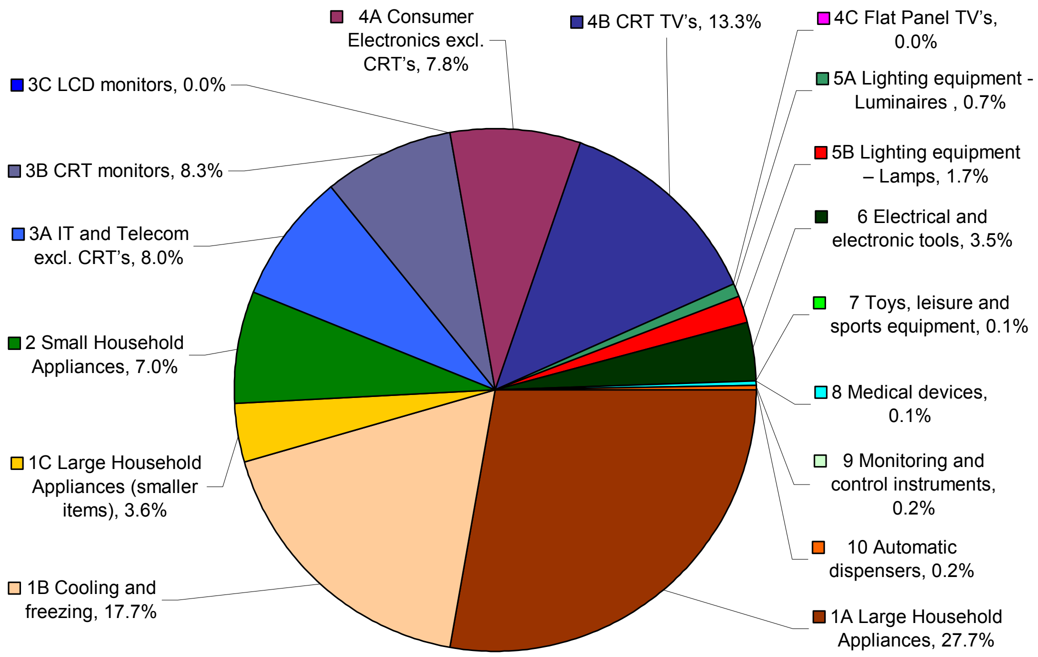

Figure i: Breakdown of WEEE arising 2005

The EU15 Member States' average collection performance is roughly half that of Switzerland and Norway. This is mainly due to lower performance in the collection of categories other than category 1. In spite of this, the WEEE Directive collection target can be easily met by EU15 Member States, but remains a very challenging target for the New Member States.

The table below shows the estimated amount of WEEE currently collected and treated as a percentage of the amounts of WEEE arising for the EU27 in 2005. The current amounts are roughly in between 25% for medium sized appliances till 40% for larger appliances, showing substantial room for improvement. Based on our assessment of data from various compliance schemes, it must be possible to collect around 75% of the large and 60% of the medium sized appliances in the long-term future. The analysis shows that returns of appliances lighter than 1kg are very low for all systems. In addition, the composition of EEE put on the market currently is different from that of WEEE arising due to changing product composition over time. This is especially the case for flat panel displays instead of CRT screens as well as the phase out of CFC's from fridges, NiCd from battery packs and PCBs in capacitors.

#	Treatment category	Current % collected of WEEE Arising
1A	Large Household Appliances	16.3%
1B	Cooling and freezing	27.3%
1C	Large Household Appliances (smaller items)	40.0%
2,5A,8	Small Household Appliances, Lighting equipment – Luminaires and 'domestic' Medical devices	26.6%
3A	IT and Telecom excl. CRT's	27.8%
3B	CRT monitors	35.3%
3C	LCD monitors	40.5%
4A	Consumer Electronics excl. CRT's	40.1%
4B	CRT TV's	29.9%
4C	Flat Panel TV's	40.5%
5B	Lighting equipment – Lamps	27.9%
6	Electrical and electronic tools	20.8%
7	Toys, leisure and sports equipment	24.3%
8	Medical devices	49.7%
9	Monitoring and control instruments	65.2%
10	Automatic dispensers	59.4%

Table i: Current amount of WEEE collected & treated as percentage of WEEE Arising

The most interesting finding, however, is that there are very large differences in performance by different Member States per sub-category. This indicates that there is much room for improvement in collection performance. There were not enough data points to prove relationships between factors influencing high versus low collection amounts in different Member States. However the data available indicated that certain factors like availability of collection points, geographical location, culture, waste collection ways and importantly the present financing mechanisms influence treatment performance. These various influencing factors are probably all relevant to a certain level and further influenced by the active role of different stakeholders involved, including public authorities and EU Member States.

Technologies and Market Developments

Companies providing treatment capacity have made, or will be making, significant investments in equipment which will enable WEEE items to be treated in a manner which meets the Annex II requirements of the Directive. Although very little information on WEEE treatment capacity in the EU27 Member States was obtained, it is likely that the EU15 Member States should have installed sufficient capacity to treat WEEE arisings by the middle of 2007. The situation in Central and Eastern Europe is likely to be different, and it currently appears that a regional approach by groups of Member States will be adopted.

Information on the plastic content of the different WEEE categories and the specific targets set in the WEEE Directive can be used to calculate that on average a recovery of 10% of total equipment weight could be achieved through the recovery of plastic polymers. As the average plastic content in electronic waste is about 20%, the fulfilment of the recovery targets may involve recovering half the plastic present in WEEE and recycling 25% of the plastics.

There are stable markets for metal recycling from WEEE given the ability to easily extract the metal and reuse to a comparable quality to virgin metal ores.

The main potential market for CRT glass is in the manufacture of new CRTs, but it is expected that current capacity will significantly decline over the next 5 years as flat panel displays replace CRTs in monitors and televisions. This means that other markets for the glass will be required for which potential capacity was only partially identified. For plastics, the role of the existence of secondary markets for energy and materials recovered from WEEE Plastics (WEEP) treatment is crucial in the successful application of such processes. In practice there are difficulties in environmental and cost efficient recovery of plastic fractions due to the heterogeneity of the polymers present in small volumes in each unit. Currently, targets for mixed metal and plastic dominated streams can discourage recyclers from trying to properly separate plastic parts for recycling.

Environmental Impacts

The figure below shows the contribution of each WEEE category to the total impacts of diverting WEEE arisings from disposal to default treatment.

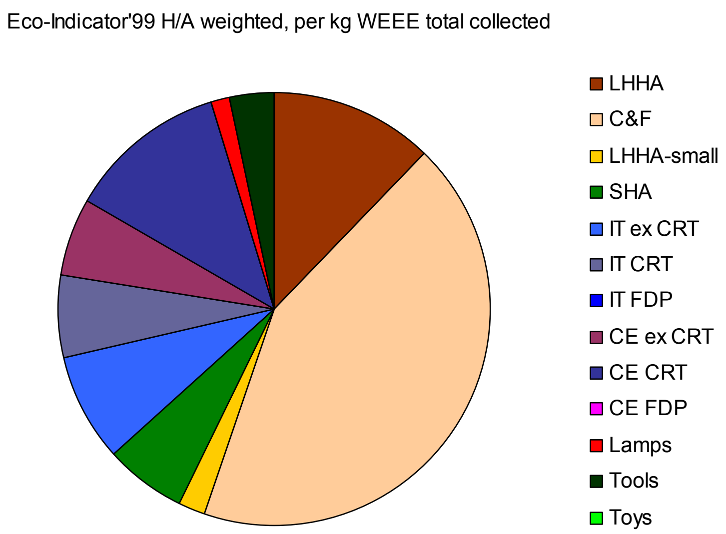

Figure ii: Contribution of categories to environmental impacts of WEEE total (EI99 H/A)

This figure demonstrates that under the Eco-Indicator'99 single indicators, the most relevant products to divert from disposal are the CFC containing fridges. Besides this, it was found that there is a considerable variety in environmental themes per treatment category due to different substances of environmental concern:

- Toxicity effects in various environmental impact categories are dominant for Category 3C LCD Monitors and Category 5B Lamps (especially in terrestrial ecotoxicity and ecosystem quality),
- Avoided ozone-layer depletion and global warming potential for Category 1B Cooling and Freezing,
- Cumulative Energy Demand and Resource Depletion for Category 1B Cooling and Freezing, 3B and 4B CRT screens, and
- Acidification for Category 3A IT excl. CRT and 3C LCD Monitors and Eutrophication for Category 3C LCD Monitors and Category 6 Tools.

The detailed data per environmental impact category grouped for all treatment categories is displayed in the table below illustrating the environmental benefits of the Directive for all WEEE per year in 2011 compared with 2005 (base year) levels. One important assumption here is that the 2011 values are based on the current 2005 impacts without taking into account the changes in product and thus waste stream compositions over time. This latter topic is recommended for further research as the sensitivity analysis showed large changes for displays and fridges over time.

Indicator	**Environmental benefit**	**Number***	**Unit**
2005 WEEE: **Arising: 8.3 Mt** **Collected: 2.2 Mt**		**2011 WEEE:** **Arising: 9.7 Mt** **Collected: 5.3 Mt**	
Weight	Growth in WEEE arising	1,359	kt WEEE Arising
Eco-indicator 99 H/A v203**	Total environmental load per year of	643,591	Europeans
Idem, Human Health**	Total environmental load per year of	423,125	Europeans
Idem, Ecosystem Quality**	Total environmental load per year of	46,038	Europeans
Idem, Resource Depletion**	Total environmental load per year of	174,589	Europeans
Cumulative Energy Demand	Equivalent with:	-75	million GJ
Abiotic depletion	Equivalent with:	-40	kt Sb
Global warming (GWP100)****	Equivalent with:	-36****	Mt CO2
Ozone layer depletion (ODP)	Equivalent with:	-4.8	kt CFC11
Human toxicity	Equivalent with:	-4,047	kt 1,4-DB***
Fresh water aquatic ecotox.	Equivalent with:	-404	kt 1,4-DB***
Marine aquatic ecotoxicity	Equivalent with:	-3,551	Mt 1,4-DB***
Terrestrial ecotoxicity	Equivalent with:	-74	kt 1,4-DB***
Photochemical oxidation	Equivalent with:	-3.0	kt 1,4-DB***
Acidification	Equivalent with:	-50	kt SO2
Eutrophication	Equivalent with:	-1,493	t PO4---

Table ii: Estimated Environmental improvement due to the WEEE Directive 2011 versus 2005

Negative means avoided environmental impact, ** Meant as a rough illustration only: 1 Pt roughly equals 1/1000 of the environmental load of one European p.year (Goedkoop 1999) ***kg 1,4-dichlorobenzene ** Under the assumption of an unchanged 80% presence of CFC fridges in the WEEE stream over time*

Please note that there are a few important assumptions behind these calculations. A key aspect here is the changing waste stream composition over time is not taken into account here. There is not enough information available yet to assess the influence of the future decline in CFC appliances returning. From the estimated 36 million tonnes of avoided CO2 emissions, 34 million tonnes results from removing CFC based cooling agents. Without CFC fridges and LHHA (these are collected anyway due to a positive net value after collection) the benefits of the Directive equal 2.3 million tonnes of CO2 emissions prevented per year.

The two key environmental findings are that from an environmental point of view, it is beneficial to collect more WEEE and to treat it more effectively. The data in this report proves that this applies to all treatment categories investigated. The environmental priorities such as toxicity control, resource and energy conservation and other environmentally relevant emissions (global warming and ozone layer depletion) per category vary substantially per category, making WEEE a very heterogeneous stream from an environmental perspective. This results in the fact that it might be better to differentiate in environmental targets per treatment category.

Economic Impacts - Administrative Burden

Our assessment of economic impact of the WEEE Directive on different stakeholders has highlighted a number of crucial aspects that need to be taken into account for the future development, simplification and improvement of policy measures for the WEEE Directive.

The Administrative Burden Survey highlighted a number of areas where the burdens experienced by stakeholders could be reduced. The main issues pointed out were referring to the achievement of a level playing field for all different stakeholders involved in the end-of-life chain by realising:

- Consistency in legislative requirements across Member States,
- Consistency in registering and reporting activities across Member States, and
- Increase stakeholder awareness of specific responsibilities. It was found that large numbers of small and medium-sized enterprises (SME's) are not even aware of their current legal obligations.

The two most crucial activities identified from the Administrative Burden Survey are registering to National Registers and reporting. Our assessment resulted in the following:

- Total Burden across EU27 for registering and reporting activities ranges from EUR 36.7 million to EUR 42.8 million under the baseline assumption of 8 hours needed per report,
- The potential number of reporting activities across EU27 sum up to at least 72 reports to be delivered every year per producer, and
- The potential threat of competition distortion due to deliberately reporting of B2C as B2B, empty reporting without further action, or simply not reporting is having unequal impact on those companies investing in realisation of full and EU-wide legal compliance.

The start-up effects on both technical costs and additional costs are still significant across different Member States. Differences in national legislative requirements, and the time required to come to agreement in the implementation phase are 'influencing factors' on costs structures and do contribute to high costs levels.

Economic Impacts – Technical Costs

Under the assumptions of actual recycling costs excluding start-up effects across the EU27, based on the average costs of five long running systems (since 2003) in the EU, estimation of the economic impact for take back and treatment of WEEE arising, ranges roughly from EUR 0.76 billion in 2005 for the current amount collected (above table) towards EUR 3.0 billion in 2020. The latter is for the maximum possible collection percentages, which are estimated at 75% for large, and 60% for smaller appliances. The technical costs shown below are for collection and recycling including revenues for secondary materials. The total costs include mainly guarantees, provisions and to a lesser extent overhead and administrative burden.

	Technical Costs [Million EUR]		Total Costs [Million EUR]	
Year	**Current Collection%**	**Maximum collection%**	**Current Collection%**	**Maximum collection%**
2005	**764**	1,692	**935**	2,045
2006	783	1,735	959	2,097
2011	889	**1,970**	1,089	**2,381**
2020	1,125	2,492	1,377	3,012

Table iii: Overall Economic Impact across EU27 assuming FULL implementation

The main factors influencing these numbers are:

- The impact of additional costs on total take back costs represents a considerable percentage across different categories,
- The impact of long running optimisation of systems, play an important role on the cost side. For the long running systems across EU, the gap between minimum and maximum cost levels is much lower, and
- The percentage of WEEE collected and treated versus potential WEEE arising in EU27 plays a crucial role in respect of overall economic impact on stakeholders responsible for financing,
- The impacts of costs along the chain depend on category compositions and recycling technologies used. They are further influenced by future developments of new technologies.

The figure below presents the breakdown of technical costs for 2005 (long running systems collecting 5 main categories):

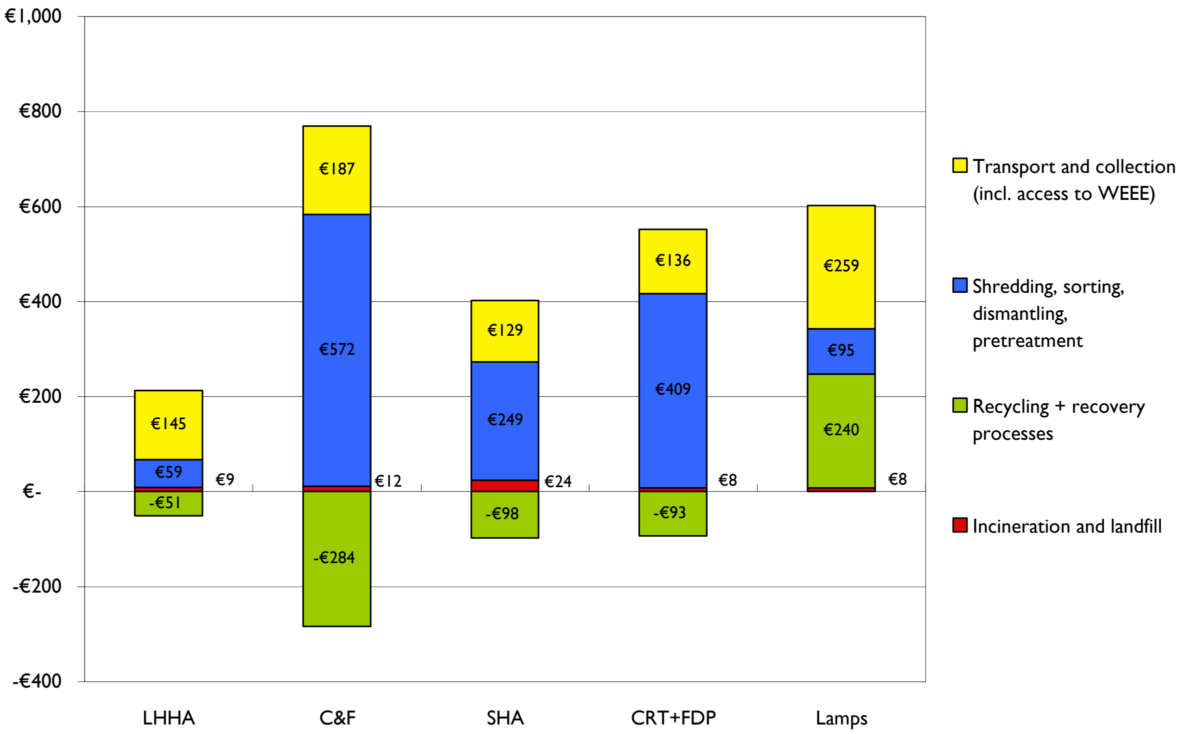

Figure iii: Breakdown of technical costs for the 5 main collection categories (2005 long running systems)

The above figure demonstrates that the technical cost breakdown in percentages is built-up very differently per category. For Category 1A, 10 Large Household Appliances, the main part is the transport costs. After these transport steps, the revenues are almost equal to the further processing costs. For Category 1B, Cooling and Freezing appliances, the treatment costs (CFC removal) are obviously a major portion of the total. This is also the case for the CRT containing appliances. Relatively high costs are in absolute numbers for Lamps Cat. 5B. After transport and pre-treatment, for the small appliances there is no net revenue from the remaining fractions at 2005 price levels.

These economic impacts of WEEE take back and treatment are influenced by:

- Prices for secondary materials. The sensitivity analysis showed that current 2007 market prices increase the revenues of the above categories by 50 – 100 EUR/tonne compared to 2005. This means a net revenue after collection and transport for some categories,
- Developments and availability of markets for downstream fractions and high-level re-application/valorisation of secondary raw materials, and
- Future developments of treatment technologies, as well as different treatment/dismantling requirements for particular product streams, which means that costs for CFC containing appliances are likely to decrease and flat panels are expected to cause an significant increase in total costs due to costly mercury removal steps.

Social Impacts

In summary, the consumers' role in guiding policies in the WEEE Directive to success must be further analysed. In the end, it is the consumer who has to return his e-waste and will also pay, no matter how the financing is arranged. This leads to the conclusion that increasing consumer awareness is a necessity for an eco-efficient WEEE implementation with maximised environmental results (collect more) and increased costs efficiency (treat better).

Besides this important finding, the lack of available data and information did not allow for a systematic and quantitative assessment to be made of the Directive's impacts on the day-to-day quality of life of individuals and communities. The social screening of this study was carried out with a systematic gathering of existing knowledge and additional empirical surveys. However, necessary evidences on positive and negative social consequences, planned interventions and any social change brought about by those interventions were missing. Only certain tendencies became obvious, which will require further investigations for building a comprehensive assessment on such.

This study's research identified the relevant affected groups related to the collection, sorting, disassembly, treatment, recovery and disposal of WEEE. Their respective roles and effects of the WEEE implementation will require further in-depth research and assessment.

In the majority of EU Member States, the national transposition of the WEEE Directive only took place after 13 August 2004 – and for some countries it is still uncompleted in June 2007. As a consequence, it is simply too early for a comprehensive social monitoring and evaluation. The question 'What is the social result of the WEEE implementation and could it be reached better through other means' cannot be satisfactorily answered at this stage. Still, for the so-called ex-post policy evaluation, the social aspects are an essential element in the possible reformulation and reorganisation of the WEEE.

Moreover for a more comprehensive assessment of the implementation of the WEEE Directive taking the economic, environmental and social dimension integrally into account, methodological challenges must be addressed. One of such is certainly the necessity of very detailed information for each dimension which so far has not been applied in a systematic and integrative way for a cross-cutting field as WEEE.

Options for Improvement

From the analysis of all possible options for changing the scope, the collection target, the recycling targets, a target for reuse and the treatment requirements, it is obvious that there are many interrelations between these: When for example the scope would be changed, it would also influence all other targets and provisions. Therefore, conflicting choices and suboptimisation should be avoided. For this reason, only a grouping of options is summarised here. This is based on the key environmental issues connected with low collection rates and lacking reporting on the quality of treatment as well as the high variety found in environmental priorities per treatment category.

The most positive environmental improvements and highest cost-efficiency can be realised by rearranging the product oriented scope towards a treatment category oriented scope. This way there can be differentiated in target setting for collection amounts, recycling percentages and treatment requirements. The additional use of different criteria based upon the environmental aspects related to the collection and treatment categories, can contribute to more environmentally relevant targets for collection, recycling and recovery and treatment and thus environmental effectiveness. The alternative ways of defining the scope of the WEEE Directive can include some of the main priorities that any determination of the scope should enable:

1. Environmental relevancy and material composition,
2. Achievement of a level playing field for different stakeholders across EU, and
3. Clarification and concurrent enforcement of harmonized approach across Member States.

In addition, different elements should be considered simultaneously with the above including a '95 character' to enable a harmonised application of the scope across EU. Due to the limited amounts of appliances covered by the Directive as real B2B, these categories can be removed without environmental drawbacks as the majority of these appliances are already taken care of by other means, regulations and existing take-back systems as well as due to its intrinsic (reuse) value. Without negative environmental effects, dual use' or grey areas products can fall under B2C (like for instance the consumer equipment in the medical category as an appliance in the Small Household Appliances treatment category), unless proof is provided that they are taken care of as B2B. This could then be deducted from overall obligations and/ or financially reimbursed to achieve 'fair' financing arrangements.

Besides collection targets, the definition of the scope will also influence the setting of recycling and recovery targets as well as treatment requirements per treatment category. These three items are discussed in more detail per treatment category:

- LHHA: For simplification reasons it is worth considering leaving these appliances out of the Directive, as they will be treated anyway due to their intrinsic value. There is also no need for recycling targets for this category,
- Cooling and Freezing appliances are very environmentally relevant in the impact assessment due to the presence of CFCs. The CFC removal is the most relevant environmental priority. They should be collected as much as possible and prevented from undergoing the same treatment as other LHHA, at least for the older CFC containing appliances in the stream. For this category, proper removal of CFC should be prioritised over high recycling percentages,
- SHHA: Small household appliances have a higher chance of leakage to domestic waste disposal. In the collection results from different Member States and systems, there are large differences in performance found. This indicates room for improvement in collection. The weight based recycling targets are the most difficult to achieve. The environmental outcomes demonstrate that increasing plastics recycling for sorted plastics does contribute to higher environmental performance. However, for smaller products and mixed plastics, the plastic recycling scenario is less eco-efficient. The analysis showed that the most positive option is to develop BAT / Industry standards for what represents best practice for dealing with SHHA as multiple environmental concerns have to be balanced at the same time,
- CRTs and FDP: Over time, CRT amounts collected will go down to zero. Due to the lead content and concerns connected to illegal waste shipments, the collection should be maximised. A specific collection target should be made dynamic over time as these appliances are replaced by flat panel displays and therefore the total weight put on market will go down. For CRT recycling, environmental evidence demonstrates that the different types of recycling have very different environmental levels of re-application. A more specific focus on CRT-to-CRT glass recycling is environmentally beneficial (as long as possible in the secondary materials market). An important finding is that the lowest environmental preferences are also being accounted for as useful re-applications and thus

as recycling operations (in the past), which can become environmentally counterproductive.

For FDPs, the numbers placed on the market are rapidly increasing, however they hardly return as waste at the moment. For LCD screens, the main environmental concern is control over the mercury content. Due to the absence of proper recycling solutions, the high risk of mercury emissions from these panels point to a strict target setting for mercury removal without causing Health and Safety risk and proper control over treatment as the technical costs per piece or per ton will likely be very high. Recycling targets are of secondary priority,

- Lamps: Similar to LCD screens, collection and recycling is very relevant in order to prevent mercury emissions. The costs of collection are high and gas discharge lamps are classified as hazardous waste. Due to the high total amount of mercury present and place on the market, collection targets should be relatively high. Again, recovery of the mercury is to be prioritised over high recycling targets.

The above findings lead to the conclusion that differentiating in environmental priorities over the various treatment categories leads to the largest improvements. The above is summarised in the below table for each treatment category:

	Collection target	**Recycling target**	**Specific Treatment Requirement ***
Large Household (1A,10)	NO	NO	NO
Cooling and Freezing (1B)	YES	Maybe	YES: CFC's
Small Household: 2A,3A,4A,6,7 (plastic dominated part)	YES	YES: For plastic recycling	YES: NiCd from Cat. 6
Small Household: (1C, 3A) (metal dominated part)	NO	NO	NO
CRT containing (3B, 4B)	YES	YES: For CRT glass	YES: Control over PbO
Flat panels (3C, 4C)	YES	Maybe	YES: For LCD Hg removal
Gas discharge lamps	YES	Maybe for HQ glass	YES: Hg removal

Table iv: Differentiated targets for collection, recycling and treatment

Targets for reuse should be further researched outside of the WEEE Directive and preferably included in EuP to avoid rebound effects of higher energy consumption compared to newer appliances.

Conditions for Success

Besides, the more differentiated target setting displayed above, there are other conditions for success following from the discussed options that promote a higher level of simplification and realisation of implementing the WEEE Directive in practice beyond changing the legal text as such.

Currently, the extended producer responsibility principle (EPR) can work counterproductively as the most relevant environmental improvement potential is connected to higher collection amounts and improved quality of treatment, which in any case are more expensive. Therefore with WEEE being a societal problem, it demands a societal solution where all stakeholders contribute in line with their positive influence on the solutions side. This leads to the conclusion that:

- Either producers should remain primarily financially responsible and should be given the necessary means including better access to WEEE, combined with a more dynamic and higher collection target based on quantities put on market in the past, OR
- Another stakeholder, the Member States themselves, or Compliance Schemes as a more independent and separate entity (with producers as part of the board together with other stakeholders) can be made primarily responsible. This way, both an incentive for collecting more and treating better can be maintained together with competition between Schemes that can form a lasting incentive to improve cost-efficiency.

In any case, by clearly addressing the responsibilities of other stakeholders as well, the collection and treatment results can be improved.

For environmental reasons, EPR with respect to Design for Recycling should be removed from the Directive and placed in (i) RoHS for removability guidance for exempted components with severe environmental or toxic properties and (ii) other ecodesign incentives can be made part of EuP for overall balancing. This would avoid design activities with contradictive environmental effects in different life-cycle stages for instance due to higher energy consumption in the use phase or higher resource consumption due to more environmentally burdening primary raw materials.

Other conditions for success are identified as:

1. Better enforcement of the key provisions at EU and Member State level on all organisational and operational parts of the recycling chain and especially to reduce illegal waste shipments,
2. Split the basic legal framework and key responsibilities from (to be developed) operational standards,
3. Enable more simplification and harmonisation throughout the EU27 as current differences in interpretation within and between Member States and even regions, does delay implementation and subsequently causes considerable environmental drawbacks,
4. Increase consumer awareness in order to stimulate more collection.

Recommendations

It is recommended to determine the influence of newer products and especially the transition from CFC to HC fridges and from CRT to flat panel displays on the waste stream composition and thus on the overall environmental impacts and benefits of collecting and treating WEEE. Research on better treatment options for LCD TV's and monitors should be done, as there are no satisfactory recycling technologies identified so far. Further development of standards for recycling based on thorough environmental research is another next step for this as well as the other treatment categories.

For medium sized appliances, it is recommended to further research splitting high value products from the rest of the small appliances as is already done in practice in some countries. This could also be of relevance when prescribing recycling targets in order to improve treatment which is preferable to promote plastic recycling, but not a proper incentive when the main environmental aim is to recover high precious metal contents. Also collection alternatives for very small appliances (< 1kg) need to be researched as they are hardly handed in by consumers at the present.

1 FOREWORD AND ACKNOWLEDGEMENTS

In its Communication of 25 October 2005 to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - implementing the Community Lisbon programme "A strategy for the simplification of the regulatory environment", the European Commission foresees a review of the WEEE Directive based on the experience of the application of the Directive and based on the development of the state of technology, experience gained, environmental requirements and the functioning of the internal market. The review shall, as appropriate, be accompanied by proposals for the revision of the relevant provisions of the Directive and be in line with the Community environmental policy.

To inform the review the European Commission will take a number of steps to gather and analyse information. Hence, it launched research studies analysing the impact and implementation of the WEEE Directive and potential changes of which this is one of several studies. The independent research studies launched by the European Commission are to complete the information needed to inform an analysis of options for review of the Directive and to provide that analysis. The information and analysis will be used as the main content of a future impact appraisal of options for review of the Directive. The aim of this research study is to give a thorough evaluation of the impacts, efficacy and efficiency of the Directive from an environmental and economic, and as far as possible, a social perspective, by analysing the collection and treatment of different categories of WEEE.

The particular assignments are laid down in the Invitation to Tender DG ENV.G.4/ET/2006/0032 2008 Review of Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) of 25 March 2006 (European Commission 2006). The bid of our consortium was evaluated favourably by the Commission. The study contract between the European Commission and United Nations University under this procurement procedure went into force on 20 September 2006, allowing exactly 10.5 months to satisfactory complete the tasks.

This is the final study report submitted on August 5, 2007.

Acknowledgements

During our work, many people provided valuable data, arguments and feedbacks. We are very grateful to the following persons for providing key information and support: Renate Gabriel, on behalf of the WEEE Forum, for delivering key economic and collection data; Klaus Hieronymi of Hewlett Packard and the European Recycling Platform (ERP) and his team for the provision of valuable data and discussions on methodologies and options; Willy Quinart from Recupel for detailed Annex II and valuable 'quality of treatment' data; Pascal Leroy (previously CECED, now representing the WEEE Forum) and Eelco Smit (EPSON and EICTA) for feedback on the WEEE Directive implementation status; Norbert Zonneveld, representing EERA, for gathering representative data from all EERA members; Rob Koppejan, Frank de Leeuw and Martin de Jager for delivering new data of amounts and compositions of lamps put on market by ELC members and Dominic Henry from the Irish register for supplying general data on appliances put on market and contacts with other EU-registers; Sepp Eisenriegler of RREUSE for widely circulating the questionnaire on social aspects among refurbishers and social enterprises. All StEP Members for completing the questionnaires and discussing possible options to the WEEE Directive based on their multitude of experiences. Furthermore, we wish to thank everyone not mentioned here for the 'truckloads' of valuable information provided.

2 CONTENT LIST

3 LIST OF FIGURES AND TABLES

4 INTRODUCTION

Introduction

The Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) is a key element of the European Union's (EU) environmental policy on waste. It addresses a particularly complex waste flow in terms of:

- The variety of products,
- The association of different materials and components,
- The hazardous substance content, and
- The growth patterns of this waste stream which can be influenced not only by need but also by changes in technology, design and marketing.

The Directive seeks to induce design modifications that make WEEE easier to dismantle, recycle and recover. Finally, it plays an important role in reducing the dispersion of hazardous substances into the environment by seeking not only to regulate the use of hazardous substances in equipment but also controlling the way that older equipment is disposed of at the end of its life. This stance reduces the contamination of shredder residue and eases recycling and disposal of these residues.

The WEEE Directive is currently being implemented by the Member States (MS) and a review of the Directive and of the targets it contains is planned for 2008. This review should include an assessment of a number of issues that have been presented to the Commission as problematic, an appraisal of the environmental benefits, economic costs and social impacts of the Directive and how to amplify these benefits. It should also assess the possibility of improving the way the Directive delivers better regulation, i.e. by clarifying and simplifying it as much as possible while maintaining the original aim of providing a high level of protection to the environment.

The European Commission has already scheduled a review of the WEEE Directive, based on the experience of the application of the Directive current technological developments, experience gained, environmental requirements, and the functioning of the internal market.

To inform the review, the EC is taking a number of steps to gather and analyze information. The adapted scheme of the review process is presented in Figure 1 below.

This final report presents the work conducted and findings made, as described under "2. *Research study re. analysis of impacts & implementation of the WEEE Directive*" in the figure below. It was conducted by the United Nations University (UNU) in collaboration with AEA Technology Environment, Gaiker, The Regional Environmental Centre for Central and Eastern Europe and Technical University of Delft.

The primary aim of the study is to contribute to the 2008 review of the WEEE Directive by presenting and evaluating options for its development that result from a sound assessment of available data and that take full account of current thinking in respect of life-cycle impacts of WEEE and the role that legislative clarity, simplicity and efficacy (better regulation) may play in providing for a high level of protection of the environment.

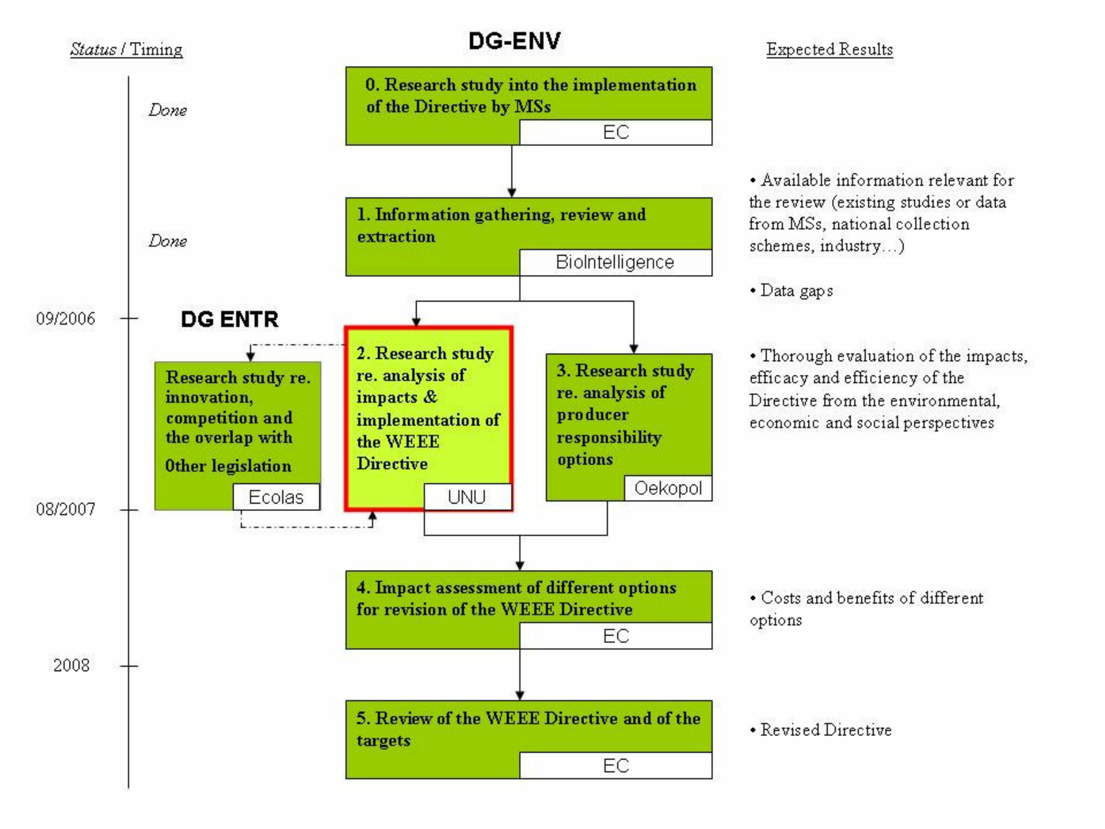

Figure 1: Review process

The approach in undertaking the work was addressed in two key tasks:

4.1 Task 1 – Evaluation

Task I

Task I aims to fully evaluate the current implementation of Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE) in the EU Member States, with particular attention to societal aspects (Environment, Economic and Social, Task 1.1). In Task 1.2, qualitative and quantitative data for assessing relevant impacts on stakeholders involved in the WEEE Recycling Chain are provided. The main result from Task I is an evaluation of the implementation status of the Directive with regard to the environmental and economic impacts and the finding of the social screening. This result is compared with the current and future status of markets and technologies for treating WEEE. It provides an overview of the main concerns regarding a successful achievement of the goals of the Directive.

4.2 Task 2 – Options

Task 2

Task 2 translates the information gathered in Task I into legislative and non-legislative options, in order to improve, further develop and simplify the WEEE Directive. These options relate to the different topics and key issues:

- Changes in the scope of the Directive,

- Changes in collection targets,
- Changes in targets for reuse and recycling,
- Targets for reuse and treatment requirements.

Some larger tasks are divided into subtasks, according to their complexity and the need for further research.

The main outcome from Task 2 is a set of suggested options for changing the WEEE Directive. They are first listed according to the different key issues mentioned in Task 1.1 (environmental, economic, social) and Task 1.2 (market and technology status and development) and then grouped.

A flow diagram illustrating the methodology is provided in Figure 2 below:

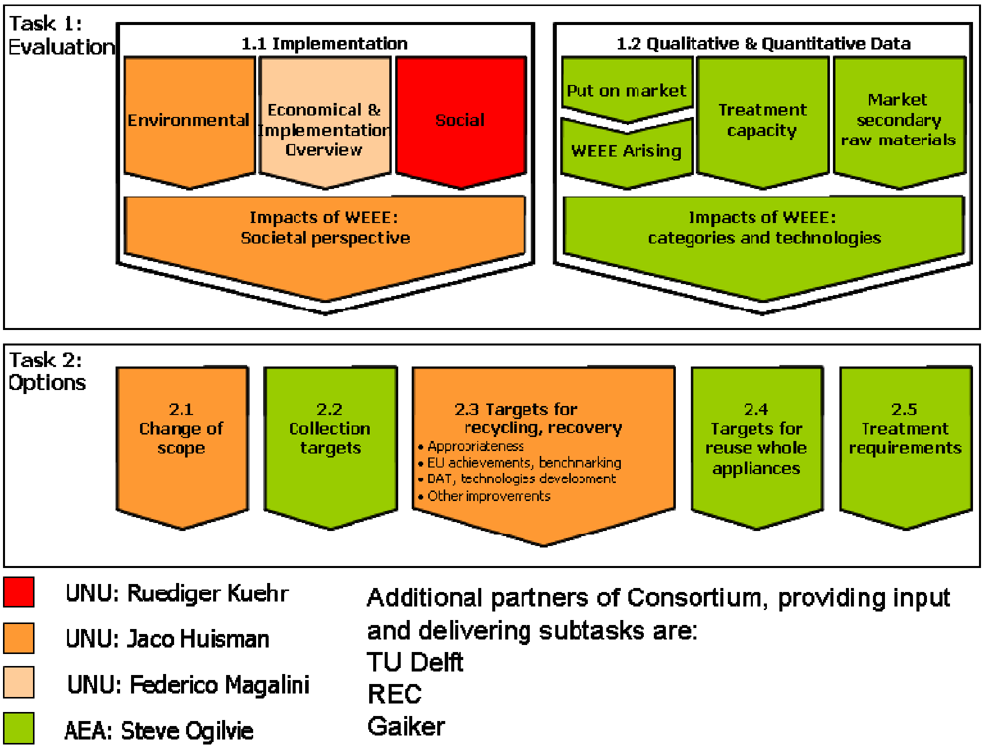

Figure 2: Structure of Task 1 – Evaluation and Task 2 – Options

4.3 Reader's Guide

Reader's Guide

The structure of the final report reflects the outcomes from the above tasks that make up this assessment. The results are presented in the sequence as outlined in Figure 3 below that allows a rigorous analysis of the impact of the Directive and its achievements.

The introduction to the report describes the scope of the study and the assignments setting the framework for the necessary research, this is followed by a chapter that outlines the background of the report. This chapter defines the five areas of improvement for the Directive. It describes how the Directive links with other legislation already in place and the need for simplification and improvements in the efficiency and efficacy of the WEEE Directive. Finally this chapter illustrates the expertise of the team carrying out this work.

Chapter 6 describes the methodologies that are utilised in Task I in order to undertake the necessary impact assessments of the WEEE Directive.

This is followed by chapter 7 which is split into two sections. The first section of chapter 7 provides an analysis of the quantities of equipment that are sold as well as the amounts of WEEE that are likely to arise as waste from 2005 up to 2020 and the amounts officially collected and treated. The second section of chapter 7 provides an analysis of the different technologies that are used for treating WEEE and the development of markets for the secondary materials that are likely to result.

Chapter 8 provides an overview of the social, environmental and economic impacts of the WEEE Directive.

Chapter 9 provides a description of the methodology used in order to undertake Task 2, an analysis of the opportunities available in order to improve, develop and simplify the current WEEE Directive.

Chapter 10 and 11 provide information on the outcomes for the individual and grouped options.

Finally the concluding Chapter 12 lays down a roadmap for action. It illustrates the need for further research, provides recommendations and presents the final conclusions to the report.

The final report is supplemented by an Annex report that contains more detailed information. Abbreviations and references can be found at the end of this report.

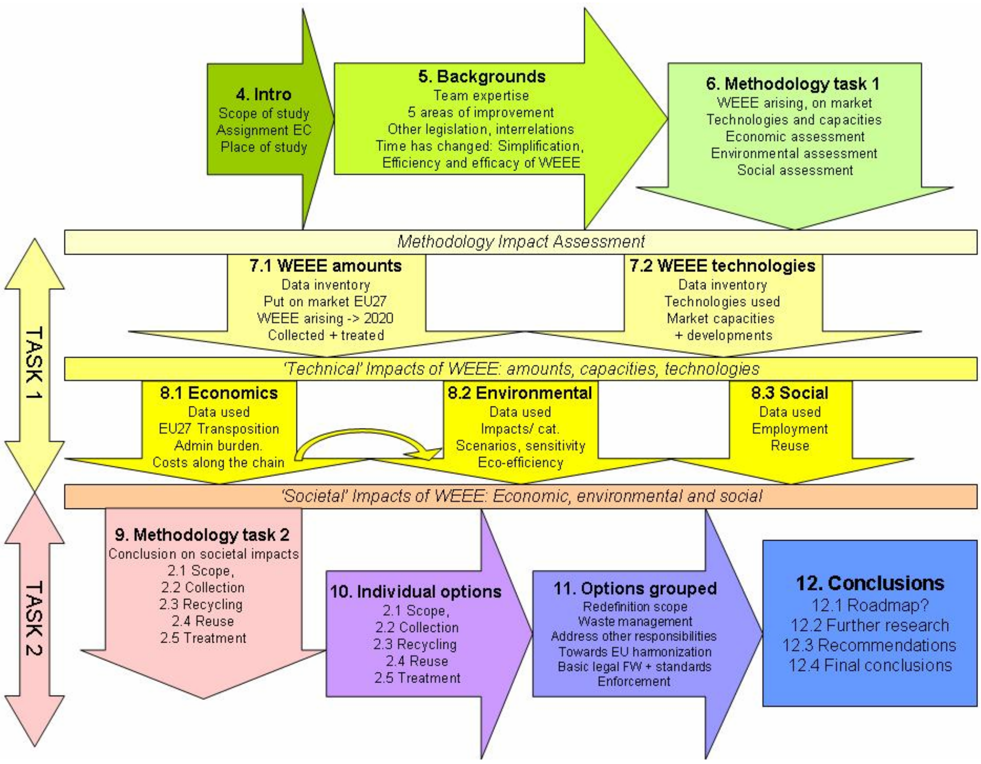

Figure 3: Structure of report

5 BACKGROUND

Background

It has been ten years since the initiation of the EU regulation of electronic waste by the Commission and the Parliament and more than three years since the WEEE Directive was officially adopted. Since its implementation - officially starting on 13 August 2005 - all stakeholders involved in the electronics recycling chain have gained experience of the impact of the Directive.

For several EU Member States the transposition of the Directive into national law, and the setting up of take-back schemes and development of recycling infrastructure was relatively easy, as they already had legislation and recycling infrastructure in place.

Some Member States already had some recycling infrastructure but no legislation present and in others, the legislation was in place, but infrastructure was yet to be developed.

In other Member States, in particular in Central and Eastern Europe, both aspects were less developed than in Western Europe.

Difficulties with the implementation arose as a result of the complexity of involving all relevant stakeholders actively and agreeing on responsibilities. These difficulties have contributed to delays in the legal transposition and practical implementation of the Directive. Figure 4 below illustrates the current legal transposition status of different Member States, Norway and Switzerland.

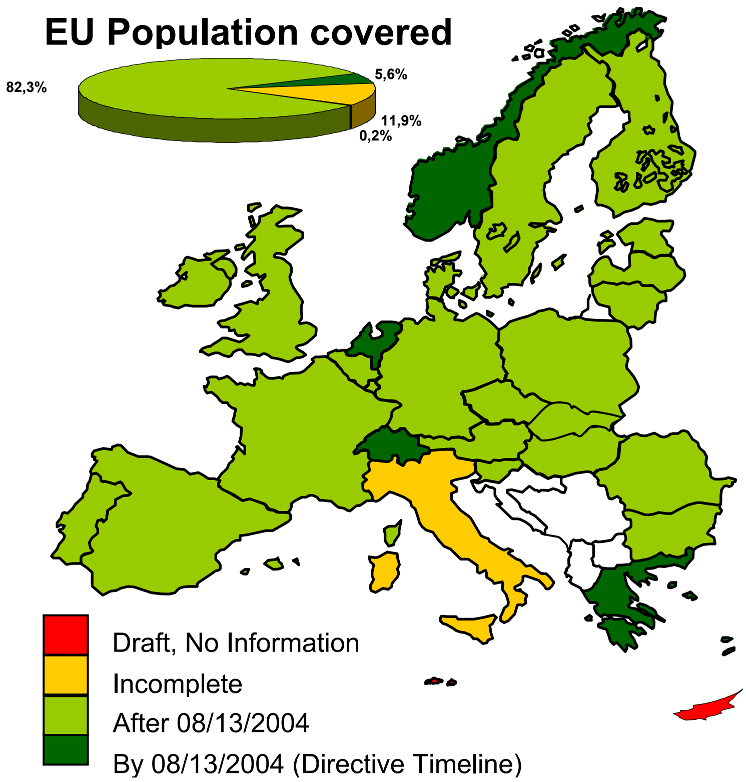

Figure 4: WEEE transposition (EU+ NO, CH), status: June 2007

The key legislative, environmental and economic observations of the Directive are further discussed in this chapter in order to indicate some of the key items that are further researched in the next chapters. Note that the below items are a non-restrictive list introducing some but not all relevant aspects of the societal impacts of the Directive. Moreover, after the impact assessment chapters, the below observations are discussed in more detail and will be addressed later for which observations indeed evidence and/ or correlations were found.

Firstly, the scope describes which electrical and electronic products are covered, followed by discussing the minimum collection target for all EU Member States, the weight based recycling and recovery targets for each product category, targets for reuse and the treatment requirements to ensure control over hazardous substances. Additionally, overlaps with other EC legislation and policies, is followed by some general observations on the Directive impacts.

5.1 Scope of the Directive

Scope

The objective of defining the (product) scope in a Directive is to describe who or what has to comply with the Directive requirements. The scope of the WEEE Directive is described in its Article 2 and by reference to Annexes 1A and 1B which categorise equipment by type and provide illustrative examples of the types of equipment that may fall into each category.

Exclusions from the scope of the Directive include:

- Parts of other equipment (where that other equipment is not covered),
- Military equipment,
- Large-scale stationary industrial tools (category 6 of Annex IA), and
- Implanted and infected products (category 8).

The definitions of scope given in Article 2 of the Directive determine which products and product categories are affected by:

- The quantity reporting requirements of Article 12,
- The recycling and recovery targets of Article 7, and
- The financing requirements of Articles 8 and 9 (the arrangements are different for WEEE from private households than other sources).

The EC has published non-legally binding Frequently Asked Questions (FAQs) which provide further clarification on scope and definitions (European Commission 2005d).

Key findings with respect of this study are:

1. In practice, waste streams are collected, divided and treated in a manner that is different from the current divisions in the product scope (in practice treatment is on the basis of material composition, the EU scope definition is on the basis of appliance use).

   Most collection schemes in the EU Member States collect in 5 or 6 groupings. These schemes reflect the treatment of WEEE based on its composition and the economies of scale achieved during collection.

   In practice, the most common divisions are:

a. Large equipment (category 1 and 10),
b. Cooling appliances (category 1),
c. Small appliances, (category 2, 3, 4, 5A Lum., 6, 7, 8 (small consumer part), 9),
d. Cathode Ray Tube (CRT) (picture tube, category 3 and 4),
e. Lighting: lamps (category 5B),
f. In some EU Member States, some Information Technology (IT) equipment (for example: computers and printers) is collected as a separate stream. Medical equipment (category 8) is usually only collected through Business to Business (B2B) channels. Generally speaking, the diversity of the waste stream does not correspond with the product (category) lists of WEEE – Annex 1.

2. Variations in reporting arising from different Member States using different product lists and criteria for determining which products fall in which category.

   Examples of complicating factors are:
   a. New types of equipment, not listed in WEEE Annex IB,
   b. Overlapping applications of consumer electronic products and IT-equipment,
   c. So-called "dual use" products e.g. computers sold as B2B (non-household), but which then become owned by consumers and discarded as B2C (Business to Consumers / household).

The consequences of this are:

1. Debate and uncertainty regarding product classification within the scope and to specific categories, with consequential problems about financing issues. For example, recycling costs have in some cases not been attributed according to quantities put on the consumer market, with the result that some producers pay relatively more than others,

2. Additional administrative and financial burdens are high in relation to the additional sampling and reporting required to transform the results for the treatment categories in practice into calculation and to submit data according to the ten categories prescribed by the WEEE Directive. Such actions have no added environmental value and place additional financial burdens that impact upon the economic viability of some schemes. These financial burdens impact upon service provision and ultimately collection and recovery levels,

3. Due to the different approaches of Member States, inefficiencies arise because every producer on the EU market must declare data - based on weight, units, or occasionally market share - for each of the 27 EU Member States. This fragmentation works against the general aim of ensuring one common marketplace. For example producers that have distribution centres covering multiple countries have multiple reporting requirements that vary for each Member State. The ensuing complexity adds significantly to the administrative burden and results in disproportionate costs especially for smaller companies. As a result market distortion exists between small and large producers.

5.2 Collection Targets

Collection

The WEEE Directive currently sets a minimum collection target of 4 kg per year per inhabitant for WEEE from private households. This target was originally based on estimates made by the EU Priority Waste Stream project group that future quantities of WEEE will be over 20 kg per person per year, of which the consumer sector accounts for 12 kg, the industrial sector for 5 kg, and the cables sector for 3 kg. No collection target was set for non-household WEEE. Currently in Western Europe the amount of WEEE produced per person is estimated to be higher, however in the new Member States amounts are substantially lower, but expected to rise in the future. The expected growth in new Member States will be due not only as a result of envisaged economic growth, but also because of large quantities of used products from the EU15, mainly televisions (TVs), washing machines and computers, being exported to the new Member States.

A general characteristic of current collection rates is that these are, in the majority of Member States, far below 100% of the goods sold many years ago. Increasing collection is therefore one of the key issues to enhance the effectiveness of WEEE and to achieve the original intent of the Directive.

Typically in Western Europe, large household appliances, such as washing machines, cookers and fridges, make up nearly 70% of the total weight of domestic WEEE arisings — but only 16% of the number of products discarded. In contrast, many more small household appliances are discarded, but these make up only about 8% of the weight. Consumer equipment, such as TVs, videos and hi-fi sets, contributes almost 13% of the total. TVs make up most of the weight in this category. The remaining 10% of domestic WEEE consists of IT/telecommunications equipment, tools, toys, monitoring and control equipment, and lighting.

In practice, large differences in reported collection performance are currently found between Member States**.** The reasons for this variability could include:

1. Smaller items are more likely to be disposed of along with the normal household waste than their larger counterparts,
2. Collection infrastructures: availability and number of collection points,
3. Commitment of municipalities and retailers (hand in mechanism: old for new, any old for new, any old when selling new, any old),
4. The time that the scheme has been in operation,
5. Public awareness, cultural and average income differences,
6. The amount of WEEE present per EU Member State,
7. The fact that not all WEEE is being reported in some countries:
    a. Appliances with a net value, like washing machines and computers, are sometimes directly traded from collection points to recyclers, and are sometimes treated in the same way without being reported,
    b. Well developed second hand markets could lower the officially reported quantities,
    c. In some cases, there are (illegal) exports outside the EU, potentially lowering the collection amounts. The claim 'appliances for reuse' is frequently used to disguise such (illegal) waste exports.

The key issues are:

1. Information derived from Western European countries with schemes in operation for a longer period shows that the 4 kg target level can be exceeded comfortably. However, for some Central and Eastern Member States this target is much more challenging. The current target of 4 kg is therefore not an incentive for further improvement in countries that are already achieving this level, whereas for other countries the target might be too ambitious, at least for the next few years,

2. The use of a visible fee could play a role, especially in regards of financing future collection and treatment. Despite defined in the WEEE Directive as a mechanism to allow producers to show purchasers costs incurred in the management of Historical WEEE arising. Despite the statement in the Directive that "*costs mentioned shall not exceed the actual costs incurred*", the current use of Visible Fee is covering, in many cases, both costs for Historical and New WEEE, as no differentiation of flows is in place in compliance schemes. Therefore, financial responsibility is on purchasers both for Historical and New WEEE. After 2011, when the Visible Fee is no longer allowed, or for the schemes currently using direct compliance costs mechanisms, the drive to collection of more than 4 kg leads to higher costs for producers. This is because of higher quantities treated which will not be compensated to better economies of scale (let alone the costs for higher quality treatment). In such cases, the financing mechanism does not support the overall goal of more collection and treatment of WEEE as producers are likely to opt for the cheapest solutions,
3. The 4 kg target does not discriminate in favour of products with the highest economic or environmental relevance. The latest environmental research demonstrates that collecting and recycling certain products (for example Chlorofluorocarbon containing (CFC) fridges, precious metal dominated products) is much more important with regard to the environmental objectives of control over hazardous substances and resources and value conservation than others,
4. There is little research available on why certain (national) collection schemes are more effective and efficient than others with regard to overall costs, achieved collection amounts and recycling percentages. Further research on the above variations is needed in order to find correlations and to determine the success factors for high collection yields. For example, indications exist that there is a close relationship between the (relative) number of easy accessible collection points and the amounts collected and treated. With such background knowledge, generating options for more ambitious and realistic targets by means of both legislative and non-legislative instruments will be prioritised and targeted.

5.3 Recycling Targets

Recycling

The objective of recycling targets is to set a level of treatment that will improve the recovery of materials. Although being relatively easy to understand, practical implementation of the targets causes several issues of concern. These concerns are discussed below in terms of suitability, interpretation and consequences for the market as well as the role of technological developments.

5.3.1 Suitability

Suitability

The initial question here is whether the current targets promote an appropriate level of treatment performance. The WEEE Directive is in fact aiming at two goals:

1. Ensuring a high level of recycling and reuse of materials,
2. Prevention and control of the release of potential toxic substances present in WEEE from entering the environment.

Depending on their material composition, for some products like cellular phones, the first goal is the most relevant. For other products toxic substance control is the dominating issue for example for Liquid Crystal Display (LCD) screens that contain mercury in backlights.

It is to be realized that in some cases there are currently no treatment technologies available that maximize both goals. Indeed in some cases achieving both goals simultaneously is contradicted on technical or thermodynamic grounds.

For many treatment categories, the separation steps are a matter of finding the right balance between maximising the recovery of materials (prevention of loss of materials in the separation process) and increasing the purity of the fractions by concentrating material content to meet market criteria and thus allowing high levels of reapplication and therefore conserving environmental and economic value. As current recycling targets only promote the first of these issues the question is whether this might negatively affect other important factors that are required for example: ensuring the achievement of a high purity of fractions to promote reuse, a high level of reapplication, maximum toxic control, or even providing a sufficient level of health and safety at the working place.

The key issues are:

1. For some categories of WEEE it appears that the targets can easily be met. For instance, for white goods, current shredding and separation technologies generally lead to recycling rates in excess of the prescribed targets. Here there is no incentive other than the reporting on the treatment performance as such. For small plastic-dominated products, it is much more difficult to achieve the targets, as the plastic fractions are often too contaminated with other materials such as glass or metals or contain a complex mixture of difficult to separate polymers preventing those fractions from being recycled or reused,

2. In some cases, as will be explained later, the weight-based recycling targets are not consistent with the environmental priorities, as in the case for recovery of precious metals from products with a high resource value, or for environmental burdening materials like CFCs or cadmium-containing plastics. An optimisation based on achieving certain recycling targets could easily lead to either loss of environmental and economic value as is the case for cellular phones, or contamination of fractions, for example when recycling plastics containing cadmium,

3. Recycling targets may also conflict with health and safety requirements. For instance, LCD panels with mercury backlights break easily during manual removal, thus potentially exposing the operator to mercury vapour. Material recycling targets could promote a higher level of disassembly or separation of materials, potentially resulting in an increase in the level of emissions of hazardous substances during treatment,

4. Fundamentally, the re-application level determines to a large extent the environmental gain achieved by recycling. This is particularly relevant for plastics and glass where big differences in such levels exist. For instance, using cleaned CRT glass for producing new CRT's has been shown to be much more resource and energy efficient than using the glass as road filling material. However, in WEEE both destinations are regarded a useful re-application and are on equal footing in the recycling percentages to be realised. In this case, the recycling percentages may even discriminate against the environmentally most preferred options as they require more cleaning and separation (and thus loss) of materials,

5. Electronic products are currently designed with less material than in the past, which is good from an overall life-cycle perspective, but from a strict weight based recycling percentage perspective it may become more difficult in the future to achieve the current recycling targets.

5.3.2 Interpretation

Interpretation

Determining and reporting recycling and recovery percentages is also subject to differences in interpretations:

1. An important issue is the definition of recycling targets and more specifically what is considered to be a recycling, recovery or disposal operation. A basic issue is here whether for instance a recycling definition is based on individual materials (iron, aluminium, glass, copper, glass, plastic (of various types) or on the basis of destinations of fractions which result from the treatments. The discussion on this comprises part of a larger debate with respect to conflicts in legislation, regulatory confusion and market distortions due to different wordings and interpretations in EU Member States,
2. Different definitions and thus calculation methods are used to calculate recycling percentages. The simple ones are easy to understand but generally poorly represent the environmental ambitions of WEEE. Calculations representing environmental objectives, at best, require an objective mathematical basis and a lot of additional data. In practice this will be very complex and costly because the outcomes depend on the complex distribution of materials over various fractions with various purities from various origins with various destinations. This is posing a dilemma between simplification and scientific precision in monitoring performance,
3. For the car industry, large-scale tests have been done to determine recycling percentages as accurately as is technically possible. The results of these tests showed that even when all measurements were performed correctly, substantial error margins were still found. Therefore, a detailed monitoring system will always contain mathematic uncertainty. This makes enforcement of non-compliance problematic (van Schaik 2004, Reuter 2006).

5.3.3 Technologies and Market Developments

Technologies and Markets

Recycling targets can play an important role in stimulating improved treatment performance. Markets generally exist for materials derived from WEEE that are economical to recover. However, for certain materials (e.g. plastics), one of the effects of the recycling targets can be the production of materials that are not absorbed by existing markets. This might be, for example, because of capacity, quality or even legal (RoHS) constraints, and thus alternative markets or applications may be necessary to ensure the beneficial use of these materials. One example of this is CRT glass where worldwide production capacity is decreasing due to flat panel production, which means that the capacity to absorb secondary glass in this option is rapidly diminishing.

5.4 Targets for Reuse

Reuse

The objectives of using targets for reuse are substituting for new production and life-time extension. Although variations are observed from region to region, in general the main types of products that are reused in the EU are mobile telephones, computers and white goods (e.g. fridges, washing machines etc). Other electronic items, such as audio-visual equipment and toys, are often sold if they still have any value, and thus are unlikely to enter the waste stream until they have reached the end of their working life. Such items are often less suitable for reuse because:

1. Newer technologies become available which allow increasing functionality dramatically but reduce reuse value considerably,
2. New products become available at a lower cost (a new DVD player can cost as little as EUR 30),
3. Some items cannot be refurbished.

Mobile telephones, computers and white goods are collected through a variety of different routes. These 'collection routes' vary from formal organised schemes to ad-hoc second-hand trading. Collection schemes for mobile telephones are well established and generally use either a collection point in a shop or a freepost envelope. They may well include an incentive to consumers to encourage them to return the phone. The main arising of computers is from businesses (replacement every 3 to 4 years is common). White goods are usually either collected by the retailer when delivering a new appliance, or are taken to a municipal collection point, but other collection systems also exist.

Once the items have been collected, they usually need to be refurbished before they can be reused. Refurbishment of both mobile telephones and computers is commercially attractive, but refurbishment of white goods is usually conducted by charity based groups (these may well also receive government funding). The refurbishment process has social benefits in creating jobs, particularly for disabled or mentally handicapped people in the refurbishment of white goods. There are also social benefits to low-income households who could not afford to buy a new white good, but would be able to buy a refurbished item.

Other issues with respect to reuse are:

1. Illegal waste shipments take place with products claimed to be still functioning and having a reuse value, but in practice these may actually be sent for 'cherry picking' and disposal to developing countries with low environmental protection levels and low labour costs,
2. Reuse might have adverse environmental effects in certain cases. For instance reuse of old televisions or refrigerators that consume many times more energy than newer models. Energy consumption is generally the most dominant environmental effect for electronic equipment throughout their entire life-cycle,
3. It is to be realized that recycling systems as organized under WEEE are generally, easily accessible systems. In such systems "value disappears" before it comes to reuse. In the Netherlands, for instance, it was observed that shops sold goods returned under WEEE to traders (so called backdoor sales) and that some municipalities allow or at least tolerate that people working at municipal recycling yards sell discarded goods to interested parties (VROM 2005). Both activities lead to a higher reuse but lower value in the downstream WEEE channels.

5.5 Treatments Requirements

Treatment

The objective of the treatment requirements as laid down in Annex II of the Directive is to ensure removal of hazardous or otherwise environmentally relevant components.

The key issues are:

1. At the time of writing of the Directive, the envisaged method was manual removal of all relevant components, even the tiniest ones, which is very costly. Moreover, shredding and separation technology has improved considerably as well as the downstream environmental control of toxic substances (in upgrading and secondary processing). As a result, the definition of 'removal' has become a key issue,
2. Furthermore, certain processes are capable of treating complete WEEE fractions (without relevant components being removed) or even complete products whilst achieving high recovery levels for valuable materials and ensuring that hazardous substances are controlled. For example, treating cellular phones (without batteries) in a modern copper smelter is the environmentally preferred option as loss of valuable precious metals through separation is avoided (Huisman 2004b),
3. An associated question is: what is the desired level of toxic control? In theory the level of toxic control should be 100%, in practice this is impossible to achieve. For example, removal of batteries, either manually or mechanically will always have a level of efficiency. This means that the technology used may have a removal efficiency of appreciably less than 100%,
4. Certain components covered by Annex II of the Directive are either not used anymore, or have been proven not to be toxic. In addition, rapidly changing products, together with changes in product composition, mean that new substances may be more relevant,
5. The relevance and need for the actual entries of the Annex II are directly connected with technology development. There is currently no established guidance on what constitutes Best Available Technologies (BAT) for the treatment of WEEE,
6. It is known that control of environmentally significant materials present in WEEE is not only a matter of removal from WEEE, but also of further downstream control on the destinations of the removed components,
7. In addition, a strict interpretation of removal as a manual activity causes both high economic burdens and undesired health and safety issues at recyclers. For instance, manual removal of mercury backlights from LCD panels can cause direct and indirect mercury emissions and thus severe environmental and health risks for dismantlers when no protective measures are present.

It is to be realised that the definition and interpretation of the Annex II treatment requirements should stimulate the desired removal efficiency level as well as promote innovation in recycling technology to achieve the desired levels of control in new or other ways.

5.6 Relation with other EU Legislation / Policy

Other Legislation

The WEEE Directive is positioned within a framework of other EU legislation. It is essential that the review of the Directive considers the interaction of the WEEE Directive with this other legislation, and in particular how it relates to developments in policy on waste management and regulation. This section provides an initial overview of the interaction of the WEEE Directive in two areas:

1. Regulatory policy issues arising from the Thematic Strategy on the prevention and recycling of waste (TSW) and the proposed Framework Directive on Waste (pWFD),
2. The comparative objectives of technology assessments under the WEEE and Integrated Pollution Prevention and Control (IPPC) Directives.

5.6.1 The Thematic Strategy on Waste and Recycling and the Proposed Waste Framework Directive

TSW and pWFD

On December 21, 2005 the European Commission published the "Thematic Strategy on Waste and Recycling" (COM 2005/666), and a proposal for a revised framework Directive on waste (COM 2005/667). Together these two documents set out the overarching policy and framework for the management of waste in the EU. The renewed EU waste policy described in the two above documents considers the impacts of waste management, but when compared to previous policies, places additional emphasis upon up-stream waste prevention and resource depletion impacts. Thereby, the policy adopts and promotes a life-cycle based approach to waste management that, whilst providing for the control of pollution associated with waste management, also recognizes that the prevention of waste and its sound management can contribute to reducing resource consumption. This is broadly complementary to the aims of the WEEE Directive, although there is a need to assess whether the detailed requirements of the WEEE Directive can contribute more effectively.

The TSW adopts a life-cycle based approach that aims to:

- Contribute to reducing the overall negative environmental impact of resource use,
- Prevent waste generation and promote recycling and recovery of waste,
- Increase the resource efficiency of the European economy,
- Reduce the negative environmental impacts of use of natural resources,
- Maintain the resource base.

Other stated objectives of the TSW are:

- To prevent waste and promote reuse, recycling and recovery so as to reduce negative environmental impacts,
- For the EU to become a recycling society, that seeks to avoid waste and uses waste as a resource,
- To provide for the introduction of high environmental reference standards that will facilitate recycling and recovery activities, in the internal market.

As well as providing the legal basis for the permitting (and hence control) of certain waste management activities, the pWFD is the legislative framework that provides the implementation of the policy set out in the TSW, and it establishes a hierarchy of waste management activities with prevention firmly the priority. The WEEE Directive includes a requirement for installations treating WEEE to be permitted in accordance with the requirements in the earlier Waste Framework Directive WFD 75/442/EC.

Of particular note in respect of the approach adopted in the WEEE Directive is that, while the pWFD provides for certain (revised) definitions and sets out the hierarchy of waste management activities, in promoting the use of "life-cycle thinking" for the development of waste strategies, it avoids setting quantitative European-wide targets for recycling and recovery. However, importantly it notes that such targets may be set in other community legislation (e.g. WEEE and End-of-life vehicle (ELV) Directives), and that the derivation of any such targets should result from a life-cycle based approach. Essentially, this means that the use of a life-cycle based methodology that considers wider resource depletion, as is proposed in this submission, is complementary to the policy set out in the TSW and pWFD.

See the reference list for a list of relevant legislation.

5.6.2 Best Available Techniques (BAT) and the Integrated Pollution Prevention and Control Directive

BAT, IPPC

Directive 96/61/EC on Integrated Pollution Prevention and Control sets out the basis for the permitting and control of pollution of certain industrial activities, including certain waste management activities. It requires Member States to ensure that:

- Installations falling within its scope have a permit,
- The conditions in the permit are enforced,
- The conditions in the permit are based upon the use of the BAT - Best Available Technologies -.

The term BAT is defined in the Directive. Further guidance is facilitated by establishing an "information exchange" involving Member States and other stakeholders. This information exchange is carried out by the European IPPC Bureau and results in the publication of BAT Reference Documents (BREFs).

Article 6 of the WEEE Directive requires Member States to set up systems that provide for the treatment of WEEE using the 'best available treatment, recovery and recycling techniques' and (in Annex II) specifies treatment procedures in respect of certain substances and WEEE. Technologies (which in this context may be taken to mean 'procedures') other than those stipulated, may be used, where they provide for a similar level of protection for human health and the environment. As an overall target, the procedures described in Annex II should be applied, such that they provide for the reuse or recycling of components or whole appliances in an environmentally sound manner.

The meaning of the term environmentally sound may be compared to the objectives of the use of BAT under IPPC. The objective of IPPC is to prevent and control industrial releases in an integrated way in order to provide for a high level of protection of the environment taken as a whole. Similarly, the use of BAT is intended to provide the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole. Each of these terms, while differently worded, can be seen to provide for a level of overall environmental protection that balances impacts upon each environmental media.

In essence it may be considered that some kind of life-cycle based approach is envisaged for technology application – this is also complementary to the aims of the proposed Framework Directive on waste and policy outlined in the thematic strategy on waste and recycling.

If the WEEE Directive were to specify technologies and techniques as BAT, it would be necessary to carry out an evaluation of those technologies and techniques to ensure that they would provide for a suitable and balanced level of protection for human health and the environment, and also that it takes account of economic factors. Such an evaluation, which identifies evaluation criteria and adopts a life-cycle based assessment, is envisaged in this study. The study will also consider the main alternatives to technology specification, which is the establishment of suitable evaluation criteria and a methodology, whose use may provide for a more local, and perhaps better tailored, set of treatment techniques. It is also necessary to ensure that the application of outcomes from this study does not give rise to distortion of the internal market, which itself might prevent or hinder additional recycling / recovery of WEEE.

5.7 Relations between the above Targets and Key Aspects of WEEE

Key Aspects

Besides the external legislative framework of the WEEE Directive, the scope and targets set in the Directive itself are highly interrelated. For example, the use of the legislative instrument of 'removal for selective treatment' has consequences for achieving recycling targets. More generally speaking, making changes in one of the above aspects and instruments will affect the others. For example:

- Changing the scope has consequences for the recycling and recovery targets,
- Promoting reuse could lower collection amounts,
- The development of a well functioning monitoring framework for recycling percentages lowers the need for treatment rules,
- Increasing collection and recycling affects market absorbance capacity,
- Etc.

Therefore, it is important to ensure that any new options that are considered do not contradict other regulations.

5.8 Monitoring and Enforcement

Enforcement

Since the targets and key aspects of WEEE are interrelated, checking implementation performance on basis of single indicators for collection, recycling, reuse and implementation of Annex II is problematic. The only way to get a good idea about what has been achieved under WEEE is to have simple input and output reporting of materials streams entering and leaving the recycling chain. This allows an integral judgement. As things stand now, methods to accomplish this are in development. This promotes better control over actual treatment which preferably should be standardised to avoid different cost levels due to largely varying quality standards for collection, treatment and also waste shipments.

5.9 "Times have Changed"

Developments

Thinking on effective and efficient legislation changes over time. Therefore, generating options must also be done carefully in a way that allows for future adaptation of the Directive to make best use of scientific insights, technology development and practical experiences with take-back and recycling. As an example of this effect, the table below highlights some of the changes in thinking about electronic waste over the last ten years.

Item	1996 status/ focus	2006 status/ focus
Starting point	Solve waste issue	Optimize waste management and save resources
Principle	Producer as main responsible party should get things started	Chain optimization is a matter of responsibility of stakeholders
Scope	'Origin based' product categories	'Destination based' waste treatment categories
Environmental issue	Waste prevention and toxicity control	Toxicity, resource efficiency, energy preservation, health and safety
Economic issue	Design for Recycling will reduce recycling costs	Maximize environmental performance as cost efficient as possible
Technology	Manual disassembly is the way to remove hazardous substances and make purer fractions	Shredding and separation has become more effective, toxic control depends much more on destinations of fractions

Table 1: Think patterns on electronic waste (1996/2006)

Two important observations over the last years are that from an environmental point of view, recovery of resource value and control over toxic substances are not always complementary. In addition to this, toxicity related environmental impacts are only in certain cases directly connected to the product as such. Often, toxic related environmental impacts only occur during or as a result of treatment. Improper treatment, for instance due to illegal export, can be a cause of this. However, treatment as such can decrease environmental impacts by preventing new material extraction and the connected energy requirements of this. Furthermore, besides 'global' environmental concerns, also very local aspects like Health and Safety concerns related to shredder dust or risks of harmful emissions during dismantling are receiving more and more attention.

Secondly, the diversity in the WEEE treatment categories is large, not only from an environmental point of view, but also economically. Treatment of certain categories like large household appliances (excl. refrigerators) and desktop PC's is almost or already economically viable as such (after being collected) due to increases in raw material prices resulting in recycling being economically attractive. This means that the intrinsic (economic) content of materials and the size of these appliances (they simply cannot be placed in the waste bin) allow treatment to happen naturally.In contrast to this, it has become apparent that other categories (lamps, refrigerators, plastic dominated products) will remain costly to treat at current material prices. For these products, there is less incentive to collect and treat more and so these small items will require different (types of) economic or legal incentives compared to large household appliances.

5.10 Simplification and Competitiveness

Simplification

The outcome of the above discussion on the regulative and non-regulative elements of the WEEE Directive must be closely considered in terms of environmental effectiveness, economic efficiency and the current social context and acceptance. Take-back and recycling is a complex field in which cooperation and the societal responsibilities of stakeholders are essential. Both the speed of implementation of WEEE as well as stakeholder involvement requires simplification of the regulations. This way, the final aim of increased environmental effectiveness and improved economic efficiency and further development of the EU market can be achieved and dynamically improved in the future. These discussion items are taken into account in the following chapter with a more in-depth analysis of the above observations.

6 METHODOLOGY TASK 1: EVALUATION

This chapter is split into two sections. In the first section the methodology for determining WEEE amounts is outlined. This includes methods for calculating in terms of quantities put on market and WEEE arising. The amounts of WEEE collected and treated will also be highlighted. Connected to this is the methodology for assessing current and future markets for secondary materials and treatment capacities. This forms the basis for the analysis found in Chapter 7.

In the second section of this chapter the methodologies for the environmental, economic and social assessment will be introduced. Following inclusion of the later outcomes of Chapter 7, this forms the basis of the analysis in Chapter 8.

6.1 Methodology WEEE Amounts and Technologies (Task 1.2)

6.1.1 Quantities Put on the Market (Task 1.2.1)

Objective

This section of the report provides information on the tonnages of electrical and electronic equipment (EEE) for each of the 10 categories considered in Annex IA that are being placed on the market in the EU27 Member States.

Methodology

Although the National Registers will report in the future, no sources of data providing information on the amount of EEE put onto the market in the EU27 Member States were identified. Some sources of information provide data for sales in the EU25, whereas others provide data that covers either the EU15 or an individual Member State. The main sources of data on numbers of units placed on the market are the current studies being conducted for the European Commission on Eco-design of Energy-using Products (EUP). These provide data on total sales in the EU25, but do not provide data for individual Member States. Other sources of data include information provided by Manufacturer Trade Associations, sources identified in the report for the EC by Bio-Intelligence Services (BIO IS 2006), and a survey conducted in the UK to determine the planned purchases of electrical and electronic items by householders.

In order to provide estimates for sales in the EU27, it was necessary to scale-up the data provided for the EU25, the EU15 or a Member State. Two scale-up options can be considered: population and GDP. The EU15 Member States represent 79% of the population of the EU27, but account for 95% of the GDP of the EU27. Due to a well established link between GDP and purchasing power, GDP data was used to determine estimates for the EU27 Member States.

Tonnages of EEE put on market per Member State have been determined from these data using “typical” weights of appliances derived from the following sources:

1. Data on weights of equipment provided in manufacturer’ specifications determined through the internet,
2. Measured weights of waste items (AEA 2006, Freegard 2004, DEFRA 2007).

For each category, data, where available, are presented on the numbers of items, and the typical weight for each type of appliance put on to the market in the EU15 and EU25 Member States. The estimated weights for each type of appliance are then totalled in order to estimate the total weight of items in each category which is placed on the market. These are then totalled to determine the total weight of electrical and electronic items placed on the market in the EU25 Member States, and then scaled up to estimate the total weight put onto the market in the EU27 Member States.

These data are then compared with the tonnage reported by EU Member State national registers for electrical and electronic equipment that have been put on the market (see Annex 6.1.1 Population and GDP Overview).

6.1.2 WEEE Arising, WEEE Collected and Treated (Task 1.2.2)

Objective

The aim of this task is the estimation of the quantities of WEEE generation.

Methodology

This task was carried out by using a number of approaches to estimate WEEE generation for a given year based on data derived from published sources and responses to questionnaires on waste generation, WEEE collection and quantities of EEE put on the market. Based on responses from the WEEE Forum, EERA and several national registers with limited data available and due to the paucity of data found to date on WEEE arisings, additional estimation techniques have been employed in order to estimate a common baseline for WEEE arisings by Member State. This is further elaborated in Chapter 7.3.

6.1.3 Treatment Capacities (Task 1.2.3) and Impacts of WEEE Categories and Technologies (Task 1.2.5)

Objective

These tasks aim to evaluate the current implementation of Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE) in the EU Member States, with particular attention to the assessment of the extent of achievement of the recycling and recovery goals set in the Directive. The tasks help evaluate the efficiency of the recovery requirements and their feasibility in the light of the current and future treatment capacities for WEEE and their constituent materials. In addition the tasks will evaluate relevant economic and environmental impacts. The focus of the analysis is on treatment methods for whole appliances and processes specific to metals, glass and plastics.

Methodology

The assessment of WEEE treatment capacity within Member States covers whole appliances treatment plants operating in each country. It also includes a review of the material specific recycling/recovery technologies available within the EU as treatment destinations for materials separated from collected WEEE (metals, glass, plastics).

In the case of WEEE plastics, the review comprises polymer recycling and recovery (material and energy) processes running in the EU and proven technologies capable of accepting such waste that are either currently in use or can be used.

The WEEE Directive has only been in operation for four years and as a result there is a lack of data on WEEE, in particular annual reports by MS monitoring WEEE Directive compliance. Therefore, the information about treatment operations and quantities of WEEE actually recycled and recovered is estimated from data provided by associations of compliance schemes, recyclers and reprocessors and by Ministries of Environment and their associated Environment Agencies or competent bodies.

Several surveys have been conducted for establishing current treatment capacity and forecasts on a country and/or material basis. The information sought includes information on costs of treatment and the environmental aspects of treatment. Annexes 6.1.3 and 8.0.1 show the basic questionnaires, but slightly different forms of the data gathering questionnaires have been sent out depending on the nature of the stakeholders questioned:

1. FORM 1 - WEEE compliance schemes (association of collective systems in the EU):
   Aggregated data about total WEEE collected, reused, recycled, recovered per category under the association members' systems; total treatment capacity installed and planned within the association; listing of treatment technologies applied; treatment input/outputs (incl. secondary material breakdown) and average treatment costs,
2. FORM 2 - WEEE compliance schemes (national collective systems):
   Overall data about WEEE collected, reused, recycled, recovered per category under the scheme; treatment capacity installed and planned within the scheme; listing of treatment technologies applied; treatment input/outputs (incl. secondary material breakdown) and average treatment costs,
3. FORM 3 - WEEE recyclers:
   Data about treatment capacity installed and planned; treatment technologies applied; treatment input/outputs (incl. WEEE products/categories treated and recovered material breakdown) and estimated treatment costs,
4. FORM 4 - Plastic recyclers associations:
   Aggregated data about total treatment capacity installed and planned within the association; treatment technologies applied; treatment input/outputs (description of WEEE plastics treated) and average treatment costs,
5. FORM 5 - Plastic recyclers:
   Data about treatment capacity installed and planned; treatment technologies applied; treatment input/outputs (incl. description of WEEE plastics treated) and estimated treatment costs.

The same question lists have been used in interviews with stakeholders.

Information gathered from these sources determines the current treatment options for plastics separated from WEEE. The analysis will consider the current volumes of waste plastic recovered through mechanical recycling and feedstock and energy recovery processes. In addition other information sources have been used to establish as much as possible a comprehensive list of WEEE Plastics treatment technologies: literature review (available reports, relevant scientific literature, conference proceedings, patents,), industrial and commercial brochures and databases, as well as information collected from industrial trade exhibitions and contacts with OEMs.

6.1.4 Markets for Secondary Material (Task 1.2.4)

Objective

This section aims to evaluate the existing markets for secondary materials derived from the treatment of WEEE and any developing new applications. The task helps to evaluate the efficiency of the weight recovery requirements for WEEE and their feasibility in the light of the current and future reapplication of the materials derived from WEEE treatment, especially metals, glass and plastics.

Methodology

There are many publicly available reports on the European capacity for absorbing secondary materials into the production of new products that were reviewed during this task to picture current and potential markets for recyclates. The major concerns affecting re-applicability of secondary materials from WEEE are those for plastics and CRT glass.

The publicly available industry data about quantities and end-uses of secondary materials obtained from WEEE plastic treatment are limited. For this reason the questionnaires prepared for surveying the actual and planned treatment capacities in Task 1.2.3 include questions about the outputs of the treatment processes (secondary materials and energy) and their fate.

6.2 Methodology Evaluation of Implementation (Task 1.1)

Objective

The aim of this chapter is to review, collect and analyse information on the implementation of the WEEE Directive in order to form the content and starting point for a more thorough Impact Assessment with regard to the impacts of the Directive on:

1. Environment: The efficiency plus effectiveness of achieving the environmental objectives have been reviewed (Chapter 6.2.2),
2. Economics: The costs and benefits along the recycling chain, as an overall societal impact, as well as the individual impact for individual stakeholders involved have been reviewed. Stakeholders are consumers (directly and indirectly), producers, governments, logistic partners, retailers, municipalities and other collection points, recyclers, secondary material processors, brokers and material traders and (national) compliance schemes (Chapter 6.2.1), and
3. Social consequences: The impacts on the day-to-day quality of life of individuals and communities have been the subject of a screening study (Chapter 6.2.3).

Methodology

The study has been carried out by using available literature plus desk research, direct meetings, email and phone contact to complement our existing knowledge and own evaluation frameworks. For the environmental and economics analysis an already existing WEEE-dedicated methodology was available containing substantial data sets on basically all key recycling chain stages. The existing methodology and information has been adapted and completed to meet the Commissions specific demands, providing an EU wide environmental and economic assessment plus screening of relevant social aspects, covering all WEEE categories.

Part of the evaluation of implementation covers an overview and assessment of:

1. Legislative requirements and transposition details according to National transpositions of WEEE Directive (assessed by means of questionnaires submitted to TAC as primary source of information, but completed with input form Industry where needed to fill gaps),
2. Organizational aspects related to the structure of National Systems (like number and kind of collection points, grouping of appliances at separate collection stage and for treatment, acceptance criteria for disposal at collection point from different type of users, etc.),
3. Compliance schemes and coverage of categories across Member States.

The listed items represent an underlying basis for the analysis of Chapter 8, and provided information which has been used to complete Chapter 9, 10 and 11 and to link options to the current organizational structure of National Systems and their potential developments.

Conclusion

The outcome constitutes an updated scientific base and impact assessment methodology for the options generated by this study. It contributes to improved insights in the relevance of the WEEE Directive's societal goals and corresponding priorities to be achieved in an eco-efficient and socially responsible way. The following sections present for each specific subtask the data gathered, an analysis of the data, and the conclusions drawn from the analysis.

6.2.1 Economic Evaluation of the Implementation (Task 1.1.2)

Objective

The aim of this section is to provide an overview of the economic implementation of the Directive.

The economic comparison has been conducted at two levels:

1. Assessment of the administrative burden and other economic inefficiencies for stakeholders in the recycling chain (consumers, retailers, producers, compliance schemes and recyclers), with particular attention to small and medium enterprises. This covers:
   a. Registering obligations,
   b. Reporting obligations (appliances put on market, collection performances, recovery and recycling percentages),
   c. Informing final users and recycling facilities,
   d. Monitoring and control enforcement, and
   e. Setting up National Registers and/or Clearing Houses.
2. Determination of the total societal costs and revenues of collection and treatment per product, product category and waste stream for a specific year. This demonstrates the current economic impacts and options for reducing costs. Moreover, it highlights the inefficiencies occurring momentarily and generates options for optimisation of revenues from recovered materials and energy.

Methodology

6.2.1.1 Methodology Administrative Burden (Task 1.1.2.2)

Admin. Burden

The administrative burden for each Member State has been analysed in relation to specific Directive requirements that have been transposed into national legislations:

1. Registration and reporting requirements for producers; this covers the frequency of reporting (annually, quarterly, monthly…), the basis for reporting (weight, units), and the level of breakdown in reporting (such as the split between B2B and B2C),
2. Retailers acting as collection points and potentially being regarded as waste collection points, with the associated environmental regulations and administrative burden,
3. Registration fees, especially for producers, and
4. Costs for monitoring and reporting requirements for recyclers.

The administrative burden has been compared across EU Member States considering, for each cost, the amount and frequency of occurrence. Particular attention has been placed on internal versus external costs for stakeholders and on EU wide versus Member State cost developments.

Two main sources of data were used and information gathered:

1. A questionnaire on administrative burden for stakeholders carrying out different activities, and
2. A survey on National Registers of Producers in order to obtain information about the general structure of the register, the reporting obligations and the main economic impacts related to registering and reporting requirements.

Administrative Burden Survey

Admin. Burden Survey

Stakeholders have been addressed by means of a questionnaire in order to gather qualitative and quantitative information on activities causing an administrative burden.

The use of a questionnaire was decided after a first round of consultation with stakeholders, designed on the framework of EC Impact Assessment Guidelines (SEC 2005, 791).

The main problems arising for stakeholders which need to be taken into account while trying to assess the administrative burden caused by legislation are:

1. New obligations: The obligations arising from the WEEE Directive represent a new and challenging field for many stakeholders (particularly if they are outside of their current business or core capabilities). Changes in organizational structure or new investments may be needed to fulfil these obligations, and they may well have impacts from a societal, economical, or environmental perspective. The main administrative responsibilities for different stakeholders can be briefly summarised as:
    a. Producers: They need to embrace take back and recycling in their business. They are responsible for financing end of life activities, may set up compliance schemes, and have to report the number of appliances placed on the market and the amounts collected and treated. They also have to inform final users about recycling facilities and provide information to recyclers on treatment requirements and how to deal with certain hazardous substances,
    b. Retailers: They need to embrace take back obligations, and deal with waste legislation (i.e. authorisation procedures, administrative management of reporting requirements). They also need to consider if registration procedures are needed to fulfil national obligations,
    c. Municipalities: They are mainly responsible for separate collection. The main changes coming into force as a result of the WEEE Directive are related to management of a new type of waste flow (particularly if no legislation on WEEE was present before the Directive was implemented), the increase in the amount of waste, reporting obligations and the potential need to register,
    d. Recyclers, refurbishers and treatment operators: The main changes resulting from the coming into force of the WEEE Directive are related to a management of a new type of waste flow (particularly if no legislation on WEEE was present before the

implementation of the Directive), the increasing flow of material, reporting obligations, registration procedures, and a BAT assessment,

e. Member states: They are mainly responsible for monitoring and control enforcement of legislative requirements (including tracking of free-riders), developing authorization procedures, and reporting performances of systems (separate collection, recovery and recycling percentages) to the Commission,
f. Associations: They are mainly responsible for providing services to their members (producers, retailers, recyclers etc.) which will assist them in meeting the compliance requirements.

2. Implementation of legislation: The late transposition of the Directive in Member States has lead to a general delay in the definition of activities that need to be carried out by different stakeholders,

3. Level of awareness: Some stakeholders, particularly SME's, may have a low level of awareness of the compliance requirements,

4. Needed infrastructures: The infrastructure needed to carry out the activities required both on the external side (e.g. National Registers of Producers) and the internal side (stakeholders need to develop their own infrastructures) may not be fully developed. SME's with limited resources may find it difficult to meet these administrative burdens.

A questionnaire for assessing the administrative burdens for stakeholders was designed in order to assess the impacts of compliance across the EU. It was distributed to a wide range of stakeholders: producers, compliance schemes, recyclers, municipalities and National Registers.

The questionnaire on administrative burdens (see Annex 6.2.1a) is structured as general information on the respondent and 6 modules (questions). The information obtained on the respondent includes an assessment of company size (micro, small, medium or large, according to EU definitions), the kind of company (Producer, Recycler, Refurbisher, Compliance Scheme, Association, etc.) and the categories covered (1 to 10).

The following 5 out of 6 modules (questions) are structured in the same way:

1. General questions (Q1 to Q5): Has one identified an administrative burden in carrying out the specific activity. There are four possible answers: two refer to the absence of a burden because the activity is not required or because no burden is experienced, and two refer to the presence of a burden either quantifiable or not:
   a. No, I don't have this activity to carry out,
   b. No, I don't feel any administrative burden in carrying out this activity,
   c. Yes, but I'm not able to specify or quantify the amount of burden, or
   d. Yes.

2. Optional listing of the main activities related to the obligation that are causing the burden (Q1a),

3. Assessment of whether in the stakeholders' opinion the activity is fundamental or not (Q1b, Yes or No),

4. Optional explanations about the response,

5. Assessment of whether the stakeholder has enough resources to carry out the requested activities (Q1c, Yes or No), and

6. Assessment of where resources are lacking (Q1d, money, time or infrastructures).

Questions 1 to 5 of the questionnaire refer to:

1. Has one identified an administrative burden in registering at a National Register (as a Producer, Collection Point, Compliance Scheme, etc)?
2. Has one identified an administrative burden in reporting the amount put on the market, take back performances, recycling targets?
3. Has one identified an administrative burden in informing the final users (incl. labelling) and recyclers?
4. Has one identified an administrative burden in monitoring & control enforcement?
5. Has one identified an administrative burden in setting up National Registers or Clearing Houses?

The final module (Q6) is structured in order to determine the percentage of employees in the company that are engaged in WEEE compliance activities.

National Registers Overview

Registers

A questionnaire has been sent to National Registers in order to obtain information on the basic requirements for producers to register, the reporting requirements, the costs to run a Register in different countries, and the total number of registered producers in each country.

The questionnaire (see Annex 6.2.1b) is structured as 3 different modules:

1. Register Set-Up, covering the following issues:
    a. Register of producers in place (name, organization, website),
    b. Employees needed to manage the Register (for confidentiality reasons, only an aggregated value has been reported), and
    c. Expenses to run the Register (for confidentiality reasons, only an aggregated value has been reported).
2. Registering Obligations, covering the following issues:
    a. Deadline for registering/annual renewal, registering fee/annual renewal,
    b. The legal requirements for registering, and
    c. Total number of registered producers.
3. Reporting Obligations, covering the following issues:
    a. Frequency of reporting (Annually, quarterly, monthly, etc.),
    b. Basis for reporting (weight, units, turnover, others, etc),
    c. Grouping of appliances, level of detail in reporting (1-10 categories, products, etc.), and
    d. Split household (B2C) versus non-household (B2B).

The questionnaire has been sent to all Member States where a National Register is currently in place (21 Member States out of 27).

6.2.1.2 Methodology Economic Impacts on All Stakeholders (Task 1.2.2.1)

Econ. Impacts

Different data sources were used in order to assess the economic impact of implementation of the WEEE Directive across the recycling chain and on different stakeholders. Questionnaires have been submitted to Associations of stakeholders at European Level (e.g. WEEE Forum, EERA, ERP) and single stakeholders (e.g. National Compliance Schemes) in order to close and fill data gaps in the existing material (BIO IS 2006) and team knowledge.

The analysis has been carried out on two different levels:

1. Compliance schemes level: collection, transportation, treatment and other additional and overhead costs have been gathered from different Compliance Schemes currently operating across Europe,
2. Recyclers level: total technical costs, including transport, treatment, revenues, R&D, disposal, have been gathered form Recyclers currently operating across Europe. In addition to the environmental data described in Chapter 6.2.2, the following economic parameters have been included in the following eco-efficiency analysis:

- Sorting, registering, transportation and buffer storage costs,
- Disassembly costs based on disassembly times for standard operations,
- Integral costs for shredding and separation,
- Costs and revenues at copper, ferrous and aluminium smelter processes (including penalties for certain materials),
- Costs at incineration sites, both Municipal Solid Waste (MSW) incineration and special waste incineration, also including penalties for key environmentally relevant materials. This also includes reference values in case products would have been disposed with MSW directly,
- Costs at landfill sites, including penalties for environmentally relevant elements occurring in disposed electronics,
- Costs for plastic recycling including cleaning, upgrading and colour sorting,
- Revenues paid for recovered materials, including changes in metal prices over time from 2001 – 2007 (which can be selected as yearly averages or as latest prices on a quarterly basis).

Conclusion

The main output from Task 1.1.2 is an overall quantification of costs and revenues along the recycling chain, including administrative burdens in monetary units, and a list of the reasons identified for the existing economic inefficiencies.

The quantification of the administrative burden in monetary units provides the basis for generating options for improvement and development of the Directive. Where possible, an EU wide overview of actual inefficiencies, related to the economic structure of the system, is defined.

6.2.2 Environmental Evaluation of the Implementation (Task 1.1.1)

Objective

The aim of this chapter is to provide a framework for the analysis of environmental impacts of WEEE take-back and recycling for all categories and products covered by the Directive for which the results are presented in Chapter 8.2. The key outcome is an overview of the environmental impacts of the WEEE Directive over time for all categories, products, processes and waste streams occurring as well as determination of the key environmental priorities.

Methodology

According to the terms of reference, the study is carried out by using an existing environmental assessment methodology dedicated to electronics recycling: the QWERTY/EE approach (Quotes for environmentally WEighted RecyclabiliTY and Eco-Efficiency) developed at TU Delft is a comprehensive and quantified methodology for addressing both environmental and economic impacts of electronics recycling. This methodology has been described extensively in scientific literature in (Huisman 2003a, b, c, 2004a, 2005b, c, 2006a). The overall method has been successfully applied over the last 7 years by all stakeholders involved in electronics take-back and recycling (Huisman 2004b,c, 2005a), and calculates the environmental impacts based on streamlined Life Cycle Assessment of products (Goedkoop 1999, Spriensma 2002), components or waste streams under different technological settings for various EU Member States. In the next sections, the methodology will be summarised shortly. For more details, please refer to (Huisman 2003a).

6.2.2.1 Methodology QWERTY

QWERTY

The Quotes for environmentally WEighted RecyclabiliTY are based on the comprehensive environmental and economic modelling of the end-of-life chain. The general idea is based on environmental and economic quantification of three values as displayed in Figure 5 (Huisman 2003a) and subsequent calculation of the distances between these three outcomes:

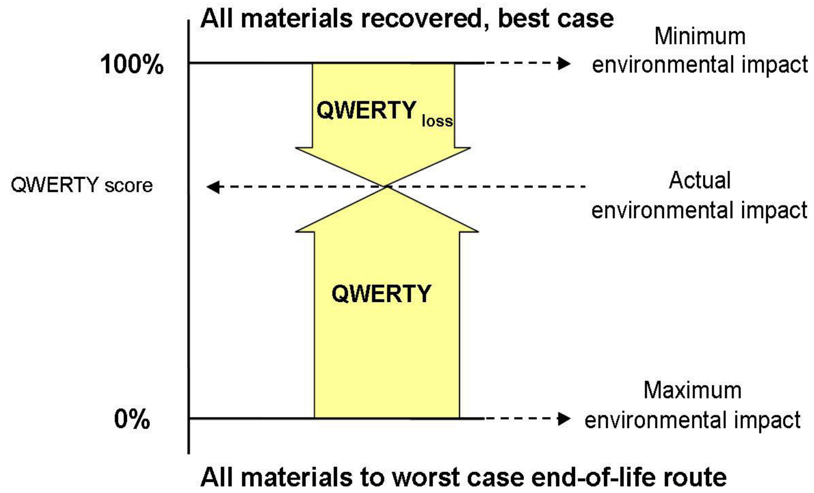

Figure 5: Calculating QWERTY values

Minimum Environmental Impact and Minimum Costs

These two values (environmental and economic) correspond with the theoretical scenario of ‘all materials being recovered completely without any environmental impact or economic costs of end-of-life treatment steps’. As such, they are representing the environmental and economic substitution values of primary materials that are the values for newly extracted and produced materials for 100%. Usually both are negative (avoided environmental impacts of new extraction and processing and revenues being negative costs). The values are strictly theoretical: in practice there will always be (environmental) costs connected to separation of materials, energy consumption and transport in order to realize recovery of materials.

Maximum Environmental Impact and Maximum Costs

These two values are defined as the theoretical scenario of 'every material ending up in the worst possible (realistic) end-of-life route', including the environmental burden plus (environmental) costs of pre-treatment: collection, transport, disassembly and shredding and separation into fractions. The 'realistic' end-of-life scenarios under consideration are controlled and uncontrolled landfill, incineration with or without energy recovery and all subsequent treatment steps for material fractions, like copper, ferrous and aluminium smelting, glass ovens and plastic recyclers. In addition this theoretical value cannot easily be exceeded except under extreme disposal conditions, which are normally forbidden by law.

Actual Environmental Impacts and Costs

These values are based on the actual environmental and economic performance of the end-of-life scenario under consideration and are compared with the two boundary conditions above and finally expressed as percentages or in absolute numbers. These actual values are obtained by tracking the behaviour of all materials over all end-of-life routes and by taking into account all costs and environmental effects connected to this. It includes all environmental impacts including recycling, fate of hazardous substances additional environmental burden of processing, transport and energy use, as well as all prevented environmental impacts (including toxicity) for recovered materials.

The values are calculated with an extensive set of MS Excel files modelling all relevant materials, components, processes, environmental, and economic values over the electronics recycling chain. These calculations will be further presented in detail in Chapter 6.2.2.3.

6.2.2.2 Methodology Eco-Efficiency

Eco-efficiency

When the environmental values and costs are combined in one eco-efficiency approach then it is possible to link environmental effectiveness with cost efficiency in order to determine what environmental improvements can be achieved for the amount of money invested.

Figure 6 shows the basic idea behind the eco-efficiency calculations of the QWERTY/EE approach. The Y-axis represents an economic indicator (in this case €) for the total costs along the recycling chain. The X-axis represents the environmental indicator (LCA scores in points from the Eco-Indicator'99). Different end-of-life scenarios for one and the same product, relative to a certain starting point (the origin in Figure 7) can be displayed as vectors in Figure 6. Such scenarios or options describe certain changes in end-of-life treatment or the application of certain technological improvements such as separate collection and treatment of cellular phones. In order to achieve higher eco-efficiencies, improvement options should lead to a change from the reference or starting point into the direction of the upper right part (point A). However, options with a direction towards the down-left part of Figure 6 should be avoided (higher costs and higher environmental impacts), because from the point of reference a lower eco-efficiency is realized (point B). The other two points C and D are leading to the same environmental improvement, but also to higher costs compared to the reference point. When point C and D are to be compared, one could say that in general direction C is more eco-efficient than direction D, because the same environmental improvement is realized with lower integral costs.

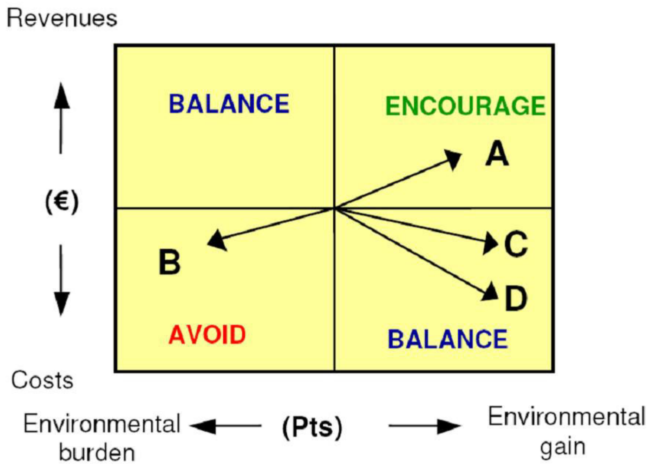

Figure 6: Example 2D Eco-efficiency graphs

Application of the eco-efficiency method to analyze take-back and recycling includes two important steps:

Step 1 is application of a 'vector approach' as described above. This means that in first instance the four quadrants are selected. When, for example, separate collection and treatment of cellular phones is applied and the resulting vector is directed to the first quadrant (for instance point A) of Figure 6, a so-called 'positive eco-efficiency' is realized, compared to the original situation (reference point). The opposite counts for the vector B. Options and directions is this case should be avoided from both an environmental as an economic point of view.

Step 2 includes calculation of environmental gain over costs ratios and ranking of the 'quotient' for the two 'balance' quadrants. This is when an environmental improvement (+) is realized and net costs (-) are needed to obtain this (or the opposite). In the case of multiple options appearing in the fourth quadrant, the 'quotient approach' can be applied to determine how much (absolute) environmental improvement (Points or other used for the relevant environmental impact category) is realized per amount of money invested (EUR) (In the second quadrant, higher revenues or lower costs are obtained against higher environmental impacts). When a certain option leading to a vector in the second quadrant is reversed, the result will appear in the fourth quadrant and can be treated similarly (by using the opposite point of the vector as reference or starting point).

6.2.2.3 Calculation Steps

Calculations

Compared to traditional product 'cradle to grave' focused LCA, the environmental impact assessment basically focuses on the 'grave to cradle' impacts of already discarded appliances. Therefore, the scope or starting point of the calculations is different and is basically ignoring previous life-cycle stages as the beginning of the calculations. The discarded products are taken as such and from the point of disposal they can end up as final waste respectively collected, treated and replacing primary materials as illustrated before with Figure 5. This starting point which differs from 'normal' LCA analysis (starting at raw material extraction) is depicted below.

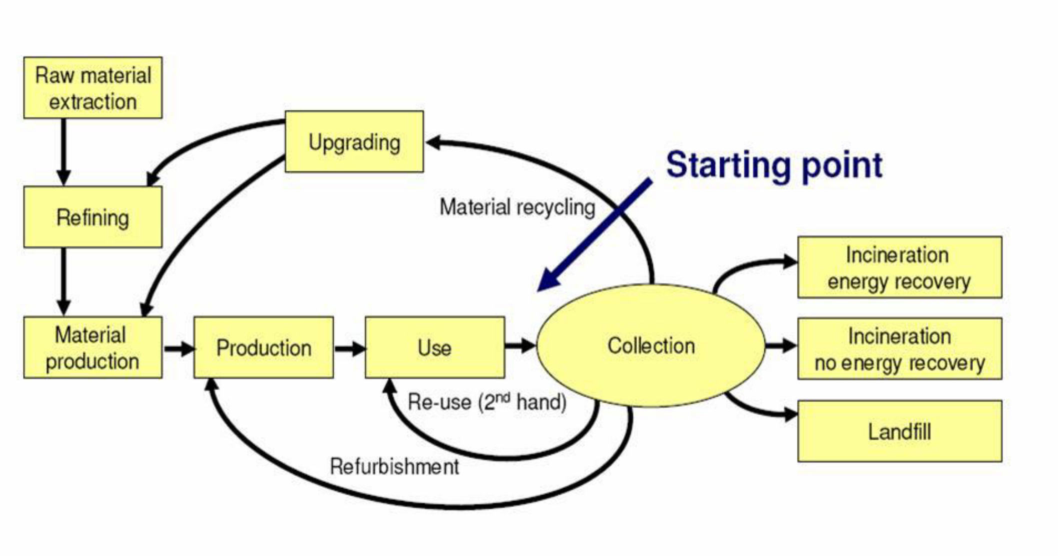

Figure 7: The recycling chain

For all further steps, the fate and inputs and outputs of all subsequent steps is calculated. This is slightly different compared to a 'regular' LCA: There is not one product taking as the functional unit for comparison and based on this, a linkage of all substance, emissions and energy streams to this functional unit, but the end-of-life chain itself is modelled and the average behaviour of products, components or complete waste streams within this system. This results in a far more comprehensive and detailed description of the waste streams and avoids making case-by-case assumptions for the specific end-of-life behaviour of individual products. This also limits the inaccuracy of assigning environmental and economic impacts to the relatively small product in larger streams. In Figure 8, the calculation steps and their sequence are displayed. These steps are specified in more detail in order to describe the assumptions and boundary conditions for the calculations in Chapter 8 as well as the general end-of-life chain data that is used.

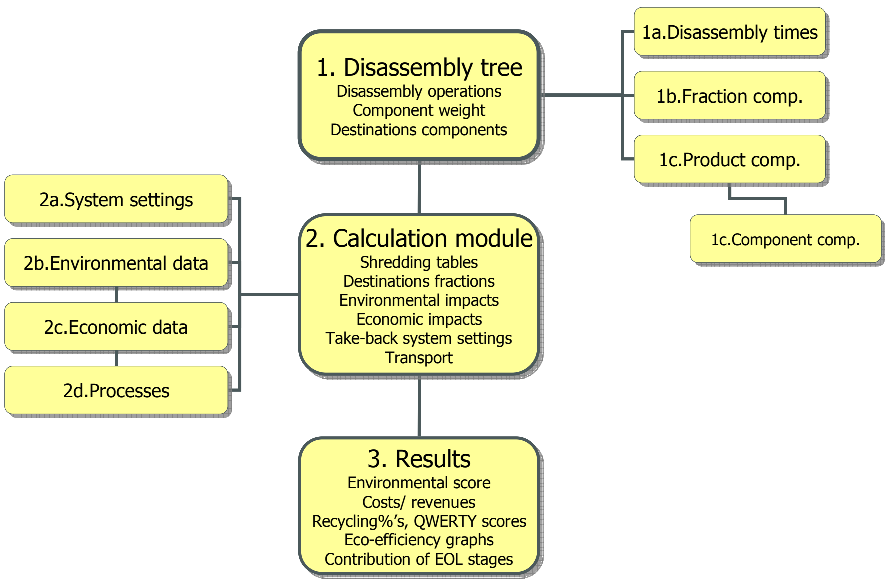

Figure 8: QWERTY/EE calculation sequence

The underlying calculations contain the following steps for the products, components or streams considered:

1. First of all, the composition and when relevant, the average disassembly steps and times needed are determined (1a). Data for the stream compositions can be obtained by calculating the compositions from the individual products or from sampling data, as they occur in practice, of these streams or from a combination of these. In Chapter 8, to derive representing category compositions, the average appliance weight and typical constitution representing the specific category is determined by combining sampling data in number of units and their weight found, with average stream compositions from literature and mass balances of recyclers and specific components compositions data (e.g. circuit boards),
2. Secondly, the average fate of the product or stream in terms of input and output materials destinations is determined in the central calculation module. For a given input it is determined what components or materials are dismantled and what part of the stream or average product is going into a specific destination or what is going through mechanical treatment. For the mechanical treatment, there are various distribution tables used reflecting the average fate of each substance (or group of substance) towards the various fractions concerned. Subsequently, the mass flow to each destination (e.g. a glass fraction going to recycling, upgrading or final disposal process) is multiplied with the corresponding environmental values either as single indicator or individual environmental impact categories in (2b). The same is done with the economic values, including market data per year and processing costs in (2c) for the relevant materials in these processes (2d). In addition, all auxiliary processes and steps are included in the system settings (2a). These describe and allocate the costs and transport steps, routes and final destinations during the various stages in the end-of-life chain,
3. In this way, overall data resulting in environmental and economic results (3) are presented. The result file shows all relative contributions in terms of environmental values of processes and substances per chosen environmental impact category. It also shows the influence of the chosen economic settings per year and the calculated weight based recycling percentages under various definitions. Furthermore, the QWERTY scores plus the aggregation of various scenarios into eco-efficiency graphs is finally obtained.

6.2.2.4 Data Used in Calculation Steps

General Data

The data used for these calculation steps as discussed above is presented in Annex 6.2.2:

1. The data available for step 1c can be found in Annex 6.2.2a. The compositions data include all main components and substances used. In Chapter 8.0.3, the main compositions per WEEE category as well as the most important data on Annex II components and materials present in average printed circuit board compositions is listed (not in Annex 6.2.2). The main data sources are also described in Chapter 8.0.3, whereas the table below specifies the elements or materials described in general.

Materials included			
Fe (in components)	Co	PC	Glass (white)
Magnetic steel	Cr	PE (HD)	Glass (LCD)
Stainless steel	Hg	PE (LD)	Other/ inerts

Materials included			
Steel low alloyed	Li	PET	Felt
Cu	Mn	PMMA	Paper
Ag	Ni	PP	Wood
Au	Pb	PS (HI)	Flame retardants
Pd	Sb	PUR (polyurethane)	PCB
Al (general)	Sn	PVC	Liquid Crystals
Al cast	Zn	Rubber (EPDM)	Oil (fridges)
Al wrought	Plastics general	Ceramics	Cyclopentane
Mg	Plastics FR	CRT rim (PbO)	Br
As	ABS	CRT-glass complete	Cl
Be	ABS/PC	CRT-glass cone	Isobutane
Bi	Epoxy	CRT-glass screen	CFC11
Cd	Other plastics	Fluorescent powder	CFC12

Table 2: Materials included in the calculations

2. Data regarding the disassembly times (step 1a of Figure 8), this data is also presented in Chapter 8.2, where the various dismantling scenarios per category are presented,

3. The system settings (per compliance scheme and per country setting) are presented in Annex 6.2.2b (step 2a of Figure 8). This includes also the transport distances covered and methods of transport to collection and treatment steps. The economic settings for operational systems are discussed in Chapter 8.1.,

4. The data on the environmental assessment models used are found in the SIMAPRO 7 LCA software (Pre 2007a), including the Eco-invent database (Frischknegt, 2004). In this study, both single indicators are used from the Eco-Indicator'99 methodology (Goedkoop et. al., 2000) as well as the Cumulative Energy Demand (CED) (Frischknegt, 2004). Also the individual environmental impact categories from CML2 (CML 2004) are considered. These methods are displayed in the next table. The units are described below (see step 2b of Figure 8),

Indicator:	Unit	Description	Method
Eco-indicator 99 H/A v203	Pt	Points	Eco-indicator 99 (Pre, 2007)
Idem, Human Health	Pt	Points	Eco-indicator 99 (Pre, 2007)
Idem, Ecosystem Quality	Pt	Points	Eco-indicator 99 (Pre, 2007)
Idem, Resource Depletion	Pt	Points	Eco-indicator 99 (Pre, 2007)
CEDv103	MJ-eq	MJ equivalent	CEDv103 (Pre, 2007)
Abiotic depletion	kg Sb eq	kg antimony equivalent	CML2 v203 (CML 2004)
Global warming (GWP100)	kg CO2 eq	kg CO2 equivalent	CML2 v203 (CML 2004)
Ozone layer depletion (ODP)	kg CFC-11 eq	kg CFC11 equivalent	CML2 v203 (CML 2004)
Human toxicity	kg 1,4-DB eq	kg kg 1,4-dichlorobenzene eq.	CML2 v203 (CML 2004)
Fresh water aquatic ecotox.	kg 1,4-DB eq	Idem	CML2 v203 (CML 2004)
Marine aquatic ecotoxicity	kg 1,4-DB eq	Idem	CML2 v203 (CML 2004)
Terrestrial ecotoxicity	kg 1,4-DB eq	Idem	CML2 v203 (CML 2004)
Photochemical oxidation	kg C2H4	kg ethylene equivalent	CML2 v203 (CML 2004)
Acidification	kg SO2 eq	kg SO2 equivalent	CML2 v203 (CML 2004)
Eutrophication	kg PO4--- eq	kg PO4--- equivalent	CML2 v203 (CML 2004)

Table 3: Environmental impact categories

The calculations are based on Life-Cycle Inventory data for all main substances mentioned above as primary production values as well as main auxiliary substances and processes like energy consumption and ways of transport. All inventory data used is listed in Annex 6.2.2c and can be found in SIMAPRO 7 software and the Eco-Invent database. Almost all data used is publicly available. Only for a small number of substances, particularly those used in electronics, have specific inventories been used. This is also listed in Annex 6.2.2c,

5. The economic data used for recovered materials are specified in the table below (step 2c of Figure 8) for the years 2005 - 2007. The processing costs are further discussed in Chapter 8.1,

Material prices	**2007**	**2006**	**2005**	**Material prices**	**2007**	**2006**	**2005**
Fe (in components)	€0.22	€0.22	€0.15	Zn	€1.49	€2.42	€1.13
Magnetic steel	€3.96	€2.90	€2.32	Plastics general	€0.40	€0.40	€0.40
Stainless steel	€3.96	€2.90	€2.32	Plastics FR	€1.37	€1.37	€1.37
Steel low alloyed	€0.22	€0.22	€0.15	ABS	€1.54	€1.73	€1.46
Cu	€4.02	€5.34	€3.04	ABS/PC	€2.84	€1.83	€1.72
Ag	€326	€283	€193	Other plastics	€0.30	€0.30	€0.30
Au	€15,721	€15,388	€11,753	PC	€2.72	€2.85	€2.85
Pd	€7,990	€8,324	€5,364	PE (HD)	€1.07	€1.18	€1.07
Al (general)	€2.06	€1.80	€1.64	PE (LD)	€1.23	€0.97	€1.18
Al cast	€2.06	€1.80	€1.64	PET	€0.66	€0.78	€0.78
Al wrought	€2.06	€2.02	€1.56	PMMA	€2.92	€3.05	€3.05
Mg	€1.58	€1.57	€1.56	PP	€1.30	€1.14	€1.01
As	€10.40	€1.64	€1.52	PS (HI)	€1.17	€1.32	€1.24
Be	€259.4	€207.6	€275.6	PUR (polyurethane)	€3.50	€3.66	€3.66
Bi	€15.40	€3.89	€5.34	PVC	€1.25	€1.30	€1.30
Cd	€2.83	€2.20	€1.03	Rubber (EPDM)	€7.29	€7.63	€7.63
Co	€20.22	€27.50	€42.20	Ceramics	€0.04	€0.04	€0.04
Cr	€2.11	€3.46	€4.20	CRT rim (PbO)	€0.40	€0.40	€0.40
Hg	€11.31	€14.80	€7.93	CRT-glass complete	€0.30	€0.30	€0.30
Li	€0.66	€0.71	€3.49	CRT-glass cone	€0.30	€0.30	€0.30
Mn	€2.63	€2.83	€2.18	CRT-glass screen	€0.35	€0.35	€0.35
Ni	€27.97	€18.73	€12.08	Glass (white)	€0.05	€0.05	€0.05
Pb	€1.25	€0.99	€0.80	Glass (LCD)	€0.05	€0.05	€0.05
Sb	€3.90	€3.89	€2.19	Br	€0.55	€0.55	€0.55
Sn	€9.34	€6.26	€6.04	Isobutaan	€0.10	€0.10	€0.10

Table 4: Material prices 2005 – 2007

6. The secondary processes included are described in the table below. All relevant technical details for each process are included in Annex 6.2.2d.

Destination/process	**Remarks**	**Background data (amongst others)**
Direct replacement	Direct use as original material, without other steps	Primary material extraction data
Environment	Direct emission (to air, water or soil)	Environmental impacts of emissions
Incineration –e	With MSW without energy	(Huisman 2003a, ANSEMS 2002a,b)

Destination/process	Remarks	Background data (amongst others)
	recovery	
Incineration + e	With MSW with energy recovery	(Huisman 2003a, ANSEMS 2002a,b)
Landfill controlled	No leaching	(Huisman 2003a, ANSEMS 2002a,b)
Landfill uncontrolled	Leaching of heavy metals included	(Huisman 2003a, ANSEMS 2002a,b)
Cement Killn	Including energy recovery value	(Huisman 2003a, ANSEMS 2002a,b, VDZ, 2001)
Building Industry	For inerts replacement of sand	(Huisman 2003, 2004c, 2005a, Goris 2004)
Ceramic Industry	For leaded glass, replacement of feldspar	(Huisman 2003, 2004c, 2005a, Goris 2004)
Battery recycling general	For average mix of NiCd, NiMH, Li-ion, alkaline)	(RECHARGE 2006, Harant 2002)
Cu smelter	Heating values all reductants included	(Huisman 2003a, 2004b, VERHOEF 2004, HEUKELOM 2005, Hageluken 2006)
Al smelter	No difference between wrought, cast and mixed	(Huisman 2003a, ANSEMS 2002a,b)
Ferro smelter	All emissions included	(Huisman 2003a, ANSEMS 2002a,b)
Glass recycling (mixed)	Mixed CRT glass to cone glass production	(Huisman 2003, 2004c, 2005a, Goris 2004)
Plastic Recycler	Recovery percentages and grade/ reapplication incl.	(Huisman 2003a, WRAP 2005a,b,2006a, MARK 2006, WOLLNY 2000)
Battery rec. Alkaline	Rec.% for Fe, Cu, Cd, Co, Mn, Ni, Zn incl.	(RECHARGE 2006, Harant 2002)
Battery rec. Li-ion	Rec.% for Fe, Cu, Cd, Co, Mn, Ni, Zn incl.	(RECHARGE 2006, Harant 2002)
Battery rec. Li-polymer	Rec.% for Fe, Cu, Cd, Co, Mn, Ni, Zn incl.	(RECHARGE 2006, Harant 2002)
Battery rec. NiCd	Rec.% for Fe, Cu, Cd, Co, Mn, Ni, Zn incl.	(RECHARGE 2006, Harant 2002)
Battery rec. NiMH	Rec.% for Fe, Cu, Cd, Co, Mn, Ni, Zn incl.	(RECHARGE 2006, Harant 2002)
CFC cracking	Full destruction of CFCs and energy recovery	(Huisman 2003a, NVMP 2005)
Compressor/ motor recycling	Manual split of copper and ferro combinations	(Huisman 2003a)
Cone glass recycling	Cone to cone glass recycling	(Huisman 2003, 2004c, 2005a, Goris 2004)
Fluorescent lamp recycling	High mercury removal efficiency	(ELC 2006)
Glass recycling (white)	Plain glass to plain glass recycling	(Huisman 2003a)
Hazardous waste incineration	See MSW incineration, lower air emissions	(Huisman 2003a, ANSEMS 2002a,b)
Hazardous waste landfill	See MSW landfill, no leaching to soil	(Huisman 2003a, ANSEMS 2002a,b)
Screen glass recycling	Screen to screen recycling	(Huisman 2003, 2004c, 2005a, Goris 2004)
Secondary Cu Pb Sn smelter	All reductants, emissions and leaching included	(Goris 2004, Huisman 2003a, 2004c, 2005a)

Table 5: Estimated weight of equipment in Category 1

Conclusions

The complete impact assessment methodology allows the environmental (including evaluation under all individual environmental impact categories) and economic determination of:

1. The impacts of activities of single stakeholders (recyclers, system operators, governments and secondary material processors) and individual stages in the end-of-life chain (collection, pre-treatment, shredding, separation, dismantling, upgrading, metal smelting, glass recycling, plastic recycling, etc.) on the total end-of-life chain. As well as potential scenarios demonstrating changes or differences in the configurations applied,
2. The consequences for system organization. This includes visualization of the influence of logistics, economies of scale, the environmental and economic effect of changing collection rates, the role of enforcement, etc.,
3. Optimization of how, from an environmental perspective, recyclers and secondary material processors and final waste processors can work towards optimal environmental and economic performance. This is achieved by quantifying the answer to "Which materials should (ideally) end up in which fractions to be treated by which secondary material processors". This also forms the basis for reviewing various incentives to improve WEEE recycling processes.

The above methodology is not a new environmental impact assessment method. It is commonly used during Life-Cycle Inventories and Life-Cycle Impact Assessment characterisations, but this method allows more detailed analysis by precising all mass flows and impacts for WEEE specifically. It is based on the best-available data for WEEE processing and reduces the influence of sweeping assumptions on products and processes entering the electronics recycling chain.

6.2.3 Social Screening (Evaluation) of the Implementation (Task 1.1.3)

Social

The review of the EU Sustainable Development Strategy (SDS), together with contributions from the Council, the European Parliament, the European Economic and Social Committee and others, has resulted in the European Council adopting a renewed SDS for an enlarged EU in June 2006 that builds on the previous SDS adopted in 2001. This strategy together with the Lisbon Strategy recognises that economic, social and environmental objectives can reinforce each other and they should therefore advance together, especially for growth and jobs.

The EU SDS sets out an approach to better policy-making based on both better regulation and the principle that sustainable development will be integrated into policy-making at all levels. In this respect all EU institutions should ensure that major policy decisions are based on proposals that have undergone high quality Impact Assessment (IA), assessing in a balanced way the social, environmental and economic dimensions of sustainable development and taking into account the external dimension of sustainable development and the costs of inaction (Council of the European Union 2006). Consequently the Review of the Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE) also has to assess the social impacts resulting from its implementation.

Social impacts are commonly defined as

"…the consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society." (ICGPSIA 1994)

Objective

The objective of Task 1.1.3 is to collect, review and analyse available information on the social impacts resulting from the implementation of the WEEE Directive in order to provide the content and starting point for a more thorough Impact Assessment. This needs to consider the impacts of the Directive on the day-to-day quality of life of individuals and communities. Consequently, the aim is to provide a systematic examination of the social impacts of the WEEE Directive in order to identify any unwanted attributes.

The aim of this screening and summary study is to provide, as far as possible, clear information on the social impacts that can then be used as a basis for the development of options. Although some information is available (from earlier studies) on the social aspects, this study illustrates the obvious data gaps that are considered as elementary for the intended impact assessment. Knowledge of these is important to decide on how to best predict social consequences, both intended and unintended, for a comparative assessment of the developed options.

In accordance with the European Commission Impact Assessment Guidelines of 2005 this screening and summary study concentrates predominately but not exclusively on:

1. Employment and Labour Market,
2. Health and Safety Standards,
3. Social Environment including Training/Capacity Building and Awareness Rising,
4. Changes of Behaviour,
5. Digital Divide.

Methodology

Social screenings and social impact assessments (SIA) draw on sociology, anthropology, demography, economics, environmental planning, political science, urban planning and regional planning. Hence the necessary methodological approach is multidisciplinary. The range of possible social impacts that might result from the implementation of the WEEE Directive is equally multidisciplinary.

Given that social impacts are in most cases intangible, hard to measure and non-reducible to quantitative indicators, a commonly agreed theoretical foundation for the proper evaluation of social impacts of environmental policies is still lacking. Many approaches are strongly oriented toward the normative element of the sustainability model and to support certain political interests.

Although analytically oriented or theory driven concepts are still rare, a point of access for the purpose of this task is the European Commission Impact Assessment Guidelines. They identify nine impact areas and resulting key-questions for a SIA, which also have relevance for the evaluation of social impacts of the WEEE Directive:

- Employment and labour markets,

- Standards and rights related to job quality,
- Social inclusion and protection of particular groups,
- Equality of treatment and opportunities, non –discrimination,
- Private and family life, personal data,
- Governance, participation, good administration, access to justice, media and ethics,
- Public health and safety,
- Crime, terrorism and security,
- Access to and effects on social protection, health and educational systems.

This sub-task on the social impacts of the WEEE Directive's implementation has been carried out by systematically gathering existing and available knowledge. In addition, published scientific literature, primary data (stakeholder interviews) and secondary sources (statistics, relevant agency publications, routine data collected by states, the files of local newspapers etc) have been reviewed. These secondary sources have been used in conjunction with the findings from stakeholder interviews to identify any potential sources of bias in the data.

Conclusion

The social impact assessment complements our initial overview of the impacts of the national WEEE implementation and thus contributes to the initial recommendations on potential changes to the Directive. This includes a list of information gaps and the need for developing appropriate criteria for (i) assessing the qualitative dimensions for a thorough assessment and (ii) linking the qualitative and quantitative dimensions.

The social part of the framework gives additional insights into how the WEEE Directive's societal goals can be achieved.
In this task, as in all others, the results are based on existing data. The main focus is on EU Member States, while the accession/candidate states are covered to the extent that it is feasible to do so.

7 ANALYSIS TASK 1: WEEE AMOUNTS AND TECHNOLOGIES

7.1 Quantities Put on the Market (Task 1.2.1)

Data Gathered

7.1.1 Category 1 - Large Household Appliances

LHHA

This category covers the following main types of appliances:

- Refrigerators and freezers,
- Washing machines,
- Dishwashers,
- Clothes dryers,
- Electric cookers, ovens and hobs,
- Microwaves,
- Electric heating appliances,
- Electric fans,
- Air conditioning units.

Refrigerators and Freezers, Washing Machines, Dishwashers and Clothes Dryers

Table 6 shows the sales of these items, as determined by the EUP study group (EUP 2007a) in the EU15 Member States in 2005. The total sales of these four types of equipment were over 41.5 million items.

Country	Refrigerators & Freezers	Washing machines	Dishwashers	Dryers
Austria	378	246	173	68
Belgium	537	315	180	230
Germany	3,774	2,599	1,803	944
Denmark	352	223	172	116
Greece	410	240	180	130
Spain	720	660	285	85
Finland	330	200	140	35
France	3,100	2,350	1,166	585
Ireland	180	110	40	60
Italy	2,825	1,860	988	125
Luxembourg	no data	no data	no data	no data

Country	Refrigerators & Freezers	Washing machines	Dishwashers	Dryers
The Netherlands	873	601	324	322
Portugal	382	322	153	47
Sweden	890	360	250	200
UK	3,691	2,220	965	1,040
Total EU15	**18,442**	**12,306**	**6,819**	**3,987**

Table 6: Sales of cold and wet appliances in the EU15 in 2005 ('000 units)

Refrigerators represent about 75% of the total number of refrigerators and freezers in this category. This suggests that the data for refrigerators includes sales of combination fridge/freezers.

Table 7 compares these figures with those reported by "Appliance Magazine" (Appliance Magazine 2006). This shows that the total sales for these 4 groups of items reported by Appliance Magazine in 2005 were 3.2 million items higher (at 44.7 million) than those determined in the EUP study (it should be noted that the EUP study states that the data in Table 6 for Austria, Germany, Finland and Portugal are those published in Appliance Magazine).

	EUP survey	Appliance Magazine
Refrigerators & Freezers	18.4	18.8
Washing machines	12.3	14.3
Dishwashers	6.8	7.2
Dryers	4.0	4.4
Total EU15	**41.5**	**44.7**

Table 7: Comparison of sales data (million items) in EU15 Member States

The average of the two sets of data for sales of each item was used to determine the total weight of items put on to the market.

Electric Cookers, Ovens and Hobs

Table 8 shows the sales (Appliance Magazine, 2006) of these items in the EU15 in 2005. The total number of items sold was 17.4 million.

	Cook tops (Hobs)	Cookers	Ovens (built-in)	Total
Austria	145	27	143	315
Belgium	168	48	96	312
Denmark	77	100	76	253
Finland	30	125	30	185
France	1,308	780	746	2,834
Germany	1,672	286	1,632	3,590
Greece	74	163	73	310
Ireland	60	60	100	220
Italy	1,031	358	985	2,374
Luxembourg	no data	no data	no data	no data
The Netherlands	191	87	82	360
Portugal	188	84	153	425

	Cook tops (Hobs)	Cookers	Ovens (built-in)	Total
Spain	1,453	165	1,114	2,732
Sweden	78	214	75	367
UK	957	1,172	1,038	3,167
Total EU15	**7,432**	**3,669**	**6,343**	**17,444**

Table 8: Sales of electric cookers ('000 units) in the EU15 in 2005

Microwaves

Data provided by GIFAM (GIFAM, 2006) shows that the sales of microwaves in France have risen from 1.59 million in 2000 to 1.93 million in 2005. The sales of 1.93 million microwaves in France in 2005 are equivalent (scaled-up using GDP data) to sales of 11.5 million in the EU15 Member States and 12.2 million in the EU27 Member States.

Electric Heating Appliances, Fans and Air Conditioning Units

Some data on sales in individual member States were identified; for example, sales of air conditioning units in Italy. However, as sales of these items are likely to be influenced by the climate in each Member State, no estimate for sales in the EU27 was made for any of these items.

Weight Arisings

Table 9 shows that an estimated total of 76.6 million items in category 1 (excluding heating and air conditioning appliances) were placed onto the market in the EU27 Member States in 2005. This represents a weight put on market of 3.0 million tonnes.

	Items put onto market in 2005 (million)		Weight per unit (kg)	Weight put onto market ('000 tonnes)
	EU15	EU27		
Refrigerators & Freezers	18.6	19.8	35	693
Washing machines	13.3	14.1	65	920
Dishwashers	7.0	7.4	50	372
Dryers	4.2	4.5	35	156
Hobs	7.4	7.9	25	197
Cookers	3.7	3.9	60	236
Ovens	6.3	6.7	40	268
Microwaves	11.5	12.2	15	184
Heating appliances	no data	No data	-	no data
Air conditioning appliances	no data	No data	-	no data
Total	**72.0**	**76.6**		**3,026**

Table 9: Estimated weight of equipment in Category 1

Table 10 compares this estimate with data supplied[1] by the national registries in Spain (SPAIN REGISTER 2006), Hungary (HUNGARY REGISTER 2006), Finland (FINLAND REGISTER 2006) and UK (UK REGISTER 2007). This shows that these estimates for the EU27 (scaled up

[1] Data were also provided by Estonia, Lithuania, Slovakia and Slovenia. However, as the total GDP of these four Member States is less than 1% of the GDP of the overall EU27 Member States, the data has not been included in this or subsequent tables).

using GDP data), particularly those determined from the data for Hungary and Spain, are significantly higher than those estimated from sales of appliances (3.03 million tonnes). The data for Hungary and Spain also shows that 96% of items put on the market in this category are classified as household items.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	477	14	491	6.29
Hungary	43	2	45	5.48
Finland	-	-	58	4.14
UK	799	-	799	4.68

Table 10: Other estimates for EEE in Category 1

7.1.2 Category 2 - Small Household Appliances

SHHA

This category covers the following main types of appliances:

- Vacuum cleaners,
- Carpet sweepers,
- Other appliances for cleaning,
- Appliances used for sewing, knitting, weaving and other processing for textiles,
- Irons and other appliances for ironing, mangling and other care of clothing,
- Toasters,
- Fryers,
- Grinders, coffee machines and equipment for opening or sealing containers or packages,
- Electric knives,
- Appliances for hair-cutting, hair drying, tooth brushing, shaving, massage and other body care appliances,
- Clocks, watches and equipment for the purpose of measuring, indicating or registering time,
- Scales.

Vacuum Cleaners

The EUP preparatory studies report (VHK 2005) estimates that sales of vacuum cleaners in the EU25 Member States were 22 million in 2003. Data based on sales in France (GIFAM 2006) suggest that the sales of vacuum cleaners were 18 million in 2005. These figures suggest that total sales of vacuum cleaners are likely to average about 20 million units per year.

The typical weight of a vacuum cleaner is 10 kg. Consequently, the total weight of vacuum cleaners (based on sales of 20 million units) put onto the market in 2005 is estimated to be 200,000 tonnes.

Other Items

No data on the sales of the other items in this category in the EU Member States were identified. A survey conducted in the UK in 2006 (EST 2006) on planned purchases found that, for example, 2.5 million households planned to purchase an electric kettle during the next 12 months; all of the findings, which include information on other EEE categories, is shown in Table 11. It is also estimated that up to 20 million clocks and watches are sold each year in the UK.

Category	Equipment	Million items
1	Microwaves	2.5
2	Electric kettle	2.5
2	Hairdryer/styler	2.0
2	Steam iron	2.0
2	Vacuum cleaner	2.0
2	Mobile phones	5.0
2	Bread maker	1.0
2	Coffee machine	1.0
2	Electric shaver	1.0
2	Electric toothbrush	1.0
2	Food processor	1.0
2	Juice machine	1.0
2	Electric blanket	0.5
2	Ice-cream maker	0.5
2	Mains powered water feature	0.5
3	Cordless telephone	2.5
3	Scanner/fax	0.5
4	Digital radio	1.5
4	Televisions	4.5
4	DVD player/recorder	2.5
4	MP3 Player	2.5
4	Printer	1.5
4	Mini-Hi fi system	1.5
4	Set-top box	1.0
4	Video camera	1.0
6	Electric lawnmower	1.0
6	Power tools	2.0
6	Garden strimmer	1.0
7	Play station/games console	1.5

Table 11: Planned purchases in the UK in 2006/07

Weight Arisings

The lack of sales data for nearly all items in this category means that it is not possible to use sales data to estimate the weight of material in this category that is put onto the market in the EU27 Member States. Table 12 presents the data supplied by the national registries in Spain, Hungary, Finland and the UK.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	50	1	51	0.65
Hungary	6	<1	6	0.75
Finland	-	-	9	0.64
UK	168	-	168	0.98

Table 12: Estimates for weight of Category 2

7.1.3 Category 3 - IT and Telecommunications Equipment

IT

This category covers the following types of appliances:

- Computers (desktop and laptop),
- Printers,
- Copying equipment,
- Facsimile equipment,
- Telephones (fixed and mobile), including answering equipment,
- Calculators.

Computers

The EUP study on computers (EUP 2006a) estimated the sales of computers in the EU25 from 2000 to 2008. These estimates are presented in Table 13, and show that flat panel (LCD) monitors will completely replace cathode ray tube (CRT) displays by 2008, and that the sales of laptop computers will increase by 50% between 2005 and 2008.

Year	Desktops	Laptops	Cathode ray monitors	Flat panel monitors
2000	24	6	24	0
2001	22	7	20	2
2002	22	8	17	5
2003	24	11	10	15
2004	26	15	6	20
2005	28	20	4	26
2006	28	23	2	32
2007	29	28	0	36
2008	30	31	0	38

Table 13: Sales (millions) of computers in the EU25 Member States

Table 15 shows the estimated weight arisings (calculated from the sales information shown in Table 13 and the typical weight per item shown in Table 14) for computers in the EU25 Member States. The estimated arisings in 2005 were 0.78 million tonnes.

	Weight (kg)		Weight (kg)
Desktop	20	CRT-monitor	16
Lap-top	2.5	Flat panel monitor	4

Table 14: Typical weights for computer equipment

Year	Desktops	Laptops	Cathode ray monitors	Flat panel monitors	Total screens	Totals
2000	480,000	15,000	384,000	0	384,000	**879,000**
2001	440,000	16,250	320,000	8,000	328,000	**784,250**
2002	440,000	20,000	272,000	20,000	292,000	**752,000**
2003	480,000	27,500	160,000	60,000	220,000	**727,500**
2004	520,000	37,500	96,000	80,000	176,000	**733,500**
2005	560,000	50,000	64,000	104,000	168,000	**778,000**
2006	560,000	57,500	32,000	128,000	160,000	**777,500**
2007	580,000	70,000	0	144,000	144,000	**794,000**
2008	600,000	77,500	0	152,000	152,000	**829,500**

Table 15: Weight arisings (tonnes) for computer equipment in the EU25 Member States

Printers, Copying Equipment and Facsimile Equipment

The EUP study on printing and copying equipment (EUP 2007b) estimated the sales of these items in the EU25 from 2004 to 2008. These estimates are presented in Table 16. Most of the sales of inkjet printers and MFDs (multi-function devices) are to home users.

Number ('000 units)	2004	2005	2006	2007	2008
B&W laser printers	3,754	3,682	3,714	3,695	3,709
Colour laser printers	669	834	873	977	1,019
B&W copiers	1,019	1,080	1,040	1,010	950
Colour copiers	137	143	163	172	179
Inkjet printers & MFDs	21,802	22,437	22,715	23,087	23,356
Large scanner	90	110	210	300	400
Total EU25	**27,471**	**28,286**	**28,715**	**29,241**	**29,613**

Table 16: Sales of printing and copying equipment in the EU25 Member States

Table 18 shows the estimated weight arisings (calculated from the sales information shown in Table 16 and the typical weight per item shown in Table 17) for printing and copying equipment in the EU25 Member States. The estimated arisings in 2005 were 0.26 million tonnes.

Item	Typical weight (kg)
Black and white laser printer	7-20 (15 assumed as most are used in offices)
Colour laser printer	15-40 (30 assumed as most are used in offices)
Black and white copier	50
Colour copier	100
Inkjet printer (includes multi-function devices)	5
Facsimile machine	5

Table 17: Typical weights for printing and copying equipment

Weight (tonnes)	2004	2005	2006	2007	2008
B&W laser printers	56,310	55,230	55,710	55,425	55,635
Colour laser printers	20,070	25,020	26,190	29,310	30,570
B&W copiers	50,950	54,000	52,000	50,500	47,500
Colour copiers	13,700	14,300	16,300	17,200	17,900
Inkjet printers & MFDs	109,010	112,185	113,575	115,435	116,780
Large scanner	2,700	3,300	6,300	9,000	12,000
Total EU25	**252,740**	**264,035**	**270,075**	**276,870**	**280,385**

Table 18: Weight (tonnes) for printing and copying equipment in the EU25 Member States

The sales of facsimile machines (EUP 2007b) were 3.46 million in 2005. This represents a weight of about 17,300 tonnes. Consequently the total weight of printing and copying equipment put onto the market in 2005 is estimated as 0.28 million tonnes.

Telephones

No data on the sales of fixed telephones and answering machines were identified, but a survey of households conducted in the UK in 2006 to identify planned purchases (see Table 11) found that 2.5 million households planned to purchase a cordless telephone in the next 12 months (and that 5 million households planned to purchase a mobile telephone in the next 12 months). The EUP study on standby (EUP 2007c) identified that the total stock of cordless telephones in the EU25 Member States in 2005 was 180 million units.

No data on sales of mobile telephones in the EU25 were identified. One estimate (3G 2005) was that mobile phone sales in Western Europe were 37.4 million units in one 3 month period in 2005, which was a 9.9 percent increase from the same time last year. This would equate to sales of about 160 to 170 million mobile phones in the EU27 Member States during 2005.

The typical weight of a mobile telephone, including the charger unit, is 0.25 kg (0.1 kg for the phone and 0.15 kg for the charger unit). Consequently, the total weight of mobile telephones (including charger units) placed onto the market in the EU27 Member States in 2005 was about 40,000 tonnes.

Calculators

No data on the sales of calculators were identified.

Weight Arisings

Table 19 shows that an estimated total of 266 million items in category 3 (excluding fixed telephones and calculators) were placed onto the market in the EU27 Member States in 2005. This represents a weight arising of about 1.1 million tonnes.

	Number of items (million)	Weight ('000 tonnes)
Computers	78	778
Printers and copying equipment	28	264
Fixed telephones	no data	no data
Mobile telephones	160	40
Calculators	no data	no data
Total EU 27	**266**	**1082**

Table 19: Estimated weight for category 3

Table 20 shows the weight of IT equipment placed on the market in each EU27 Member State (excluding Malta and Cyprus) calculated using data on sales provided by EITO (EITO 2006) and the typical weights of equipment shown in Table 14 and Table 17). The total weight of 1.15 million tonnes is comparable with the 1.08 million tonnes shown in Table 19.

Country	2003	2004	2005	2006	2007
Austria	15,447	16,924	18,384	19,039	19,738
Belgium/Luxembourg	19,487	21,928	24,235	25,693	27,490
Denmark	17,930	19,165	20,978	20,878	19,852
Finland	12,373	13,872	15,661	16,015	16,291
France	119,831	137,949	153,179	161,780	168,048
Germany	193,721	208,072	218,644	223,612	228,264
Greece	8,811	10,024	10,843	11,700	12,591
Ireland	8,729	10,110	11,574	12,424	13,094
Italy	90,074	100,283	108,363	114,503	119,992
Netherlands	36,186	39,593	44,665	47,990	49,681
Portugal	11,931	13,795	15,746	16,832	17,773
Spain	44,762	51,847	55,930	59,447	61,898
Sweden	24,066	24,808	29,644	29,644	29,138
UK	163,741	184,095	197,497	210,389	220,653
EU15	**767,087**	**852,464**	**925,342**	**969,946**	**1,004,503**
Bulgaria	2,946	3,712	5,400	5,202	5,930
Czech Republic	13,321	15,515	17,891	19,423	20,813
Estonia	1,917	2,557	2,944	3,070	3,286
Hungary	10,410	11,990	13,260	14,578	15,894
Latvia	1,937	2,252	2,645	2,893	3,166
Lithuania	2,768	3,428	4,118	4,655	5,017
Poland	34,898	39,693	49,009	55,887	59,276
Romania	8,627	12,198	16,818	18,612	21,470
Slovakia	4,662	6,028	6,478	7,291	8,057
Slovenia	3,502	4,325	4,646	4,949	5,183
EU27 less Malta & Cyprus	**852,075**	**954,163**	**1,048,551**	**1,106,504**	**1,152,594**

Table 20: Tonnage arisings in the EU27 for IT equipment based on EITO data

Table 21 compares these estimates with data supplied by the national registries in Spain, Hungary, Finland and the UK, and shows that the scaled up EU estimate determined from the data provided by Spain, Hungary and the UK is similar to the estimate based on sales data presented in Table 19 and Table 20. The data for both Hungary and Spain also shows that the household sector accounted for about 60% of the weight of IT equipment.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	44	31	75	0.97
Hungary	5	4	9	1.04
Finland	-	-	22	1.57
UK	192	-	192	1.13

Table 21: Estimates for weight for category 3

7.1.4 Category 4 - Consumer Equipment

Consumer Equipment

This category covers the following main types of appliances:

- Televisions,
- Video recorders and DVD players,
- Video cameras,
- Audio equipment,
- Radio sets,
- Musical instruments.

Televisions

There are four types of television screen technology; plasma, liquid crystal display (LCD), cathode ray tube (CRT) and reverse projection. The EUP study (EUP 2006b) estimated the sales of each of these in the EU25, and Table 23 shows that total sales of televisions will rise from 30.3 million in 2000 to 36.5 million in 2010.

Table 24 shows the estimated total weight (determined from the sales shown in Table 23 and the typical weight for each type of television shown in Table 22) of televisions placed on the market. This increases from 806,000 tonnes in 2000 to 956,000 tonnes in 2003, but then reduces to 777,000 tonnes by 2010. This reduction in weight is due to the change from CRT to LCD screens (sales of CRTs represented 99.9% by weight of television sales sold in 2000, but this falls to 21% by 2010 when sales of LCD televisions represent 52% by weight of all sales).

Type	Size	Average weight (kg)
Plasma	14" – 26"	-
	27" – 39"	36.5
	40" – 70"	42.2
LCD	14" – 26"	7
	27" - 39"	16
	40" – 70"	22
CRT	14" – 26"	20
	27" – 39"	53
	40" – 70"	-
Reverse Projection	14" – 26"	-
	27" – 39"	-
	40" – 70"	51

Table 22: Typical weights for televisions

Type	Size	Year										
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Plasma	14" – 26"	0	0	0	0	0	0	0	0	0	0	0
	27" – 39"	0	2	20	60	136	90	143	195	0	0	0
	40" – 70"	8	16	53	164	620	1,706	2,720	3,699	4,862	5,257	5,518
	Total	8	18	73	224	756	1,796	2,863	3,894	4,862	5,257	5,518
LCD	14" – 26"	5	16	108	724	1,922	4,339	7,532	7,713	6,994	5,940	5,696
	27" - 39"	0	0	1	46	480	2,748	5,204	7,889	11,021	12,592	13,721
	40" – 70"	0	0	0	0	0	145	959	1,928	3,179	5,227	6,472
	Total	5	16	109	770	2,402	7,232	13,694	17,530	21,194	23,759	25,889
CRT	14" – 26"	24,216	22,315	20,931	19,093	17,960	14,648	10,233	6,896	5,168	3,776	2,944
	27" – 39"	6,054	7,438	8,970	10,281	9,671	7,888	5,510	4,597	3,445	2,517	1,963
	40" – 70"	0	0	0	0	0	0	0	0	0	0	0
	Total	30,270	29,753	29,901	29,374	27,630	22,536	15,743	11,493	8,613	6,293	4,907
Reverse projection	14" – 26"	0	0	0	0	0	0	0	0	0	0	0
	27" – 39"	0	0	0	0	0	0	0	0	0	0	0
	40" – 70"	15	75	227	307	311	237	201	168	204	214	215
	Total	15	75	227	307	311	237	201	168	204	214	215
Total EU 25		**30,298**	**29,862**	**30,310**	**30,675**	**31,099**	**31,801**	**32,501**	**33,085**	**34,873**	**35,523**	**36,529**

Table 23: Sales ('000 units) of televisions in EU25 Member States

Type	Size	Year										
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plasma	14" – 26"	0	0	0	0	0	0	0	0	0	0	0
	27" – 39"	15	72	746	2,208	4,967	3,278	5,225	7,107	0	0	0
	40" – 70"	277	585	1,918	5,968	22,627	62,276	99,275	135,024	177,463	191,881	201,407
	Total	292	657	2,665	8,176	27,594	65,554	104,500	142,131	177,463	191,881	201,407
LCD	14" – 26"	35	112	755	5,067	13,451	30,374	52,722	53,992	48,958	41,578	39,869
	27" - 39"	0	0	17	739	7,686	43,971	83,260	126,216	176,334	201,476	219,539
	40" – 70"	0	0	0	0	0	3,182	21,089	42,423	69,940	114,994	142,390
	Total	35	112	773	5,806	21,138	77,527	157,070	222,631	295,232	358,048	401,797
CRT	14" – 26"	484,320	446,295	418,614	381,862	359,190	292,968	204,659	137,916	103,356	75,516	58,884
	27" – 39"	320,862	394,227	475,426	544,888	512,537	418,043	292,033	243,652	182,596	133,412	104,028
	40" – 70"	0	0	0	0	0	0	0	0	0	0	0
	Total	805,182	840,522	894,040	926,750	871,727	711,011	496,692	381,568	285,952	208,928	162,912
Reverse projection	14" – 26"	0	0	0	0	0	0	0	0	0	0	0
	27" – 39"	0	0	0	0	0	0	0	0	0	0	0
	40" – 70"	765	3,825	11,577	15,657	15,861	12,087	10,251	8,568	10,404	10,914	10,965
	Total	765	3,825	11,577	15,657	15,861	12,087	10,251	8,568	10,404	10,914	10,965
Total EU 25		**806,274**	**845,116**	**909,054**	**956,389**	**936,319**	**866,179**	**768,512**	**754,898**	**769,051**	**769,770**	**777,082**

Table 24: Weight (tonnes) of televisions put on the market in EU25 Member States

Other Items

No data on the sales of the other items in this category in the EU27 Member States were identified. The EUP study on standby (EUP 2007c) estimates the total stock for a number of items in the EU25 and these are shown in Table 25 (the number of TV digital units falls by the year 2020 because set-top boxes are replaced by units in the television).

	2005	2010	2020
Radio	114.4	115.7	116.8
DVD	143.3	174.0	253.4
Audio mini-system	114.4	115.7	116.8
TV digital receiver	56.3	115.0	97.8

Table 25: Estimated stock (millions) of items in the EU25 Member States

The survey of purchasing intentions in the UK (see Table 11) identified that 2.5 million households planned to purchase a DVD player during the next 12 months, and that 1.5 million households planned to purchase an audio mini-system in the next 12 months.

Weight Arisings

Table 26 shows the data supplied by the national registries in Spain, Hungary, Finland and the UK. The estimated weight for the EU27, based on scale-up of the data provided for Spain and the UK, is comparable with the estimated weight of 0.87 million tonnes for televisions put onto the market, but the scaled up data for Hungary is almost twice this value. The data for Hungary and Spain also shows that the household sector accounted for 99% of the total weight of material in this category put onto the market.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	73	1	74	0.95
Hungary	16	<1	16	1.97
Finland	-	-	20	1.43
UK	186	-	186	1.09

Table 26: Estimated weight for category 4

7.1.5 Category 5 - Lighting Equipment

Lighting Equipment

This category consists of:

- Luminaries for fluorescent lamps with the exception of luminaries in households,
- Straight fluorescent lamps,
- Compact fluorescent lamps,
- High intensity discharge lamps, including pressure sodium lamps and metal halide lamps,
- Low pressure sodium lamps,
- Other lighting or equipment which does not use filament bulbs.

Table 27 shows that the overall market (ELC 2007) for lamps in the EU 27 Member States (excluding Malta and Cyprus) is 776 million items.

Member State	Lamps market (millions)	Member State	Lamps market (millions)
Austria	10	Latvia	2
Belgium	16	Lithuania	4
Bulgaria	8	Luxembourg	1
Cyprus	no data	Malta	no data
Czech Republic	14	Netherlands	30
Denmark	12	Poland	30
Estonia	2	Portugal	11
Finland	5	Romania	50
France	90	Slovakia	5
Germany	132	Slovenia	3
Greece	13	Spain	70
Hungary	10	Sweden	15
Ireland	8	United Kingdom	115
Italy	120	**Total EU27**	**776**

Table 27: Estimated market for lamps in EU27 Member States

Weight Arisings

Table 28 shows the data supplied by the national registries in Spain, Hungary, Finland and the UK. The estimated weight for the EU27, based on the average of the scale-up of the data provided for Spain, Hungary and Finland, is about 0.70 million tonnes. This is much higher than the scaled-up figure for the UK of 0.09 million tonnes. The reason for this difference is not clear. However, it is noteworthy that the data for Hungary and Spain also shows that the commercial sector accounted for about 80% of the total weight of material in this category put onto the market. A further complication is that it is not clear whether or not data has included lamps and luminaries.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	8	42	50	0.64
Hungary	1	4	5	0.65
Finland	-	-	11	0.79
UK	15	-	15	0.09

Table 28: Estimates of weights for category 5

7.1.6 Category 6 - Electrical and Electronic Tools (with the exception of large-scale stationary industrial tools)

Tools

This category covers:

- Drills,
- Saws,
- Sewing machines,

- Equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching,
- Folding, bending or similar processing of wood, metal and other materials,
- Tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses,
- Tools for welding, soldering or similar use,
- Equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means,
- Tools for mowing or other gardening activities.

No data on sales of these items in the EU27 Member States were identified. The survey of purchasing intentions in the UK (see Table 11) conducted in 2006 identified that in the next 12 months, 2 million households plan to purchase power tools, 1 million households plan to purchase a lawn mower, and 1 million households plan to purchase a garden strimmer.

Weight Arisings

Table 29 shows the data supplied by the national registries in Spain, Hungary, Finland and the UK. The estimated weight for the EU27, based on the average of the scale-up of the data provided by these Registers, is about 0.4 million tonnes. The data for Hungary and Spain also shows that the household sector accounted for about 75% of the total weight of material in this category put onto the market.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	12	4	16	0.21
Hungary	3	<1	3	0.42
Finland	-	-	8	0.57
UK	70	-	70	0.41

Table 29: Estimated weights for category 6

7.1.7 Category 7 - Toys, Leisure and Sports Equipment

Toys

This category covers:

- Electric trains or car racing sets,
- Hand-held video game consoles,
- Video games,
- Computers for biking, diving, running, rowing, etc.,
- Sports equipment with electric or electronic components,
- Coin slot machines.

No data on sales of these items in the EU27 Member States were identified. Nintendo is estimated (REGHARDWARE 2007) to have sold 1.7 million "Nintendo DS" games units and 0.7 million "Wii" games consoles in Europe in December 2006, and 1.5 million households in the UK plan to buy a games console during the next 12 months.

Weight Arisings

Table 30 shows the data supplied by the national registries in Spain, Hungary and Finland. The estimated weight for the EU27, based on the average of the scale-up of the data provided for Spain, Hungary, Finland and the UK, is about 0.15 million tonnes. The data for Hungary and Spain also shows that the household sector accounted for about 50% of the total weight of material in this category put onto the market (most of the weight put onto the commercial market is likely to be equipment in fitness centres).

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	6	5	11	0.14
Hungary	<1	<1	1	0.07
Finland	-	-	2	0.12
UK	44	-	44	0.26

Table 30: Estimated weights for category 7

7.1.8 Category 8 - Medical Devices (with the exception of all implanted and infected products)

Medical Devices

This category covers:

- Radiotherapy equipment,
- Cardiology and dialysis equipment,
- Pulmonary ventilators,
- Nuclear medicine,
- Laboratory equipment for in-vitro diagnosis,
- Analysers,
- Fertilization testers,
- Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability.

A report (GOODMAN 2006) estimates that 32,000 tonnes (0.03 million tonnes) per year of these products are placed onto the EU market. Table 31 shows the data supplied by the national registries in Spain, Hungary, Finland and the UK. There is a wide variation in the estimated weight for the EU27. The data for Hungary and Spain also show that the commercial sector accounted for about 90% of the total weight of material in this category put onto the market.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	1	8	9	0.15
Hungary	<1	<1	<1	0.05
Finland	-	-	1	0.08
UK	3	-	3	0.02

Table 31: Estimated weights for category 8

7.1.9 Category 9 - Monitoring and Control Instruments

M&C

This category covers:

- Smoke detector,
- Heating regulators,
- Thermostats,
- Measuring, weighing or adjusting appliances for household or as laboratory equipment,
- Other monitoring and control instruments used in industrial installations (e.g. in control panels).

Weight Arisings

A report (GOODMAN 2006) estimates that 42,800 tonnes per year (0.04 million tonnes) of these products are placed onto the EU market. Table 32 shows the data supplied by the national registries in Spain, Hungary, Finland and the UK. There is a wide difference between the scaled-up values for the EU27, but the data for Spain and the UK (representing ~25% of the total GDP of the EU27) suggests that the amount of category 9 equipment put onto the market is between 10,000 and 30,000 tonnes per year. The data for Hungary and Spain also show that the commercial sector accounted for about 75% of the total weight of material in this category put onto the market.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU27 (million tonnes)
Spain	0.3	0.8	1.1	0.01
Hungary	<1	<1	<1	0.07
Finland	-	-	3.9	0.28
UK	6	-	6	0.03

Table 32: Estimated weight for category 9

7.1.10 Category 10 - Automatic Dispensers

Aut.Disp.

This category covers:

- Automatic dispensers for hot drinks,
- Automatic dispensers for hot or cold bottles or cans,
- Automatic dispensers for solid products,
- Automatic dispensers for money,
- All appliances which deliver automatically all kind of products.

Weight Arisings

No data on sales of these items in the EU25 Member States were identified. Table 33 shows the data supplied by the national registries in Spain, Hungary, Finland and the UK. The data for Hungary and Spain also show that the commercial sector accounted for about 99% of the total weight of material in this category put onto the market.

	Household ('000 tonnes)	Commercial ('000 tonnes)	Total ('000 tonnes)	Estimate for EU25 (million tonnes)
Spain	<1	6	6	0.08
Hungary	-	<1	<1	0.04
Finland	-	-	<1	0.01
UK	<1	-	<1	0.01

Table 33: Estimated weight for category 10

Analysis

7.1.11 Overall Weight Put on the Market

The two approaches to estimating the weight of EEE put onto the market in the EU27 Member States are to:

- Use data on sales of equipment, or
- Use data provided by national registries.

Table 34 shows that sales data are only available for items in categories 1, 3 and 4, and the total weight of these items is about 5.0 million tonnes per year. Estimates have been made for the weight of items in categories 8 and 9, but the total for these is less than 0.1 million tonnes per year.

Category	Items	Weight (million tonnes) in EU27
1	Cold, wet and cooking	3.0
3	Computers, printers and copiers	1.1
4	Televisions	0.9

Table 34: Summary of sales data

There are currently limited data supplied by national registries on tonnages by category put onto the market. The total tonnages put onto the market in Estonia, Finland, France (FRANCE REGISTER 2007), Hungary, Lithuania, Slovakia, Slovenia, Spain and the UK in 2006 are presented in Table 35. The total weight of material put onto the market in these seven Member States was 4.07 Million tonnes.

Member State	Weight of items put on market ('000 tonnes)
Estonia	6
Finland	135
France	1,465
Hungary	85
Lithuania	33
Slovakia	48
Slovenia	28
Spain	783
UK	1,483

Table 35: Estimated weight put on the market in 2006

These nine Member States represent, between them, 44% of the total GDP of the EU27 Member States thereby giving a reasonable level of confidence for the tonnage scale-up estimate for the EU27. This scale-up figure for the total weight of electrical and electronic equipment put onto the market each year in the EU27 Member States is 9.3 million tonnes. This is almost twice the weight estimated for items for which limited sales data is available. Given the legal obligation for producers to notify amounts put on the market , this strongly suggests that the use of data from national registers is a much better approach to determining the weight of EEE put onto the market than the use of sales data. Table 36 shows the weight percentage of each category put on the market (based on the data for Estonia, Finland, Hungary, Lithuania, Slovakia, Slovenia, Spain and the UK.

Category	Wt% of total market
1	55.8
2	9.3
3	12.0
4	12.1
5	3.4
6	4.0
7	2.2
8	0.5
9	0.4
10	0.3
Total	**100.0**

Table 36: Distribution (Wt %) between categories

This table indicates the likely category breakdown for WEEE arising in future years (see Table 41) and shows that category 1 is the largest category, representing over 55% of the total weight put onto the market. However, as discussed earlier, data from additional national registries will be required in order to further improve confidence in any estimates for percentage of arisings produced in each category.

Estimates for EEE and WEEE made during the 1990's predicted a weight of about 7 million tonnes. There are a number of reasons why the current tonnage estimate, based on limited data from national registries, is likely to be higher:

- Expansion of the EU from 15 to 27 Member States; however it should be noted that the original EU15 Member States accounted for 95% of the GDP of the EU27 in 2005, and thus account for 95% of total tonnage using the scale-up procedure used to estimate EU27 arisings,
- Households account for a high percentage of the tonnage placed onto the market. Consequently, growth in the number of households will increase the tonnage placed onto the market.

The non-household tonnage may have been under-estimated when earlier predictions were made. The current WEEE Directive appears to be mainly aimed at items that would have been disposed of in municipal solid waste (MSW) and the definitions of some categories suggest that they only cover household items (for example, category 1 is "large household appliances"). As a result it is possible that household type items which are used in commercial premises (for example, a dishwasher in the kitchen at an office) may not have been included in earlier estimates, but will probably be included in data determined by national registries.

Table 37 shows the weight percent distribution between household and non-household markets (based on the data for Spain). Household markets represent over 97% of the total weight of items in category's 1, 3 and 4, and non-household markets represent over 90% of the total weight of items in category's 8 and 10. 86% of the total weight of EEE items was placed onto the household market. The non-household percentage for category 7 items is most likely due to sports and leisure equipment rather than toys.

Category	% household	% non-household
1	97	3
2	98	2
3	59	41
4	99	1
5	16	84
6	77	23
7	55	45
8	9	91
9	30	70
10	1	99
Total Spain	**86**	**14**

Table 37: Distribution (wt %) between household and non-household markets in Spain in 2006

Conclusion

The two sources of data which can be used to estimate the tonnage put onto the market are: sales data and data supplied by national registries. Publicly available sales data is limited and does not cover some categories, or all of the items in categories for which data is available. This strongly suggests that the use of data from national registers is a much better approach to determining the weight of EEE put onto the market than the use of sales data.

The initial estimate for the amount of EEE placed onto the market in the EU27 million states is 9.3 million tonnes per year. This is based on scale-up of data from 9 national registries (these Member States represent 44% of the total GDP of the EU27). Data from additional registries, particularly those for Germany and Italy, will be required in order to further improve levels of confidence in this estimate.

This estimate for weight put onto the market of 9.3 million tonnes is significantly higher than estimates determined from predictions made during the 1990's which estimated the tonnage of EEE at about 7 million tonnes. This increase is likely to be due to three factors; expansion of the EU, growth in the number of households in each Member State, and inclusion of items which may have been excluded because the earlier estimates might have only considered household sources.

Recommendations

Data from national registries are better for estimating tonnage put on the market than the use of individually reported sales data.

National registries should be encouraged to either make data publicly available, or provide it to the EC for collation and possible auditing.

7.2 WEEE Arisings (Task 1.2.2)

Data Gathered

Initially, the type and quantity of relevant data contained in the BIO Intelligence Services synthesis report (BIO IS 2006) was reviewed, and where considered necessary, the original reference studies were scrutinised for further detailed information. In addition, further reports and sources of data that have been published since the publication of the BIO IS synthesis report were identified. These included:

- WEEE Flows in London (ENHANCE 2006),
- ICER Commercial (non-household) WEEE Arisings (ICER 2006) , and
- Preliminary results published by certain National registers (Austria, Estonia, Finland, Lithuania, Slovakia and Spain).

Responses to the questionnaires sent out to stakeholders were also received and accommodated in our analysis.

Analysis

Current WEEE Arisings

The data identified and received were very limited. Undoubtedly, these data were derived from estimations using various calculation techniques and methods. Furthermore, it was usually unclear which types of equipment had been considered in these estimations. Very often, data covered WEEE from households only without any estimation or conjecture about the likely arisings from non-household sources. Although the European Commission's FAQs document on the WEEE and ROHS Directives attempts to provide non-statutory guidance on what equipment should and should not be covered by the WEEE Directive, the lack of clarity for many estimates on which end-of-life equipment has been considered to be either in or out of the scope of the WEEE Directive makes assessment of the actual amounts difficult. Relative affluence can influence the quantities of WEEE generated. Thus, WEEE arisings estimates expressed in terms of kg per inhabitant vary widely. This is illustrated in the table below:

Country	GDP (US$/head) (CIA WorldFactbook)	WEEE (kg/head)	Year estimated
Denmark	34,600	23.2	2000
Estonia	16,700	8.2	2005
Finland	30,900	23.0 7.3	2003 2005 (Register estimate*)
France	29,900	24.0	2005
Germany	30,400	14.6	2005
Hungary	16,300	11.4	2005
Lithuania	13,700	6.3	2003
Poland	13,300	8.4	2008 (forecast)
Sweden	29,800	23.9	1999
UK	30,300	29.4 23	2005 (Household+ non-HH) 2006 (based on London Study)
Bulgaria	9,600	5.7	2006

Table 38: Reported WEEE Arisings (kg/inhabitant)

**Pirkanmaa Regional Environment Centre (the national authority in producer responsibility in Finland) does not make the estimate for the waste generated, but the compliance schemes and producers give this estimate themselves. The compliance schemes have given estimates of the waste generated from the appliances they have put on the market.*

Thus, we suggest that WEEE arisings currently exhibit the following ranges:

- Western Europe ~ 14-24 kg/head
- New Members ~ 6-12 kg/head

The data in the above table leads to the conclusion that, although significant variability can be expected in the figures reported, there appears to be a rough correlation with affluence (expressed in terms of GDP/head).

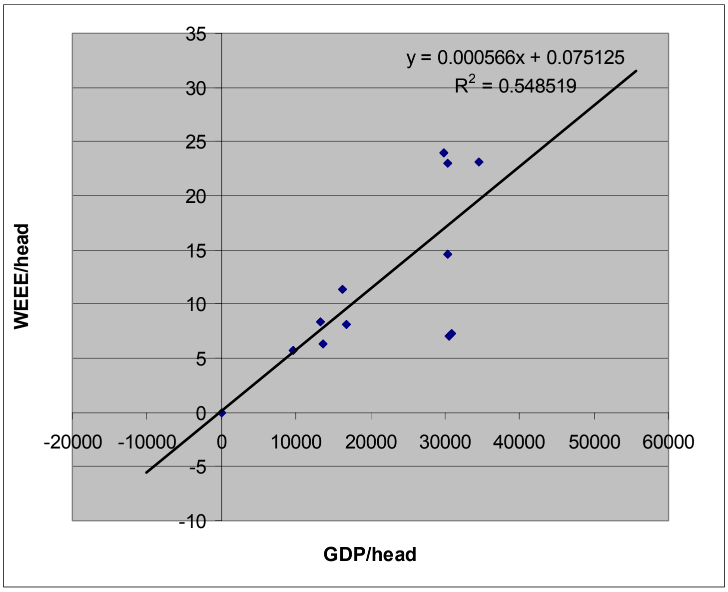

Figure 9: Plot of WEEE/head versus GDP/head

A plot of the data known to date is illustrated in the figure above. A best-fit straight line can provide a method for making estimates for WEEE arisings in other Member states where data is lacking - this estimation approach (Method 1) can be revised if more estimates become available. However, since the Directive does not place a requirement for the reporting of WEEE arisings, official arisings data cannot be expected to be reported.

Although the R-squared value for the linear fit to the data in the above figure is low, application of this straight-line relationship to the EU27 yields a figure of 7.2 million tonnes for total WEEE arisings (7.1 million tonnes for the EU25, 6.4 million tonnes for the EU15). This suggests that this method is a fair guide provided the potential error margins at individual Member State level are understood and taken into account.

An alternative approach (Method 2) was used in order to test whether or not the estimates from Method 1 were reasonable. This alternative method (Beigl) was based on an empirical approach to the prediction of municipal solid waste (MSW) arisings for cities (note: cities are most likely to be the major source of WEEE). The empirical formulae used to calculate the predicted MSW arisings per head were identified for cities with different levels of prosperity. These formulae are illustrated in Figure 10.

These formulae were applied to each of the Member States (allocating each Member State to either a very high, high, or medium/low prosperity category) to derive an estimate for that Member State's MSW (in kg/head) and subsequently by applying the figure for the average % of WEEE in MSW to derive kg/head estimates for WEEE for each Member State.

Member States were ranked according to WEEE kg/head and plotted to obtain an averaged relationship between rank and WEEE kg/head. The figure below shows the resulting chart and relationship. The best-fit straight-line relationship was used to calculate estimated WEEE arisings across the EU25.

The estimated equations of the final MSW generation model for cities are represented by:

$$MSW^t = 359.5 + 0.014 \cdot GDP^t - 197.1 \cdot \log\left(INF^t_{urb}\right) \quad (1)$$

for cities with *very high* prosperity,

$$MSW^t = 276.5 + 0.016 \cdot GDP^t - 126.5 \cdot \log\left(INF^t_{urb}\right) \quad (2)$$

for cities with *high* prosperity, and

$$MSW^t = -360.7 - 375.6 \cdot \log\left(INF^t_{nat}\right) + 8.93 \cdot POP^t_{15-59} - 123.9 \cdot HHSIZE^t + 11.7 \cdot LIFEEXP^t \quad (3)$$

for cities with *low or medium* prosperity,

where MSW^t is the municipal solid waste generated per capita and year, GDP^t is the national gross domestic product per capita at 1995 purchasing power parities, INF is the infant mortality rate per 1,000 births in the city (INF_{urb}) or in the country (INF_{nat}), $POP_{15-59}{}^t$ is the percentage of the population aged 15 to 59 years, $HHSIZE^t$ is the average household size and $LIFEEXP^t$ is the life expectancy at birth and t is the year.

Figure 10: Empirical Formulae (Beigl)

This approach yielded a figure of 7.9 million tonnes of WEEE for the EU25 (7.0 million tonnes for the EU15), corresponding with the estimate from Method 1.

A further method (AEA 1997) that can be used to check the estimated average arisings of WEEE from households is to consider which items of electrical and electronic equipment a typical household would contain (based on both manufacturers' estimates of saturation rates, the fact that most households are now likely to have more than one TV and more than one computer), and how many times equipment would be replaced over a twenty year period (based on manufacturers' estimates of typical working life). This method provides a 'sense check' for the estimations made using Methods 1 and 2 described above. Table 39 shows that a Western (EU 15) European household will generate slightly over 900 kg of WEEE over a 20 year period. This is equivalent to 46 kg of WEEE per year, which is equivalent to a rate of about 20 kg/person per year.

Item	Number in Household	Wt of item (kg)	Wt in household (kg)	Typical life (years)	No. of replacements in 20 years	Wt of waste in 20 years (kg)
Washing machine	0.9	65	58.5	8	2.5	146
Tumble dryer	0.4	35	14	10	2.0	28
Dish washer	0.4	50	20	10	2.0	40
Refrigerator	0.5	35	17.5	10	2.0	35
Fridge/freezer	0.7	35	24.5	10	2.0	49
Freezer	0.6	35	21	10	2.0	42
Microwave	0.9	15	13.5	7	2.9	39
Electric cooker	0.5	60	30	10	2.0	60
Vacuum cleaner	1	10	10	10	2.0	20
Iron	1	1	1	10	2.0	2
Kettle	1	1	1	3	6.7	7
Toaster	0.9	1	0.9	5	4.0	4
Food mixer	0.8	1	0.8	5	4.0	3
Television	1.8	30	54	10	2.0	108
Video recorder & DVD player	2	5	10	5	4.0	40
Hi-Fi system	2	10	20	10	2.0	40
Radio	1	2	2	10	2.0	4
Computer	1.5	25	37.5	4	5.0	188
Other electronic games	1.5	3	4.5	5	4.0	18
Hair dryer	0.5	1	0.5	10	2.0	1
Electric heaters	0.2	5	1	20	1.0	1
Telephone	2	1	2	5	4.0	8
Electric Drill	0.8	2	1.6	10	2.0	3
Power saw	0.2	2	0.4	10	2.0	1
Other DIY (Do it yourself) tools	0.2	2	0.4	10	2.0	1
Lawn mower	0.8	15	12	10	2.0	24
Other garden tools	0.3	10	3	10	2.0	6
Total			**362**			**917**

Table 39: Weight of WEEE generated in a typical EU15 household

Table 39 also shows that the three main WEEE items are washing machines, televisions and computers; these represent, between them, almost 50% of the weight of WEEE that is generated.

A similar approach can be taken for some non-household arisings. For example, in an office, every office worker will have a computer, but equipment such as printers and photocopiers are shared between a number of office workers, and they will also share kitchen facilities at their place of work. An initial estimate, based on UK employment data, suggests that current business arisings from offices are about 6 kg per working person per year, which is equivalent to 3 kg/person per year based on the total population of the UK. Scale-up of this data (based on population) shows that the estimated WEEE arising in the EU15 Member States would be 6.4 million tonnes arising from households, and 0.9 million tonnes arising from offices. This gives a total of 7.3 million tonnes for the EU15, and thus the estimated WEEE arising (based on GDP) for the EU27 Member States would be 7.8 million tonnes. This is similar to the estimates described previously.

To summarise, the estimations of WEEE arisings using the two methods described above are grouped and compared with reported data in Table 40 below:

	WEEE (tonnes)	Estimated WEEE (tonnes)	Estimated WEEE (tonnes)
Country	**Reported**	**Method 1**	**Method 2**
Austria		152,504	176,499
Belgium		186,433	218,805
Cyprus		9,173	11,072
Czech Republic		113,573	139,587
Denmark	125,000	106,381	119,418
Estonia	9,000 to 13,000	12,833	16,886
Finland	84,000*	91,978	106,752
France	1,500,000	1,029,451	1,098,762
Germany	1,200,000	1,425,740	1,589,328
Greece		139,966	176,063
Hungary	115,000*	93,916	120,921
Ireland		95,667	92,985
Italy		970,612	995,124
Latvia		17,405	22,447
Lithuania	22,000	26,818	37,178
Luxembourg		14,353	10,551
Malta		4,566	5,726
Netherlands	114,000	282,707	323,258
Poland	321,300	290,233	392,931
Portugal		115,811	137,899
Slovakia		49,474	61,465
Slovenia		24,572	30,642
Spain		624,401	708,444
Sweden	215,000	152,670	158,441
UK	1,385,000*	1,034,090	1,122,867
Bulgaria	42,800	40,684	N/a
Romania		103,928	N/a
EU15	**7,000,000**	**6,422,764**	**7,035,198**
EU25		**7,065,327**	**7,874,052**
EU27		**7,209,939**	**N/a**

* Average of more than one data point

Table 40: WEEE Arisings (Reported & Estimated)

Note that these estimates are based on predominantly household WEEE data. From data reported to one register (SPAIN REGISTER) for 'put on market', total EEE figures are about 15% higher when non-household EEE is included. Thus, using this same relationship for equipment at end-of-life, then total WEEE arisings (household and non-household) for the EU27 are likely to be about 8.3 to 9.1 million tonnes per year. Furthermore, this would imply that total WEEE arisings (including B2B WEEE) might reach about 12.3 million tonnes by 2020 (see Forecast WEEE Arisings below).

Clearly, there are discrepancies between actual reported estimates and the estimates derived from the two estimation methods. For example, the reported estimates for France and Germany appear to be in contradiction with the estimates obtained from methods 1 and 2. This illustrates the error margins to be expected when considering the individual Member State level. We have calculated an error margin of around +/- 20% (based on the standard deviation on the differences between the individual country reported figures and figures estimated by Method 1) whereas the range found for the total EU arising figure indicates a better error margin of only +/- 5%.

We conclude that, given the scarcity of data on WEEE arisings estimates, combined with the lack of clarity on what exactly is covered by each WEEE estimate, extrapolation of the estimates to other countries provides a reasonable result but that the accuracy should be regarded with caution.

Forecast WEEE Arisings

Given the difficulties in obtaining accurate figures for WEEE arisings discussed above, the forecasting of future arisings of WEEE is beset with problems. Many techniques have been used: some based on the concept of typical product lifetimes, others based on market saturation factors, others on linear extrapolation, trend analysis or periodic approaches (or even combinations of these). The various techniques for estimating future arisings of WEEE have been reviewed (Walk, 2004). Lack of reliable quantitative baseline data was cited as a major problem with prognosis models. The UK Market Transformation Programme (MTP) "What if?" Tool uses a complex iterative approach to calculate the predicted future impacts for particular products. However, this tool requires a detailed knowledge of the sales history of an item (i.e. going back to the early 1990s). UK stock, sales, usage and resource consumption data has been gathered on household and industrial products, such as televisions, fridges and electrical motors. This information is used to model how products will evolve in the market place and to estimate future environmental impacts under different strategy scenarios. The "What-If?" Tool presents headline data on the potential impacts of these market transformation strategies to:

- Inform policy discussions and government decisions,
- Facilitate the data and information exchange,
- Provide an opportunity to cross reference and challenge data & assumptions.

The tool is currently being expanded to cover waste and hazardous materials arising from end-of-life products. Future waste estimates are calculated iteratively to obtain the best fit between average product lifetime and acceptable standard deviation for a normal distribution of product lifetime applied to the year by year sales figures for the products under consideration. The method uses sales data because these are considered to be the most reliable information on which to base the calculations. The modelling of products for the UK shows the following typical trend relationship between product sales and product waste arisings (the chart shown is for UK Cooling appliances).

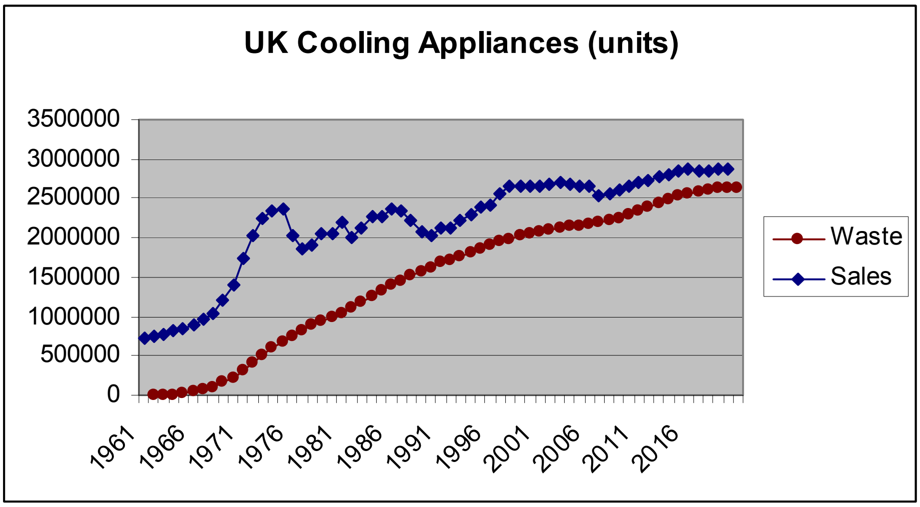

Figure 11: Relationship between sales and waste (Cooling Appliances)

This chart illustrates clearly that:

During the early years of sales, the numbers of equipment items reaching end of life lags behind sales (growing market). The lag time is related to the typical lifetime of equipment. There is a trend for products to reach a market saturation point. At such a stage, then sales figures represent replacements for equipment reaching end-of life (mature market).

One would also expect that in a declining market, sales would fall away and wastes would follow by a similar lag time to that encountered during the growth period. Clearly, the figure above shows the trends for an aggregated group of products. The situation will be much less clear for individual product types (for example, consumer behaviour might be such that a small product is stored rather than disposed of at end of life, or the consumer may decide to buy more than one item for use. This could be the case for TV's). However, overall, it would be expected that the relationship illustrated above should hold true when considered in aggregate form.

The MTP approach is founded on extensive sales information over a number of years. The purchase of this information for the whole of the EU would be extremely expensive. Furthermore, the current amount of data collected for 'Put on the Market' is insufficient for performing a complete modelling analysis. In future, information on 'Put on the Market' will be reported to the European Commission as a requirement on the Directive. It will take several years to build up a year on year database of market information for the entire EC, consequently it will be some time before this type of complete analysis will be possible to cover all Member States. In the absence of sufficient data, we have calculated forecasts for future WEEE arisings using the Method 1 relationship between WEEE, GDP and populations with the following assumptions:

1. Population growth rate for all countries reaches 0% by 2020 (In several new Member States, population growth is currently negative, presumably as a consequence of migrations to the west following accession),

2. Population growth rates in the intervening years follow a linear relationship between current growth rates and the rate in 2020,
3. GDP in each country grows at a fixed annual rate to 2020. (Average rates in 2005 have been taken. These were 2.2% p.a. for W. Europe (EU15) and 5.4% p.a. for the new Member States (EU16-27)),
4. A baseline year for GDP/head of 2005 has been selected,
5. GDP/head for each country and each year is calculated as a function of GDP growth and population growth,
6. WEEE/head figures have been calculated as per Method 1 relationship,
7. WEEE arisings forecasts were calculated simply from WEEE/head calculations and population forecasts.

Year:	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WEEE Calculated (tonnes)																
Austria	152,504	155,844	159,261	162,753	166,321	169,968	173,695	177,503	181,396	185,373	189,439	193,593	197,839	202,178	206,612	211,144
Belgium	186,433	190,520	194,698	198,966	203,329	207,787	212,343	216,998	221,756	226,619	231,588	236,666	241,856	247,159	252,579	258,118
Denmark	106,381	108,714	111,097	113,533	116,023	118,567	121,167	123,825	126,540	129,315	132,152	135,050	138,012	141,040	144,134	147,295
Finland	91,978	93,995	96,056	98,162	100,314	102,513	104,760	107,057	109,404	111,803	114,254	116,760	119,320	121,936	124,610	127,342
France	1,029,451	1,052,032	1,075,104	1,098,682	1,122,775	1,147,396	1,172,555	1,198,266	1,224,540	1,251,389	1,278,826	1,306,865	1,335,517	1,364,798	1,394,721	1,425,299
Germany	1,425,740	1,456,971	1,488,887	1,521,506	1,554,842	1,588,912	1,623,731	1,659,317	1,695,685	1,732,853	1,770,840	1,809,662	1,849,338	1,889,887	1,931,328	1,973,681
Greece	139,966	143,042	146,179	149,384	152,659	156,005	159,423	162,917	166,486	170,133	173,860	177,667	181,558	185,534	189,597	193,748
Ireland	95,667	97,761	99,907	102,099	104,340	106,630	108,970	111,361	113,805	116,302	118,854	121,463	124,128	126,853	129,636	132,482
Italy	970,612	991,918	1,013,686	1,035,929	1,058,657	1,081,881	1,105,613	1,129,862	1,154,641	1,179,962	1,205,835	1,232,274	1,259,290	1,286,898	1,315,108	1,343,936
Luxembourg	14,353	14,668	14,990	15,320	15,656	16,000	16,351	16,711	17,078	17,453	17,836	18,228	18,628	19,037	19,455	19,882
Netherlands	282,707	288,905	295,239	301,711	308,325	315,085	321,992	329,051	336,265	343,638	351,172	358,871	366,740	374,781	382,999	391,397
Portugal	115,811	118,339	120,926	123,570	126,272	129,033	131,855	134,739	137,687	140,699	143,777	146,923	150,138	153,424	156,781	160,213
Spain	624,401	638,165	652,204	666,546	681,197	696,165	711,456	727,076	743,034	759,336	775,990	793,003	810,384	828,141	846,281	864,814
Sweden	152,670	156,019	159,440	162,936	166,509	170,159	173,890	177,703	181,599	185,580	189,649	193,807	198,056	202,398	206,835	211,370
UK	1,034,090	1,056,748	1,079,913	1,103,586	1,127,777	1,152,500	1,177,765	1,203,585	1,229,971	1,256,937	1,284,494	1,312,656	1,341,437	1,370,849	1,400,907	1,431,625
Total WEEE (tonnes)																
Cyprus	9,173	9,667	10,187	10,734	11,312	11,920	12,562	13,237	13,949	14,700	15,491	16,324	17,202	18,128	19,103	20,131
Czech Republic	113,573	119,663	126,084	132,851	139,983	147,501	155,425	163,776	172,579	181,857	191,635	201,942	212,806	224,256	236,324	249,044
Estonia	12,833	13,520	14,244	15,008	15,813	16,661	17,555	18,497	19,491	20,538	21,641	22,804	24,030	25,323	26,685	28,120
Hungary	93,916	98,944	104,244	109,831	115,719	121,926	128,468	135,364	142,632	150,293	158,368	166,880	175,850	185,306	195,272	205,777
Latvia	17,405	18,334	19,314	20,347	21,436	22,584	23,793	25,069	26,413	27,830	29,323	30,897	32,556	34,305	36,149	38,092
Lithuania	26,818	28,251	29,762	31,355	33,033	34,802	36,667	38,633	40,705	42,889	45,191	47,618	50,176	52,871	55,713	58,708
Malta	4,566	4,810	5,067	5,339	5,625	5,927	6,246	6,581	6,935	7,308	7,701	8,115	8,552	9,012	9,497	10,009
Poland	290,233	305,746	322,099	339,335	357,503	376,652	396,835	418,109	440,531	464,165	489,075	515,330	543,004	572,172	602,915	635,319
Slovakia	49,474	52,123	54,916	57,860	60,962	64,233	67,679	71,312	75,141	79,177	83,431	87,914	92,640	97,620	102,870	108,403
Slovenia	24,572	25,888	27,277	28,741	30,284	31,910	33,625	35,432	37,337	39,345	41,462	43,693	46,045	48,523	51,136	53,890
Bulgaria	40,684	42,851	45,134	47,540	50,076	52,749	55,567	58,538	61,668	64,968	68,446	72,113	75,977	80,050	84,343	88,868

Year:	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WEEE Calculated (tonnes)																
Romania	**103,928**	**109,450**	**115,266**	**121,397**	**127,859**	**134,670**	**141,850**	**149,418**	**157,395**	**165,803**	**174,666**	**184,008**	**193,854**	**204,233**	**215,172**	**226,702**
Total WEEE (tonnes)																
Total WEEE (tonnes) EU27	***7,209,939***	***7,392,891***	***7,581,181***	***7,775,019***	***7,974,601***	***8,180,137***	***8,391,840***	***8,609,938***	***8,834,664***	***9,066,264***	***9,304,995***	***9,551,125***	***9,804,933***	***10,066,710***	***10,336,763***	***10,615,411***

Table 41: Forecast Household WEEE Arisings EU27

These estimates are used in our environmental and economic calculations, the results of which are presented in Chapter 8.

Conclusion

Currently, the available data on WEEE arisings are poor and estimation techniques are required for extension of known data to EU-wide coverage. Our estimations indicate that current WEEE arisings across the EU27 amount to around 8.3 – 9.1 million tonnes per year.

Our simple forecasting technique would suggest that by 2020, household WEEE arisings could grow annually at between 2.5% and 2.7% reaching about 10.6 million tonnes by 2020. This would imply that total WEEE arisings (including B2B WEEE) might reach about 12.3 million tonnes by 2020.

The national registers are beginning to report information gathered as a requirement of implementation of the Directive into national regulations. However, WEEE arisings, if reported, are likely to remain only as estimates since the Directive does not require Member States to report on WEEE arisings figures.

Recommendations

Over the years since the WEEE Directive was first proposed, it has proven to be very difficult to measure actual WEEE arisings. The routes for disposal are manifold, making it extremely difficult to establish true and accurate data. Not surprisingly, reliance has been placed on estimation techniques, which, fortunately, show remarkable agreement with each other.

As the various estimates made show reasonable agreement, it can be assumed that estimated data are a good proxy for actual data.

Given the difficulties surrounding obtaining actual data on WEEE arisings, the focus of the WEEE Directive should remain on achieving the separate collection of as much WEEE as is practically possible. The kg/inhabitant target is very dependent on there being enough quantities of WEEE being available for collection. This may not necessarily always be the case. A better and more practical basis for setting a collection target might be amounts 'put on the market' in the previous year. This basis would provide a better linkage back to the producer than a waste arisings basis. This observation will be discussed further in Chapter 10.2.

7.3 WEEE Collected and Treated

Data Gathered

This section initially looks at the types of WEEE that are collected currently, and then examines the activity to treat WEEE items.

Amounts of WEEE Collected

Member States are beginning to report national figures for the amounts of WEEE collected annually. Given the different stages that Member States have reached in implementing the WEEE Directives into national law, the data set is currently incomplete. Table 42 below shows reported tonnage data and estimated tonnages gathered during the course of this study.

Country	2005	2006
Austria	51,961	
Belgium	67,500	76,143
Czech Republic		17,429
Denmark	37,500	
Estonia	4,804	
Finland	42,429	
Hungary	12,812	18,500
Ireland	25,006	
Netherlands	90,060	
Poland		2,800
Slovakia		3,560
Sweden	126,500	

Table 42: Reported Annual WEEE Tonnage Collected

By way of comparison, the reported tonnages of WEEE collected in 2005 in Norway, Switzerland and Japan were 119,000, 61,216, and 645,556 tonnes respectively. Benchmarking of comparative collection performance is described further below.

Composition of Collected WEEE

Figure 12 shows the breakdown of the collected WEEE streams in a number of European countries (WEEE Forum 2005). For individual data points, see: (ECOLEC 2005, El-Kretsen 2006, El-retur 2006, SENS 2006A, SENS 2006B, SWICO 2006, Recupel 2006, ICER 2005, NVMP 2006, ICT Milieu 2007, APME 2001).
The information provided by the WEEE Forum represents 2005 and is influenced by a number of factors which are explained in Figure 12 as well:

1. Number of WEEE Forum members in the respective country,
2. Starting year of operations,
3. The number of inhabitants served,
4. Whether the data represents the whole country or not,
5. The 'market share' of the system in the country,
6. Whether there is competition with other schemes,
7. Whether there are complementary systems present (for instance for lamps),
8. Whether all or specific appliances are covered,
9. The share of non-household WEEE.

	WEEE collected [kg / inh.a] DATA 2005	NO	SE	FI	IE	EE	NL	BE	ES	CZ	SK	AT	CH	HU
	remarks - **number** of WEEE systems - **WEEE amounts** collected **2005** determined *(x of y WEEE Forum members at **this** time)*	1	1	0 of 1	1	1	1 of 2	1	2 of 4	3 of 4	1 of 2	1	2 of 2	1 of 1
	remark - **start** of operation = collection	1999	2001	2005	2005	2005	1999	2001	2005	2005	2005	2005	1991 / 1994 / 2003	2005
	remark - collection **already in full operation**	YES	YES	n.d.	YES	YES	YES	YES	under dev.	under dev.	under dev.	YES	YES	under dev.
	other remarks - **influencing** collected amounts	-	-	n.d.	-	to build up coll. fac., awareness,...			to build up coll. fac., awareness,...	to build up coll. fac., awareness,...	to build up coll. fac., awareness,...	-	-	to build up coll. fac., awareness,...
	inhabitants served	4,604,745	9,011,392	n.d.	**2,023,577**	1,370,000	16,306,000	10,472,842	**n.s.**	10,300,000	5,379,455	8,127,000	7,461,100	10,500,000
	remark - **inhabitants** served	whole country	whole country	n.d.	**part** of country	whole country	whole country	whole country	several political **regions** of country	whole country	whole country	whole country	whole country	whole country
	remark - data **calculated on**	whole country	whole country	n.d.	**part** of country	whole country	whole country	whole country	**whole country**	whole country	whole country	whole country	whole country	whole country
	remark - **market share**	very high	very high	n.d.	**part** of country served	very high	very high	very high	n.s.	n.s.	n.s.	n.s. - about 50 %	very high	n.s.
	remark - relevant **competitor** system/s - **same** WEEE cat./s	NO	NO	n.d.	YES - ERP	NO	NO	NO	YES	NO - not beside WF_members	YES - different	YES (+2 rel.)	NO	YES - different
	remark - relevant **complementary** systems - **other** WEEE cat.	YES - RENAS	NO	n.d.	NO	NO	NO	NO	YES - lamps	YES - lamps	YES - lamps	NO - lamps covered	NO	NO - lamps covered
	remark - only specific **kinds of appliances** covered	most	all	n.d.	all	all	all	all	YES	all	all	all	all	all
	remark - only specific **'sources'** of WEEE served	all	all	n.d.	all	all	all	all	under dev.	under dev.	under dev.	all	all	under dev.
	remark - est. **'share' business appl.** incl.	10%	n.s.	n.d.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	31%
1a	Large household appliances	5.4	3.9	n.d.	5.0	0.10	1.14	1.6	n.d.	0.014	0.8	0.6	2.6	0.4
1b	Cooling&freezing appliances	2.8	1.1	n.d.	1.7	0.4	1.45	1.2	n.d.	0.13	0.128	1.4	1.6	0.6
2	Small household appliances	0.5	1.4	n.d.	0.3	0.003	0.53	1.0	n.d.	0.005	0.06	0.3	1.4	0.04
3a	IT & T equipment *(excl. CRT's)*	1.8	1.5	n.d.	0.2	0.02	-	0.6	0.03	0.06	-	incl. in S(HH)A	2.1	0.1
3b	IT & T screens - CRT's	0.9	1.0	n.d.	0.19	0.02	-	0.42	n.d.	0.06	-	0.1	1.4	0.0
4a	Consumer equipment *(excl. CRT's)*	0.6	0.7	n.d.	0.12	0.008	0.42	0.44	n.d.	0.001	-	incl. in S(HH)A	0.7	0.1
4b	TV sets - CRT's	1.4	1.6	n.d.	0.5	0.10	0.76	1.04	n.d.	0.05	-	0.2	1.5	0.1
5	Lighting equipment	-	0.7	n.d.	0.09	n.d.	0.03	0.13	n.d.		-	0.1	0.1	0.01
6	Electrical and electronic tools	-	0.1	n.d.	0.07	n.d.	0.06	0.12	n.d.	0.001	-	incl. in S(HH)A	0.0	0.004
7	Toys, ...	0.04	0.02	n.d.	n.d.	n.d.	0.03	-	n.d.		-	incl. in S(HH)A	0.0	0.001
8	Medical devices	0.06	0.02	n.d.	n.d.	n.d.	0.0002	0.001	n.d.	0.009	-	incl. in S(HH)A		-
9	M&C instruments	-	n.d.	n.d.	0.001	n.d.	0.0002	-	n.d.	0.00002	-	incl. in S(HH)A		no amounts 05
10	Automatic dispensers	0.01	no amounts 05	n.d.	n.d.	n.d.	0.02	-	n.d.	0.006	-	incl. In L(HH)A		-
	total - country	**13.4**	**12.2**	n.d.	**8.2**	**0.63**	**4.44**	**6.51**	**0.03**	**0.33**	**0.95**	**2.77**	**11.4**	**1.28**

Figure 12: Arisings of domestic WEEE by category of equipment in Western Europe (WEEE Forum 2005)

Analysis

Benchmarking

The comparative collection performance of Member States, Norway, Switzerland and Japan where data on collected amounts by category are available are shown in terms of Kg per inhabitant for each product category in Table 43.

Country	Category Number										Totals
	1	2	3	4	5	6	7	8	9	10	1-10
Japan	2.58	n.d.	n.d.	0.82	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	N/A
Norway	8.15	0.46	2.68	2.01	-	-	0.04	0.06	-	0.01	13.41
Switzerland	4.19	1.40	3.52	2.17	0.12	0.04	0.01	0.00	0.00	0.00	11.44
Austria	2.00	0.3	0.1	0.2	0.1	Inc 2	Inc 2	Inc 2	Inc 2	Inc 2	2.77
Belgium	2.99	1.12	1.16	1.64	0.20	0.14	0.00	0.02	0.00	0.00	7.26
Czech R	0.14	0.00	0.12	0.05	0.00	0.00	0.00	0.01	0.00	0.01	0.33
Estonia	0.48	0.00	0.04	0.10	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.63
Finland	4.75	0.28	1.44	1.30	0.27	0.03	0.00	0.02	0.01	0.00	8.10
Hungary	0.91	0.04	0.09	0.22	0.01	0.00	0.00	0.00	0.00	0.00	1.27
Ireland	6.68	0.28	0.43	0.67	0.09	0.07	n.d.	n.d.	0.00	n.d.	8.22
Netherlands	2.59	0.53	n.d.	1.18	0.03	0.06	0.03	0.00	0.00	0.02	4.44
Slovakia	0.35	0.04	0.05	0.20	0.02	0.00	0.00	0.00	0.00	0.00	0.66
Sweden	5.01	1.41	2.54	2.36	0.74	0.11	0.02	0.02	n.d.	n.d.	12.20
UK	7.17	0.54	0.59	1.10	0.04	0.35	0.16	0.00	0.00	0.00	9.95
J/NO/CH average	4.97	0.93	3.10	1.67	0.06	0.02	0.02	0.03	0.00	0.01	10.80
Euro average	3.11	0.42	0.65	0.88	0.14	0.08	0.02	0.01	0.00	0.00	5.31

n.d. = no data, Inc 2 = included in category 2 figure

Table 43: Collection performance (Kg/inhabitant) by Category

Note that Japanese legislation requires the collection and recycling of only 4 types of equipment (washing machines, refrigerators, TVs (i.e. CRTs), and air conditioning units). Consequently, the figures for Kg/inhabitant do not cover the whole category range for WEEE. However, these types of equipment represent a significant proportion of WEEE in overall weight terms. Hence, the comparable performance for category 1 (Large Household Appliances) as displayed in the table above.

Although collection performance for category 1 equipment for EU15 Member States is similar to performance in Norway and Switzerland, it would appear that Norway and Switzerland perform better when collecting other categories of equipment. This may be due to the relative maturity of the collection systems in these two countries, their high GDP as well as their geographical situation and level of control over their own borders/ harbours and thus avoidance of waste shipments. Sweden is the only EU country listed that has overall comparable performance (Cat. 1-10 = 12.2 kg/inhabitant).

As the average overall EU performance is 5.31 kg/inhabitant for the running systems, the current WEEE Directive collection target (4 Kg/inhabitant) is clearly not a very challenging one for EU15 countries. However, for the new Member States, this is a serious challenge.

Amounts of WEEE Treated

Data on amounts of WEEE treated are limited to the countries with systems in place for a longer period. Sometimes, it was found that the amounts claimed to have been treated were higher than the amounts collected, or that kg/inhabitant figures for amounts treated were not consistent (i.e. higher) with kg/inhabitant figures for collection (or even products placed on the market). For example, data for Estonia received showed kg/inhabitant figures of 0.63, 4.6 and 4.3 for amounts collected, treated, and put on market respectively. If all of these are correct, then a significant proportion of WEEE must be collected through 'unofficial' channels.

It would appear that data on amounts treated may have included items outside of the scope of WEEE. For example, in the past, a shredder operator might have had great difficulty in identifying which proportions of his outputs were attributable to WEEE input. As the national registers become better established and the systems for tracking evidence of recycling and recovery become widely adopted, , like for example with the WEEE Forum REPTOOL, the data in this part of the waste management chain will begin to improve.

Estimates can be made of amounts treated as a percentage of WEEE arisings from examination of average data provided by the previous sources combined with data from the recyclers (EERA 2007) on the amounts treated across the EU. These estimates are presented in Table 56 in Chapter 8.0.5. and have been used to assess the impacts (environmental and economic) of collection and treatment of WEEE for the current situation in 2005. The situation has also been presented for the case of assuming full implementation of the Directive (see Table 58 in Chapter 8.0.5).

Conclusion

The average compositional breakdown for the EU has been calculated from data collected using all of the available data outlined above and is shown in Table 44 below.

No.	Description	Abbreviation	Subcategory	Category
1	**Large Household Appliances**	**(LHA)**		**49.07%**
1A	Large Household Appliances	(LHHA)	27.70%	
1B	Cooling and freezing	(C&F)	17.74%	
1C	Large Household Appliances (smaller items)	(LHHA-small)	3.63%	
2	**Small Household Appliances**	**(SHA)**		**7.01%**
2	Small Household Appliances	(SHHA)	7.01%	
3	**IT and telecom equipment**	**(IT&T)**		**16.27%**
3A	IT and Telecom excl. CRT's	(IT ex CRT)	8.00%	
3B	CRT monitors	(IT CRT)	8.27%	
3C	LCD monitors	(IT FDP)	0.00%	
4	**Consumer equipment**	**(CE)**		**21.10%**
4A	Consumer Electronics excl. CRT's	(CE ex CRT)	7.82%	
4B	CRT TV's	(CE CRT)	13.28%	
4C	Flat Panel TV's	(CE FDP)	0.00%	
5	**Lighting equipment**	**(Light)**		**2.40%**
5A	Lighting equipment – Luminaires	(LUM)	0.70%	
5B	Lighting equipment – Lamps	(Lamps)	1.70%	
6	**Electrical and electronic tools**	**(Tools)**	**3.52%**	**3.52%**
7	**Toys, leisure and sports equipment**	**(Toys)**	**0.11%**	**0.11%**
8	**Medical devices**	**(Med.)**	**0.12%**	**0.12%**
9	**Monitoring and control instruments**	**(M&C)**	**0.21%**	**0.21%**
10	**Automatic dispensers**	**(Aut.Disp.)**	**0.18%**	**0.18%**
	Totals		**100.00%**	**100.00%**

Table 44: Average category composition of collected WEEE

For the purposes of assessment and analysis of the amounts collected by compliance schemes operating currently across the EU, the table above can be rearranged according to five main treatment categories. These treatment categories represent the typical groupings of equipment handled by collection points. This rearranged table is presented in Table 56 in Chapter 8.0.5.

EU15 Member States' collection performance is comparable with collection performance observed elsewhere internationally. Although most EU15 countries are slightly behind the likes of Norway and Switzerland, this is mainly due to lower performance in the collection of categories other than category 1. The WEEE Directive collection target can be easily met by EU15 Member States, but remains a very challenging target for the New Member States. It is noteworthy that, even in Sweden, only ~50% of WEEE which has been sold some ten years ago is collected and treated in WEEE systems operating according to the Directive. The most interesting finding however is that there are very large differences in performance by different member states per category. This indicates a need for improvement in collection performance. In addition, more data sets are required to draw firm conclusions about quantities of WEEE treated and the rationale and differing impacts of high versus low treatment in different member states. In order to judge how treatment performance can be improved such insights are necessary in order to determine the causes e.g. availability of collection points, geographical location, culture, MSW collection methods, presence of harbours, etc.

Recommendations

The purpose of a collection target is to ensure that a high level of return of equipment reaching end-of-life is achieved, thereby minimising the leakage of potentially hazardous materials into the environment whilst ensuring a high level of resource conservation. This will be further discussed in detail in Chapter 10.2, where also the mechanisms behind leakage will be discussed.

To achieve the aims of the WEEE Directive, it is important that targets should be challenging and achievable for all Member States. This will require targets to be set in a way that accommodates the particular circumstances faced by each Member State with the ultimate aim of bringing all Member States up to parity.

7.4 Treatment Capacities (Task 1.2.3) and Impacts of WEEE Categories and Technologies (Task 1.2.5)

Data Gathered

7.4.1 Treatment Capacities (Task 1.2.3)

This section initially looks at the types of WEEE which are collected, and then describes the types of processes which are used to treat WEEE items. It then provides a more detailed assessment of methods for producing a plastics fraction from WEEE items. Note that this refers to "Best Available Techniques" (BATs), and that these BATs are not always available inside each individual Member State, either due to delay in investment or due to lacking economy of scale.

Composition of Collected WEEE

For the purposes of this study an average category composition of collected WEEE has been determined from calculations on data from a number of sources (see Table 44 in Chapter 7.3). The materials breakdown of WEEE items differs by type of equipment and by different models and makes of equipment. From the data obtained during this work, average compositional contents of differing types of equipment have been derived. These are shown in Chapter 8.2.

WEEE Processing Capacity

Treatment processes aim at either removing the hazardous items from WEEE or at separation of as much as possible of the main recyclable materials (e.g. Metals, glass, and plastics), or both of these aims. The European trade association for WEEE recyclers is the European Electronics Recyclers Association (EERA). EERA aims for the harmonization of national and international regulations for WEEE recycling in order to achieve a free market for demand and supply of environmentally sound processing services. The EERA members are signatories to codes of conduct that aim to safeguard the protection of human health and the environment.The EERA members treat around 1200 kton of WEEE annually in 2005 and expect this to be 1500 kton in 2006 (EERA 2007). It is estimated that the EERA members represent around 60% of the EU market and thus the total amounts treated for 2005 are around 2 million tons.

Although very limited information on WEEE treatment capacity in the EU27 Member States has been obtained, it is likely that the EU15 Member States should have installed sufficient capacity to treat collected WEEE by the middle of 2007. For example, a report (ICER 2006b) on treatment capacity in the UK produced in 2006 found that the UK already had in place sufficient capacity to treat most of the WEEE that is likely to be separately collected. There were two areas where there was a shortfall: small mixed WEEE and CRTs. However, when all the planned integrated facilities are in place (this is expected by June 2007), there should be enough capacity to treat all small mixed WEEE. The capacity for processing CRT's is also likely to be expanded to meet demand now that the UK has implemented the WEEE Directive.

The situation in Central and Eastern Europe is likely to be different, and it currently appears that a regional approach will be adopted. For example, Lithuania is planning to serve the Baltic States needs, and Hungary is expected to provide capacity for its neighbouring countries, which will include Bulgaria and Romania. Limited data obtained from Member State responses to questionnaires and other published sources are shown in the table below.

Country	Amounts* treated in Country (tonnes)	Amounts exported for treatment (tonnes)
Estonia	1143	5044
Finland	35086	585
Hungary	10257	-
Latvia	3095	-
Lithuania	1897	-
Netherlands	72103	-
Poland	12080	-
Slovakia	2556	-
Slovenia	316	-
Totals	**138533**	**5629**

Table 45: Reported tonnages of WEEE treated

* Reported in either 2005 or 2006

Given the very limited data availability on amounts of WEEE treated through 'official' WEEE system channels, it is clear that the management of significant proportions of WEEE currently go unreported.

7.4.2 Technologies

WEEE can be processed using long established processes, such as the use of shredders/fragmentisers to process the majority of items in category 1 apart from fridges and freezers (shredders and fragmentisers also processed fridges and freezers until the legislation on ozone depleting substances (ODS) was introduced).

For a number of products e.g. fridges and freezers, small WEEE items, CRTs and fluorescent lighting, specialist processing facilities are required. Some of these specialised processes may be located at an integrated WEEE treatment facility that has been designed to treat smaller WEEE items in accordance with the treatment requirements of the WEEE Directive. In addition, dismantlers process some IT and telecoms equipment.

Shredders/Fragmentisers

Shredders/fragmentisers are long-established processes for treating general ferrous metal. They normally process a mixture of end-of-life vehicles (ELVs), mixed light iron items, and large household appliances (white goods). The fragmentiser shreds the material to less than 150 mm in size, and the shredded material is fed to an air separator which separates the material into two fractions; a heavy, metal-rich, stream and a light, mainly non-metallic stream. Ferrous metal is extracted from the heavy stream using an overband magnet to produce the ferrous metal product. The remaining material from the heavy product, which is a mixture of non-ferrous metals, rubber and other non-metallic items, is then processed in a heavy media plant to recover the non-ferrous metals. The light stream, which is the residual waste stream, contains materials such as plastics.

The residual waste stream was historically consigned to landfill. However, the introduction of the WEEE Directive (and the ELV Directive) now means that processing of this stream is now necessary in order to meet the recycling targets for both category 1 WEEE items and ELVs. The additional processing is mainly concentrating on recovering plastics.

Dismantlers

Dismantling of ICT equipment has been operating for many years. This is because whilst it is a labour intensive process, the value of the materials and components is greater than the cost for dismantling. Some mechanical processing of the dismantled units may be conducted to enable additional materials to be separated for recycling.

Some dismantlers are likely to expand their operations by processing small mixed WEEE items. This is because manufacturers will need to meet the costs for this activity.

Fridges and Freezers

The Ozone Depleting Substances Regulation, which came into force in January 2002, requires all ozone depleting substances to be recovered from refrigeration equipment.

In fridges and freezers both the coolant and insulating foam can contain Ozone depleting substances. There are several techniques for recycling fridges including various stages:

1. Puncture coolant circuit to drain/remove the liquid coolant,
2. Manual removal of compressor and coolant circuit and removal of trays, switches, plugs and cables etc.,
3. Shredding of fridge in a sealed container with nitrogen injected to prevent possible explosions and compress the CFCs. (The shredding is often through use of a horizontal accelerating tool),
4. Removal and containment of the nitrogen dust after shredding has been completed,
5. Separation of shredded products e.g. metals (through using magnetic and eddy, foam and plastics through sieving,
6. Recovered Ozone depleting substances (including foam) are incinerated at high temperatures to destroy the chlorine and prevent further environmental damage. Other destruction methods use chemical or catalytic processes.

Small WEEE Items

Processes for treating these items are based on shredding, followed by mechanical separation. One process (Sims Mirec 2007) uses a two stage shredding process to reduce the material to less than 20 mm in size. Metal is then extracted from the shredded material using an overband magnet to remove ferrous metal followed by an eddy current separator which removes non-ferrous metal. The remaining non-metallic material is then processed in a water separator that produces two product streams; one is mainly circuit boards and wire, whilst the other contains mixed plastics and glass. The mixed plastics and glass stream is then sent to another process for further separation to recover the plastics.

Fluorescent Lighting

Fluorescent lights are classified as hazardous under the European Hazardous Waste Directive because of their mercury content. Annex II of the WEEE Directive requires that the mercury be removed from these lights. Currently there are two methods for removing mercury from fluorescent lamps. One method is to cut the end off the tube and remove the mercury and phosphor powder, and the second is to shred the complete light and then mechanically separate out the powder.

An established technique for re-processing fluorescent tubes involves breaking the tube into waste fractions and then extracting the mercury. The process is done in two stages:

1. The fluorescent tubes are crushed, sieved and separated producing a fluorescent powder, glass and metal. The powder is heated under vacuum while simultaneously supplying oxygen to the afterburner. Through varying the vacuum pressure mercury can be extracted from the powder and collected in condensers. Approximately 99% of the mercury can be recovered,
2. Alternatively size reduction equipment techniques can be used. These operate by crushing the tubes, while a filter traps the mercury vapour that can then be either disposed of or sent for recycling. The mercury can be sold back into industry for use in products such as barometers, thermometers etc. The glass used to make other glass products such as containers and the end pieces (normally consisting of either brass or aluminium) of the tubes sold on to scrap metal merchants to be reprocessed.

Cathode Ray Tubes (CRTs)

The WEEE Directive requires that the CRT is removed from the TV/monitor, and that the fluorescent coating in the CRT is removed. The methods that can be used to achieve this are:

1. Manually remove the CRT from the TV/monitor, split it to separate the funnel glass from the front panel glass, and manually remove the coating from the front panel glass,
2. Manually remove the CRT from the TV/monitor, shred it, and then mechanically recover the products (including the coating).

The main approach that is used is removal of the CRT, followed by separating the front glass from the panel glass. There are six methods that can be used to split the front glass from the panel glass:

1. NiChrome hot wire cutting,
2. Thermal shock,
3. Laser Cutting,
4. Diamond wire,
5. Diamond saw,
6. Water jet.

The Water jet method is being developed in the USA and the diamond wire method is very slow and generates dust. Most of the technical problems with the Nichrome hot wire method have been overcome, and the laser cutting method is also being used (Proventia, 2007) commercially.

After the front glass and funnel glass have been separated, the fluorescent coating is removed. Cutting processes use water as a lubricant and this turns the phosphor coating into a sludge which is then vacuumed off.

The alternative processes involve shredding of the CRT, and then separating the front and panel glass and recovering the coating. When the whole unit is shredded, the glass is mechanically separated from the other material streams, such as metals, plastics, circuit board and cable. The two types of glass can be separated using a number of different techniques including density separation, sizing, UV light, visible light or X-ray fluorescence. One example of this type of process is that developed by the Sims Mirec group (Sims Mirec 2007).

One potential issue with this option is demonstrating compliance with the Annex II requirement that the fluorescent coatings have been removed as a separately identifiable fraction. Furthermore, it is unlikely to be regarded as BATRRT (best available treatment, recycling, and recovery techniques) if the mixing and contamination of the various fractions preclude recycling of the glass.

A further potential treatment route for CRTs is in lead recycling. This smelting process could take un-shredded CRTs, but may not "technically" meet the requirements of Annex II regarding removal of the fluorescent coating. This will be further analyzed in chapter 8.2.4.[2]

[2] For more details on this see Huisman 2004c, 2005a

Plastics

Little information exists about the actual amount and composition of collected WEEE plastics in Europe, but Figure 13 shows that on average, plastics make up about 20% by weight of end-of-life electronic products, although the share of plastics and the polymer composition vary enormously between categories (ETC/WRM 2000, APME 2001).

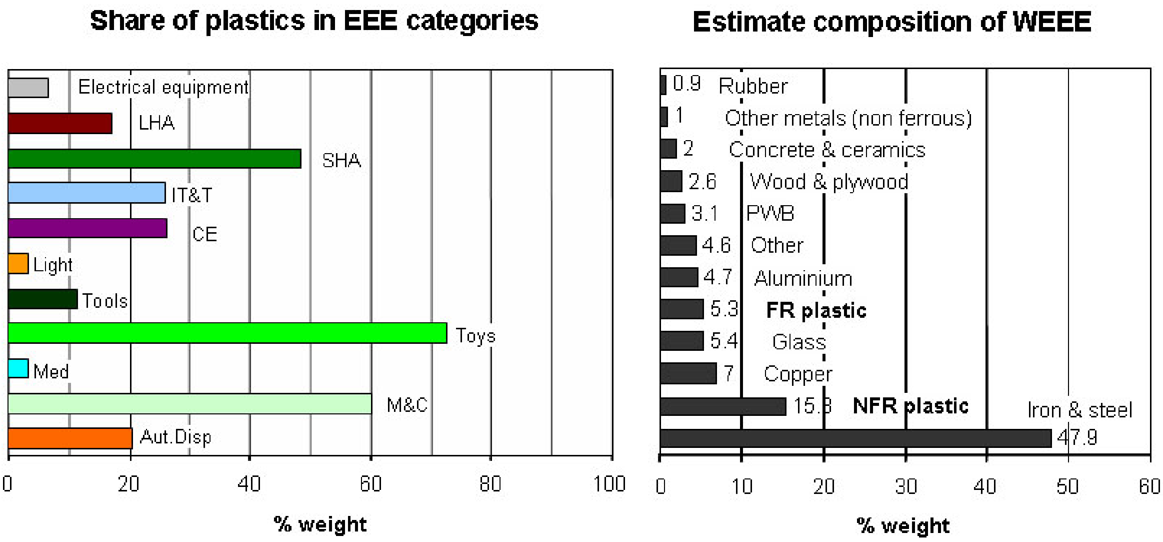

Figure 13: Average plastic in each of the E&E categories (left) and its overall content in WEEE (right)

Figure 14 shows that just three (IT&T equipment, large household appliances and consumer electronics) out of the ten WEEE categories covered by the Directive 2002/96/EC account for around 85% of plastic consumption in the sector (APME 2001).

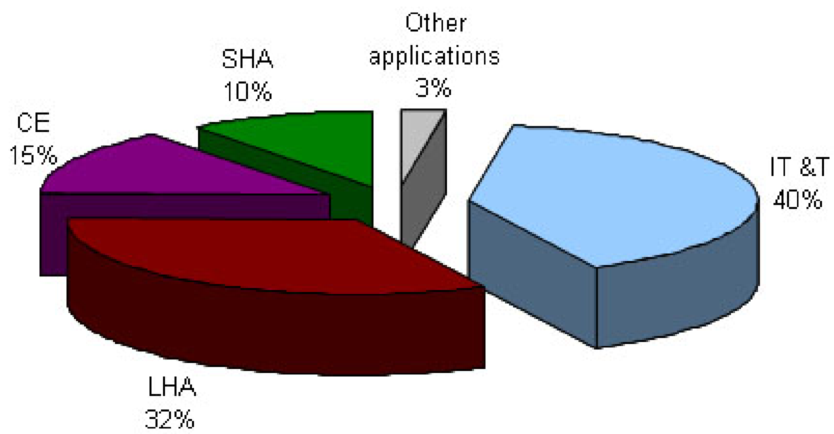

Figure 14: Plastic consumption by main categories in E&E sector in Europe, Year 2000

And as depicted in Table 42, those same three categories represent above 85% of collected WEEE nowadays and, hence, are the major sources of recoverable plastic in the waste stream.

The conclusion from the national WEEE collection results shown in Figure 12 and the typical consumption figures by polymer supplied by the industry, the most common polymers in current collected WEEE are:

- Polystyrene (PS) and Acrylonnitrile Butadiene Styrene (ABS) from inner shelving and liner of cold appliances,
- ABS, Polycarbonate and ABS blends (PC/ABS) and High Impact Polystyrene (HIPS) from CE and IT&T equipment, such as TV sets and computers (especially monitors) and mobile phones,
- Polyurethane (PUR) from large household cooling appliances insulation,
- Polypropylene (PP) due to parts in large household appliances (e.g. washing machines and dishwashers).

Epoxy resins used as substrate in Printed Wiring Boards (PWBs) are another polymer that is consistently found in most collected WEEE, but that, due to removal requirements set out in the WEEE Directive and current industry practices, are directed to metal-rich recovery routes. In addition, a broad range of polymers are present in small quantities in miscellaneous WEEE, as they are used for specific roles.

Two main routes (see Figure 15) can be foreseen as alternative treatments for plastic from WEEE:

1. Pre-shredding mechanical recycling treatments (based on hand/automated sorting & disassembly of large plastic parts), and
2. Post-shredding technologies, either aimed at mechanical recycling of sorted polymers fractions or at recovery of mixed plastics —or unsorted shredder residue.

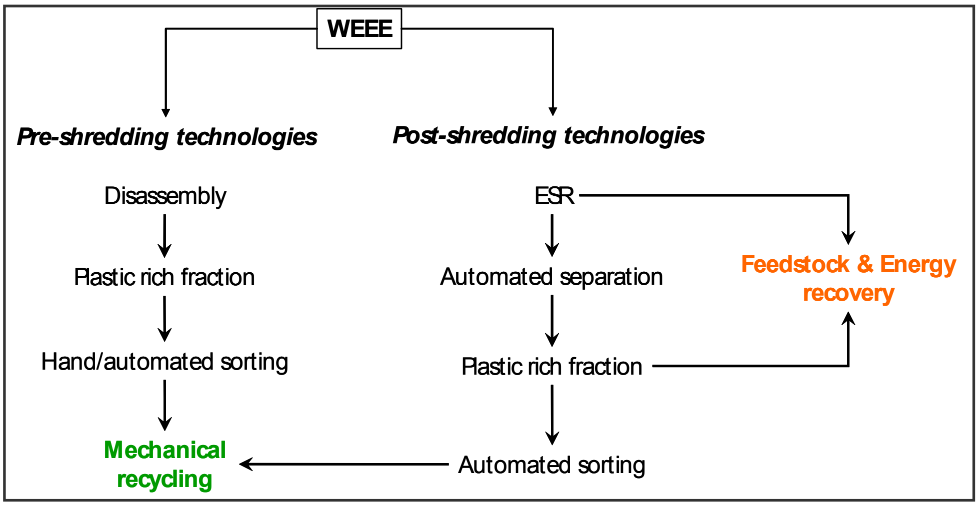

Figure 15: Treatment routes for WEEE plastics

In the case of large plastic parts from manual dismantling, the recycling alternative usually consists of several steps of cleaning and inserts removal, the (automated) identification of polymers/additives and the sorting into regrind compatible fractions for reprocessing. This recycling option is usually the treatment choice for styrenics from housings of TVs & monitors and inner shelving & lining of cooling appliances, as well as the potential alternative for the rigid PUR foam insulation of refrigerators and freezers. The recycling options for miscellaneous small equipment, (e.g. mobile phones, SHA, IT peripherals) are mechanical treatment based on coarse shredding and mechanical separation of plastics into different polymer fractions.

Processes that can accept the whole waste stream or post shredder plastic rich mixtures from electronic scrap (ESR) can be viable alternatives to help increase the recovery ratio of complex waste mixtures like WEEE, where the presence of fillers and additives in the heterogeneous polymer fraction, as well as contamination with other materials, hinders recycling by requiring expensive sorting and cleaning stages and affecting the final quality of the plastic recyclates. Incineration with energy recovery and use of plastic rich ESR as secondary fuel and raw material in industrial processes (cement kilns, blast and smelter furnaces) are recovery solutions to otherwise untreated waste fractions annually in excess in the EU such as plastic content in shredder residue. Feedstock recovery processes (especially oxidative and thermal processes: pyrolysis, gasification and combined technologies) are a reasonable alternative to combustion for opening new markets to materials and energy recovered from plastic waste (pyrolytic oils, syngas, methanol, olefins, marketable non-plastic by products such as vitrified mineral slag and electricity or district heating), Unfortunately there is limited market availability of feedstock recovery processes within the EU currently.

Publicly available literature that describes polymer recovery processes and assesses their suitability for treating plastic fractions from WEEE can be found within the following references: Boerrigter 2000, Boerrigter 2001, Tukker 1999, Fisher 2005, Mark 2005, Mark 2006, Delavelle 2005.

A brief description of some of the most common recovery processes is also included in Annex 7.4.2, which also contains a detailed table of the technologies identified to date that are specifically designed for or can accept WEEE plastic, showing their status of development, capacity treatments and the outputs of the processes.

The shortage of data about quantities of WEEE collected, recycled and recovered is particularly pertinent with reference to the amounts of plastic materials separated from WEEE that are effectively treated and fed back into manufacturing processes. In order to ascertain the polymer treatment methods applied, the actual volumes and characteristics of the plastic waste fraction undergoing mechanical recycling and those of the fractions ending in energy recovery and disposal, the project team has conducted a survey among industry and Public Administration stakeholders to estimate the existing and future treatment capacities.

The results of the survey among WEEE recycling EERA members confirm the lack of information about the amounts of plastics generated from WEEE treatment and their final destinations (see Figure 16). When positive answers have been obtained, recycling appears as the most frequently declared end for plastic fractions - both mixed and sorted. In the case of mixed plastic fractions several recyclers have also declared that those streams are totally or partially disposed of without any recovery (landfill/incineration) or sent to other recovery options i.e. energy recovery. The individual shares of sorted plastic fractions ending up landfilled or used for energy recovery are minor: 10% of total amount generated by one respondent and 20% of sorted plastic stream produced by another interviewee (EERA 2007).

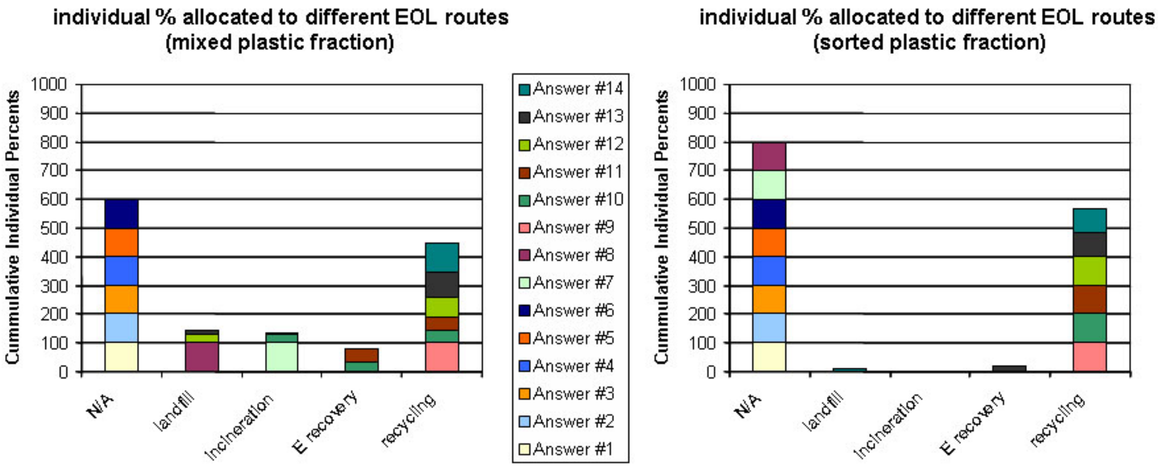

Figure 16: Individual percentage (by weight) of plastic fractions generated from WEEE treatment directed to different disposal/recovery routes

In 2004, ADEME (Delavelle 2005) conducted a similar survey among WEEE recyclers in France and the answers received proved that plastic mechanical recycling and recovery through oxidative thermal methods (pyrolysis/gasification) were the most common choices. The survey also investigated the degree of development of the different recovery options chosen. Figure 17 shows the distribution (in number) of the ways of recovery of the plastics resulting from WEEE in France in 2004, according to their degree of development, as surveyed.

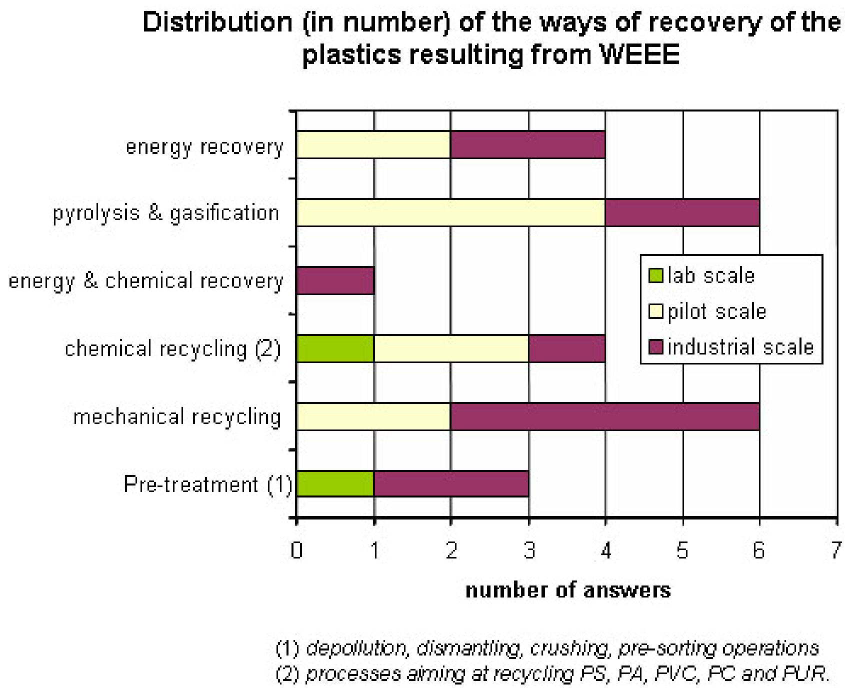

Figure 17: Distribution of recovery ways of WEEP in France (Delavelle 2005)

The responses to both surveys give an indication of the relative number of treatment/disposal options chosen for plastic generated from WEEE as declared by recyclers, but the actual shares of WEEE plastics sent to the various disposal and recovery options remain undisclosed as no data about plastic tonnes generated/treated were provided together with those figures.

The European Plastics Recyclers Association (EuPR) estimates that the overall plastics mechanical recycling rates for all applications in Europe is only 4.1% of plastics raw material placed on the European market, i.e. 2.2 million tonnes total processed waste in the EU (EuPR 2006). An average mechanical recycling level below 16% is achieved in the EU for post-consumer packaging, but the rates are very low for other streams such as electronics. EuPR claims that the recycling levels for post-consumer plastics waste went down in 2004 and the export flows are continuing to damage their business. According to the last Plastics Europe estimates, total recovery of WEEP, as a proportion of end-use plastics waste, stood at around 4.1% in 2002 —equivalent to 35,000 tonnes (PlasticsEurope, 2006).

An analysis of the publicly available annual reports of some of the long-running WEEE compliance schemes and plastic recyclers associations allows some additional data about plastic recycling to be extracted: 230 tonnes of non BFR plastics were recycled in Norway in 2005 (El-Retur 2006) and almost 1,500 tonnes of BFR plastics destroyed. On the other hand, around 5800 tonnes of plastic-metal mixtures (PWB incl.) were also recycled. The total collected WEEE amounted to 61,729 tonnes. In Belgium (Recupel 2007), 55% plastic recycling was claimed in year 2005, with the following shares per WEEE categories: 50% plastic in cooling appliances, 45% in other LHHA, 71% in screens and 53% in other applications. Considering the average plastic content in the different WEEE categories indicated and the breakdown figures of the total 67,634 tonnes collected, an estimate of 7,700 tonnes recycled plastics can be calculated. In Spain, the amounts of plastics from brown and white goods recycled in 2003 were 4,738 tonnes and 1,074 tonnes, respectively (ANAIP 2004). On the other hand, several authors have reported on potential treatment capacities for plastics in general and for WEEP in particular, via different technologies.

Conclusions

In summary, from the best understanding of the present situation and the potentially successful scaling up of the most promising industry trials, the following recycling and recovery potential capacities for WEEE plastics in the EU can be estimated:

Technology	Capacity (estimate)	Comments	Reference
Mechanical recycling	> 80,000 tpa	35,000 t (in 2002, prior to MBA plant) + 40,000 t MBA Austria	(PlasticsEurope, 2006) (Slijkhuis, 2006)
Feedstock recycling: secondary raw material in metal smelters	55,000 tpa PWB (plastic 30-70%) + 30,000 tpa WEEE (25% plastic) Or 19,000 tpa WEEP (in metal rich mixtures) + 10,000 tpa PWBs (plastic 30-70%)	3 smelters in the EU: >30,000 t/yr WEEE (25% plastic content) 45,000 t/yr PWBs or 15,000 t/yr WEEE plastics metal rich (76% plastic content). 10,000 t/yr PWBs (plastic content: 30-70%),	(Tange 2006)
Feedstock recycling: secondary raw material in blast furnaces	1.6 Mtpa MPW (% WEEP= n.a.)	1.6 Mt Plastics or RDF, considering World crude steel production in 2003, for EU (15) + rest of Europe, ISRI , replacement potential 0.03 t RDF/ t pig iron	(Mark 2005)
Feedstock recycling:	40,000 tpa	Potential SVZ plant WEEP	(tecpol 2006)

Technology	Capacity (estimate)	Comments	Reference
gasification		capacity based on trials	
Energy recovery: co-combustion in MSWI	5 Mtpa of MPW (% WEEP= n.a.)	304 large (>30,000 tpa) MSWI plants in Europe in 2000. Typical plants capacity >100,000 tpa. 96% of the large plants recover energy from waste.	(Mark 2005)
Energy recovery: secondary fuel at cement kilns	> 6.0 Mtpa of MPW (% WEEP= n.a.)		(Mark 2005)

n.a. = not available

Table 46: Potential capacity treatments for plastics generated from WEEE treatment

Note that the lack of available or declared recycling and recovery percentages should be taken into consideration. Even the WEEE Forum cannot yet deliver an overview as their REPTOOL has not been fully implemented on this. More importantly, this indicates a clear lack of overview on what (contacted) recyclers are doing.

Analysis

7.4.3 Impacts of WEEE Categories and Technologies (Task 1.2.5)

The three main materials arising from WEEE are metals, glass and plastics.

Metals

There appear to be no major difficulties concerning the recovery and recycling of metals from WEEE. There are ample capacities and markets available.

Glass

The main source of glass in WEEE is in displays (both CRTs and Flat Panel displays). Whilst our impact assessments indicate that closed-loop recycling of CRT glass is preferable, there are declining markets for new CRTs. Alternative outlets will be necessary and are summarised below (see sections: Cathode Ray Tubes, liquid crystal displays and plasma displays below).

Plastics

Data from literature seems to confirm that at present plastic output streams from WEEE recycling operations are mostly not recovered, but are landfilled together with other residue streams, as opposed to the apparent preference for the recycling option that could be concluded from the responses to the enquiry exercise.

In spite of the lack of information and current monitoring of the flows of WEEE plastic fractions, some estimates of potentially achievable recycling and recovery capacities are offered through the extrapolation of figures for industrial scale trials to industry installed capacities, provided that inlet requirements and process adaptations are given.

Several questions arise when evaluating the WEEP treatment options and market capacities. On the one hand, plastic dominated categories such as SHHA, CE and toys should rely on substantial plastic recycling and recovery to attain the targets set in the Directive. On the other hand Annex II requires that plastics containing brominated flame retardants are removed from any separately collected WEEE and are disposed of or recovered in compliance with Article 4 of Council Directive 75/442/EEC on Waste. Therefore, some points require further clarification:

1. Clear distinctions are required between recovery and disposal. These distinctions should be backed up by objective generally applicable definitions of removal, recycling and recovery which are required in order to assess the fulfilment of recycling and recovery targets and to classify accordingly the processes that the WEEE may undergo (e.g. debates concerning the use of waste as a fuel in cement kilns being classified as recovery, while burning waste in dedicated incinerators, even with energy recovery, is to be classified as disposal…),
2. Annex II and RoHS Directive requirements about BFR should be aligned to avoid contradictory approaches to some substances and components as, for instance, DecaBDE containing plastics, TBBPA in PWB substrates (removal obligations for PWBs with surface $<10\ cm^2$?),
3. The removal obligation can reduce the amount of plastics available for recycling and hinder the meeting of recycling targets in some plastic dominated WEEE categories,
4. Recycling of BFR plastics into non E&E applications (houseware, automotive, building…) can cause dispersion of additives into other diverse streams, which could be interpreted as against the principle that recovery should ensure that pollutants are not transferred into products and minimises the formation, transfer and dispersion of hazardous substances in the process.

Annex II Issues

Article 6 of the WEEE Directive requires Member States to ensure that producers (of EEE), or third parties acting on their behalf, set up systems in accordance with community legislation to provide for the treatment of WEEE using best available treatment, recovery and recycling techniques (BATRRT). These systems may be set up individually by producers, or collectively. The systems must comply with Article 4 of the Waste Framework Directive and treatment must, as a minimum, include the removal of all fluids and selective treatment in accordance with Annex II of the Directive. The UK is one Member State that has produced (DEFRA 2006) a guidance document on this aspect.

The de-polluting activities required under the WEEE Directive are narrower in scope than the classifications under the Hazardous Waste List. A number of studies (AEA 2004, AEA 2006, Rotter and Janz 2006a, Rotter and Janz 2006b) have assessed the chemical composition of WEEE items, and discussed whether or not these items are hazardous. The work conducted in the UK concluded that the removal and treatment requirements of Annex II of the WEEE Directive were generally in line with the requirements of the Hazardous Waste Directive.

However, a number of potential issues have been identified regarding the Annex II requirements. Some of these relate to hazardous content, whilst others are due to operational (and hence cost) issues. Consequently, it is necessary to consider whether changes to Annex II for each of the following requirements are required.

Technologies to Treat Refrigerants

Refrigerants

Annex II requires that:

The following substances are removed from any separately collected WEEE:

- Chlorofluorocarbons (CFCs),
- Hydro chlorofluorocarbons (HCFCs),
- Hydro fluorocarbons (HFCs), and
- Hydrocarbons (HCs).

For 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.

CFCs and HCFCs were used in fridges and freezers until the early 1990s, when it was found that these chlorinated gases damaged the ozone layer. Regulation 3093/1994 amended by Regulation 2037/2000 banned their manufacture and regulated their treatment. Due to the long life cycle of cooling appliances, those gases still make up a significant part of today's WEEE stream.

HFC was introduced as a substitute to CFC and HCFC and is currently still used. Although HFCs do not contribute to damage to the ozone layer, they are global warming gases with a GWP above 15, and therefore require proper treatment in order to meet the requirements of Annex II.

In the mid-1990s, manufacturers started to make use of hydrocarbons as refrigerants (isobutane) in the compressor cooling system and as blowing agents for the polyurethane foam insulation (cyclopentane). The hydrocarbons used in refrigerators, freezers and air conditioners do not deplete the ozone layer, and their GWP is typically 3 or 4, i.e. below the GWP threshold of 15 set by Annex II.

The current wording of Annex II can be interpreted as implying that as the hydrocarbons used in fridges and freezers have both no ozone depletion potential and a global warming potential of less than 15, they do not need to be extracted when the appliance is recycled. The main environmental issue for the hydrocarbons used as refrigerants is their contribution to volatile organic compound (VOC) emissions. However, studies (United Nations 1991, Fraunhofer 2005) have identified that the level of VOC emissions from hydrocarbons used as refrigerants is small when compared to emissions from vehicle traffic. This suggests that there is very little justification on environmental grounds for the hydrocarbons used in cooling appliances to be extracted from the appliances and treated. Consequently, CECED, together with EERA and the WEEE-forum, have developed a protocol (CECED 2007) for recycling these appliances. This requires the removal of liquid refrigerants, but allows for emissions of hydrocarbons from the insulation foam provided that the level of emissions complies with national legislation. The protocol also covers health and safety issues, particularly measures that significantly reduce explosion potential. See Chapter 8.2.2 for more details on the environmental impact assessment on these appliances.

The current number of WEEE items containing hydrocarbon refrigerants is likely to be low, but will increase in future. Consequently, this is an area of Annex II that will require clarification when revisions to the Directive are considered.

CRTs

Technologies to Treat Cathode Ray Tubes (CRTs)

Annex II requires that:

- The CRT has to be removed from separately collected WEEE, and
- The fluorescent coating in the CRT has to be removed.

A number of processes for achieving these requirements have been developed. These separate the CRT glass into front glass and funnel glass, and thus produce glass products which are suitable for recycling. These products could be used in the manufacture of new CRTs, but it is expected that current capacity will significantly decline over the next 5 years as flat panel displays (LCD and plasma) replace CRTs in televisions. This means that other markets for the glass will be required if the recycling targets for items in categories 3 and 4 are to be met. However, other markets are currently limited. One option is to use CRTs to provide silica for use in smelting furnaces, and this would also enable the lead in the funnel glass to be recovered. As the CRT could be used in this application without having to separate the two types of glass, this means that the fluorescent coating would not be removed. Consequently, the European Commission is currently considering whether the recycling of CRT glass through commercial smelting operations meets the treatment requirements in Annex II of the Directive. See Chapter 8.2.4 for more details and scenarios analyses as part of the environmental impact assessment.

LCDs

Technologies to treat Liquid Crystal Displays (LCDs)

Liquid crystal displays (LCDs) are used in a wide variety of applications. Liquid crystals are embedded between thin layers of glass and electrical control elements. A cellular phone display contains about 0.5mg of liquid crystals, and the display in a portable computer contains about 0.5g. The UK guidance for LCDs states that LCDs will need to be removed, and the backlights will then need to be separated from the LCD. Removed gas discharge back-lights and LCDs should be stored separately in appropriate labelled containers.

Work conducted in the UK (AEA 2006b) has shown that:

1. The presence of the liquid crystals does not exceed the hazardous waste threshold limits in the LCD panel (It should be noted that even if liquid crystals are classified as H14 R50-53 'Very toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment' giving a threshold limit of >=0.25%, then the LCD panel would not exceed this limit),
2. The design of a LCD unit makes it difficult to access the backlights in order to remove them unless suitable tools are used. It is also difficult to fully remove the backlight units from some LCD units without breaking them,
3. The LCD unit itself would not be hazardous on account of the mercury present in the backlights. However, if the backlights were removed, they would be classified as hazardous.

The report concluded that LCD units can be considered to be non-hazardous waste unless they are broken down into components, which is likely to happen when either dismantled or shredded.

Currently there are limited techniques for recycling LCDs (Sustainable Electronic and Electronic System for the Automotive Sector, 2006) and little economic evidence to justify the recovery of liquid crystals. This is because the LCDs may contain liquid crystals made from up to 500 different liquid crystal components requiring separation and purification and thus it is more economically attractive to utilise new liquid crystals.

Most LCD recycling processes focus on the utilisation of the glass. LCD screens are usually made of two glass sheets with a thin film of liquid crystal material sandwiched between. The Electronic Industries of Japan in 2000 conducted a survey investigating the potential for utilising recycled LCD glass in glass recycling initiatives. It found that substituting LCD glass for silica rock in Zinc recycling operations offered the most economically attractive recycling option (LCD Industries Committee, 2007).

Sharp plc (Sustainable Electronic and Electronic System for the Automotive Sector, 2006) has developed a technique for recovering the LCD glass through crushing, mixing with clay and feldspar before moulding the slurry into tiles before firing in a kiln. It has also developed techniques for recovery of the plastic components from LCDs.

In Europe the EU funded Liquid Crystal Display Reuse and Recycling (reLCD) project seeks to develop a cost effective technique for refurbishing discarded LCDs into working products. In the UK, academics at the University of York have developed technology they believe offers a "clean, efficient way to recover the mixture of liquid crystals from waste LCD devices" (LetsRecycle.com, 2006) though at present this technique has not been disclosed and is currently undergoing a period of testing.

Annex II of the Directive states that the Commission shall evaluate as a matter of priority whether the entry regarding liquid crystal displays needs to be amended. It may well consider whether or not it is necessary to remove the LCD unit. See Chapter 8.2.4 for more details on the environmental impact assessment of LCD screens.

Plasma TVs

Panasonic has developed a lead free plasma television that will enable cleaner recycling of the product (Digital Home, 2007). Traditionally lead oxide glass is a key component when manufacturing Plasma Display Panels, as the lead helps to maintain stable production and quality by optimising the softening points of the other materials. Panasonic has developed a new lead free glass material with similar properties to lead oxide glass, making the recovery of the glass panels easier.

Technologies to Treat Printed Circuit Boards

Circuit Boards

Annex II states that:

- Printed circuit boards of mobile phones and of other devices must be removed from any separately collected WEEE if the surface area of the circuit board is greater than 10 square centimetres.

An increasing number of white goods contain circuit boards that are larger than 10 square centimetres, for example, electronic timers in washing machines and variable speed controllers in vacuum cleaners. Nearly all electronic items, including, for example, calculators and remote control units, also contain circuit boards that may be larger than 10 square centimetres.

Recycling processes for WEEE items that contain a circuit board usually involve shredding of the item, followed by mechanical separation into different product streams. The current wording of Annex II can be interpreted as meaning either that circuit boards have to be removed whole (complete) before the item is shredded, or that the circuit board can be separated (as a number of pieces) from the shredded item. The first interpretation would involve manual dismantling, and this would have a high cost. Consequently, circuit boards tend to be preferably "removed" by separating them after the shredding process.

The circuit boards are usually sent to a smelter or precious metal refiner where the metals are recovered (the reinforced polymeric matrix of the circuit board is used for fuel and flux in the smelting operation).

Trials have also been conducted on processing mobile phones in a smelter. As the whole content of the phones is processed in the smelter, it could be argued that this does not meet the Annex II requirement to "remove" the circuit board. However due to the high precious metal content as well as the control over all metals this might be a preferable solution. See Chapter 8 for an analysis of all manual removal of printed circuit boards.

Annex II of the Directive states that the Commission shall evaluate as a matter of priority whether the entry regarding printed circuit boards for mobile phones needs to be amended. It may well consider whether or not it is necessary to remove the circuit board from collected mobile phones.

Technologies to Treat Capacitors

Capacitors

Annex II sets requirements for the removal of both of the following types of capacitors:

- Capacitors containing polychlorinated biphenyls (PCB),
- Electrolyte capacitors containing substances of concern (which have a height > 25 mm, and a diameter > 25 mm or proportionately similar volume).

Historically, polychlorinated biphenyls (PCBs) were extensively used in electrical equipment such as capacitors and transformers. However, their use in open applications was widely banned in 1972 and they have not been used in the manufacture of new equipment since 1986. Plants that had been installed prior to 1986 were allowed to continue until the end of their working life. Thus, unless an appliance is more than 20 years old, the chance that it contains capacitors containing PCBs is very remote.

Typically, large capacitors were used for power factor correction and similar duties. Small capacitors were used in fluorescent and other discharge luminaries and with fractional horsepower motors of the type used in domestic and light industrial electrical equipment. They were not labelled as containing PCBs, although they were normally date-coded, and thus, as a precautionary measure, it should be assumed that capacitors manufactured before 1976 contain PCBs unless they are marked as not containing PCBs.

Work conducted in the UK (AEA 2006b) found large capacitors in microwaves and lawnmowers. The report concluded that it is very unlikely that a capacitor in a microwave or lawnmower would contain PCBs, as they have not been used since the mid 1970's. The capacitor in one microwave was clearly marked as containing no PCBs. In addition, it should be noted that washing machines with more than one spin speed do not contain a starter capacitor.

It is very unlikely that PCBs have been used for many years in any capacitors fitted in the types of equipment that are being separately collected for recycling. However, given the environmental concerns regarding PCBs, and the fact that the occasional very old item containing a capacitor will be collected for recycling, it seems sensible for this requirement to remove capacitors containing PCBs to remain.

The second Annex II requirement is for removal of electrolytic capacitors which are above a specified size and contain "substances of concern". Capacitors of this size are typically used as smoothing capacitors in power supplies that use a transformer; for example those in stereo equipment. However, more modern equipment tends to use switch-mode power supplies that do not require large electrolytic capacitors.

There is currently no definition of "substances of concern". The assessment (AEA 2004) of hazardous content of an electrolytic capacitor conducted during the earlier study showed that capacitors, which are used in modern equipment, are very unlikely to be hazardous.

Nearly all capacitors of the size covered by the Annex II requirement are now mounted directly on a circuit board, and so are removed if the circuit board is removed. However, as discussed earlier in the section on circuit boards, these are generally separated from the WEEE item after it has been shredded. This means that the capacitor could not be separated for separate processing. Consequently, as electrolytic capacitors are very unlikely to be hazardous, and there is no definition of "substances of concern", the Commission needs to consider whether or not this requirement in Annex II could be removed.

Conclusions

Companies providing treatment capacity have made, or will be making, significant investments in equipment which will enable WEEE items to be treated in a manner which meets the Annex II requirements.

Although very little information on WEEE treatment capacity in the EU27 Member States was obtained, it is likely that the EU15 Member States should have installed sufficient capacity to treat WEEE arisings by the middle of 2007. The situation in Central and Eastern Europe is likely to be different, and it currently appears that a regional approach will be adopted. Lithuania is planning to serve the Baltic States needs, and Hungary is expected to provide capacity for its neighbouring countries, which will include Bulgaria and Romania.

Information on the plastic content of the different WEEE categories and the specific targets set in the WEEE Directive can be used to calculate that on average a recovery of 10% of total equipment weight could be achieved through the recovery of plastic polymers. As the average plastic content in electronic waste is about 20%, the fulfilment of the recovery targets may involve recovering half the plastic present in WEEE and recycling 25%. However the current recovery of polymers from electronic waste is limited and the actual recycling figures are some distance from these objectives. For example, as can be derived from the Spanish data: The 2003 recycling figures (5,800 t plastics from white and brown goods) indicate a recycling ratio of 18% of plastic present in those WEEE categories and around 14% of total plastic in collected WEEE (equivalent to less than 3% of total weight of collected WEEE).

Recommendations

There are a number of areas where either clarification of the requirements, or changes to the existing requirements, may be required. The main areas are:

- Refrigerants,
- Cathode ray tubes (CRTs),
- Brominated flame retarded plastics,
- Liquid crystal displays (LCDs),
- Printed circuit boards,
- Capacitors.

The Annex II requirements do not cover plasma displays (these contain phosphor coatings). As these are starting to appear in the waste stream, the treatment requirements for these will need to be considered. There may well be other items of equipment in future, which may raise concerns about proper treatment. Consequently, whilst there certainly appears to be a need for clarification on some of these requirements, the Commission will need to consider the impacts that any changes might have on both current and future investment in treatment capacity. This is further elaborated on in Chapter 10.5.

7.5 Markets for Secondary Materials (Task 1.2.4)

Data Gathered

Market failures (e.g. over supply) and barriers (e.g. poor recycling infrastructures or networks) often constrain and undermine some markets for secondary materials (OECD, 2005). Table 47 summarises the potential sources of market inefficiency for secondary materials.

Causes of Market Inefficiency	Explanation
Transaction costs in secondary materials markets	Arises from the diffuse and irregular nature of waste generation. May also arise from the heterogeneous nature of secondary materials.
Information failures related to waste quality	Arises from the difficulty of buyers to detect waste quality, and the relative ease with which sellers can conceal inferior quality goods.
Consumption externalities and risk aversion	Perceived costs associated with the quality of final goods derived from secondary materials relative to those derived from virgin materials.
Technological externalities related to products	Complexity of recycling due to the technical characteristics of the recyclable material and products from which secondary materials are derived.
Market Power in primary and secondary markets	Substitution between primary and recyclable materials may be restricted due to imperfect competition and strategic behaviour on the part of firms.

Table 47: **Potential Sources of Market Inefficiency (OECD, 2005)**

There are several factors that can negatively influence markets for secondary materials, including:

- Uncertainty (inconsistency) in the quality of the material to be recycled,
- Concerns associated with the ability of recycled materials to produce products of comparable quality to those utilising virgin materials,

- The potential additional costs and added complexity of using recycled materials,
- Identifying sources of recycled materials.

The extent of barriers and market failures can vary significantly between materials creating uncertainty for potential buyers or manufacturers. Buyers and manufacturers need to be educated/knowledgeable in a wide range of issues for all different types of materials.

However, markets for many recyclable materials are growing. This is often due to policy incentives and changes to commercial conditions as the utilisation of recycled materials can be more attractive (economically and environmentally) than virgin raw materials. Various initiatives have been adopted in the EU in recent years to assist the ability to overcome the barriers to secondary material markets, including:

- Economic (market) instruments to drive, stimulate, support and subsidise secondary material markets assisting their utilisation,
- Policy instruments to raise awareness of recycling materials assisting to overcome the lack of knowledge barriers,
- Technology advances are improving the opportunities to utilise more low quality recycled materials,
- Greater environmental awareness is challenging businesses to adopt more environmentally friendly practices and utilise secondary materials.

It is important to understand the interaction between the different potential policies to assess their impact upon the market for secondary recycled materials. Below are more detailed discussions on specific secondary markets for individual material streams that are commonly found in WEEE. This Section focuses on the main materials coming out of WEEE i.e. metals, glass, and plastics.

Metals

Over 400 million tonnes of metal are recycled worldwide each year. There are worldwide markets for recycled metals including Europe (particularly Spain) and Asia (particularly India). The metal recycling market is supported by the ease of which the metal components can be recovered and smelted down for reuse in new products. The quality of the new metal is of comparable quality to that using virgin material.

Ferrous Metals

Ferrous metals account for about 50% of the total weight of WEEE arisings; this mainly comes from large household appliances. There are no market issues for the clean shredded product produced by fragmentisers (which also process ferrous metal produced through dismantling operations).

As steel scrap is a vital ingredient in all steel-making processes, there is always ample demand for recycled steel with markets virtually unlimited. (European Confederation of Iron & Steel Industries, 2006). There is considerable diversity in the market for recycled steel and Figure 18 shows the relationship between global steel production and scrap consumption, highlighting the utilisation of scrap steel and the continued growth in the world scrap steel market in recent years. Figure 19 shows that this continued growth in demand for scrap steel resulted in a doubling of the market price between 1999 and 2004. See also Chapter 6.2.2.4, Table 4 for all material prices.

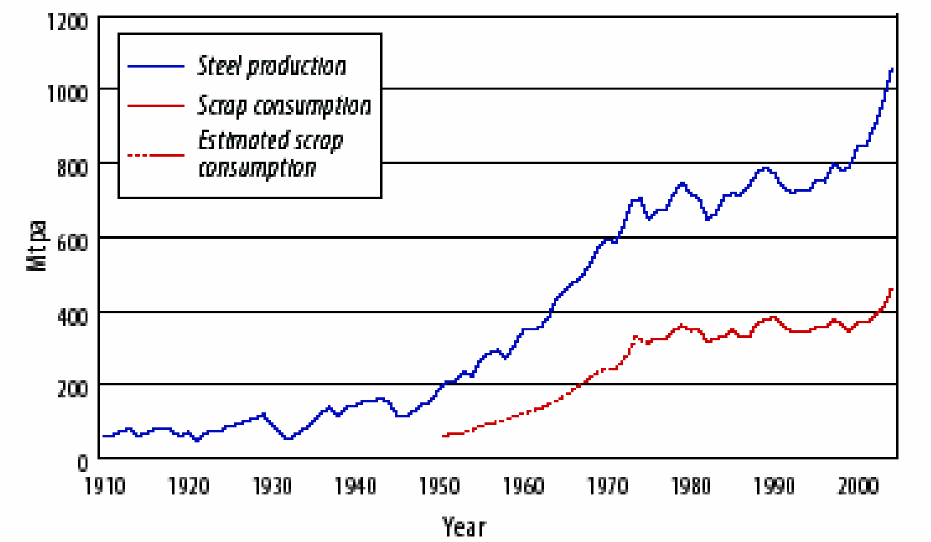

Figure 18: Global steel production vs. scrap consumption (Eurofer, 2006)

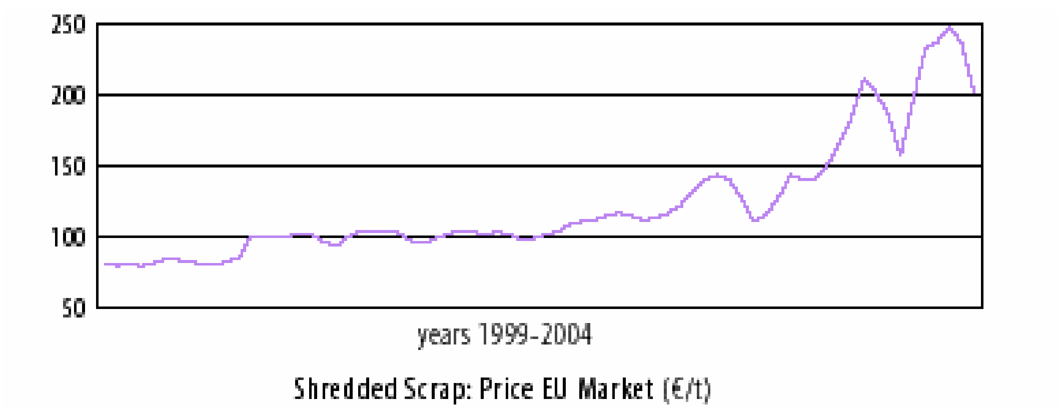

Figure 19: EU market price in €/t for shredded scrap steel (Eurofer, 2006)

Non-Ferrous Metal

Non-ferrous and precious metals account for about 5% of the total weight of WEEE arisings. The typical non-ferrous metals recovered from WEEE include Aluminium, Copper, Tin and Precious metals. The main uses for these non-ferrous metals in EEE are:

- Copper in cable, wiring, motors and circuit boards,
- Aluminium in heat sinks and casings,
- Brass in electrical contacts,
- Precious metals, particularly gold, palladium, platinum and silver, used as coatings on electrical contacts and connectors.

The non-ferrous metal stream resulting from a treatment facility may go for further separation in a heavy media density separation plant to improve the quality and therefore the value of the individual metal streams. These will then go to a copper smelter/precious metals refiner, e.g. Boliden in Sweden or Umicore in Belgium. Circuit boards containing non-ferrous (including precious) metals also go to smelters to recover these metals. The circuit board material is used for fuel and flux in the smelting operation. There is no shortage of demand for the non-ferrous stream resulting from WEEE treatment operations.

Glass

Displays (particularly CRTs) account for the largest amounts of glass used in EEE. CRTs contain two types of glass; front panel glass and funnel glass. They are fused together with a lead frit. The flat viewing section (also called screen or panel), contains up to 14% barium oxide and up to 12% strontium oxide. The thinner conical section (the funnel) contains up to 25% lead oxide and the electron gun section (the neck) has up to 40% lead oxide. Although the term “activated glass” is not defined in the European Waste Catalogue (EWC), it appears that activated glass refers to any glass to which either a coating has been applied or the glass has been doped with small quantities of material. This has implications regarding the hazardous nature of certain glass parts.

A number of potential uses for CRT glass have been identified. These include:

- Use of CRT panel glass in bricks and tiles,
- Use of both CRT panel glass and funnel glass in the manufacture of new CRTs,
- Use of both CRT panel glass and funnel glass as a fluxing material in smelting operations.

One specification (Schott 2002) for panel glass used in the manufacture of new CRTs states that it must be free of any contamination from fluorescent layers, metal and other non-glass particles. It also states that the particle size must be as large as possible and that the glass must not have been shredded. The specifications for use of panel glass in other applications are less stringent; for example, for use of panel glass as a flux in brick manufacture, the panel glass can contain up to 1% of other CRT glass components.

Although packaging glass can easily be recycled, panel glass is not suitable for recycling into container glass because of its barium and strontium content. One potential use other than manufacture of new CRTs is in the manufacture of building products. It is estimated that the use of glass in bricks could save up to 5% of the energy used in the firing process, and that if all bricks were made with 5% glass, the size if the market would be at least five times the waste arisings of CRT panel glass. However, further research is needed to determine if this application would be economically viable because of the high costs for grinding the glass to the fine size required for use in brick manufacture.

Although there were a number of CRT manufacturing plants in the EU15 Member States, most of the CRTs are now produced in the Far East, and the plants which are still producing CRTs in Europe will cease as production of televisions and monitors moves to flat panel (LCD and plasma) products. CRTs are expected to become obsolete in the next five to ten years as Flat Panel Displays (FPD) become more common, and thus it is anticipated that these plants will also move towards production of flat panel displays within the next five years. This means that the current market for use of old CRTs to make new CRTs is likely to decline significantly over the next five years.

Many of the plants that currently manufacture CRTs are in non-OECD countries. As the lead funnel glass is classified as hazardous because of its lead content, the Basel Convention on transfrontier shipment of waste essentially prohibits the export of hazardous waste to non-OECD countries for recovery. However, plate glass from which the coating has been removed is classified as non-hazardous, and so can be exported to non-OECD countries for recovery/recycling.

There has been much debate about whether or not materials that are produced from waste products for recycling should be classified as a product rather than as a waste. This will become more of an issue when the only plants that can recycle funnel glass to produce new CRTs are located in countries which are not in the OECD, and when this way, less lead and thus lead mining would be needed in these countries.

The funnel glass could be used to provide silica/sand for use in smelting furnaces. However, sufficient lead needs to be recovered from the glass to allow the resulting slag to be used in applications such as road aggregates. The funnel glass can be used by copper smelters, and the European Commission is currently considering whether the recycling of CRT glass through commercial smelting operations meets the treatment requirements in Annex II of the Directive.

It may be possible to treat the funnel glass in order to separate the lead from the glass. Although one study (DTI 2003) indicated that the removal of lead, barium and strontium oxide to an acceptably low level from CRT glass was not practical under the experimental conditions investigated, one company (Nulife Glass 2006) claims to have developed a method of applying specific heat conditions, chemical additives and unique handling designs to separate the lead element of a CRT. The outputs from the process are two distinct streams of glass and lead, and this company claims that these can be used in new manufacturing processes. The company also claims that their process offers an environmentally friendly and economical solution, but there is little evidence that this can yet be achieved on a commercial basis. See Chapter 8.2.4 for more environmental details and environmental impacts of various glass routes.

Plastics

For WEEE plastics (WEEP), securing sufficient volumes of homogeneous supply and reliable identification of additives, potential contaminants and polymer are the key points to be considered in the analysis of the existing and potential secondary markets.

Plastics are estimated to account for 20 to 25% of the total weight of electrical and electronic equipment (see Figure 13). WEEP normally consists of a mixture of Polypropylene, Polyurethane and the following types of plastics, generally termed engineering thermoplastics (ETPs) (SPE Annual Recycling Conference, 1999):

- High impact polystyrene (HIPS),
- Acrylonnitrile Butadiene Styrene (ABS),
- Polycarbonate (PC),
- PC/ABS blends,
- Polyphenylene Oxide blends (PPO),
- Other.

Table 48 and Table 49 show the generation and type (Fisher 2004) of plastic type found in electrical and electronic equipment in Western Europe in 2000.

Application	Tonnes ('000)
Wire and cables	995
IT and telecommunications	586
Large household appliances	481
Consumer electronics	217
Small household appliances	151
E&E tools	11
Automatic dispensers	10
Toys	8
Medical equipment	4
Lighting equipment	3
Monitoring and control instruments	3

Table 48: Total consumption of E&E plastics by product type in Western Europe in 2000

Plastic	Tonnes ('000)	Percent total plastic
ABS	496	33
PS & HIPS	287	19
PP	266	18
PUR	125	8
EP	55	4
PVC (ex wire and cable)	54	4
PC	53	4
UP	48	3
PA	45	3
POM	26	2
PBT & PET	19	1
PE	8	1
Total	**1,482**	**100**

Table 49: Plastic consumption in E&E equipment by plastic type in Western Europe in 2000

Although it is technically possible to recycle most polymers found in mixed WEEE, they first need to be separated into single or compatible polymer types to be used in high value applications. There are markets for recycled mixed plastics (e.g. in timber substitutes), but these are generally of low value. There are also a number of barriers to recycling plastics found in WEEE. These include:

- Industry generally believes that recovered plastic is of low grade and low value,
- Concern that there may be insufficient guaranteed consistent supply within Europe to justify switching to recycled plastic. For mainstream production of visible or critical parts, manufacturers must be confident of obtaining a consistent and reliable supply of the same grade of material,
- The potential for contamination, due to the number of polymers used in plastic products,
- When purchasing virgin plastics, customers are typically supplied with a certificate of analysis, while recovered plastics are generally sold in smaller batches with a higher probability of contamination,

- Plastic segregation often relies on a visual inspection of either the markings or physical properties to determine the type of polymer which often leads to misidentification of polymer types,
- Plastics used in EEE applications often contain flame retardants and other additives which can affect the flow properties of recovered plastics making them more difficult to reprocess,
- Concern that the forthcoming Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation may prohibit the use of certain substances likely to be found in plastics recovered from WEEE and that it may also prevent the recycling of plastics in Europe.

Frequently, WEEE plastics contain additives (e.g. flame retardants, cadmium-based stabilisers) and fillers and often they have painted, metallised or coated surfaces. Recycling and recovery of WEEE plastics also faces other drawbacks, like heterogeneity of the plastic stream (different manufacturers use different polymers or different grades of one polymer for the same application), existence of composite parts (frequently, small parts are made of three or more polymers) and contamination (metallic inserts, foam, rubbers, labels, coatings, paints and lacquers).

The last point is particularly true for small appliances and consumer electronics: radio, audio, video, telephones, CPUs, peripherals, small domestic appliances, toys, etc. This type of equipment includes plastic parts of reduced size and weight. This is of little interest to recyclers, since in principle it is not possible with a reasonable effort to obtain significant quantities or homogeneous quantities of material.

On the other hand, plastics (re)processors must know if and how the additives and contamination affect (i) the performance of recycled plastic, because it will determine the markets into which they can sell their flake and/or resin; (ii) their treatment process, because it may involve additional conditioning stages for feedstock products or entails changes in yields and emissions. For example, plastics containing older fire retardant formulations (currently restricted by RoHS Directive) cannot be sold to manufacturers of new computer parts, but they may be sold for use in lower-end products (alternative fuel in cement kilns or direct energy use in MSW incinerators, provided that they are equipped appropriately to keep emissions below legal limits). End-markets processors — primarily plastics compounders and moulders —must understand which fire retardants and fillers are used in consumer electronics and in what quantities. Such information is critical because it could impact the final composition and performance of the product they manufacture.

Lumber, outdoor furniture and roadbed materials have been the markets for recovered electronic plastics (Dillon 1998, Hadley 2000, ICER 2004). Mixed computer and electronic equipment plastic casings can be recycled into low-end applications such as an aggregate for base course in road beds and parking lots or a consumer cold patch used for filling potholes. WEEE engineered plastics are being recycled into the synthetic core of high performance laminated flooring products. Applications for mixed plastic that may still contain small amounts of metal but can be made into products by intrusion moulding — without the need for further sorting or processing — have been researched. Such applications include flood and sea defences, manufacture of soil erosion blocks (e.g. for motorway embankments) and wood substitute products (e.g. scaffolding, planks and benches).

However, the engineering thermoplastics recovered from WEEE have a potential for higher market values and could be recycled into products that, for example, meet fire safety requirements. Many new product applications are now under development, including camera casings, battery boxes, compact disc trays, hot mix asphalt concrete, and high quality pellets for use in moulded plastic parts. More than 30 products have been identified as viable end markets for engineering thermoplastics from recovered electronics. These include parts and products in several market sectors:

- Telecommunications - spools; novelty phones; fax machines; modems - hubs for networks,
- Automotive - bumpers, mirror housings; liners on pick-up trucks; low temperature engine parts,
- Electrical - fuse boxes, enclosures, connectors, wire nuts, wire coating,
- Construction - flooring, counter tops, artificial timber, concrete additives etc.,
- Material handling - pallets, totes,
- Computer / data processing (e.g. IBM developed closed loop recycling process of PVC and PC/ABS into computer keyboards),
- Household appliances - vacuum cleaners, power tools, TVs,
- Gardening – handles,
- Traffic control - speed bumps, parking stops etc.

In the case of plastics from EOL white goods, the pieces of polyurethane foams from refrigerators insulation can be shredded and the resulting powder used as oil binder or compressed into pellets or briquettes that can be later used in the manufacture of new foams and boards for thermal and noise insulation (ISOPA 2005).

Analysis

In the past, as a general rule, markets have existed for materials derived from WEEE where these materials have been economically viable to recover. One of the effects of the WEEE Directive will be the production of materials via WEEE treatment processes that may not be assimilated by existing markets (for example, because of capacity constraints or quality constraints). Alternative markets or market development activities may be necessary to ensure the beneficial use of these materials. However, the development of future markets will depend on both the evolution of the restricted specifications currently used by industry, and the impacts of legislation on waste, products and processes.

The markets for recycled plastics are still limited due to technical feasibility and economics. High-end applications are required to make up for the costly recycling process, but high added value applications entail narrow and strict aesthetics and technical specifications for polymers that might be difficult to meet by using reprocessed post-consumer plastics. Furthermore, developing EU legislation on restricted substances constrains the range of potential applications for recoverable polymers containing additives (both in closed and open loop recycling).

Energy recovery is a sound option for mixed plastics rejected by mechanical recycling, including those containing brominated flame retardants, heavy metals, and insulating foams. Many pilot tests have been carried out directed towards energy and feedstock recovery from WEEE plastics in novel thermal processes, in cement kilns (as alternative fuel) and in MSW incinerators (WEEE addition to standard fuel mix —occasionally with bromine recovery).

Conclusion

WEEE items contain three main categories; metals, glass and plastics.

There are stable markets for metal recycling from WEEE given the ability to easily extract the metal and reuse to a comparable quality to virgin metal ores.

The glass in the CRT represents a significant percentage of the total weight of a TV or monitor, and thus recycling of most of the glass in a CRT should enable the relevant category recycling targets to be achieved. The main potential market for CRT glass is in the manufacture of new CRTs, but it is expected that current capacity will significantly decline over the next 5 years as flat panel displays (LCD and plasma) replace CRTs in televisions. This means that other markets for the glass will be required if the recycling targets for items in categories 3 and 4 are to be met. However, other markets are currently limited. One option is to use CRTs to provide silica for use in smelting furnaces, and this would also enable the lead in the funnel glass to be recovered. As the CRT could be used in this application without having to separate the two types of glass, then national guidance on the current Annex II requirements would have to consider that the fluorescent coating is "removed" in this type of process.

The role of the existence of secondary markets for energy and materials recovered from WEEP treatment is crucial in the successful application of such processes. Firstly, failure in market demand for plastic secondary materials (and energy) may imply unfeasibility to achieve the total weight recovery/recycling targets as fixed in the 2002/96/EC Directive for several categories of WEEE of plastic-dominated composition, which turn out to be products that have more difficulties in environmental and cost efficient recovery of plastic fraction due to the heterogeneity of the polymers present in small volumes in each unit. Secondly, the fact that recycling targets can be easily achieved by cost effective metal recycling in metal dominated products (e.g. large household appliances) can discourage WEEE recyclers from trying to properly separate (otherwise easily dismountable and low contaminated) plastic parts for recycling.

Recommendations

There is a need to consider whether the recycling of CRT glass through commercial smelting operations meets the treatment requirements in Annex II of the Directive.

The closed-loop recycling market location is shifting towards Asia and Brazil where lower manufacturing and labour costs are more attractive than in Europe. However, many of these countries are not in the OECD, and the Basel Convention on trans-frontier shipment of waste essentially prohibits the export of hazardous waste (for example, funnel glass from CRTs destined for reapplication into new funnel glass might be strictly considered to be a waste export rather than export of a raw material) to non-OECD countries for recovery. There may also be issues due to the fact that the separation and processing conducted in these countries may not necessarily be carried out to EU standards. Export of CRT glass to destinations where it is used as secondary CRT glass is proven to be very environmentally beneficial in Chapter 8.2.4. A narrow interpretation of the Basel Convention rules on this, can work counterproductively when it is not made possible to export CRT glass to these specific destinations.

8 ANALYSIS TASK 1: EVALUATION OF IMPLEMENTATION

8.0 Data Gathered General

Data Gathered

8.0.1 Overview Data Sources

Environmental Data, Costs along the Recycling Chain Data

In addition to the general data available in the QWERTY calculations in 6.2.2 explaining the calculation sequences, further data is gathered to expand and to widen the calculations to all WEEE categories. Therefore, specific questionnaires were sent to various stakeholders. An overview of the questionnaires and details requested is available in Annex 8.0.1. It lists the types of data (environmental and economic calculations, WEEE arising and WEEE put on market) that were requested from these key stakeholders.

Who	Product comp-ositions	Amount treated	Recyc./ recovery %	Techni-cal costs	Sampling data	Annex II compo-nents	CRT glass desti-nations	Plastic desti-nations
EERA		YES	Indicative	Indicative	N.A.	6 recyclers	9 recyclers	9 recyclers
ELC	Average for all members	All countries	Glass rec.%	YES		Hg contents		
Orga Lime	N.A.							
CECED	YES	N.A.				N.A.		
EICTA	3 producers							
WEEE Forum		16 systems	5 systems	16 systems	N.A.	1 system	N.A.	N.A.
ERP		7 systems	2 systems	7 systems	N.A.	N.A.		

Table 50: Overview of key data requested/ received

The initial questionnaires were used to provide a good overview of the general data at an aggregated EU-wide level: The responses received are summarised as follows:

1. EERA published the questionnaire on their intranet data-gathering tool which allowed a certain level of aggregation, and thus provided data which would probably not have been obtained from individual members due to competition sensitive information. Besides responses on the administrative burden, some indications on the recycling percentages and treatment costs could also be derived. The same counts for some of the Annex II components removed during treatment. In addition, EERA provided information on the destination of CRT glass fractions as well as of mixed (from mechanical treatment) respectively sorted plastics (from dismantling activities),
2. ELC provided data on the compositions of lamps with specific focus on the Hg content, plus data on the amounts treated in the EU27 as well as technical costs in ranges. See Chapter 8.0.5.5 for more details on amounts and compositions of Category 5B, Lamps,

3. From Orgalime, estimated amounts of WEEE put on market, typical product lifetimes (for Task 1.2) and organisational/ administrative burden information were obtained,
4. From CECED, information on product compositions was received as well as a set of references to technical documentation on Category 1B, Cooling and Freezing. In addition, information was received for Task 1.2 and the administrative burden. See Chapter 8.0.5.2 for more details on amounts and compositions,
5. From EICTA, specific information was asked for laptops and printers as well as flat panel displays. For these products, information was received from EPSON, Philips, Panasonic and Alcatel-Lucent. See Category 3A and 4A in Chapter 8.0.5.4 for more details and more information on amounts and compositions,
6. Importantly, from Recupel, very detailed data was received on the monitoring of recycling operations in the form of amounts of Annex II components removed per treatment category as well as the detailed breakdown of the determination of recycling and recovery percentages. With regard to Annex II components, the amounts declared as removed were the highest numbers found and thus were good indicators of maximum separation levels technically possible. See Chapter 8.0.3 for more detailed information. The information received was also used for comparisons of treatment scenarios where Annex II components were removed in different ways,
7. From the WEEE Forum, EU-wide information was received on amounts treated and the technical costs (in minimum – maximum range). This information is displayed in Chapter 8.0.5. In addition, from 5 long running systems (running since before 2005 and having at least 3 years of datasets available: NO, CH, SE, NL and BE), more specific average costs were received permitting the assessment of the impacts assuming a 'full implementation'. In addition, from some systems the declared recycling and recovery percentages were found,
8. From ERP, data was received on the amounts treated and the technical costs of 7 systems. From 2 systems, the recycling and recovery percentages were available. No information on Annex II components was available.

The key data used for the environmental and economic impact assessment is discussed in the next section. The individual data per category is presented in Chapter 8.0.5.1 to Chapter 8.0.5.5. See Chapter 8.0.6 for a discussion on the quality and availability of the data delivered.

8.0.2 Key Social Data

A three-step approach was adopted:

1. The analysis of all available information in the CIRCA database;
2. The gathering and analysis of additional scientific literature and secondary sources;
3. The gathering and analysis of additional primary data obtained through stakeholder interviews.

Subsequent work identified positive and negative social consequences, planned interventions and any social change brought about by those interventions.

All reviewed sources are listed and the extracted information is carefully referred to in the screening summary and analysis.

The first two steps of the screening allowed the identification of the data gaps.

For the third step, a standardised questionnaire (see Annex 8.0.2) was used to ask member states, competent authorities, compliance and collection schemes, industry, and other stakeholders for information relevant to the social impact of the WEEE Directive's implementation. The stakeholders were provided with a summary of the context, scope and objectives of this list of 28 questions. The questionnaire was widely distributed through various distribution lists, from associations to their members and dedicated stakeholders affected by the WEEE Directive and those with a direct interest were informed and invited to submit their information. This empirical survey started on 18 January 2007 and ended on 18 February 2007 (which allowed stakeholders one month to respond).

Some of the questionnaire's questions were also provided for inclusion in the Small and Medium Enterprises Panel of the European Information Centre (EIC) through close cooperation with the European Commission.

The returned information has been collected and analysed and is made available with this draft final report.

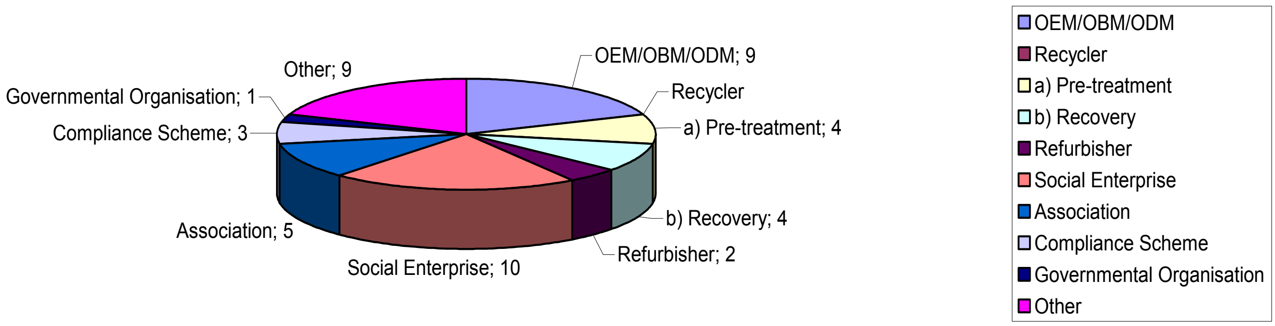

Figure 20: Overview returned questionnaires on social questionnaires

In addition the discussions and findings of the European Commission's Expert Workshop of 15 March 2007 and additional suggestions of necessary follow-up actions in order to facilitate a satisfactory integration of information in the final WEEE Review process are reflected in this report.

8.0.3 Key Environmental Data

In Chapter 6.2.2 the environmental and economic data describing the end-of-life chain is given. Besides these calculation sequence data, the following inputs data are used in addition:

1. Annex II components removed at treatment: In (Recupel, 2007), the following data on Annex II components is presented. These data are used to predict the maximum amount of Annex II components that are currently found in the various treatment categories.

Annex II amounts (in kg)	**Category**				
Description	**C&F**	**LHHA**	**CRT**	**SDA**	**Lamps**
Amounts treated total	13560966	178822445	16973405	26469677	1145874
Oil				24204	
PCB capacitors + suspected	815	19889		1382	
Mobile phones				961	
Mercury containing parts	365			204	
Circuit boards				56275	
Circuit boards, HQ				135600	
Circuit board chassis			396041		
Ink lints				32895	
Toner cartridges				33905	
Plastics BFR			25393		
Asbestos containing				986	
Gas discharge lamps		350		22	
LCD modules				938	
Other hazardous				1955	
All batteries				12850	
Oil fridge	58049				
Other oil	166	550		45	
Plastics BFR			871281		
CRT's			2158413		
Cone glass			298835		
Mixed glass fines			12451		
Fluorescent powder			26552		
Fluorescent powder (lamps)					22425
Circuit boards			187232		
Mixed waste from mech. treatment		550	139172	21568	

Table 51: Annex components per treatment category (Recupel, 2007)

Based on data from (Morf 2004), the amount of PCB in PCB capacitors (see above table) is determined as 1.2%. From (Philips 2004) and from various product analyses, the suspected mercury containing parts are estimated to contain 1.5 g per kg of Hg. Further data with regard to the presence of Annex II components in WEEE can be found in (Truttman 2006, Morf 2006a, RECHARGE 2006, Chancerel 2006, Rudenauer 2005a, CECED-EERA-WEEE FORUM 2006, CECED 2006a,b, Hornberger 2005, TAC 2005, DTI 2006c, EERA 2007b, LAGA 2004, RECHARGE 2006, Harant 2002, Neira 2006),

2. Printed circuit board compositions are derived from many sources: (Huisman 2003a, Philips 1998 – 2007, BIO IS 2006, Morf 2004, Angerer 1993, Wichman 2002, Muller 2005, Rudenauer 2005, Truttman, Chancerel 2006, Hageluken 2006, Streicher 2006, ICER 2007, Neira 2006, Freegard 2004, NOKIA 2005, Huisman 2004b, Kemna 2005a, 2007) as well as from chemical analyses of non-disclosed producers and products. Table 52 contains the final compilation of these compositions per WEEE category. Underlying individual data points cannot be disclosed due to confidentiality reasons. The data in the table was used as input data for the calculations. For all categories, sufficient individual data points were available to compile Table 52, except for the data for Category 3C, for which there are

only a few data sources available. These two sets were used for the further calculations, but were probably not reflecting the respective circuit board compositions of the category in a sufficient manner (the other components data are reliable though). Especially, the precious metal data for Cat. 3C which is expected to be substantially higher than found in practice. This is due to a limited availability of data points. As a result, in the remaining calculations, the outcomes for Cat. 3C should be considered as initial indications,

3. The data in Table 52 is combined with the sampling data of DEFRA 2007 to derive estimates for the compositions of the categories with small appliances (1C,2,3A,4A,6,7). For category 5A there are not enough separate data available and they are already included in the compositions and amounts of category 2. The same applies for the B2C appliances of category 8. For category 9, some numbers on the overall compositions are present in (DEFRA, 2007). However, the printed circuit board fractions cannot be determined due to lack of data. Category 10 is included in the amounts and composition of Category 1A and not determined separately. For more details about each treatment category, see Chapter 8.0.5.

Component Materials	1A LHHA	1C LHHA-small	2 SHHA	3A1 IT ex CRT PC's	3A2 IT ex CRT Printing devices	3A3 IT ex CRT Small IT	3B IT CRT	*3C IT FDP**	4A1 CE ex CRT Large Audio	4A2 CE ex CRT VCRs DVD etc.	4B CE CRT	4C CE FDP	5B Lamps	6 Tools	7.1 Toys Game cons. Power b.	7.2 Toys Game cons. control b.
Fe	9.9E-02	2.1E-01	1.2E-01	1.3E-01	3.9E-01	8.0E-02	1.0E-01	*5.2E-03*	9.3E-02	5.3E-02	1.1E-02	1.2E-01	1.2E-01	4.1E-02	2.7E-02	8.3E-02
Cu	1.3E-01	1.3E-01	1.1E-01	1.8E-01	1.4E-01	1.0E-01	1.8E-01	*4.0E-01*	1.9E-01	1.6E-01	1.2E-01	2.2E-01	1.1E-01	1.6E-01	2.0E-01	2.0E-01
Ag	1.6E-04	4.8E-05	2.2E-04	1.0E-03	3.5E-04	5.7E-03	1.5E-04	*1.3E-03*	5.2E-04	7.0E-04	1.6E-03	2.5E-04	2.2E-04	1.1E-03	4.3E-04	3.0E-04
Au	3.8E-05	1.4E-05	2.0E-05	2.3E-04	4.7E-05	1.3E-03	9.2E-06	*4.9E-04*	6.8E-05	1.0E-04	1.1E-04	6.0E-05	2.0E-05	1.8E-05	1.6E-04	1.8E-05
Pd	2.0E-05	2.9E-05	1.2E-05	9.0E-05	9.0E-06	4.7E-04	3.4E-06	*9.9E-05*	8.0E-06	2.1E-05	4.1E-05	1.9E-05	1.2E-05	4.8E-05	1.8E-05	
Al (general)	7.7E-02	7.6E-02	8.6E-02	4.0E-02	4.4E-02	2.0E-02	4.6E-02	*1.9E-02*	1.3E-01	5.9E-02	6.3E-02	1.5E-01	8.6E-02	5.8E-02	6.1E-02	1.8E-01
As						2.7E-05										
Be						8.8E-05										
Bi						2.0E-04	6.9E-04			6.0E-04	4.0E-04					
Cd						1.4E-06										
Cr	1.0E-04	2.9E-04	2.1E-04	5.5E-04	7.5E-04	2.5E-02	6.9E-04	*2.0E-04*	0.0E+00	4.0E-04	2.1E-04	3.5E-04	2.1E-04	2.1E-04		
Ni	5.0E-04	9.0E-04	1.1E-03	9.0E-03	1.2E-03	3.5E-02	2.5E-03	*9.0E-03*	2.8E-03	2.8E-03	3.0E-03	1.8E-03	1.1E-03	1.1E-03	3.5E-03	1.0E-03
Pb	1.5E-02	1.0E-02	3.0E-02	3.3E-03	5.4E-03	1.4E-02	1.1E-02	*5.7E-03*	5.6E-03	1.6E-02	1.5E-02	6.8E-03	3.0E-02	3.0E-02	4.5E-03	5.8E-03
Sb	9.0E-04	6.0E-04	6.0E-04	4.5E-04	4.0E-04	3.1E-03	2.2E-03	*4.0E-04*	1.2E-03	1.3E-03	3.5E-03	4.0E-04	6.0E-04	6.0E-04		
Sn	2.4E-02	5.8E-03	2.7E-02	4.8E-03	6.9E-03	2.1E-02	5.7E-04	*1.3E-03*	4.5E-03	6.6E-03	7.9E-03	1.0E-02	2.7E-02	2.7E-02	3.0E-03	3.2E-03
Zn	3.2E-02	6.8E-03	1.4E-02	1.6E-02	1.6E-02	1.4E-02	1.9E-02	*2.5E-03*	1.3E-02	1.7E-02	3.9E-03	1.3E-02	1.4E-02	1.4E-02		
Plastics general	4.4E-01	3.9E-01	4.6E-01	2.5E-01	2.3E-01	5.3E-01	3.9E-01	*1.1E-01*	1.6E-01	3.7E-01	2.7E-01	2.0E-01	4.6E-01	4.8E-01	2.8E-01	2.0E-01
Epoxy		1.7E-01	1.6E-01				4.6E-02		2.0E-01		3.9E-01		1.6E-01	1.5E-01		
Ceramics	1.4E-01			1.9E-01	6.9E-02		5.2E-02	*4.4E-01*	2.0E-01	6.4E-02	1.0E-01	1.8E-01			4.2E-01	3.3E-01
Glass LCD						1.0E-01										
Other average	4.4E-02	0.0E+00	0.0E+00	1.7E-01	9.9E-02		1.5E-01			2.3E-01		1.1E-01		3.0E-02		

Component **Materials**	1A LHHA	1C LHHA-small	2 SHHA	3A1 IT ex CRT PC's	3A2 IT ex CRT Printing devices	3A3 IT ex CRT Small IT	3B IT CRT	*3C IT FDP**	4A1 CE ex CRT Large Audio	4A2 CE ex CRT VCRs DVD etc.	4B CE CRT	4C CE FDP	5B Lamps	6 Tools	7.1 Toys Game cons. Power b.	7.2 Toys Game cons. control b.
Liquid Crystals						8.0E-03										
Br		3.2E-03	1.0E-04			3.8E-02	2.9E-03		1.2E-03	2.5E-03	1.2E-02		1.0E-04	1.2E-02		
Cl		3.9E-03	4.3E-03			5.0E-04				1.0E-02	2.3E-03		4.3E-03	2.7E-03		

Table 52: Average Printed Circuit Board compositions per treatment category (in fractions, total = 1) * *Limited number of data points*

8.0.4 Key Economic Data

Administrative Burden Survey

The questionnaire was distributed to stakeholders in EU by means of National Registers (those who agreed to send it to their registered members), European Associations (CECED, EICTA, ORGALIME, WEEE Forum, ELC, EERA, CEMR, etc) and Some National Associations (like ANIE, ZVEI, etc.).

The response status (May 15, 2007), according to stakeholder type is shown in Table 54 below:

	Size					
Stakeholder Type	**Micro**	**Small**	**Medium**	**Large**	**N.A.**	**Total**
Association					3	3
Compliance Scheme	5		1			6
Distributor	2	1		1		4
Municipality				1	2	3
Producer	6	2	6	27	6	47
Recycler					15	15
Refurbisher				1		1
Total Contacted	13	3	7	30	26	79
	16%	4%	9%	38%	33%	

Table 53: Overview respondents Administrative Burden Survey

The complete table of responses to the Administrative Burden Questionnaire is listed in Annex 8.0.4a. The questionnaire and information or opinions provided by respondent stakeholders represent a valuable source of information which could be used by the Commission to develop a specific and more "closed-answers" oriented questionnaire which could be used to obtain views on the suggested options for improvements.

To be highlighted is that EERA replied to the questionnaire in an aggregated form and only for Questions 2 and 4. As it was not possible to trace back the individual size of the responding company and specific comments, all responses are simply listed in Annex 8.0.4: There is no correlation between responses on the same line or size of the responding company. In Chapter 8.1.1, aggregated responses are presented for Question 2 and Question 4 only.

National Registers Overview

The questionnaire has been distributed according to Table 54 and the complete overview of responses is in Annex 8.0.4b, Overview National Registers responses.

Member State	Qlist to National Register	Member State	Qlist to National Register	Member State	Qlist to National Register
Austria	Replied	Germany	Not Replied	Netherlands	Not Replied
Belgium	Not Replied	Greece	Not Replied	Poland	Replied
Bulgaria	No Register Info	Hungary	Replied	Portugal	Replied

Member State	Qlist to National Register	Member State	Qlist to National Register	Member State	Qlist to National Register
Cyprus	No Register Info	Ireland	Replied	Romania	No Register Info
Czech Republic	Replied	Italy	No Register Info	Slovakia	Replied
Denmark	Replied	Latvia	Replied	Slovenia	Not Replied
Estonia	Replied	Lithuania	Replied	Spain	Replied
Finland	Replied	Luxembourg	Not Replied	Sweden	Replied
France	Replied	Malta	No Register Info	United Kingdom	No Register Info

Table 54: Overview National Registers of Producers

Some of the National Registers have not replied (or replied partially) to the questionnaire. In some Member States there is still no National Register in place, or it is being set up as the start-up for take back obligations is 1st July 2007 (e.g. Italy, UK). In some other Member States, where previous legislation was in place (e.g. Netherlands), the role of National Register is still done by Collective Schemes in place.

8.0.5 Overview Product and Collection Categories

The following data summarise the dataset built up for the study in order to fully evaluate the economic and environmental impact of the WEEE Directive across EU27. In the following sub-chapters, the main outcomes and analysis on data gathered are based on the data from Chapter 7 on amounts of WEEE as well as more information on compositions and sampling data of WEEE streams: Data is presented based on:

- Current amounts of WEEE collected and treated in Table 55,
- Product compositions and average weight per categories, clusters of categories or product sub-categories in Tables 57 - 67.

This information is used in the following assessment of environmental and economic impact of WEEE across EU.

In Chapter 7.2 and 7.3, the analysis of amounts collected by compliance schemes currently operating across EU has resulted in the assessment of current breakdown of WEEE Arisings, according to Table 54. In order to assess the environmental and economic impacts of collecting and treating WEEE compared to no action, three levels of data are required over time. First, the total amount of WEEE arising as waste requires determination; this was completed in Chapter 7.2. Secondly, the current percentage of the total amount of WEEE arising as currently being collected and treated per category (representing the 2005 average status of amounts collected vs. not-collected). Thirdly, the case for an assumed full implementation in all EU27 Member States (i.e. the maximum achievable percentages of WEEE) based on the highest numbers found in different member states with a long running compliance scheme (including Switzerland and Norway). This is assumed to be achievable in 2011. These three levels are displayed in the following three tables below. At first, the breakdown in categories of the total amount of WEEE arising as waste is presented:

#	Treatment Category	Abbrev.	% of total	
A	**Large Household Appliances**	**(LHHA)**		**27.88%**
1A	Large Household Appliances	(LHHA)	27.70%	
10	Automatic dispensers	(Aut.Disp.)	0.18%	
B	**Cooling and freezing**	**(C&F)**		**17.74%**
1B	Cooling and freezing	(C&F)	17.74%	
C	**Small Domestic Appliances**	**(SDA)**		**31.13%**
1C	Large Household Appliances (smaller items)	(LHHA-small)	3.63%	
2	Small Household Appliances	(SHHA)	7.01%	
3A	IT and Telecom excl. CRT's	(IT ex CRT)	8.00%	
4A	Consumer Electronics excl. CRT's	(CE ex CRT)	7.82%	
5A	Lighting equipment - Luminaries	(LUM)	0.70%	
6	Electrical and electronic tools	(Tools)	3.52%	
7	Toys, leisure and sports equipment	(Toys)	0.11%	
8	Medical devices	(Med.)	0.12%	
9	Monitoring and control instruments	(M&C)	0.21%	
D	**CRT Appliances**	**(CRT)**		**21.55%**
3B	CRT monitors	(IT CRT)	8.27%	
4B	CRT TV's	(CE CRT)	13.28%	
3C	LCD monitors	(IT FDP)	0.00%	
4C	Flat Panel TV's	(CE FDP)	0.00%	
E	**Gas Discharge Lamps**	**(Lamps)**		**1.70%**
5B	Lighting equipment – Lamps	(Lamps)	1.70%	

Table 55: Current breakdown of WEEE Arising

For each category, the current amounts collected and treated have been determined, as a percentage of WEEE arising, considering average data provided by EERA (EERA 2007) on amounts treated across the EU27 in total and the above breakdown of this total amount per subcategory and the data provided in Chapter 7, Table 40 and Table 41 as well as Figure 12 and Table 43 of Chapter 7.3 and the data discussed in Chapter 7.4.1 on treatment capacities, containing the current collection amounts per Member State with operational systems based on (WEEE Forum 2005). Here it needs to be highlighted again that some product categories, specific products or sub-categories are treated together, for example Small appliances of Cat. 2 together with the small "domestic" medical devices of Cat. 8 and the luminaries of Cat. 5 as well as Cat. 10 Automatic Dispensers. are grouped with 1A LHHA. Analysis of these categories led to the calculated current collection percentages per category in Table 56.

#	Treatment category	Current % collected of WEEE Arising	2005 amounts collected and treated (ktons)
1A	Large Household Appliances	16.3%	348
10	Automatic dispensers	59.4%	
1B	Cooling and freezing	27.3%	362
1C	Large Household Appliances (smaller items)	40.0%	231
2,5A,	Small Household Appliances, Lighting equipment – Luminaires	26.6%	269

#	Treatment category	Current % collected of WEEE Arising	2005 amounts collected and treated (ktons)
8	Medical devices	49.7%	
9	Monitoring and control instruments	65.2%	
3A	IT and Telecom excl. CRT's	27.8%	288
3B	CRT monitors	35.3%	150
3C	LCD monitors	40.5%	7
4A	Consumer Electronics excl. CRT's	40.1%	150
4B	CRT TV's	29.9%	236
4C	Flat Panel TV's	40.5%	7
5B	Lighting equipment – Lamps	27.9%	28
6	Electrical and electronic tools	20.8%	35
7	Toys, leisure and sports equipment	24.3%	20

Table 56: Current Amount of WEEE collected & treated as % of WEEE Arising (2005)

This breakdown is used to assess the impact of collection and treatment (both environmental and economic) of WEEE arising starting in 2005 and ending with the next table for assumed full implementation in 2011.

Further analysis has been carried out on amounts currently being collected by compliance schemes (ERP and WEEE Forum), amounts currently being treated by recyclers and estimation and benchmarking between different Compliance Schemes in order to assume the case for full implementation of the WEEE Directive across EU27, where the highest collection amounts in kg per (sub)category per inhabitant were used. This breakdown is reported below.

#	Treatment category	Future % collected of WEEE Arising	2011 max. amounts (ktons)
1A, 10	Large household appliances	16,3%*	348*
1B	Cooling & freezing appliances	75%	1158**
1C	Large Household Appliances (smaller items)	75%	507
2, 5A, 8, 9	Small Household Appliances, Lighting equipment – Luminaires and "domestic" Medical devices, Monitoring & Control	60%	706
3A	IT & T equipment (excl. CRT's)	60%	724
3B	IT & T screens - CRT's	75%	579
3C	LCD monitors	75%	15**
4A	Consumer equipment (excl. CRT's)	60%	261
4B	TV sets - CRT's	75%	688
4C	Flat Panel TV's	75%	15**
5B	Lighting equipment – Lamps	60%	87
6	Electrical and electronic tools	60%	98
7	Toys, ...	75%	72

*Is not changed as more and more not reported but directly treated in same installations due to positive EOL value, ** no change in average waste stream compositions assumed*

Table 57: Estimated future of WEEE collected & treated as percentage of WEEE Arising (assuming a *full implementation* across EU27 in 2011)

Again note that Table 57 is based on assuming that in practice these maximum percentages will be achieved in 2011 for the EU27 in total. These numbers will never be 100% in practice as there will always be equipment that will not be handed in for various reasons: discarding with MSW, reuse outside of Europe, building up of stocks (bottom of the drawer or in the attic) at consumers, illegal exports, mixing with other (non hazardous waste), reuse of components and other treatment scenarios with other waste streams (washing machines in car shredders). There is very little information about the exact mechanism available, however it is clear that in practice even with full implementation and maximised collection efforts, a 100% collection rate will never be reached. Therefore, as the above numbers are to be regarded as estimated maximum achievable percentages under current practices, they are used to indicate the costs and benefits of the WEEE Directive in the further analysis: In the next section, the compositions of the above categories are presented. Later, in Chapters 8.1 and 8.2, the above amounts and breakdowns are multiplied by the total environmental and economic impacts per average kg or piece of equipment in the respective categories.

8.0.5.1 Large Household Appliances

Data LHHA

Category 1A: Large Household Appliances

This treatment category covers both LHHA as well as Automatic Dispensers. Category 1A includes the following types of appliances: washing machines, dishwashers, clothes dryers, electric cookers, ovens and hobs. Basically, all appliances are included here with a weight over 35 kg. The smaller appliances in the WEEE product category 1 are regarded as part of Category 1C and often treated together with smaller appliances.

Category 10 covers automatic dispensers for hot drinks, automatic dispensers for hot or cold bottles or cans, automatic dispensers for solid products, automatic dispensers for money, all appliances which deliver automatically all kinds of products. These appliances are often, but not always, treated with Category 1A or collected (returned through lease) and treated within B2B channels.

Composition data is derived from (Rudenauer 2005a,b, DEFRA 2007, RECUPEL 2007, Morf 2004, BIO IS 2006, Kemna 2007). The data from (RECUPEL 2007) in Table 51 is used for determining the amount of Annex II components in these appliances. In the next table, the input data constructed from the various sources and literature and the main destination of certain removed components is summarised, forming the basis for the environmental and economic calculations.

Destination*	Components	Weight (g)
	Steel low alloyed	29,411
Building industry (filling material)	Other, inerts (concrete)	10,948
	Plastics general	6,732
Plastic Recycling	Rubber (EPDM)	1,521
	Copper	1,204
	Wood	970
	Mains cord	955
	Stainless steel	907
	Al (general)	906
	Glass (white)	403
	PUR (polyurethane)	169
	Capacitors	60.8
	PWB 1A LHHA	49.7
	Oil	1.68
Environment (emission)	PCB	0.71
	Total	**54,240**

** When nothing is mentioned, components go through shredding and separation*

Table 58: Average Composition 1A + 10, LHHA + Aut.Disp.

Note that Table 58 above is the aggregated component compositions of an average Cat.1A appliance and in the 'destinations' column the fate of certain components for this default scenario. In Chapter 8.2.1 the total calculated weight and environmental weight 'composition' is presented by multiplying the above with all individual component compositions as well as other treatment scenarios than the above default will be evaluated (including disposal with MSW, no dismantling of Annex II components, etc.).

8.0.5.2 Cooling and Freezing

Data C&F

Category 1B: Cooling and Freezing (C&F)

This category covers the following types of appliances: Refrigerators, freezers and air conditioning units. The compositions data are mainly based on the mass balances of an anonymous recycler and on the key data presented in (Dehoust 2007, Truttman 2006, Rudenauer 2005a, CECED-EERA-WEEE FORUM 2006, CECED 2006a & b, Hornberger 2005). In addition, general data are derived from (TAC 2005), (Kemna 2007), (Morf 2004a) and (BIO IS 2006), which are used to check and increase accuracy of the first sources, with special attention to the amount and composition of the cooling agents in the compressor and insulation. Data on the copper content in the compressor is found in Kemna (2007). However, from processors it is known that they contain on average 7% of copper. The amount of HC's in the first stage of processing is derived from Hornberger (2005) and Dehoust (2007). With regard to the presence of both CFC and 'Pentane' based fridges, there are not enough data found to point out a current average presence. Therefore an 80% - 20% mixture was assumed for the calculations (Dehoust 2007). In addition to this, the environmental impacts of averages of both types of fridges was calculated. The amount of cooling agents in the 80% - 20% average plus the 'CFC-only' and 'pentane-only' case is also presented below, on the right hand side assuming the remaining product composition (on the left) is similar.

Destination*	Components	Weight (g)	Destination	Cooling agents	Weight (g)
	Steel low alloyed	16,415	CFC cracking	CFC12 (CFC fridge only)	122
Ferro fraction	Fe (compressor)	7,848	CFC cracking	CFC11 (CFC fridge only)	263
Plastic Recycler	PUR (polyurethane)	3,750	Cement Killn	CFC11 (CFC fridge only)	36.7
Plastic Recycler	PS (polystyrene)	2,660	Environment (emission)	CFC11 (CFC fridge only)	6.1
Incineration + en. rec.	Plastics general	2,375	Environment (emission)	CFC12 (CFC fridge only)	0
	Al (general)	1,255	**1a. Total**	**CFC fridge only**	**38,080**
	Stainless steel	1,000	Incineration + en. rec.	Isobutaan (Pentane fridge only)	55
Copper fraction	Copper (compressor)	682	Incineration + en. rec.	Cyclopentane (Pentane fridge only)	235
Cement Killn	Plastics general	665	**1b. Total**	**Pentane fridge only**	**38,370**
Incineration + en. rec.	Other average (inerts , other waste)	420	CFC cracking	CFC12 (average CFC/Pentane fridge)	97.20
Glass recycling (white)	Glass (white)	285	CFC cracking	CFC11 (average CFC/Pentane fridge)	210.53
	Copper	210	Cement Killn	CFC11 (average CFC/Pentane fridge)	29.38
Incineration + en. rec.	Oil (Fridges)	205	Emission	CFC11 (average CFC/Pentane fridge)	4.90
Incineration + en. rec.	Plastics general	190	Emission	CFC12 (average CFC/Pentane fridge)	0.00
Cu smelter	Mains cord	120	Incineration + e	Isobutaan (average CFC/Pentane fridge)	11.00
Environment	Hg switches	0.0010	Incineration + e	Cyclopentane (average CFC/Pentane fridge)	47.00
Environment	PCB	0.00003	**2. Total**	**Average mix of CFC and Pentane fridges**	**38,480**

** When nothing is mentioned, then assumed to go through shredding and separation*

Table 59: Average Composition Category 1B, C&F

Again note that Table 59 above is the aggregated component compositions of an average Cat.1B appliance and in the 'destinations' column the fate of certain components for this default scenario. The left part of the table represent the average material composition of the fridge, the right side the three different cooling agents options: 1a represents a CFC-only fridge, 1b represent the average Pentane based fridge and 2.Total the average (80%-20%) mix of these two representing the current stream of these mixed appliances. For the CFC-12 in the compressor, a 95% removal efficiency is assumed (see 'destinations' column above). This assumption is tested in the sensitivity analysis in Chapter 8.2.2. In Chapter 8.2.2, the total calculated weight and environmental weight 'composition' is presented by multiplying Table 59 above with all individual component compositions (for instance including the PWB composition of Table 52).

8.0.5.3 Small Household Appliances

Data SHHA

Category 1C: LHHA - Small

This category covers the following types of appliances: Microwaves, electric heating appliances, electric fans. Key data are based on the large sampling exercise of DEFRA (2007). General data on compositions of smaller appliance are derived from Truttman (2006), Morf (2004a), Freegard (2004), Srocka (2005), BIO IS (2006). Cat.1C specific composition data are derived from (AEA 2004, 2006a,b, Rotter 2006a,b). Again, the data from (RECUPEL 2007) in Table 51 are used for determining the amount of Annex II components in these appliances. In the next table, the input data constructed from the various sources and literature.

Components	Weight (g)	Appliances	Pieces (#)
Steel low alloyed	6,985	Microwaves	381
Plastics general	1,302	Electric heating appliances	258
Copper wire	609	Electric fans	187
Copper	285	Electric radiators	51
Al (general)	226	Dehumidifiers	13
Stainless steel	226	Fanning, ventilations	6
Wood	147	Other large for heating, beds, furniture	4
Other average	125	Airconditioners*	4
Mains cord	101	Electric hot plates	3
Rubber (EPDM)	49.6	**Total number**	**907**
PWB 1C LHHA-small	48.5	**Total weight (tons)**	**9.20**
Glass (white)	21.4	**Weight per appliance (g)**	**10,143**
Oil (Fridges)	9.29		
Batteries, accumulators (average)	4.92	* Should have been in Cat. 1B	
PUR (polyurethane)	2.25		
PS (polystyrene)	1.13		
LCD screens	0.36		
Hg switches	0.087		
PCB	0.0062		
Total	**10,143**		

Table 60: Average Composition Category 1C, LHHA-small

Again note that the above is the aggregated component compositions of an average Cat.1C appliance. As a default scenario as with all small appliances, no dismantling but shredding and separation of these appliances is taken. This baseline scenario is tested in the sensitivity analysis in Chapter 8.2.3 by comparing with other scenarios like specific removal or not of Annex II components and disposal with MSW. Chapter 8.2.3 also contains the total calculated weight and environmental weight 'composition', presented by multiplying Table 60 above with all individual component compositions.

Category 2: Small Household Appliances (SHHA)

This category covers the following types of appliances: Vacuum cleaners, carpet sweepers, other appliances for cleaning, appliances used for sewing, knitting, weaving and other processing for textiles, irons and other appliances for ironing, mangling and other care of clothing, toasters, fryers, grinders, coffee machines and equipment for opening or sealing containers or packages, electric knives, appliances for hair-cutting, hair drying, tooth brushing, shaving, massage and other body care appliances, clocks, watches and equipment for the purpose of measuring, indicating or registering time and scales.

Key data are found from the large sampling exercise of (DEFRA 2007). General data on compositions of smaller appliance are derived from (Truttman 2006, Morf 2004a, Freegard 2004, Srocka 2005, BIO IS 2006). Cat. 2 specific composition data are also found in (Rotter 2006a,b). Data from (RECUPEL 2007) in Table 51 are used for determining the amount of Annex II components in these appliances. In the next table, the input data constructed from the various sources and literature, forming the basis for the environmental and economic calculations.

Components	**Weight (g)**	**Appliances**	**Pieces (#)**
Plastics general	2,112	Vacuum cleaners	2,713
Motor	693	Toasters, sandwich roasters	427
Steel low alloyed	638	Irons	343
Copper	93.0	Kettles	320
Stainless steel	69.7	Food processors	172
Al (general)	69.7	Hair cutting, tooth brushes, body care, Clocks, watches, time reg.	160
Rubber (EPDM)	35.8	Fryers	108
Copper wire	28.0	Grinders, coffe makers	26
Mains cord	27.0	Sewing kitting, etc.	11
Other average	11.9	Elec. Knives	7
Wood	6.42	Scales	6
Oil	3.84	**Total number**	**4293**
PWB 2 SHHA	6.83	**Total weight (tons)**	**16.32**
Average PWB Audio, 2000, FR2 powerboard, without transf.	3.34	**Weight per appliance (g)**	**3,801**
Capacitors	2.21		
Batteries, accumulators (average)	3.88		
LCD screens	0.15		
Hg switches and backlights	0.036		
PCB	0.0025		
Total	**3,805**		

Table 61: Average Composition Category 2,5A,8, SHHA, LUM, Med.

The above is the aggregated component composition of an average Cat. 2 appliance. As a default scenario in common with all small appliances, no dismantling is undertaken but instead, shredding and separation of these appliances occurs. This baseline scenario is tested in the sensitivity analysis in Chapter 8.2.3 by comparing with other scenarios. Within Chapter 8.2.3 the total calculated weight and environmental weight 'composition' is also presented by multiplying Table 61 above with all individual component compositions as presented in Table 52 and Annex 6.2.2.

Category 3A: IT and Telecom excl. CRT's (IT ex CRT)

This category covers the following types of appliances: Printers, copying equipment, facsimile equipment, telephones (fixed and mobile), including answering equipment, calculators, computers (desktop and laptop). Key data are found from the large sampling exercise carried out by DEFRA in 2007. General data on compositions of smaller appliance are derived from (Truttman 2006, Morf 2004a, Freegard 2004, Srocka 2005, BIO IS 2006). Cat.3A specific composition data is also found in (Rotter 2006a,b, Ezroj 2005, Niera, 2006, MPPI 2006, NVMP 2006, Kemna 2007). Data from (RECUPEL 2007) in Table 51 are used for determining the amount of Annex II components in these appliances. In the next table, the input data constructed from the various sources and literature, forming the basis for the environmental and economic calculations.

Components	Weight (g)	Appliances	Pieces (#)
Steel low alloyed	2,461	PC's	1,175
Plastics general	1176	Keyboards	1,026
Motor	81.7	Printers	1,024
Copper	68.6	Telephones	325
PWB 3A IT ex CRT Part1 PC's	67.4	Copiers	311
PWB 3A IT ex CRT Part2 Printing devices	67.4	Mouse	142
Stainless steel	51.5	*Typewriters**	*100*
Al (general)	51.5	Faxes	70
Other average	47.9	FDD/ HDD	32
Mains cord	43.0	Laptops	24
PWB 3A IT ex CRT Part3 Small IT	39.4	Screens	12
Other average	9.27	Pocket calculators	4
Steel low alloyed	8.91	**Total number**	**4.245**
Capacitors	5.22	**Total weight (tons)**	**17.78**
Oil	3.84	**Weight per appliance (g)**	**4.188**
Batteries, accumulators (average)	3.83	* not in scope	
Batteries, accumulators (average)	2.03		
LCD screens	0.15		
LCD backlights	0.036		
PCB	0.0025		
Total	**4,188**		

Table 62: Average Composition Category 3A IT ex CRT

Again, the above is the aggregated component composition. Further composition and scenario information are presented in Chapter 8.2.3.

Category 4A: Consumer Electronics excl. CRT's (CE ex CRT)

This category covers the following types of appliances: Video recorders and DVD players, Video cameras, Audio equipment, Radio sets, Musical instruments. Key data are found from the large sampling exercise of (DEFRA 2007, Eikelenberg 2003, v.d. Wel 2002, Rotter 2006a,b). General data on compositions of smaller appliance is derived from (Truttman 2006, Morf 2004a, Freegard 2004, Srocka 2005, BIO IS 2006). Data from (RECUPEL 2007) in Table 51 are used for determining the amount of Annex II components in these appliances. In the next table, the input data constructed from the various sources and literature, forming the basis for the environmental and economic calculations.

Components	**Weight (g)**	**Appliances**	**Pieces (#)**
Steel low alloyed	1,621	VCR, DVD	1,278
Plastics general	950	Hifi- CDR	1,196
Wood	302	Speakers	1,152
Motor	284	Radios	428
Copper	226	Settop boxes	160
Stainless steel	169	Record turntables	149
Al (general)	169	Audio amplifier	146
PWB 4A CE ex CRT Part2 VCRs DVD etc.	104	Car stereo	125
PWB 4A CE ex CRT Part1 Large Audio	86.1	Musical instruments*	36
Wood	65.8	Videocam	28
Other average	42.1	Cameras	22
Copper wire	19.2	Other	8
Other average	9.21	TV's*	1
Mains cord	3.89	**Total number**	**4,729**
Oil	3.72	**Total weight (tons)**	**19.20**
Batteries, accumulators (average)	2.99	**Weight per appliance (g)**	**4,060.05**
Capacitors	1.43	* Should be in Category 7?	
LCD screens	0.14	* Should be in Category 4B	
LCD backlights	0.035		
PCB	0.0025		
Total	**4,060**		

Table 63: Average Composition Category 4A CE ex CRT

The above is the aggregated component composition. The data for the PWB's is split in a part representing metal dominated products like VCR's and DVD players which are relatively more 'rich' (higher portion of controlboards) in composition than the second part of large audio equipment (higher portion of powerboards). Further composition and scenario information are presented in Chapter 8.2.3.

Category 6: Tools (Tools)

This category covers drills, saws, sewing machines, equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching, folding, bending or similar processing of wood, metal and other materials, tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses, tools for welding, soldering or similar use, equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means, tools for mowing or other gardening activities. Key data are found from the large sampling exercise of (DEFRA 2007, Rotter 2006a,b) General data on compositions of smaller appliance is derived from (Truttman 2006, Morf 2004a, Freegard 2004, Srocka 2005, BIO IS 2006) Data from (RECUPEL 2007) in Table 51 are used for determining the amount of Annex II components in these appliances. Furthermore data on NiCd batteries are used as a relatively high amount of these large battery packs are found in this category. In the next table, the input data constructed from the various sources and literature, forming the basis for the environmental and economic calculations.

Components	**Weight (g)**	**Appliances**	**Pieces (#)**
Plastics general	2,213	Lawnmowers*	794
Motor	1,763	Strimmers	281
Steel low alloyed	1,611	Turning, milling, sanding, grinding, etc	234
Copper	133	Drills	118
Al (general)	107	Spraying, spreading, dispersing	82
Mains cord	103	Sewing machines	63
Other average	70.9	Hedgecutters	54
Battery (NiCd)	52.2	Saws	41
Batteries, accumulators (average)	27.8	Mowing, gardening	4
Stainless steel	26.7	Riveting, nailing, etc	2
Average PWB Audio, 2000, FR2 powerboard, without transf.	20.0	Welding, soldering	1
Rubber (EPDM)	7.50	**Total number**	**1,674**
Capacitor (film, lacquered)	4.85	**Total weight (tons)**	**10.28**
LCD screens	0.22	**Weight per appliance**	**6,141**
Total	**6,141**	* Not known whether this high number is to be regarded as 'normal'	

Table 64: Category 6 Tools

The above is the aggregated component composition. Further composition and scenario information are presented in Chapter 8.2.3.

Category 7: Toys (Toys)

This category covers electric trains or car racing sets, hand-held video game consoles, video games, computers for biking, diving, running, rowing, etc., sports equipment with electric or electronic components, coin slot machines. Key data are found from the large sampling exercise of (DEFRA 2007). General data on compositions of smaller appliance is derived from (Truttman 2006, Morf 2004a, Freegard 2004, Srocka 2005, BIO IS 2006). Data from (RECUPEL 2007) in Table 51 are used for determining the amount of Annex II components in these appliances. In the next table, the input data constructed from the various sources and literature, forming the basis for the environmental and economic calculations.

Components	Weight (g)	Appliances	Pieces (#)
Plastics general	7,763	Game consoles	10
Steel low alloyed	3,863	Handheld videoconsoles	7
Other average	1,176	Toy cars	6
PWB 7 Toys Part2, Game cons. controlb.	70.0	Scooters	6
PWB 7 Toys Part1, Game cons. powerb.	59.4	Sport computers (biking running)	3
Batteries, accumulators (average)	6.28	**Total number**	**32**
LCD screens	0.46	**Total weight (tons)***	**0.41**
Total	**12,938**	**Weight per appliance (g)**	**12,938**
		* Relatively small sample	

Table 65: Average Composition Category 7 Toys

The above is the aggregated component composition. Further composition and scenario information are presented in Chapter 8.2.3. Note, that in practice, the game consoles are becoming more and more similar to PC's and are expected to be gathered with Cat.3B as part of the small appliances stream.

Category 8: Medical Equipment (Med.) and Category 5A: Lighting equipment – Luminaires (LUM)

This category covers: radiotherapy equipment, cardiology and dialysis equipment, pulmonary ventilators, nuclear medicine, laboratory equipment for in-vitro diagnosis, analysers, fertilization testers, other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability. Data on compositions and Annex II components for this category are scarce. Some data on B2C medical devices are found from the large sampling exercise of (DEFRA 2007) and on Annex II components in (Goodman 2006). However, the amount of data are insufficient to compile average compositions as most of the B2B appliances are already collected and treated outside the consumer oriented compliance schemes. Only a few countries, like Sweden have more than a few years experience with this category (El-Kretsen, 2005). Due to the fact that the B2C medical devices are included in the sampling of Cat. 2 in the data from (DEFRA 2007), it is therefore included in the composition and amounts of Cat. 2. The same counts for Cat. 5A, Lum. For the environmental evaluation in Chapter 8.2.3, these two categories are included in Cat. 2. For the economic evaluation of Chapter 8.1.2, these two categories are treated separately.

Category 9: Monitoring and Control (M&C)

This category covers: smoke detectors, heating regulators, thermostats, measuring, weighing or adjusting appliances for household or as laboratory equipment, other monitoring and control instruments used in industrial installations (e.g. in control panels). Although there is some information present in the literature (DEFRA 2007), mainly on specific industrial installations with a relatively large appliance weight, the limited availability of other data points and the very low number of appliances collected, leads to insufficient data to determine average compositions of these products. Further environmental analysis on Cat. 9 products is therefore not possible. The small declared amounts treated and some data points on the technical costs associated however, enable inclusion in the economic analysis of 8.1.2.

8.0.5.4 CRT Appliances

Data CRT's

Category 3B: IT and Telecom CRT's (monitors) (IT - CRT) and Category 4B: Consumer Electronics CRT's (TV's) (CE - CRT)

These categories cover CRT monitors and CRT TV's. Key data are available from (Goris, 2004; Huisman, 2003a, 2004c, 2005a). Other specific data are found in (Kemna 2007, ICER 2004). Specific TV data is found in (PHILIPS CONSUMER ELECTRONICS 2006). CRT monitor data are displayed on the left side of the next table, CRT TV's on the right side.

Components CRT Monitors	Weight (g)	Components CRT TV's	Weight (g)
CRT-glass screen	5,647	CRT-glass screen	11,857
CRT-glass cone	2,781	CRT-glass cone	5,928
PWB 3B IT CRT	1,385	ABS (housing)	2,827
ABS (housing)	1,339	PWB 4B CE CRT	1,644
Steel low alloyed	770	Plastics general	1,212
Other average (inerts)	686	Wood	1,004
Coil	578	Speakers	761
Plastics general	574	Coil	758
Speakers	366	Mains cord	525
Mains cord	261	Al (general)	122
Al (general)	238	Electrongun	33
Electrongun	27.4		
Total	**14,653**	**Total**	**26,671**

Table 66: Average Composition Category 3B IT – CRT and 4B CE - CRT

The above are the aggregated component compositions. Further composition and scenario information are presented in Chapter 8.2.4. Here, also the various options for treating CRT glass as well as the sorted plastics from housings are evaluated.

Category 3C: Flat display panels (LCD monitors) (IT-FDP) and Category 4C: Flat display panels (LCD and plasma TV's) (CE-FDP)

This category covers LCD monitors as well as LCD and Plasma TV's, LED TV's. Some compositions data are available from (Kemna 2007, PHILIPS CONSUMER ELECTRONICS 2006). However, the data on printed circuit boards compositions are discussed in Chapter 8.0.3 and might not be representing the precious metal content very accurately for LCD Monitors. The data for LCD TV's are more accurate, but only available for larger types. Reliable data on printed circuit board compositions of small sized LCD TV's are not found. In the next table, the general composition of a LCD monitor is displayed on the left side of the next table, LCD TV's on the right side.

Components LCD monitors	Weight (g)
Steel low alloyed	1,771
LCD screens	645
PC (polycarbonate)	520
PMMA	450
PWB 3C IT FDP	410
ABS	360
PE (polyethene, HD)	300
Cable internal (general)	230
PA (polyamide)	198
Al (general)	130
Mains cord	110
Plastics general	90.0
PET	60.0
Plastics general	3.10
LCD backlights	1.94
Total	**5,279**

Components LCD TV's	Weight (g)
Glass (white)	6,273
Steel low alloyed	5,864
ABS (housing)	4,145
Plastics general	4,047
Fe	3,908
PWB 4C CE FDP	1,780
Al (general)	1511
Copper	441
PVC	252
LCD backlights	50.0
Other average	26.7
PC (polycarbonate)	2.36
Total	**28,300**

Table 67: Average Composition Category 3C IT – FDP

The above are the aggregated component compositions. Further composition and scenario information are presented in Chapter 8.2.4. This chapter also outlines the difficulties of dismantling and other treatment options as well as the potential destinations of sorted plastics from housings are evaluated.

8.0.5.5 Lighting Equipment – Lamps

Data Lamps

Category 5A: Lighting - Luminaires

This category consists of Luminaries for fluorescent lamps with the exception of luminaries in households. (included in Cat. 2 SHA)

Category 5B: Lighting - Lamps (Lamps)

This category consists of straight fluorescent lamps, Compact fluorescent lamps, High intensity discharge lamps, including pressure sodium lamps and metal halide lamps, Low pressure sodium lamps, other lighting or equipment which does not use filament bulbs. Data on composition have been received from (ELC, 2007a,b,c). The table below is derived from very detailed market data on gas-discharge lamps in the subcategories TL standard, TL luxurous, CFL and HID. The numbers are based on the breakdown of estimated 2006 compositions of 662 million lamps, representing a weight of 95,4 ktons and a total amount of Hg included of around 4250 kg, which equals 45 ppm of Hg per 144 g lamp. In addition, it is calculated and estimated in detail that in 2011 these numbers will be around 833 million lamps, weighing 112 ktons and 2460 kg of Hg which equals 22 ppm per lamp of 134 g. The data provided are in line with the amount of fluorescent powders and Hg declared in (RECUPEL, 2007).

Components	**Weight (g)**
Glass (high quality)	114
Glass (low quality)	9.85
Al (general)	8.03
Copper	2.63
Plastics general	2.47
Fluorescent powder (excl. Hg)	2.37
Steel low alloyed	2.25
PWB 5B Lamps	1.23
Ceramics	0.54
Stainless steel	0.45
Sn (in HT solder)	0.082
Pb (in HT solder)	0.054
Hg	0.0064
Total	**144.2**

Table 68: Average Composition Category 5B Lamps

Table 68 above is the aggregated component composition. Further composition and scenario information are presented in Chapter 8.2.5. Special attention is paid to the influence of the relatively large amount of Hg present in gas discharge lamps on the environmental assessment and its specific impacts under different environmental impact assessment categories.

8.0.6 Data Quality and Availability

The data in Figure 21 presents the overall data availability and quality for the environmental and economic impacts assessment.

Category	Amounts treated	Compositions	Sampling data (units)	Rec%	Technical costs	Annex II comp.	CRT glass	Plastics
1A LHHA	Fair	Good	Good	Fair	Good	Good	N.A.	N.A.
1B C&F	Good	Excellent	Good	Fair	Good	Excellent	N.A.	N.A.
1C LHHA-small	Fair	Good	Excellent	Fair	Good	Good	N.A.	N.A.
2 SHHA	Fair	Good	Excellent	Fair	Good	Good	N.A.	Fair
3A IT ex CRT	Fair	Good	Excellent	Fair	Good	Good	N.A.	Good
3B IT CRT	Good	Excellent	Excellent	Fair	Good	Good	Good	Good
3C IT FDP	Fair	Fair	Weak	Fair	Weak	Good	N.A.	Fair
4A CE ex CRT	Fair	Good	Excellent	Fair	Good	Good	N.A.	Good
4B CE CRT	Good	Excellent	Excellent	Fair	Good	Good	Good	Good
4C CE FDP	Fair	Fair	Weak	Fair	Weak	Good	N.A.	Fair
5A LUM	Incl. in Cat.2			Fair	Good	N.A.	N.A.	Fair
5B Lamps	Good	Excellent	Good	Fair	Good	Excellent	N.A.	N.A.
6 Tools	Fair	Good	Good	Fair	Good	Good	N.A.	Fair
7 Toys	Fair	Fair	Fair	Fair	Good	Good	N.A.	Fair
8 Med.	Incl. in Cat.2			None	Weak	None	N.A.	None
9 M&C	Incl. in Cat.2			Weak	Weak	None	N.A.	None
10 Aut.Disp.	Incl. in Cat.1A			Weak	Weak	Fair	N.A.	N.A.

Figure 21: Data availability and quality per WEEE category

SME Panel

A Small and Medium Sized Enterprise (SME) Panel convened by the European Commission's Directorate General for Environment also informed the evaluation of the current implementation of Directive 2002/96 on Waste Electrical and Electronic Equipment in the EU Member States. A questionnaire, to which the contractor provided further questions, served as an additional tool for obtaining information for the Commission's review by collecting information on the experiences, difficulties and costs encountered by SMEs whilst implementing the WEEE Directive.

The contractor was provided with aggregations of returned questionnaires from fourteen EU member states plus Norway and the respective reports of national coordinators.

The findings of the SME panel provided interesting feedback on the average awareness of SMEs on the WEEE topic. Nevertheless, the inclusion of the data and information provided was hindered partly by the lack of information on the respondent's background and the provision of answers in aggregated form. In consequence it was very difficult to track replies of single SMEs or identify the linkage between the clustered replies in the coordinators' reports and single SMEs in order to carry out an in-depth analysis of the answers provided. For example the German coordinator reports on section C1 "what are on average the cost burdens to SMEs when complying with the WEEE Directive?" provided answers varying from EUR 500 to 100,000. This information was of limited value without describing the correlations with the respective quantities and values of products put on the market. As a result, this approach led to inconsistency in replies especially for quantitative information.

Surprisingly meetings with SME representatives indicated that none of these representatives were involved in or informed about the Panel, although all of them are active participants in WEEE-related activities of large national associations.

Nevertheless the SME panel response contains a wide range of opinions and comments that explain the concerns and experiences of a large but often under-represented stakeholder-group. It partly supports, explains and sometimes also opposes concerns of large companies. It was noted that many of the SME panel respondents were hardly aware of even the existence of the WEEE Directive, although the legal obligations already exist. As a result, it was difficult to draw environmental and economic impact conclusions from this group of stakeholders as little data was available. See also Chapter 8.1.1 on "Registered Producers" for more information.

8.1 Economic Evaluation of the Implementation (Task 1.1.2)

The assessment of economic impact of WEEE Directive has been carried out according to the objective and methodology outlined in Chapter 6.2 The analysis has been split according to the two main concurrent aspects:

1. Administrative Burden (Task 1.1.2.2), including:
    a. Administrative Burden Survey, and
    b. Registering and Reporting Burden overview.
2. Determination of costs along the chain (or Economic impact on stakeholders) (Task 1.1.2.1), split up into two different analysis:
    a. Assessment of total economic impact across EU27, and

b. Breakdown of costs along the chain, further connected with the environmental assessment of Chapter 8.3 and eco-efficiency analysis.

8.1.1 Administrative Burden (Task 1.1.2.2)

Analysis
Admin. Burden

The analysis of the received questionnaires enables some general remarks:

- There is still a low level of involvement by stakeholders other than producers. This is because the other stakeholders involved in the recycling chain (distributors, municipalities, refurbishers, social enterprises, etc.) do not have structured and central organisations at National and European Level,
- There is still a low level of involvement by micro and small size stakeholders, due to both their level of awareness and the resources available (mainly time) to either respond to questionnaires and surveys or conduct their normal day-to-day business activities (SME Panel 2007),
- Some stakeholders, particularly those with a low level of awareness of the topic (even if it affected their legislative requirements), provided limited answers,
- The different aims of different organisations (such as national registers) increases the overall burden,
- The highest level of burden perceived is related to activities that stakeholders (mainly producers, considering the replies breakdown per stakeholder type) have to conduct in each country (registering and reporting); a lower level of burden is perceived for informing final users or recyclers and even less for monitoring and control, enforcement or setting up National Register or Clearing House (as these activities are in the great majority carried out not directly by producers), and
- Some recurrent arguments were found in the responses to the questionnaire, especially in those providing good insights and explanations of the main reasons for each burden.

The responses received highlight the following outcomes. It's important to remember that answers to the first, top-level questions (Q1 to Q5) included the following 4 options:

1. No, I don't have this activity to carry out,
2. No, I don't feel any burden in carrying out this activity,
3. Yes, I feel a burden but I'm not able to quantify, and
4. Yes.

Q1) Assessment of burden in registering to National Register (Q1;Table 69) and availability of resources to carry out activity (Q1c; Table 70):

Question 1						
	--- Increasing Burden -->>					
Stakeholder Type	*1*	*2*	*3*	*4*	*N.A.*	Total
Association			1	2		3
Compliance Scheme		2	1	1	2	6
Distributor		1	3			4
Municipality	1		2			3
Producer		7	17	23		47
Refurbisher				1		1
Total	1	10	24	27	2	64
	1.6%	15.6%	37.5%	42,2%	3,1%	
	17.2%		79.7%			

Table 69: Overview burden perceived in registering activities

A high percentage of stakeholders are experiencing a burden in carrying out such activities (in some Member States, even other stakeholders like Municipalities, retailers or compliance schemes need to be registered to a competent body), even if more than 82% (of those who ticked an answer) considered it as a necessary activity (especially for free-rider tracking). Those who responded that it was a superfluous activity were mainly highlighting difficulties in coordination between MS and overlapping issues with reporting requirements.

The main reasons for the burden were:

1. Legal aspects connected to registration (how, where, details to be submitted),
2. Producer Definition, Distributors involvement, etc
3. B2B versus B2C (definition, split,…),
4. Type of Equipment (units, weight, level of detail) and frequency of reporting, and
5. Lack of consistency across MS.

Question 1c					
Stakeholder Type	**Size**	**Y**	**N**	**N.A.**	**Total**
Association	N.A.	1	2		3
Total Associations		1	2		3
Compliance Scheme	Micro	4	1		5
	Medium	1			1
Total Compliance Schemes		5	1		6
Distributor	Micro	1	1		2
	Small	1			1
	Large	1			1
Total Distributors		3	1		4
Municipalities	Large			1	1
	N.A.	1	1		2
Total Municipalities		1	1	1	3
Producer	Micro	2	3	1	6

Question 1c					
Stakeholder Type	**Size**	**Y**	**N**	**N.A.**	**Total**
	Small	1	1		2
	Medium	4	1	1	6
	Large	15	11	1	27
	N.A.	5	1		6
Total Producers		27	17	3	47
Refurbisher	Large	1			1
Total Refurbishers		1			1
Total		38	22	4	64

Table 70: Overview availability of resources for reporting activities (breakdown per stakeholder type and size)

Regarding the availability of resources, even if the registering activity is in most cases a "one-off" activity, a large number of stakeholders are experiencing a lack of resources; one of the most recurrent reasons is lack of time or difficulties in tracking all needed requirements according to different legislative requirements across EU (the overall survey showed as 82% of those who ticked any lack of resources in question 1 pointed out time, 82% infrastructures and 32% money).

Q2) Assessment of burden in reporting market share, take back performances and recycling targets (Q2; Table 71) and availability of resources to carry out activity (Q2c; Table 72):

Question 2						
	--- Increasing Burden -->>					
Stakeholder Type	***1***	***2***	***3***	***4***	***N.A.***	**Total**
Association			1	2		3
Compliance Scheme		1	2	3		6
Distributor		1	3			4
Municipality	3					3
Producer	4	6	12	25		47
Recycler	1	4	8	2		15
Refurbisher				1		1
Total	8	12	26	33		79
	10.1%	15.2%	32.9%	41.8%	0.0%	
	25.3%		74.7%			

Table 71: Overview burden perceived in reporting activities

There is a high percentage of stakeholders experiencing a burden in carrying out this activity, but more than 79% (of those who ticked an answer) considered it a necessary activity (especially for allocating responsibilities and assessing take back performances or obligations – as in some Member States take back obligations for the Country or for each specific producer refer to percentage put on market in the previous year).

The main factors causing burdens were:

1. Different definitions of weight or difference in basis for reporting (units, weight, other mechanisms),
2. Level of details in reporting (1-10 categories or cluster of products or even product level),

3. B2B versus B2C (definition, split), and
4. Lack of consistency across MS.

Question 2c					
Stakeholder Type	**Size**	**Y**	**N**	**N.A.**	**Total**
Association	N.A.	1	2		3
Total Associations		1	2		3
Compliance Scheme	Micro	4	1		5
	Medium	1			1
Total Compliance Schemes		5	1		6
Distributor	Micro	1	1		2
	Small		1		1
	Large	1			1
Total Distributors		2	2		4
Municipalities	Large			1	1
	N.A.			2	2
Total Municipalities				3	3
Producer	Micro		4	2	6
	Small		1	1	2
	Medium	3	1	2	6
	Large	13	12	2	27
	N.A.	5	1		6
Total Producers		21	19	7	47
Recycler	N.A.	11	4		15
Total Recyclers		11	4		15
Refurbisher	Large		1		1
Total Refurbishers			1		1
Total		40	29	10	79

Table 72: Overview availability of resources for reporting activities (breakdown per stakeholder type and size)

Regarding availability of resources, it is important to remember that there are different reporting activities in different member states (once, twice or even twelve times a year), and this has resulted in stakeholders experiencing a lack of resources. Even those who stated they have enough resources highlighted the lack of infrastructures and time (the overall survey showed that 65% of those who ticked any lack of resources in question 2 pointed out infrastructures; 61% time and 52% money).

Q3) Assessment of burden in informing final users and recyclers (Q3; Table 73) and availability of resources to carry out activity (Q3c; Table 74):

Question 3						
	--- Increasing Burden -->>					
Stakeholder Type	*1*	*2*	*3*	*4*	*N.A.*	**Total**
Association		2		1		3
Compliance Scheme	1	3	1	1		6
Distributor	2	1	1			4
Municipality	3					3
Producer	7	12	10	18		47
Refurbisher				1		1
Total	13	18	12	21	0	64
	20.3%	28.1%	18.8%	32.8%	0.0%	
	48.4%		51.6%			

Table 73: Overview burden perceived in informing final users and recyclers

About 50% of stakeholders experienced a burden in carrying out this activity, and 67% (of those who ticked an answer) considered it a necessary activity.

The main factors causing a negative impact were:

- Raising awareness for final users (respondents also argued that it should be up to the Member State to run such campaigns),
- Setting up of a website for informing final users or providing disassembly sequences for recyclers (one respondent commented that recyclers know their job and disassembly sequences or other information is not really needed and used), and
- Country specific information needed to be translated into different languages.

Question 3c					
Stakeholder Type	**Size**	**Y**	**N**	**N.A.**	**Total**
Association	N.A.		1	2	3
Total Associations			1	2	3
Compliance Scheme	Micro	2	1	2	5
	Medium	1			1
Total Compliance Schemes		3	1	2	6
Distributor	Micro	1		1	2
	Small		1		1
	Large			1	1
Total Distributors		1	1	2	4
Municipalities	Large			1	1
	N.A.			2	2
Total Municipalities				3	3
Producer	Micro		3	3	6
	Small		1	1	2
	Medium	2	1	3	6
	Large	14	8	5	27
	N.A.	4	2		6
Total Producers		20	15	12	47
Refurbisher	Large	1			1

Question 3c					
Stakeholder Type	**Size**	**Y**	**N**	**N.A.**	**Total**
Total Refurbishers		1			1
Total		25	18	21	64

Table 74: Overview availability of resources for informing final users and recyclers (breakdown per stakeholder type and size)

Of stakeholders that experienced a lack of resources (42% of those who ticked the answer) need to be highlighted especially time (78% of those who ticked any lack of resources in question 3 pointed out time, 67% money and 56% infrastructures).

Q4) Assessment of burden in monitoring and control enforcement (Q4; Table 75) and availability of resources to carry out activity (Q4c; Table 76):

Question 4						
	--- Increasing Burden -->>					
Stakeholder Type	***1***	***2***	***3***	***4***	***N.A.***	**Total**
Association	1			2		3
Compliance Scheme		2	3	1		6
Distributor		1	1	2		4
Municipality	3					3
Producer	15	7	12	10	3	47
Recycler	1	4	8	2		15
Refurbisher				1		1
Total	20	14	24	18	3	79
	25.3%	17.7%	30.4%	22.8%	3.8%	
	43.0%		53.2%			

Table 75: Overview burden perceived in monitoring and control enforce activities.

A considerable percentage of stakeholders experienced problems in carrying out this activity, even if 25% do not have to deal with it as it is mainly to the responsibility of the competent bodies. 81% of those who ticked an answer considered that the activity is needed, even if it has to be carried out by competent bodies. The main reason for the burden was the need to audit the recyclers and consistency in reporting standards and formats.

Question 4c					
Stakeholder Type	Size	Y	N	N.A.	Total
Association	N.A.		2	1	3
Total Associations			2	1	3
Compliance Scheme	Micro	2	2	1	5
	Medium	1			1
Total Compliance Schemes		3	2	1	6
Distributor	Micro	1	1		2
	Small		1		1
	Large	1			1
Total Distributors		2	2		4
Municipalities	Large			1	1
	N.A.			2	2

Question 4c					
Total Municipalities				3	3
Producer	Micro		2	4	6
	Small		1	1	2
	Medium		2	4	6
	Large	9	8	10	27
	N.A.	2		4	6
Total Producers		11	13	23	47
Recycler	N.A.	11	4		15
Total Recyclers		11	4		15
Refurbisher	Large	1			1
Total Refurbishers		1			1
Total		28	23	28	79

Table 76: Overview availability of resources for monitoring and control enforce activities (breakdown per stakeholder type and size)

When looking at availability of resources the picture is quite balanced, even though a high percentage of stakeholders did not provide an answer to the question. Of those who ticked any boxes for lack of resources, 71% highlighted time as factor, 62% were concerned with infrastructures and 48% of respondents found money an obstacle.

Q5) Assessment of burden in setting up a National Register or Clearing House (Q5; Table 77) and availability of resources to carry out activity (Q5c; Table 78)

Question 5						
	--- Increasing Burden -->>					
Stakeholder Type	*1*	2	*3*	*4*	*N.A.*	Total
Association			1	2		3
Compliance Scheme	3		2	1		6
Distributor	3		1			4
Municipality	3					3
Producer	21	8	6	8	4	47
Refurbisher				1		1
Total	30	8	10	12	4	64
	46.9%	12.5%	15.6%	18.8%	6.3%	
	59.4%		34.4%			

Table 77: Overview burden perceived in setting up of National Register of Producers and/or Clearing House

A considerable percentage of stakeholders experienced a burden in carrying out this activity, especially when considering that more than 46% do not have to deal with this activity. 93% of those who ticked an answer consider that the activity is needed, even if has to be carried out by competent bodies.

Question 5c					
Stakeholder Type	**Size**	**Y**	**N**	**N.A.**	**Total**
Association	N.A.		2	1	3
Total Associations			2	1	3
Compliance Scheme	Micro	2		3	5
	Medium	1			1
Total Compliance Schemes		3		3	6
Distributor	Micro		1	1	2
	Small			1	1
	Large	1			1
Total Distributors		1	1	2	4
Municipalities	Large			1	1
	N.A.			2	2
Total Municipalities				3	3
Producer	Micro		1	5	6
	Small			2	2
	Medium			6	6
	Large	10	4	13	27
	N.A.	2		4	6
Total Producers		12	5	30	47
Refurbisher	Large	1			1
Total Refurbishers		1			1
Total		17	8	39	64

Table 78: Overview availability of resources for setting up National Register and/or Clearing House activities (breakdown per stakeholder type and size)

When looking at availability of resources the great majority of stakeholders answered that they have enough resources. This was mainly because they are not carrying out this activity.

National Registers Overview

Information was gathered by means of a questionnaire to National Registers, as the main official and reliable source of information. 14 out of 21 registers in place replied to the questionnaire. Feedback and gaps were also closed by means of Associations of Producers (EICTA and CECED), some TAC Members and national compliance schemes providing information. The overview of data source is presented in Table 79:

Member State	**Data source**	**Member State**	**Data source**	**Member State**	**Data source**
Austria	National Register	Germany	Industry	Netherlands	Industry
Belgium	Scheme (partial)	Greece	Sent	Poland	Industry
Bulgaria	Industry (partial)	Hungary	National Register	Portugal	National Register
Cyprus	N.A.	Ireland	National Register	Romania	Industry (partial)
Czech Republic	National Register	Italy	Industry	Slovakia	National Register

Member State	Data source	Member State	Data source	Member State	Data source
Denmark	National Register	Latvia	National Register	Slovenia	Sent
Estonia	National Register	Lithuania	National Register	Spain	National Register
Finland	National Register	Luxembourg	Scheme (partial)	Sweden	National Register
France	National Register (partial) iIndustry	Malta	N.A.	United Kingdom	TAC

Table 79: Overview data source for Registering and Reporting Burden

The findings, based on the responses received, could be summarised as follows:

1. National Registers Running

According to the WEEE Directive National Registers of Producers have been set up in almost every Member State (Italy and UK are still missing as the registers are still being set-up; no information was available regarding Bulgaria, Cyprus, Malta and Romania).

2. Joining Fee or Annual Renewal

a. 10 (Austria, Czech Republic, Estonia, France, Latvia, Lithuania, Netherlands, Slovakia, Spain and Sweden) National Registers are free of charge to join. 9 of them (Denmark, Finland, Germany, Hungary, Ireland, Poland, Portugal, UK and, probably Italy) have a joining fee, varying from EUR 13 to EUR 2,000 (some of them have a fixed fee, some others have a fee varying on turnover of number/weight of appliances put on market),
b. 7 (Czech Republic, Denmark, Ireland, Lithuania, Poland and Portugal) National Registers have a mandatory annual renewal which is free in Czech Republic and Lithuania),
c. 5 (Denmark, Ireland, Poland, Portugal and Sweden) have a renewal fee that has to be paid every year. These 5 National Registers have different level of fees and sharing mechanism, depending on:
    - Weight of appliances put on market (Denmark). The annual renewal for each registered producer is calculated according to the total weight of appliances every producer put on the market in the previous year. For 2006 the amount is about 0.008 EUR/kg excluding VAT (0.06 DKK/kg)[3],
    - Annual Turnover (Ireland). For Ireland the annual fee to be paid depends on turnover[4]: EUR 250 for turnover up to EUR 250,000, EUR 500 for turnover up to EUR 500,000, EUR 1,000 for turnover up to EUR 1,000,000 and EUR 2,000 for turnover above EUR 1,000,000,
    - Annual Turnover and size (Poland). The breakdown of fees depends on size (micro company or other companies) and Annual turnover (varying from less than EUR 128,000 (PLN 500,000) to more than EUR 1,280,000 (PLN 5,000,000). Joining fees and renewal vary from EUR 13 (PLN 50) to EUR 2,000 (PLN 7,500),

[3] https://www.weee-system.dk/files/Charges%20med%20logo.pdf
[4] http://www.weeeregister.ie/

— Number of appliances put on market (Portugal). The annual fee to be paid depends on the number of appliances put on the market[5]: EUR 375 up to 3,750 units, 0.10 EUR/unit from 3,751 units to 10,000 units, 0.01 EUR/unit from 10,001 units to 60,000 units and a fixed fee of EUR 1,500 for more than 60,000 units put on the market,

— Fixed amount (Sweden) equal to EUR 350.

3. Registered Producers

The number of registered producers in different countries varies, according to the following Table 80:

Member State	Registered Producers	Member State	Registered Producers	Member State	Registered Producers
Austria	1,300	Germany	7,089 (Industry)	Netherlands	2,135 (Scheme)
Belgium	2,341 (Scheme)	Greece	N.A.	Poland	2,146 (Industry)
Bulgaria	N.A.	Hungary	715	Portugal	928
Cyprus	N.A.	Ireland	850	Romania	N.A.
Czech Republic	1,860	Italy	N.A.	Slovakia	700
Denmark	979	Latvia	605	Slovenia	N.A.
Estonia	104	Lithuania	546	Spain	951
Finland	800	Luxembourg	405 (Scheme)	Sweden	1,000
France	3,744	Malta	N.A.	United Kingdom	N.A.

Table 80: Overview registered Producers at National Registers

Large differences in numbers of registered producers have been found, even considering neighbour Member States, and the estimation of WEEE arising in different Member States. The following main issues need to be taken into account:

1. Differences are in place in the "definitions" of producers and consequently on entities that need to register in each Member State,
2. The role of distributors that in some Member States could be registered as single producer and put on market appliances manufactured by different OEMs, and
3. The impact of awareness in SMEs (SME panel 2007). SMEs from Member State where National Register is in place are sometimes not aware of such obligations or the existence of a Register (e.g. Report of coordinators from Austria, Germany, France, Lithuania, Poland, Spain and Sweden).

Industry across Europe raised the issue of free-riding, especially in respect of SMEs and their lack of awareness. In particular, estimations of the total number of potentially registered producers provided figures ranging from more than double to five times more in big European countries.

Sometimes also different obligations connected to registering as B2B or B2C had impacts on numbers of registered producers, and raised concerns across Industry in terms of:

- Registering for "safety reasons", being aware that having a "registration number" in many countries is now an essential pre-requisite to put products on market, and

[5] http://www.anreee.pt/inter/areareg_tarifario.asp

- Registering only as B2B, even placing on market on B2C channel (especially when no clear definitions or criteria are in place), in order to avoid obligations connected to the management and financing of household WEEE arising.

4. Reporting Details

The complete overview is summarized in Table 81:

Member State	Frequency	Basis	Level Breakdown	Split B2B/B2C
Austria	Quarterly/Annually	Weight	5 categories	Yes
Belgium	Monthly/Quarterly	Units	1-10 cat., sub-cat.	Yes
Bulgaria	Monthly/Quarterly	Weight	N.A.	Yes
Cyprus	N.A.	N.A.	N.A.	N.A.
Czech Republic	Annually	Weight & Units	1-10 categories	Yes
Denmark	Annually	Weight	1-10 categories	Yes
Estonia	Annually	Weight & Units	1-10 categories	No
Finland	Annually	Weight & Units	1-10 categories	Yes
France	Half-Yearly	Weight & Units	1-10 cat., sub-cat.	Yes
Germany	Monthly (Annually for B2B)	Weight	1-10 cat., sub-cat.	Yes
Greece	N.A.	N.A.	N.A.	N.A.
Hungary	Annually	Weight	1-10 categories	Yes
Ireland	Monthly	Weight & Units	Visible Fee sub-cat.	Yes
Italy	Annually	Weight & Units	1-10 cat., sub-cat.	Yes
Latvia	Quarterly	Weight & Units	1-10 categories	No
Lithuania	Annually	Weight	1-10 categories	No
Luxembourg	Quarterly	Units	1-10 cat., sub-cat.	No
Malta	N.A.	N.A.	N.A.	N.A.
Netherlands	Quarterly (ICTM); Bi-Monthly (NVMP)	Weight (ICTM); Units (NVMP)	Visible Fee sub-cat.	Yes
Poland	Quarterly	Weight	1-10 categories	No
Portugal	Half-Yearly	Weight & Units	1-10 cat., sub-cat.	No
Romania	Yearly	Weights & Units	1-10 cat., sub-cat.	N.A.
Slovakia	Annually	Weight	1-10 categories	No
Slovenia	N.A.	N.A.	N.A.	N.A.
Spain	Quarterly	Weight	1-10 cat., sub-cat.	Yes
Sweden	Annually	Weight	1-10 categories	Yes
United Kingdom	Quarterly	Weight	1-10 categories	Yes

Table 81: Overview reporting requirements National Registers of Producers

Considering the information in Table 81, the following issues have been identified as crucial:

1. Frequency: This impacts on the burden for reporting (the higher the frequency, the higher the number of hours required to report and, consequently, higher economic and administrative burdens). On the other hand frequency of reporting could increase the control of the number of free-riders (a higher frequency provides more control on free-riders in the market, especially producers that might enter and leave a market in less than one year). When the amounts put on the market are used to define financing

obligations for producers or compliance schemes, stakeholders have argued that, for some markets, fluctuations could be very high and low frequency of reporting (annual) could be in-sufficient to precisely allocate obligations,

2. Basis: The weight of appliances put on the market is used in most Registers (only a couple of them are asking for Units). The main problem is lack of consistency in weight definition (i.e. including or excluding batteries, cable, accessories),
3. Grouping: The level of detail in reporting can vary because of the information that is needed (e.g. Ireland, related to the Visible Fee sub-categories); other kind of grouping could depend on separate collection clusters (e.g. Austria),
4. Split B2B/B2C: The split of B2B/B2C in reporting varies from country to country. The needed of split B2B/B2C appliances put on market and, in particular the definition of B2B/B2C have a great impact on the financing aspects of WEEE; especially when no defined rules or criteria are in place to differentiate appliance this could caue potential asymmetry in the market due to different financing mechanism as defined by article 8 and 9 of the WEEE Directive. In particular, when different obligations or options are in place in respect of:
   - Providing financial guarantees in respect of the different flows of appliances: in some Member States financial guarantees are to be provided even in respect of B2B appliances,
   - Mandatory financial obligations in respect of Historical WEEE: in particular the needed of financing, in proportion of the market share, costs arising from take back of household appliances. Declaration of B2B/B2C amount impact on financing obligation in respect of WEEE arising.

Information gathered from National Registers, together with information provided by Industry, TAC members and some Compliance Schemes, have enabled calculations on the economic burden arising per producer and across EU27 for registering and reporting activities to be carried out.

The following data have been used in these calculations:

- Data officially gathered from National Registers or provided by Industry, TAC Members or Compliance Schemes were used as primary source of information,
- For the remaining Member States, the information was assumed to be the minimum requirements (zero joining/renewal fees, minimum frequency of reporting – annual, registered producers as average across EU),
- Labour costs as of Eurostat[6] 2004;

The analysis on hours needed to fulfil reporting obligations has been assessed assuming, for the baseline scenario, being equal in every Member State and ranging from 2 to 18.

The minimum and maximum burdens have been assessed, as every producer in each country has to pay the minimum or maximum joining/renewal fee.

[6] http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=Yearlies_new_economy&root=Yearlies_new_economy/B/B2/B22/dbb10000

The following figure shows the amount of the economic burden related to registering and reporting activities. A baseline of 8 hours needed for every reporting period results in a burden of EUR 36.7 million to EUR 42.8 million per year across the EU27.

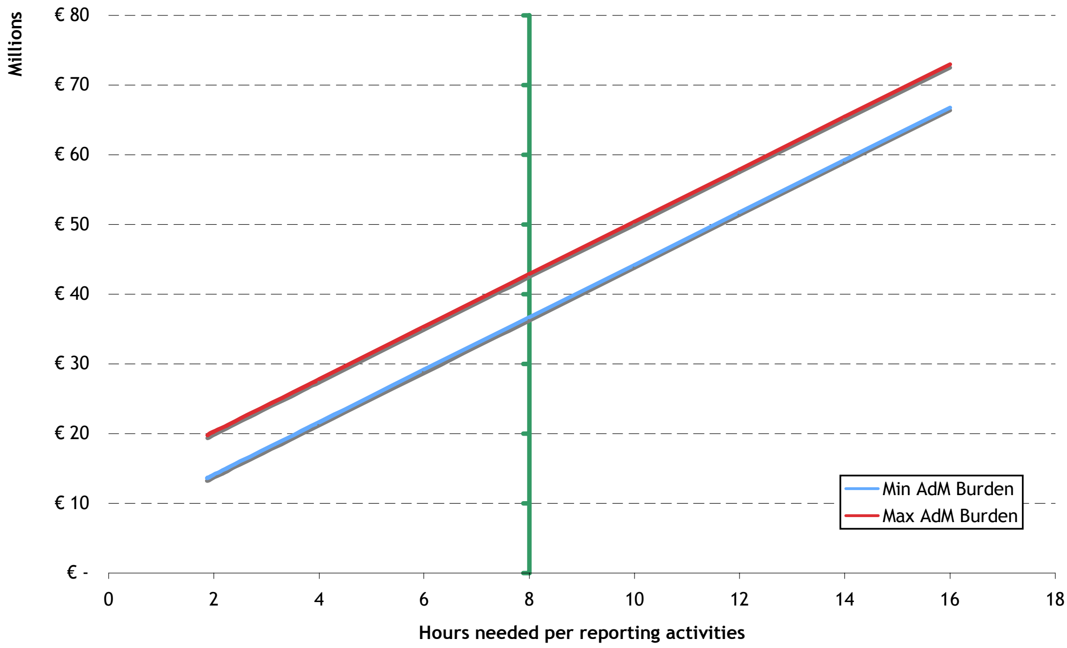

Figure 22: Annual EU economic burden in registering and reporting activities: analysis on hours requested

The following quantifies the economic burden relating to reporting activities for each producer (according to different Member States), in the initial assumptions of 8 hours requested for each reporting activity.

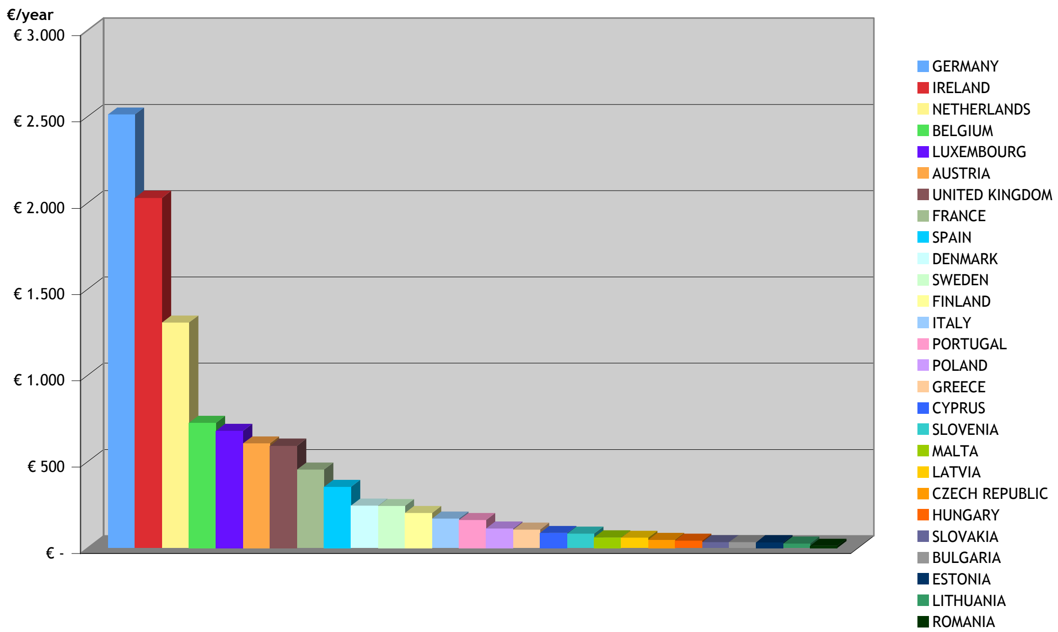

Figure 23: Annual economic burden per producer in reporting activities: analysis on average of 8 hours

Two different effects need to be taken into account to assess the economic burden connected to reporting activities:

- The number of hours spent carrying out reporting related activities,
- The frequency that reporting occurs, and
- The different labour costs in different Member States.

Figure 24 shows the annual economic burden per producer, depending on frequency of reporting, specific labour cost and varying depending of hours needed per reporting. Table 82 below shows the hourly increase of economic burden, depending on current Member States frequencies and taking into account labour costs.

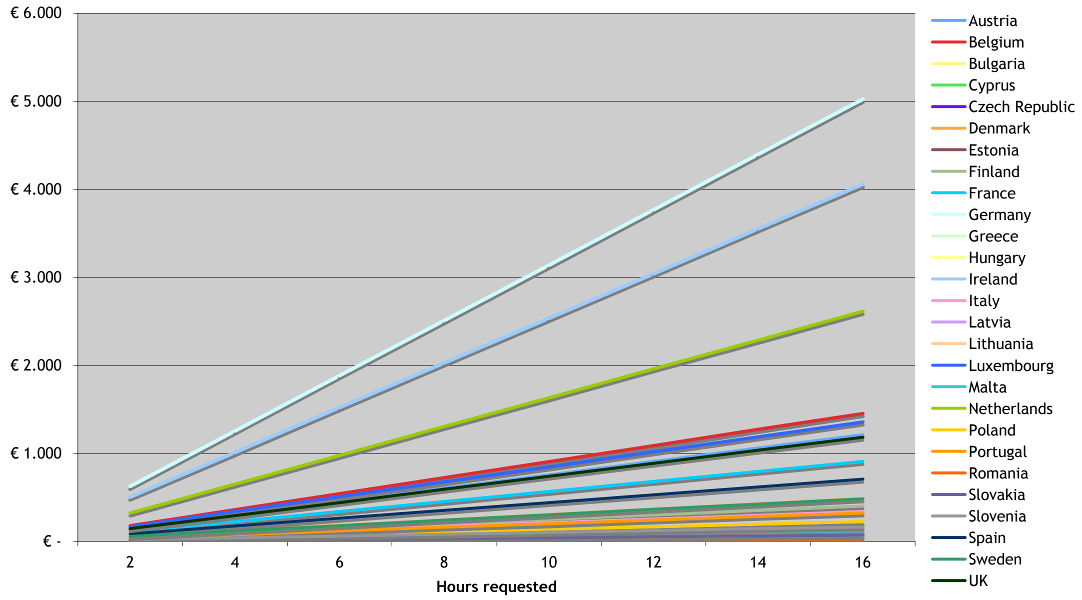

Figure 24: Annual Economic Burden per producer, depending on hours spent in reporting (Member State specific)

Member State	Hourly increase [EUR/h spent on reporting]	Member State	Hourly increase [EUR/h spent on reporting]	Member State	Hourly increase [EUR/h spent on reporting]
Germany	314.04	Denmark	30.7	Malta	7.77
Ireland	253.68	Sweden	30.43	Latvia	7.56
Netherlands	163.38	Finland	25.34	Czech Republic	5.85
Belgium	90.87	Italy	21.39	Hungary	5.54
Luxembourg	84.99	Portugal	20.4	Slovakia	4.41
Austria	75.9	Poland	14.22	Bulgaria	4.35
United Kingdom	74.13	Greece	13.37	Estonia	4.24
France	56.92	Cyprus	11.1	Lithuania	3.22
Spain	44.28	Slovenia	10.41	Romania	1.76

Table 82: Hourly increase in Economic Burden in Reporting

According to interviews and feedback from questionnaires, the hours spent in each Member State vary and sometimes, in the same country, the hours requested range from less than one hour to 8-10 hours.

Producers provided figures of 8 hours/week spent on average to carry out reporting activities across the EU. The information gathered so far is summarized in the following Table 83.

			Hours requested for each reporting activities					
	Size	**MS covered**	**Czech Republic [h/rep.]**	**France [h/rep.]**	**Germany [h/rep.]**	**Ireland [h/rep.]**	**Spain [h/rep.]**	**ALL EU [h/year]**
Producer 1	Large	3	8	12	10			152
Producer 2	Large	1			8			96
Producer 3	Large	1			0,3			4
Producer 4	Large	2			4		0,5	50
Producer 5	Medium	1			5			60
Producer 6	Micro	1				8		96
Producer 7	Micro	1				16		192
Producer 8	Large	27						384
Producer 9	Large	20						360
Producer 10	Large	27						16

Table 83: Overview hours requested per reporting activities according in different Member States

Further aspects need to be taken into account to fully evaluate the influencing factors of assessment of economic burden in reporting activities:

- The labour cost of qualified workers in the companies is higher than the average labour cost per different Member States,
- The average hours needed to report in a specific Member States due to the high level of details requested or the way that reports need to be submitted,
- The impact of economic burden on the size of producers. Considering figures provided by specific stakeholders in Table 83 it is possible to highlight how, in the same country, both a large producer and a medium one are spending the same amount of hours. The first producer was required to report on 73 different product categories, while the second one needed to report on just two product categories. Micro sized producers in another country are spending even more time. The impacts and benefits of standardization in reporting could be even higher for SMEs, which would reduce the impact on compliance,
- The impact of Investments in IT infrastructures inside the company in reducing reporting time. Producers provided figures of a few million euros of investments to change and update IT infrastructure in order to optimise reporting across EU27, and
- The experiences of lack of time and infrastructures pointed out in Questionnaire on Administrative burden in question 1 (registering) and question 2 (reporting) and their impact on potential bad/missing registration/reporting. Potential consequences on level of free-riding in the Country and market distortions in assessment of market share for the financing of WEEE arising need to be taken into account.

In addition to the previous elements on the implications of formats for reporting (frequency, basis, level of breakdown and split) to National Register of Producers, the roles and potential impacts of compliance schemes need to be taken into account.

National Registers of Producers have been set up according to article 12.1 of the WEEE Directive, aiming at collecting information on quantities put on market, as well as collected, reused, recycled and recovered. One of the aims is to report, on a two-yearly basis, to the European Commission performances of Member States in terms of targets set up in the Directive. A second aim is the enforcement of obligations, ensuring a level playing field for stakeholders, particularly avoiding the presence of free-riders on the market, ensuring each producer placing appliances on the market being registered in order to fulfil consequent take back obligations (both in respect of Historical WEEE, as well as new appliances put on market after entry into force of the Directive).

Compliance schemes have been set up in Member States in order to take over part of the responsibilities of producers in respect of operative management of take back obligations. Producers joining a Compliance Scheme have to declare the amount of products placed on the market in order to fulfil financial obligations in respect of the Scheme (usually compliance schemes across EU charge their members Compliance Fees depending on the amount – expressed in units or weight – of appliances put on market). In many countries compliance schemes are also taking over the reporting obligations of their member producers in respect of the National Register. Potentially, additional economic burdens are occurring when:

1. The Producer is reporting to a Scheme on a format (frequency, basis, breakdown or split) different from the reporting format defined by National Register. In these cases the Scheme is not taking over reporting responsibilities, producers need to report to the Scheme to fulfil contractual obligations in respect of financing, and to the National Register to fulfil legislative obligations in respect of reporting appliances put on market,
2. The Producer is reporting to the Scheme on a format different from the standard defined by National Register and the Scheme is taking over the reporting responsibilities in respect of National Register. In this case, the Compliance Scheme incurs the economic burden of reporting on a different format.

When examining the economic burden of set-up and management of National Registers, the following considerations need to be taken into account:

1. Two National Registers declared their initial set-up costs, ranging from EUR 54,000 to EUR 130,000. Figures provided by Industry in another Member State rose up to EUR 6,000,000.
2. Five National Registers declared their annual operative management costs, ranging from about EUR 8,000 to EUR 550,000.
3. Many of the respondents were unable to quantify the exact expenses for setting-up or management of the National Register as being part of bigger entity (e.g. Environmental Associations, of Ministry of financed by other bodies).

Furthermore, the different activities that each National Register might carry out (in particular in monitoring and enforcement or providing other services to members) increase difficulties in providing a closer range in such economic values.

8.1.2 Economic Impacts on Stakeholders (Task 1.1.2.1)

Analysis
Econ. Impacts

The first level of analysis of costs along the chain points out the overall economic impact of WEEE arising in EU27, according to estimation of WEEE arising and technical take back and recycling costs. Such analysis has been carried out considering the following, basic assumptions:

- WEEE arising in 2005-2020 according to Chapter 7.1,
- Breakdown of WEEE arising in product categories, in any given year, according to Chapter 8.0.5,
- Economic impact according to ranges of data (ERP 2006, WEEE Forum 2005) provided by compliance schemes currently operating across Europe (23 Compliance Scheme, operating in Austria, Belgium, Czech Republic, Estonia, France, Hungary, Ireland, Netherlands, Poland, Portugal, Sweden, Slovakia, Spain, Norway and Switzerland), reflecting costs of 2005 and 2006, merged together and made anonymous, where needed for receiving such information under an NDA (expressed in EUR/t).

Economic impact reflects different kinds of costs and, in particular:

- Technical and Operational costs. They include: costs for collection (even remuneration/reimbursement of municipalities or retailers where needed – by law or agreements/negotiations), costs for transportation and costs for treatment, and
- Additional costs. They include (where sustained by different national compliance schemes): “kick back” from distribution chain for levying fees, other costs (including the administration of the Scheme, costs for levying funds as financial guarantees, costs for monitoring, enforcement or control, costs for PR or awareness raising – sometimes defined by law), R&D costs and special costs for example costs for sorting and sampling and costs for specific waste streams such as batteries or packaging.

Total costs are the sum of Technical costs and Additional costs. Such costs do not include the economic burden in compliance for producers, caused by registering, reporting or other activities as descrbed in previous chapter. The focus of the Economic Evaluation of the implementation is on Technical and Operational costs for take back. The relationship between Technical costs and Additional costs is demonstrated in the following paragraph, which outlines the main factors.

Before presenting the main results from the analysis carried out, it’s important to highlight the following issues, in order to avoid any misleading interpretation of the figures:

- Financing principles of EOL activities are laid down in Article 8 of the WEEE Directive in respect of WEEE from private household (in particular article 8.2 for New WEEE, and article 8.3 for Historical WEEE) and Article 9, as amended by Directive 2003/108/EC, in respect of WEEE from user other than private household:
- According to Article 8.2, “producers can choose to fulfil this obligation either individually or by joining a collective scheme”,
- According to Article 8.3, “The responsibility for the financing […] shall be provided by one or more systems to which all producers existing on the market […] contribute proportionately...”, and

- According to Article 9.1, "financing of the costs for […] WEEE from users other than private households from products put on market after 13 August 2005 is to be provided for by producers". Producers are allowed to stipulate specific contractual agreements with customers in respect of financing of WEEE arising. In respect of historical WEEE, Producers are responsible only when replacing equivalent equipments. Otherwise final users are responsible.

To fulfil their obligations in respect of financing (both in respect of Historical/New WEEE and Household/non-Household WEEE), producers have the following main options:

- Comply "individually", setting up their own product recovery network or Compliance Scheme,
- Comply "collectively", setting up a new Compliance Scheme,
- Comply "collectively", joining an existing Scheme, managed by any third party organization.

Collective compliance, according to Article 8.3 of WEEE Directive, is needed at least for Historical WEEE. Depending on the different options (complying individually, setting up collectively a compliance Scheme or joining an existing, collective one) compliance with take back obligations could be achieved by means of:

- Compliance Costs: internal compliance costs for producers setting up their own compliance scheme, or
- Compliance Fees: external compliance fees for producers paying an existing Compliance Scheme that they joined to take over their take back responsibilities.

Both compliance costs and compliance fees represent part of the economic impact for producers in complying with WEEE Directive obligations. In addition to these costs, the internal administrative burden needs to be added in order to assess the overall economic impact for producers. Data gathered from national compliance schemes currently operating across Europe represent costs incurred in compliance (i.e. the amount the Scheme are paying for fulfilling all the take back activities, established by different contractual agreements with their members) with the WEEE Directive and, in particular, with different national transpositions of the WEEE Directive. For this reason, they also reflect, in particular (WEEE Forum 2005):

- Need/requests to pay for collection at collection point (see obligation to collect or reimburse collection points by legal framework, the issue of ownership of WEEE collected, residual value of appliances),
- Area coverage and service level required, e.g. number of collection points requiring servicing, minimum amounts of WEEE to be collected,
- Economies of scales and the amount of WEEE to be collected and treated,
- Geographical and traffic situation for transport costs,
- Political will to include handicapped people, socio-economic enterprises and/or smaller enterprises in the collection and treatment of WEEE,
- Pre-conditions and costs to achieve (and keep) permits for collection and treatment of WEEE,
- Treatment standards given by National authorities and (therefore) to be fulfilled by the different compliance schemes,

- General economic data – e.g. working wages, transport costs, and
- Disposal costs for residues (e.g. landfill costs, incineration costs), possible profits for valuable materials (e.g. also determined by treatment options within county, distance to sea harbours, etc.).

For these reasons ranges of costs could provide a figure of the overall economic impact of the WEEE Directive across EU27 and not specific detailed information at Member State level.

Total costs in compliance (Technical costs plus Additional Costs) are influenced by Additional costs (sometimes representing a relevant part of total costs across different product categories). Ranges and kind of Additional costs, as pointed out in the previous chapter, depend upon:

- Specific legislative requirements of National Transpositions of the WEEE Directive: for instance the needed to finance or reimburse separate collection activities carried out by Municipalities/Retailers (CMER 2006), or to contribute to the awareness raising in final users, and/or
- Specific agreements between different stakeholders involved in the take back chain (for example the revenues collected by a distribution chain levying fees).

Beside Technical costs, Additional costs in each Compliance Scheme reflect the contractual responsibilities taken over or agreements done with members like (WEEE Forum 2005):

- Remuneration ('kick-back') to be paid to the distribution chain (e.g. for levying of (visible) fees),
- Other costs to be covered by the Compliance Scheme based on responsibilities taken over like:
    - Costs for levying of funds (financial guarantees), control of free riders, technical control/auditing of collection facilities and/or treatment partners, PR and awareness raising,
    - R&D costs,
    - Special costs for WEEE such as differentiation of products at collection facilities or sorting/ sampling of WEEE on request of branch associations or members, cost for determination of sales data or costs for any clearing house,
    - Special costs for other wastes streams taken over (e.g. batteries, packaging material).

All those costs represent and cover part of the responsibilities in compliance with the WEEE Directive requirements or contribute to the effectiveness implementation of any Scheme (including sometimes enforcement or control over free-riders, auditing of recyclers, awareness raising).

The differences between responsibilities (costs) taken over by each scheme or carried out individually by single producers impact on the overall picture: for instance according to the majority of National Transpositions of the WEEE Directive, joining a compliance, collective scheme, represents an exemption criteria for providing financial guarantees in respect of new appliances placed on the market. Such provision has a great economic and financial impact on compliance costs for individually compliant producers and also influences (levying, when part of compliance fees paid by producers raise partly or completely such amounts) the additional costs of compliance schemes. Table 85 compares the amount of total costs and technical costs with the amount of financial guarantees to be provided by producers individually compliant according to three of the national transpositions of the WEEE Directive which defined such amounts in the legal text of the transposition (Hungary, Poland and Slovakia).

The breakdown of costs presented reflects the different influencing factors pointed out in the previous paragraphs. Each Compliance Scheme is running under specific boundary conditions defined by:

- National transposition of the WEEE Directive, and
- Agreements made with stakeholders involved in the recycling chain (municipalities, retailers, recyclers, national associations etc.).

Those two main aspects impact on differences in additional costs and contribute to increase the gap in total costs for different compliance schemes. Comparison of compliance fees of different compliance schemes across Europe (i.e. the specific amount of money – expressed in EUR/unit, EUR /tonne or other mechanism, - per product or product (sub)category, that producers are paying, on contractual basis, to fulfil their obligations), does not lead to the identification of technical costs.

Compliance fees reflect the overall cost structure of each compliance scheme and could not lead to one-to-one comparison of technical costs.

Table 84 presents the ranges for total costs (i.e. technical costs plus additional costs) and technical costs (i.e. sum of collection, transportation and treatment costs). Ranges have been defined considering, for each product category, the minimum and maximum value across different compliance schemes.

The following aspects have impact on technical costs:

- Collection: includes costs for containers/boxes to be provided/reimbursed to collection points, costs for sorting according to treatment categories, or any other activity to ensure a separate collection of WEEE stream arising,
- Transportation: including costs for transportation from collection points to treatment facilities and costs for logistic administration,
- Treatment: includes costs for treatment (including disposal fees for hazardous substances) as well as revenues for fractions to be valorised. Negative Treatment costs mean the revenues for fractions sold on market in order to cover all expenses in operating the treatment plant. In considering operating costs both technical recycling costs (e.g. dismantling activities, shredding and separation) – and disposal fees for hazardous components, materials, fractions and incineration are taken into account. The impact of such different elements will be further investigated in the eco-efficiency calculations performed in Chapter 8.2 and 8.4.

Category		Total Costs [EUR/t]		Technical Costs [EUR/t]	
		MIN	MAX	MIN	MAX
1a	LHHA	-	933.16	-	386.38
1b	C&F	194.00	880.37	170.00	739.97
2	SHA	138.56	1,246.03	123.00	426.98
3a	IT ex CRT	135.38	1,703.56	123.00	826.69
3b	IT CRT	164.00	1,416.36	140.00	598.36
4a	CE ex CRT	138.56	1,328.47	123.00	469.58
4b	CE CRT	164.00	1,393.65	140.00	598.37
5	Light	555.78	2,568.62	505.38	1,709.20
6	Tools	204.09	1,043.99	161.82	495.44
7	Toys	390.42	610.49	340.01	483.79
8	Med.	168.35	562.24	149.19	437.93
9	M&C	253.26	1,382.48	202.86	588.00
10	Aut. Disp.	254.63	483.99	204.23	359.69

Table 84: Breakdown Total Costs and Technical Costs per product category, in EUR/tonnes

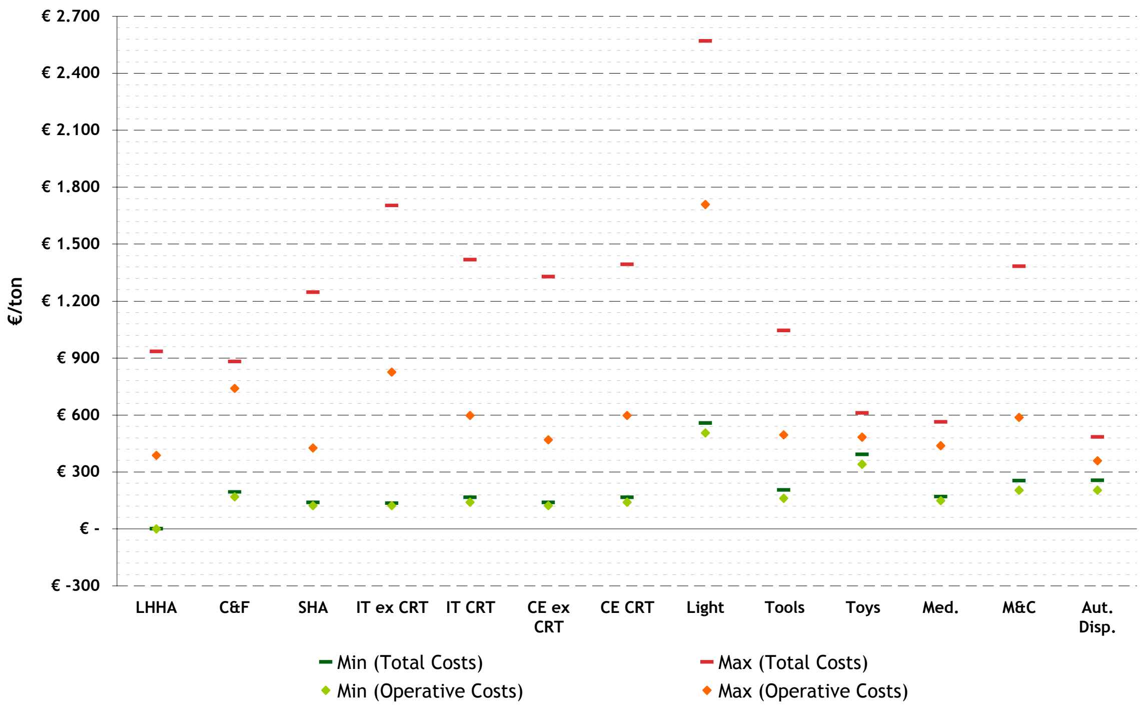

Figure 25: Breakdown Total Costs and Technical Costs per product category, in EUR/tonnes

		Total Costs [EUR/t]		Technical Costs [EUR/t]		Financial Guarantees [EUR/t]		
		MIN	MAX	MIN	MAX	HU	PL	SK
						FT/EUR 254.71	*PLN/EUR 3.91*	*SKK/EUR 34.70*
1a	LHHA	-	933.16	-	386.38	102.08	511.51	144.07
1b	C&F	194.00	880.37	170.00	739.97	392.60	511.51	489.84
2	SHA	138.56	1,246.03	123.00	426.98	274.82	511.51	345.77
3a	IT ex CRT	135.38	1,703.56	123.00	826.69	392.60	511.51	489.84
3b	IT CRT	164.00	1,416.36	140.00	598.36	392.60	511.51	489.84
4a	CE ex CRT	138.56	1,328.47	123.00	469.58	372.97	511.51	461.03
4b	CE CRT	164.00	1,393.65	140.00	598.37	372.97	511.51	461.03
5	Light	555.78	2,568.62	505.38	1,709.20	745.95	5,115.09	922.06
6	Tools	204.09	1,043.99	161.82	495.44	333.71	511.51	432.21
7	Toys	390.42	610.49	340.01	483.79	392.60	511.51	489.84
8	Med.	168.35	562.24	149.19	437.93	-	511.51	-
9	M&C	253.26	1.382.48	202.86	588.00	-	511.51	-
10	Aut. Disp.	254.63	483.99	204.23	359.69	-	511.51	-

Table 85: Comparison of Costs and financial guarantees

Assumptions made in the beginning of the paragraph allow defining the current ranges of economic impact across EU27 both for technical costs and total costs. Table 86 shows the total economic impact for collection and treatment of **all WEEE arising** in EU27. In Annex 8.1.2 a breakdown of annual costs (2005-2020) per product category (1-10) is also provided.

	Total Costs [Million Euro]		Technical Costs [Million Euro]	
Year	**MIN**	**MAX**	**MIN**	**MAX**
2005	1,022	9,800	892	4,772
2006	1,048	10,049	915	4,893
2007	1,075	10,305	938	5,018
2008	1,102	10,568	962	5,146
2009	1,131	10,840	987	5,278
2010	1,160	11,119	1,012	5,414
2011	1,190	11,407	1,038	5,554
2012	1,221	11,703	1,065	5,699
2013	1,253	12,009	1,093	5,847
2014	1,286	12,323	1,122	6,001
2015	1,319	12,648	1,151	6,159
2016	1,354	12,982	1,182	6,322

	Total Costs [Million Euro]		Technical Costs [Million Euro]	
Year	**MIN**	**MAX**	**MIN**	**MAX**
2017	1,390	13,327	1,213	6,490
2018	1,427	13,683	1,246	6,663
2019	1,466	14,050	1,279	6,842
2020	1,505	14,429	1,314	7,026

Table 86: Overall economic impact across EU27, Million EUR

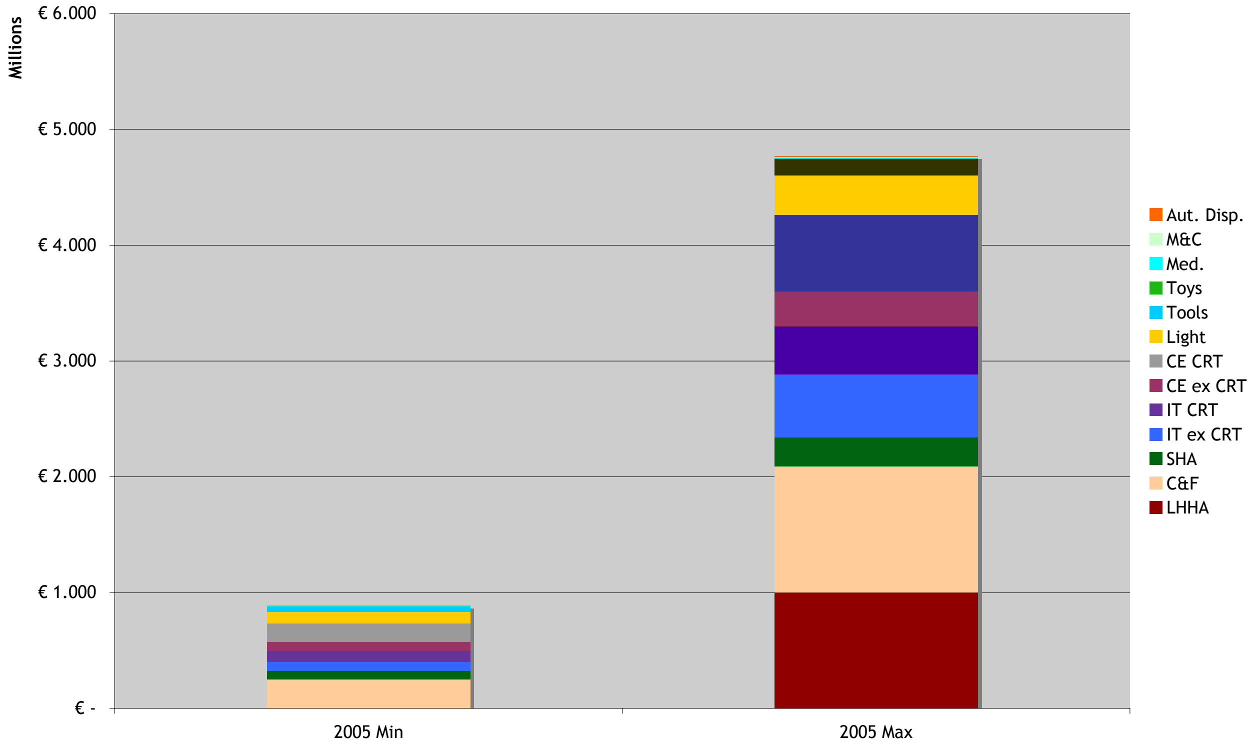

Figure 26: Breakdown of overall economic impact across EU27 across categories 2005, in Millions EUR

The baseline data represent the maximum range of costs assuming all WEEE arising are being collected and treated, according to the current breakdown of costs. Developments of new technologies (having different technical treatment costs, reduction in disassembly time, changes in disposal/incineration fees) as well as development of markets for secondary raw materials and fractions could contribute in changing the baseline. Estimations for 2007 and data for the first part of the year further provided (ERP 2007, Recupel 2007) show how costs are decreasing over time: up to 27% in total costs for specific categories. Such trends have been seen in technical costs and in particular in treatment costs for scheme running since 2003 as well (WEEE Forum 2005). In Chapter 8.2 it is calculated in the sensitivity analysis what the influence of increasing material prices (see Chapter 6.2.2 for the values) is on the total costs of treatment. In general, from 2005 to the 2007 price level, shows a increased revenue of roughly 50 - 80 EUR/ton. Optimization of the recycling chain, as well as changes in valorization of downstream fractions play a crucial role, as well as other changes in the influencing factors previously pointed out. In chapter 8.2, the impact of changes in metal prices for downstream fractions has been further evaluated.

Ranges of total costs, as far as technical costs in the presented baseline are great. This mainly depends on two concurrent factors:

1. Differences in ranges, both in total and technical costs. Differences in ranges for total costs have been addressed in previous chapters: they depend on the impact of additional costs and influencing factors,
2. Differences in technical costs depend upon different level of development of compliance schemes across Member States: the WEEE Directive was published in 2003, it should have been transposed by member states into national law by 13 August 2004 and finally it should have come into force by 13 August 2005. Some Member States got an extension of the initial deadline for meeting collection targets (Art. 5.5 of the WEEE Directive) and recovery and recycling percentages (Art. 7.2 of the WEEE Directive) according to Council Decision 2004/312/EC and 2004/486/EC. In particular Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland and Slovakia of 2 years and Slovenia of 1 year. Romania and Bulgaria had also extended deadlines according to Accesion Treaty in O.J. of 21 June 2005 L 157/11.Despite these actions most Member States delayed transpositions and, consequently, implementation,
3. In some cases the delay in transposition was less relevant because in some Member States previous legislation was already in place and infrastructures and systems were already active (e.g. Austria, Belgium, Denmark, Sweden, Luxembourg). These delays were mainly due to realignment of legal text with the WEEE Directive,
4. In other Member States without legislation prior to the Directive, there is new legislation enacted but subsequent Decrees are sometimes still missing. Such delays in the start-up phase of National Systems, sometimes the need for new investments in infrastructure, impact also on costs, that could include part of the initial investments made by different stakeholders. Lower amounts of WEEE arising and negotiations in the first, start-up phase also impact on negotiations between stakeholders and on contracts and costs,
5. Differences in ranges are further amplified by total WEEE arising per product category (in particular the first 5 categories represent a considerable part of total weight arising).

For the reasons outlined above, further assumptions about a full implementation across EU27 were made, in order to provide a more stable figure of Technical costs. Data from long running schemes (fully operative before 2005, having at least 3 data sets for definition of minimum, maximum and average costs, Table 87) have been considered in order to:

- Get more stable cost ranges and, in particular, average costs,
- Ensure a better consistency in cost's tracking breakdown across categories,
- Reduce the potential impact of start-up costs for compliance schemes, and
- Reduce the impact of overcapacities and initial negotiations across the chain.

		Total Costs [EUR/t]			Technical Costs [EUR/t]		
		MIN	MAX	Average	MIN	MAX	Average
1a	LHHA	54.46	457.90	235.31	41.24	386.38	162.11
1b	C&F	338.46	811.49	557.70	318.97	739.97	482.15
2	SHA	272.44	499.21	383.13	182.99	426.98	280.96
3a	IT ex CRT	272.08	539.23	379.69	182.62	469.58	323.15
3b	IT CRT	349.26	621.48	499.29	323.07	551.82	443.95
4a	CE ex CRT	254.48	549.37	422.12	165.02	469.58	335.41
4b	CE CRT	428.55	621.41	528.01	366.93	551.76	452.76
5	Light	561.15	840.00	662.83	505.38	787.12	601.49
6	Tools	220.83	341.49	300.79	161.82	299.22	219.90
7	Toys	409.56	609.16	495.15	340.01	483.79	394.32
8	Med.	238.64	529.79	409.64	149.19	437.93	346.92

Table 87: Breakdown Total Costs and Technical Costs per product category for long running Compliance Schemes, expressed in EUR/tonnes

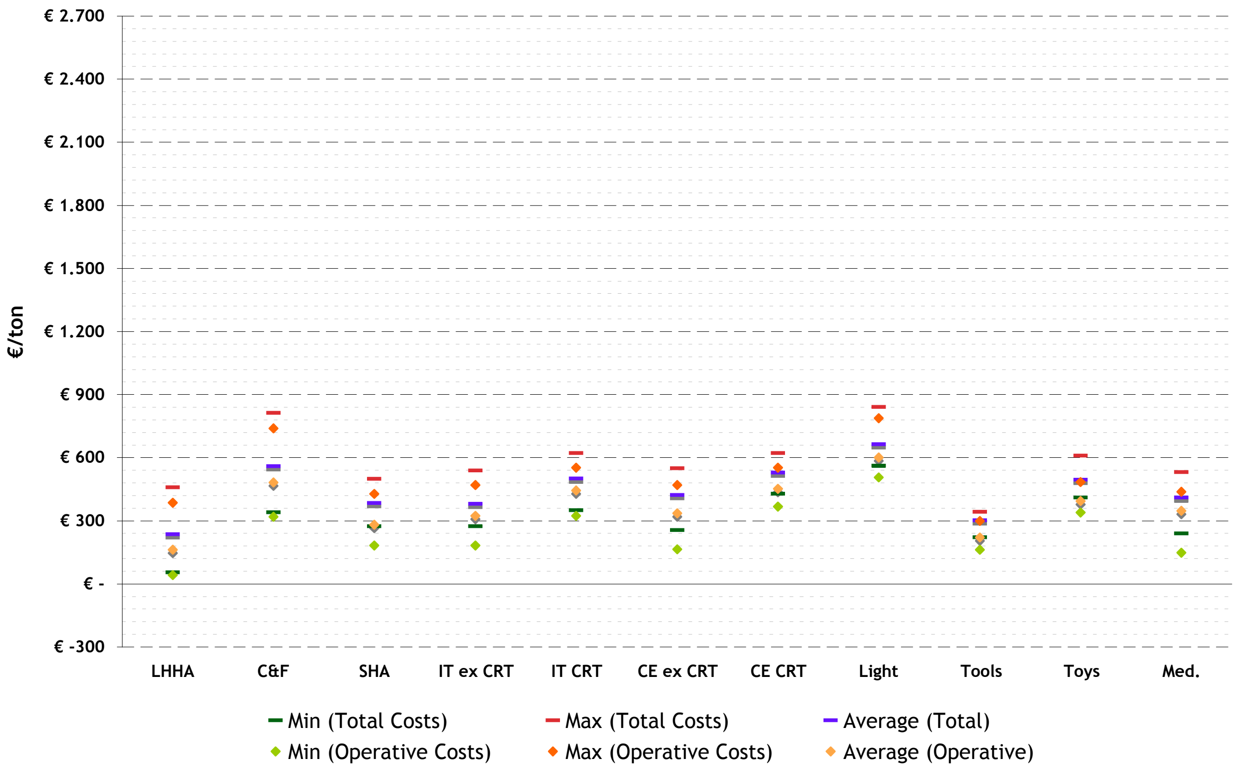

Figure 27: Breakdown Total Costs and Technical Costs per product category for long running Compliance Schemes, expressed in EUR/t

Comparing the breakdown for current schemes (Table 84) with the one for long running ones (Table 87) two different effects could be observed:

- For some categories (in particular Cat. 9 and 10) there are no long running schemes. The main reasons to be pointed out are:
  - Those appliances were in the majority of cases out of the scope of previous take back legislations,
  - They are mainly a non-household stream (in many cases OEMs are taking care of them at EOL for refurbishment or reuse), and
  - Some of the appliances in those categories are sometimes collected and treated, at least for "household equivalent streams" together with other categories (in particular with Cat. 2 appliances or Cat. 1a),
- Differences between minimum and maximum values across categories are lower considering only long running Schemes. This suggests that, in the long term, effects of start-up costs, negotiations along the chain (for example between compliance schemes and logistics providers or recyclers) and other "influencing factors" of Technical as well of Additional costs have a lower impact on costs of any specific Compliance Scheme,
- For some categories minimum values (both in Total and Technical costs) are lower considering all Schemes currently operating across Europe (this means that some schemes, set-up across Europe after 2005, have lower costs). Reasons for such effects depend upon:
  - Potential overcapacity present in the recycling chain (including start-up effects and potential dumping policies of stakeholders),
  - Lower recycling costs or cost-effectiveness of specific Schemes,
  - Specific differences in the "influencing factors" pointed out in the previous chapter due to different National Transpositions of the WEEE Directive, negotiations along the chain or Country-based differences.

To provide an estimation of economic impact under the assumption of full implementation of the WEEE Directive across EU27, the following assumptions have been considered:

- Average costs have been taken into account in order to provide a more stable figure of total economic impact of the WEEE Directive,
- Changes in the current breakdown of WEEE collected & treated, in order to take into account developments in the current collection rate, under the assumption of a full implementation, according to breakdown of Chapter 8.0.5.1.

The baseline of collecting and treating all WEEE arising has been set at the upper level (100% collection cannot be reached in practice).

Year	Total Costs [Million EUR]			Technical Costs [Million EUR]		
	Current 2005 collection % level	Maximum 2011 collection % level	ALL WEEE Arising (100% collection)	Current 2005 collection % level	Maximum 2011 collection % level	ALL WEEE Arising (100% collection)
2005	935	2,045	3,332	764	1,692	2,697
2006	959	2,097	3,417	783	1,735	2,765
2007	984	2,151	3,504	803	1,780	2,836
2008	1,009	2,206	3,593	824	1,825	2,908
2009	1,035	2,262	3,686	845	1,872	2,983
2010	1,061	2,321	3,781	867	1,920	3,060
2011	1,089	2,381	3,879	889	1,970	3,139
2012	1,117	2,443	3,979	912	2,021	3,221
2013	1,146	2,506	4,083	936	2,074	3,305
2014	1,176	2,572	4,190	961	2,128	3,391
2015	1,207	2,640	4,301	986	2,184	3,481
2016	1,239	2,710	4,414	1,012	2,242	3,573
2017	1,272	2,782	4,532	1,039	2,302	3,668
2018	1,306	2,856	4,653	1,067	2,363	3,765
2019	1,341	2,933	4,777	1,095	2,426	3,866
2020	1,377	3,012	4,906	1,125	2,492	3,971

Table 88 - Overall Economic Impact across EU27 assuming full implementation, Million EUR

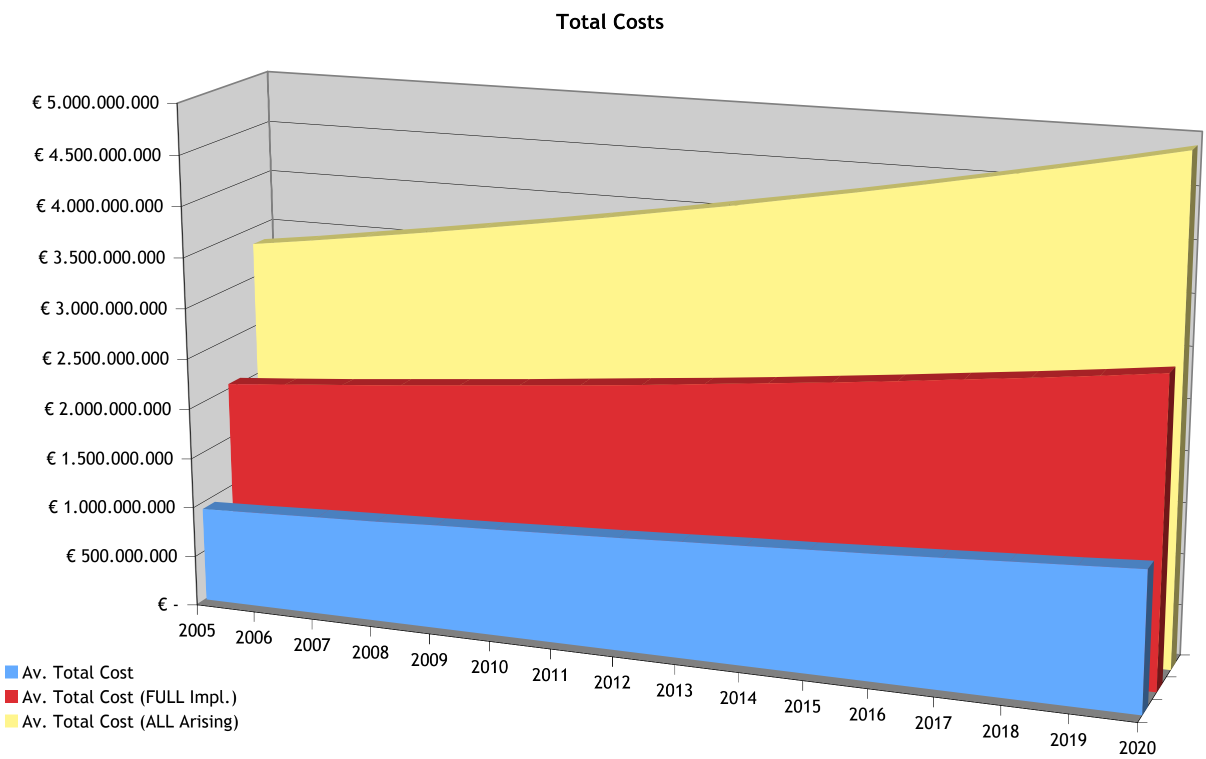

Figure 28: Baseline Economic Impact under full implementation assumptions (Total costs)

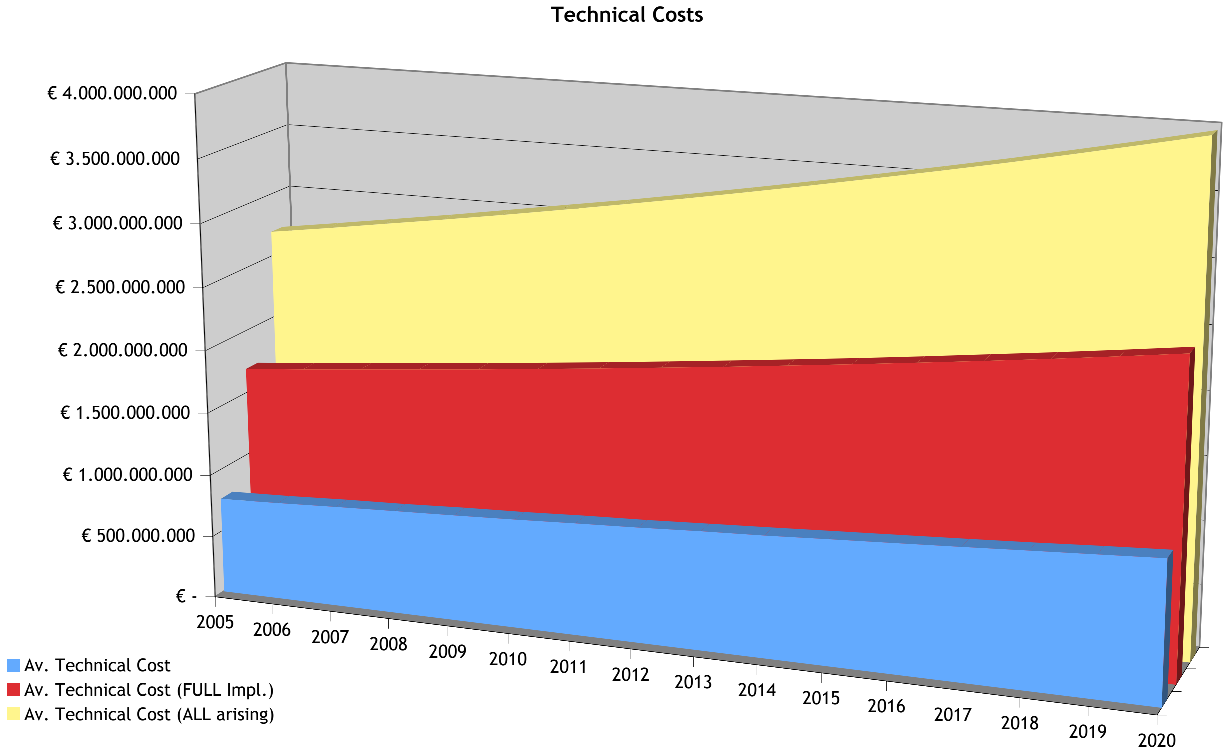

Figure 29: Baseline Economic Impact under full implementation assumptions (Technical costs)

Further insight and analysis of the breakdown of technical costs along the recycling chain are provided in Chapter 8.2, highlighting the relationship between the environmental impacts and economics of take back and recycling.

8.2 Environmental Evaluation of the Implementation (Task 1.1.1)

In this chapter, the environmental impact assessment is presented based on the methodology described in Chapter 6.2.2. In addition to the environmental focus, for all categories described below there is also the connection with the economic data as technical costs are displayed in the eco-efficiency diagrams in the subchapters at the end (Chapter 8.2.1.5, 8.2.2.5, 8.2.3.5, 8.2.4.5 and 8.2.5.5). In these diagrams, various recycling scenarios in addition to the default or most common scenario are described in order to illustrate the sensitivity of the results with respect to various environmental and economic settings. This also reduces the influence of various assumptions on costs, materials prices and treatment settings as well as on environmental impacts as all results under the earlier mentioned environmental impact categories would be determined. As a consequence many tables and charts are obtained from these assessments and the majority of these can be found in Annex 8.2. The most relevant charts (weight versus environmental weight and eco-efficiency diagrams) are displayed in higher resolution in this annex.

Analysis LHHA

8.2.1 Large Household Appliances (LHA - 1A,10)

8.2.1.1 Data and Assumptions

The compositions data presented in Chapter 8.0.5.1 are used. The economic part of the eco-efficiency calculations is based on the WEEE Forum long running systems data for the average costs. The maximum level of PCB's removable is taken from (Recupel, 2007). The estimated PCB level is 31 ppm. For the default treatment scenario, the concrete counterweights are assumed to be removed before shredding and thus not appearing in the resulting metal fractions from shredding and separation. For this category 1A and 10, an average weight per appliance of 54.24 kg is determined. The different key assumptions and the sensitivity of the results are tested in the eco-efficiency analysis below. For this treatment category, first the total chemical composition (resulting from the 'component' composition in Chapter 8.0.5.3 and environmental weight is presented by applying the QWERTY methodology using Eco-Indicator '99 H/A v203. All other starting points, background data and calculation steps are described in Chapter 6.2.2.3.

8.2.1.2 Weight and Environmental Weight

Table 89 and Figure 30 display the weight versus environmental weight of an average LHHA appliance. Note that the values below represent the difference between minimum and maximum environmental impact and do not represent a certain treatment scenario, but merely the environmental relevance of the individual materials present.

Material	Weight (g)	Material	Environmental Weight (%)
Ag	0.0080	Ag	0.0%
Al (general)	910	Al (general)	4.3%
Au	0.0019	Au	0.0%
Ceramics	37.6	Ceramics	0.0%
Cr	0.0050	Cr	0.00%
Cu	1,736	Cu	11.25%
Fe	4.92	Fe	0.01%
Glass (white)	403	Glass (white)	0.53%
Ni	0.025	Ni	0.00%
Oil	1.68	Oil	0.00%
Other/inerts	11,920	Other/inerts	14.52%
Pb	0.75	Pb	0.01%
PCB	0.71	PCB	0.19%
Pd	0.0010	Pd	0.05%
Plastics general	8,514	Plastics general	25.14%
PUR	169	PUR	0.50%
PVC	191	PVC	0.78%
Sb	0.045	Sb	0.00%
Sn	25.5	Sn	0.70%

Material	**Weight (g)**	**Material**	**Environmental Weight (%)**
Stainless steel	907	Stainless steel	5.07%
Steel low alloyed	29,411	Steel low alloyed	36.79%
Zn	7.67	Zn	0.07%
Total	**54,240**	**Total**	**100%**

Table 89: Weight versus Environmental Weight (EI99-H/A) Cat.1A,10

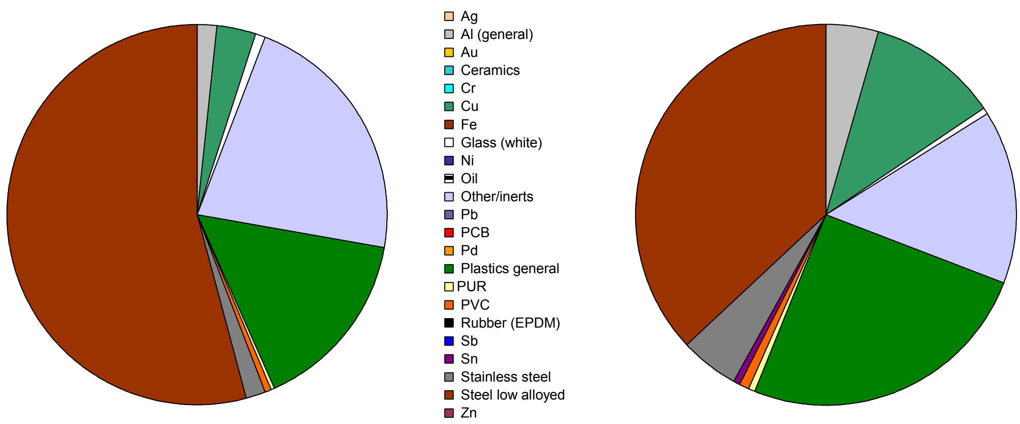

Figure 30: Weight versus Environmental Weight Cat.1A,10 LHHA (EI'99 H/A)

Figure 30 shows that for the chosen environmental assessment model, the relative importance of steel and the inerts (concrete counterweight) is relatively low in the environmental pie chart and the opposite counts for the aluminium, copper, stainless steel and plastic content. In Annex 8.2.1, all environmental weight graphs are presented for all impact categories described in Chapter 6.2.2. Here it can be seen that the results are consistent over all environmental impact categories. Even in the Human-Health pie chart in the Annex 8.2.1, the effects of the PCB's are marginal due to their very low concentration. In the category: 'Fresh water aquatic ecotoxicity', a limited contribution of the PVC and a higher contribution of the stainless steel (due to the Ni and Cr content), becomes clearly visible. Overall, the different environmental impactcategories demonstrate the same direction and reflects as in Figure 30 above, the large contribution of materials such as steel, copper, aluminium, plastics and stainless steel.

8.2.1.3 Environmental Impact under Various Impact Categories

Table 90 shows the outcomes of the default treatment scenario (see Chapter 8.0.5.1 for the description) as well as the theoretical scenario of disposal with MSW without energy recovery for the organic materials and uncontrolled landfill of the inorganic materials. Obviously, an appliance weighing over 50 kg will not, in practice be discarded in a small waste bin. However, the comparison is made in order to determine the costs and benefits of collecting and treating these appliances versus doing nothing.

Indicator:	Default	MSW	Unit	Method
Weight	54.24	54.24	Kg	Average weight per piece
Eco-indicator 99 H/A v203	- 3.69	1.04	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Human Health	- 1.52	0.51	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Ecosystem Quality	- 0.41	0.34	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Resource Depletion	- 1.76	0.19	Pt	Eco-indicator 99 (Pre, 2007)
CEDv103	- 1,053	70.28	MJ-eq	CEDv103 (Pre, 2007)
Abiotic depletion	- 0.625	0.032	kg Sb eq	CML2 v203 (CML 2004)
Global warming (GWP100)	- 38.61	29.14	kg CO2 eq	CML2 v203 (CML 2004)
Ozone layer depletion (ODP)	-0.000008	0.000093	kg CFC-11 eq	CML2 v203 (CML 2004)
Human toxicity	- 45.43	208.99	kg 1,4-DB eq	CML2 v203 (CML 2004)
Fresh water aquatic ecotox.	0.13	35.33	kg 1,4-DB eq	CML2 v203 (CML 2004)
Marine aquatic ecotoxicity	- 56,534	17,542	kg 1,4-DB eq	CML2 v203 (CML 2004)
Terrestrial ecotoxicity	- 0.325	0.029	kg 1,4-DB eq	CML2 v203 (CML 2004)
Photochemical oxidation	- 0.035	0.002	kg C2H4	CML2 v203 (CML 2004)
Acidification	- 0.262	0.040	kg SO2 eq	CML2 v203 (CML 2004)
Eutrophication	- 0.012	0.011	kg PO4--- eq	CML2 v203 (CML 2004)

*** Values in red are environmental impacts; negative values in black are prevented environmental impacts**

Table 90: Results per environmental impact category Cat.1A,10

A further description of the above environmental impact categories can be found in Chapter 6.2.2 above. The results of are compared with the other product and treatment categories in Chapter 8.4. For all above environmental impact categories, the default treatment scenario is a clear environmental improvement over not treating these products, even taking into account all environmental impacts of the transport and further processing. The benefits from this treatment also have to be taken into account and are multiplied later in Chapter 8.4 with the potential total amount of WEEE arising from Chapter 7 above.

8.2.1.4 Environmental and Economic Impacts for Average Collection and Treatment

In Table 91, the breakdown of environmental impacts (based on the default Eco-Indicator'99 single scores) and economic impacts (based on the 2005 average for the WEEE Forum long running systems) per stage in the recycling chain is displayed.

Process	Total	Costs	Revenues	Total	Burden	Gain
Transport and collection (incl. access to WEEE)	€7.86	€7.86		0.293	0.293	
Other costs	€3.97	€3.97				
Shredding, sorting, dismantling, pre-treatment	€3.19	€3.19				
Emissions in/before pre-treatment				0.036	0.036	
Incineration and landfill	€0.48	€0.55	€(0.07)	0.032	0.203	-0.171
Recycling processes	€1.11	€1.15	€ 0.04)	0.032	0.040	-0.007
Recovery processes	€(3.85)	€6.04	€(9.90)	-4.088	2.057	-6.146

Process	Total	Costs	Revenues	Total	Burden	Gain
cost or environmental burden	€ 12.76	Per piece		-3.69	Pts per piece	
revenue or environmental gain	€ 0.24	Per kg		-0.068	Pts per kg	

Table 91: Environmental and economic impacts along the chain Cat.1A,10

The table shows that costs in the collection and transport stage are the most relevant. These costs are still higher than the revenues for the further treatment, leading to a net cost of around EUR 240 per ton. Note that the revenues after collection almost offset the cost of pre-processing. Regarding the environmental impacts, the avoided environmental burden is much higher than the impacts of collection and pre-processing. Obviously, the metal (steel) prices have a large influence on the total economic picture. Therefore, in the next section, the effect of higher 2007 material prices is analysed as well as the minimum and maximum values of the WEEE Forum's long running systems in order to demonstrate the spread in costs.

8.2.1.5 Eco-efficiency and Sensitivity Analysis

In Figure 31, the eco-efficiency of various scenarios is displayed. Default treatment as described above is visualised with point A. The environmental benefits compared to the MSW points are substantial. The minimum value (A1) shows the total costs can also be 'negative', e.g. a net revenue (upwards) is found due to the high metal content and value. The effect of 2007 metal prices (B,B1 and B2) lead to an improvement of around EUR 3.50 per piece, which is roughly EUR 70 per ton. The effect of the manual removal of suspected PCB containing capacitors plus mercury containing switches (C) is very low, which is in line with the environmental findings per impact category. The main reason for this is the low quantity in relation to the total appliance weight and the dominance of energy and material (PVC and stainless steel) related influence even in the toxicity related environmental impact categories. In Annex 8.2.1, these detailed data points are presented as well as the various calculated recycling and recovery percentages, QWERTY-recovered and QWERTY-loss values.

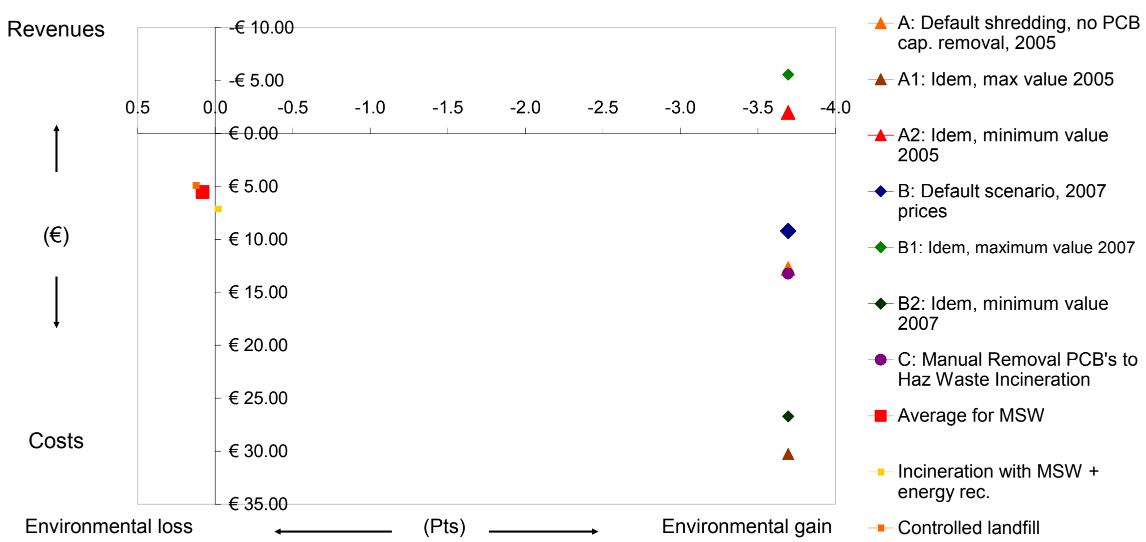

Figure 31: Eco-efficiency scenarios Cat.1A LHHA (EI'99 H/A)

Conclusions

Apparently, the LHHA category is both in environmental and economic terms dominated by the high metal content. The outcomes for environmental impact categories show rather similar impacts for each material. The total costs for fully operational systems are around EUR 240/ton (+/- EUR 300/tonne. The increase in metal prices has reduced these costs by approximately EUR 70/tonne. The environmental effects of PCB containing capacitors potentially being present and mercury switches are very marginal compared to other impacts.

Analysis C&F

8.2.2 Cooling and Freezing (C&F - 1B)

8.2.2.1 Data and Assumptions

The compositions data presented in Chapter 8.0.5.3 are used. The economic part of the calculations is further based on the WEEE Forum's long running systems data for the average costs. For the default treatment scenario, the removal of the CFC12 from the compressor is assumed to take place in the first treatment stage. The CFC11 present in the foams is removed mechanically with an assumed efficiency of 95%. It is assumed that the stream contains 80% CFC and 20% Pentane based fridges. For this category 1B, the average weight per appliance of 38.20 kg is determined. The different key assumptions and the sensitivity of the results are tested in the eco-efficiency analysis below with specific focus on the various scenarios and efficiencies of CFC and HC removal. For this treatment category, first the total chemical composition and environmental weight is presented by applying the QWERTY methodology using Eco-Indicator '99 H/A v203. All other starting points, background data and calculation steps are described in Chapter 6.2.2.3.

8.2.2.2 Weight and Environmental Weight (per subcategory)

Table 92 and Figure 32 display the weight versus environmental weight of an average fridge. Note that the values below represent the difference between minimum and maximum environmental impact and do not represent a certain treatment scenario, but merely the environmental relevance of the individual materials present.

Material	Weight (g)	Material	Environmental Weight (%)
Al (general)	1,255	Al (general)	3.95%
Cu	958	Cu	4.12%
Fe	7,848	Fe	6.46%
Glass (white)	285	Glass (white)	0.25%
Hg	0.000002	Hg	0.00%
Oil	205	Oil	0.27%
Other/inerts	420	Other/inerts	0.34%
PCB	0.000027	PCB	0.00%
Plastics general	3,260	Plastics general	6.39%
PS (polystyrene)	2,660	PS (polystyrene)	4.74%
PUR	3,750	PUR	7.36%
PVC	24.0	PVC	0.06%
Stainless steel	1,000	Stainless steel	3.71%
Steel low alloyed	16,415	Steel low alloyed	13.63%
Cyclopentane	47.0	Cyclopentane	0.07%

Material	Weight (g)	Material	Environmental Weight (%)
Isobutaan	11.0	Isobutaan	0.02%
CFC11	245	CFC11	28.56%
CFC12	97.2	CFC12	20.08%
Total	**38,20 kg**	**Total**	**100%**

Table 92: Weight versus Environmental Weight (EI99-H/A) Cat.1B

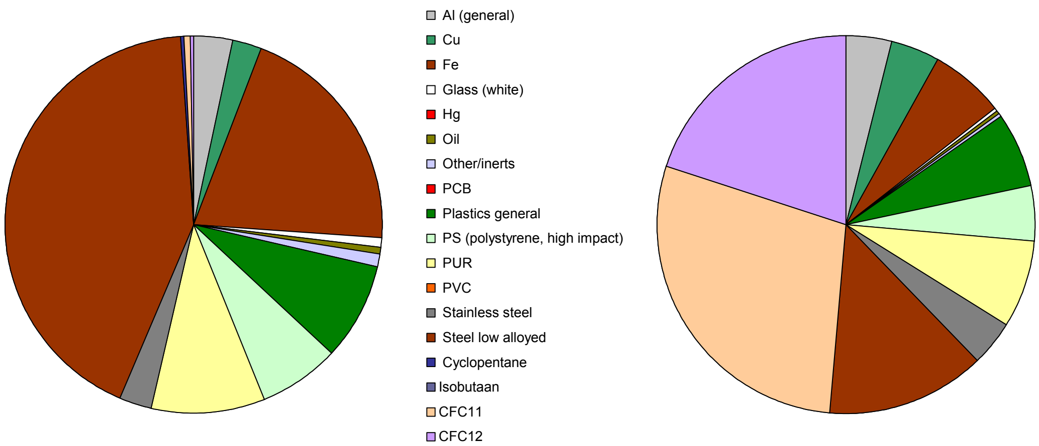

Figure 32: Weight versus Environmental Weight Average CFC 80%/ Pentane 20% (EI'99 H/A)

Table 32 and Figure 32 show that for the chosen environmental assessment model, the relative importance of the plastics and metals is much lower compared to the environmental impacts of the CFCs due to their high ozone-layer depletion and global warming potential. This effect is demonstrated clearly in Annex 8.2.2, where the Eco-Indicator'99, Human Health and CML2 GWP and ODP categories show very high impact potential for the CFCs. The HC cooling agents only have very limited influence on the CML2 POCP: Photochemical oxidation values. All environmental weight graphs are presented in Annex 8.2.2 for all impact categories described in Chapter 6.2.2. Here it can be seen that the results for the impact categories GWP and ODP are very different due to the CFC presence. Due to this dominant presence, the aggregated Eco-Indicator'99 categories are showing a high relevance of the CFCs. Therefore, due to the different cooling agents, Figure 32 is also calculated for the average CFC-only and average Pentane fridge only in Figure 33 and Figure 34.

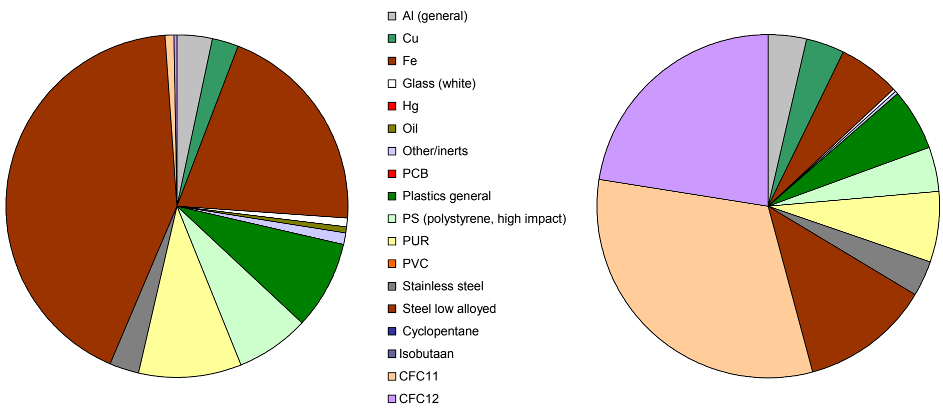

Figure 33: Weight versus Environmental Weight CFC-only fridge (EI'99 H/A)

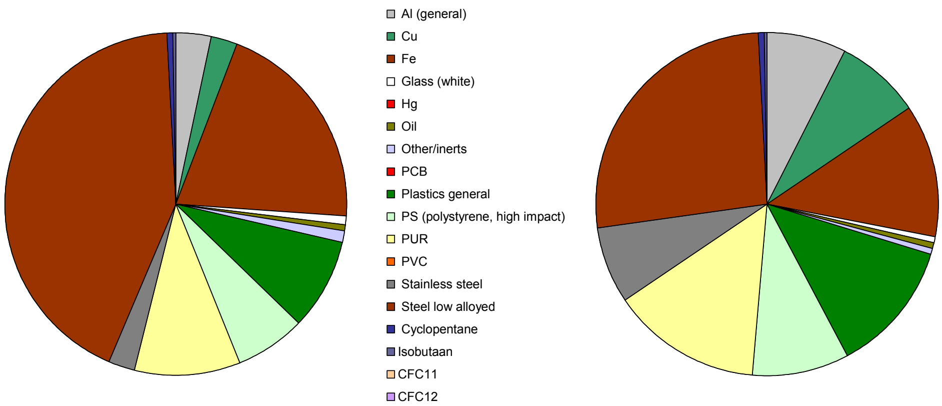

Figure 34: Weight versus Environmental Weight Pentane-only fridge (EI'99 H/A)

These two figures demonstrate that the past phase-out of CFC has changed the environmental priorities connected to the materials radically. Obviously, the newer cooling agents impose a lower environmental burdening. Note the similarity between this graph and the Cat.1A average environmental weight (the Fe and steel can be summed up, as well as the different plastic types in Figure 34).

8.2.2.3 Environmental Impact under Various Impact Categories

Table 93 shows the outcomes of the default treatment scenario as well as the theoretical scenario of disposal with MSW without energy recovery for the organic materials and uncontrolled landfill of the inorganics plus the loss of the cooling agents as emissions to air. Obviously, a fridge will in practice not be discarded in a small waste bin, but CFC emissions are a real risk when discarded appliances are not treated properly (for example in a car shredder, or without removal of the oil). Hence, the comparison is again made in order to determine the costs and benefits of collecting and treating these appliances versus not doing so.

Indicator:	**Default**	**MSW**	**Unit**	**Method**
Weight	38.20	38.20	kg	Average weight per piece
Eco-indicator 99 H/A v203	- 3.95	14.52	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Human Health	- 1.48	14.19	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Ecosystem Quality	- 0.33	0.16	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Resource Depletion	- 2.14	0.18	Pt	Eco-indicator 99 (Pre, 2007)
CEDv103	- 1,135.13	65.39	MJ-eq	CEDv103 (Pre, 2007)
Abiotic depletion	- 0.62	0.03	kg Sb eq	CML2 v203 (CML 2004)
Global warming (GWP100)	- 25.06	2,187.22	kg CO2 eq	CML2 v203 (CML 2004)
Ozone layer depletion (ODP)	0.0049	0.3250	kg CFC-11 eq	CML2 v203 (CML 2004)
Human toxicity	- 64.80	85.77	kg 1,4-DB eq	CML2 v203 (CML 2004)
Fresh water aquatic ecotox.	- 4.12	19.69	kg 1,4-DB eq	CML2 v203 (CML 2004)
Marine aquatic ecotoxicity	- 55,147	14,231	kg 1,4-DB eq	CML2 v203 (CML 2004)
Terrestrial ecotoxicity	- 0.27	0.02	kg 1,4-DB eq	CML2 v203 (CML 2004)
Photochemical oxidation	- 0.01	0.02	kg C2H4	CML2 v203 (CML 2004)
Acidification	- 0.28	0.03	kg SO2 eq	CML2 v203 (CML 2004)
Eutrophication	- 0.02	0.01	kg PO4--- eq	CML2 v203 (CML 2004)

Table 93: Results per environmental impact category Cat.1B

A further description of the above environmental impact categories can be found in Chapter 6.2.2. The results of the above will be compared with the other product and treatment categories in Chapter 8.4.2. For all the above environmental impact categories, the default treatment scenario is a clear environmental improvement over not treating these products, even including all environmental impacts of the transport and further processing. This counts specifically for the ODP and GWP values. The total prevented GWP is more than 2,000 kg CO2 equivalent per fridge!

The benefits from treatment per piece will also be multiplied later with the potential total amount of WEEE arising from Chapter 7.

8.2.2.4 Environmental and Economic Impacts for Average Collection and Treatment

In Table 94, the breakdown of environmental impacts (based on the default Eco-Indicator'99 single scores) and economic impacts (based on the 2005 average for the WEEE Forum long running systems) for each stage in the recycling chain is displayed.

Process	Total	Costs	Revenues	Total	Burden	Gain
Transport and collection (incl. access to WEEE)	€7.13	€7.13				
Other costs	€2.89	€2.89		0.20	0.20	
Shredding, sorting, dismantling, pre-treatment	€21.84	€21.84				
Emissions in/before pre-treatment	0.01	0.01		0.16	0.16	0.00
Incineration and landfill	€0.44	0.52	(0.07)	-0.01	0.18	-0.18
Recycling processes	€0.03	0.05	(0.02)	-0.01	0.05	-0.06
Recovery processes	(€10.87)	4.80	(15.67)	-4.30	1.71	-6.01
cost or environmental burden	**€21.46**	per piece		**-3.95**	Pts per piece	
Revenue or environmental gain	**€0.56**	per kg		**-0.104**	Pts per kg	

Table 94: Environmental and economic impacts along the chain Cat.1B

The table shows that costs in the collection and transport stage are lower than the treatment costs (due to the relatively costly removal of CFCs plus oil from the compressors and the closed system to remove the CFCs from the PUR foam). These costs are substantially higher than the revenues for the further treatment, leading to a net cost of around EUR 560 per ton that is much higher than the values for Cat.1A/10. Note that the revenues after treatment are also significant, but do not cover the treatment and collection costs. Regarding the environmental impacts, the avoided environmental burden due to replacing primary material extraction is much higher than the impacts of collection and pre-processing (the avoided burden of potential CFC emissions is not included here as it only reflects the default scenario!). In the next section, the effect of higher 2007 material prices is analysed as well as the minimum and maximum values of the WEEE Forum long running systems in order to demonstrate the sensitivity of the costs.

8.2.2.5 Eco-efficiency and Sensitivity Analysis

In Figure 35, the eco-efficiency of various scenarios is displayed. Default treatment as described above is reflected with point A. The environmental benefits compared to the MSW points are substantial. The minimum value (A1) and maximum value (A2) show the range in total costs is from EUR 280/t till EUR 950/t. The effect of 2007 versus 2005 metal prices (B) leads to an improvement of around EUR 80 per ton. The environmental burden under Eco-Indicator'99 single indicator values of emitting the CFC from an average CFC/HC fridge (C2) or a 'CFC-only' fridge (E2) is very high. The same counts to a lesser extent for losing the CFC12 pressure from the compressor only (CFC recovery from foam assumed to be the same, E3). The numbers of 'pressure-less' fridges arriving at treatment facilities, may constitute grounds to investigate further the transport and handling activities that are a potential cause for gas release.

In Annex 8.2.1, the detailed data points are presented as well as the various calculated recycling and recovery percentages, QWERTY-recovered and QWERTY-loss values.

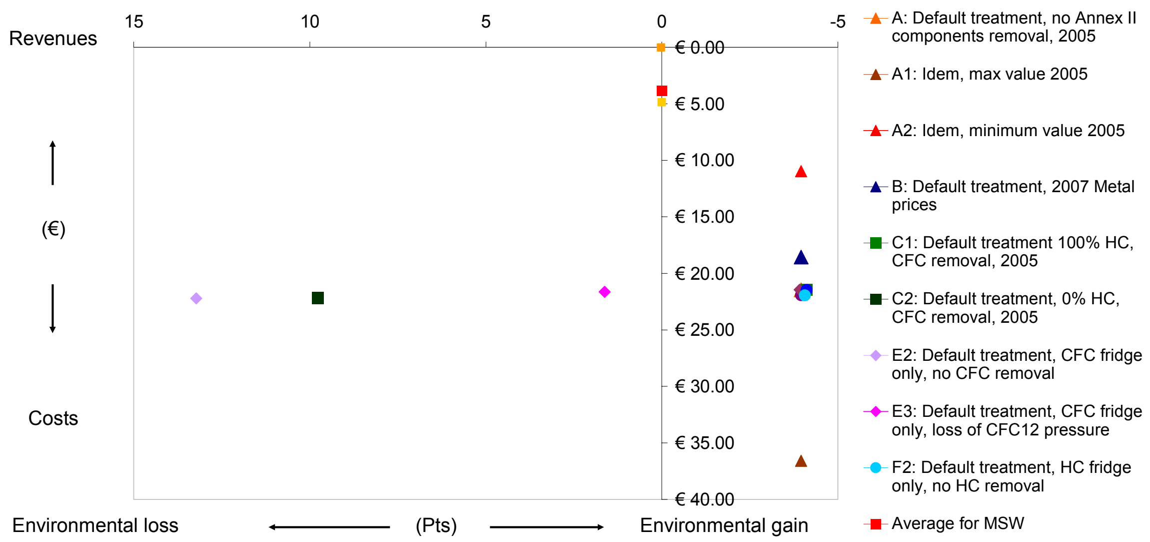

Figure 35: Eco-efficiency scenarios Cat.1B C&F (EI'99 H/A)

For clarity, these individual values for the effect of the CFCs scenarios depicted in Figure 35 are displayed in the next table. This due to the fact that the results are very sensitive for the environmental impact categories GWP, ODP and POCP compared to the other categories. Note that emissions of the cyclopentane and isobutane have an effect on the photochemical oxidation potential.

Scenario	GWP (kg CO2 eq)	ODP (kg CFC11 eq)	POCP (kg C2H4 eq)
A: Default treatment, 95% CFC removal, 2005	-25,1	0,005	-0,006
C1: Default treatment 100% HC, CFC removal, 2005	-47,6	0,000	0,000
C2: Default treatment, 0% HC, CFC removal, 2005	2109,7	0,325	-0,006
E2: Default treatment, CFC fridge only, no CFC removal	2648,8	0,406	-0,028
E3: Default treatment, CFC fridge only, loss of CFC12 pressure	982,9	0,080	-0,028
F1: Default treatment, HC fridge only	-47,6	0,000	-0,028
F2: Default treatment, HC fridge only, no HC removal	-46,9	0,000	0,081

Table 95: Environmental impact categories of treatment scenarios Cat.1B

Conclusions

The Eco-Indicator'99 single indicator values show that half of the environmental impacts are related to the CFCs and the other half to the other materials present. This demonstrates that there are two environmental priorities for treatment present at the same time: Control over the CFC content plus the recycling of the materials. Comparing CFC fridges in this category with other LHHA in Cat.1A, shows that there is a much higher environmental gain for each piece collected and treated compared with the 'do-nothing' scenario.

Finally, it is recommended that further research is carried out into waste stream compositions over time to determine how the transition from CFC to HC fridges influences the waste stream of these products. It is also considered necessary that the potential loss of pressure during transport, handling and feeding of treatment lines containing HC and CFC's should receive some attention as well in order to see if methods of prevention can be put in place. In addition an examination should be carried out into where to draw the boundary in splitting CFC and HC fridges as separate streams without causing risk of 'mistreatment' due to wrongly labelled appliances. The high impacts of the CFC appliances in terms of specific environmental impact categories will be discussed later in Chapter 8.4.2.

Analysis SHHA

8.2.3 Small Household Appliances (1C,2,3A,4A,5A,6,7,8)

8.2.3.1 Data and Assumptions

The compositions data presented in Chapter 8.0.5.3 are used. The economic part of the calculations is further based on the WEEE Forum's long running systems data for average costs. As a default recycling scenario, shredding and separation of the appliances is assumed. This scenario is evaluated for all the categories below. As the appliances in the categories 1C, 2, 3A, 4A, 5A, 6, 7, 8 ('consumer part') are usually grouped together at collection points and also treated as such, they are also analysed under the same collection and treatment settings. However, due to the variety in compositions, effort is also made to evaluate how the average treatment settings influence the results in comparison with dedicated settings for the product-category and the potential effect of increasing plastics recycling is studied. The studies involve focusing on manual removal of Annex II components and plastic housings for dedicated treatment as well as application of 'high value shredding and separation settings' to concentrate valuable components as much as possible for certain (sub)categories. In addition, the different key assumptions and the sensitivity of the results are tested in the eco-efficiency analysis below, including the influence of metal prices and the spread in costs per category found. Within this treatment category, the total chemical compositions and environmental weights are presented for every subcategory by applying the QWERTY methodology using Eco-Indicator '99 H/A v203. All other starting points, background data and calculation steps are described in Chapter 6.2.2.3.

8.2.3.2 Weight and Environmental Weight (per subcategory)

Table 96 and Table 97 and Figures 36 - 41 display the weight versus environmental weight of the average appliances present in Category 1C, 2+5A+8, 3A, 4A, 6 and 7. Note that the environmental values below represent the difference between minimum and maximum environmental impact and do not represent a certain treatment scenario, but merely the environmental relevance of the individual materials present.

Category	Cat1C	Cat2,5A,8	Cat3A	Cat4A	Cat6	Cat7
Material	**Weight (g)**	**Weight (g)**	**Weight (g)**	**Weight (g)**	**Weight (g)**	**Weight (g)**
Ag	0.0023	0.00033	0.48	0.12	0.0010	0.072
Al (general)	230	70	58.1	187	109	27.9
As	-	-	0.0011	-	-	-
Au	0.00068	0.00010	0.079	0.016	0.00028	0.0080
Be	-	-	0.0052	-	-	0.00059
Bi	-	-	0.048	0.06	-	-
Br	0.16	0.022	1.48	0.36	0.064	-
Cd	0.18	0.14	0.21	0.11	8.57	0.23
Ceramics	-	1.11	20.1	24.6	2.43	42.5
Cl	0.19	0.027	0.010	1.04	0.078	-
Co	0.23	0.18	0.27	0.14	1.29	0.29
Cr	0.014	0.0020	0.63	0.042	0.0058	-
Cu	956	484	159	423	1,075	25.58
Epoxy	8.40	1.18	-	17.2	3.47	-
Fe	11.2	349	80.3	156	913	11.14
Glass (white)	21.4	-	-	-	-	-
Hg	0.00013	0.00005	0.000054	0.000053	0.000001	0.000002
Glass (LCD)	0.14	0.057	3.99	0.055	0.084	0.18
Liquid Crystals	-	-	0.24	-	-	-
Mn	0.012	0.010	0.015	0.0075	0.070	0.016
Ni	0.63	0.46	3.15	0.89	13.5	1.22
Oil	9.29	3.84	-	-	-	-
Other/inerts	126	12.3	80.1	79.3	83.9	1,177
other plastics	0.81	0.64	0.97	0.49	8.76	23.9
Pb	0.50	0.070	1.06	2.19	0.21	0.078
PCB	0.0062	0.0025	-	-	-	-
Pd	0.0014	0.00020	0.030	0.0029	0.00058	0.00059
Plastics general	1,397	2,158	1,240	1,004	2,258	7,764
PS (HI)	1.13	-	-	-	-	-
PUR	2.25	-	-	-	-	-
PVC	20.3	5.40	8.60	0.78	20.7	-
Sb	0.029	0.0041	0.19	0.24	0.012	-
Sn	0.28	0.92	3.96	1.65	2.06	0.75
Stainless steel	226	69.7	51.5	169	26.7	-
Steel low alloyed	6,985	638	2,470	1,621	1,611	3,863
Wood	147	6.42	-	368	-	-
Zn	0.59	0.47	3.99	3.24	2.11	0.34
Total	**10,143**	**3,802**	**4,188**	**4,060**	**6,141**	**12,938**

Table 96: Weight Cat. 1C,2,3A,4A,5A,6,7,8 - SHHA

Category	Cat1C	Cat2	Cat3A	Cat4A	Cat6	Cat7
Material	Envl. Weight (%)	Envl. Weight (%)	Envl. Weight (%)	Envl. Weight (%)	Envl. Weight (%)	Envl. Weight (%)
Ag	0.00%	0.00%	0.32%	0.09%	0.00%	0.02%
Al (general)	4.93%	2.88%	2.20%	7.94%	2.66%	0.44%
As	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Au	0.08%	0.02%	16.20%	3.78%	0.04%	0.69%
Be	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bi	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
Br	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
Cd	0.12%	0.18%	0.25%	0.15%	6.60%	0.11%
Ceramics	0.00%	0.01%	0.15%	0.20%	0.01%	0.13%
Cl	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
Co	0.01%	0.01%	0.01%	0.01%	0.04%	0.01%
Cr	0.00%	0.00%	0.09%	0.01%	0.00%	0.00%
Cu	27.96%	27.01%	8.21%	24.60%	35.82%	0.55%
Epoxy	0.16%	0.04%	0.00%	0.64%	0.07%	0.00%
Fe	0.06%	3.73%	0.80%	1.75%	5.85%	0.05%
Glass (white)	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%
Hg	0.10%	0.08%	0.07%	0.08%	0.00%	0.00%
Glass (LCD)	0.00%	0.00%	0.04%	0.00%	0.00%	0.00%
Liquid Crystals	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mn	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Ni	0.07%	0.10%	0.64%	0.20%	1.76%	0.10%
Oil	0.08%	0.06%	0.00%	0.00%	0.00%	0.00%
Other/inerts	0.69%	0.13%	0.78%	0.87%	0.53%	4.80%
other plastics	0.01%	0.02%	0.02%	0.01%	0.13%	0.24%
Pb	0.02%	0.00%	0.06%	0.14%	0.01%	0.00%
PCB	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%
Pd	0.33%	0.09%	12.46%	1.33%	0.15%	0.10%
Plastics general	18.65%	54.89%	29.23%	26.66%	34.33%	76.51%
PS (HI)	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
PUR	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%
PVC	0.37%	0.19%	0.28%	0.03%	0.43%	0.00%
Sb	0.00%	0.00%	0.02%	0.03%	0.00%	0.00%
Sn	0.03%	0.22%	0.86%	0.40%	0.29%	0.07%
Stainless steel	5.71%	3.36%	2.29%	8.50%	0.77%	0.00%
Steel low alloyed	39.61%	6.87%	24.72%	18.28%	10.40%	16.17%
Wood	0.81%	0.07%	0.00%	4.04%	0.00%	0.00%
Zn	0.02%	0.04%	0.28%	0.26%	0.10%	0.01%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Table 97: Environmental Weight (EI99-H/A) Cat. 1C,2,3A,4A,5A,6,7,8 - SHHA

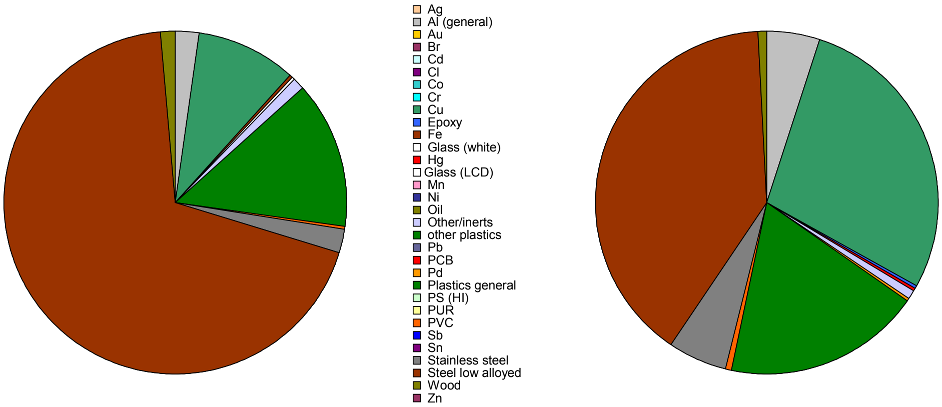

Figure 36: Weight versus Environmental Weight Cat.1C SHHA (EI'99 H/A)

In the above figure, it appears that this subcategory is very much metal dominated. The reason is probably that in the sampling data of (DEFRA 2007), the highest number and weight of appliances found are microwaves, electric heaters and electric fans (respectively 381, 258 and 187 on a total of 907 appliances) from which probably the first two are containing a very high metal content. In the Eco-Indicator'99 single indicator based environmental weight, the aluminium and stainless steel content and to a lesser extent, the plastics have a relatively higher contribution than the iron content. In Annex 8.2.3 the above graph is also displayed for all individual impact categories. Here it can be seen that the results are quite similar to the Category 1A results. The metal domination occurs for all environmental impact categories. With regard to the Hg content, the most relevant impacts are in CML-2 under terrestrial ecotoxicity. It must be noted that there is no human toxicity value present in Eco-Indicator'99, only the effect on Ecotoxicity is included. In CML2 in all human and ecotoxicity categories, Hg has a very high characterisation factor. Even there, the estimated content is only causing a very small overall contribution especially compared to for instance the copper content. In the category: 'Fresh water aquatic ecotoxicity', a limited contribution of the PVC and a higher contribution of the stainless steel (due to the Ni and Cr content), becomes visible. Generally speaking, when the variety of effects in the different environmental impact categories would be aggregated, Figure 36 is a good illustration of the various effects. Also note the high consistency of the outcomes under Cumulative Energy Demand and the CML 2 themes of Global Warming Potential, Abiotic Depletion, Acidification and POCP.

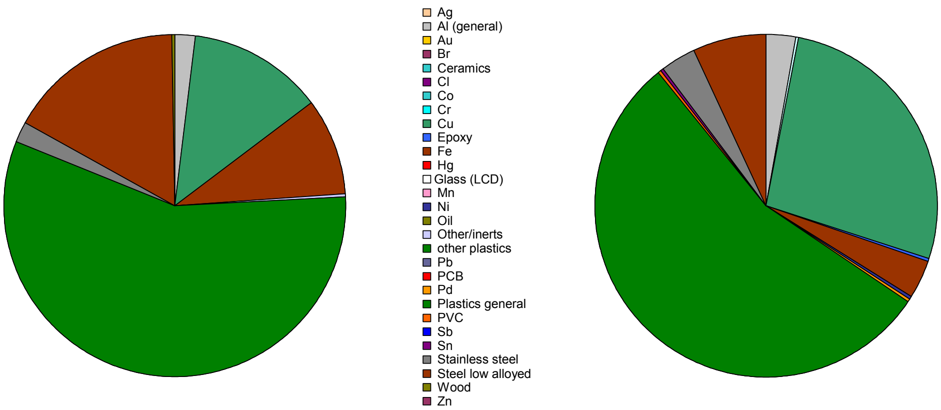

Figure 37: Weight versus Environmental Weight Cat.2 SHHA (EI'99 H/A)

Category 2 as shown above is obviously a much more plastic dominated category. Again, the copper content occupies a relatively high portion of the environmental weight graph, while the plastics are still having the biggest contribution overall. In the fresh water aquatic ecotoxicity and marine aquatic ecotoxicity, the aluminium and copper are more important, in all other categories, there is high consistency of the relative importance of the materials. See Annex 8.2.3 again for all detailed pictures.

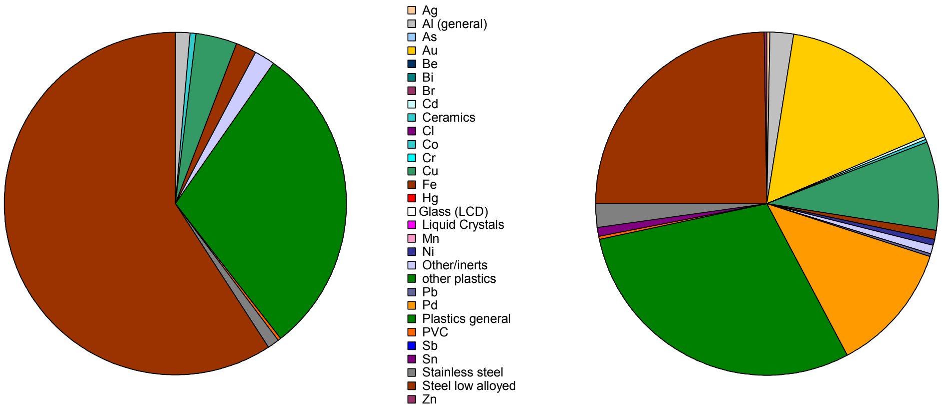

Figure 38: Weight versus Environmental Weight Cat.3A IT ex CRT (EI'99 H/A)

In contrast to Category 2, Category 3A shown above is clearly showing a very different picture for the environmental weight compared to the products weight. The main data source of (DEFRA 2007) shows that the largest part of the weight is due to the desktop PC's (1175) and printers (1026). In this stream only a very small number of laptops and phones in the return stream are found. As a result, the above picture basically demonstrates the contribution of the plastic dominated printers as well as the contribution of the relatively rich and steel dominated desktop PC's share. As a result of the latter, the environmental weight diagram shows also a substantial contribution of the precious metal content. In Annex 8.2.3, the largest differences in individual environmental impact categories are found for the acidification and eutrophication graphs due to the high energy demand and SO2-emissions of raw material extraction of gold and palladium. Despite this, the above figure is a good average reflection of the various environmental impacts. Basically, the diversity in environmental priorities like recovery of precious and base metals and the relevancy of the plastic content for this category are well demonstrated.

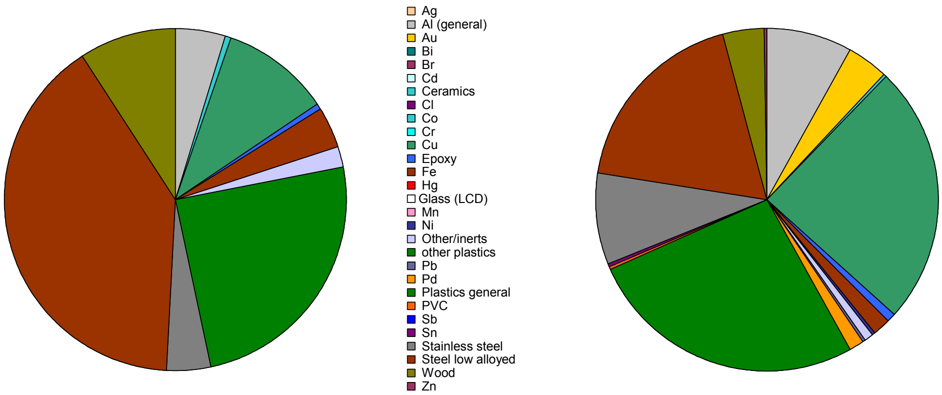

Figure 39: Weight versus Environmental Weight Cat.4A CE ex CRT (EI'99 H/A)

The picture of category 4A is rather similar compared with that of cat.3A, except for much lower precious metals contributions found. This is as expected due to the absence of the richest and most frequently found products as PC's and phones in comparison with Category 3A. Category 4A (and B later on) are the only ones found with a significant amount of wood (in this case from loudspeakers). See again Annex 8.2.3 for more details per environmental impact category.

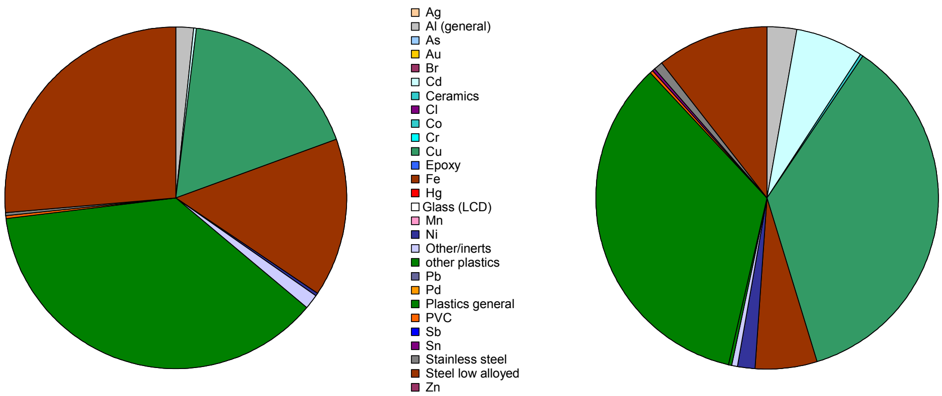

Figure 40: Weight versus Environmental Weight Cat.6 Tools (EI'99 H/A)

In the collected tools of Category 6 in Chapter 8.0.5.3, lawnmowers are the highest number of a single type of product found. The weight versus environmental weight graphs of cat. 6 also show two substances with a significant environmental burden compared to other categories: that is the Ni and Cd from battery packs. The influence of these batteries is particularly present in the CML-2 human toxicity graph in Annex 8.2.3 and is similarly present in the Eco-Indicator'99 Human Health and Ecosystem quality graphs. Therefore, in the eco-efficiency analysis of various scenarios, the influence of removing external batteries manually from WEEE is investigated in further detail.

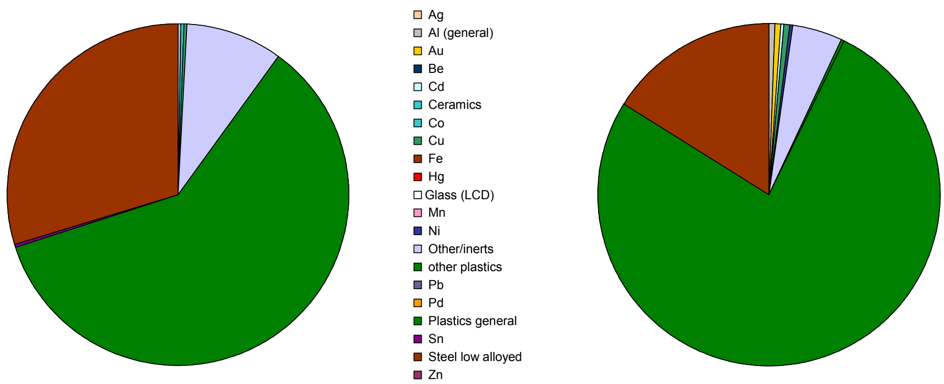

Figure 41: Weight versus Environmental Weight Cat.7 Toys (EI'99 H/A)

The data for cat.7 found in (DEFRA 2007), is less representative compared to the other categories with small appliances due to the much smaller weight involved. The data in (DEFRA 2007) is only representing 32 appliances from which the majority are game-consoles with a relatively high weight per unit of 12,9 kg. The very small number of small toys is however very likely a very representative finding: they are usually not handed in for recycling at collection points. Therefore, data describing these game-consoles is used to indicate the weight versus environmental weight of this category as being collected and treated in practice. For these appliances, the plastic content is relatively high. The resulting graphs per environmental impact categories in Annex 8.2.3 all show the same high contribution of the plastics.

8.2.3.3 Environmental Impact under Various Impact Categories

For the above categories, in the next Table 98 and Table 99 the actual results per environmental impact category are demonstrated for the default shredding and separation scenario as well as the worst case disposal with MSW (uncontrolled landfill and incineration without energy recovery).

Category	**1C**	**2,5A,8**	**3A**	**4A**	**6**	**7**	
Indicator:	**Default**	**Default**	**Default**	**Default**	**Default**	**Default**	**Unit**
Weight	10.14	3.80	4.19	4.06	6.14	12.94	kg
Eco-indicator 99 H/A v203	-0.97	-0.41	-0.73	-0.52	-0.71	-0.24	Pt
Idem, Human Health	-0.53	-0.20	-0.55	-0.31	-0.33	-0.01	Pt
Idem, Ecosystem Quality	-0.161	-0.015	-0.042	-0.052	-0.050	0.162	Pt
Idem, Resource Depletion	-0.28	-0.19	-0.13	-0.16	-0.34	-0.39	Pt
Cumulative Energy Demand	-181.35	-69.09	-101.80	-84.59	-119.16	-194.01	MJ-eq
Abiotic depletion	-0.116	-0.036	-0.057	-0.045	-0.066	-0.112	kg Sb eq
Global warming (GWP100)	-5.92	1.12	-2.01	-2.25	-1.22	8.26	kg CO2 eq
Ozone layer depletion (ODP)	-0.00000	-0.00000	-0.0000	-0.0000	-0.0000	-0.00000	kg CFC-11 eq
Human toxicity	-7.14	34.30	16.86	4.20	35.82	158.09	kg 1,4-DB eq
Fresh water aquatic ecotox.	0.50	6.30	2.72	1.38	5.85	27.18	kg 1,4-DB eq
Marine aquatic ecotoxicity	-13,199	-587	-3,768	-6,222	-3,715	6,717	kg 1,4-DB eq
Terrestrial ecotoxicity	-0.108	-0.048	-0.034	-0.046	-0.090	-0.064	kg 1,4-DB eq
Photochemical oxidation	-0.0094	-0.0024	-0.0097	-0.0040	-0.0054	-0.0060	kg C2H4
Acidification	-0.087	-0.039	-0.190	-0.054	-0.095	-0.050	kg SO2 eq
Eutrophication	-0.0026	-0.0008	-0.0005	-0.0014	-0.0028	0.0032	kg PO4--- eq

Table 98: Results per environmental impact category for default treatment

Category	1C	2,5A,8	3A	4A	6	7	
Indicator:	**MSW**	**MSW**	**MSW**	**MSW**	**MSW**	**MSW**	**Unit**
Weight	10.14	3.80	4.19	4.06	6.14	12.94	kg
Eco-indicator 99 H/A v203	0.16	0.17	0.11	0.09	0.45	0.60	Pt
Idem, Human Health	0.07	0.08	0.05	0.04	0.29	0.28	Pt
Idem, Ecosystem Quality	0.056	0.077	0.045	0.037	0.139	0.270	Pt
Idem, Resource Depletion	0.03	0.02	0.01	0.01	0.03	0.05	Pt
Cumulative Energy Demand	12.85	5.76	5.62	5.31	11.36	18.76	MJ-eq
Abiotic depletion	0.006	0.003	0.003	0.002	0.006	0.008	kg Sb eq
Global warming (GWP100)	4.80	6.69	3.82	3.13	7.24	24.04	kg CO2 eq
Ozone layer depletion (ODP)	0.00002	0.00001	0.0000	0.0000	0.0001	0.00001	kg CFC-11 eq
Human toxicity	33.98	53.38	29.33	23.75	63.99	192.52	kg 1,4-DB eq
Fresh water aquatic ecotox.	5.85	9.08	4.97	4.06	9.71	32.55	kg 1,4-DB eq
Marine aquatic ecotoxicity	2,906	4,252	2,381	1,944	4,639	15,244	kg 1,4-DB eq
Terrestrial ecotoxicity	0.007	0.003	0.003	0.003	0.016	0.006	kg 1,4-DB eq
Photochemical oxidation	0.0004	0.0002	0.0002	0.0002	0.0005	0.0005	kg C2H4
Acidification	0.006	0.003	0.003	0.003	0.008	0.011	kg SO2 eq
Eutrophication	0.0018	0.0017	0.0011	0.0010	0.0021	0.0063	kg PO4--- eq

Table 99: Results per environmental impact category for disposal with MSW

A further description of the above environmental impact categories can be found in Chapter 6.2.2. The results of Table 99 will be compared with the other product and treatment categories in Chapter 8.4.2. For all above environmental impact categories, the default treatment scenario is a clear environmental improvement over not treating these products, even including all environmental impacts of the transport and further processing. The benefits from treatment are multiplied later with the potential total amount of WEEE arising from Chapter 7 and discussed further in Chapter 8.4.2.

8.2.3.4 Environmental and Economic Impacts for Average Collection and Treatment

In Table 100, the breakdown of environmental impacts (based on the default Eco-Indicator'99 single scores) and economic impacts (based on the 2005 average for the WEEE Forum long running systems) per stage in the recycling chain is displayed.

Category	Cat.1C		Cat.2,5A,8		Cat.3A	
Process	**Costs**	**Revenues**	**Costs**	**Revenues**	**Costs**	**Revenues**
Transport and collection (incl. access to WEEE)	€1.31		€0.49		€0.54	
Other costs	€1.04		€0.39		€0.24	
Shredding, sorting, dismantling, pre-treatment	€2.41		€0.91		€1.20	
Incineration and landfill	€0.10	(€0.01)	€0.11		€0.07	(€0.01)
Recycling processes	€0.05	(€0.02)	€0.08	(€0.04)	€0.04	(€0.02)
Recovery processes	€2.39	(€3.39)	€0.87	(€1.33)	€0.77	(€1.25)
Total	**€3.89**	p. piece	**€1.48**	per piece	**€1.59**	per piece
Total	**€0.38**	per kg	**€0.39**	per kg	**€0.38**	per kg

Category	Cat.4A		Cat.6		Cat.7	
Process	**Costs**	**Revenues**	**Costs**	**Revenues**	**Costs**	**Revenues**
Transport and collection (incl. access to WEEE)	€0.53		€0.78		€1.86	
Other costs	€0.35		€0.50		€1.30	
Shredding, sorting, dismantling, pre-treatment	€0.83		€1.61		€2.41	
Incineration and landfill	€0.08	(€0.01)	€0.14	(€0.02)	€0.48	(€0.07)
Recycling processes	€0.04	(€0.02)	€0.08	(€0.03)	€0.27	(€0.12)
Recovery processes	€1.33	(€1.42)	€1.71	(€2.92)	€1.03	(€0.62)
Total	**€1.71**	per piece	**€1.85**	per piece	**€6.55**	per piece
Total	**€0.42**	per kg	**€0.30**	per kg	**€0.51**	per kg

Table 100: Economic impacts along the chain Cat.1C,2,3A,4A,5A,6,7,8

The table shows that costs in the collection and transport stage are the most relevant. These costs are still higher than the revenues for the further treatment, leading to a net cost of around EUR 300/ton till EUR 510/ton. Note that the revenues after collection almost offset the cost of pre-processing.

Category	Cat.1C		Cat.2,5A,8		Cat.3A	
Process	**Burden**	**Gain**	**Burden**	**Gain**	**Burden**	**Gain**
Transport and collection (incl. access to WEEE) Shredding, sorting, dismantling, pre-treatment	0.058		0.038		0.024	
Incineration and landfill	0.035	-0.031	0.038	-0.038	0.030	-0.027
Recycling processes	0.053	-0.059	0.076	-0.076	0.043	-0.052
Recovery processes	0.439	-1.464	0.076	-0.532	0.159	-0.905
Total	**-0.97**	Pts p. piece	**-0.38**	Pts p. piece	**-0.73**	Pts p. piece
Total	**-0.096**	Pts per kg	**-0.100**	Pts per kg	**-0.174**	Pts per kg
Category	**Cat.4A**		**Cat.6**		**Cat.7**	
Process	**Burden**	**Gain**	**Burden**	**Gain**	**Burden**	**Gain**
Transport and collection (incl. access to WEEE) Shredding, sorting, dismantling, pre-treatment	0.02		0.03		0.07	
Incineration and landfill	0.02	-0.02	0.06	-0.05	0.18	-0.17
Recycling processes	0.04	-0.04	0.11	-0.09	0.26	-0.32
Recovery processes	0.14	-0.68	0.39	-1.14	0.25	-0.51
Total	**-0.52**	Pts p. piece	**-0.69**	Pts p. piece	**-0.24**	Pts p. piece
Total	**-0.128**	Pts per kg	**-0.113**	Pts per kg	**-0.019**	Pts per kg

Table 101: Environmental impacts along the chain Cat.1C,2,3A,4A,5A,6,7,8

Regarding the environmental impacts, the avoided environmental burden is much higher than the impacts of collection and pre-processing. Due to the precious metal content, the highest environmental gains per kg are found for cat.3A, the lowest impacts are found for cat.7 having the highest plastics content. Obviously, the metal (steel) prices have a marked influence on the total economic picture. Therefore, in the next section, the effect of higher 2007 material prices is analysed as well as the minimum and maximum values of the WEEE Forum long running systems in order to demonstrate the spread in costs.

8.2.3.5 Eco-efficiency and Sensitivity Analysis

In Figure 42 till Figure 46, the eco-efficiency of various scenarios are displayed for the categories 1C,2+5A+8,3A,4A,6,7. Default treatment as shredding and separation without any disassembly as described above is reflected with point A in all graphs. The A1 and A2 respectively show the WEEE Forum long running systems spread in costs. Scenario B illustrates the effect of increase in material prices comparing the current (April 2007) level with average 2005 price levels. The scenario C1 and C2 compare the default treatment and default destinations of the mixed plastics with 100% plastics recycling of these (C1: assumption that this technically possible) and versus incineration with energy recovery in a modern MSW incinerator (C2). The scenario D in each graph is the analysis of manual dismantling of all Annex II components mainly batteries and circuit boards) plus shredding and separation of the remaining. Scenario E (potentially applicable for high value inputs like PC's) is illustrating 'high value settings', which means that a relatively largercopper fraction including a lot of plastics is created in order to avoid loss of precious metals.

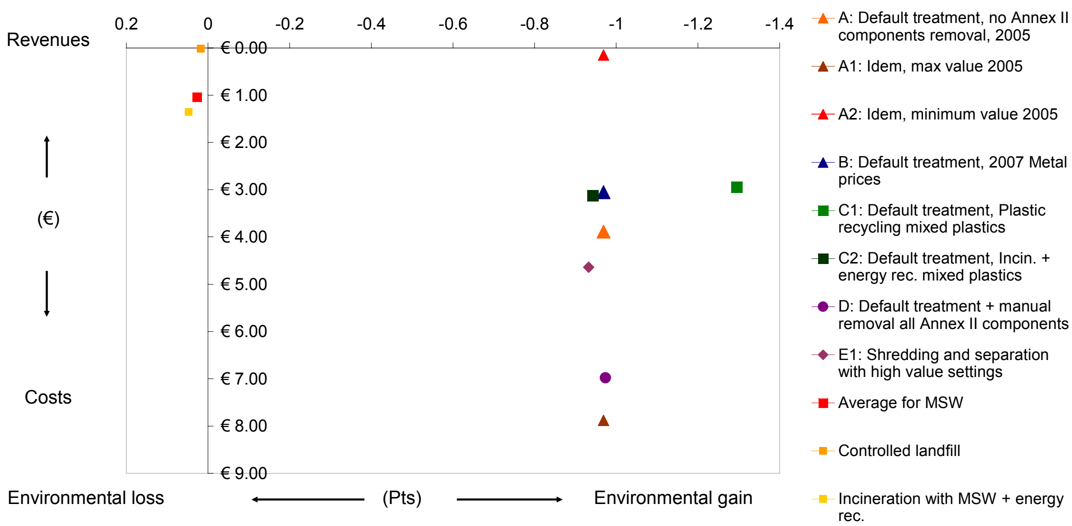

Figure 42: Eco-efficiency scenarios Cat. 1C (EI'99 H/A)

For cat. 1C, the minimum value (A1) shows the total costs of treatment can be close to zero due to the high metal content and value. The distance towards the maximum value is rather high at EUR 770/ton. The effect of 2007 material prices (B) compared to the average leads to a costs improvement of EUR 80/ton (from EUR 380 to EUR 300). Scenario C1 and C2 show a clear environmental benefit of applying plastics recycling instead of incineration without energy recovery at comparable costs levels. The effect of the manual removal of Annex II components in scenario D (mainly printed circuit boards) is very low, which is in line with the environmental finding per impact category. In order to calculate the impact of manual removal an assumption of an average 400 seconds per product (10.1 kg) dismantling time was used prior to shredding. In Annex 8.2.3, the detailed data points are presented as well as the various calculated recycling and recovery percentages, QWERTY-recovered and QWERTY-loss values. The environmental benefits compared to the MSW points are substantial in all cases as was already shown in Table 99. Scenario E (high value settings) is not leading to a significant environmental improvement and much higher costs mainly due to the relatively high plastic content and the low amount of precious metals.

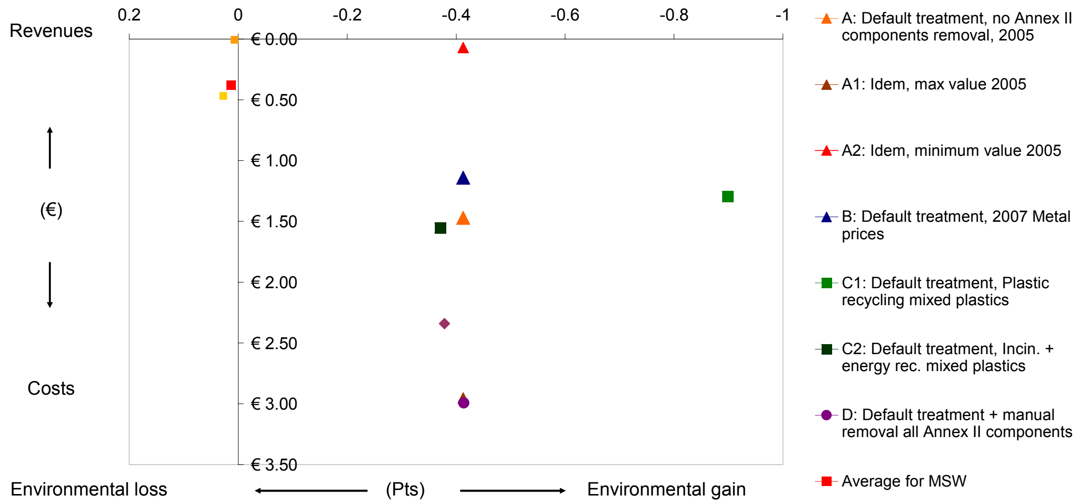

Figure 43: Eco-efficiency scenarios Cat. 2,5A,8 (EI'99 H/A)

In Figure 43 the same scenarios for the combined categories 2,5A and 8 are displayed. The minimum value (A1) shows the total costs can again be close to zero. The distance towards the maximum value is rather high at EUR 760/ton. The effect of 2007 material prices (B) compared to the average leads again to an estimated costs improvement of EUR 80/ton. Scenario C1 and C2 show a clear environmental benefit of applying plastics recycling instead of incineration without energy recovery at comparable costs levels even more significant than in the case of cat. 1C due to the higher plastic content. The effect of the manual removal of Annex II components in scenario D (mainly printed circuit boards) is very low, which is in line with the environmental finding per impact category. The underlying assumption was an average 200 seconds product (3.8 kg) dismantling time before shredding. Scenario E (high value settings) is obviously leading to worsened environmental outcomes and much higher costs mainly due to the losses of plastics and low gain of recovery of precious metals. Issues connected with this observation will be further discussed in Chapter 10.3. In Annex 8.2.3, the detailed data points are presented as well as the various calculated recycling and recovery percentages, QWERTY-recovered and QWERTY-loss values. The environmental benefits compared to the MSW points are substantial in all cases as already demonstrated in Table 99.

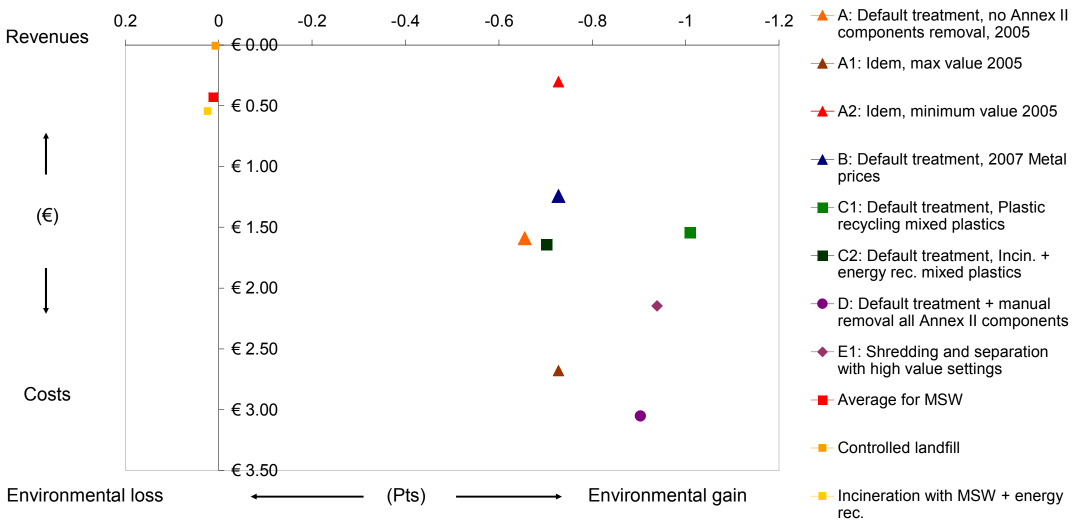

Figure 44: Eco-efficiency scenarios Cat. 3A (EI'99 H/A)

Figure 44 is displaying the results for the same scenarios for cat. 3A. This category (average appliance weight of 4.2 kg) includes both relatively rich and metal dominated PC's as well as plastic dominated printers and again content-wise metal rich phones. The minimum value (A1) shows the total costs can again be close to zero. The distance from the maximum value is rather high at EUR 570/ton. The effect of 2007 material prices (B) compared to the average leads again to an estimated costs improvement of only EUR 50/ton. Scenario C1 and C2 show a clear environmental benefit of applying plastics recycling instead of incineration without energy recovery at comparable costs levels but less significant than in the case of cat.2 due to a more mixed content (plastic and steel housings). The effect of the manual removal of Annex II components in scenario D (mainly printed circuit boards) is significant, which is mainly caused by removing high grade circuit boards from PC's. The underlying assumption was an average 200 seconds product (4.2 kg) dismantling time before shredding. However, the same result can be obtained by scenario E (high value settings) in an even more cost efficient way and with also more environmental benefits. Apparently the 'high value settings' makes economic and environmental sense (which is obvious as such settings are applied/ developed for such products in practice). Again, the relation with the instrument of recycling targets should be considered. This is relevant for discussing recycling targets later on in Chapter 10.3. In Annex 8.2.3, the detailed data points are presented as well as the various calculated recycling and recovery percentages, QWERTY-recovered and QWERTY-loss values. The environmental benefits compared to the MSW points are substantial in all cases as was already displayed in Table 99.

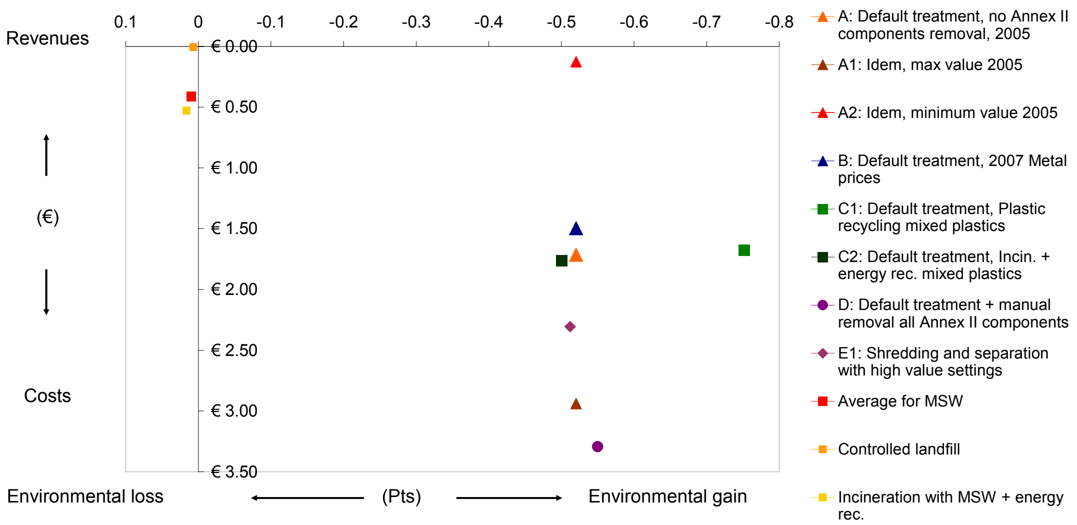

Figure 45: Eco-efficiency scenarios Cat. 4A (EI'99 H/A)

Figure 45 is displaying the same scenarios for cat. 4A. This category (average appliance weight of 4.1 kg) consists of more of relatively plastic (and in the past wood) dominated products like speakers and audio but also metal dominated products like DVD players, VCR's etc. However, as could be seen from the weight versus environmental weight graphs there are fewer precious metals compared to cat.3A. In this case the scenarios A and B show similar outcomes as for cat.3A. Scenario C1 and C2 show again a clear environmental benefit of applying plastics recycling instead of incineration without energy recovery at comparable costs levels. The effect of the manual removal of Annex II components (200 seconds product (4.1 kg) dismantling time before shredding) in scenario D (mainly printed circuit boards) is positive but much smaller than for cat.3A. However, the costs of doing so are relatively high compared to the environmental benefits. Unlike the case of cat.3A, the same result cannot be obtained by scenario E (high value settings). Apparently here the higher plastic and lower precious metal content does not make economic and environmental sense. For more details: see Annex 8.2.3.

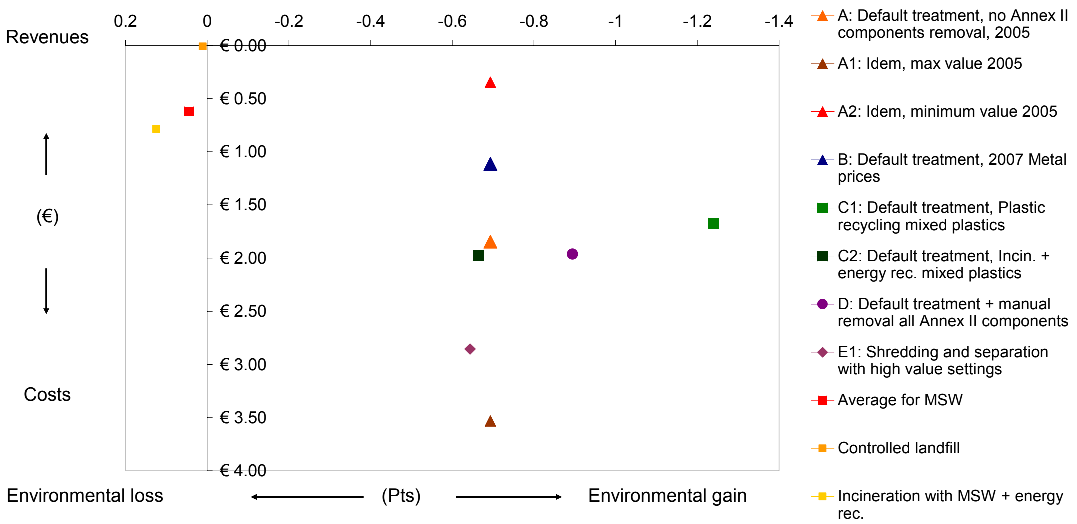

Figure 46: Eco-efficiency scenarios Cat. 6 (EI'99 H/A)

Figure 46 is displaying the eco-efficiency outcomes for cat.6 Tools. This category (average appliance weight of 6,1 kg) is comparable to cat.4A in terms of plastics content. However, here also many more battery packs are found. In this case the scenarios A and B show an interesting result. The costs are 120/ton lower for 2007 material prices, probably due to the higher Ni content (in NiCd and NiMH batteries). Scenario C1 and C2 show again a clear environmental benefit of applying plastics recycling instead of incineration without energy recovery at comparable costs levels. The effect of the manual removal of Annex II components (60 seconds product (6.1 kg) dismantling time) in scenario D (mainly NiCd and other batteries) is positive and almost at the same costs level. The costs of doing so are relatively low compared to the similar scenarios for circuit boards in category 3A and 4A. Again, scenario E (high value settings) has a negative outcome due to the higher plastic and lower precious metal content then for instance compared to cat.3A. For more details: see Annex 8.2.3.

For cat. 7 toys, due to the lack of precise data, the eco-efficiency scenarios are calculated but are displayed in Annex 8.2.3 as they are less reliable an more a rough indication compared to the other categories analysed in this Chapter. In addition, the type of plastics used in this category (besides the game consoles) is rather different from the other categories. Therefore, comparing plastics recycling in this case compared to the other categories is not possible.

Conclusions

Although the categories 1C,2,3A,4A,5A,6,7,8 are usually collected together, still a large number of differences are found for the various 'sub-collection categories' in terms of environmental and economic outcomes. Basically, the analysed categories can be split into:

1. Metal dominated products (mainly 1C) which could also be treated with the larger appliances of category 1A,
2. Plastic dominated products 2, part of cat.3A, 4A, 6 and 7 for which plastic recycling does make sense and,
3. Precious metal dominated products of cat.3A (PC's and phones, plus DVD players etc. from 4A). However, for the latter it is not possible with the data available to draw a theoretical line on which products could qualify for a dedicated treatment that focuses on avoiding loss of precious metals.

In all cases manual removal of Annex II components (mainly circuit boards) is not really contributing to better environmental performance, except in the case of PC's (but dedicated treatment under high value shredding settings is doing the same, resulting in even better environmental and economic results) as well as in the case of large external batteries in tools.

In general it is recommended to perform further research on splitting high value products from the rest of the small appliances (this is carried out in some countries already) and how the relation between optimal treatment and the instrument of recycling targets turns out. In some cases plastic recycling is a favourable scenario and in others a more dedicated – high value treatment where this plastic recycling is less relevant. Importantly, these two directions conflict as, in practice, they cannot be done at the same time. For category 7, it was not possible to evaluate the many different scenarios due to the lower quality of available data. However, as sales of game consoles (large and small) is increasing, further research is recommended as these products are becoming more and more similar to desktop PC's except, perhaps for the application of plastics housings. It is possible that desktop PC's may move towards the use of plastic housings.

Analysis CRT

8.2.4 CRT and FPD Appliances (3B,3C,4B,4C):

8.2.4.1 Data and Assumptions

From Chapter 8.0.5.4 composition data are used. As a default recycling scenario for CRT TV's and monitors, the dismantling of the casings, removal of the electrongun, pressurisation of the CRT and removal of the CRT is taken. The CRT is assumed to be further split in screen and cone glass (either through hot-wire, diamond saw or mechanical treatment with optical separation) plus re-application of the screen to screen glass and cone to cone glass. The remaining electronics are assumed to undergo shredding and separation. For category 3B (average weight of 14.6 kg) and Category 4B (average weight of 27.6 kg), also other options for CRT glass are evaluated (use as filling material instead of sand, use in ceramic industry as feldspar replacement and direct treatment in a secondary copper – lead –tin smelter).

For the LCD TV's and Monitors, the default scenario is assumed to be manual separation of the panel and the attached Hg containing backlights. However, this scenario can be questioned as not very realistic due to the difficulty of removal and likelihood of the lamps to break even when done carefully. On the other hand, removing of the complete panel and consigning to hazardous waste landfill is far from ideal as a substantial amount of valuable material is thrown away in this manner. Also direct shredding and separation could have the potential to cause direct mercury emissions to air. All of these different scenarios are evaluated.

The average weight of LCD monitors (5.1 kg) is based on limited data from the EuP case studies (Kemna 2007). However, the data on printed circuit board compositions are only known for the controlboards and not the present powerboards and this lack of data is likely to cause an overestimate of the precious metals content. The data used for LCD TV's (excl. plasma screens) are based on available data of different 32" sized screens that are likely to be heavier than the average screen size. Both calculations for flat panel displays are to be regarded as indications of how this (sub-stream might look in the future and not as a reflection of today's treatment as very few of these appliances are currently being discarded.

Within this 'displays' category (3B/4B vs. 3C/4C), all the total chemical compositions and environmental weights are presented for all product categories by applying the QWERTY methodology using Eco-Indicator '99 H/A v203. All other starting points, background data and calculation steps are described in Chapter 6.2.2.3.

8.2.4.2 Weight and Environmental Weight (per subcategory)

Table 102 and Figures 47 - 50 display the weight versus environmental weight of the average appliances present in Category 3B,4B,3C and 4C. It should again be noted that the data for the flat panels in cat.3C/4c should be interpreted carefully.

Category	Cat3B	Cat3B	Cat4B	Cat4B	Cat3C	Cat3C	Cat4C	Cat4C
Material	Weight (g)	Envl. Weight (%)	Weight (g)	Envl. Weight (%)	Weight (g)	Envl. Weight (%)	Weight (g)	Envl. Weight (%)
ABS	1,339	12.53%	2,827	13.15%	360	5.00%	4,145	17.18%
Ag	0.21	0.06%	2.65	0.38%	0.52	0.22%	0.45	0.06%
Al (general)	301	4.86%	225	1.80%	236	5.64%	1,776	12.68%
Au	0.013	1.12%	0.17	7.62%	0.20	26.22%	0.11	4.16%
Bi	0.95	0.03%	0.66	0.01%	-	0.00%	-	0.00%
Br	3.97	0.01%	20.4	0.03%	-	0.00%	-	0.00%
Ceramics	282	0.88%	440	0.68%	180	0.83%	315	0.44%
Cl	-	0.00%	3.78	0.01%	-	0.00%	-	0.00%
Co	0.18	0.00%	0.21	0.00%	-	0.00%	-	0.00%
Cr	3.78	0.24%	3.75	0.12%	0.082	0.01%	0.62	0.02%
CRT-glass cone	2,781	17.09%	5,928	18.11%	-	0.00%	-	0.00%
CRT-glass screen	5,647	20.84%	11,857	21.74%	-	0.00%	-	0.00%
Cu	723	15.92%	971	10.63%	310	10.13%	824	8.04%
Epoxy	63.6	0.89%	636	4.43%	-	0.00%	-	0.00%
Fe	420	1.78%	594	1.25%	2.17	0.01%	4,127	7.75%
Glass (white)	14.0	0.06%	16.9	0.04%	-	0.00%	6,273	12.51%
Hg	-	0.00%	-	0.00%	0.0060	0.11%	0.075	0.39%
Glass (LCD)	-	0.00%	-	0.00%	248	1.57%	-	0.00%
Ni	8.91	0.77%	11.5	0.49%	3.69	0.47%	3.20	0.12%
Other/inerts	911	3.79%	38.1	0.08%	-	0.00%	217	0.40%
Pb	15.3	0.37%	24.7	0.30%	2.34	0.09%	12.1	0.13%
Pd	0.0048	0.83%	0.067	5.84%	0.041	10.50%	0.034	2.61%
PE (HD)	-	0.00%	-	0.00%	300	3.69%	-	0.00%
PET	-	0.00%	-	0.00%	60.0	0.68%	-	0.00%
Plastics general	1,286	12.93%	1,935	9.67%	1,400	20.88%	4,449	19.81%
PVC	52.2	0.72%	105	0.72%	91.8	1.88%	252	1.55%
Sb	3.02	0.14%	5.75	0.13%	0.16	0.01%	0.71	0.01%
Sn	0.81	0.07%	13.0	0.60%	0.53	0.07%	18.3	0.75%
Steel low alloyed	770	3.29%	-	0.00%	1,885	11.94%	5,864	11.09%
Wood	-	0.00%	1,004	2.08%	-	0.00%	-	0.00%
Zn	25.9	0.77%	6.41	0.10%	1.03	0.05%	23.0	0.30%
Total	**14,653**	**100%**	**26,671**	**100%**	**5,082**	**100%**	**28,300**	**100%**

Table 102: Weight versus Environmental Weight (EI99-H/A) Cat.3B,3C,4B,4C

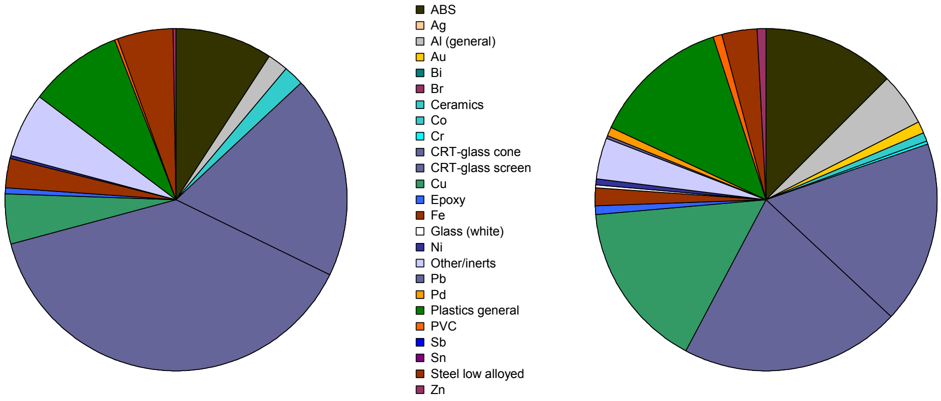

Figure 47: Weight versus Environmental Weight Cat. 3B IT CRT (EI'99 H/A)

The above graph demonstrates that for the chosen environmental assessment model, the relative contribution of the materials is rather similar to the weight contribution, except for the copper content. In Annex 8.2.3 the above graph is also displayed for all individual impact categories. Here it can be seen that the results are rather similar in most categories, with exceptions for the non-presence of the CRT glass in the CML-2 human toxicity chart, due to the higher relative contribution of the plastics here, as well as in fresh water aquatic ecotoxicity where the PVC content appears. Under marine aquatic ecotoxicity the aluminium content is much larger. Under terrestrial ecotoxicity, the Cr content becomes visible. Still, despite these differences, the Eco-Indicator'99 single indicator graph seems to be a good representation and illustration of the sum of the individual environmental impact categories. See Annex 8.2.4 for all details.

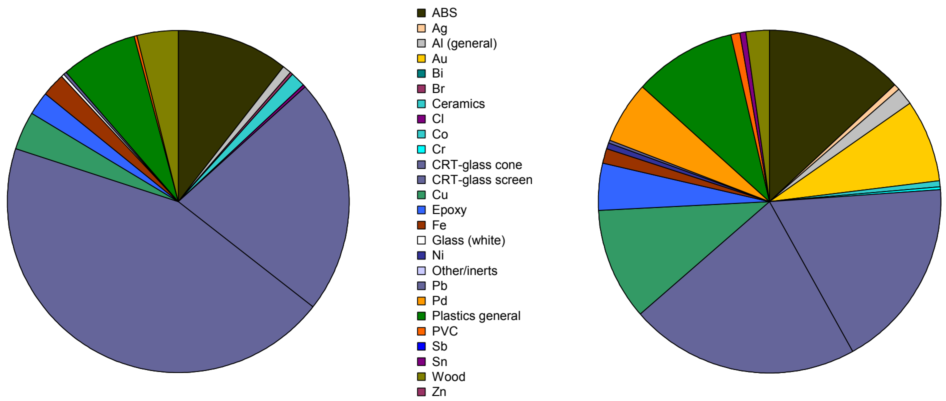

Figure 48: Weight versus Environmental Weight Cat. 4B CE CRT (EI'99 H/A)

The above graph demonstrates that compared to the CRT monitors, there are only minor differences due to higher values of precious metals in the TV electronics as well as the (small) presence of wood (TV encasings). Despite these differences, the two pie charts are very similar. Due to the relatively higher precious contents of CRT TV's, the gold and palladium content is more significant in the Acidification and POCP impact categories. See Annex 8.2.4 for all details.

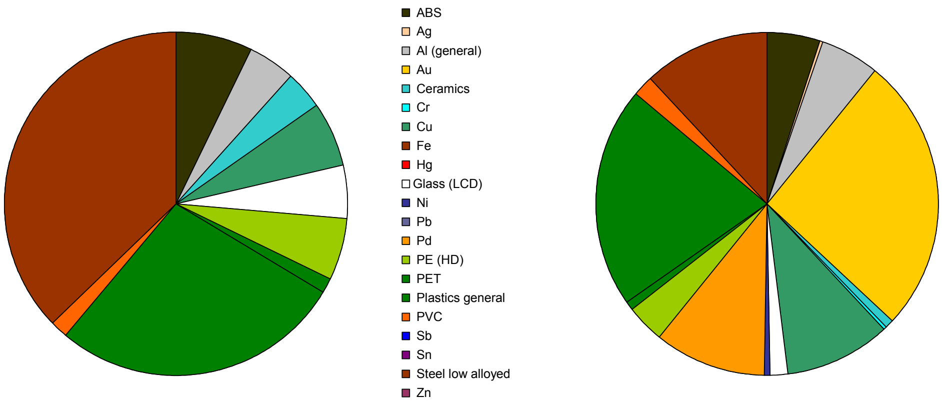

Figure 49: Weight versus Environmental Weight Cat. 3C IT FDP (EI'99 H/A)

Compared to the CRT Monitors, Figure 49 shows a completely different picture. This is due to the high influence of the precious metals and obvious absence of the CRT. In Annex 8.2.4 it can be observed that the above pie chart is very similar in most environmental impact categories, except for terrestrial ecotoxicity where the Hg content is very dominant. The Hg content (estimated at 6 mg per appliance) is located in the backlights of these monitors. It is important to notice here that LCA methods do not represent local workplace conditions, which should be included in the overall assessment due to the relevance of workers health and safety in this case. When Hg is released to air, Maximum Acceptable Concentrations in the workplace (around a few µg/l or µg/m3) are violated easily. Note that there are no human toxicity characterisation values included for Hg in the Eco-Indicator'99 methodology, only ecotoxicity effects are included. See Annex 8.2.4 for more details. Based on these specific high outcomes, the proper removal of Hg can be regarded as highly relevant under these environmental impact categories.

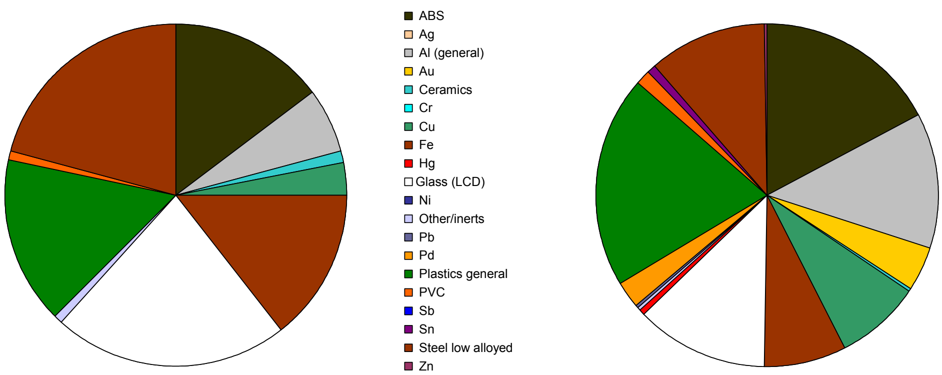

Figure 50: Weight versus Environmental Weight Cat. 4C IT FDP (EI'99 H/A)

Figure 50 shows less influence of the precious metals in LCD TV's. Despite the probable overestimate for Cat.3 the graphs are rather similar for the other substances. Again, even more than in the case of Cat.3C, the Hg content contributes roughly 75% of the total terrestrial ecotoxicity of this product category. The reason for this high contribution is due to the presence of multiple parallel mounted series of Hg backlights. In this case, it is calculated that the Hg content is around 75 mg for a large appliance (not reflecting the average screen size very well). It is known that in newer products the concentration is probably lower, but not much technical information is available on this at present. Again it should be noted that the

Hg impacts on workers health and safety cannot be reflected by the LCA method as the Hg emission contributes a very local impact which is, potentially, directly 'under the nose of a dismantler'.

8.2.4.3 Environmental Weight under Various Impact Categories

The next table shows the individual environmental impacts for each environmental impact categories for both the default treatment as well as the disposal with MSW (including worst case emissions from the Hg assumed to be emitted entirely to the air).

Category	**Cat.3B**		***Cat.3C***		**Cat.4B**		***Cat.4C***		
Indicator:	**Default**	**MSW**	***Default***	***MSW***	**Default**	**MSW**	***Default***	***MSW***	**Unit**
Weight	14.65	14.65	*5.08*	*5.08*	26.67	26.67	*28.30*	*28.30*	kg
Eco-indicator 99 H/A v203	-1.97	0.16	*-2.04*	*0.09*	-4.50	0.31	*-3.71*	*0.65*	Pt
Idem, Human Health	-0.68	0.08	*-1.48*	*0.05*	-1.92	0.16	*-1.95*	*0.29*	Pt
Idem, Ecosystem Quality	-0.179	0.031	*-0.106*	*0.059*	-0.348	0.064	*-0.085*	*0.267*	Pt
Idem, Resource Depletion	-1.11	0.05	*-0.45*	*0.00*	-2.23	0.09	*-1.68*	*0.10*	Pt
Cumulative Energy Demand	-323.12	16.97	*-251.54*	*2.03*	-645.93	32.95	*-811.26*	*40.84*	MJ-eq
Abiotic depletion	-0.169	0.008	*-0.114*	*0.002*	-0.330	0.015	*-0.406*	*0.018*	kg Sb eq
Global warming (GWP100)	-12.75	6.89	*-7.67*	*5.40*	-24.29	14.35	*-29.14*	*27.77*	kg CO2 eq
Ozone layer depletion (ODP)	0.0000	0.0000	*-0.0000*	*0.0009*	0.0000	0.0000	*-0.0000*	*0.0001*	kg CFC-11 eq
Human toxicity	1.39	14.69	*3.14*	*34.76*	24.12	30.92	*9.27*	*106.94*	kg 1,4-DB eq
Fresh water aquatic ecotox.	2.52	2.55	*3.07*	*6.98*	6.36	5.42	*10.49*	*24.21*	kg 1,4-DB eq
Marine aquatic ecotoxicity	-8,947	1,479	*-8,867*	*4,339*	-8,608	3,078	*-40,368*	*12,434*	kg 1,4-DB eq
Terrestrial ecotoxicity	-0.058	0.004	*-0.063*	*0.178*	-0.106	0.008	*-0.164*	*2.133*	kg 1,4-DB eq
Photochemical oxidation	-0.0065	0.0005	*-0.0163*	*0.0009*	-0.0216	0.0010	*-0.0302*	*0.0012*	kg C2H4
Acidification	-0.135	0.008	*-0.359*	*0.002*	-0.540	0.015	*-0.476*	*0.018*	kg SO2 eq
Eutrophication	-0.0051	0.0023	*-0.0038*	*0.0017*	-0.0090	0.0045	*-0.0122*	*0.0074*	kg PO4--- eq

Table 103: Results per environmental impact category Cat.3B,3C,4B,4C

Except for fresh water aquatic ecotoxicity, in all cases the 'saving from the waste bin' has a significant improvement. This becomes even more significant when taking into account the total numbers and weight of appliances in the overall WEEE stream, as will be discussed in Chapter 8.4.2.

8.2.4.4 Environmental and Economic Impacts for Average Collection and Treatment

In Table 104 and Table 105, the breakdown of environmental impacts (based on the default Eco-Indicator'99 single scores) and economic impacts (based on the 2005 average for the WEEE Forum long running systems) per stage in the recycling chain is displayed.

Category	**Cat.3B**			**Cat.4B**		
Process	**Total**	**Costs**	**Revenues**	**Total**	**Costs**	**Revenues**
Transport and collection (incl. access to WEEE)	€1.90	€1.90		€3.76	€3.76	
Other costs	€0.81	€0.81		€2.01	€2.01	
Shredding, sorting, dismantling, pretreatment	€6.19	€6.19		€9.93	€9.93	
Incineration and landfill	€0.11	€0.13	(€0.01)	€0.19	€0.21	(€0.02)
Recycling processes	€0.03	€0.05	(€0.02)	€0.06	€0.10	(€0.04)
Recovery processes	(€1.73)	€4.16	(€5.89)	(€1.86)	€7.56	(€9.43)
Total	**€7.32**	per piece		**€14.08**	per piece	
Total	**€0.50**	per kg		**€0.53**	per kg	
Category	***Cat.3C***			***Cat.4C***		
Process	***Total***	***Costs***	***Revenues***	***Total***	***Costs***	***Revenues***
Transport and collection (incl. access to WEEE)	*€0.66*	*€0.66*		*€3.99*	*€3.99*	
Other costs	*€0.28*	*€0.28*		*€2.13*	*€2.13*	
Shredding, sorting, dismantling, pre-treatment	*€7.70*	*€7.70*		*€13.96*	*€13.96*	
Incineration and landfill	*€0.09*	*€0.10*	*(€0.01)*	*€0.86*	*€0.89*	*(€0.03)*
Recycling processes	*€0.03*	*€0.04*	*(€0.02)*	*€0.09*	*€0.15*	*(€0.06)*
Recovery processes	*(€2.02)*	*€1.30*	*(€3.32)*	*(€3.59)*	*€5.83*	*(€9.42)*
Total	***€6.74***	*per piece*		***€17.44***	*per piece*	
Total	***€1.33***	*per kg*		***€0.62***	*per kg*	

Table 104: Economic impacts along the chain Cat.3B,3C,4B,4C

Category	**Cat.3B**			**Cat.4B**		
Process	**Total**	**Burden**	**Gain**	**Total**	**Burden**	**Gain**
Transport and collection (incl. access to WEEE) Shredding, sorting, dismantling, pre-treatment	0.071	0.071		0.125	0.125	
Incineration and landfill	0.005	0.039	-0.033	0.011	0.071	-0.060
Recycling processes	-0.002	0.056	-0.057	-0.005	0.103	-0.108
Recovery processes	-2.042	0.259	-2.301	-4.627	0.359	-4.987
Total	**-1.97**	Pts per piece		**-4.50**	Pts per piece	
Total	**-0.134**	Pts per kg		**-0.169**	Pts per kg	

Category	Cat.3C			Cat.4C		
Process	**Total**	**Burden**	**Gain**	**Total**	**Burden**	**Gain**
Transport and collection (incl. access to WEEE) / *Shredding, sorting, dismantling, pre-treatment*	0.027	0.027		0.154	0.154	
Incineration and landfill	0.005	0.030	-0.025	0.036	0.124	-0.088
Recycling processes	-0.006	0.044	-0.050	-0.007	0.166	-0.173
Recovery processes	-2.061	0.167	-2.229	-3.895	0.843	-4.739
Total	**-2.04**	Pts per piece		**-3.71**	Pts per piece	
Total	**-0.401**	Pts per kg		**-0.131**	Pts per kg	

Table 105: Environmental impacts along the chain Cat. 3B,3C,4B,4C

The economic analyses shows the high costs for manual dismantling resulting in much higher costs per ton (over EUR 1300/ton) for the relatively light LCD monitor in comparison with the other categories.

8.2.4.5 Eco-efficiency and Sensitivity Analysis

In Figures 51-54, the eco-efficiencies of various scenarios are displayed for the categories 3B,3C,4B,4C.

For the CRT based products, default treatment (A) is dismantling of the displays and further shredding and separation of the electronics. The scenarios A1 and A2 respectively show the WEEE Forum long running systems spread in costs. Scenario B illustrates the effect of increase in material prices comparing the current (April 2007) level with average 2005 price levels. Scenario C is the incineration with energy recovery instead of plastics recycling of the housings under the default scenario A. The scenarios D1 till D3 are the alternative destinations of the CRT glass respectively building industry, ceramic industry and secondary Cu-Pb-Sn smelter of which the latter includes only a partial dismantling of the housings and the complete rest including CRT processed in an integral way. These results are fully in line with earlier findings in (Huisman 2004b, 2005a).

For the LCD products, the scenario D represents complete shredding and separation of the appliances and scenario E, partial removal of the panel with destination hazardous waste landfill.

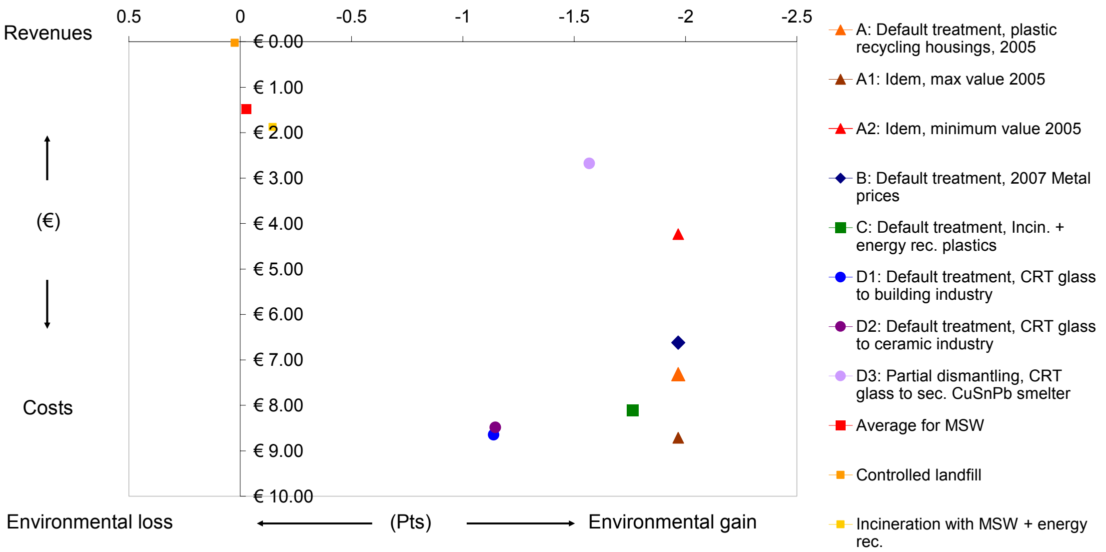

Figure 51: Eco-efficiency scenarios Cat.3B (EI'99 H/A)

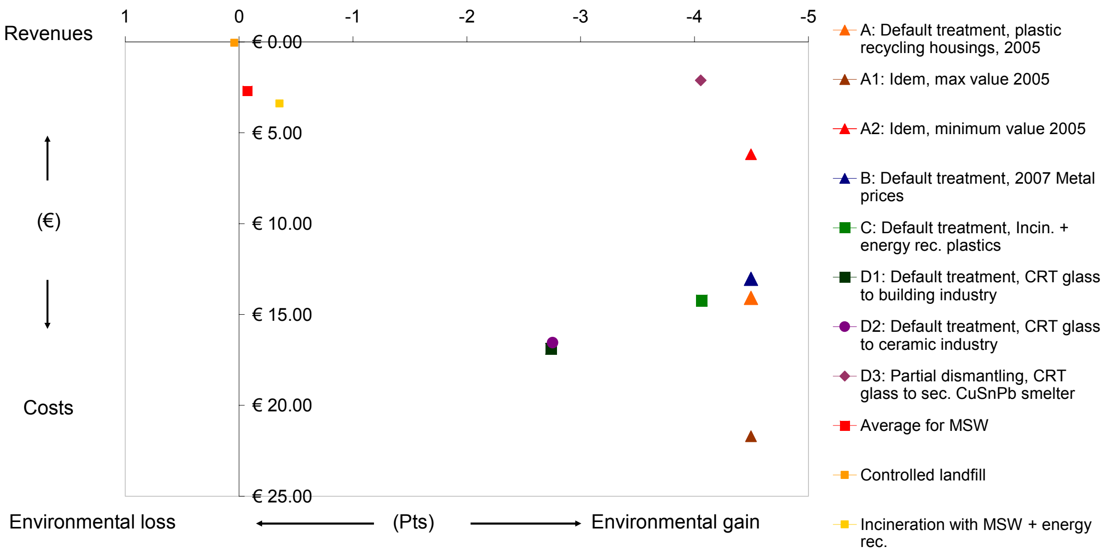

Figure 52: Eco-efficiency scenarios Cat.4B (EI'99 H/A)

Both graphs above demonstrate very similar outcomes for CRT Monitors and TV's. The average costs are around 500/ton (+/- 250), ranging with + 250/ton for the maximum (A2) to – 250 (A1). The effect of 2007 material prices (B) compared to the average leads to a costs improvement of 50/ton under the assumption that the prices for CRT glass are still at 2005 levels (no information available). Scenario C shows a clear environmental benefit of applying plastics recycling in the default scenario (A). The scenarios D1 till D3 show again like in (Huisman 2004c, 2005a), that the CRT back to CRT glass options are environmentally preferable over application in the building respectively ceramic industry at slightly better cost levels. Compared to the integral smelter option this is also environmentally preferable, however the latter is much more cost-efficient due to the reduced dismantling time (450s to 250s per CRT appliance). In Annex 8.2.3, the detailed data points are presented as well as the various calculated recycling and recovery percentages, QWERTY-recovered and QWERTY-loss values. Another important outcome is that the recycling percentages calculated for the scenarios A,D1-3 are the same under the present definition that all these operations are regarded a useful re-application of CRT glass. However, the environmental outcomes show a different preference in environmental level of re-application.

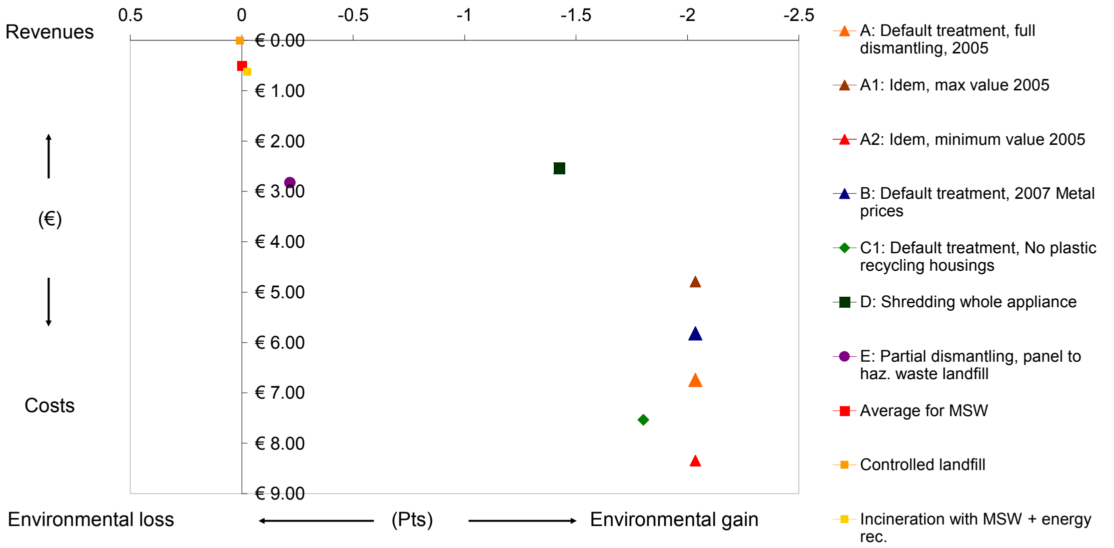

Figure 53: Eco-efficiency scenarios Cat.3C (EI'99 H/A)

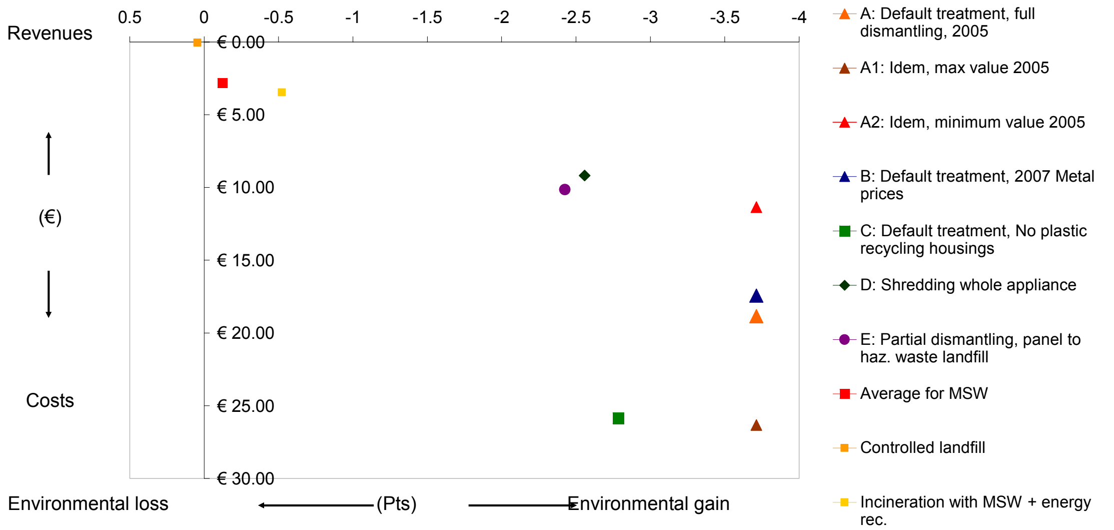

Figure 54: Eco-efficiency scenarios Cat.4C (EI'99 H/A)

The two graphs for the LCD containing appliances show similar outcomes. In both cases full dismantling is environmentally preferable, but in both these cases there are direct occupational health and safety risks due to the risk of mercury emissions at dismantling. Also direct shredding and separation is not currently a viable option as the same risks of mercury emissions will occur. Currently it is unknown whether the effects of shredding mercury containing WEEE will occur directly or slowly from contaminated fractions. In the case of partial dismantling and consigning the panels to hazardous waste landfill this risk could be controlled better, but then a substantial amount of material value cannot be recovered and recycling targets are not achieved.

Conclusions

The main findings for the CRT containing appliances are that as long as CRT back to CRT glass recycling can be done, this should be promoted over other 'useful' re-applications. However, further research is needed in particular to investigate the possibilities for future high re-applications as smelters and other options have limited capacity for treatment of large amounts of leaded glass. Moreover, the effect of the transition from CRT to FDP displays on the future discarding behaviour is unknown at present. For LCD containing appliances, no satisfactory full scale recycling operations have been identified yet. Full dismantling, partial dismantling (which still has a high risk of breakage), and shredding as described above, have similar negative effects on the environment and human health and cannot currently be recommended as suitable disposal routes. This means options that can enable proper control over the mercury contents as well as recovery of the valuable metal content still have to be developed. Without such further insights it is also not possible to give any design for recycling recommendation although easier dismantling of the Hg backlights could reduce dismantling costs significantly. There are additional concerns regarding how an easier dismantling system could have potentially negative impact due to accidental breakages during the collection and transportation phase.

The envisaged future application of LED instead of Hg backlights will reduce the risks related to Hg. However, these appliances with relatively long life time will return as waste for many years. In addition, the use of Gallium, Arsenic and Selenium might cause new toxicity related concerns. Further research on this is therefore recommended.

Analysis Lamps

8.2.5 Lighting Equipment - Lamps (Lamps)

8.2.5.1 Data and Assumptions

From Chapter 8.0.5.5 composition data is used. As a default recycling scenario is the treatment in a dedicated lamp shredding line connected to a mercury removal installation, including glass recycling of high quality content (see also Chapter 7.4). The average weight of a gas discharge lamps is based on (ELC 2007 a,b,c) assuming an average mix of TL, CFL and HID lamps. Costs data are again from the 5 WEEE Forum long running systems 2005. The QWERTY methodology using Eco-Indicator '99 H/A v203 is applied. Considering the almost 4.3 tonnes of mercury placed on the market annually, it is important to notice that there are no human toxicity values for mercury present in this method. Therefore special focus is on the environmental impact categories from CML 2: which are incorporated in this assessment and the human toxicity and terrestrial ecotoxicity impact categories. All other starting points, background data and calculation steps are described in Chapter 6.2.2.3.

8.2.5.2 Weight and Environmental Weight (per subcategory)

The below table shows the average weight versus the environmental weight of average gas discharge lamps. Note that the values below represent the difference between minimum and maximum environmental impact and do not represent a certain treatment scenario, but merely the environmental relevance of the individual materials present.

Material	Weight (g)	Material	Environmental Weight (%)
Ag	0.00027	Ag	0.0%
Al (general)	8.13	Al (general)	14.9%
Au	0.000025	Au	0.2%
Br	0.00012	Br	0.0%
Ceramics	0.54	Ceramics	0.19%
Cl	0.0053	Cl	0.00%
Cr	0.00026	Cr	0.00%
Cu	2.76	Cu	6.90%
Epoxy	0.19	Epoxy	0.31%
Fe	0.14	Fe	0.07%
Fluorescent powder	2.37	Fluorescent powder	1.52%
Glass (white - low quality)	9.85	Glass (white - low quality)	5.02%
Hg	0.0064	Hg	8.57%
Glass (white - high quality)	114	Glass (white - high quality)	54.98%
Ni	0.0014	Ni	0.01%
Pb	0.092	Pb	0.26%
Pd	0.000015	Pd	0.29%
Plastics general	3.03	Plastics general	3.45%
Sb	0.00074	Sb	0.00%
Sn	0.11	Sn	1.20%
Stainless steel	0.45	Stainless steel	0.97%
Steel low alloyed	2.25	Steel low alloyed	1.09%
Zn	0.017	Zn	0.06%
Total	**144**	**Total**	**100%**

Table 106: Weight versus Environmental Weight (EI99-H/A) Cat.5B

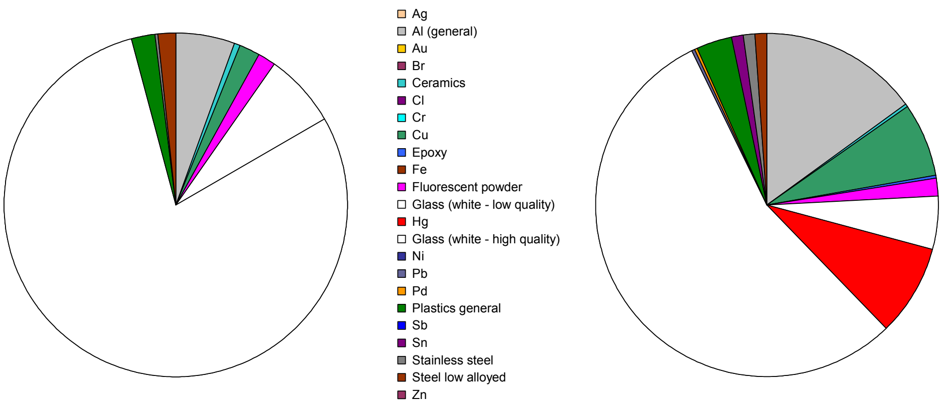

Figure 55: Weight versus Environmental Weight Cat. 5B Lamps (EI'99 H/A)

Figure 55 shows that for the chosen environmental assessment model, the glass is relatively higher in importance than other materials in the environmental pie chart. Although mercury has a high impact despite the relatively low concentration that it is found within lamps (even in the Eco-Indicator'99 values, which is due to the ecotoxicity values only). In the below graph, the CML-2 terrestrial ecotoxicity is shown. Besides this graph, in Annex 8.2.5, all environmental weight graphs are presented for all impact categories described in Chapter 6.2.2. Here it can be seen that the mercury content is particularly relevant for the different environmental impact categories addressing toxicity and in particular in the case of terrestrial ecotoxicity, the Hg content has an extremely high contribution.

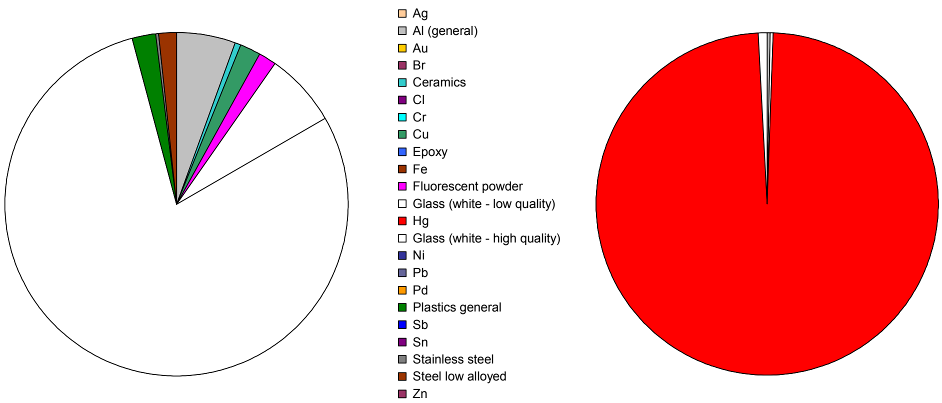

Figure 56: Weight versus Environmental Weight Cat.5B Lamps (CML2 Terrest. Ecotoxicity)

8.2.5.3 Environmental Impact under Various Impact Categories

For cat.5B, the actual results per environmental impact category are demonstrated for both the default treatment scenario as well as the worst-case scenario of disposal with MSW (assuming full Hg emission to the air).

Indicator:	Default treatment	MSW	Unit	Method
Weight	0.144	0.144	kg	Average weight per piece
Eco-indicator 99 H/A v203	-0.0163	0.0052	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Human Health	-0.0052	0.0005	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Ecosystem Quality	-0.0016	0.0043	Pt	Eco-indicator 99 (Pre, 2007)
Idem, Resource Depletion	-0.0095	0.0005	Pt	Eco-indicator 99 (Pre, 2007)
Cumulative Energy Demand	-2.727	0.1660	MJ-eq	CEDv103 (Pre, 2007)
Abiotic depletion	-0.0014	0.00008	kg Sb eq	CML2 v203 (CML 2004)
Global warming (GWP100)	-0.155	0.018	kg CO2 eq	CML2 v203 (CML 2004)
Ozone layer depletion (ODP)	6.9E-09	2.3E-08	kg CFC-11 eq	CML2 v203 (CML 2004)
Human toxicity	-0.325	0.435	kg 1,4-DB eq	CML2 v203 (CML 2004)
Fresh water aquatic ecotox.	-0.028	0.058	kg 1,4-DB eq	CML2 v203 (CML 2004)
Marine aquatic ecotoxicity	-204	185	kg 1,4-DB eq	CML2 v203 (CML 2004)
Terrestrial ecotoxicity	-0.000	0.182	kg 1,4-DB eq	CML2 v203 (CML 2004)
Photochemical oxidation	-0.000048	0.000005	kg C2H4	CML2 v203 (CML 2004)
Acidification	-0.00083	0.00007	kg SO2 eq	CML2 v203 (CML 2004)
Eutrophication	-0.00004	0.00001	kg PO4--- eq	CML2 v203 (CML 2004)

Table 107: Results per environmental impact category Cat.5B

A further description of the above environmental impact categories can be found in Chapter 6.2.2. The results of Table 107 will be compared with the other product and treatment categories in Chapter 8.4.2. For all the above environmental impact categories, the default treatment scenario is a clear environmental improvement over not treating these products, even including all environmental impacts of the transport and further processing. The benefits from treatment will also be multiplied later with the potential total amount of WEEE arising from Chapter 7 in Chapter 8.4.2.

8.2.5.4 Environmental and Economic Impacts for Average Collection and Treatment

In the next table, the breakdown of the environmental and economic impacts is presented. The total costs per ton are estimated at around 660. The range of treatment costs for the long running system will be displayed in the next section.

Process	**Total**	**Costs**	**Revenues**	**Total**	**Burden**	**Gain**
Transport and collection (incl. access to WEEE)	€0.037	€0.037		0.0007	0.0007	
Other costs	€0.009	€0.009				
Shredding, sorting, dismantling, pre-treatment	€0.014	€0.014				
Incineration and landfill	€0.001	€0.001		0.0000	0.0001	-0.0001
Recycling processes	€0.000	€0.000	(€0.000)	0.0000	0.0001	-0.0001
Recovery processes	€0.034	€0.055	(€0.020)	-0.0170	0.0022	-0.0192
Total	**€0.10**	per piece		**-0.02**	Pts per piece	
Total	**€0.66**	per kg		**-0.113**	Pts per kg	

Table 108: Environmental and economic impacts along the chain Cat.5B

8.2.5.5 Eco-efficiency and Sensitivity Analysis

In Figure 57, the eco-efficiency of various scenarios are displayed. Default treatment as described above is reflected with point A. The environmental benefits compared to the MSW points are substantial. The minimum value (A1) shows a value of around EUR 400/tonnes until the maximum value reaches EUR 1000/tonnes. The effect of 2007 metal prices (B) is marginal (EUR 20/t). Obviously, both the scenario of not recovering the Hg content (C1) and not recycling the glass (D) have a net negative environmental effect. In Annex 8.2.1, the detailed data points are presented as well as the various calculated recycling and recovery percentages, QWERTY-recovered and QWERTY-loss values.

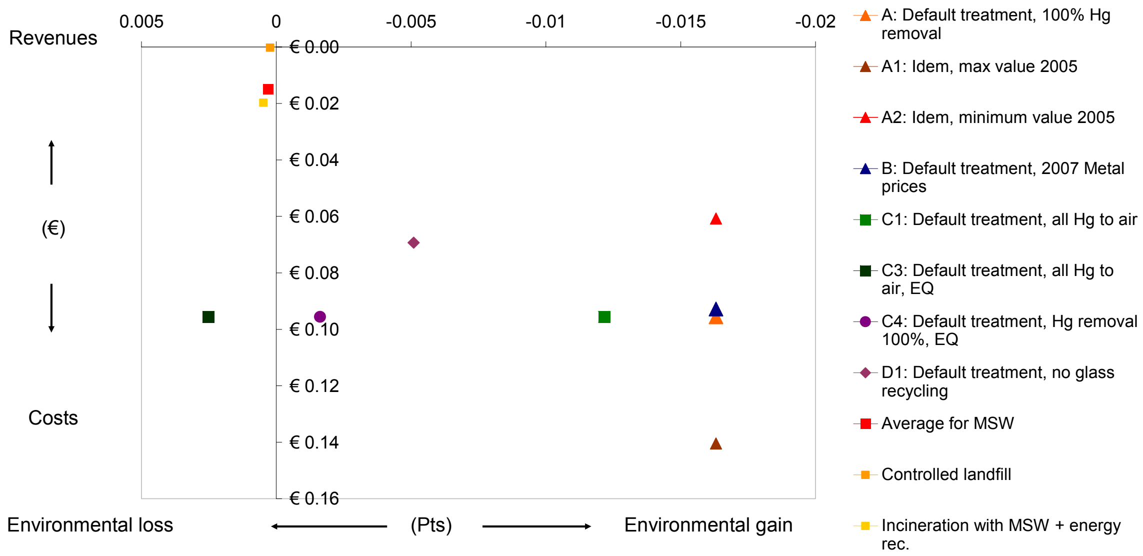

Figure 57: Weight versus Environmental Weight Cat.5B Lamps (EI99 H/A)

Conclusions

The main findings for the lamps of cat.5B which, due to the high Hg content, is the need to have a high mercury recovery which is crucial from an environmental perspective. This can be realised in practice by collecting them as many as possible and by treating them properly with a high mercury removal efficiency. Also the glass recycling appears to have a positive result, although it is clearly ranked second after Hg removal.

The results for the different product and treatment categories will be evaluated in Chapter 8.4.2 where the different environmental impacts will be compared with each other based on both single indicators as well as per individual environmental impact category.

8.3 Social Screening (Evaluation) of the Implementation (Task 1.1.3)

Information Summary Social

8.3.1 Employment and Labour Market

Affecting Specific Groups

The income generated by the collection and dismantling of WEEE is often referred to as a good job opportunity for disadvantaged people in the first labour market (RREUSE 2006a, p. 2, WILLIAMS 2006). According to an Impact Assessment of the WEEE Directive in Lithuania (ECGL 2003, p. 6) various projects illustrated that WEEE dismantling appears particularly suitable to integrate long-term unemployed and disabled. A report of the Dutch ROS-plus model supports this thesis, but also mentions young people that do not possess any school-leaving qualifications (E&D 1999, p. 12). A Finnish study extends the suitability to the homeless (YLA-MELLA 2004). A German study emphasises the importance of social enterprises for the integration of physically and mentally handicapped persons (STAPEL 2003).

In addition, some analysts argue that reuse also offers essential household items for people with low incomes to raise their standards of living and to participate in social activities, bridging the “digital divide” or delivering necessary means of communication for commercial or cultural purposes (RREUSE 2006a, p. 2).

A general report of the Directorate General Environment of the European Commission on waste management in Europe (DG ENV 2001a) indicates that information on the nature of waste management employment is limited and appears somewhat contradictory. Some studies indicate that jobs are of a higher quality in waste management than in some other environment-sector activities. Other data indicate that waste management jobs are mainly low-skilled and low-paid. The poorest quality jobs appear to be in collection and transport, manual sorting and composting, whilst higher-quality jobs are associated with the more technology-intensive, specialised activities, but it is not yet clear if this contradiction also applies to the WEEE sector.

The analysis of the returned questionnaires supports the thesis that the implementation of the WEEE Directive is particularly affecting workers involved with the manual collection, dismantling, refurbishment and repair of WEEE. This research also illustrates the importance for high-qualified experts such as legal and marketing consultants, researchers and trainers, to which the available literature is not yet referring.

During the expert-workshop no particular group was highlighted as being particularly affected by the Directive, but reference was made to an unnamed British study, which concluded that all stakeholders (producers, distributors, consumers, local authorities, recycling operators, businesses, charities) are affected by the Directive from a social aspect, logistical operators.

But in summary, solid evidence for affected groups is not yet available, although there seems to be common agreement on a certain importance for less-qualified persons in the WEEE collection and treatment.

Job Creation & Losses

A general study of Directorate General Environment of the European Commission (DG ENV 2001a) on waste management points to the poor quality information of statistical data collected at the European level on waste management-related employment because of (i) classifications which exclude a wide range of waste related activities; and (ii) few countries submitting regular, up-to-date information. The same study estimates that the level of employment in the EU in organisations for which waste management is a primary activity totals around 200,000 to 400,000. This represents approximately 0.2-0.4% of total EU employment. There is also waste-related employment in other sectors, but the number of jobs is small compared to the specialised waste management sector (possibly another 3000 to 12000 jobs).

In a Communication of the Commission on the thematic strategy the waste management and recycling sector in the EU25 is considered to be rather labour intensive with 1.2 to 1.5 million jobs (COMMISSION 2005).

The same DG ENV (DG ENV 2001a) study says that data on trends in employment in waste management are ambiguous. Industry experts indicate that there is a general trend towards fewer, but higher quality jobs arising from productivity increases as processing technologies improve. For individual companies, higher waste management costs could potentially increase prices, reduce market share, lower output and potentially reduce employment. The trend for lower employment per tonne of waste may, however, be compensated by a growth in absolute waste quantities and potentially by increasing levels of control over waste disposal (DG ENV 2001a). But there is no statistical evidence for this yet. In contrast, NeWET (2001, p. 98) argues that it is already proven that collection, disassembly and recycling leads to jobs for less-qualified workers.

Data on the employment effects of the WEEE legislation are limited; in Lithuania it has been estimated that 290 jobs have been created (ECGL 2003, p. 7). Early assumptions of NeWET from 2001 speak of approximately 3,870 jobs being created under the implementation of the WEEE Directive in Germany. In the Netherlands, the consensus is that few, if any, jobs have been created other than a small number in local authorities. Additional employment in administration of the collective schemes has been kept to a minimum to reduce costs. Meanwhile, the organisation of the collective schemes has resulted in significant consolidation in the recycling sector with the displacement of small organisations, including social welfare organisations. The loss of jobs in these small organisations has probably been offset by increases in employment in the larger firms to deal with additional throughput of WEEE (DG ENV 2001a, p. IV). Already in 2000, initial studies emphasised the high-competition on the WEEE disassembly and recycling market, also leading to the closing down of companies (HANKE 2000). Whether there are evidences to confirm this thesis after the implementation of the WEEE Directive has not yet proven.

RREUSE, the European network of national and regional social economy federations and enterprises, states that at least 40.000 jobs for long-term unemployed, handicapped or people at risk are created in the reuse and recycling branches. Given the size of their market share, RREUSE considers this a remarkable sector for employment opportunities for people with limited chances elsewhere. (RREUSE 2006a)

Some German experts see the danger that the number of social enterprises for WEEE disassembly will substantially decrease in the coming years due to the necessity to implement the latest techniques as it is already common in the manufacturing processes in Asia. Hence, small companies without strategic partners will not survive the growing competition in the recycling market (FRICKE 2006).

Although waste management policies may increase demand for waste management services, this does not necessarily result in additional jobs. The interdependencies are rather complex and not yet satisfactorily examined. Technology substitution for labour, increased productivity and consolidation in the waste management sector may severely constrain job creation. There is also some evidence in waste management, that these factors could actually reduce employment opportunities for the socially excluded.(DG ENV 2001a, p. VI). In consequence it must also be questioned whether there is any evidence of the net-generation of 30 jobs in recycling-companies with an annual turnover of EUR 5 million (or per EUR 50,000 annual turn-over one job) (NeWET 2001) as was suggested by the European Commission when it introduced the draft WEEE to the European Parliament

Increased recycling creates jobs, as recycling 10,000 tonnes of waste needs up to 250 jobs compared with 20 to 40 jobs needed if the waste is incinerated and about 10 for landfill. Taking into account the reduced job creation in the extraction and production of virgin materials this should result in a limited net creation of jobs (COMMISSION 2005).

Also the analysis of the returned questionnaires has not given a clear answer. Although twenty-three of thirty-one respondents answered that the implementation of the WEEE Directive facilitated the creation of new jobs, the total sum is below 500, of which app. 50% are permanent. Twenty-five of thirty respondents also emphasised that the implementation of the WEEE Directive also facilitated the loss of jobs, especially in manual work. The total sum of lost jobs also goes into several hundreds. As a result, according to the returned questionnaires the net-effect between creation and loses might be zero, but less-qualified workers seem to be disproportionately disadvantaged.

In contrast in the SME Panel 158 of 162 respondents answered the question of whether the WEEE Directive leads to the creation of jobs with "Yes", whereas thirty-nine of forty-nine answered the question on losses of jobs with "Yes".

A. Employment and Labour Market	**Questionnaire**		**SME Panel**		**TOTAL**	
1. Does the implementation of the WEEE Directive facilitate new job creation in your company/organisation?						
Yes	23		158		181	
No	8	31	4	162	12	193
5. Does the implementation of the WEEE Directive facilitate loss of jobs in your company/organisation?						
Yes	5		39		44	
No	25	30	10	49	35	79

Table 109: Creation & Loss of Jobs

During the expert-workshop it was mentioned that refurbishment, resale and reuse of equipment does lead to the creation of jobs, but given that the current WEEE Directive does not affect reuse as an option for treatment as reuse of whole appliances takes place before EEE becomes WEEE and thus would not be caused by the Directive itself at this stage.

In summary, solid evidencs for either the creation or loss of jobs because of the implementation of the WEEE Directive is not yet available. But there seems to be common agreement that so far the effects are relatively low, although less-qualified workers may be disproportionately disadvantaged.

8.3.2 Health and Safety Standards

Improper recycling of WEEE can mobilise harmful substances. According to Hanke et al. (2001) special treatment is necessary in especially two areas: a) dismantling and b) shredding.

Negative health effects can occur in the process of dismantling cathode ray tubes (CRT) and circuit boards. Hence (Hanke et al. 2001) call for an assessment of the efficiency of venting chambers / cabins and clear rules for their usage. Moreover they recommend the clear separation of dismantling and treatment of cathode ray tubes, short cleansing intervals in order to reduce the arisings of dust that could contain harmful substances such as cadmium. In the eyes of Hanke et al. the same might apply for workers in repairing companies, which has to be justified by the respective authorities (Hanke et al. 2001, p. 129).

For shredding, the health effects are not considered to be as severe as for CRT dismantling. This is also due to improved protective clothing, shortened cleansing intervals with industrial vacuum cleaners instead of brushes, clear framing of certain working areas, and last but not least the utilisation of water curtains to avoid dust transport (IBID, p. 130).

In the available literature special action is only seen to improve skin protection programmes in addition to continuation of preventive measures and information.

Twenty-three of thirty respondents to the questionnaire do not see that the implementation of the WEEE-Directive results in any new measures in their companies/organisation affecting health and safety standards (e.g. safety regulations, introduction of technologies…). The seven respondents answering with "Yes" see these measures mainly in

1. More damaged appliances due to new collection scheme – difficult, risky to unload, increased contamination,
2. Personal protection measures, improved treatment tools, following ISO instructions, very coarse dismantling possible.

Once again in contrast to the questionnaire the SME panel found that out of ninety-eight respondents twenty-one feel that it resulted in new measures.
In summary, solid evidence that the implementation of the WEEE-Directive has resulted in any new measures in companies/organisations affecting health and safety standards is not yet available. As stressed during the expert-workshop one reason is certainly that health & safety issues are addressed in separate legislation as well. As a result there is a need for the WEEE Directive to be harmonised with relevant health and safety legislation. There was common agreement that health and safety issues are of high importance inrecycling centres (when dismantling appliances) and for refurbishing centres (when preparing appliances for reuse).

8.3.3 Social Environment including Training/Capacity Building and Awareness Rising

Information & Campaigning

To encourage the public to bring their old EEE to the appropriate recycling centre consumers should be informed about the environmental impacts they cause by using and discarding EEE (EHSNI 2005). For some, the success of a WEEE programme will in part be dictated by the clarity with which it can be explained to the consumer and the ease with which the consumer can engage with the collection and financing system (IPTS 2006, p. VIII). They also should be informed about possibilities for reducing these impacts, such as existing take-back systems. An important role is seen for local authorities in this awareness raising (ACRR 2003, p. 81), but also for producer responsibility organisations (IIIEE 2004, p. 196), consumer associations and NGOs (EEA 2003, p. 40). Nevertheless, some authorities also point to the fact that a high level of consumer awareness does not necessarily lead to the highest WEEE collection volumes (IPTS 2006, p. 43). In addition local authorities and governments are criticised in Germany for not substantially informing consumers about proper ways of e-waste disposal. The German Association for Environmental Consultancy calls for clear definitions of who informs and who monitors. It also suggests laying down funding for the authorities in charge of awareness rising when approving a new EU Directives (BFUB 2006).

The European Environment Agency (2003, p. 40) recognises the importance of information campaigns that can be launched in co-operation with consumer associations and NGOs. Industry can support these activities by publishing product information about the environmental performance. Eco-labelling systems can be implemented to increase transparency on the market. Information on sustainable consumption patterns can be integrated into the education system.

The range of reported communication activities used by two Northern Ireland pilot schemes included newspaper advertisements, leaflets, special internet-websites and branding through the provision of the pilot-project's logo. One outcome of the accompanying background research was that app. 80 percent mentioned local recycling centres as their preferred method of disposal in contrast to asking the community to collect large items and bring small WEEE to recycling centres, community collecting WEEE, and retailer take-back (EHSNI 2005, p. 51).

In the Netherlands, the NVMP-System builds on consumer motivation through a free-of charge phone number, a website, TV-spots, and leaflets for school collection campaigns and local collection tests. In addition the visible fee on different selected goods is seen as another awareness-rising mean (E&D 1999, CANNEMAN 2006).

In addition to the above mentioned means in Northern Ireland and the Netherlands, Irish campaigns also used radio advertisements and community newsletters (EPA Ireland 2003, p. 115ff) A study by the Clean Technology Centre of the Cork Institute of Technology for the Irish Environmental Protection Agency suggests campaigns to educate and encourage people to buy recycled EEE could be used to counter the perception that recycled goods are inferior (ibid, p. 76). This study also recommends using existing methods for raising public awareness of the potential to recycle items, but in particular smaller items, as these are often discarded with general household waste (ibid, p. 184). Moreover, it highlights two main issues for public campaigning: (i) the development of a single, national WEEE website and (ii) the development of a coordinated strategy for communicating with the public and stakeholders on the introduction of the WEEE Directive (ibid, p. 194).

British comments illustrate the need for extensive information campaigns, as the majority of those questioned were unaware of the WEEE Directive, which will make it mandatory for consumers to responsibly dispose of their old gadgets (BBC 2005).

Eighteen of twenty-nine respondents to the questionnaire answered with "Yes" that the implementation of the WEEE-Directive results in a new need for campaigning of companies/organisations. These activities are mainly centred around providing background information, the need for training and guidance, advertise/lobbying/PR/marketing through presentations, studies, handbooks, sensitisation, coordination, and registration/contracting/ embedding in national implementation schemes.

This question was not addressed in the SME Panel.

During the expert workshop it was stressed that according to the Directive the governments have the requirements to raise awareness but they pass it on to producers. As awareness raising costs money, it is very important to clarify who bears this responsibility. Moreover experts agreed for the need to clearly distinguish between awareness raising and advertising, because awareness raising has the objective of changing consumer's behaviour.

In summary, there is common agreement that training/capacity building and awareness raising, information & campaigning are elementary for a successful implementation of the WEEE Directive, but require clarifications and enforcements of the responsibilities laid down.

Training

The diversity of working activities in the Dutch ROS-plus model or in the British CREATE leads to a multitude of work experience. This can lead to further duties and functions within

ROS-plus, CREATE or elsewhere in the employment market (E&D 1999, p. 12, EPA Ireland 2003, WILLIAMS 2006).

NeWET stresses the necessity to qualify employees according to a) their own qualifications and experiences and b) which duties they perform with the recycling or refurbishment processes. As a result they pledge to provide training on the subject, social and methodological competences (NeWET 2001, p.101).

Social companies such as the Austrian DRZ are training long-time unemployed and disadvantaged persons for reintegration into the job market (DRZ 2007).

Both, the questionnaire and the SME Panel did not generate usable results on this issue.

In summary, despite carrying out a few sample surveys there is hardly any information available on the training needs resulting from the implementation of the WEEE Directive.

Changes of Behaviour

Consumers represent the demand side in the market system. They can influence product design, increase the demand for eco-efficient services, buy long-life products or stop buying needless products. As stated in the Commission Staff Working Paper on the Extended Impact Assement of the Battery Directive, the consumer determines the rate of participation in any scheme and thus the final collection rate (COMMISSION 2003).

The European Environment Agency, Digital Europe and ACRR highlight product leasing or selling services as an approach to saving raw materials and resources instead of selling products (EEA 2003, p. 40, ACRR 2003, p. 80). The leasing approach is realised by producers of copiers, for example, Xerox and Kodak. The copier in use remains the property of the producer. It is therefore in the producers' interest to extend the life span of the product. End-of-life products are returned to the producer thus encouraging them to develop efficient reuse and recycling strategies. Xerox reuses up to 60 % of end-of-life copiers in the production of new machines. Other parts of the old equipment are recycled so that the remaining waste from end-of-life copiers is reduced by 90 %.

Pilot-studies in a few selected public and private enterprises in Brussels aiming to assess energy and paper saving potentials by proper use, factors influencing consumption and ways to modify consumption identified three potential scenarios for improvement:

1. Awareness and education of employees,
2. Introduction of new technologies and eco-efficient tools,
3. Reflection on the structural organisation and the management of information flows for the whole organisation.

The finding of these pilot-projects is that through making the most of existing tools, a reduction of 10-30 percent of energy and paper was possible. The main deficiency is that employees have only limited knowledge of the methods available for achieving these improvements.

Neither the questionnaire nor the SME Panel generated any usable results on this issue.

In summary, despite the above examples there is a lack of information available on approaches resulting from the implementation of the WEEE Directive, that are aimed at changing consumer's behaviour.

8.3.4 Digital Divide

The use of cheaper used appliances offers an important means for people with low income to raise their standards of living and to participate in social activities, bridging the "digital divide" or delivering necessary means of communication for commercial or cultural purposes. But the "digital divide" is a growing problem between the post-industrialised and transition countries and developing countries (MOCIGEMBA 2006).

Unfortunately, recent studies of e-waste exports showed that all too often reuse is claimed for activities, which turn out to be nothing more than illegal dumping of hazardous wastes or recycling of materials while greatly endangering the health of local people as well as the environment. That is why reuse activities must follow clear environmental and social standards, making sure that people engaged in reuse are working under favourable conditions, the activities are environmentally sound and the reused products are of high quality and fulfil high standards of functionality as well as security.

To tackle the problem with "sham reuse", the criteria for exports, especially of WEEE or non-waste used EEE should be clarified. Though all EU member states are parties to the Basel Convention and the Basel Ban Amendment, banning the export of hazardous wastes to developing countries for disposal and for recycling, recent investigations have proved that outdated, non-functioning and non-repairable equipment from these countries are showing up in Asia and Africa (RREUSE 2006a, p. 4).

Although illegal waste exports from the EU to developing countries seem to be quite common, there are also legal loopholes for the export of used equipment, because there are no criteria for reusability. Thus, the provisions of the WEEE Directive for the control of exports have to be properly developed, making sure that not only recycling outside the EU has to follow EU standards, but also exports for reuse are only possible when reuse and adequate treatment of non-reusable parts are guaranteed (OECD 2005, p. 34).

The analysis of the returned questionnaires show that contributions to equal access to IT services and goods for the entire society mainly centre around

- Charity: donation of (2nd hand) equipment,
- Support of NGO or non-profit-organisation, campaigning,
- Remarketing, recycling, repairing, exporting, reselling, reuse.

But the majority of respondents do not see any influence due to the implementation of the WEEE Directive.

In summary, evidence that the implementation of the WEEE Directive has an input, either negative or positive, on the digital divide, does not yet exist.

8.4 Conclusions and Recommendations

8.4.1 Economic Impacts of Total WEEE

Economic Impacts

The assessment of economic impact of WEEE Directive on different stakeholders has highlighted a few crucial aspects that need to be taken into account for the future development, simplification and improvement of policy measures like the WEEE Directive.

Administrative Burden

Looking at "internal" economic impacts on stakeholders, the Administrative Burden Survey highlighted a number of areas where the burdens experienced by stakeholders could be reduced.

These areas are:

- Consistency in legislative requirements across Member States and an increase of traceability of legislative requirements, especially for small and medium sized stakeholders,
- Consistency in registering and reporting activities across Member States, especially on information to be submitted, frequency of reporting, basis for reporting (unit, weight, etc) and definitions (weight, B2B/B2C split, producer/distributor, etc), and
- Increase stakeholder awareness of specific responsibilities and clearly address the activities that need to be carried out. This report has found that large number of SME's do not know their current legal obligations or sometimes even about the existence of the Directive as such.

The main issues highlighted refer to the achievement of a level playing field for all the different stakeholders involved in the end-of-life chain, especially across different Member States (increasing harmonization) and in respect of different stakeholders' size.

The capability of stakeholders involved to quantify in economic terms the administrative burden (when experienced), is very low, especially considering the aspects highlighted in Chapter 6.2.1.

The assessment of economic impact of the two activities (registering to National Register and Reporting) pointed out as the most crucial ones in the Administrative Burden Survey, highlighted the following main aspects:

- Total Burden across EU27 for registering and reporting activities ranges from EUR 36.7 million to EUR 42.8 million under the baseline assumption of 8 hours for each reporting activity reporting. This cost burden rises up to EUR 66,8 million to EUR 73 million when it is assumed it takes 16 hours for each reporting activity,
- The potential number of reporting activities across EU27, according to data provided officially by National Registers and completed with a "minimum requirements" assumption provide an average estimate of 72 reports to be delivered each year,
- The yearly economic impact of reporting activities on each single producer (depending and influenced by the number of reporting activities required in each Country and labour wage), under the assumption of 8 hours/reporting, ranges from EUR 2.500 per year for Germany to EUR 14 per year for Romania. The main aspects that need to be fully taken

into account are the potential impacts (at system level) of bad/missing reporting when the main difficulty experienced by stakeholders was not restraints on money but time and infrastructures. Furthermore, economic consequences (penalties) for potential bad/missing reporting could increase the economic burden for stakeholders,

- The impact of investments in IT infrastructure in order to optimise reporting activities across EU27 has a potential benefit on economic impact of reporting (reducing the number of hours needed to fulfil activities – down to 16 hours/year for reporting across EU27). On the other hand, such internal optimisation is not affordable for SMEs (investments needed ranged up to a couple of million euros, according to figures provided by specific stakeholders), and
- The potential threat of competition distortion due to deliberately reporting of B2C as B2B, empty reporting without further action or simply not reporting is very real and has a potentially severe impact on those companies investing in full and EU-wide legal compliance.

Many of the issues pointed out in the previous paragraph steers towards the urgent need for development of a EU-wide harmonized approach. Currently, some of the National Registers of producers are trying to develop a common dataset of definitions and procedures that when implemented across EU, could be of help in decreasing or removing some of the causes of administrative burden. Furthermore, the effectiveness of reporting activities at EU level, control and assessment of take back and recycling performances across Member States could be improved EU-wide. Pressure from the Commission is clearly needed to speed up these processes.

Costs along the Recycling Chain and Total Costs

Looking at the economic impact for take back activities and costs along the chain, it needs to be highlighted that the current lack of consistent datasets for the EU27 is a reality. This is due to late transposition of the WEEE Directive in different Member States, and delays in implementation and start-up of the systems. Despite this, from the amounts of WEEE arising multiplied with the current 2005 collection percentages and the estimated maximum percentages for a full implementation (2011 scenario), the total economic impact is calculated. See Chapter 8.0.5 Table 55 – 57 for a further description.

The start-up effects on costs (both technical costs and additional costs) are still significant across different Member States, as highlighted in chapter 8.1.2. Furthermore, differences in national legislative requirements, and agreement in the implementation phase (addressed as "influencing factors" on costs structures), contribute to increase the gaps between minimum and maximum costs levels.

Under the assumptions of going from the current status (2005 collection %) to a full implementation (2011 maximum achievable collection %) of the WEEE Directive across the EU27, estimation of the economic impact for take back and treatment of WEEE arising is made: The total cost increase according to Table 110 roughly from EUR 0.9 billion in 2005 towards EUR 2.4 billion in 2020. The technical cost increase from EUR 0.7 billion (2005) to EUR 2.0 billion (2011). In the below table, it should be remembered that technical costs include costs for collection (including remuneration of collection points, where needed), costs for tranportation and costs for treatment. Total costs also include all additional costs as kick back from distribution chain, costs for levying funds, PR, R&D costs and all other costs descrbed in Chapter 8.1.2.

	Technical Costs [Million EUR]		Total Costs [Million EUR]	
Year	Current Collection%	Maximum collection%	Current Collection%	Maximum collection%
2005	**764**	1,692	**935**	2,045
2006	783	1,735	959	2,097
2007	803	1,780	984	2,151
2008	824	1,825	1,009	2,206
2009	845	1,872	1,035	2,262
2010	867	1,920	1,061	2,321
2011	889	**1,970**	1,089	**2,381**
2012	912	2,021	1,117	2,443
2013	936	2,074	1,146	2,506
2014	961	2,128	1,176	2,572
2015	986	2,184	1,207	2,640
2016	1,012	2,242	1,239	2,710
2017	1,039	2,302	1,272	2,782
2018	1,067	2,363	1,306	2,856
2019	1,095	2,426	1,341	2,933
2020	1,125	2,492	1,377	3,012

Table 110: Overall Economic Impact across EU27 assuming FULL implementation

The assumptions of full implementation have been made in order to assess the potential impact when all Member States are collecting, the actual maximum kg per head found across different Member States. These assumptions enable to assess the impact of the current delays in transposition and implementation in most Member States.and thus finally the effect of the WEEE Directive over time. In order to illustrate the effect over time, as the 2011 full implementation is an important assumption, also the numbers for the the other years till 2020 are presented.

The main aspects to be highlighted in order to get more insights into the breakdown and future influencing factors on these figures could be summarized as follows:

- The impact of additional costs on total take back costs represents a considerable percentage across different categories. Such costs need to be addressed and analysed taking into account the "impact factors",
- The impact of long running optimization of systems, plays an important role on the cost side. Looking at long running systems across EU, except for specific cases, the gap between minimum and maximum cost levels (both technical and additional) is much lower, and
- The percentage of WEEE collected and treated versus the potential amount of WEEE that potentially can be collected in the EU27 plays a crucial role in respect of overall economic impact on stakeholders responsible for financing.

Furthermore, economic impacts of WEEE take back and treatment are influenced, as pointed out in Chapter 8.2, by:

- The future developments of treatment technologies, as well as different treatment/dismantling requirements for particular product streams

- Changing product compositions over time which has not been taken into account in the 2011 calculation (like the amount of collected CFC containing appliances decreasing or the change from CRT to flat panels), and
- Developments of markets for downstream fractions and high-level re-application/valorisation of secondary raw materials.

8.4.2 Environmental Impacts of Total WEEE

Environmental Impacts

Based on data from Chapter 8.2 and all assumptions mentioned in the previous section, all results generated are compared and summarised according to:

- Environmental impacts per piece for collection and treatment versus 'MSW',
- Contribution of the categories to the total impacts of WEEE arising,
- Ranking of different product per kg per environmental impact category,
- The total impacts of WEEE from 2005 to 2011.
- Eco-efficiency analysis per treatment category.

Environmental Impacts of Recycling versus Disposal

In Figure 58, the environmental impacts per average piece of equipment are presented for the default recycling scenario versus disposal with MSW (or not recycling them, for large appliances). Due to the high contribution of the GWP and ODP effects in the Human Health, part of the single score Eco-Indicator'99 values, Cat.1B clearly has the highest total impacts due to the benefits of avoiding CFC emissions by collecting and treating properly. As the average weight per appliance in the category is obviously influencing the outcomes, therefore the same graph is also shown in Figure 59 per kg of average appliance representing the WEEE categories.

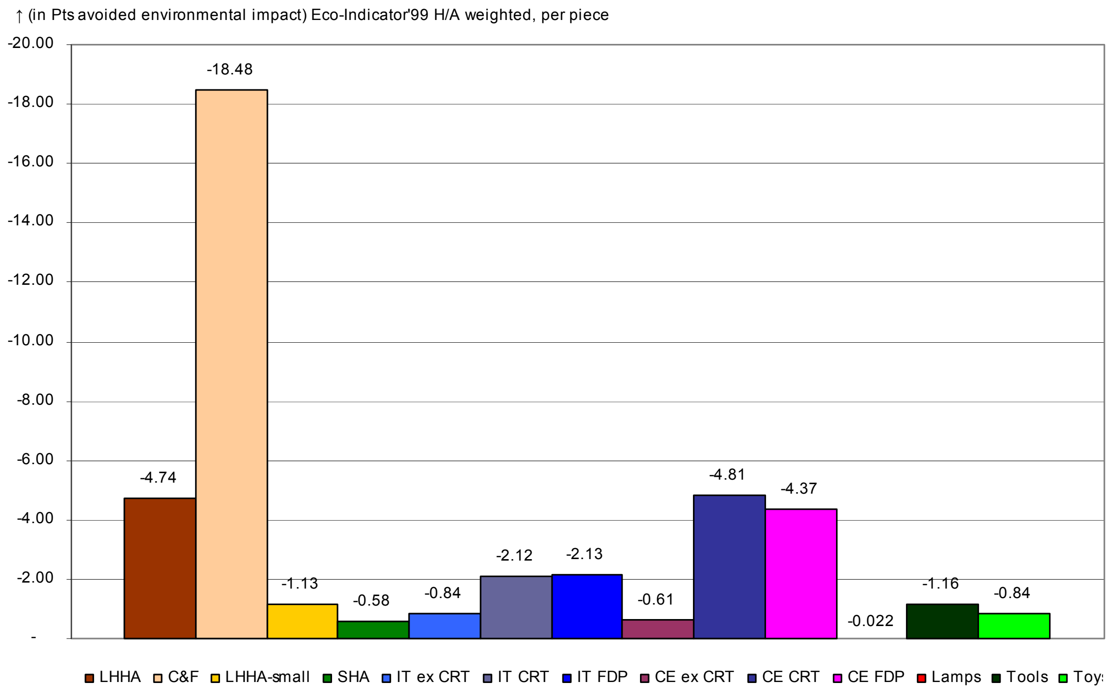

Figure 58: Environmental impacts per average piece diverted from disposal (EI99 H/A)

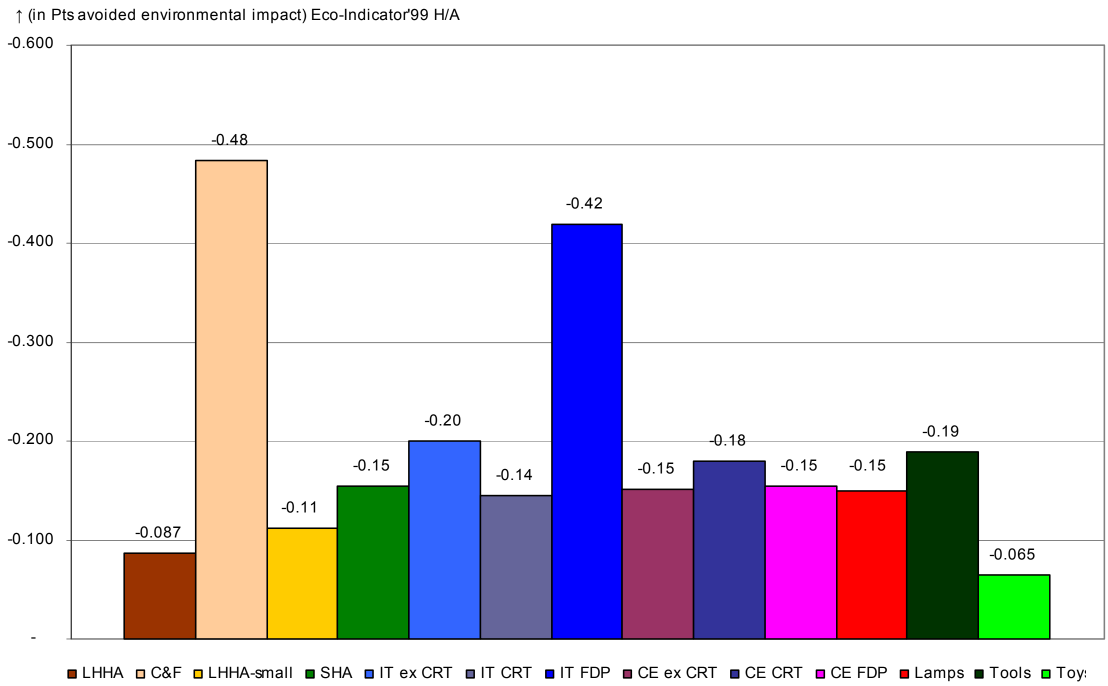

Figure 59: Environmental impacts per average kg diverted from disposal (EI99 H/A)

These graphs enable comparing different products for the same weight. On this basis, the two most relevant categories per kg appear to be cat.1B C&F as well as cat.3C IT FDP. The latter is due to the double presence of mercury as well as a relatively high precious metals content in the compositions data as discussed earlier in Chapter 8.2.4.3. Please note, that this score could contain an overestimate due to lack of sufficient data points for the PWB compositions as at the same time the rather similar LCD TV's are not substantially higher or lower than most of the other WEEE categories. In order to see the individual environmental impacts of the categories in the above figure, see Annex 8.4.2.a. From this information it is clear that there are for specific categories, specific environmental impacts. Especially for GWP and ODP, the impacts of Cat.1B C&F are very high. For gas discharge lamps, the Hg-content causes very high terrestrial ecotoxicity values and to a lesser extent the same for marine aquatic ecotoxicity. For products with high precious metal contents, the POCP and Acidification Potentials are relatively higher. Together with the CRT containing appliances, the Eco-Indicator'99 resource depletion values are noticeable. These specific environmental issues are also found back in an even more pronounced way when the contribution of the individual WEEE categories is determined when all contributions of the individual categories are multiplied with the average weight percentage of the categories contribution to the total amount of WEEE arising. These values are displayed in Chapter 7.2 and Chapter 8.0.5. See the next graph for the contribution of each WEEE category to the total impacts of diverting WEEE arising from disposal to default treatment.

Contribution of the Categories to the Total Impacts of WEEE Arising

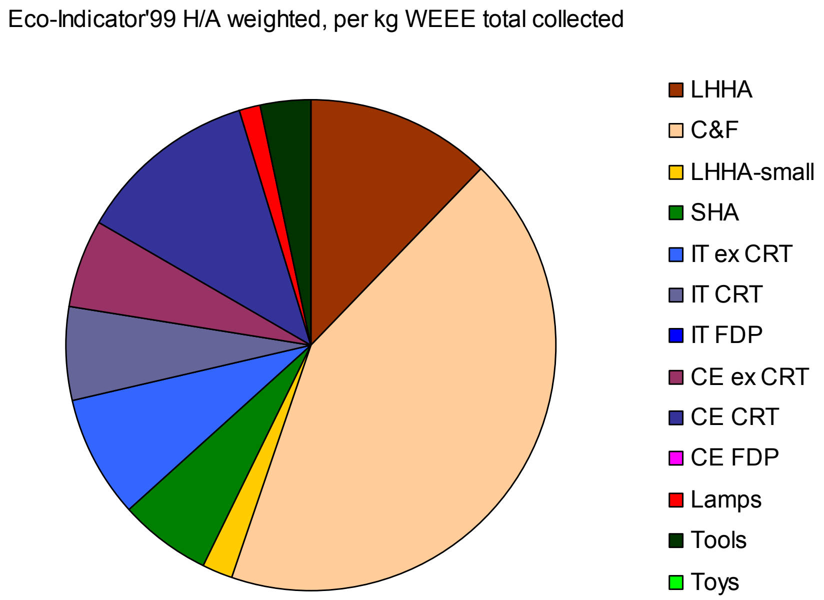

Figure 60: Contribution of categories to environmental impacts of WEEE total (EI99 H/A)

This figure demonstrates that under the Eco-Indicator'99 single indicators, the most relevant products to divert from disposal are the CFC containing fridges. These priorities are determined for each environmental impact categories and displayed in Annex 8.4.2.b. The individual pie charts are grouped in one table showing the ranking of product categories for each individual impact category.

Impacts of Different Products per Environmental Impact Theme

The difference between the above figure and the below table is due to the current low collection rate of FDP appliances. In the below table, the impacts per kg saved from the waste bin are illustrated:

Category	1A	1B	1C	2,5A,8	3A	3B	3C	4A	4B	4C	5B	6	7
Eco-indicator 99 H/A v203	12	1	11	7	3	10	2	8	5	6	9	4	13
Idem, Human Health	12	**1**	9	8	3	10	2	5	7	6	11	4	13
Idem, Ecosystem Quality	10	11	6	4	7	9	2	5	8	12	1	3	13
Idem, Resource Depletion	10	6	13	8	11	3	1	9	2	5	4	7	12
Cumulative Energy Demand	9	2	12	11	4	6	1	7	5	3	10	8	13
Abiotic depletion	6	2	8	11	4	7	1	9	5	3	12	10	13
Global warming (GWP100)	10	**1**	13	4	6	8	2	9	5	3	12	7	11
Ozone layer depletion (ODP)	8	**1**	7	4	5	12	2	9	13	6	11	3	10
Human toxicity	5	8	7	3	10	12	1	4	13	9	2	6	11
Fresh water aquatic ecotox.	4	6	9	2	8	12	1	3	13	10	7	5	11
Marine aquatic ecotoxicity	8	5	6	10	7	11	2	3	13	4	1	9	12
Terrestrial ecotoxicity	10	9	7	5	8	13	3	6	12	2	**1**	4	11
Photochemical oxidation	9	8	5	10	2	12	1	4	7	3	13	6	11
Acidification	12	10	9	7	2	8	1	6	3	4	11	5	13
Eutrophication	10	3	9	5	11	8	1	6	7	4	12	2	13
*** In bold: per kg of product arising, this impact category is dominated by this product category**													

Table 111: 'Saving from waste bin' ranking per kg

This table demonstrates the variety in environmental themes and also shows where the highest impacts are due to certain relevant substances like:

- Toxicity effects in various compartments Category 3C FDP and Category 5B Lamps (especially in terrestrial ecotoxicity, ecosystem quality),
- Avoided ozone-layer depletion and global warming potential for Category 1B C&F,
- Cumulative Energy Demand and resource depletion Category 1B C&F, 3B and 4B CRT screens,
- Acidification for Category 3A IT ex CRT and 3C IT FDP and Eutrophication for Category 3C IT FDP and 6 Tools.

The Benefits of the WEEE Directive from 2005 to 2011

Finally, the current total impacts of WEEE are displayed in one graph for the 2005 situation as well as the estimated 2011 impacts (or avoided environmental burden due to preventing raw material extraction or emissions). To obtain the total impacts, the amount collected and treated is multiplied with the (avoided) impacts of collection and treatment and added to the remaining not-collected (assumed disposed) amounts to MSW multiplied by the impacts of disposal. The resulting graph clearly demonstrates for each single category, that the benefits of the WEEE Directive are very much related to increased collecting and treating more appliances. One important assumption here is that the 2011 values are based on the current 2005 impacts without taking into account the changes in product and thus waste stream compositions as well as in development in recycling technologies applied. In particular the transition from CRT to flat panels displays and from CFC to HC based fridges will have an impact on the above graph. At present there is not enough data available to determine how this affects the waste stream composition over time.

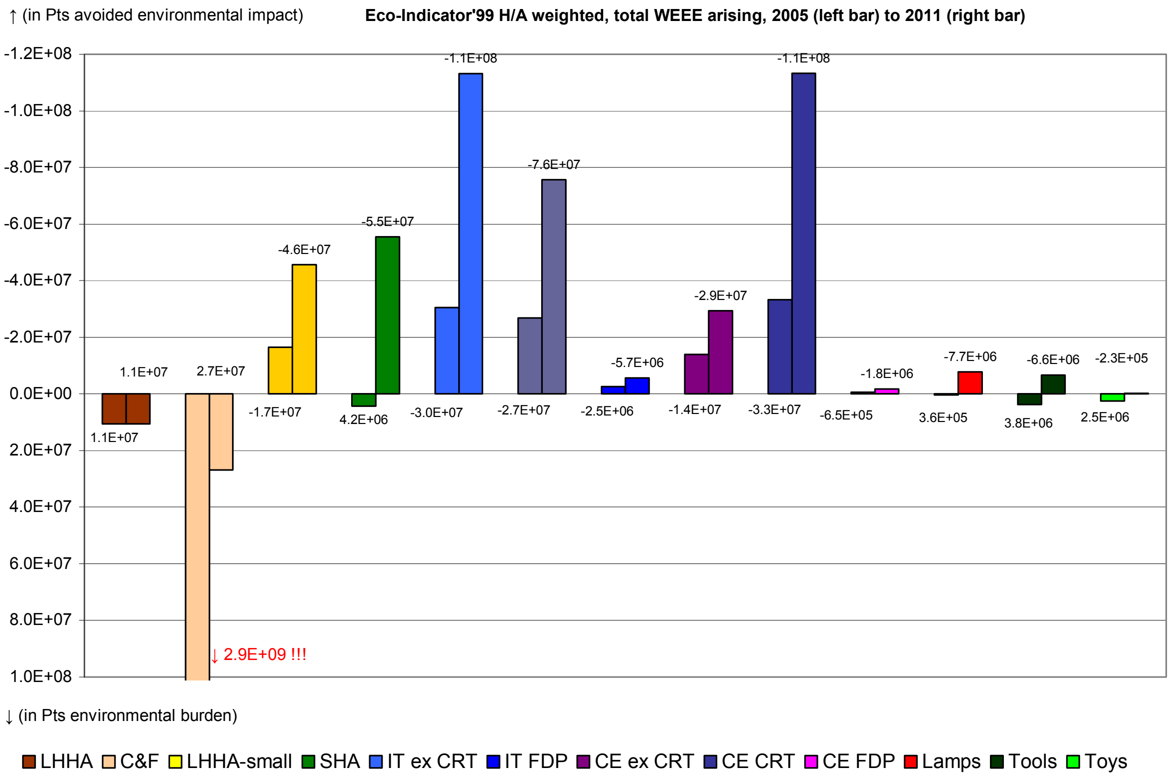

Figure 61: Total environmental impact for 2005* compared to 2011 (EI99 H/A)**

** Current 2005 collection (left) ** Maximum collection 2011 full implementation (right)*

The assumptions behind this graph are exactly the same as in Chapter 8.4.1 for the economic impacts. The environmental values are in all cases improving by diverting more appliances from disposal, even under higher amounts of total WEEE arising as waste.

The detailed data per environmental impact category grouped for all treatment categories is displayed in the below table.

Indicator	Environmental benefit	Number*	Unit
2005 WEEE: Arising: 8.3 million tons Collected: 2.2 million tons		**2011 WEEE: Arising: 9.7 million tons Collected: 5.3 million tons**	
Weight	Growth in WEEE arising	1,359	kton WEEE Arising
Eco-indicator 99 H/A v203**	Total environmental load per year of	-643,591	Europeans
Idem, Human Health**	Total environmental load per year of	-423,125	Europeans
Idem, Ecosystem Quality**	Total environmental load per year of	-46,038	Europeans
Idem, Resource Depletion**	Total environmental load per year of	-174,589	Europeans

Indicator	Environmental benefit	Number*	Unit
2005 WEEE: **Arising: 8.3 million tons** **Collected: 2.2 million tons**		**2011 WEEE:** **Arising: 9.7 million tons** **Collected: 5.3 million tons**	
Cumulative Energy Demand	Equivalent with:	75	million GJ
Abiotic depletion	Equivalent with:	-40	kton Sb
Global warming (GWP100)	Equivalent with:	-36	million ton CO2
Ozone layer depletion (ODP)	Equivalent with:	-4.8	kton CFC11
Human toxicity	Equivalent with:	-4,047	kton 1,4-DB***
Fresh water aquatic ecotox.	Equivalent with:	-404	kton 1,4-DB***
Marine aquatic ecotoxicity	Equivalent with:	-3,551	Mton 1,4-DB***
Terrestrial ecotoxicity	Equivalent with:	-74	kton 1,4-DB***
Photochemical oxidation	Equivalent with:	-3.0	kton 1,4-DB***
Acidification	Equivalent with:	-50	kton SO2
Eutrophication	Equivalent with:	-1,493	ton PO4---

Table 112: Estimated Environmental improvement due to the WEEE Directive 2011 versus 2005

** Negative means avoided environmental impact, ** Meant as a rough illustration only: 1 Pt roughly equals 1/1000 of the environmental load of one European p.year (Goedkoop 1999) ***kg 1,4-dichlorobenzene*

Please note all assumptions made behind these calculations in Chapter 8.2. A key aspect here is that the changing waste stream composition is not taken into account here. There is not enough information available to assess the influence of less and less CFC appliances, in Cat.1B Cooling and Freezing (might cause an overestimate of the GWP and ODP values), of the change from CRT to flat panels in Cat.3C and 4C for LCD appliances, the influence of changing from NiCd to Li-ion battery packs for Cat.6 Tools and the decreasing amounts of Hg applied in energy saving lamps for Cat.5B Lamps. It is recommended to further research this aspect when more collection and sampling information becomes available. In addition, these above values could also be compared with other envisaged effects of environmental legislation in other areas.

Eco-efficiency

The eco-efficiency outcomes of Chapter 8.2 comparing recycling with disposal of all categories leads to the following outcomes:

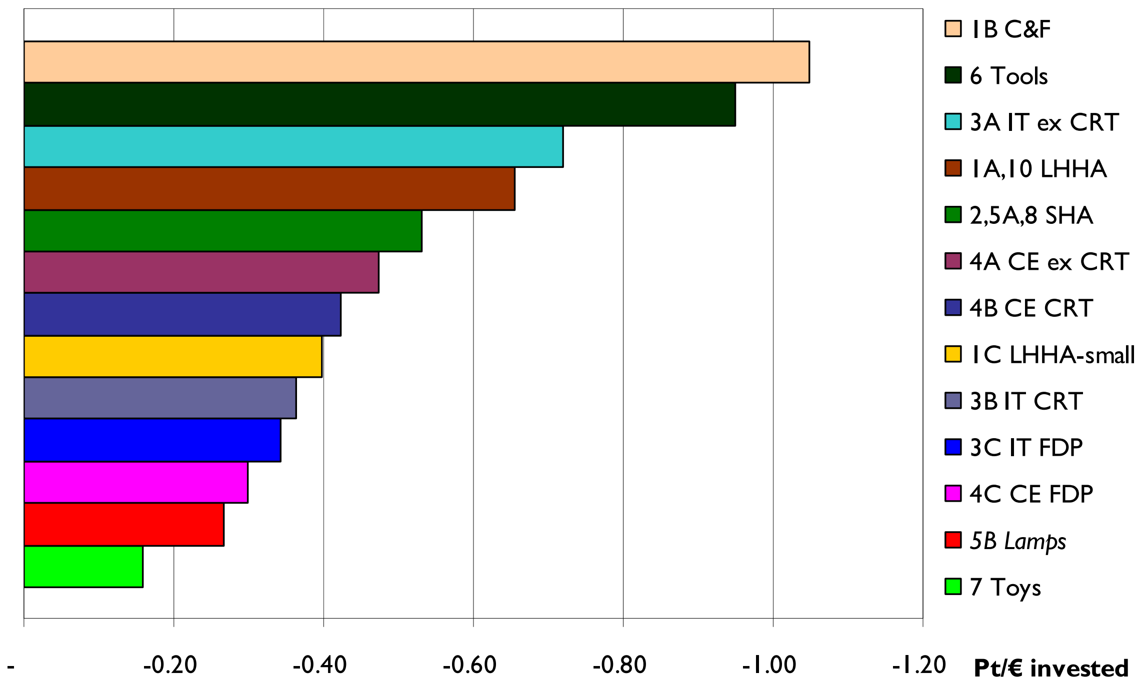

Figure 62: Eco-efficiency of saving products from disposal (in Points EI99 H/A)

Figure 62 shows that the treatment of the categories 1B Cooling and Freezing and 6 Tools have the highest environmental benefits per EUR invested. In these cases the environmental benefits are very high for the costs made. Cat. 7 Toys etc. has the lowest environmental benefits for one EUR invested due to the low electronics content and value. Remarkebly, Cat. 3C, 4C and 5B containing Hg are also low. This is partly due to the absence of human toxicity values in the Eco-Indicator'99 method as well as the relatively high costs of treatment. In Annex 8.4.2, the results per environmental impact category are presented. Note, that the eco-efficiency based on terrestrial ecotoxicity is very high for Cat. 5B. Lamps. The graphs in Annex 8.4.2 illustrate for instance that the eco-efficiency varies from 0.16 Points prevented environmental impact per EUR invested for Cat. 7 Toys as the lowest and 1.05 Points per EUR invested for Cat.1B Cooling and Freezing. For Global Warming Potential the results vary from 2.1 kg till 9.4 kg of CO2 emission prevented per EUR invested for all categories except Cat. 1B. Here the value is a very high 125 kg CO2 emission prevented for one EUR invested. As discussed before, it should be noted that changing product composition over time will change the above findings.

Collating the data provided in Chapter 8.2 provided more insights on where to realise maximum environmental effectiveness and cost efficiency simultaneously.

The two key findings are that from an environmental point of view, it is necessary to collect more WEEE and to treat it more effectively. The data in this chapter proves that this applies for all treatment categories.

8.4.3 Social Impacts of Total WEEE

Social Impacts

The above screening summary shows that that there are no comprehensive studies on the social aspects of the WEEE implementation available at present. In addition the rather limited information does not contain the necessary data to undertake an analysis and to support certain statements. As a direct result of this lack of data it is not currently possible to analyse and develop conclusions and recommendations without further research.

8.4.4 Conclusions

Conclusions

The main conclusions from the environmental impact assessment, which has been comprehensively performed with the most detailed and recent data are:

1. The most obvious conclusion from the previous analysis can be summarised in simple words: Collecting more is always better for the environment. For all categories and environmental impact categories the effect of diverting product from disposal has a net environmental gain which is the highest for Cat. 1B Cooling and Freezing appliances and the lowest for Cat. 7 Toys etc. ,
2. Secondly, there are many different environmental aspects relevant at the same time. WEEE is not a homogenous waste stream, but very diversified with specific focus points like control over toxicity (see Hg content in lamps and flat panels, Cd in battery packs), avoidance of global warming and ozone-layer depleting substances, recovery of resources (high grade circuit boards in PC's and LCD monitors), recovery of energy and avoiding depletion of fossil fuels (plastics recycling). In some specific cases, especially for the Hg containing appliances, the LCA values do not display local workplace concerns,
3. In some cases, the use of weight based targets is not an appropriate incentive for better treatment: Especially for CRT glass, some re-application options are much more preferable than others from an environmental point of view, whereas current targets promote the lowest environmental re-application levels,
4. Cost efficiency is very important: The eco-efficiency calculations of Chapter 8.2 demonstrate that there are certain scenarios where only a small environmental improvement is made against very high costs. This is particularly the case for manual dismantling of printed circuit boards. In other cases however, for example the dismantling of large external batteries in the case of cat.6 tools, the environmental effect of a relatively expensive exercise demonstrates high environmental improvements. This also illustrates a second key finding: in many cases high quality treatment requires an increase in costs but there are proportional environmental benefits,
5. The impacts of costs along the chain play a fundamental role from a cost-efficiency perspective (including the potential impact of development of downstream markets for valuable fractions). Such impacts change according to category average composition and recycling technologies used to treat different WEEE streams. Table 113 presents the breakdown of total costs for 2005, under assumption of fully operational conditions (WEEE Forum 2005),, for different product categories. Table 113 and Figure 62 represent the breakdown of the total cost provided in Table 110 with the overall economic impact

under 2005 collection results. Figure 62 demonstrates that the technical cost breakdown in percentages per category is built-up very differently. For Category 1A, 10 LHHA, the main part is the transport costs and after such transport, the revenues are almost equal to the further processing costs. For Category 1B, C&F obviously the treatment costs are a major portion of the total which is also the case for the CRT containing appliances. The relatively highest costs in absolute numbers Cat. 5B, for Lamps are in percentages spread over collection, shredding and further treatment (Hg recovery).

2005 Collection% level (Costs in million EUR)					
Category **Stage**	**LHHA** **1A+10**	**C&F** **1B**	**SHA** **1C,2,3A,4A,5A,6,7,8,9**	**CRT + FDP** **3B,4B (3C,4C)**	**Lamps** **5B**
Transport and collection (incl. access to WEEE)	50	68	129	65	7
Shredding, sorting, dismantling, pretreatment	20	207	246	200	3
Incineration and landfill	3	4	23	4	0
Recycling + recovery processes *	-18	-103	-94	-46	7
Sum Technical	56	176	303	223	17
Sum Additional	25	27	85	32	2
Total Costs	82	204	389	254	18
2011 Collection% level (Costs in million EUR)					
Category **Stage**	**LHHA** **1A+10**	**C&F** **1B**	**SHA** **1C,2,3A,4A,5A,6,7,8,9**	**CRT + FDP** **3B,4B (3C,4C)**	**Lamps** **5B**
Transport and collection (incl. access to WEEE)	59	216	307	176	22
Shredding, sorting, dismantling, pretreatment	24	662	590	530	8
Incineration and landfill	4	13	56	10	1
Recycling + recovery processes *	-20	-329	-232	-121	21
Sum Technical	66	563	721	595	52
Sum Additional	30	88	203	86	5
Total Costs	95	651	924	680	58

Table 113: Total breakdown of total costs along the recycling chain in a given year (2005)

** A minus in the table means a revenue*

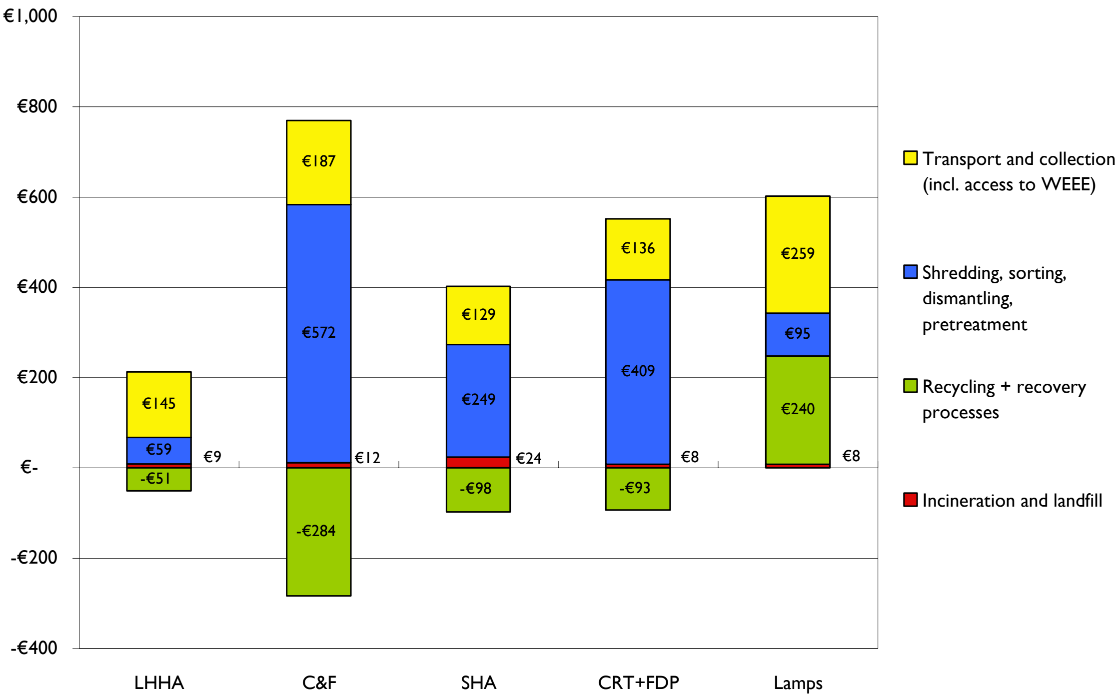

Figure 63: Breakdown of technical costs for the 5 main collection categories per ton

6. Finally collating the data provided in this Chapter has provided more knowledge on where to realise maximum environmental effectiveness and cost efficiency simultaneously. The two key findings are that from an environmental point of view, it is necessary to collect more WEEE and to improve quality of treatment, including control over the destinations of material fractions with a high environmental value. The data in this chapter proves without exceptions that this is applicable for all treatment categories, however the environmental priorities (toxic control, resource and energy conservation and health and safety) are varying.

8.4.5 Recommendations

Recommendations

For LHHA, the Annex II removal obligations should be re-examined, as over time Hg components and PCB capacitors are less and less likely to be found. Here, further research on the compositions over time (and maybe regional differences as well) should be further investigated.

It is recommended that further research should be carried out to determine the influence of newer products and especially the transition from CFC to HC fridges and from CRT to flat panel displays on the waste stream composition and on the overall environmental impacts and benefits of collecting and treating WEEE. The data for LCD monitors should be improved as well as research on better treatment options for these appliances.

For small appliances, it is recommended to perform further research on separating high value products from the rest of the small appliances as is already done in practice in some countries. This could also be of relevance when prescribing recycling targets in order to improve treatment that is preferable to promote plastic recycling, but not a proper incentive when the main environmental aim is to recover high precious metal contents.

The main findings for the CRT containing appliances are that as long as CRT back to CRT glass recycling can be done, this should be promoted over other 'useful' re-applications. This should also be reflected by recycling targets that do promote the higher levels of re-application. However, further research is needed to particularly investigate the absorbance capacity of secondary processing as CRT production will diminish over the years to come, and smelters and other options have limited capacity for treatment of large amounts of leaded glass. For LCD containing appliances, options that can both enable proper control over the mercury contents as well as recovery of the valuable metal content should be developed.

For gas discharge lamps, with concerns over high mercury content, incentives should be focusing on collecting more discarded products, as well as achieving high mercury removal efficiency and also promoting glass recycling at the same time.

In general it is recommended to further research the ranking of the different eco-efficiency scenarios: to compare costs and environmental outcomes in order to derive priorities as to which scenarios should be promoted first. A specific recommendation is that due to the technical developments in plastics recycling as well as increases in material prices, there should be a re-examination of the various options for plastics recycling. In addition an investigation should be carried out into the issue of keeping BFR's in plastic re-applications compared to not recycling BFR's. Such an investigation could be carried out in a similar fashion to this environmental impact assessment of all WEEE categories, but with more specific technical data for the respective technologies applied as well as the individual plastic types and constituents with focus on heavy metals (Cd and Pb) as well as BFR's.

Additionally, it is recommended to place the outcomes of this investigation in a broader perspective by comparing the potential environmental benefits or risks of the WEEE Directive with EU wide or national targets for certain environmental themes like global warming, reducing toxic substances (RoHS substances), ozone-layer depletion and resource conservation as well as the related costs for these in order to enable eco-efficiency comparisons and set consistent priorities in environmental legislation in general.

9 METHODOLOGY TASK 2: OPTIONS (Task 2.1 – 2.5)

In this chapter the methodology for developing individual options as assigned by the Commission is presented. It focuses on: scope (Chapter 9.1), collection targets (Chapter 9.2), recycling and recovery targets (Chapter 9.3), targets for reuse (Chapter 9.4) and treatment requirements (Chapter 9.5) In this Chapter, the objectives, the complete list of options and the analysis steps themselves are presented. The options are individually discussed in Chapter 10, where a first selection is made and a first screening of potential impacts is listed. In addition, the boundary conditions for applying selected options and the relation with other options and other legislation are highlighted. A grouping of the options can be found in Chapter 10.6, a further discussion on the alignment of options and other conditions for success outside of changing the legal framework is then discussed in Chapter 11.

9.1 Changes to the Scope of the Directive (Task 2.1)

Objectives

The objective of defining a scope in any Directive is to describe which products fall under the provisions. The scope of the WEEE Directive is described in Article 2 and by reference to Annexes 1A and 1B, which categorise equipment by type, and provides illustrative examples of the types of equipment that may fall into each category.

According to Article 2 of the WEEE Directive, appliances listed in product categories (1 to 10) in Annex 1A, and in particular those listed, as examples, in the non-exhaustive list in Annex 1B, fall in the scope of the Directive. However, it is crucial to define appliances included or excluded from the scope of the Directive. Even when it is cleared by the potential inclusion of those appliances listed in Annex 1B, many grey areas remain. In particular for those appliances potentially falling under the more general entries such as 'Other products or equipments for…' Such general entries are present in almost all product categories under Annex 1B.

The issue of defining how to include/exclude new products in the scope, especially taking into account future development of new products, which may not fall into the current product categories, shall be taken into account as well. The aim for the following Chapter 10.1 is to analyse the implementation of the product scope and to suggest improvements to this part of the Directive. In addition the issue of arranging the scope by 'treatment categories' as opposed to the current 'product categories' has been considered. Articles 8 and 9 dealing with the definition of B2B versus B2C are examined, as they contribute to the current non-harmonised situation in the EU.

Options Derived

The main options for change and/ or improvement of the scope are structured into three areas. The options will be based on outcomes and recommendations derived from Chapters 7 and 8, feedbacks and input from experts and stakeholders as well as from the Commission.

The first series addresses extending the scope or the opposite: inclusion or exclusion in the scope of the Directive on the basis of societal relevancy:

1.1 Inclusion or Exclusion from the Scope

Option 1.1.1 New types of equipment, not listed in WEEE Annex IB
Option 1.1.2 Review of the exclusions of 'part of another equipment'

Option 1.1.3 Review of the exclusions of 'military equipment'
Option 1.1.4 Review of the exclusions of 'large-scale stationary industrial tools'
Option 1.1.5 Review of the exclusions of 'implanted and infected products'
Option 1.1.6 List of 'Types of Equipment'
Option 1.1.7 Base scope on article 95
Option 1.1.8 Base scope on 'practical relevance'

The second series deals with B2B and harmonising the scope in the EU: the split between B2B and B2C equipment and non-harmonised scope in the EU:

1.2 B2B versus B2C and Harmonisation across Member States

Option 1.2.1 Applying a '95' character
Option 1.2.2 Differentiation per (sub)category
Option 1.2.3 Self-regulation
Option 1.2.4 Exclude 'real' B2B equipment

The third series discusses other options and definitions to determine the scope:

1.3 Alternative Definitions

Option 1.3.1 Waste stream instead of a product scope
Option 1.3.2 Criteria lists
Option 1.3.3 Reference list from other nomenclature
Option 1.3.4 Scope defined according to 'product potentially occurring in WEEE stream'

The presented areas of change and options listed concern different stakeholders and different obligations as the definition of the scope has impacts on all subsequent obligations and activities. The definitions of scope given in Article 2 of the WEEE Directive determine which products and product categories are affected, in particular, by:

- The quantity reporting requirements of Article 12, see also options in Chapter 9.2 and 10.2,
- The recycling and recovery targets of Article 7, see also options in Chapter 9.3 and 10.3, and
- The financing requirements of Articles 8 and 9 and in particular the different provisions for different steams of WEEE: households and other than household.

It is then crucial to analyse how each of the proposed options is linked to other obligations and options, this will be done in the following chapters.

Methodology

The analysis is carried out by:

1. Evaluating the key findings and concerns from Chapter 7 and 8,
2. Evaluating existing literature, plus email and phone contact with national collection schemes and industry associations,
3. Considering feedback from experts after the workshop held in Brussels on the 15th March 2007,
4. Considering feedback from the European Commission itself,

5. Contacts with collection schemes and industry associations were used to derive examples of products lists, criteria lists, of experiences with inclusion or exclusion of specific product groups,
6. Furthermore, a screening analysis of the most relevant environmental issues based on the environmental outcomes of Chapter 8 was made in order to demonstrate appropriateness with respect to the environmental objectives of the Directive,
7. Finally, analysis of the consequences of the non-harmonised interpretation of the existing scope e.g. the definition of B2B equipment and difference in interpretation for e.g. B2B – B2C ‘dual use products’, are made.

9.2 Collection Targets (Task 2.2)

Objectives

The purpose of a collection target is to ensure that a high level of return of equipment reaching end-of-life is achieved, thereby minimising the leakage of potentially hazardous materials into the environment whilst ensuring a high level of resource conservation.

To achieve the aims of the WEEE Directive, it will be important that targets should be challenging and achievable in each Member State. This would require targets to be set in a way that fits with the particular circumstances faced by each Member State, with the ultimate aim of bringing all Member States up to par.

The aim of this section is to propose options so that the environmental goals of the Directive are better served. The main options for change and improvement focus on encouraging environmentally responsible behaviour and maximising amounts that can be collected in practice.

Options Derived

The following options for increasing collection rates were derived. These are grouped into three areas:

2.1 Maintain or Increase Targets, Type of Target

Option 2.1.1 Maintain current targets
Option 2.1.2 Higher or specific collection targets for more hazardous WEEE
Option 2.1.3 Alternative definition (% based on previous years put on market)

2.2 Reducing Leakage from Collection Infrastructure

Option 2.2.1 Mandatory hand in by retail and municipalities at certified compliance schemes
Option 2.2.2 Mandatory trade-in mechanism
Option 2.2.3 Minimum number of collection points

2.3 Other Options for Improvement

Option 2.3.1 Introduction of a return premium for consumers
Option 2.3.2 Lower compliance cost when collection target achieved
Option 2.3.3 Mandatory consumer education
Option 2.3.4 Introduce a Recycling Fund mechanism
Option 2.3.5 Other financing models to promote better collection
Option 2.3.6 More enforcement of illegal waste shipments

Methodology

The following steps were conducted:

1. An assessment of the environmental evaluation to identify the types of WEEE which have the greatest environmental impacts and hence require an appropriate level of collection,
2. A review of collection rates achieved in both Member States and other non-EU countries, and how these compare with both amounts put onto the market and estimated WEEE arisings,
3. A review of legislative requirements, voluntary agreements and (if any) more innovative incentives that improve collection of WEEE, with specific attention to the WEEE categories that are of specific concern,
4. An assessment of options for reducing leakage of collected WEEE.

The analysis is carried out including:

- The key findings and concerns from Chapter 7 and 8,
- Feedback from experts after the Workshop held in Brussels on the 15th March 2007,
- Feedback from the European Commission.

9.3 Targets for Recycling and Recovery (Task 2.3)

Objectives

The aim of this chapter is to propose options that foster more effective recycling and hazardous control by means of using recycling and recovery targets or not. The relevance of applying targets for recycling and recovery is to ensure environmentally safe treatment as it aims at recycling of materials that would otherwise not be recycled due to economic reasons. Mainly recyclers will be affected by the proposed options for change in recycling and recovery targets.

At first, the appropriateness of the current targets is reviewed, a benchmark with other regions in the world is carried out and the influence on treatment technology and the development in infrastructure is discussed. Moreover, when applying weight based recycling targets the definitions and interpretations of these are evaluated. As a starting point, the aim of the instrument recycling targets must be clarified, as it matters whether they are used to improve treatment as such or whether they form a way of reporting and controlling the processing of WEEE. In addition, it is evaluated whether they work or could work as a true incentive or whether such requirements are superfluous when it comes to simplification of legislation. Finally, links and potential overlap or connections with other legislation and other options for improving are introduced. The above aspects are clarified below in introducing the methodology for the next chapter 10.3. The starting point for Chapter 10 is taken from Chapter 8 with the findings on the main environmental, economic and social impacts. This input is needed to assess whether the current targets form a (proper) incentive for promoting eco-efficiency of take-back and recycling or not.

Options Derived

The main groups of options for changing the current targets for recycling and recovery are divided in changing the target level itself, different ways of defining targets and other options to improve WEEE treatment.

The first series of options for change relates to increasing or decreasing the targets in order to readdress the current level of achievements in processing and is divided as such:

3.1 Increasing/Decreasing Targets

Option 3.1.1 Delete targets from the Directive altogether
Option 3.1.2 Decrease, maintain and increase targets levels for specific categories
Option 3.1.3 Introduce targets for cat.8: medical equipment

The second series of options for change relates to options for defining the recycling and recovery targets differently. The relevance of the definition is obvious: it should define recycling and recovery operations in such a way that it clearly addresses and positively discriminates between various treatment and non-treatment methods as well as the material fractions undergoing them. It influences the way and level of detail of reporting and thus the administrative burden for recyclers and compliance schemes:

3.2 Different Definitions of Targets

Option 3.2.1 Keep current target definition
Option 3.2.2 Targets for specific material fractions
Option 3.2.3 Targets based on processes defined as BAT
Option 3.2.4 Other definitions for recycling and recovery
Option 3.2.5 Definition of waste versus raw material
Option 3.2.6 Harmonisation and realignment of definitions
Option 3.2.7 Environmentally weighted targets

The third series of options relate to realising the objective of recycling targets in other ways. Alternative options might accomplish the same goal with lower costs and improved environmental performance. Some of the options are closely related to the treatment standards of Chapter 9.5 and 10.5 as the goal is more or less similarly addressing quality of treatment:

3.3 Other Options to Improve Processing

Option 3.3.1 No targets, only use of BAT for WEEE processes
Option 3.3.2 Deviation allowed under "Environmental Equivalency Principle"
Option 3.3.3 Monitoring and enforcement of existing measures
Option 3.3.4 Removal targets for specific potentially toxic components
Option 3.3.5 Measure but don't enforce

Methodology

Based on the outcomes of Chapter 7 and 8 the following aspects have been reviewed to analyse the implications of the various options proposed:

1. Appropriateness: Are the targets an incentive for environmental improvement?
    a. The appropriateness of the targets is evaluated: Therefore, it is highlighted where environmentally counterproductive effects are found between weight-based targets and more comprehensive environmental goals. This is investigated by means of determining the role of environmentally relevant materials with e.g. a high primary resource value, toxic properties or otherwise environmentally burdening materials (see general methodology: QWERTY). Here, it is also analysed whether there are cases where aspects other than high weight-based targets are having priority over high recycling rates, such as health and safety aspects,
    b. The use of the current targets is evaluated per product category: environmental plus economic evaluations from Chapter 8 are discussed in order to determine whether the current targets create an incentive for improving treatment operations,

   c. For many treatment categories, the separation steps are a matter of optimising maximum recovery of materials versus purity of fractions to reach acceptance or market criteria for material fractions. It is evaluated as to whether or not, for certain treatment categories the weight-based recycling targets do indeed support the economic and optimal environmental situations.

2. Benchmark with other countries, internally and on the various definitions used:
   a. Based on the outcomes of Chapter 7, treatment achievements in terms of reported recycling and recovery targets are summarised. In addition a reflection on the reliability is given for instance due to differences in interpretation and mathematical uncertainties,
   b. Evaluation of calculation structures and definitions of what is included in recycling and recovery definitions are presented.

3. Future development of recycling infrastructure:
   a. Based on reviewing information on technologies currently in use for WEEE treatment in the EU, the influence of developing new or alternative treatment technologies is highlighted,
   b. The role of recycling targets in promoting or hindering the development or application of such new technologies is investigated. In recognition of the important role that 'techniques' and 'procedures' have in ensuring good waste management practice, the role of treatment standards and good practices for specific WEEE categories are also taken into account.

4. Interpretation of the definition of recycling and recovery:
   a. Different interpretations and applications of the definitions might lead to conflicts between legislation and thus to regulatory confusion, to inconsistent application of the legislation and to market distortions. Consequently, an analysis is done on how this affects the implementation and revision of the WEEE Directive with focus on legislative streamlining of the WEEE Directive with respect the surrounding Community legislation,
   b. The results from Chapter 8 are discussed in terms of the influence of differences in wording and interpretations on potential environmental performance.

The analysis is carried out considering:

- The key findings and concerns from Chapter 7 and 8,
- Feedback from experts after the Workshop held in Brussels on the 15th March 2007,
- Feedback from the European Commission itself.

9.4 Targets for Reuse for Whole Appliances (Task 2.4)

Objectives

As evidenced in Chapter 8.3, data on the social effects of the WEEE legislation are limited, if at all existing. Consequently, there is no evidence that the reuse for whole appliances would have a positive effect on the creation of jobs. But there is common agreement among experts that it would have an impact, although estimates range from the creation of very few, to several thousand jobs (NeWET 2001). Moreover early pilot-projects highlight product leasing or selling services as an approach to saving raw materials and resources instead of selling products. But the main deficiency is that consumers have only little awareness about the environmental impacts of products purchased throughout their entire lifetime. In addition the use of cheaper second hand appliances offers an important means for people with low income to raise their standards of living and to participate in social activities, bridging the "digital divide" or delivering necessary means of communication for commercial or cultural purposes. Unfortunately recent studies of e-waste exports show that all too often reuse is claimed for activities which turn out to be nothing more than illegal dumping of hazardous wastes or recycling of materials elsewhere which greatly endanger the health of local people as well as the environment. In addition, for certain appliances like old TV's or washing machines extended life times can have negative environmental consequences due to much higher energy consumption of old products. All these social impacts require further research in order to illustrate the existing interdependencies and linkages and from this also to retrieve a better understanding of the effects that revision of targets for reuse of whole appliances could have.

Options Derived

The following options for setting reuse targets were derived. These are grouped into three areas, and were discussed in further detail at the Expert Workshop. These are:

4.1 Define Requirements

Option 4.1.1 Establish a clear definition of "Re-use of whole appliances" term
Option 4.1.2 Determine the scope of reusable products (i.e. specific Product List)

4.2 Increase, Add, Maintain or Delete (entry specific) Requirements

Option 4.2.1 Business as usual (BAU) – i.e. No target
Option 4.2.2 Specific targets (per category)

4.3 Alternative Options (instead of reuse targets)

Option 4.3.1 Delay setting re-use targets until more information about the return status is available
Option 4.3.2 Re-use targets linked to design
Option 4.3.3 Promotion of rental of equipment
Option 4.3.4 Promote collection points to take reuse products to second markets

Methodology

The study was carried out in four stages:

1. The first stage of this work involved obtaining information on the arisings of these items and the percentages that are considered to be suitable for reuse,
2. In the second stage of work issues and typical costs for refurbishment of these items were assessed. This included information on the technical feasibility of refurbishing items so that they can be reused, the availability of spare parts, and the types and sizes of the markets for each type of product,
3. The third stage of work involved an assessment of the environmental and social issues associated with reuse. This was done through the use of existing reports, literature searching on the internet, and discussions with relevant stakeholders,
4. The final stage of the work involved a number of measures that could be considered for encouraging reuse, and the advantages and disadvantages of each of these.

9.5 Treatment Requirements (Task 2.5)

Objectives

The main recommendations from the impact assessment of this study are derived from Chapter 8:

- There are indications that significant amounts of WEEE arisings are not going through 'official' treatment routes,
- Older items of concern are found less and less (like PCB containing capacitors in washing machines)
- Newer items of concern are not yet covered by the current Annex II (e.g. plasma display screens),
- Market uncertainties about quality of material fractions coming from WEEE treatment are hindering full exploitation of these potential resources,
- The wording and interpretation of Annex II requirements can influence the use of certain technologies for treatment. Technologies which are strictly taken not allowed under the current wording might prove to be the best practicable options for certain items of WEEE (for example secondary smelters for CRT glass when there are no direct recycling options anymore due to diminishing CRT production).

The aim of this section is to propose options for improving treatment standards for WEEE. In Chapter 7.4, the current use of technologies and processes has been discussed and in Chapter 8 the main environmental, economic and social impacts of processing have been reviewed. Possible options have been derived from this review process.

Options Derived

The following options for improving treatment requirements have been derived, grouped into three series, and were discussed in further detail at the Expert Workshop. These are:

5.1 Increase, Add, Maintain or Delete (entry-specific) Requirements as such

Option 5.1.1 Delete current requirements altogether
Option 5.1.2 Delete specific (superfluous) requirements
Option 5.1.3 Maintain current requirements
Option 5.1.4 Specify removal efficiencies per entry
Option 5.1.5 Introduce requirements for other (new) hazardous components

5.2 Alternative Definitions of Requirements

Option 5.2.1 Align Annex II with ROHS & Batteries Directives
Option 5.2.2 Establish a clear definition of "remove"
Option 5.2.3 Describe treatment technologies per entry
Option 5.2.4 Before, after and part of treatment
Option 5.2.5 Concentration and system limits

5.3 Alternative Options instead of Treatment Rules

Option 5.3.1 Prescribing BAT
Option 5.3.2 Industry standards
Option 5.3.3 Monitoring and enforcement
Option 5.3.4 Measure removal efficiencies but don't enforce
Option 5.3.5 Coverage by other legislation
Option 5.3.6 Criteria lists for technologies, outlets

Option 5.3.7 Criteria list to promote reuse components/ whole appliances
Option 5.3.8 Cover removal by licensing/ permit

Methodology

The unofficial TAC Guidance Document (TAC 2005) and the UK information on draft guidance for treatment of WEEE to meet Annex II and Annex III requirements have been reviewed. These documents already contain:

1. An overview of the most relevant substances,
2. Proposals for the interpretation of removal,
3. Substances to be removed prior or within further treatment, based on:
   a. An assessment of technologies used, and
   b. Other relevant legislation sometimes already covering the intended effects,
   c. The role of monitoring and reporting removed substances.

The relevance, need and actual entries of Annex II are connected directly with technology development and definition of Best Available Technologies that can properly deal with WEEE.

It is already known that the control of environmentally burdening materials present in WEEE is not only a matter of removal from WEEE, but also of further downstream control on the destinations of the removed components. In addition, a strict interpretation of removal as a manual activity causes high economic burdens and sometimes even undesired health and safety issues at recyclers.

Therefore, technologies are examined that can deal with these items and components in an environmentally safe way, whilst avoiding potential conflicts between achieving recycling targets, removal of Annex II components, and the monitoring and reporting of hazardous materials in the resulting fractions. The relationship with other environmental legislation has been investigated as well as other ways of realising similar or better environmental protection.

10 ANALYSIS INDIVIDUAL OPTIONS (Task 2.1 – 2.5)

The findings in this chapter are based on the impact assessment outcomes of the previous Chapters which show the environmental priorities in relation to cost efficiency for all categories, substances and environmental themes over time as well as the eco-efficiency of various scenarios, the team's own experiences and the arguments provided by stakeholders during the Workshop of March 15, 2007. These latter findings are included in Annex 10. In the text below, based on technical arguments from the stakeholder contributions, only those arguments which influence environmental performance have been selected.

10.1 Changes to the Scope of the Directive (Task 2.1)

Introduction, Recommendations from Task 1

The definition of a scope is not only relevant for the development of all other options, it is also affects, for instance, producer responsibility, financing, as well as which products should be collected and recycled, and thus the environmental performance of the Directive. Potential changes in the scope of the WEEE Directive impact on the whole structure and provisions of the WEEE Directive itself. Furthermore, the scope of the RoHS Directive, as defined in Article 2, is currently referring directly to the scope of the WEEE Directive. One of the main differences between the two Directives is the different legal basis:

- The WEEE Directive is based on Article 175 of the EC Treaty. This means it's a 'minimum requirements' approach and thus Member States could transpose the Directive in a more strict way,
- The RoHS Directive is based on Article 95 of the EC Treaty. This means Member States should transpose such Directive without changes that could hamper the harmonization of such approach.

One of the main issues is to ensure that any change, both in the current transposition/implementation and future development of WEEE Directive, does not lead to asymmetry or fragmentation of the internal market or create barriers to trade. Currently there is the risk (ORGALIME, 2006) that extension of scope of the WEEE Directive, both in transposition phase and in practical implementation by Member States, leads to an indirect extension of the scope of RoHS Directive. Any different interpretation of scope of the WEEE Directive should not lead to a non-harmonized scope of the product oriented RoHS Directive across the EU.

A practical example of such an issue could be represented by car radios. According to the 'Frequently Asked Questions on the WEEE and RoHS Directive EC DG ENV (2007)', published by the EC, section 1.11, '*if devices are not specifically designed to be used in vehicles, those devices would be covered by the RoHS Directive. If the devices are designed primarily for use in vehicles (such as car radios) then the ELV Directive applies*'. According to such an explanation, car radios, should not be included in the Scope of WEEE Directive or RoHS.

However, as in the following examples, the status of car radios currently varies in the following countries:

- They are falling outside of the scope according to the official list of the National Register of Producers Portugal (2007),
- They are falling inside the scope according to the official list of NVMP (the National Compliance Scheme in Netherlands, (2007)).
- They are following outside of the scope, according to Hungary transposition, when built in and purchased with a motor vehicle Hungarian transposition of WEEE Directive, (2004), otherwise they are falling inside the scope.
- They are found back in the collection streams, despite being out of the scope, according to the sampling data of Table 63 in Chapter 8.0.5.3. From 4,729 appliances, 125 were car stereo's (DEFRA 2007).

This also raises the question as to whether a definition of scope would actually influence consumer behaviour or if the definition of the scope would be driven by what consumers would hand in at collection points in reality, or, on the other hand, whether all appliances with a positive environmental outcome of collecting and recycling should be included in the scope.

From the above example and many others, it can be concluded that:

- Some products (like the car radio) are falling in or out of the scope in different countries of the EU (but this is in line with Article 175 of the Treaty) and, sometimes, even in the same country, depending on the built-in or not status, and
- Such products are then falling within the scope of RoHS (based on Article 95 of the Treaty) in the Netherlands but not in Portugal and even in Hungary in the case not built in.

The consequences of such non-harmonized scope of WEEE, and indirectly impacting the scope of RoHS are relevant for producers selling products in these Member States, as their equipments need to be RoHS compliant in some of them and not in others. As a result, these different interpretations do cause disruptions of the internal EU market.

One of the main issues pointed out by different stakeholders, both in the questionnaire on administrative burden and in interviews, as well as during the expert workshop, was the need to achieve a level playing field across the EU. Harmonization is needed in particular with respect to the scope of the WEEE Directive, as different approaches with regard to the definition of scope currently exist in the EU27. To further illustrate these differences which are reported to be manifold, the following is found:

- There is an inclusion/exclusion list provided by the National Register of producers in Portugal (2007), defining the status (in or out of the scope) of appliances potentially falling in 'grey area', or
- The exhaustive list in Annex 1B of Hungary (Kelemen 2006), is also referring to the combined nomenclature of the customs, as defined in Commission Regulation (EC) 1810/2004,
- In the great majority of Member States no official documents or criteria, legally binding, except the National Transposition of the WEEE Directive itself exists. For this reason, there is no clear list of products falling in or out of the scope across different Member States, because not all entities at Member State level have clearly decided (except few cases like Portugal or Hungary) about exhaustive inclusion or exclusion. This means that there is no certainty on specific products falling in 'grey areas' at Member State level and, furthermore, across different Member States. It's then not possible even to get a clear and

exhaustive picture on the amount or kind of products falling into such 'non-harmonized' status, simply because no clear assessment is possible whether a product is really falling in or out of the scope, except for some explanatory cases (Goodman 2006, TAC 2006)

The above is hampering effectiveness of policy measures and resulting in a fragmentation of the EU market as well as substantial administrative burden as pointed out in Chapter 8.1.1. The differences can be summarised as follows:

1. Different criteria with respect to definition of appliances in and out of the scope of the WEEE Directive; in some Member States, different coverage of appliances is in place: sometimes the same appliance does not have the same status – in or out of the scope – across different Member States (e.g. the example of car radios in the previous paragraphs or examples listed in Annex 2 of the report on Review of RoHS Directive – Goodman 2006),
2. Different criteria with respect to the definition of B2B/B2C appliances put on market in particular are having an impact on the need to provide financial guarantees according to the WEEE Directive. In addition, due to the different National transpositions there is no common definition of B2B/B2C in place across the EU. This means that, especially for 'dual use' products, declared as B2B or B2C when placed onto market, could have a huge financial impact considering the amount of financial guarantees to be provided, according to Table 85. Financial guarantees need do be provided, according to the WEEE Directive, only for B2C appliances put on market, and only a few Member States (e.g. Estonia, Italy, Portugal) request this even for B2B appliances. This means that a producer, placing on market one thousand tonnes of TV and declaring such TV only as B2B, potentially save EUR 372,000 (in the case of Hungary) up to EUR 511,000 (in the case of Poland). Despite the fact that in most Member State joining a collective Compliance Scheme is an exemption criterion for providing financial guarantees (as explained in Chapter 8.1), the issue of definition of B2B/B2C, connected to the needed of financial guarantees could play a crucial role, especially for those producers deciding to comply individually and then non exempted from providing such a guarantees,
3. For instance in Hungary the definition of B2B/B2C has been set by law to ensure the same provisions on financial guarantees, but also by the use of a Visible Fee (Kelemen 2006). According to the WEEE Directive, the use of Visible Fee is allowed only for B2C Historical WEEE, but when there is no common definition of B2B/B2C, potential differences and distortion could arise (in some Member State the visible Fee is also allowed for B2B appliances; in some others it is prohibited for B2C appliances and allowed for B2B). According to the Hungarian approach, only those appliances listed in annex 1B of Hungarian transposition are eligible to have a Visible Fee on point of sale, as clearly defined as B2C, and
4. Different criteria for the definition of B2B versus B2C WEEE streams are having an impact on the determination of the financial obligations as defined by the WEEE Directive in different National transpositions. This means that the assessment of financial obligations in respect of B2C historical WEEE, and sometimes even of new WEEE, are calculated based on market share of producers. This means that declarations of B2C appliances put on market reflect the financial obligations of B2C WEEE arising. However, when products declared as B2B, this could happen especially for dual use products, are then ending up in the B2C stream, the costs for managing such appliances are shared only on those producers having declared B2C appliances.

Basically WEEE is not a homogenous waste stream, but very diversified with specific focus points and also very different Industries and business models behind these products. Furthermore, also from an environmental perspective, different priorities have been highlighted in Chapter 8.2. According to different 'environmental themes' and environmental impact assessment indicators in Table 111 – 'saving from waste bin' ranking per kg, there are many different environmental aspects relevant at the same time. The main environmental aspects can be summarised as follows:

1. Control over toxicity (see Hg content in lamps and flat panels, which is mainly occurring for category 5B, 3C, 4C and for instance Cd in battery packs for Cat. 6). See Chapters 8.2.3, 8.2.4 and 8.2.5 for the environmental findings,
2. Avoidance of global warming and ozone-layer depleting substances (these mainly occur for category 1B). See Chapter 8.2.2 for the environmental outcomes,
3. Recovery of abiotic resources: (metals and precious metals from high grade circuit boards in PCs and LCD monitors; which mainly occur for categories3 and 4,). See Chapter 8.2.3 for further details, and:
4. Recovery of energy and avoiding depletion of fossil fuels (plastics recycling; mainly occurring for categories 2, 3A, 4A, and to a lesser extent in category 7). See Chapter 8.2.3 for details.

These different environmental priorities and potential impacts also need to be considered as well as the number and weight of appliances put on market. According to Table 36 – Distribution (Wt%) between categories (In Chapter 7.1), category 1 is the largest category and could represent between 55% and 60% of the total weight put onto the market (depending on specific Member State). Categories 6 to 10 together represent only about 6% of total weight put on market and when tools are not taken into account, less than 1% in the environmental weight of Figure 60: Contribution of categories to environmental impacts of WEEE total in Chapter 8.4.2.

As it is not possible (due to lack of specific data on appliances out of the scope) to make environmental quantification on diverting such from disposal, the existing evidence in Chapter 8 is used to highlight where there are significant environmental impacts under which conditions: In Figure 63 and Annex 8.4.2, the eco-efficiency outcomes per product category is presented. This figure illustrates the environmental benefits per EUR invested. However, it does not relate to the total quantity of products that can arise as WEEE. Therefore the following table is calculated to illustrate the environmental impact of saving products from disposal. For each product category, the total WEEE arising is multiplied by the environmental impact of diverting 100% of these appliances from disposal (see Chapters 8.2 and 8.4 for the details of these two scenarios). From the outcomes, the contribution of each product category to the total of the environmental impacts per environmental theme is determined. See Table 114.

From this table it can be concluded that category 3C and 4C (flat panels) and category 7 (toys) are in all cases contributing less than 1% to the total impacts regardless of the environmental theme considered. However, the amounts currently arising as waste are still very low for the flat panels, in contrast to the toys category. For the latter, the eco-efficiency outcomes also show the lowest priority for this category when costs of treatment are included. It is important to notice the composition of the 'toys part' in the small appliances stream. See Chapter 8.0.5.3 and 8.2.3 for these details. The outcomes are mainly for toys with a rather high portion of electronics (game-consoles). For more plastic based products with hardly any electronics, the environmental and eco-efficiency outcomes will be even lower. This illustration demonstrates that in determining the scope one could ‘draw a line somewhere‘ in order to address really environmentally relevant products. However, where this should be done exactly is a political decision in the end. In addition, the issue remains whether the scope as such should reflect a high environmental ambition, or whether it should target what is happening in practice as a result of consumers discarding behaviour.

In any case, it needs to be decided whether:

1. The scope of the Directive is primarily used to appoint responsibilities for its provisions,

2. To set the level of environmental ambition by describing which appliances should be collected and treated and which are not, or:

3. To improve the basis for a more differentiated environmental target setting for the various treatment categories with respect to collection amounts to be achieved, recycling rates to be obtained and requirements for treatment.

WEEE arising kton

8,291,430,000

Indicator:	Cat.1A	Cat.1B	Cat.1C	Cat.2,5,8	Cat.3A	Cat.3B	*Cat.3C*	Cat.4A	Cat.4B	*Cat.4C*	Cat.5B	Cat.6	Cat.7
Name	**LHHA**	**C&F**	**LHHA-small**	**SHA**	**IT ex CRT**	**IT CRT**	***IT FDP***	**CE ex CRT**	**CE CRT**	***CE FDP***	**Lamps**	**Tools**	**Toys**
Weight	25.7%	16.0%	7.0%	12.2%	12.5%	8.0%	0.2%	4.5%	9.5%	0.2%	1.5%	1.7%	1.0%
Eco-indicator 99 H/A v203	11.6%	39.8%	4.0%	9.7%	12.9%	6.0%	0.4%	3.5%	8.8%	0.2%	1.2%	1.7%	0.3%
Idem, Human Health	7.7%	52.4%	3.3%	7.3%	14.4%	3.3%	0.5%	3.1%	5.9%	0.1%	0.5%	1.4%	0.2%
Idem, Ecosystem Quality	20.4%	11.7%	8.5%	16.8%	14.7%	6.5%	0.4%	5.6%	8.3%	0.1%	3.5%	3.0%	0.5%
Idem, Resource Depletion	17.9%	18.8%	4.2%	13.1%	8.6%	12.3%	0.3%	3.8%	16.0%	0.2%	2.0%	2.0%	0.7%
Cumulative Energy Demand	22.6%	21.3%	5.7%	10.2%	13.6%	7.9%	0.4%	4.2%	10.3%	0.3%	1.3%	1.5%	0.7%
Abiotic depletion	24.1%	21.0%	6.5%	9.7%	13.6%	7.5%	0.4%	4.1%	9.5%	0.2%	1.2%	1.5%	0.7%
Global warming (GWP100)	3.1%	89.3%	0.7%	1.7%	1.7%	1.0%	0.0%	0.6%	1.3%	0.0%	0.2%	0.2%	0.1%
Ozone layer depletion (ODP)	0.0%	99.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Human toxicity	33.3%	17.4%	7.8%	16.9%	10.3%	2.0%	0.3%	6.0%	0.7%	0.2%	2.2%	2.2%	0.7%
Fresh water aquatic ecotox.	32.5%	19.4%	7.2%	17.4%	13.1%	0.0%	0.3%	5.8%	-0.7%	0.2%	1.7%	2.1%	0.8%
Marine aquatic ecotoxicity	25.8%	21.4%	8.2%	11.4%	13.5%	4.2%	0.4%	6.7%	3.1%	0.3%	3.0%	1.7%	0.5%
Terrestrial ecotoxicity	6.1%	4.4%	2.9%	6.0%	4.1%	1.2%	0.3%	2.0%	1.5%	0.6%	69.4%	1.1%	0.2%
Photochemical oxidation	18.6%	13.4%	7.1%	8.6%	31.1%	4.0%	0.7%	4.9%	8.5%	0.2%	0.6%	1.7%	0.5%
Acidification	9.9%	9.0%	4.4%	9.4%	39.7%	5.4%	1.0%	4.4%	13.6%	0.2%	0.7%	2.0%	0.3%
Eutrophication	20.4%	23.1%	5.7%	15.2%	9.4%	7.5%	0.4%	5.0%	9.0%	0.3%	1.0%	2.5%	0.4%

Contribution to total: Red: > 50%, Orange >10%, Green <1%

Table 114: Environmental relevance of individual product categories to the total environmental impacts of WEEE

10.1.1 Inclusion or Exclusion from the Scope (Task 2.1.1)

Selection of Options

The first series of options addresses extending the scope or the opposite: certain equipment can, on the basis of environmental relevancy, be included or excluded from the scope of the Directive. The dataset of options presented in Chapter 9.1 has been further analysed in order to come up with the most relevant options for improvement. The dataset includes the following items:

Option 1.1.1 New types of equipment, not listed in WEEE Annex IB
Option 1.1.2 Review of the exclusions of 'part of another equipment'
Option 1.1.3 Review of the exclusions of 'military equipment'
Option 1.1.4 Review of the exclusions of 'large-scale stationary industrial tools'
Option 1.1.5 Review of the exclusions of 'implanted and infected products'

Other options suggested by stakeholders during the Expert Workshop embraced the following, additional ones:

Option 1.1.6 List of 'Types of Equipment'
Option 1.1.7 Base scope on article 95
Option 1.1.8 Base scope on 'practical relevance'

All options listed could be grouped according to three different main groups for analysis:

1. Options regarding the change (increase) of scope (Option 1.1.1),
2. Options regarding the review of current exclusions from the scope of the WEEE Directive (Options 1.1.2 to 1.1.5), and
3. Options regarding a common approach with respect to definition of scope and increase of harmonization or simplification across EU (Options 1.1.6 to 1.1.8).

Description/ Type of Incentives

Option 1.1.1 New types of equipment, not listed in WEEE Annex IB

One of the main concerns pointed out by stakeholders reflects the current lack of harmonization regarding the scope of the WEEE Directive. Annex 1B represents a '*list of products which shall be taken into account for the purpose of this Directive*'. Such list is an indicative and not an exhaustive one. For this reason one of the relevant issues regarding the scope is the definition of specific appliances falling under the provisions of the WEEE Directive. Despite that the potential inclusion of appliances is listed in Annex 1B, many grey areas still remain. In particular for those appliances potentially falling under the more general entries such as 'Other products or equipments for…' Furthermore the reference to 'household' in heading of category 1 tends to indicate that 'non-household' refrigerators for instance are excluded from the scope, even if there is no clearance about that. As appliances falling under Annex 1B are falling under Annex 1A, any increase of Annex 1B should not be regarded as increase of scope of the WEEE Directive, but 'de facto' as a clarification of the current scope. For this reason, the addressed increase of the scope of the WEEE Directive, shall take into account the following two aspects:

- Coverage of all EEE; this means, according to the definition of EEE in Article 2 of the WEEE Directive, the scope should then reflect not only annex 1A categories, but new categories which need to be added,

- Coverage of 'parts'; this means the inclusion in the scope of those products that are not finished products, according to the definitions in the FAQs, but are part of equipment falling into the scope of WEEE Directive (e.g. PC components like motherboards, or other spare parts for upgrade or repair).

Option 1.1.2 Review of the exclusions of 'part of another equipment'

Option 1.1.2 addresses to the current exclusion from the scope of the WEEE Directive for equipment part of another type of equipment that does not fall within the scope of the Directive itself, according to Article 2.1. According to the 'Frequently Asked Questions on the WEEE and RoHS Directive (FAQs) published by the EC, the interpretation of such exclusion in provided, even if not legally binding. Based on this document, a 'Guide to the scope of the WEEE and RoHS Directive' has been published by ORGALIME in 2006. Such document represents a valuable source of information but does not allow stakeholders involved or Member States to define in a clear and unique way which appliances are covered. FAQs are not legally binding and thus potential different interpretations from Member States can occur as well as from other entities (as justice courts) are still allowed.

It has to be highlighted that stakeholder feedback during the Expert Workshop on Option 1.1.2, did not point out the need to remove the exclusion for 'part of another equipment' but rather the need to be made clear how the approach towards such exclusions can be implemented across the EU. This is focusing much more on the harmonization issue than on change of scope of the Directive itself for environmental reasons.

Option 1.1.3 Review of the exclusions of 'military equipment'

Such option reviews the current exclusion of military equipment from the scope of WEEE. According to FAQs examples of such excluded products include arms, munitions and war material.

Option 1.1.4 Review of the exclusions of 'large-scale stationary industrial tools'

According to Annex 1B of the WEEE Directive Large-scale stationary industrial tools (LSIT) falling under category 6, are exempted from the scope of WEEE.

The interpretation of such exemption, given in FAQs states that LSIT '*are machines or systems consisting of a combination of equipment, systems, finished products and/or components, each of which is designed to be used in industry only, permanently fixed and installed by professional at a given place in an industrial machinery or in an industrial building to perform a specific task. Not intended to be placed on the market as a single functional unit*'

Option 1.1.5 Review of the exclusions of 'implanted and infected products'

Such exemption is currently accorded to medical devices falling under category 8 of annex 1A. The main reason for such exclusion is the potential safety and healthy risk for persons having to deal with at end of life. The FAQs provided also a definition of infected, as '*Infected products are understood to be products that have come into contact with blood or other biological contaminants prior to end-of-life*'.

Option 1.1.6 to 1.1.8 List of 'Types of Equipment', Article 95, and 'practical relevance'

Options 1.1.6 to 1.1.8, suggested by stakeholders during Expert Workshop, cover the two following aspects of:

1. Clarification of the scope which can be achieved by means of:
   a. Definition of an exhaustive list (Option 1.1.6). Such option includes a definition of exhaustive list of products in the form of current Annex 1B, in order to clearly define which appliances fall in or out of the scope of the Directive.
   b. Definition of scope by means of 'practical relevance' (Option 1.1.8). Such option introduces, in the definition of appliances covered by the WEEE Directive, a 'practical relevance' criterion. Such criterion can be based on the amount and likelihood of WEEE arising in the waste stream and the connected recycling and hazardous substance relevancy as proxy for the need to regulate such streams (i.e. appliances mainly arising in the (household) waste stream need to be in the scope of the Directive, products unlikely to arise in the waste stream, for instance due to value, size or being leased),
2. Harmonization across EU (Option 1.1.7), achievable by means of a '95 character' to the scope of the Directive. This option helps to overcome the current lack in harmonization of scope across different Member States and steers towards lesser fragmentation of the EU internal market due to the various WEEE provisions.

Impacts/Advantages, Disadvantages

Option 1.1.1 New types of equipment, not listed in WEEE Annex IB

Increase of scope of the WEEE Directive need to be regarded in respect of:

1. Appliances matching the definition of EEE in Article 2 of the WEEE Directive but not included in Annex 1A (e.g. electricity-generating equipments),
2. Parts of appliances that are not considered as finished products but are included, or could be included, as components into products that are falling under the scope (e.g. motherboards, memory cards, and other semiconductor components):
   a. In the case they are finished products their coverage is defined by the current annex 1A and 1B
   b. In the case they are non finished products and are included in products that are outside the scope of WEEE Directive, the exclusion criteria is already defined in the WEEE Directive as further explained in the FAQs.

It needs to be highlighted that regarding the inclusion in the scope of the WEEE Directive of EEE not falling in Annex 1A:

- Recital 16 of the WEEE Directive states that 'In order to attain the chosen level of protection […] Member States should adopt appropriate measures to minimise the disposal of WEEE as unsorted municipal waste'. It should be noted that in (DEFRA 2007), 12% of the large sample did consist of uncategorised products or components from which non-WEEE items were 9.9%, cables and plugs 1.3%, batteries 0.1% and individual unallocated materials 0.6%. Non-WEEE items in such sampling exercise stand for "material not falling within any of the WEEE Directive categories" and include, for example, "typewriters, weaving machines, petrol lawn mowers and other metal items, wood, fabric, cardboard and plastic". It was also noted in this and other sampling studies (DEFRA 2007) that the very small appliances do not return in the WEEE streams. It should be highlighted that the percentage of Non-WEEE (9.9%) includes both appliances falling out of the current WEEE Directive categories (e.g. typewriters, petrol lawn mowers), non-EEE items (e.g. metal, wood, fabric items, but also the petrol lawn mowers) and appliances falling in the "grey area" (e.g. car stereo),

- From an environmental perspective, the highest priorities highlighted in Chapter 8.2 demonstrated how much larger the environmental impacts are of specific appliances already tackled by the current scope (e.g. Cooling & Freezing appliances and all other equipment in Cat. 1-6), see also Table 114 at the beginning of this chapter,
- No detailed analysis is available or possible considering product currently falling out of the current scope of the WEEE Directive, even if the previous two considerations apply.

Regarding the inclusion in the scope of parts, the considerations in the beginning of the paragraph need to be taken into account.

The current lack in harmonization across EU27 with respect of the exclusion criteria for 'parts of another equipment', already pointed out, are further highlighted in the following paragraphs referring to option 1.1.2. The following considerations need to be taken into account in respect of the inclusion of parts of equipment:

- According to the FAQs, EEE should have a direct function to be included in the scope of WEEE Directive, in order to be considered finished product. Parts sometimes do not have any direct function unless incorporated into a final product (e.g. a motherboard need to be incorporated in PC to fulfil his function). The same criteria could apply when considering the example provided in (Goodman 2006) Option 1.1.2 considering the "device to measure temperature",
- According to Article 3 of the WEEE Directive, the definition of Waste Electrical and Electronic Equipment refers to 'EEE which is waste […], including all components, subassemblies and consumables, which are part of the product at the time of discarding'. According to such definition, in FAQs (e.g. paragraph 1.10) components, subassemblies and consumables becomes WEEE when they are discarded together with the appliance falling into the scope that contains them. According to this approach, in the case of components installed in a desktop PC, they are all part of the discarded PC and then falling into the scope of WEEE. The main problem occurs when such single parts are not discarded within the Desktop PC but as spare parts, possibly after upgrading, for example.

The following explanatory example taken and adapted from (EICTA 2007), provide further insights:

A consumer purchases a desktop computer branded with the name of a specific producer (thus this producer is responsible for all the provisions of the WEEE Directive). At some point, the consumer decides to upgrade the computer and purchases a new microprocessor and additional memory each branded by a different Producer. Under the position of some Member States, the old microprocessor and old memory would not be labelled since they were sold to original OEM by different suppliers (that's what's currently happening in the majority of cases) who manufactured and registered the desktop unit itself; when such 'parts' are intended to be in the scope of the WEEE Directive as such, they would need to be labelled, the producer registered and so on with all the related provisions of the WEEE Directive. The same provisions do not apply to the initial suppliers of the Desktop producer and to parts in the original Desktop PC.

The main arguments here are that whether a particular component is in the scope should not depend on how the product is sold (built in or upgraded). The same considerations applies to the example of car radios in the beginning of Chapter 10.1.

Furthermore, from a take back perspective, looking at the recycling chain in the case the disposed desktop computer coming to a recycling facility, these issues need to be addressed:

- Is the entire weight of this unit attributed to the Producer that initially placed the Desktop PC on the market?
- How should recyclers deal with assessment of potential presence of parts from other producers inside the Desktop PC? Chapter 8.2 highlighted the high impact on recycling costs of manual dismantling and disassembly. Furthermore, from an environmental perspective, there is no value added from such dismantling activities, despite the potential recovery of purity sub-fraction to be recycled.
- Are OEMs (i.e. Producers) responsible for the recycling costs for the new processor and memory purchased to upgrade the Desktop PC, but not the OEMs (i.e. suppliers) of the first Producer of the Desktop PC? Such approach would potentially fragment and cause distortion in the market and constitutes a kind of barrier to trade for those OEMs that address the market of upgrading parts. In addition, especially for the breakdown of the small appliances stream, who should pay for the large portion of non-WEEE items and other items formally out of the scope (12% of the total)?
- The potential negative environmental impact of discarded parts ending up in the MSW stream (especially for the smaller items) has not been highlighted in the sampling exercise carried out in UK (DEFRA 2007).

These arguments point out the main aspects which need to be taken into account when addressing the inclusion of parts 'as such' into the scope of WEEE Directive. But more fundamentally, they raise the question as to whether the definition of scope should be there to clarify the reach of the current producer responsibilities, whether they should reflect environmental ambition with respect to what should be collected, or whether they should reflect actual or potential discarding behaviour and the composition of WEEE streams in practice and, based on practical result, who is responsible for financing and the structure of the financing system.

Option 1.1.2 Review of the exclusions of 'part of another equipment'

The current approach of Annex IA or 1B does not allow defining whether a product is clearly in or out of the scope. For some products the assessment of whether they are finished products or components (both used in appliance falling under the scope or not of the WEEE Directive) is not always easy. The following example from (Goodman 2006) is very interesting: an 'electronic product used to measure temperature which has a meter to indicate the temperature as well as an electrical connection to provide this information as an electrical signal' could be recognized as:

1. If used in isolation to measure ambient temperature is a product falling into category 9,
2. If attached to a production line to measure temperature within a process, then this is a component on a LIST under category 6 and then excluded from the scope of WEEE Directive,
3. If installed in a self-contained machine tool, used in a workshop (not a production line) to measure cooling oil temperature, would be as a component within a category 6 product, and

4. If installed in a refrigerator to control temperature, this is a component of a category 1 product.

As in the previous example, the same appliances could fall under different status (in or out of the scope), depending on the specific use. Furthermore, it needs to be highlighted how manufacturers often do not know in advance how such products will be used due to sales through distributors.

Furthermore it's important to highlight that appliances potentially meeting such criterion are (ORGALIME 2006) components, subassemblies and spare parts that are not finished products (According to FAQs), but are part of equipment which do not fall under the scope of the WEEE Directive and include:

- Means of transport (e.g. equipments intended to be used on airplanes, cars, boats,…),
- LSIT (e.g. equipment that are part of industrial fixed installations), and
- Fixed installations.

These types of electronic equipment are managed in a very different way at end of life. In many cases OEMs are taking care of appliances containing such equipment and they are not returned in MSW. However, the problem is that this exclusion is not enforced across the EU in the same way. Therefore, the problem is lack of harmonization in the approach and not the scope itself.

It needs to be highlighted anyway that the total amount of appliances falling under categories 6 to 10 of the WEEE Directive currently only represent less than 6% of WEEE put on market, according to Chapter 7.1. In addition, many of the appliances in Cat. 8-10 are not found in the household stream, according to Compliance Schemes data (WEEE Forum 2005, ERP 2006). This is representing less than 1% of WEEE arising, and sampling exercise carried out in UK (DEFRA 2007) that found no appliances falling in such categories. The main impact of such exclusion criteria is lack of harmonization across EU. Considering the previous example, taken from the Monitoring & Control (category 9) Industry needs to be related to the average size and number of single producers: according to (GOODMAN 2006) SMEs represent 80% of this industry, placing on the market different types of diverse products in relatively small quantities. This means that potential distortion of this market is potentially high. This is also found in the SME panel questionnaires where a considerable number of SME's were found to be unaware of the existence of the WEEE Directive. In addition, it is demonstrated that these appliances are far less significant than other categories as displayed in Table 114 at the beginning of the Chapter.

Option 1.1.3 Review of the exclusions of 'military equipment'

Reasoning of exclusion from the scope of the WEEE Directive for military equipment relies on the aspects connected with the protection of interests of security of Member States. In particular some of the provisions of the WEEE Directive (e.g. the need to provide information on refurbishing, upgrading, or disassembly sequences according to Article 11 of WEEE Directive) seems to be quite dangerous and counterproductive when it comes to arms or war materials.

Furthermore it needs to be considered that:

- There is no detailed information available on all equipments connected with the protection of interests and security of Member States, like arms, munitions and war material, and

- Such appliances are not ending up in the MSW stream. For military equipment (arms, munitions, etc), specific procedure and regulations on the disposal or de-commissioning phase are in place in order to ensure health and safety standards.

No information is available on number and kind of appliances related to the security of Member States 'put on market'. It needs to be considered that such appliances (like arms, munitions and war material) are not 'put on market' but rather 'purchased' on contractual basis by ministry of Defence or other authorised entities. Furthermore, no information on materials or components used in military appliances is available or known, in order to make possible an environmental assessment or impact of such flows of equipments (there is some very limited information available in the US: DEER2, 2002).

No appliances falling into the 'military equipment' category have been found in the WEEE stream of appliances collected and treated across EU by Compliance Schemes (WEEE Forum 2005, ERP 2006), nor EERA members (EERA 2007) or in the sampling exercise in the UK (DEFRA 2007).

For the above reason, an in depth assessment of review of such exclusion is not possible, but the small amount to be expected in household stream make the current exclusion of such appliances to be reasonable.

Option 1.1.4 Review of the exclusions of 'large-scale stationary industrial tools'

In FAQs the definition of LSIT is provided. With regard to the exclusion from the scope of WEEE Directive for 'large-scale stationary industrial tools' (LSIT) the following needs to be considered:

- Such exclusion covers a specific stream of electrical and electronic appliances put on market. The German Machine Tool Industry account for more than 10 billion EUR of production value, representing the second country after Japan in respect of production and exporting more than 50% of production outside Germany, according to 2005 sales data. About 66% of German Machine Tool Industry has less than 250 employees (thus Medium sized). Such appliances are machines or systems designed to be used in industry only, ranging form 100 kg to over 100 tonnes in weight (GERMAN MACHINE TOOL INDUSTRY2006). They are installed by specialized personnel and permanently located during their phase use (ORGALIME 2006),
- LSIT machine tools are not found in the general household environment and do not end up in the MSW stream due to their size and value: typically they still have a considerable value even after being used in production for more than 20 years. There is a well-organised international market for used machine tools. These are refurbished and updated with modern technology and can still be in used in Europe or sold to countries all over the world. Machine tools are definitely not found in household waste (GERMAN MACHINE TOOL INDUSTRY2006). As a result no appliances falling into LSIT definition have been anyway found in the WEEE stream of appliances collected and treated across EU by Compliance Schemes (WEEE Forum 2005, ERP 2006), nor EERA members (EERA 2007) nor in the sampling exercise in UK (DEFRA 2007).
- For machine tools more than 50% of the commercial value is produced outside the manufacturer's premises from different suppliers (GERMAN MACHINE TOOL INDUSTRY 2006). For this reason, the inclusion of such appliances in the scope of the WEEE Directive hints specific problems related to the supply chain fragmentation (e.g. the

need of make available hazardous substances or components according to Article 11 of the WEEE Directive).

Option 1.1.5 Review of the exclusions of 'implanted and infected products'

With regard to the exclusion from the scope of WEEE Directive for implanted and infected products (falling under category 8) the following needs to be considered (Goodman 2006):

- Regarding the infected products, there is a health and safety risk for people involved in EOL activities. For these reasons medical staff (the last user) are not allowed, or in the most of the cases do not disinfect such products. Normally such EOL products are incinerated and could not be recycled, and
- Regarding the implanted products, they are usually not recoverable when a patient dies and in any event, if removed, they could be infected products.

The Medical Industry raised concerns on the harmonisation of such exclusion criteria across EU pointing out as:

- According current definition of 'infected' provided in FAQs, nearly 80% of appliances put on market would be 'infected' at end of life. Sometimes products are de-contaminated anyway after any single use (e.g. an endoscope) on a patient in the hospital. Such appliances, falling into B2B definition could then be also decontaminated at end-of-life, according to specific decontamination procedures in place and regulated. In some countries anyway, transboundary shipments of B2B medical appliances (from hospitals to OEM) for refurbishments were denied as the Basel Convention was applied. On the other hand one has to consider the 'social value' of equipment for reuse from the EU to industrialising countries.
- In some countries (e.g. Poland) the both criteria 'implanted' and 'infected' need to be met to exclude appliances from the scope of WEEE. Harmonization in respect of such criteria is needed in order to avoid fragmentation of the EU market. Especially in the medical sector, SMEs account for more than 80% of the industry and in the majority of cases single products supplied are less than 500 in the EU annually (Goodman 2006). This means that non-harmonized scope in respect of products in specific countries could hamper competitiveness of SMEs and fragmentation of the EU market, especially considering the provisions related to each single producer, especially even when a number of products are falling into the scope in some countries (e.g. Need to register at National Register sometimes hinting a national entity in place) and not in others.

Currently appliances falling under category 8 represent less than 1% of total weight put on market in EU 27 (see Table 114), and mainly falling into B2B market, according to data presented in Chapter 7. WEEE arising falling into category 8 is about 0,12% of total weight, according to Table 55, and mainly includes B2C 'domestic' medical appliances, collected together with Small Household Appliances, thus not related to the great majority of declared appliances put on market. The reason is that there are mainly B2B appliances sold in category 8; the average lifetime is often up to 20-30 years according to (Goodman 2006).

Option 1.1.6 List of 'Types of Equipment'

Option 1.1.6 (i.e. having an exhaustive list of appliances falling under the scope of the Directive) could contribute to achieve a level playing field across EU for stakeholders. If applied, it would be beneficial that such a provision is integrated with a '95 character', in order to ensure the maximum level of harmonisation. This is because clarification of the scope 'as such' could not steer automatically towards the desired level of harmonization across EU, without a legally binding approach for the Member States.

The main reasons for harmonization in respect to scope rely on different impacts that provisions of the WEEE Directive have on stakeholders when products are falling into the scope (e.g. registering, reporting, reporting, comply with all other provisions related to take back activities). The example of car radio provided in the beginning of the paragraph, as well as considerations about industries with a high level of SMEs involved, point out the need that the same products have the same status across the EU27. For some industries (e.g. Monitoring & Control) examples have been found (Goodman 2006) of producers selling less than two products sold in Europe annually. Estimation of Test & Measurements Collations pointed out in the sector, show on average that around 1,600 different models are in production but sold in very small numbers annually. As a result applying this option would mean a large improvement in terms of simplification.

On the other hand, an exhaustive list needs to be kept updated (in time!) in order to ensure new products out of the list as being developed by the electronics industry are inserted. The main risks and problems to be faced with are:

1. Inclusion of any new product in the 'coverage' list should be done in a timely-manner to ensure provisions of the WEEE Directive cover such products more or less directly when being placed on the market. This means that an assessment body should be in place that can in fact enable such a kind of analysis on new products 'on-time'. Or the TAC representing the Member States now would have the technical capability to decide much faster than currently,
2. Such a list should be legally binding for Member States (e.g. under '95 character') but should also be developed and kept updated in a flexible and timely way, in order to be able to respond to a rapidly changing market,
3. Inclusion of a product in such 'coverage' lists has a direct impact on all the subsequent provisions of the WEEE Directive (and partially of RoHS, as the scope of RoHS is referring to the scope of WEEE). Such provisions need to be taken into account even before placing new products on the market. This could turn into a kind of retroactive obligation for manufacturers who subsequently need to re-design products to be RoHS compliant.

The reasoning of stakeholders suggests these options rely on the much-needed increase of harmonization in respect of scope of the WEEE Directive. Problems highlighted for this option seems anyway to preclude such solution.

Option 1.1.7 Base scope on Article 95

This could have a positive impact on harmonization across the EU only if common understanding of the scope is in place. As a disadvantage, the use of a '95 character' does not automatically turn into a harmonized implementation of the scope, especially when there is no clear definition of legally binding criteria for the assessment of how a specific product is falling under the scope of the Directive. Therefore, this option needs to be integrated with additional measures to achieve a clear legal status in order to solve the current lack of harmonization across EU.

Option 1.1.8 Base scope on 'practical relevance'

Under the current producer responsibility provisions, it does not take into account (as a kind of ex-post assessment) changes in the waste stream composition due to new appliances put on the market. Therefore, when the criterion of inclusion in the scope of the WEEE Directive is the presence of appliances in the waste stream, there are different issues to be taken into account:

1. The breakdown of appliances put on market does not reflect one-to-one the breakdown of WEEE Arising and WEEE collected and treated due to:
   a. Different market saturation aspects,
   b. Different average lifetime of appliances that, together with saturation aspects shift the disposal of specific kind of products (e.g. FPD are nowadays sold in large quantities but not coming back yet in the same ratio in waste stream in the next years),
   c. Different EOL strategies in particular with respect to reuse and refurbishing,
   d. Different take back priorities and recycling technologies that prioritize specific waste streams (e.g. recyclers have economic incentive in collecting and treating specific appliances, having higher revenue due to their intrinsic content of valuable fractions as pointed out in Chapter 8.2), and
   e. Different disposal attitudes and awareness of final users in different regions in the EU,
2. The breakdown of WEEE arising does not reflect different environmental priorities, as highlighted in Chapter 8.2 and in particular:
   a. Control over toxicity (e.g. Hg contents in lamps and FPD, Cd battery pack for tools),
   b. Avoidance of global warming and ozone-layer depleting substances (e.g. mainly in cooling appliances),
   c. Recovery of abiotic resources (e.g. metals and precious metals), and
   d. Recovery of energy and avoiding depletion of fossil fuels (e.g. plastic recycling.

This option can have a negative impact on potential leakage flows due to change of the waste stream composition, when new appliances arising in the waste stream are not covered by the scope as these appliances had no 'practical relevance' in the past. The definition of the scope of the WEEE Directive on the basis of appliances found in the waste stream does not allow defining in advance which appliances are covered.

Boundary Conditions

Options referring to scope of the WEEE Directive have potential impact on all provisions of the Directive itself. Furthermore, as explained in the beginning of the paragraph, the RoHS Directive will also be influenced by a change in the scope of the WEEE Directive.

10.1.2 B2B versus B2C and Harmonisation (Task 2.1.2)

Selection of Options

The second series of options deals with B2B and harmonising the scope in the EU: the split between B2B and B2C equipment and non-harmonised scope in the EU. The list of options presented in Chapter 9.1 has been further analysed in order to come up with the most relevant ones:

Option 1.2.1 Applying of a '95 character'
Option 1.2.2 Differentiation per (sub)category
Option 1.2.3 Self-regulation

Other options suggested by stakeholders during the Expert Workshop embraced the following, additional ones:

Option 1.2.4 Exclude 'real' B2B equipment

Description/
Type of Incentives

Option 1.2.1 Applying a '95 character'

With respect to Option 1.2.1, there is a cross cutting issue with the first series of options. For this reason the option has been further investigated in the following paragraph, as the harmonization issue is one of the most relevant with respect to the scope of the WEEE Directive.

This option steers towards a more harmonized approach in terms of split between B2B/B2C. The underlying aspect to this option is to increase harmonization across EU for currently different potential provisions for similar flows of appliances.

Option 1.2.2 Differentiation per (sub)category

Regarding Option 1.2.2, it has to be highlighted that currently in some Member States, specific categories have been defined by law as B2B only or B2C only. The most recurrent cases are:

- Appliances of category 5B considered as B2C only, or
- Appliances of categories 8, 9 and 10 considered as B2B only.

Sometimes the industry itself aimed towards such approach in order to get such clear definition. That's the case of lighting Industry (ELC 2007).

Regardless these particular cases, the main reason for having specific definitions of B2B or B2C is the different financing mechanisms and provisions defined by Article 8 and 9 of the WEEE Directive. The underlying aspect here is to increase harmonization across the EU on different potential provisions and flows of appliances between different Member States, as pointed out in the beginning of Chapter 10.1.

Option 1.2.3 Self-regulation

This option embraces the same issues pointed out in the previous two options (i.e. the harmonization definition/split of B2B/B2C), allowing Industry itself to define such criteria.

Option 1.2.4 Exclude 'real' B2B equipment

This option aims at changing the framework requirements for B2B appliances. These appliances could be excluded from the scope of WEEE Directive when it is clear that such appliances will not occur in the municipal waste stream. This has to be proven by, for instance, demonstrating the weight or general nature of the product or by demonstrating otherwise that these products are not likely to enter the household stream and/ or are taken care of in a different manner in the case of a 'lease construction'.

Impacts/Advantages,
Disadvantages

Option 1.2.1 Applying a '95 character'

This option prevents a large variety of approaches in classification as B2B/B2C in different Member States. Thus it avoids the creation of market barriers by establishing different requirements regarding financial regime and guarantees and retroactive liabilities across Member States due to different requirements of Article 8 and 9 of the WEEE Directive. Registers and Compliance Schemes use very different definitions based on a range of criteria. This means that for every National Register or Compliance Scheme producers need to verify what the criteria for B2B and B2C are and this leads to a lot of unnecessary administrative work. For this reason a harmonized approach could have positive benefits in terms of:

1. Achieving a level playing field for all stakeholders, avoiding in particular, escape routes with respect to obligations in particular for dual use products, and
2. Reducing the administrative burden in compliance.

Sometimes it's simply up to the person filling in the reporting form to National Register or Compliance Scheme to tick B2B or B2C flags beside the amount declared, without any proof or criteria for the choice made. The economic impact of such non-harmonized approach leads to distortion in particular in the assessment of market share of producers and consequently to fragmentation and distortion of financial obligations, especially for a collective financing approach, based on market share assessment. According to Article 8 of the WEEE Directive, that should be the case at least for the historical B2C stream.

Option 1.2.2 Differentiation per (sub)category

Differentiation examples per (sub)categories found across Member States, allow highlighting how they are mainly focusing on Lamps (Cat. 5) and equipments falling into categories 8 to 10 mainly.

Rather than assigning a B2B or B2C-only character to some of the categories, it is important to establish a common set of criteria to differentiate between B2B and B2C in a consistent way as B2C products can be found for category 8, 9 and 10 also (e.g. all equipments falling into category 8, suitable for domestic use).

In particular the issue of so-called 'dual-use' products i.e. products that could be sold both as B2B or B2C – like PCs, Monitors, TVs – which do end up in the household waste stream more commonly than other 'intrinsic' B2B products need to be considered. Examples taken from Chapter 7, considering data of National Register of Spain for 2006 demonstrate this.

Category	Weight% Put on Market	% household	% non-household
1	58,3	97	3
2	6,3	98	2
3	11,6	59	41
4	10,7	99	1
5	6,8	16	84
6	2,0	77	23
7	2,1	55	45
8	1,2	9	91
9	0,2	30	70
10	0,8	1	99
Total Spain	**100**	**86**	**14**

Table 115: Total weight put on market and breakdown B2B/B2C in Spain, 2006

The above table allow also showing the impact of definition 'by law' as B2C of appliances in category 5 in some Member States. The percentage of weight put on market as B2B (and consequently of financial obligations where collective approach is in place) is quite relevant, especially considering B2B or B2C lamps entering the waste stream cannot be distinguished. Potential distortion of financial obligation in the case of dual-use products is more relevant than in other cases: in the case of a collective approach, producers responsible for 16% of weight put on market are financially responsible for 100% of discarded lamps found in the waste stream.

Option 1.2.3 Self-regulation

With respect to option 1.2.3 it has to be highlighted that a 'self regulation' approach of the industry could not lead to the desired harmonization across EU and, in particular, does not allow a proper enforcement and control over free-riders. In particular the economic impact and distortion of the internal market due to different criteria in declaring B2B/B2C, especially when not properly enforced, is potentially very high, especially for dual use products. Considering the breakdown of B2B/B2C in Table 115 above, and the same example of category 5, the total cost arising in 2011, considering the Full Implementation assumption of Chapter 8 (e.g. amount collected as Table 57 and arising costs as Table 113), corresponds to EUR 58 million. In the case of a pure Collective approach, Producers responsible for 16% of appliances put on market are then responsible for costs of WEEE Arising. When lamps put on market declared as B2B are ending up in the B2C stream, corresponding arising costs are shared only on those producers declaring B2C appliances put on market. The same counts for Monitors arising in Category 3: in a collective approach the financial impact of any ton of Monitors put on market and declared as B2B, ending up in the B2C WEEE Stream counts for EUR 460 per ton (i.e. technical costs, according to analysis in Chapter 8 and Table 113). Such aspects mainly occur when "dual use" products de-facto are not possible to distinguish as such, either at put on market stage or at WEEE arising stage.

Furthermore, any 'self-regulatory' approach by Industry only should then be legally binding in order to avoid a non-harmonised implementation of such agreements as well as opening an escape route like declaring B2C appliances put on market as B2B.

Option 1.2.4 Exclude 'real' B2B equipment

Analysis in Chapter 7 has pointed out how B2B appliances mainly appear in the categories 6 to 10. Such appliances represent, in weight, less than 6% of total amount put on market. High percentage of dual use products, falling into the first 5 categories is sometimes declared as B2B, but no real 'intrinsic' B2B appliances are found in the first categories, especially considering the heading itself of such categories (e.g. Large Household appliances, Small household appliances, Consumer equipment). Such headings emphasize the 'domestic' or 'household' main content of such categories.

Furthermore, for 'real' B2B appliances there are consolidated best practices in place that prevent such appliances from ending up in the municipal solid waste stream: they currently represent less than 1% of WEEE arising at municipal collection points or retailers and then entering the Compliance Scheme's stream (WEEE Forum 2005, ERP 2006). According to sample exercise in UK (DEFRA 2007), no appliances falling into categories 8 to 10 were found in MSW. At EOL they are very often managed on a contractual basis by producers and often refurbished, updated and sold again (Goodman 2006, GERMAN MACHINE TOOL INDUSTRY2006).

On the other hand, the issue of dual-use products is much more relevant in terms of weight put on market (as affecting, in particular, appliances in category 3 and 4 that represent, together, more than 20% of weight put on market), as shown in Table 115, considering the example of Spain. Dual use products need to be addressed in order to avoid such appliances, potentially falling under B2B channel, represent a leakage stream or to be an escape route from financial obligations. For this reason, different criteria will be addressed in the next section, in order to ensure a proper coverage of such appliances.

10.1.3 Alternative Definitions (Task 2.1.3)

Selection of Options

The third series of options discusses other options and definitions to determine the scope: The dataset of options presented in Chapter 9.1 has been further analysed in order to come up with the most relevant ones:

Option 1.3.1 Waste stream oriented instead of a product oriented scope
Option 1.3.2 Criteria lists
Option 1.3.3 Reference list from other nomenclature

Other options suggested by stakeholders during the Expert Workshop include the following:

Option 1.3.4 Scope defined according to 'products potentially occurring in WEEE stream'

With respect to option 1.3.4, it should be noted that there is overlap with Option 1.1.8 already suggested by other stakeholders during the expert workshop and analysed in the previous chapter.

Description/ Type of Incentives

Option 1.3.1 Waste stream instead of a product scope

This option means that the current 'product oriented' scope will be changed into a 'waste stream oriented scope' which might mean a significant simplification of the scope as products do not come back along product categories but 'in the container where they belong'. The rationale behind option 1.3.1 could be found highlighting how most of the collection schemes in the EU Member States collect in 5 or 6 groupings. In practice, the most common divisions are:

1. Large equipment, (category 1 and 10),
2. Cooling appliances, (category 1),
3. Cathode Ray Tube (CRT) containing (picture tube, category 3 and 4),
4. Lighting: lamps (category 5), and
5. Small appliances, (category 2, 3, 4, 6, 7, 8, 9).

The reasons for this division are economies of scale in collection logistics and in treatment by grouping waste according to its composition. Therefore, the idea of arranging the scope based on material categories rearranges the scope in line with the current collection and treatment practice. This is particularly relevant for the setting of targets for collection and recycling which is extremely relevant, as the environmental evidence in Chapter 8 has pointed out.

Option 1.3.2 Criteria lists

With respect to option 1.3.2 it has to be highlighted how the use of criteria lists works in order to determine which products fall in or out of the scope of the Directive. This could increase clarification and harmonization across EU (when such criteria are legally binding).

These criteria lists could be based on the function, market or product characteristics or other elements that will be further evaluated in next paragraphs. Such criteria could also include a substantial part of the elements of options described in the first and second series (e.g.

exclusion criteria of option 1.1.2 or enable the exclusion of particular B2B appliances in option 1.2.4).

The desired clarification with respect to scope and subsequent harmonization across the EU needs to be achieved by means of a mixed approach. Two main different issues need to be taken into account in the development of such approach:

- Clarification of scope, and
- Harmonization of the scope.

Both above issues need to be addressed simultaneously: harmonized definition of scope could not simply be achieved by means of '95 character' (option 1.1.7 or 1.2.1), as then the issue of defining and keeping updated a '95 character', exhaustive list needs to be considered (option 1.1.6).

For this reason, a flexible approach needs to be considered and, in particular, the definition of scope by means of a criteria list. Such a list could achieve the desired clarification of scope and, when legally binding, also contribute to the desired harmonization.

Option 1.3.3 Reference list from other nomenclature

The use of common nomenclature (like the customs CN code) could improve the traceability of appliances put on market by means of other statistics already available on Eurostat. Such an approach is currently present in Hungary, where the 8-digits code of CN nomenclature (custom tariff numbers) and their descriptions are used in Annex 1B of the transposition decree.

Impacts/Advantages, Disadvantages

Option 1.3.1 Waste stream instead of a product scope

Analysis in Chapter 8 has identified different environmental priorities, according to different product streams, as well as different recycling technologies and scenarios required. In most of the cases, recycling technologies are driving the collection clusters.

This way of defining the scope is much more focused on the original intent of the Directive regarding the 'waste management goals' of collecting more and treating better, which have proven to be very relevant from the environmental impact assessment. See especially Table 111: 'Saving from waste bin' ranking per kg, Table 56: Current Amount of WEEE collected & treated and the next table displaying the currently low collection rates and the effect on the total environmental impacts of WEEE in Figure 61: Total environmental impact for 2005 – 2011. This also enables setting equal collection and recycling targets within one and the same treatment channels and avoids sampling and environmental burden due to product categories treated in different treatment categories when it comes to allocating the cost of collection and treatment. Overall, a high level of simplification of the scope can be realised.

In this respect, to use the example of toys: One can for example choose to include game consoles (which are become more and more computer look-alikes) and other toys with a high electronics portion in category 3 or 4 and leave all others out of the scope. One can also choose to include all toys with electronic parts, but then many low value products like teddy bears with a battery inside will cause disturbance in recycling operations due to other types of materials and plastics present in comparison with current material compositions. The issue of deciding on environmental relevance in other ways is further discussed in this Chapter 10.1.

From individual product analysis of smaller WEEE items (cellular phones, PDA's, etc.) it is known that they even have a positive eco-efficiency when collected and treated. However, these appliances do not come back in the current WEEE channels (Huisman 2004b). The only small items collected in significant numbers are gas discharge lamps (see Chapter 8.2.5). These are already estimated at 22% return rates compared to products put on market, which is a relatively high number compared to all other small items (maybe except batteries). From an environmental point of view there are clear indications from the evidence provided in Chapter 8 that rearranging the scope from a waste management point of view might be preferable in order to address the variety in environmental impacts and weight per appliance and thus the target setting for collection and recycling. Such a way of determining the scope based on material content will obviously have consequences for the arrangement of financial obligations of producers. Therefore, the choice of financing mechanism by producers or consumers can make such a new arrangement either easier or more complicated. This is briefly discussed in this Chapter as well as in Chapter 11 when conditions for success are highlighted.

Option 1.3.2 Criteria list

The introduction of a (legally binding) criteria list could contribute in achieving:

1. Clarification of appliances falling under the scope of the Directive (including the current exclusion criteria as defined in Article 2 of the WEEE Directive and interpretation in the FAQs). A definition of a criteria list enables:
    a. An ex-ante assessment of appliances falling under the scope by producers (including new products), and
    b. The creation of a level playing field across industry, increasing certainty about appliances falling under the scope of WEEE Directive
2. Embrace a broad range of products/products category without need to be continuously updated. Such criteria enable even a broader definition of the scope. The definition of criteria list is a flexible approach that could avoid the risk of ex-post evaluation when new product put on market need to be inserted in a detailed list,
3. Enable the inclusion/exclusion of "finished products", according to FAQs being part of appliances falling then in or out of the scope of the WEEE Directive,
4. Enable the definition of B2B/B2C appliances and address the dual-use product issue. Such criteria list could also increase the harmonization in B2B/B2C split across EU, as currently no consolidated/consistent approaches are in place. Option 1.2.4 (i.e. exclude 'real' B2B appliances) could also be effectively implemented by means of such an approach, and
5. Embrace a set of criteria in order to prioritize some waste stream of product categories with high environmental impact (both per unit or depending on total amount put on market). Such a criteria list could also enable the creation of incentive mechanism to better enforce the provisions and aims of the WEEE Directive. This is also connected to Option 1.3.2.

Example of a criteria list, even if not legally binding, is the 'guide to the scope of the WEEE and RoHS Directive' published by ORGALIME in 2006, based on the FAQs document published by the EC. The decision tree has been defined in order to clearly assess whether an appliance falls within the scope of the WEEE Directive when meeting or not the exclusion criteria as defined by the WEEE Directive and according to interpretations provided by EC in FAQs.

A criteria list has been defined by a specific industry (e.g. Toys Industry) and received approval in some Member States to enable an assessment of products falling inside or outside the scope (and consequently the related obligations for toys producers). Such a list, as defined in a decision tree, includes the following criteria to be met:

1. Does the appliance (i.e. toy) depend on electricity to fulfil its primary function? The decision here should then consider if the major proportion of play value is retained once the electrical element is removed.
2. Does the appliance contain more than one part? When such criterion is met electrical games are included (e.g. electrical games, remote controlled cars, etc).
3. Does the appliance contain both electrical and non-electrical parts? When such criterion is met, only EEE parts should be included in the scope of WEEE (e.g. for a train set the electrical dependent part is only the engine and controller, not the coaches).

A criteria list has been also been proposed by EICTA (EICTA 2006) in order to distinguish between B2C and B2B appliance. Such criteria list includes:

1. Evidence in the form of signed contract between the business user and the Producer (or party representing the Producer e.g. reseller under contract), that clearly assigns responsibilities for end of life collection and treatment costs, ensuring that the EEE will not be disposed of through municipal waste streams, or
2. EEE that due to its features is not used in private households and that will therefore not be disposed of through municipal waste streams. This criterion should be supported by either one or a combination of the following criteria:
    a. EEE that is operated by specialised software as for example an operating system or system environment requiring a special configuration for professional use,
    b. EEE operating at a voltage or having a power consumption outside of the range available in private households,
    c. EEE requiring professional licenses to operate, e.g. Base Stations requiring the license of the telecommunication regulator,
    d. EEE of large size or weight requiring to be installed and de-installed or transported by specialists,
    e. EEE which requires a professional environment and / or professional education (e.g. medical X-ray equipment),
    f. EEE in category 10 of Annex 1A,
    g. EEE outside of the scope of the General Product Safety Directive for consumer products, or
    h. Statistics showing evidence that a particular type of EEE is not disposed through municipal waste streams (producer to provide argumentation / documentation).

Option 1.3.3 Reference list from other nomenclature

The definition of scope by means of the recourse to common or existing nomenclature (e.g. the Prodcom List (2007) or Combined Nomenclature (2007)) could increase the harmonization in the definition of scope, if such nomenclature is used and consistent across EU27.

Comparison of data and statistics available on Eurostat, under the Prodcom database are anyway quite difficult (IVF 2005a), as sometimes for countries with few manufacturers, the production figures are hidden due to rules within Eurostat (competitive secrecy). Unfortunately such an approach leads to the same problems of listing pointed out with Option 1.1.6: Keeping such lists updated, enforcing across the EU27 (e.g. by means of '95-character') and avoiding retroactive obligation for producers is causing problems. Furthermore, the potential update of such lists embraces also other aspects (f.i. the custom declaration system and other reporting standards or format) that hamper the effective use of this option.

10.1.4 Conclusions

With regard to the definition of the scope, it needs to be decided whether the scope is primarily needed for:

1. Appointing responsibilities to the relevant stakeholders,
2. Setting the level of environmental ambition by describing which appliances should be collected and treated and which are not, or:
3. To improve the basis for a more differentiated environmental target setting for the various treatment categories with respect to collection amounts to be achieved, recycling rates to be obtained and requirements for treatment.

The main aspects to be taken into account in regard of options referring to inclusion or exclusion from the scope of the WEEE Directive are summarised as follows:

1. The current exclusions are appropriate taking into account environmental evidences and practical experience with implementation of the WEEE Directive. In simple words: the current scope or better said, the current WEEE streams collected and treated are the right one from an environmental perspective, as highlighted in Table 114,
2. The most important aspect now is the lack of harmonization of the scope across the EU. Such harmonization is much needed for a limited percentage of products on the total weight put on market, but could potentially generate market fragmentation or distortion in particular Industries due to the intrinsic characterization of such markets (e.g. Tool Industry, Medical Industry or Monitoring & Control Industry), in particular with high involvement of SMEs (Justel 2007). The issue of harmonization of the scope needs both a further clarification of itself and also practical enforcement of the chosen approach across the EU. The harmonization issue also includes the definition of criteria and approaches to split B2B/B2C as well as the definition of alternative criteria to assess the WEEE product coverage. The main aspects related to the harmonization of B2B versus B2C refer to the current lack of consolidated approaches across Member States: such aspects currently hamper efficient policy measures and increase market fragmentation and distortions across stakeholders and Member States. Differences in approaches are caused by different interpretations of provisions of the WEEE Directive and sometimes even of differing National transposition of the financing obligations (Article 8 and 9 of the WEEE Directive) in respect of:

- Individual or collective approach for specific streams (Historical versus New or B2B versus B2C) mandatory or prohibited by law,
- Need to provide financial guarantees in respect of different streams (in particular the extension of financial guarantees to B2B appliances put on market), and
- Exemption criteria for financial guarantees (e.g. joining a collective scheme).

Furthermore the coverage of "real B2B" appliances by Compliance Schemes across EU is still very low, as shown in Table 56, considering WEEE arising in 2005, collected and treated across EU. This is mainly due to the fact that:

- Compliance Scheme running since before the entry into force of the WEEE Directive were focusing mainly on household appliances and sometimes new categories of products covered were added in last years to accomplish the product category list of Annex 1A, and
- "Real B2B" appliances tend not to end up in the municipal waste stream, and thus are not collected via Compliance Schemes. In most cases the focus is on household appliances and providing B2B service to potential members by different contracts agreements. Such appliances are not normally found in the municipal solid waste stream. Even before the advent of the WEEE Directive, a machine tool was not discarded via municipal channels; the same does not apply for household refrigerators, TV or other common household appliances.

The below table summarises the main impacts of the various options discussed:

Option	**Description**	**Environmental effectiveness**	**Cost efficiency**	**Other impacts/ social**	**Simplification (legal framework)**	**Other options/ legislation affected**
1.1.1	Add new types of equipment (new equipment out of Annex 1A)	Low. Current scope already tackle most relevant products	Varies per categories		None	
1.1.1	Add new types of equipment (include parts)	Low. Current scope already tackle most relevant products			Negative. Different provisions for parts built in or purchased for service	
1.1.2	Exclude "part of another equipment"	?			Positive	
1.1.3	Exclude "military equipment"	?	?		Positive	
1.1.4	Exclude "LSIT"	?	?		Positive	
1.1.5	Exclude "implanted and infected" products	?	?		Positive	Option 3.1.3
1.1.6	Exhaustive list of equipments	Very low. Only small number of products affected.	Neutral		Low: list needs to be kept updated	
1.1.7	Base scope on Article 95	Neutral. Only small number of products affected.	Positive: less EU differences for producers		Positive. But scope needs to be clear.	
1.1.8	Base scope on 'practical relevance'	Negative. Product need to be tacked due to environmental concerns (control toxicity, resources), not occurrence in Waste Stream	Negative		Low. Changing over time.	

Option	Description	Environmental effectiveness	Cost efficiency	Other impacts/ social	Simplification (legal framework)	Other options/ legislation affected
1.2.1	Apply Article 95 to the definition/split of B2B/B2C	Neutral	Positive. Less admin. burden		Positive. Ensure level playing field.	
1.2.2	Differentiate B2B/B2C per (sub)category	Neutral	Positive		Positive. Ensure level playing field.	
1.2.3	Self regulation by Industry	Negative	Negative		Negative. Increase free-riding.	
1.2.4	Exclude "real" B2B equipment	Neutral	Positive	Less risk of declaring too much as B2B	Positive.	
1.3.1	Define a waste stream oriented scope	Positive. Allows more specific target setting where really needed	Positive. Less admin. burden		Very Positive.	Options 10.2 10.3 10.5
1.3.2	Define scope by means of criteria list	Neutral	Positive		Positive	
1.3.3	Define scope by means of reference to other nomenclature	Neutral	Neutral		Low	
1.3.4	Define scope according to products occurring in the WEEE stream	Negative. Products need to be tackled according to environmental concerns			Negative. Changing over time.	

Table 116: Overview impacts options (scope)

Any increase of the scope (Options 1.1.1 to 1.1.8) has less environmental impact than a better enforcement of the current scope of the WEEE Directive, for particular categories. From an environmental perspective Table 114 and evidence in Chapter 8.2 show how the main relevant products and product categories are currently tackled by the current scope (e.g. Cooling & Freezing appliances containing ODS and other appliances falling in the current categories 1 to 6):

1. There are no products having huge environmental impact falling in "grey-areas" or inside or outside the scope across different Member States: CFC containing appliances are tackled across EU27, as well as other "environmentally relevant" products. For this reason the environmental effectiveness of the increase of the scope of WEEE Directive is low.

2. Currently appliances falling into the first six categories represent more than 99% of WEEE taken care by Compliance Schemes according to Table 55 and nearly 95% of WEEE processed by EERA across EU,

3. Tables 56 and 57, as well as Table 117 (in Chapter 10.2) show a considerable room for improvement in collection rate for specific categories of appliances (e.g. Cooling & Freezing, Small Household Appliances, IT & CE, Lamps). For this reason, options related to collection targets (e.g. Option 2.1.2, 2.2.1, 2.2.2) have a better environmental effectiveness when combined with the current scope of the WEEE Directive. Analysis in Chapter 8.2 further

support from an environmental perspective any increase in collection of specific product categories currently tackled by the scope of WEEE Directive, as summarized in Figure 58 and Figure 59 due to positive environmental benefits (e.g. Cooling & Freezing appliances or FPD considering the impact per kg of products).

4. Any increase in collection rate and proper treatment of appliances discarded has a strong correlation with economic impacts on stakeholders as collecting & treating simply costs more, according to analysis carried out in Chapter 8.1 and summarised in Figure 62. There is a trade-off in the eco-efficiency analysis summarised in Figure 63: for some categories, environmental benefits are very high for the costs made, for some others the same does not apply.

Taking into account the above considerations, the most favourable options are according to the table:

1. Option 1.1.7 and Option 1.2.1, both referring to the adoption of "95 character" in the definition of scope and in the split of B2B/B2C
   The main impacts of a non-harmonised scope on stakeholders with respect to all different provisions of the WEEE Directive are:
   a. Administrative Burden: in particular assessing different compliance requirements across Member States (e.g. registering and reporting standards), and
   b. Market Distortion: in particular with different provisions on Individual/Collective approach allowed according to different National Transpositions, competitiveness or different approaches in compliance by SMEs.

   These elements enable a fundamental consideration: any chosen scope of the WEEE Directive, defined from any environmental priority, needs to be clear and then enforced across EU27 in the same way (Option 1.1.7). This means that the same products need to have the same status across different Member States. Option 1.2.1 needs to be considered together with the definition of a legally binding criterion to assess the B2B or B2C status of appliances.

2. Option 1.2.4, Exclude "real" B2B equipment
   Due to the limited amount of appliances covered by the WEEE Directive as real B2B, appliances falling into such categories could be removed, especially knowing all of these appliances are already taken care of by other means/ regulations/ own take-back systems and due to intrinsic value. Such an option could play a significant role in the simplification of the WEEE Directive. Option 1.2.4 needs to be considered together with the definition of criteria (Option 1.3.2) to address the dual-use products issue and safeguards and incentives that true B2B appliances or B2C appliances used in businesses are collected as much as possible and treated under high standards.

3. Option 1.3.1 Define a waste stream oriented scope, and Option 1.3.2 Define scope by means of criteria list
   Positive Environmental benefits could be achieved by means of a "waste stream oriented scope" (Option 1.3.1), enabling to set equal collection and recycling targets within one and the same treatment channels and avoids sampling and environmental burden due to product categories treated in different treatment categories when it comes to allocating the cost of collection and treatment. Overall, a high level of simplification of the scope could also be realised. The definition of scope according to waste stream has a positive environmental effect when allowing a more focused target setting:

a. Currently, appliances containing cooling agents are falling into category 1 (e.g. household refrigerators), category 8 (e.g. freezers) and category 10 (e.g. automatic dispensers for cold drinks),
b. Despite the current lack of specific target on recovery of hazardous substances and environmentally relevant agents (e.g. CFC gases in blowing agents or foam) further described in chapter 10.3, there are now even different recovery percentages on appliances, according to Article 7 of the WEEE Directive: targets for appliances in categories 1 and 10, no targets for appliances in category 8,
c. Such appliances, despite falling into 3 different product categories have the same technical requirements on treatment perspective.

The same counts for other products, currently falling into different categories, and also having different recovery targets, and. although collected and treated together, such as appliances falling into product categories 1C (e.g. a microwave oven), 2 (e.g. a vacuum cleaner), 3A (e.g. a printer) and 5A (e.g. a luminaire), and all falling in SHHA waste stream. These 4 products have different weight based recovery targets but in majority of cases are collected in the same container, transported and treated together in recycling facility (having then to report to environmental agencies in many cases the mass balance). At the end, according to the reporting standard defined in Commission Decision 2005/369/EC, performances achieved and reported by Member States, should reflect the product category breakdown. Administrative burden and difficulties in reporting performances according to a format that does not reflect the current operations further hamper the effectiveness of any real, effective monitoring effort.

The main findings in the analysis of the scope of the WEEE Directive pointed out how any method of defining the scope needs to embrace the main priorities that any determination of the scope should then enable:

1. Environmental relevancy and material composition,
2. Achievement of a level playing field for different stakeholders across EU, and
3. Clarification and concurrent enforcement of harmonized approach across Member States.

Any chosen approach for definition of scope needs to address both aspects at the same time. For this reason different elements should be considered at the same time, including a '95 character' to enable a harmonized application of the scope across EU27 (Option 1.1.7) and to address the most important environmental concerns as well as avoiding delays in implementation due to interpretation problems which also has negative environmental effects.

A criteria list for the definition of the scope (Option 1.3.2) allows achieving the desired aims (even considering options referred to in Chapters 10.1.1 and 10.1.2) in a flexible way. The use of different criteria based upon the (environmental aspects of the) collection and treatment categories could furthermore contribute to more environmentally relevant targets for collection (Chapter 10.2), recycling and recovery (Chapter 10.3) and treatment (Chapter 10.5) and thus environmental effectiveness. This should be linked to the findings on collected amounts and stream compositions as described in Chapter 7 and the environmental and economic impact assessment of Chapter 8 which are appointing the most relevant products and materials to collect and treat.

10.2 Collection Targets (Task 2.2)

Introduction

For all options presented here: the environmental and economic impact assessment of Chapter 7 and 8 show the environmental priorities in relation to cost efficiency for all categories, substances and environmental themes over time as well as the eco-efficiency of various scenarios. Chapter 9 introduced the methodology used for this chapter. The findings of the workshop held are integrally presented in Annex 10. Conditions for a successful implementation when changing the legal framework will be further highlighted in Chapter 11 in a more integral manner.

This section assesses options for changes to the current collection target of 4 kg/inhabitant per year. It considers:

- Changes to the type of collection target, and
- Options for reducing leakage from the collection infrastructures.

It also discusses other options for increasing the amount of WEEE which is collected and sent to a suitable treatment facility for recycling, takes into consideration the findings from the workshop on collection targets, and proposes an approach for setting a new collection targets.

The data on amounts of EEE items put onto the market shows that the average across all EU27 Member States is around 21 kg/inhabitant per year. The amounts of WEEE arising are lower than this figure, and are currently estimated to be equivalent to an average across all EU27 Member States of 15 kg/inhabitant per year. The comparative collection performance of Member States, Norway and Switzerland where data on collected amounts by category are available is shown in terms of kg per inhabitant for each product category in Table 117.

	Category Number										
Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Totals 1-10**
Norway	8.15	0.46	2.68	2.01	-	-	0.04	0.06	-	0.01	13.41
Switzerland	4.19	1.40	3.52	2.17	0.12	0.04	0.01	0.00	0.00	0.00	11.44
Austria	2.0	0.3	0.1	0.2	0.1	Inc 2	Inc 2	Inc 2	Inc 2	Inc 2	2.77
Belgium	2.99	1.12	1.16	1.64	0.20	0.14	0.00	0.02	0.00	0.00	7.26
Czech R	0.14	0.00	0.12	0.05	0.00	0.00	0.00	0.01	0.00	0.01	0.33
Estonia	0.48	0.00	0.04	0.10	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.63
Finland	4.75	0.28	1.44	1.30	0.27	0.03	0.00	0.02	0.01	0.00	8.10
Hungary	0.91	0.04	0.09	0.22	0.01	0.00	0.00	0.00	0.00	0.00	1.27
Ireland	6.68	0.28	0.43	0.67	0.09	0.07	n.d.	n.d.	0.00	n.d.	8.22
Netherlands	2.59	0.53	n.d.	1.18	0.03	0.06	0.03	0.00	0.00	0.02	4.44
Slovakia	0.35	0.04	0.05	0.20	0.02	0.00	0.00	0.00	0.00	0.00	0.66
Sweden	5.01	1.41	2.54	2.36	0.74	0.11	0.02	0.02	n.d.	n.d.	12.20
UK	7.17	0.54	0.59	1.10	0.04	0.35	0.16	0.00	0.00	0.00	9.95
NO/CH average	4.11	0.93	3.10	1.39	0.06	0.02	0.02	0.03	0.00	0.01	9.67
Euro average	**3.11**	**0.42**	**0.65**	**0.88**	**0.14**	**0.08**	**0.02**	**0.01**	**0.00**	**0.00**	**5.31**

n.d. = no data, Inc 2 = included in category 2 figures

Table 117: Amounts of WEEE collected (kg/inhabitant per year)

Importantly: the above table shows very large differences per category even for countries with high totals over all ten categories. This indicates that there is substantial room for improvement even in these Member States. Also see the estimated potential improvements per category that are possible in Chapter 8.0.5 in Table 56 and Table 57.

Some EU15 Member States (and Norway and Switzerland) are already collecting over 10 kg/inhabitant per year, but much lower WEEE arisings as there is less sold mainly in the new EU Member States could mean that achieving this target would be extremely challenging for others. This may well require different collection targets to be set in different Member States or groups or Member States.

The main disadvantage with the current target is that it does not specify the types of WEEE items that need to be collected. Member States that have higher levels of WEEE arisings can easily meet the target without needing to separately collect any of the more hazardous WEEE items. Other Member States where a large amount of Cat.1A LHHA is collected and treated outside of the WEEE-channels might have much better overall performance but lower total quantities per inhabitant. See Chapter 8.4.4, Figure 62 for the varying economics per collection category which makes that there is an economic driver to collect and treat regardless of incentives coming from the WEEE Directive and Chapter 10.1, Table 114 for the different environmental priorities per product category.

10.2.1 Maintain or Increase Targets, Type of Target (Task 2.2.1)

Description/
Type of Incentives

The findings from the environmental impact assessment of Chapter 8.2 show that certain products and product categories should be prioritised. Thus there is a need to focus efforts on the products that exhibit the greatest environmental impacts in order to ensure that an appropriate level of collection is achieved for these products.

The current 4 kg/inhabitant target does not specify which items of WEEE should be collected. This can result in a situation in which the collection target is achieved, but there is very little improvement in environmental efficiency. Consequently, the first series of options addresses maintaining, increasing or defining collection targets, and these are:

Option 2.1.1 Maintain current targets
Option 2.1.2 Higher or specific collection targets for more hazardous WEEE
Option 2.1.3 Alternative definition (% based on previous years put on market)

Option 2.1.2 is intended to maximise the amounts of hazardous WEEE that should be brought under control and is intended to ensure that minimum levels of collection be achieved for categories where the greatest environmental improvements can be gained. This option should also provide better linkage to recycling targets.

Option 2.1.3 sets a target based on a percentage of material put onto the market in the previous year(s).

Impacts/Advantages,
Disadvantages

Option 2.1.1 Maintain current targets

Over 55% by weight of items put onto the market are in category 1 (see Table 36). As the average amount of EEE put onto the market in the EU27 Member States is about 21 kg/inhabitant, then setting a general target to collect as much as 10 kg/inhabitant could still be met purely by collecting category 1 items only. Consequently, unless a very high collection target (e.g. over 15 kg/inhabitant per year) was set, Member States that have high arisings of WEEE would have little incentive to improve collection of WEEE categories which contain more hazardous materials (particularly categories 3 and 4), see Table 114 in Chapter 10.1 and Table 117. Thus, maintaining the current collection target offers no opportunity for significant improvement in environmental performance.

Option 2.1.2 Specific or higher collection targets for more hazardous WEEE

The use of this approach should result in better management of the hazardous fractions of WEEE, and thus its main advantage is that it would reduce the overall environmental impacts. However, it would result in higher economic impacts (as these items are likely to be more expensive to treat), but this could act as an incentive to improve the technology used in the treatment of hazardous WEEE items.

There are three disadvantages with this approach:

- The RoHS Directive could erode the relevance of such targets in the longer term, as newer equipment tends to contain less hazardous materials than equipment made in earlier years. However, there will still be a need to collect older equipment as it enters the WEEE stream,
- A list of 'more relevant' WEEE items would need to be developed. It would also need to be updated as required when new products were to come to market, and this could result in significant legislative revisions for Member States,
- There would be a decreased administrative burden in reporting the amounts of 'more relevant' WEEE items which had been collected when it would be reported in less than the current 10 product categories.

However, the analysis in Chapter 8 demonstrates that the advantages listed below are to be regarded as more important than the disadvantages:

- The highest environmental improvements can be realised simply by collecting and treating more,
- Despite the RoHS Directive, especially for category 3C and 4C, and 5B substantial amounts of new hazardous material containing appliances are still put on market (e.g. Hg backlight behind LCD screens) from which the lamps in Category 5 are relatively light and therefore easily ignored with a more general target,
- If the division for the scope into treatment categories from Chapter 10.1 is followed, the targets can in principle be divided in only 5 or maybe 6 groups and not be bound to individual items.

As a disadvantage, there is obviously an increase in costs: Table 88 shows our estimates of the overall economic impact in moving from current to future (maximised) potential (2005 to 2020). Figure 63 shows the relation between this cost and increase and the resulting environmental benefits in an eco-efficiency ranking per category.

Two possible approaches to setting weight-based targets for collection of different categories of WEEE are in principle:

- An overall collection target, with a minimum percentage of this to be from specified categories: The three main WEEE categories which contain a higher proportion of more hazardous or environmentally relevant materials are categories 3 and 4 and 5B. These represent about 20% of the amount of material put onto the market. Thus for example, if an overall target to collect 10kg/inhabitant was set, then a minimum target of 2kg/inhabitant of items in categories 3 and 4 could be set,

- An overall collection target, but with minimum targets for all or for specific categories, or as based on the total collection and treatment categories. The main disadvantage of this approach is that it would provide little incentive to collect WEEE categories for which no collection target was set.

Option 2.1.3 Alternative definition (% based on previous years put on market)

This could be used to increase the collections of both the total amount of WEEE and the amounts of the 'more hazardous' items. However, there is the issue with this type of option, as it does not consider the differences between the established/saturated markets in the EU15 Member States and the developing/expanding markets in the EU Accession Member States. This would make it more difficult to plan for collection and treatment as the target quantity of material could well be different each year (a fixed collection target is easier to understand and implement). However, it does better reflect the overall difference in potential amount of WEEE arising than applying the same target for all EU member states. For example, as the average amount put on market for the EU27 is about 21 kg/inhabitant and the average WEEE arisings are about 15 kg/inhabitant, then an average of about 70% of amounts put on market would be the maximum available for collection. Our analysis of 'full implementation' potential (see Table 57) indicates that (apart from LHHA) up to 60-75% of WEEE arisings by category are the maxima achievable in practice. Thus, collection targets of between 42% and 52.5% (depending on category) of the amounts put on market could be set.

Conclusions

The differences in WEEE arising in different Member States suggest that the best approach may be to set different collection targets for 'clusters' of Member States. Or to determine in a more advanced way a percentage either based on the estimated WEEE Arising as demonstrated in Chapter 7.2 or based on amounts put on market. For the former, this would however require improving the accuracy of these numbers as well as validation by a competent body. However, there is a need to make sure that these targets are accompanied by appropriate measures in Member States which ensure that an appropriate percentage of the more hazardous or environmentally relevant WEEE items are collected. Options 2.1.2 and 2.1.3 would all enable this to be achieved.

10.2.2 Avoiding Leakage from the Collection Infrastructures (Task 2.2.2)

Description/
Type of Incentives

The differences in the amounts of WEEE items which are collected for treatment, particularly between the EU15 Member States, demonstrate that leakage is occurring on a large scale. Concerns exist around the opportunities available for WEEE to escape the proper management system either as illegal exports out of the EU to countries ill-equipped to manage WEEE in an environmentally sound manner, or as back-door sales to unlicensed operators again with the risk that WEEE is not managed in an environmentally sound way. Recent examples substantiating these concerns include reports about shipments of WEEE disguised as goods from the port of Hamburg (DEUTSCHE UMWELTHILFE 2007) and findings that 28% of businesses (collectors and exporters) were found to be exporting WEEE illegally from the

Netherlands (VROM 2007). A study in the United Kingdom showed that about 10% of WEEE transports were shipped illegally to non-OECD countries. VROM estimates that 15% of the WEEE stream is not collected as a result of free riders, i.e. producers or importers who sell electrical and electronic equipment but do not live up to their take back obligations regarding WEEE (ETC/RWM 2007). These are only few examples of reported experiences from various European countries. At present there is only a rather limited knowledge about these illegal shipments, also crossing the border-lines overland via trucks, to build solid conclusion on. However, there is common agreement that substantial leakage occurs for any WEEE items which have a value, such as large domestic appliances (which contain mainly metals), desktop computers, TV's and mobile telephones. There are well-established 'grey markets' for these items. Items for which there appears to be lower levels of leakage are mainly those which have reuse value elsewhere and are more costly to recycle/ treat; these are likely to be the more hazardous items.

A number of options for reducing leakage have been considered. These are:

Option 2.2.1 Mandatory hand in by retail and municipalities at certified compliance schemes

Option 2.2.2 A different trade-in mechanism at retail collection points

Option 2.2.3 A minimum number of collection points

Impacts/Advantages, Disadvantages

Option 2.2.1 Mandatory hand in by retail and municipalities at certified compliance schemes

The main advantage of this Option is that it would ensure that all separately collected WEEE is transferred to accredited reprocessors, thereby ensuring proper treatment. This would reduce 'cherry picking' of the better quality WEEE prior to reprocessing, with the potential to achieve the 'full implementation' case described in terms of amounts and costs in Table 57 and Table 110.

The main disadvantage is the increased enforcement burden on competent bodies, and the need for the input/output data from collection points to be reported to competent bodies and validated. In order to make this work, also a reimbursement or payment for handing over WEEE might be further investigated instead of a compensation payment for storage and collection efforts.

Option 2.2.2 A different trade-in mechanism at retail collection points

With this option it is meant that consumers can hand in old product at retail shops when these shops are selling equipment in the same category. So instead of the often 'old-for new' approach this might enable higher collection by removing barriers for returning discarded products. This approach is in place in Norway and Switzerland, countries that are collecting relatively high amounts, according to data in Chapter 7. Denmark, in the national transposition of the WEEE Directive, enforced such mechanism, even if on a voluntary basis for retailers: this means that retailers that choose to provide take back service to final users are providing such service not on "old for new" basis but accept any kind of appliance they are selling from final users, without an equivalent purchase.

The disadvantage of this option could be that more centrally located retailers would receive more, but this could be compensated by a reimbursement or even a volume based payment: data from (Recupel 2007) shows the highest annual take back increase for retailers, compared to municipalities collection points under the reimbursement contract (in place since 2003, 2004 and 2006). A similar effect is known to have appeared in Switzerland.

	2003	2004	2005	2006
Annual grow rate for Retailers	90,37%	34,44%	24,28%	16,03%
Annual grow rate for Municipalities	14,07%	27,09%	14,01%	8,77%

Table 118: Growth in collection per year from retailers and municipalities

Both the above table and the Table 117 at the beginning of this Chapter indicate that countries with a relatively high number of well accessible collection points do collect more. Therefore, the following option is researched:

Option 2.2.3 A minimum number of collection points

The WEEE directive is currently not prescriptive on requirements for the collection infrastructure, as it only requires Member States to set up efficient collection schemes which both achieve a high level of collection and minimise the disposal of WEEE as unsorted municipal waste. This involves ensuring the availability and accessibility of the necessary collection facilities taking into account in particular the population density. This could take the form of either numbers/head or numbers/population density area.

The main envisaged impacts of this option are the location and cost implications for conforming to a minimum standard for collection point provision.

The main advantage of this option is that it enables a harmonised level of collection capacity provision to be achieved across the EU. Although it would provide Member States with clarification on minimum standards expected for efficient collection of WEEE, data would be required on current experiences from the Member States in order to establish an optimum level which balances costs against environmental improvement (collection efficiency).

The main disadvantage is that it dictates a 'one size fits all' approach to collection. In practice, different Member States may wish to approach collection infrastructure provision in different ways. A system based on one collection point per X people could result in the need to travel a long distance to reach the point in rural/remote areas and would not encounter the individual infrastructures and preconditions in the Member States. There clearly is a need to set minimum criteria for accessibility and quality of service, but the individual Member States seem best positioned to decide about these.

Closely linked to the definition of scope in collection and treatment categories is the following: In addition to any requirements for a minimum number of collection points, collection centres tend to be organised on a practical basis for keeping hazardous and non-hazardous WEEE separate, and the use of five separate containers appears to be a common recommendation:

- Container 1 – Large household appliances
- Container 2 – Cooling and Freezing (containing Ozone Depleting Substances),
- Container 3 – Small household appliances (Mixed WEEE (all other WEEE),
- Container 4 – TVs and monitors (containing CRTs),
- Container 5 – Lighting,

- and sometimes: (Container 6 – PC's and laptops as different shredding settings or dismantling can make environmental and economic sense).

The overall calculated costs for these container streams are presented in Table 113 and graphically in Figure 63. The main advantage of this collection system is that it enables the separation of non-hazardous and hazardous WEEE to take place, as those bringing WEEE to the collection centre have a practical and clearly understandable system for depositing their WEEE appropriately.

The main disadvantages are that municipal waste collection centres are constrained by the limited site area at some collection centres (and thus there might not be space for five separate containers) which can be very costly to adapt. Protocols may also be required to establish typical category compositions reporting to each container (especially for container 3). For example, see (DEFRA 2007).

Further information on current experiences from the Member States would be required in order to establish best practices in terms of overall collection efficiency. Data would also be required in to establish EU-wide protocols for a preferred standard collection structure. This aspect can also be incorporated in standards for compliance schemes or within more dynamic negotiations between member states and compliance schemes. This issue will be further discussed in Chapter 11 that also focuses on responsibilities in general. Right now financial responsibility could mean that collecting more is adding costs for producers and the mechanism itself might therefore be counterproductive.

Conclusions

Leakages in collection are any volumes that are not incorporated in the 'official' waste stream.

Some items which are collected may not be appearing in official figures because they are sold directly to treatment facilities by the municipalities. Items which are sent to another EU Member State for re-use are likely eventually to be recycled in that Member State. However, the issue of export of items to countries outside the EU is a current concern as this can result in both a probable lower quality of treatment and a loss of resources from the EU when the item is recycled. Despite reviewing existing and potential new rules, monitoring and enforcement of export streams is highly recommended. Guidance (CORRESPONDENTS 2007) is now available that should help to reduce illegal exports of WEEE.

It will be very difficult to solve all of the problems related to leakage. A suitably high overall collection target may well reduce leakage via sales to the 'grey market', but fair financial compensation to municipalities and retailers for their efforts for acceptance of WEEE might well provide an incentive for them to present all collected WEEE to the recognised systems (particularly if this covers loss of income from possible sales of items to the 'grey market').

10.2.3 Other Options for Improvement (Task 2.2.3)

Description/
Type of Incentives

A number of other options for improving collection rates have been identified. These are:

Option 2.3.1 Introduction of a return premium for consumers
Option 2.3.2 Lower compliance cost when collection target achieved
Option 2.3.3 Mandatory consumer education
Option 2.3.4 Introduce a Recycling Fund mechanism

Option 2.3.5 Other financing models to promote better collection
Option 2.3.6 More enforcement of waste shipments

Some of these options represent the 'carrot' approach rather than the 'stick' approach of mandating targets for collection. This is brought about through providing the appropriate economic conditions in order to ensure that higher levels of collection are promoted and consumer behaviour is steered towards better environmental management choices for discarding their end-of-life equipment.

Impacts/Advantages, Disadvantages

Option 2.3.1 The introduction of a return premium for consumers

There are various ways that such a return premium could be introduced. The main impact would be greater return rates at collection points (measured as increased tonnages of collected WEEE). There would also be an environmental benefit due to the reduced amount of WEEE leaking to unsorted disposal routes.

The main advantage is that it would be easy to introduce and implement. The main disadvantage is the risk of fraudulent activity if it is not properly controlled and installed equally in all Member States.

Although there are examples of refund systems operating successfully (e.g. deposit refund systems for beer bottles), none have been identified that apply to highly diverse product streams such as WEEE. Therefore, we conclude that this option is probably unworkable in general, but might be further researched as a way to stimulate collection of the very small WEEE items which currently are not returning in the collection streams.

Option 2.3.2 Lower compliance cost when collection target achieved

This could be a percentage of the compliance cost which is paid back to producers when targets are achieved. However, it could result in 'penalties' for schemes which did not meet targets. This could lead to the development of a trading scheme/market mechanism for achieving a collection target at minimum cost.

Option 2.3.3 Mandatory consumer education

Mandatory consumer education is already included in the WEEE Directive, but it may well be better to promote general recycling and encourage households to recycle as much as possible, which would include WEEE items. It could be made part of a standard for compliance schemes to spend a certain percentage of the turnover on this. Also currently very successful school projects could be recommended to be part of such P.R. arrangements like for instance done in the Netherlands (NVMP 2005).

At the consumer level, there appears to be a lack of awareness of the WEEE Directive. For example, a poll in the UK (HERALD 2007) has found that that only 2% of people know about the Waste Electrical and Electronic Equipment (WEEE) directive, and a logo displayed on new electrical products to show they should be recycled is widely misunderstood. The survey of over 2000 people throughout the UK by the electrical retailer, Comet, revealed that 71% had no idea what the logo meant. Almost one in five thought it meant "no wheelie bin collection in this area", and 16% thought it meant "please do not leave wheelie bins out in the street". Furthermore, just under half of those surveyed had never recycled an electrical product, and one in five seemed unaware that such products could be recycled.

The impact of promotional and education programmes on recycling behaviour has been researched (WRAP ROTATE 2006) through developing empirical models of changes to participation rates in recycling behaviour. However, because of the multivariate nature of the models, each coefficient could only be interpreted conditional on the presence of the other variables in the equation. Although awareness raising programmes have a positive effect on consumer behaviour, quantification of impact of consumer education is currently extremely difficult.

Option 2.3.4 Introduce a Recycling Fund mechanism

In some Member States mechanisms to ensure fulfilment of recycling targets have been developed as either a 'Recycling Fund' or a 'Product Fee'. The fund is paid when placing equipments on market and could be reimbursed when producers demonstrate that in a give year they fulfilled the take back obligations.

For instance in some Member States, the Recycling Fund works as follows:

- WEEE from private households – fulfilled targets – no obligation to pay contribution to the Recycling Fund,
- WEEE from private households – not fulfilled targets – obligation to pay contribution to the Recycling Fund for the missing amount,
- WEEE from other users than private households – obligation to pay contribution to the Recycling Fund for the full amount put on the market,
- WEEE from other users than private household collected – fulfilled targets, reimbursement of the amount paid.

The main advantage is that it provides an economic incentive to recycle. The main disadvantage is that it can be a barrier to trade, particularly for SME's. It is also known that WEEE based Recycling Funds are used for other purposes and/ or lacking incentives to promote cost-efficient operations.

Option 2.3.5 Other financing models to promote better collection

Although these options will have similar issues to those for a recycling fund mechanism, it is highly recommended to further investigate financial incentives that can promote higher collection and better treatment.

Option 2.3.6 More enforcement of waste shipments

Some items which are classified as 'reusable' may well be being exported for treatment. This could result in them being treated in facilities which are less environmentally acceptable than those in the EU Member States. Better enforcement on waste shipments would both reduce leakage that occurs between the collection point and the treatment point and enable more WEEE items to be treated in approved facilities. Guidance for monitoring these waste shipments now exists for distinguishing between EEE (for re-use) and WEEE but the resources needed for adequate monitoring (presumably paid for through registration fees charged) would also need to be increased. The additional costs are indicated in Table 113. It should also be noted that specific products or material fractions can better be treated outside the EU when specific requirements are met: This is for instance the case for CRT glass which is used to produce new CRT glass and thus replacing high amounts of primary materials and energy as well as for sorting of non-ferro fractions into very pure individual materials (e.g. copper, aluminium and stainless steel). In the future by applying high level manual dismantling, under the precondition that these operations are well controlled and monitored and Health and Safety plus working conditions are overseen carefully, this might be the most eco-efficient solution for recycling of products into very pure and clean fractions.

Conclusions

The current producer oriented financing mechanism is likely to be counterproductive in future, other options need to be further researched on how a financial incentive for more collection and better treatment can be arranged. Currently, collecting more and treating under better quality conditions will cost more. This can become a particular problem for the collective schemes when the Visible Fee will be abandoned in 2011 and the financial impact on producers might very well cause them to opt for 'bare-minimum' scenarios with regard to collection and treatment. This is probably already the case for some of the individual systems. This important issue is further explained and discussed in more detail in Chapter 11.

The low collection percentages in Chapter 7 and 8 as well as the huge spread in kg's collected per inhabitant in total and per category in Table 117 clearly indicate large leakage streams instead of collection and treatment. In all cases, an active role of the Member States to promote higher collection rates is recommended and more enforcement on waste shipments will reduce the amount of material which is sent to less environmentally acceptable treatment facilities.

10.2.4 Conclusions

The current WEEE collection target is 4 kg/inhabitant per year. However:

- A wide variation in actual collection rates exists. Much higher collection rates (over 10 kg/inhabitant per year) are being achieved in some Member States (and in Norway and Switzerland), but the collection rates in some other member States are currently below the 4 kg/inhabitant target,
- The target can easily be met by EU15 Member States purely by collecting category 1 items (white goods), and thus provides no incentive to improve environmental performance by increasing the collection rate for the 'more hazardous' items (which will be more expensive to treat),
- The target cannot easily be met in the 10 new EU member states.
- It allows scope for leakage because amounts collected in some Member States are much higher than the current target, and thus the target can be met even though some collected items are either sold to the 'grey market' or exported rather than being directed through the proper channels (i.e. authorised treatment facilities and authorised exporters).

Our analysis in Chapters 7 and 8 indicates that significant environmental improvements can be achieved by collecting more and treating it properly:

- Environmental impacts – more 'hazardous items are collected, and leakage should be reduced as more material is sent to authorised treatment facilities. Thus environmental performance is improved (see Figure 61).
- Economic impacts – Increased collection results in higher collection infrastructure costs and higher treatment costs (see Table 110).
- Social impacts - Higher collection targets would have higher social impacts; more education is likely to be required in some Member States, and there will be more jobs in

both collection infrastructure (transport of items to treatment facilities) and treatment facilities.

The impacts of each of the options discussed previously have been qualitatively assessed in the table below not just in terms of environmental, economic and social aspects but also in terms of whether or not simplification of the legal framework is likely and other options or legislation is affected.

Option	**Description**	**Environmental effectiveness**	**Cost efficiency**	**Other impacts/ social**	**Simplification (legal framework)**	**Other options/ legislation affected**
2.1.1	Maintain collection target	Neutral	Neutral	Neutral	Neutral	Neutral
2.1.2	Higher or specific collection targets for more hazardous WEEE	Very Positive	Negative	Better	Neutral	WFD, Option 1.3.1, Options in 10.5
2.1.3	Alternative definition (% based on previous years put on market)	Potentially positive	Potentially higher		Positive	EuP
2.2.1	Mandatory hand in by retail and municipalities at certified compliance schemes	Positive	Negative	Positive	Negative	
2.2.2	A different trade-in mechanism at retail collection points	Potentially positive	Neutral		Negative	
2.2.3	A minimum number of collection points	Potentially positive	Negative		Negative	
2.3.1	Introduction of a return premium for consumers	Positive	Negative	Positive	Negative	
2.3.2	Lower compliance cost when collection target achieved		Neutral	Neutral	Negative	
2.3.3	Mandatory consumer education	Potentially Positive	Negative	Very positive	Neutral	
2.3.4	Introduce a Recycling Fund mechanism		Negative	Neutral	Potentially positive	
2.3.5	Other financing models to promote better collection			Neutral	Potentially positive	
2.3.6	More enforcement of waste shipments	Positive	Negative	Improved	Potential for simplification	TFS

Table 119: Overview impacts options (Collection)

The most relevant options that would lead to an improvement over the current situation are:

1. Option 2.1.2 Higher or specific collection targets for more hazardous WEEE.
   Although the ROHS directive will have the effect of reducing the hazardousness of WEEE in the longer term, it has been shown (Chapter 8) that more (toxic) control is very environmentally beneficial. Thus it is relevant to set specific collection targets for items such as mercury containing gas discharge lamps and LCD backlights. In addition, the ozone-layer depletion and global warming potential of CFC fridges also make minimising leakage

from controlled collection and recycling systems highly relevant. From an economic point of view, this will cause higher costs as quantified in Chapter 8.4.4, Figure 62, and Chapter 8.2 in the Figure 35,53,54 and 57 (with the exact cost with disposal scenarios per scenario in the corresponding tables in Annex 8.2.4). From reporting such quantities, when arranged according to the treatment categories not much more administrative burden is expected. See Option 1.3.1 of Chapter 10.1,

2. Option 2.1.3 Alternative definition (% based on previous year's put on market)
   In terms of setting an overall collection target, it is clear that the current 4kg/head target is difficult for some Member States and unchallenging for others. An alternative definition based on percentage of amounts put on the market in the previous year offers a fair way of applying a target which can be responsive to the dynamics of the EEE/WEEE market in each Member State. From a simplification point of view, obviously declarations of the exact amounts put on market are needed,

3. Option 2.3.6 More enforcement on waste shipments
   There is mounting evidence that illegal shipments of WEEE under the guise of equipment for reuse occurs widely. There is also evidence that increased monitoring and enforcement can help to eliminate this practice, see VROM (2007) and CORRESPONDENTS (2007),

4. Option 2.3.3 Mandatory consumer education
   Evidence from recent surveys shows that there remains a lack of consumer awareness of the WEEE directive. Although the quantification of the likely benefits of consumer awareness raising initiatives is difficult currently, it is clear that these do have a positive effect on consumer behaviour. One suggestion is to adapt Article 10(2) as such: "Member States shall adopt appropriate measures so that consumers participate in the collection of WEEE and to encourage them to facilitate the "achievement of the collection target".

10.3 Targets for Recycling and Recovery (Task 2.3)

Introduction

For all options presented here: the environmental and economic impact assessment of Chapter 7 and 8 show the environmental priorities in relation to cost efficiency for all categories, substances and environmental themes over time as well as the eco-efficiency of various scenarios. Chapter 9 introduced the methodology used for this chapter. The findings of the workshop held are integrally presented in Annex 10. Conditions for a successful implementation when changing the legal framework will be further highlighted in Chapter 11 in a more integral manner.

The acting principle underneath the recycling and recovery targets is to have an incentive for optimising material recovery (on a weight basis). However, the general appropriateness of these targets should be accompanied by incentives for the inputs and outputs of treatment processes as well as other environmental considerations than recycling of kg's alone. These other conditions are: loss of low concentration but highly valuable materials (environmentally and economically), the control over toxic substances, health and safety and general optimisation of secondary material streams to downstream processes. Therefore, the options discussed below are closely linked to the options discussed in Chapter 10.5 on treatment requirements.

On the other hand, the recycling percentages can be used for promoting higher levels of recycling for material fractions with a net economic deficit. This could specifically count for CRT glass and plastics. For all metal dominated material fractions, the environmental and economic optimisation goes hand in hand as long as decontamination (before or after a process) is addressed. Importantly, the targets are also acting as a monitoring, control and enforcement instrument. As Chapter 8 demonstrated, for certain fractions, the quality of treatment is proven to be very relevant.

In the WEEE Directive, the following percentages per average weight of appliance are prescribed:

'(a) for WEEE falling under categories 1 and 10 of Annex IA,— the rate of recovery shall be increased to a minimum of 80 % by an average weight per appliance, and — component, material and substance reuse and recycling shall be increased to a minimum of 75 % by an average weight per appliance'

For the other categories these numbers are:

- Cat. 3 and 4: Recycling: 65%, recovery: 75%,
- Cat. 2,5A,6,7,9: Recycling: 50 %, recovery: 70%,
- Cat.5B: Recycling, recovery: 80%

In the below table some declared recycling percentages are presented. These numbers are meant to illustrate the further discussion in this chapter.

		EERA 2005		Recupel 2006				NVMP 2005	
Category		Recyc.	Recov.	Recyc.	Recov.	Incin.-e	Landfill	Recyc.	Recov.
1A	LHHA	75-90%	80-91%	84.3%	84.5%	0.1%	14.7%	77.0%	79.6%
1B	C&F	80-95%	90-98%	77.3%	90.7%	1.0%	8.3%	79.4%	93.0%
2	SHHA	55-80%	65-85%	79.7%	83.8%	0.9%	15.4%	67.3%	72.7%
3A	IT ex CRT	65-80%	70-90%	79.7%	83.8%	0.9%	15.4%	N.A.	
3B	IT CRT	65-96%	80-100%	84.3%	86.5%	3.6%	9.3%		
4A	CE ex CRT	65-80%	70-85%	79.7%	83.8%	0.9%	15.4%	67.3%	72.7%
4B	CE CRT	70-96%	75-100%	84.3%	86.5%	3.6%	9.3%	83.7%	93.4%
34C	IT/ CE FDP	N.A.							
5B	Lamps	70-80%	74-80%	93.3%	0.0%	0.0%	6.7%	93.2%	93.2%
6	Tools	40-70%	45-85%	79.7%	83.8%	0.9%	15.4%	67.3%	72.7%
7	Toys	50-70%	54-70%	79.7%	83.8%	0.9%	15.4%	67.3%	72.7%
8	Med.	70-90%	80-90%	79.7%	83.8%	0.9%	15.4%	67.3%	72.7%
9	M&C	65-95%	65-95%	79.7%	83.8%	0.9%	15.4%	67.3%	72.7%
10	Aut.Disp.	70-80%	80-85%	84.3%	84.5%	0.1%	14.7%	76.7%	80.5%

Table 120: Recycling percentages

Generally speaking, there are very few reliable data available on the recycling percentages (and the exact definitions used). It is known, that detailed EU wide declaration of these percentages (as well as removed Annex II components) is probably a good measure of the quality of treatment. Therefore, the lack of data on both aspects might indicate the needs for better quality of treatment and of control over quality of treatment or at least at the need for much better control over the recycling operations.

In the next table, the recycling and recovery percentages are presented for the theoretical calculations of Chapter 8, under different definitions. In the first column with data, the percentage shown is the amount of materials (not fractions!) which are recycled and applied in the original form, excluding all losses during treatment: So metals to same metals, glass to same glass, plastics to same plastic applications. So all recovery percentages are included, this not the same as the more commonly used 'WEEE Recycling' percentage of the second column which represent the fractions send to the respective recycling destination. So for instance the copper fraction (including other materials) to a copper smelter is accounted for in the total. The recovery definition is similar but with all fractions to recovery processes included and the last column is the environmentally weighted equivalent which is explained in Chapter 6.2.2. This column shows the total environmental recovery of materials minus all losses due to materials not recycled, transport and processing and emissions.

		Recycling	Recycling	Recovery	QWERTY
	Treatment	**Strict**	**WEEE recycling**	**WEEE recovery**	**Gain**
1A	Default	60,1%	93,7%	93,7%	63,1%
1B	Default	75,6%	87,5%	89,3%	82,1%
1C	Default	71.2%	84.4%	92.0%	62.6%
2,5A,8	Default	36.2%	46.0%	74.3%	48.0%
3A	Default	59.3%	70.9%	85.9%	57.9%
4A	Default	51.7%	70.7%	84.2%	56.6%
6	Default	53.1%	63.3%	82.4%	54.9%
7	Default	28.4%	41.1%	70.3%	37.9%
3B	Default incl plastic rec. housings	77.7%	87.8%	93.1%	76.6%
4B	Default incl plastic rec. housings	80.7%	88.5%	93.9%	76.8%
3C	Default, full dismantling	55.8%	71.9%	84.5%	76.3%
4C	Default, full dismantling	48.9%	66.4%	74.1%	64.4%
5B	Default	86.3%	89.8%	91.3%	85.4%

Table 121: Recycling percentages

10.3.1 Increasing/ Decreasing the Targets (Task 2.3.1)

Description/ Type of Incentives

The first series of options for change relate to the increasing/ decreasing the targets. The key issue is whether the current targets form a (proper) incentive for promoting eco-efficiency of take-back and recycling when taking into account the results from Chapter 7 and 8.

Option 3.1.1 Delete targets from the Directive altogether

There are various advantages and disadvantages of deleting targets altogether. First of all the targets should be much more connected to the actual treatment and more precisely to the collected streams. Additionally, without targets or another safety net, the market will go for the cheapest solution in treatment which might lead to much more disposal of potentially recyclable fractions. Another drawback is that the existence of targets made investments in recycling technology possible and deleting them might cause competition differences and more importantly, less incentive for innovations in for instance plastic recycling technologies. Finally, the existence of recycling targets is also regarded as an important monitoring instrument of the actual treatment. However, seen in the light of other more important environmental priorities (for instance Hg or CFC removal from appliances) as well as the enactment of alternative proposals as for instance landfill bans for high calorific waste might render weight based recycling targets superfluous. From the workshop, there was actually considerable consensus on the 'monitoring instrument' part as well as the actual incentive for development of more plastics recycling technologies for the plastic dominated collection streams. In addition, the results are easy to communicate performance to consumers. As a result of the above arguments the option of complete deletion is not further analysed, which doesn't mean that some of the arguments should be disregarded. Within the next option of differentiation, other ways of defining targets and alternatives these arguments will be relevant.

Option 3.1.2 Decrease, maintain and increase targets levels for specific categories

The analysis in Chapter 8 indicated a variety in environmental priorities which partly can be supported by having weight based recycling targets, partly by other means that should prevail and also categories where the environmental and economic optimisation make such targets superfluous. Both the environmental outcomes of Chapter 8 as well as the long term objective for simplification make this option relevant: Recycling targets are particularly helpful for the plastic dominated categories to promote plastics recycling as well as for the CRT containing appliances when addressing higher levels of re-application. Therefore it is further analysed in the next section on a treatment by treatment category basis following the criteria introduced in Chapter 9.

Option 3.1.3 Introduce targets for cat.8: medical equipment

This option is regarded as less relevant when Table 114 of Chapter 10.1 is considered. First of all when it would be proposed, there are not enough data to determine a target level. In addition, most of the B2C appliances in this category are collected and treated as (a small) part of the small domestic appliances stream. The B2B appliances are usually already subject to bilateral agreements between customers and recyclers. In addition, from the numbers in Chapter 7 on WEEE Arising and Collected and treated, the total weight is very small. Defining and enforcing recycling targets for medical equipment probably makes sampling of the small appliances stream a very costly effort, without much environmental gain as they are already treated with the other categories. Basically applying one target for small plastic dominated products does already include the B2C medical appliances. For B2B appliances in this category, often other RoHS substances related aspects play a role for very specific products. Therefore, control over Health and Safety as well as component reuse aspects plays an important role for B2B medical equipment. See also Chapter 10.1. As a result, the introduction of recycling targets for medical equipment is not further assessed from an environmental and economic impacts perspective.

Impacts/Advantages, Disadvantages

Option 3.1.2. Decrease, maintain and increase targets levels for specific categories

The discussion on differentiation as well as on the current treatment versus the defined target levels is based on the above tables showing the achieved levels and calculated levels for current default treatment.

Cat.1A,10: LHHA, Aut. Disp.

Basically, Chapter 8.2.1 demonstrated that recycling targets (and maybe even collection targets) are not really necessary as the environmental optimisation goes hand in hand with the economic value recovery. The targets are easily achieved for these appliances. However, the presence of concrete counterweights does influence the targets for an overall high metal content category. Taking into account the low plastics content makes that there is actually no need for a (high) target and promoting high re-application levels does not make any environmental or economic sense. Therefore, a weight based target does not form an incentive for improving treatment. With respect to technologies used both at shredding lines for electronics as well as car shredders: the environmental and economic optimisation and material recovery are going in the same direction. Summarised: there is no need for recycling targets for this category. However, when collected, reporting on the achieved recycling percentage can be useful in order to demonstrate that proper treatment is taking place, the actual level itself is then less relevant.

Cooling and Freezing

For this category, from the analysis in Chapter 8.2.2, control over the CFC is the first environmental priority and recycling will take place more or less by itself after the CFC removal step. Targets are achieved in most countries. From a weight based perspective the category is dominated by metals. However, the environmental calculations demonstrate that the first environmental priority, especially looking at ozone layer depletion and global warming, is the CFC removal and control over this is crucial. In this respect from an environmental point of view, having recycling targets for CFC fridges only is not an appropriate environmental incentive. For HC fridges, this is different as the burdening cooling agents are far less harmful here (see Chapter 8.2.2). For CFC fridges, the recently developed CECED, WEEE Forum and EERA treatment standard already covered this issue (see options under 2.5 for treatment standards). However, the legal status of such is uncertain. For Cat. 1B, proper removal of CFC's should be prioritised over high recycling percentages as clearly demonstrated in Chapter 8.2.2.

Small Household Appliances

The total stream of small appliances, often not split in metal, precious metal or plastics dominated stream has, dependent on the collection and eventual sorting, the risk of applying targets on the total. The most difficult to achieve targets for subcategories within this treatment category are those of category 2 and 7 which are mixed with more metal rich fractions from category 1C and 3A. The environmental outcomes demonstrate (dependent on the environmental impact categories) that increasing plastics recycling for sorted plastics does contribute to higher environmental performance. However, for smaller products and mixed plastics, the plastic recycling scenario is less eco-efficient and certain technical boundaries might occur, for instance due to presence of BFR's as well as the plastic types present (category 7 is differing from the other categories for part of the appliances). Large housings are easier to be recycled whereas mixed plastics recycling is more difficult. There are many developments in plastics recycling as described in Chapters 7.4 and 7.5. However more research is needed to actually assess which of the many options for mechanical and thermal treatment should be promoted from an environmental and eco-efficiency point of view. For small appliances, targets are often not achieved in most of the member states.

CRT Appliances and Flat Panel Displays

The recycling targets as applied now do already form an intention to apply recycling of CRT glass. Much more relevant is that after separation of the picture tubes, there is enough economic incentive for the time being to apply CRT to CRT glass recycling. However, environmental evidence demonstrates that the different types of recycling have very different environmental levels of re-application as displayed below in the discussion on the target definition. This indicates there is a problem with the definition of recycling as such. A more specific focus on (as long as possible in the secondary materials market). This has been documented in high detail in (Huisman 2004c, 2005a).

Before discussion in further detail, the below graph is relevant for taking into account environmental preferences in applying CRT glass (Huisman 2004c, 2005a):

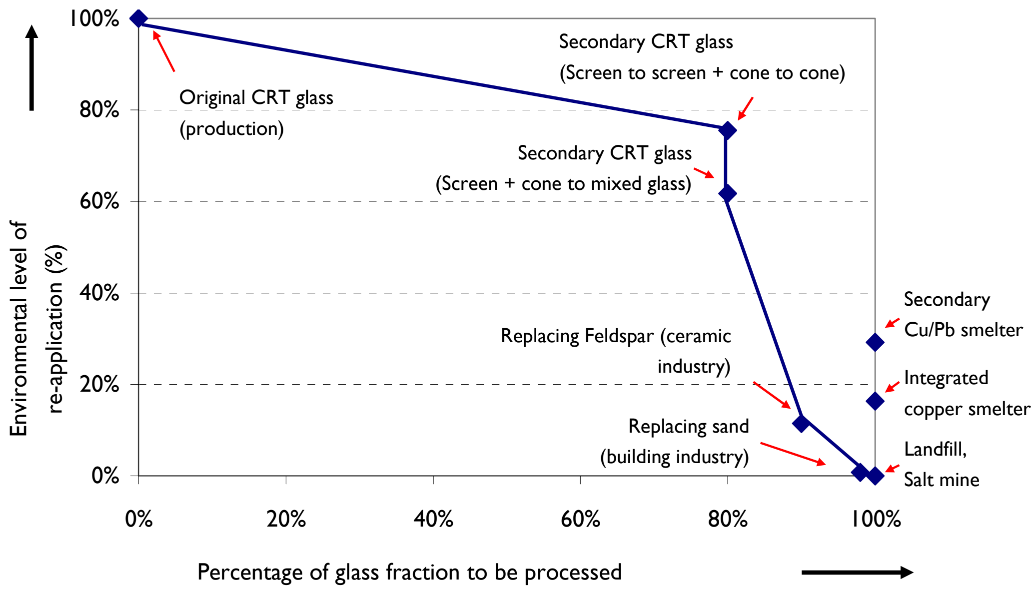

Figure 64: Environmental level of re-application of CRT glass treatment options

The x-axis shows the percentage of a CRT glass fraction which can be processed. The y-axis the environmental outcome in %, with the original 'best case' material value of (primary) CRT glass (production value) as 100% and the 'worst case' landfill scenario as 0%. The graph shows a higher level of re-application in this case for screen – screen + cone – cone glass compared to screen and cone glass to cone glass recycling. The environmental order of preference for the above figure is quite clear: both CRT glass recycling options are preferable from an environmental perspective. The scenario of stripped appliances to a secondary Cu-Pb-Sn smelter is to be preferred over all other non-CRT glass recycling options. In particular due to the lead recovery, the Secondary Cu-Sn-Pb smelter scores better than for instance the ceramic industry and the integrated copper smelter.

An important finding with this graph is however that the lowest environmental preferences can take CRT glass as a fraction for almost a 100% whereas there is no discrimination as these options are also being accounted as useful re-applications and thus as recycling operations (in the past). Basically, when such options would be the cheapest solutions, they would also be accounted as a 100% recycling of the CRT glass and thus environmentally counterproductive.

LCD screens are further discussed in Chapter 10.5 as the Hg containing backlight lamps and the uncertainty on proper treatment makes that the setting of recycling targets is a second priority here.

Lighting Equipment – Lamps

From Chapter 8.2.5 it can be seen that the main environmental concern is recovery of the mercury as can be seen in Table 114. However, also the recycling of the high-quality glass (but under the potentially conflicting requirement to be absolutely Hg-free), is appearing to have a significant environmental gain. Maintaining a recycling target, although being the secondly ranked environmental preference, appears to be beneficial from an environmental point of view.

Conclusions

The environmental analysis in Chapter 8 demonstrated the following:

- Chapter 8.2.1: Targets for Large Household Appliances are superfluous,
- Chapter 8.2.2: For CFC fridges, CFC removal should be the first objective,
- Chapter 8.2.3: For small appliances, recycling targets do promote plastics recycling,
- Chapter 8.2.4: For CRT containing appliances, with a proper definition, the highest re-application levels should be promoted,
- Chapter 8.2.5: Mercury removal is the first environmental priority.

A well defined recycling target should encourage the best and highest levels of treatment the most. However, markets and technical constraints can hamper this. Additionally, technological developments are hard to predict. In some cases ambitious targets could lead to better technologies, on the other hand too high or too low targets could have both adverse effects on the economics and willingness to finance in new technologies. Also other options to have the proper incentives for improvement in treatment do exist as will be discussed in 10.3.3.

10.3.2 Different Definitions of the Targets (Task 2.3.2)

Introduction

Before discussion of the definition options below, as stated in Chapter 10.3.1, there are different methods to determine reported recycling percentages. The definition of the targets is a key problem and will determine the actual levels. Results can be delivered under various possible definitions, for instance based on:

- The amount of materials treated by a recycler per total amount collected/ discarded,
- The amount of materials not sent to final waste disposal,
- The total amount of materials sent to secondary material processing, (e.g. the weight of a copper fraction to a copper smelter),
- The amount of target materials sent to secondary material processing (e.g. the weight of the copper in the copper fraction sent to a copper smelter),
- The amounts of materials actually recovered and reapplied in its original form: (e.g. the amount of copper and other materials actually recovered at a copper smelter),
- In addition various options exist to include/ exclude energy recovery in the above options.

Therefore, more harmonisation and more precise definition of recycling and recovery targets is required as well as measuring the requirement for any type of enforcement or incentive for better treatment.

The second series of options for change relate to options for defining the recycling and recovery targets differently. The relevance of the definition is obviously: it should define recycling and recovery operations in such a way that it clearly addresses and positively discriminates between various treatment and disposal methods as well as the material fractions undergoing this.

The main issue with the definition of targets is that in the cases where it indeed forms an incentive for more material recovery, the weight based target as such does not discriminate between more and less environmentally preferable options when they are addressed as such, as illustrated above for the case of CRT glass. This also applies for the different levels of re-application of plastics where ideally speaking the highest levels are achieved, for instance for plastic types replacing the same plastic type and not in lower grade applications. As stated above, using a weight based target requires also a much better definition of what actually is accounted for as a recycling operation both in terms of the operation itself as well as which material to be included/ excluded in the case of mixed fractions. When that is not part of the definition, the risk of grouping plastics with metal rich fractions could appear in order to obtain prescribed target levels, which is both environmentally and economically not preferable.

In practice so far very limited problems have shown up. However when in the future more and more monitoring and control over treatment will take place, the definitions should be made much clearer. In this respect, the WEEE Directive is not unique. The same holds for instance for the ELV Directive where it is also found that high targets might be easy to understand, the actual enforcement will be become troublesome. Even for more homogenous stream like cars, the uncertainty in sampling and treatment in case of a very strict definition (read actual kg's within fractions being recycled) will be substantial (van Schaik 2006). For the more heterogeneous stream of WEEE, this problem is even more troublesome as it will also be impossible to trace back actual levels with high uncertainty back to individual products or product groups. This is already the case as most levels declared now are very often a mix of product categories together. It also touches upon responsibility: enforcement back to products and thus producers is not possible.

However, this could be made a compliance scheme responsibility. On the other hand, to improve treatment, one has to measure first; enforcement can follow later. As stated above, the recycling targets are not specific for WEEE only and are already part of the revision process of the new Waste Framework Directive. It is therefore recommended to realign with the outcomes of that process as the WFD is placed higher in the legislative hierarchy.

The environmental outcomes of Chapter 8 do provide evidence for the diversity in environmental priorities per treatment category. This is an important outcome as well as taking into account the observed dynamics in treatment technology, markets for secondary materials and changes in product designs over time. See the variety of environmental priorities in Chapter 8.2 and in Chapter 10.1.1 which is concluded upon in the previous section.

Description/ Type of Incentives

Option 3.2.1 Keep current target definition

Deletion of the targets also removes a very useful aspect, namely that measuring of performance is being initiated. Therefore, this option will shortly be followed up, but more focus will be given to alternatives that give more precise and simpler incentives for better treatment where necessary as the initial objective of targets. On the other hand, the environmental drawbacks of keeping the current definition are high: They are non-discriminating between higher and lower levels of re-application as well as the risk of mixing materials (metals with more plastics) to achieve target levels.

Option 3.2.2 Targets for specific material fractions

The benefit of this option is that the two main material fractions which need targets, plastics and CRT glass, can be addressed more specifically. Instead of product category based targets, for instance addressing minimal level of plastic fractions out of treatment that need to be recycled or as a percentage or CRT glass fraction that need to be re-applied, could be a proper incentive. This will be further discussed in the next section.

Option 3.2.3 Targets connected to processes defined as BAT/ or included in standards

Basically this option means inclusion and connection of recycling targets within WEEE processes to be defined as BAT. This does not really reflect on how such a target should look but merely using a target within and connected to such yet to be defined processes. As a result, more aspects (health and safety, resource conservation, quality of the process) can be addressed in a more integral way. This option will be further discussed.

Option 3.2.4 Other definitions for recycling and recovery

The idea behind this option is to use different multiplication factors of targets for instance for higher levels of re-application for CRT glass or different factors for use of plastics for energy recovery compared to material recycling. Such multiplication factors could be derived from graphs similar to Figure 64 above. The available research for the case of CRT glass can already form a basis for such factors. However for plastic re-application; much more research on all implications of energy recovery versus material recycling should be done. As this option is a rather advanced one, it is recommended not to follow up individually, but to incorporate the idea within the development of treatment standards.

Option 3.2.5 Definition of waste versus raw material

Although being a very relevant issue for many recyclers and important from the perspective of removing certain barriers for resource cycles, this issue of when obtained material fraction have becomes a new raw material or remain to be classified as waste is not further discussed here. It should be part of the interpretation of the renewed Transfrontier Shipment Regulations (Council Regulation 1013/2006). Special attention might be needed for environmentally beneficial recycling of cleaned and separated CRT glass, although lead containing, that is destined for re-application in new CRTs in non-OECD countries (mainly Brazil and China).

Option 3.2.6 Harmonisation and realignment of definitions within Option 3.2.3

Although currently there is not much activity in enforcing recycling targets in many Member States, in the future, differences in harmonisation of recycling definitions used and enforced is likely to happen. Although higher targets are currently an option for member states, it might not be advisable in order to avoid disturbing the internal market for recyclers. In that respect it might be important to promote more grouping of similar streams for multiple Member States to enhance economies of scale and to have similar levels of enforcement in order to at least make it possible to compare treatment result for various countries, which is currently almost impossible. This is only possible if one strives towards using recycling targets and similar EU wide definition as part of treatment standards in general. Therefore, this option is also not further discussed stand-alone, but as part of the Option 3.2.4 on standards.

Option 3.2.7 Environmentally weighted targets

The QWERTY methodology in this report that enables the calculation of environmentally weighted recycling performance has proven to be very helpful in evaluating environmental performance as demonstrated in Chapter 8. With this method it is even possible to calculate individual product performance as part of the existing recycling streams. However, the method is very comprehensive and mainly developed as an evaluation and/ or monitoring tool and due to its complexity not designed for this purpose. Therefore, this method and its very thorough descriptions of the end-of-life chain should preferably be used for such evaluation purposes only in order to determine whether or not there are contradiction between weight based targets and environmental outcomes from a manifold point of view. Therefore, the option is not followed up, but the method can be used upon request in the development of proper treatment standards which need balancing of sometime contradictive environmental objectives like presented in the example of CRT glass. Its outcomes can be used for further development of standards as described in Option 3.2.3 and Option 5.3.2 in Chapter 10.5.3.

Impacts/Advantages, Disadvantages

Option 3.2.1 Keep current target definition

One of the arguments raised to keep the current definition is that most Member States still have to start reporting on the treatment performance. However, as this study should assume full implementation status, this is not a valid argument for the purpose of this study as by the same argument, there are no EU-wide problems occurring yet. On the other hand, besides the incentive now for more plastics recycling mainly for the smaller appliances, the main advantage of keeping the target definition might be the starter for at least measuring treatment performance in many MS. Based on the environmental arguments and options for future development and possibilities for simplification, the current target definition can probably be improved.

Option 3.2.2 Targets for specific material fractions
Option 3.2.3 Targets based on processes defined as BAT
Option 3.2.6 Harmonisation and realignment of definitions

These three options are clearly linked with each other as indicated above. The key incentives that a weight based target could bring is connected to those materials or maybe better, those treatment categories that do not have a net positive value after collection due to the presence of plastics or CRT glass. For the LHA treatment category, it should be avoided that the metal based subcategory (1C, part 3A and 4A) of these two streams are used to make a higher average recycling level by including more of the more difficult to recycle plastics in the metal streams. Therefore, either it might be preferable to apply a volume based recycling percentage of the total incoming stream. Setting a target however must be done with care as *'achievement of collection rates are influenced by different factors such as the 'sources' of collection (private consumers, business consumers), general economic data as well as consumer awareness. Additionally, the value of the appliances and/or the material, convenience of the collection system, general basic data like population density and the legislation itself are important factors in this context.' as commented in the Expert Workshop (see Annex 10).*

A possible approach, by defining plastic recycling targets for small appliances collected (Cat.1C,2,3A,4A,5A,6,7,8,9), would preferably consist of a general aim (for example max. 5% landfill and max. 45% energy recovery and thus 50%+ to plastics recycling based on the input stream).

Such a target definition should preferably be integrated in treatment standards for the treatment category. A general aim leaves room for not defining precise levels and only the overall objectives. Thus room is left for more dynamic ways to achieve the goals presented. This is also observed by industry: *'This is the best option: recycling technology applied will define ecological quality of outcome and resources need to fulfil this outcome. Input/Output-Thinking should be practiced also here.'* And: *'Legislation should not prescribe technologies, but common reference standards could help to foster a level playing field'* Moreover, when either BAT processes or industry standards are developed for WEEE processing, it will form an incentive to try to compete on treatment quality levels in the long term. It is also important, within BAT description or voluntary industry standards, that there should be a better balance (after research) between control over hazardous substances and actual material recovery in cases where these are still contradictive.

Finally, it would result in simplification of the legal text of the Directive itself and at the same time leave more room for ongoing innovation and development in recycling technologies. This option will also be further discussed in Chapter 10.5.

Conclusions

From the standpoint of simplification and alignment of definition, the definitions for recycling, recovery (and also reuse) should be aligned with the ones in the WFD, TSW, and other waste specific legislation. This also counts for the TFS rules and especially on the aspect of what is waste and what is raw material. In addition, the requirements that affect whether levels can be achieved due to other hazardous waste regulations should also be investigated. These connections with other legislation should be taken into account.

Recycling targets should preferably be expressed as minimum percentages to be recycled for plastics and/or CRT glass present in the respective collection categories. In the case of plastics this could be accompanied with a maximum level allowed to landfill and the remaining as use as energy recovery. In the case of CRT glass, it is recommended to further describe which processes should be regarded as CRT glass recycling at what minimum level outside the legal text when there is an industry standard developed which promotes higher levels of re-application based on market developments.

10.3.3 Other Options to Improve Processing (Task 2.3.3.)

Description/
Type of Incentives

Option 3.3.1 No recycling targets, only use of BAT for WEEE processes
Option 3.3.2 Deviation allowed under 'Environmental Equivalency Principle'
Option 3.3.3 Monitoring and enforcement of existing measures
Option 3.3.4 Removal targets for specific potentially toxic components
Option 3.3.5 Measure but don't enforce

The third series of options for change relate to realising maximum environmental protection across the rest of the EU. The proposed options might accomplish the same goal with less costs and improved environmental performance. However almost all of the options below are already included in the discussion on the appropriateness of recycling targets as well as in the definition of such in the two previous sections. Others are closely related to the treatment standards of 2.5 as the goal is similar and will be discussed there. As a result, the options below are only discussed briefly in relation to the above and as elaboration of the above recommendation.

Impacts/Advantages, Disadvantages

Option 3.3.1 No recycling targets, only use of BAT for WEEE processes

In the long term when standards or BAT have been developed, then indeed for some categories recycling targets might become superfluous. However, these BREF´s should be developed first in the long run: with focus on targeted environmental protection levels. A connected option might be to install an EU-wide recyclers certification scheme to not only promote standards but also to approve them and to audit whether or not recyclers do comply in practice.

Option 3.3.2 Deviation allowed under 'Environmental Equivalency Principle'

The environmental equivalency principle means that deviations form the targets should be made possible when other environmental priorities are hampered by only striving for higher material recycling ratios and when clearly proven as such. When installing treatment standards, this principle can be used for allowing more freedom to achieve the required results. It could be an integral part in BREF or standard development but would juridically be difficult to apply as a separate legal derogation.

Option 3.3.3 Monitoring and enforcement of existing measures

For any recycling target level set, a definition or other ways of improving treatment quality, enforcement are key issues. In this respect there is common agreement and confirmation from all stakeholders involved that this very much lacking right now. This is further discussed in Chapter 11.

Option 3.3.4 Removal targets for specific potentially toxic components

See Chapter 10.5

Option 3.3.5 Measure but don't enforce

For the categories which are very metal dominated, which do not necessarily need recycling targets as for instance pointed out in Chapter 8.2.1.5, it might still be recommended to prescribe declaration of achieved recycling targets without setting a target level. This enables monitoring on whether treatment actually is taking place.

10.3.4 Conclusions

Conclusions

The impacts of each of the options discussed previously have been qualitatively assessed in the table below not just in terms of environmental, economic and social aspects but also in terms of whether or not simplification of the legal framework is likely and other options or legislation is affected.

Option	Description	Environmental effectiveness	Cost efficiency	Other impacts/ social	Simplification legal framework	Other options/ legislation affected
3.1.1	Delete targets from the Directive altogether	No effect on cat. 1A,1C,3A, 10 Negative for others	Positive	Less control over treatment	Positive	
3.1.2	Decrease, maintain and increase targets levels for specific categories	idem	?		Negative/ Positive when no targets for 1A, 1C, 3A,10	
3.1.3	Introduce targets for cat.8: medical equipment	No effect	Negative		Negative	
3.2.1	Keep current target definition	Neutral	Neutral	Neutral	Neutral	Neutral
3.2.2	Targets for specific material fractions	Potentially positive	Neutral	Neutral	Negative	
3.2.3	Targets based on processes defined as BAT	Positive	Neutral	Neutral	Very positive: less legal provisions	IPPC
3.2.4	Other definitions for recycling and recovery	?	Negative	Neutral	Negative	Inconsistent with ELV, Bat.Dir. etc.
3.2.5	Definition of waste versus raw material	?	?	?	Positive	WFD
3.2.6	Harmonisation and realignment of definitions	Positive: effect on quality of treatment	Positive	Enables EU monitoring treatment quality	Positive	All other waste legislation
3.2.7	Environmentally weighted targets	Positive?	Negative	Can be included in development of standards	Very negative	
3.3.1	No targets, only use of BAT for WEEE processes	Positive	Neutral	Neutral	Very positive: less legal provisions	IPPC
3.3.2	Deviation allowed under "Environmental Equivalency Principle"	?	Negative	Increases flexibility, less control over quality?	Very negative: how to decide	
3.3.3	Monitoring and enforcement of existing measures	Very positive	Positive	Capacity and expertise needed	Positive?	1012/2006 EC
3.3.4	Removal targets for specific potentially toxic components	Positive	Negative	How to measure	Very negative	
3.3.5	Measure but don't enforce	Positive for Cat.1A, 1C,3A,10			Positive	

Table 122: Overview impact options (Reuse)

The environmental analysis for each treatment category as in Chapter 8, highlighted the large difference in environmental priorities for the different treatment categories. From the specific recycling and recovery rates calculated theoretically for all scenarios in Chapter 8.2.1.5, 8.2.2.5, 8.2.3.5, 8.2.4.5 and 8.2.5.5 it is concluded that the most effective target setting from an environmental point of view would be to:

1. Option 3.1.2. Maintain or increase targets for

- Small household appliances in order to promote more plastics recycling and for CRT Appliances in order to promote higher levels of re-application. The connected costs are discussed in Chapter 8.4.4 in Figure 62 as well as for small household appliances in Chapter 8.2.3.3 and 8.2.3.5. For CRT containing appliances this is displayed in Chapter 8.2.4.3 and 8.2.4.5.

2. Option 3.3.5. Measure achieved recycling level for the other categories

- Cat.1A,10: LHHA, Aut. Disp., see Chapter 8.2.1 for an extensive discussion on why recycling targets are superfluous,
- Cooling and Freezing, see Chapter 8.2.2 for an extensive discussion on why recycling targets are not the prime environmental concern,
- Lighting equipment – Lamps, see Chapter 8.2.5 for an extensive discussion on why recycling targets are not the prime environmental concern.

3. Option 3.1.3. Targets for medical:

Targets would increase administrative burden and complexity for a negligible amount of products and are superfluous as one target for small plastic dominated products already includes B2C medical appliances. For B2B appliances in this category, often other RoHS substances related aspects and control over health and safety is much more important.

When applied, the following boundary conditions should be taken into account:

4. Option 3.2.6. Harmonisation and realignment of definitions
5. Option 3.2.3. Incorporate targets in BAT or industry standard
6. Option 3.3.3. Monitoring and enforcement

From the above options, it can be concluded that setting these differentiated targets combined with the development of integral treatment standards is to be preferred. This will maximise cost efficiency and provide a way of balancing different environmental priorities at the same time. When developed together, this promotes long-term quality improvement of treatment by targeting the multitude of environmental concerns in an integral way. In any case, monitoring and enforcement of compliance and comparison of performance between Member States require a much clearer definition and harmonised standard of what exactly to account as being recycled and recovered. A standard definition and way of measuring (such as the WEEE Forum REPTOOL) can support the above for such monitoring in everyday practice. A boundary condition is that such a tool or standard should focus on the key environmental priorities for the five treatment categories as pointed out before. In this way, the monitoring and reporting of treatment performance makes environmental sense by avoiding the gathering of superfluous treatment data and thus minimising the administrative burden at the same time.

10.4 Targets for Reuse for Whole Appliances (Task 2.4)

Introduction

For all options presented here: the environmental and economic impact assessment of Chapter 7 and 8 show the environmental priorities in relation to cost efficiency for all categories, substances and environmental themes over time as well as the eco-efficiency of various scenarios. Chapter 9 introduced the methodology used for this chapter. The findings of the workshop held are integrally presented in Annex 10. Conditions for a successful implementation when changing the legal framework will be further highlighted in Chapter 11 in a more integral manner.

The objective of setting any target for the reuse of whole appliances is to set a minimum level to be expected for product reuse following the initial use by the original owner/user of the product. According to Anderson, the Rreuse network has about 17,000 people in social organisations who collect, repair and recycle about 300,000 tonnes of equipment from about 1200 work centres, and supplying mainly to an 'excluded' market.

Reuse is defined by the WEEE Directive as:
'…any operation by which WEEE (or components thereof) are used for the same purpose for which they were conceived, including the continued use of the equipment (or components thereof) which are returned to collection points, distributors, recyclers or manufacturers.'

Currently, the WEEE Directive combines reuse with recycling as a 'reuse and recycling' target set at different levels for different categories of WEEE. Thus reuse of both whole appliances and components are already included within this overall target. Experiences from the UK on computer reuse and trials on refrigerator take-back (DTI 2000 and DEFRA 2003) have shown that reuse and refurbishment tends to take place where there is a market for these items and the means to cover the costs of refurbishment/repair. Where margins are low, reuse activity tends to be run by charitable organisations. Viable activities have focused on refurbishment of washing machines and IT equipment but for refrigerators the rate of refurbishment achieved was very low (~2 % of used appliances collected were reusable, mainly because the age of the equipment made it difficult/impossible to obtain spare parts such as shelves and compartment doors). Elsewhere, typically 5-10% of collected equipment is found to be reusable.

Other obstacles to reuse exist. These include:

1. Software licensing

Computers without any operating system (OS) or appliances installed or included are less attractive to many potential buyers. Preparing the machines for reuse within an OS involves extra costs and trouble – either for the refurbisher or the consumer.

2. User Awareness

Apart from online marketplaces, many consumers are not aware of an existing reuse market either as a place to sell their machines or a potential place to purchase one.

3. Standardization of used equipment prices

To ensure smooth trade, buyers and sellers should know the appropriate price of a product. Either side may balk at a deal if there is significant uncertainty on the price (Williams & Kuehr 2003) Knowledge about an appropriate price for products is thus important for a well functioning reuse market. "Blue Books" are more and more helping in here, but it is hard to find one's way through these, due to the vast array of configurations available for computers alone. The value varies considerably depending on its installed memory, storage devices, and software.

4. Taxation

In some EU member states the taxation system has also an effect in the reuse market. For example in Germany, firms can count 100-percent of the costs of a computer and its peripherals as depreciation within three-year period after purchase. Even private PC users can count depreciation of 35 to 50 percent of the purchase price if they proof that a certain amount of use is for work. For regions with high taxes, users are economically rewarded for replacing their PC at least every three years. Although the service delivered by a used PC may be the same as a new one, the taxable deductions are far larger for the latter as they depend on the price paid.

5. Various

Data security is also an issue – removing personal data from a hard-drive. Age of equipment can also be problematical, for example, where a computer is only capable of functioning with older, unsupported software.

The environmental benefits of reuse are very limited according to Rechberger (2006). He examined two extreme scenarios: one with no reuse of products and another with reuse of all products giving between 50% and 100% product life extension. The study found that even intensive product reuse of EEE reduces total resource consumption (materials and energy) of a highly developed economy by less than 1%. Given that practical experiences have shown that reuse possibilities are very low (i.e. much lower than 100%), the argument for a separate target for reuse of whole appliances is weak. This is further substantiated by Rose and Stevels (2001) which showed that the environmental benefits are very low compared to materials recycling.

As illustrated in chapter 8.3.4 the use of cheaper used appliances offers an important means for people with low income to raise their standards of living and to participate in social activities, bridging the "digital divide" or delivering necessary means of communication for commercial or cultural purposes. But given that EEE is only entering the waste chain when it is considered to be out of value, it might also no longer be supportive for these social aspects. There are already auto-regulating reuse systems through e.g. online marketplaces in place, which support the reuse of whole appliances with perceived value for the consumer. For example, The Freecycle Network™ (www.freecycle.org) is made up of many individual groups across the world. It is a grassroots and entirely non-profit movement of people who are giving and receiving items not just electrical and electronics for free in their own towns. Each local group is moderated by a local volunteer. Membership is free and growing rapidly. World-wide currently, there are over 4,000 Freecycle communities with over 3.5 million members, and there are national web-sites in France, Germany and the UK.

Targets for reuse of whole appliances are being proposed as possible means to reinforce reuse where appropriate. The stakeholders that would be affected are mainly those in the reuse sector (this includes charity and community organisations).

The main options for change and/or improvement are structured in 3 areas:

- Define requirements,
- Increase, add, maintain or delete (entry specific) requirements,
- Alternative options (instead of reuse targets).

This section discusses these options, reviews the findings from the expert-workshop on reuse, and then proposes an approach for reuse of appliances.

10.4.1 Define Requirements

Description/
Type of Incentives

The relevance of definition and scope is to establish clear and unequivocal understanding of which products should be considered for promotion of reuse and of which aspect in the treatment chain to which reuse refers. Indeed, one cannot even consider targets until this is done! Definitions need to provide a clear understanding of not only what is covered by the term reuse but also what is meant by 'whole appliance'. Furthermore, experience from certain take-back and refurbishment trials (DEFRA 2004) has demonstrated that some products are more readily refurbishable than others. The reasons for this are complex but this does raise the issue of the possible need to define a specific product list for appliances for which it is possible to achieve a certain level of reuse. Consequently, the first set of options addresses the definition of requirements, and these are:

Option 4.1.1 Establish a clear definition of 'Re-use of whole appliances' term
Option 4.1.2 Determine the scope of reusable products (i.e. specific Product List)

The participants in the expert workshop also suggested a number of other options:

Option 4.1.3 Other options: An accreditation system for refurbishers, A label providing information about the refurbisher, a reused appliance should have an energy label

Impacts/Advantages,
Disadvantages

Option 4.1.1 Establish a clear definition of 'Re-use of whole appliances' term

Practically, it would be difficult and time-consuming to distinguish reuse as defined by the WEEE Directive from reuse that occurs at other points in the life cycle of an appliance. A product which is reused because it has not reached the end of its useful economic life is not a waste, and this activity would not be covered by the WEEE Directive. Thus if a target for reuse of whole appliances was introduced in the WEEE Directive, it would only be targeting a small fraction of the reuse activity. Consequently, it is arguable that the WEEE Directive is not the right place for promoting reuse. Furthermore, such a target might encourage illegal exports for reuse and hence the leakage already discussed in chapter 10.2. According to ACR+ "Only the origin of the products or components to be reused differs, from a legal point of view, but very often the same enterprise is carrying out both sorts of reuse. The definition of reuse (Art. 3 of the proposal on WFD) should therefore cover both reuse for waste and reuse for non-waste. This would also give more meaning to the citation of reuse networks as prevention measures in Annex IV, entry 16, and would help to examine clearly the status and activities of reuse organisations."

The EuP Directive may be a better place for encouraging reuse because of the requirement to consider how the design of a product will impact on its life cycle. This is also recommended because, for energy using products, enhancing product lifetime might even be environmentally counterproductive compared to buying a new, more energy efficient appliance (e.g. suspected for washing machines and old TV's).

Consumers may feel more confident about buying a reused appliance rather than a refurbished appliance. However, as all appliances would need to be tested to determine if they need repair/refurbishment, and would also need to be cleaned thoroughly before sale to a consumer, then an appliance which is classified as reused would merely be one which did not need any repair or refurbishment. Consequently, there does not seem to be a need for this sub-division for whole appliances.

It would also be difficult to establish a clear definition of component reuse. This is because the definition of components can cover both sub-assemblies, and individual parts.

Clear definition of reuse that is supportive to the activities of the various reuse social organisations is a necessary first step. Currently, evidence for providing a sound basis for reuse quota setting is lacking, and should be further explored. The findings from the Expert Workshop were also in favour of establishing clear definitions.

Option 4.1.2 Determine the scope of reusable products (i.e. specific Product List)

Many consumers throw away products because of minor problems. Up to 75% of these products are often repairable, but consumers purchase a new product because the cost for repair may well be a large percentage of the cost for purchasing a new product or even higher. Van Nes (2003) showed that there are three main reasons for discarding without potential for reuse: irreparability, other functionality demand and changes in life.

One option for developing a list of reusable products is to use an assessment of their suitability for repair/refurbishment. Some products are more able to be repaired than others; for example a thermostat can be replaced easily in a refrigerator, but it could be much more difficult to replace components on a circuit board. However, whilst the replacement of a thermostat in a refrigerator can be done at relatively low cost and effort, it is unlikely to be economic (based on the sale price) to replace more expensive components. Thus, even if a list of reusable items was developed, the economics of any repair that is required will determine whether or not the item is actually repaired/refurbished and then reused.

It would also be difficult to establish a list of products that are subject for reuse because any policy on reuse/ refurbishment of products should not be contradictory to other European Directives and political targets (e.g. compliance with the RoHS Directive or carbon dioxide reduction or chemical bans) or product safety aspects.

Option 4.1.3 Other options: An accreditation system for refurbishers

Two possibilities were found: Development of a label providing information about the refurbisher, or reused appliances should have an energy label. An accreditation system for refurbishers who are able to refurbish appliances to the required standard could be developed. This would require standards for requirements covering factors such as energy consumption and safety to be set for refurbished products. The accredited refurbishers would need to demonstrate that they could achieve these standards and requirements, and could then place a label on the appliance stating that the product had been refurbished by them. This would demonstrate to consumers that the refurbished appliance met the required standard.

The main environmental impacts for these products are:

- Energy efficiency - older appliances are likely to be less energy efficient than newer appliances, and thus from an environmental viewpoint, it may be better to recycle an old appliance and replace it with a more energy efficient appliance rather than refurbishing and then reusing it,

- Water consumption – older appliances tend to use more water than newer appliances.

EU law requires consumers to be informed about the energy consumption of an appliance through the EU energy label. However, if the appliance does not have an energy label, and its energy efficiency rating cannot be identified from manufacturers' data, then it may not be economic to determine the energy efficiency by conducting the required test procedure.

Consumer safety is also very important. The main safety issues for reusable products are electrical safety and potential fire hazards. All reusable appliances will need to be tested to determine if it meets the required electrical safety standard, but it would be much more difficult to conduct a test for fire safety.

A label could also state that:

- This appliance meets electrical safety standards,
- This appliance will be more expensive to operate than a newer appliance.

This should increase consumer confidence in the refurbished product, and will also provide them with information on the environmental consequences of their decision to purchase a reused appliance (in a similar way to the energy label shown on a new appliance).

Conclusions

Most reuse will occur before the end of an appliance's useful economic life, i.e. before the appliance becomes a waste. The current definition of reuse in the WEEE Directive includes both reuse and refurbishment but these are two different activities, and thus indicate that there is a need for a clear definition of reuse. It is also recommended to further research when and for which appliances reuse and lifetime extension can be environmentally beneficial and when not.

10.4.2 Increase, Add, Maintain or Delete (entry specific) Requirements

Description/
Type of Incentives

The fundamental principle behind reinforcing reuse is the improvement of environmental efficiency to the benefit of society. Setting targets is perceived as the approach to bring this about, and thus there is a need to consider the following options:

Option 4.2.1 Business as usual (BAU) – i.e. No Target
Option 4.2.2 Specific targets (per category)

The participants in the workshop also suggested a number of other options:

Option 4.2.3 Other: Separate reuse and refurbishment targets, A target based on reuse, refurbishment and recycling

Impacts/Advantages,
Disadvantages

Option 4.2.1 Business as usual (BAU) – i.e. No Target

The market already auto-regulates (in a certain manner) the uptake of reuse. Much of this reuse activity takes place before the equipment reaches a collection point because the user and potential reuser perceives value in this equipment. Money can change hands or items can be exchanged for free. Once there is a perception of no value, then items are discarded (hopefully to a WEEE collection point). At this point, the recycler/reprocessor/refurbisher can choose the most appropriate course of action to take for each piece of equipment to be treated. This sector is in the best position to do this, being fully aware of the market conditions at any particular time, and thus this flexibility should be retained.

Option 4.2.2 Specific targets (per category)

The advantages of setting specific targets are:

- Member States are made responsible for meeting these reuse/refurbishment targets, and so will need to support the reuse sector in order to achieve them,
- Additional targets may improve the level of reuse work at the local level and thus could make this more economically viable. However, the reuse sector may well then become responsible for meeting the targets.

The disadvantages of setting specific targets are:

- Setting artificial, unrealistic and imprecise targets may well create problems for those who have been made responsible for achieving the targets,
- Difficulties in defining when (in the chain) reuse occurs,
- Reuse targets should not stand alone; rather they should be included in the recycling targets met by producers,
- The level of reuse and refurbishment activity depends on the market economy. Any artificial mechanism, such as targets or subsidies, may affect this, and could result in a reuse industry that could not survive on its own.

Option 4.2.3 Other: Separate reuse and refurbishment targets, A target based on reuse, refurbishment and recycling

It will be much more difficult to establish different targets for reuse and refurbishment due to both the need to establish clear definitions and the issues regarding the setting of specific targets.

A target based on reuse, refurbishment and recycling could be considered. Reuse/refurbishment could be included as one approach for achieving the recycling targets which have to be met by producers. However, most items which end up in the waste stream are unlikely to be suitable for reuse or refurbishment, and there could well be additional administrative burdens due to the need to demonstrate that equipment had actually been reused (rather than being exported for treatment).

One additional idea might be to let Member States try to also declare the amount of products under the scope of WEEE that are being reused through known second hand shops (for instance, as done in Belgium) and larger refurbishers. The administrative burden can be minimal and for instance based on the total weight or pieces reused/ refurbished per year.

Conclusions

There are differences in the amounts of the different categories of WEEE which can be reused and the environmental benefits are doubtful. This will make it difficult to set targets for different categories. It will be also be difficult to make one stakeholder (producer, refurbisher, consumer, authority) responsible for achieving any separate target for reuse/refurbishment.

10.4.3 Alternatives (instead of Reuse Targets) (Task 2.4.3)

Description/ Type of Incentives

The following options were considered:

Option 4.3.1 Delay setting re-use targets until more information about the return status and existing markets is available

Option 4.3.2 Re-use targets linked to design

Option 4.3.3 Promotion of rental of equipment

Option 4.3.4 Promote collection points to take reuse products to second markets

The participants in the workshop also suggested a further option:

Option 4.3.5 Promote reparability by making use of standard components

Impacts/Advantages, Disadvantages

Option 4.3.1 Delay setting re-use targets until more information about the return status and existing markets is available

The advantage of this option is that it provides a sound basis upon which the most appropriate target can be chosen. The disadvantages are that the difficulties in setting targets will still need to be considered, and it may take a considerable time to collect the required (or any) data on which to base decisions.

Option 4.3.2 Re-use targets linked to design in EUP

The principle behind this option is that reuse occurs throughout the life of a product and not just on arrival at a collection point. Therefore reusability should be treated as a design issue rather than a waste issue.

This is not the remit of the WEEE Directive, and the EuP Directive appears to be a much better approach to encouraging reuse because of the need to develop designs which consider the overall life-cycle of the product.

Option 4.3.3 Promotion of rental of equipment

The principle of this option is to change the nature of product ownership. Leasing is becoming more popular in the business sector, and rental/leasing arrangements generally ensure the proper take-back of equipment once it reaches end of life. This increases the chances that the equipment is kept in a good enough condition such that refurbishment opportunities can be maximised.

The advantages of this option are that it can also encourage the re-development of a repair culture, which could maximise the service life of the product. The disadvantages are that it may only be appropriate for B2B equipment, and it may reduce the demand for new equipment which could both affect manufacturers and lead to slow down in the introduction of innovative product developments. Moreover for certain product categories it is even advisable to quickly replace old equipment to ensure e.g. a better energy-efficiency etc. Hence, a clear distinction between various categories is a must, as they have also a rather different environmental impact through production and consumption (Rechberger 2006). However, the WEEE Directive is not a suitable tool for restricting access by imposing rental/leasing obligations on producers and distributors.

Option 4.3.4 Promote collection points to take reuse products to second markets

Although this would increase the potential for reusing suitable products, they cannot go directly from collection points to the second-hand market because they would need to be checked first to guarantee that they met safety and performance criteria. Consequently, they would still need to go to a refurbisher. Additionally, this might also open up for cherry picking and illegal exports of WEEE and further leakages streams, which are known to have taken place in The Netherlands on a large scale (VROM 2005, 2007a,c)

Option 4.3.5 Promote reparability by making use of standard components

There may well be options to improve the options for repairing products if standard components were used. However, this will be an issue for product designers, and thus is not an issue for the WEEE Directive.

10.4.4 Conclusions

Conclusions

Due to the limited amounts of data and evidence, it is not possible to provide conclusive arguments for or against options for reuse of whole appliances. More background research is required as a first step, which is outside the scope of the present assignment under this study. Nevertheless, we have provided our own arguments based on our experiences and discussions with experts. Two main options have emerged:

1. Initially, development of a clearer definition of reuse, because the present definition in Article 3 of the WEEE Directive tries to cover both, reuse of complete appliances and major maintenance and minor repairing, which is usually defined as refurbishment. Both, reuse and refurbishment imply very different activities. This needs to be appropriately be reflected in policy to correspond with reality. Then further research is needed to develop a suitable reuse target. This would provide greater clarification for the organisations that are engaged in reuse and refurbishment activities and for their status within the product life cycle,

2. Place reuse measures in EUP not in WEEE
Concluding from our discussions with experts the use of the EuP Directive to encourage reuse/refurbishment by designing products which are easier to refurbish appears to be a better approach to increasing reuse than setting targets or other requirements in the WEEE Directive.

The impacts of any potential changes which could increase reuse are according to the discussions:

- Environmental impacts – a lower energy efficiency will make it more difficult to achieve targets for reducing carbon dioxide emissions, the promotion of reuse/refurbishment outside the waste-stream might increase reusability of whole appliances through different but appropriate collection.
- Economic impacts – the economic impacts for refurbishment are a balance between the cost of the spare parts needed to refurbish an old appliance and the sales value of the refurbished item. The economic impacts for the user of the refurbished appliance are a lower cost for the appliance, but higher operating costs due to lower energy efficiency,

- Social impacts - these are usually positive. Refurbishment organisations can provide jobs for those who find it difficult (for various reasons) to obtain employment in other fields. Moreover, low-cost products for reuse can be purchased by low-income persons, which would support a closing of the digital divide even within the 27 EU member states.

The impacts of any changes in reuse/refurbishment targets in the WEEE Directive on the following legislation will need to be considered:

- The ROHS Directive,
- The Waste framework Directive and the current review of this Directive,
- The EuP Directive.

10.5 Treatment Requirements (Task 2.5)

Introduction

For all options presented here: the environmental and economic impact assessment of Chapter 7 and 8 show the environmental priorities in relation to cost efficiency for all categories, substances and environmental themes over time as well as the eco-efficiency of various scenarios. Chapter 9 introduced the methodology used for this chapter. The findings of the workshop held are integrally presented in Annex 10. Conditions for a successful implementation when changing the legal framework will be further highlighted in Chapter 11 in a more integral manner.

Times have changed and treatment technologies have improved since the WEEE directive was adopted. Dismantling is not the only solution for control over hazardous components with large improvements in shredding and separation technologies. Guidance on interpretation of the directive's Annex II requirements has been developed (TAC 2003) and various studies have examined the nature and extent of the problem of hazardous materials and components in WEEE. New products have appeared on the market – some replacing other products (most notably the shift from CRTs to FDPs for TVs and monitors) – which can potentially raise new issues regarding proper treatment of these items when they reach end-of-life. Generally, there has been a trend of newer equipment containing fewer hazardous materials and components and in lower amounts than their older counterparts (c.f. AEA Technology. 2006b and Greenpeace 2006 regarding lap-top computers). Although, vigilance is still required by treatment operators especially when encountering very old items of equipment, Annex II needs flexibility for adaptation to these changes.

In Chapter 7 and 8, the environmental impact assessment addressed the key concerns with regard to Annex II components present in the treatment categories, these results are summarised below as an introduction to discussing the need and way to deal with the current treatment requirements from a broader environmental perspective:

For Category 1A, the only environmental concerns are PCB containing capacitors and mercury switches. However from the concentration levels presented in Chapter 8.0.5.1 and the eco-efficiency analysis in 8.2.1.5 it is found that the appearance in the most relevant environmental impact categories (the toxicity indicators), is very limited due to the minimum age of appliances found (which are almost all newer than the latest applications in the past). The issue will completely disappear within a few years. For typical materials/ components present and Annex II items that can be removed, see Table 89 in Section 8.2.1 and Annex 10.5 for estimates by category for the years 2005 to 2020.

For Category 1B, when comparing CFC fridges in this category with other LHHA in Cat.1A, it shows that the CFCs are very environmentally burdening for the environmental impact categories GWP and ODP. Proper treatment with high removal efficiencies as well as avoiding the potential loss of pressure during transport, handling and feeding of treatment lines is important as well as avoiding the risk of 'mistreatment' due to wrongly labelled appliances (which might have occurred in the early days of shifting from CFC to HC). For typical materials/ components present and Annex II items that can be removed, see Table 92 in Section 8.2.2 and Annex 10.5 for estimates by category for the years 2005 to 2020.

For Category 1C, 2, 5A, 8, 3A, 4A, the effect of the manual removal of Annex II components (mainly printed circuit boards) is very low. Especially for powerboards, the control over Annex II materials should be a matter of having control over downstream treatment rather than a strict interpretation of the Annex II entries. The size (> 10 cm2) and nature (cellular phones) is in this respect irrelevant. In the case of Category 3A however, the economic impact of the manual removal of printed circuit boards is significant, which is mainly caused by removing high grade circuit boards from PC's. But here, the same result can be obtained applying high value shredding settings for these appliances, which is not only more cost efficient but has even greater environmental benefits. A similar finding applies to cellular phones (Huisman 2004a). Apparently the optimisation of mechanical treatment of printed circuit boards in appliances leads to both an economic and an environmental optimum. For typical materials/ components present and Annex II items that can be removed, See Table 96 in Section 8.2.3 and Annex 10.5 for estimates by category for the years 2005 to 2020.

For CRT containing appliances (3B, 4B), in (Huisman 2004c, 2005a), it is shown that the CRT back to CRT glass options are environmentally preferable over application in the building and ceramic industry respectively at slightly better cost levels. This re-application (see also Chapter 10.3) is environmentally much more important than the original 'toxic control' issue. However, here the markets for new CRT production will disappear in about 5 to 8 years from now and other applications have to be found which presents a market absorbance issue. Some secondary copper-lead-tin smelters can treat this as well, but capacities remain an issue.

For LCD containing appliances (3C, 4C), so far no satisfactory full scale recycling operations have been identified yet. Full dismantling (still high risk of breakage of Hg backlights), partial dismantling and shredding as described above are not all preferable solutions. This means options that can both enable proper control over the mercury contents as well as recovery of the valuable metal content still have to be developed. For typical materials/ components present and Annex II items that can be removed, See Table 102 in Section 8.2.4 and Annex 10.5 for estimates by category for the years 2005 to 2020.

The main finding for the lamps of cat.5B is that having high mercury recovery efficiency is crucial from an environmental perspective. This can be realised in practice by collecting as much as possible and in a safe way (avoidance of breaking) and to treat them properly.

All above key issues demonstrate that these Annex II requirements do not stand alone. They affect other environmental effects like resource conservation, changing secondary materials markets, Health and Safety and developments in treatment technology. For this reason, the options below demand that control over hazardous substances requires a much more integral or balanced approach than 'they should be removed' only. For typical materials/ components present and Annex II items that can be removed, see Table 106 in Section 8.2.5 and Annex 10.5 for estimates by category for the years 2005 to 2020.

10.5.1 Increase, Add, Maintain or Delete (entry-specific) Requirements as such (Task 2.5.1)

Description/ Type of Incetives

The findings from the environmental evaluation show that certain products should be prioritised. Thus there is a need to focus efforts on those products that exhibit the greatest environmental impacts in order to ensure that an appropriate level of treatment is achieved for these products. The options derived in this group address possible changes to the existing Annex II requirements.

Option 5.1.1 Delete current requirements altogether
Option 5.1.2 Delete specific (superfluous) requirements
Option 5.1.3 Maintain current requirements
Option 5.1.4 Specify removal efficiencies per entry
Option 5.1.5 Introduce requirements for other (new) hazardous components

Impacts/Advantages, Disadvantages

Option 5.1.1 Delete current requirements altogether

New equipment placed on the market is now generally less environmentally damaging than older equipment; for example, PCBs, CFCs and NiCd batteries are not applied anymore. Furthermore, some stakeholders claim that better treatment control should be through the promotion of BAT guidelines rather than prescribing treatment processes that could stymie innovation in treatment technology. The benefit of using BAT guidelines is that they can be easily updated to reflect technological progress, while remaining technologically neutral. Thus deletion of Annex II might be possible.

However, deletion of Annex II would remove any incentive to maintain a high level of toxic control. Furthermore, analysis shows that the currently collected mix of appliances contains varying amounts of (even newly applied) hazardous substances (like in LCD screens and energy saving lamps). This can pose an exposure hazard to workers in shredder plants (mercury, lead, cadmium and manganese) and CRT processing plants (cadmium and lead) (0142_2000 E-Schrott). Unless it can be proven that no hazardous substances are contained in the input, separation and special treatment will remain necessary as a 'fail-safe' mechanism for selected products.

Option 5.1.2 Delete specific (superfluous) requirements

It is possible that parts of the Annex II requirements may be superfluous either by the existence of other legislation or as a result of product changes, or by reasons of being prematurely over-prescriptive. For example, removal of circuit boards from mobile phones (and circuit boards altogether) may be considered to be superfluous as both the value and option to treat them integrally in copper smelter are present as long as shredder dust emissions are under control. Moreover, powerboards containing high amounts of steel and aluminium are shredded together with the remaining electronics in order to separate steel, aluminium and copper parts. Therefore, removal of them prior to further treatment is completely superfluous.

Another example is HC in refrigerators and freezers (the HC currently used have roughly a factor 400 lower kg CO2 equivalent). These items could be cheaper to recycle without jeopardizing the environment if they are kept separate from CFC, HCFC and HFC fridges. However, in case of doubt for older products due to false labelling, they should be treated as CFC fridges.

With regard to electrolytic capacitors, no substances of concern have been identified other than the very remote possibility of polychlorinated biphenyls (PCBs), which is already prescribed in entry 1 of Annex II. Thus there is no need for the requirement concerning electrolytic capacitors.

Another example is that of external cables. The possible substances of concern in these are also present in internal cables, which are not subject to this Annex II requirement to be removed. In addition, removal of external cables from appliances is counterproductive to the aim of increasing the possibilities for re-use of equipment.

Our analysis in Chapter 8 leads us to agree with the proposals for deletions from Annex II (1) in the TAC working group guidance (extract):

Annex II 1 item to be deleted	**Explanation**
External electric cables	There is no need to keep the entry on external cables (12), because the original reason, the labour aspects are because of the way of transport and treatment improved. The possible substances of concern are also in internal cables, which are not subject to specific rules. Furthermore, removal is also contra productive for the re-use possibility of the appliances.
Electrolyte capacitors (>25 mm)	The entry on electrolyte capacitors, containing substances of concern (15) is not necessary, because until now there are no other substances of concern found than PCB's, which is already prescribed in entry 1.
LCD displays	The entry on LCD's (11) is not necessary, because when backlights are used, it will be covered by the entry on mercury (2) because of the mercury content of these backlights. When no backlights are used, there is no need for specific removal, because no hazardous items are found in these LCD's. Liquid Crystals (LC's) are not toxic, neither are they mutagenic, suspicious of carcinogenicity and are not toxic to aquatic organisms. LC's may be irritant or sensitising and some are not readily biodegradable. (Information from Merck: Toxicological and ecotoxicological investigations of liquid crystals and disposal of LCD's; Becker e.a. febr. 2003)

Table 123: Annex II items to be deleted (TAC 2003)

In the interests of possible simplification, it would be sensible to regularly revise / adapt Annex II to progress. Furthermore, given that one can never know when an item of concern might turn up in the waste stream, it is advisable that any simplification to Annex II stresses the need for vigilance regarding this aspect.

Option 5.1.3 Maintain current requirements

Given the relatively recent adoption of the WEEE directive and that many Member States were late in their implementation of the directive into national law, there is a strong argument that it is currently too early to consider changing the Annex II requirements because many stakeholders are still adjusting their working practices to bring them into line with the

Directive. The Annex II requirements are broadly in line with the Hazardous Waste Directive. Therefore, Annex II should remain unchanged for the time being.

However, given the fact that the current project has to assume full implementation and should be looking forward as well as addressing simplification options that promote new developments in treatment technology, this option should not be followed up, but replaced by simpler ways to at least achieve the same environmental level of protection. Moreover, the current Annex II has become out-dated in the sense that it was based upon the idea of manual dismantling as the sole solution only and is therefore currently hampering the development of alternative treatment options. The TAC working group guidance on Annex II and Article 6.1 provides an overview of best practice and proposals for amendments based on these considerations. The TAC can provide the vehicle for supporting and further development of Annex II requirements.

Option 5.1.4 Specify removal efficiencies per entry

The aim of this option is that specific toxic substances removal efficiencies could be defined by compliance schemes or Member States. Such target efficiencies will then ensure that toxic substances are appropriately controlled. Whilst this option appears to be very appealing, there are practical difficulties that will need to be overcome. This is particularly the case where proof of efficient removal will require very clear details on how this should be measured. It is known that measurement of removal efficiencies as such is probably almost impossible and impractical.

Option 5.1.5 Introduce requirements for other (new) hazardous components

Inevitably, there will be the possibility that new types of equipment appearing on the market in the future, may contain substances of concern that are not covered currently by the RoHS directive. Thus, it is inevitable that Annex II will need to be updated at regular intervals to accommodate these new entries to the market. For example, hindsight shows that it is clear that Annex II was formulated before plasma screens started to become more widespread. These screens contain phosphor materials and the glass could be considered to be activated glass due to the phosphor coating. Thus an entry 'plasma displays' might be required in Annex II 1, and an appropriate treatment requirement entry is needed in Annex II 2 to ensure that these plasma screens are properly dealt with at end-of-life. Another issue refers to the presence of Beryllium containing components in mobile phones, PC's and mainframes. Given the specific toxic nature of Beryllium (much higher than for instance lead), it could be included for in treatment requirements. Specific attention should be given to shredder dust. There are very clear indications of high toxic loads due to materials emitted this way, especially for Hg and Cd (Morf, 2004, Hanke 2000). This might be incorporated in Annex II 2 not as directly linked to specific components, but as a general requirement for shredding operations.

10.5.2 Alternative Definitions of the Requirements (Task 2.5.2)

**Description/
Type of Incentives**

The options in this section were devised to build on the requirements laid out in Annex II in order to provide greater clarity and understanding on tackling the environmental priorities for proper treatment of the WEEE waste stream.

Option 5.2.1 Align Annex II with ROHS & Batteries Directives

Option 5.2.2 Establish a clear definition of 'remove'
Option 5.2.3 Describe treatment technologies per entry
Option 5.2.4 Before, after and part of treatment
Option 5.2.5 Concentration and system limits

Impacts/Advantages, Disadvantages

Option 5.2.1 Align Annex II with ROHS & Batteries Directives, Concentration and system limits for incoming streams

An important alignment with the RoHS scope can be to introduce similar concentration limits for Annex II components to be removed from a particular input stream, monitored by regular input stream sampling for example, 1 ppm for Hg, BFR pieces > 10 g, etc. and based on which Annex II entries are still relevant for the treatment category. An additional advantage would be that there would be no legal violations when an occasional Hg switch is shredded once a year in a large stream. However, consistency between these three documents should be aimed for. For example, plastics containing flame retardants need addressing. Currently Annex II requires the removal of plastic containing brominated flame retardants, but on the other hand, the ROHS directive exempts the use of decaBDE in polymeric applications (Commission Decision 2005/717/EC, of 13 October 2005). This is an apparent inconsistency.

This option is very closely linked to Option 5.2.5 below which focuses on the output streams. The key point there is that output streams from treatments carried out according to Annex II should have the best possible potential to be used in the manufacture of new equipment (thereby enabling closed-loop recycling).

Option 5.2.2 Establish a clear definition of 'remove'

The interpretation of the term 'have to be removed' within the first sub-section to Annex II is crucial. The word 'remove' also appears at points elsewhere in the Annex II. The TAC working group guidance document on Annex II (0053 TAC 2005) refers to remove as follows:

'Substances, preparations and components may be removed manually, mechanically or chemically, metallurgically with the result that hazardous substances, preparations, and components and those mentioned in Annex II are contained as an identifiable stream or identifiable part of a stream at the end of the treatment process. A substance, preparation or component is identifiable if it can be (is) monitored to prove environmentally safe treatment.'

As a consequence of this TAC interpretation, two different categories were distinguished in their guidance:

1. Those substances, preparations and components that must be removed as a first step in the treatment process (e.g. all fluids to be drained), and
2. Those substances, preparations and components that must be removed as an identifiable stream (or part of) in the later steps in the treatment process.

The TAC guidance document provides a list of those items to be removed a) as a first step, and b) as an identifiable stream (or part of), and represents the basis of current technical knowledge about appropriate treatment.

Further interpretation of 'remove' is provided by the UK Department of Environment, Food and Rural Affairs (DEFRA 2006):

'Removal …. is interpreted as including mechanical, chemical or manual processes and could occur at any stage in the treatment process. The manner in which removal is achieved will therefore depend on the type of WEEE involved, whether hazardous components are present and whether or not it is intended that a component is to be reused. Removal may therefore be a staged process and may also be undertaken at different facilities.

'Removal may be by manual or mechanical means. The items listed in Annex II can be broadly split into two groups; those that should be removed as a whole, and those that can be removed as materials i.e. in fragments or equivalent. Items should be safely removed as a whole where the material items concerned are hazardous and to do otherwise would lead to manifest pollution of the waste stream. Items may be removed as materials where the benefits gained by their removal as a whole in health and safety or environmental terms would be disproportionate to the costs involved.'

DEFRA UK Guidance	TAC Guidance	DEFRA UK Guidance	TAC Guidance
Annex II items that should be removed safely as a whole	**Annex II items to be removed as a first step**	**Annex II items that can be removed as materials**	**Annex II items to be removed as an identifiable fraction**
1. Capacitors containing polychlorinated biphenyls (PCBs) 2. Mercury containing components 3. Toner cartridges 4. Asbestos 5. Components containing refractory ceramic fibres 6. Components containing radioactive substances 7. Gas discharge lamps 8. Cathode ray tubes 9. Electrolyte capacitors containing substances of concern Batteries that can be removed prior to treatment and internal hazardous batteries	a) PCB's/PCT's containing capacitors, etc. b) Mercury containing backlighting lamps of LCD's). If backlights are not possible to remove manually, the whole screen must be removed. c) Other mercury containing components, such as switches, contacts, thermometers, thermostats and relays. d) External batteries (= all batteries that can be removed prior to treatment without special equipment), and internal hazardous batteries, excluding printed circuit board mounted batteries. e) Toner cartridges, liquid and pasty, as well as colour toner f) Asbestos waste and components which contain asbestos g) Other gas discharge lamps than mentioned in b) h) Refractory ceramic fibres	10. Plastic containing brominated flame retardants 11. CFCs, HCFCs, HFCs and HCs 12. External electric cables 13. Circuit boards 14. Liquid Crystal Displays 15. Batteries other than those mentioned in the list in the left hand column 16. The fluorescent coating in cathode ray tubes.	j) Other batteries than mentioned in d) k) 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 l) Plastics with brominated flame-retardants m) Cathode ray tubes and fluorescent coating. When not metallurgically treated, than as a first step n) Chlorofluorocarbons (CFC), hydro chlorofluorocarbons (HCFC) or hydro fluorocarbons (HFC) and other gases that are ozone depleting or have a global warming potential (GWP) above 15 o) Liquid crystal displays (together with their casing where appropriate) of a surface greater than 100 square centimetres p) External electric cables q) Electrolyte capacitors containing substances of

DEFRA UK Guidance	TAC Guidance	DEFRA UK Guidance	TAC Guidance
Annex II items that should be removed safely as a whole	**Annex II items to be removed as a first step**	**Annex II items that can be removed as materials**	**Annex II items to be removed as an identifiable fraction**
	(RCF's) i) WEEE components containing radioactive substances such as smoke detectors		concern (height > 25 mm or proportionately similar volume)

Table 124: Comparison of DEFRA and TAC Guidance on Annex II items to be removed as components or materials

'The removed substances, preparations, and components shall be disposed of or recovered in accordance with Article 4 of the Waste Framework Directive….'

There is good agreement on interpretation between both of the above mentioned documents. Importantly, when followed up upon: the removal definition should especially be formalised in the legal text of the revised Directive.

Option 5.2.3 Describe treatment technologies per entry

The aim of this option is to specify the necessary treatment technologies that should be used for dealing with specific Annex II items, thereby specifying BATRRT for each item. Whilst this would certainly provide greater clarity on treatment requirements it is arguable that policy ought to define the environmental priorities to be achieved rather than being over-prescriptive on the particular technologies to be used. This option could be achieved through defining the desired outputs (e.g. a toxic substance must be removed as an identifiable stream) and allowing market forces to drive technology developments.

Option 5.2.4 Before, after and part of treatment *Not as part of legal text*

The aim of this option is to provide clarity as to when and where removal of an item should occur in the treatment process. This could be useful for clarification on which steps should be done before others (e.g. proof of reusability before removal of external cables). However, much of this option could be achieved through adoption of guidance (see Option 2.2 above, TAC and DEFRA guidance documents) without recourse to defining these requirements in the legislation. It is noteworthy that this option was not favoured by stakeholders at the Expert Workshop discussions.

Option 5.2.5 Concentration and system limits for outgoing streams

The aim of this option is to provide threshold values or limits for particular treatment requirements beyond which there would be an exemption. For example, an Annex II requirement where the hazardous substance concentration (say) of an output stream should not exceed a certain level. This would provide a basis on which a treatment operator can decide on the technology that will be needed to ensure that compliant (or better) performance is maintained. The disadvantages of this option lie in the need for tight monitoring and enforcement of treatment operators to ensure that suspect practices (e.g. dilution to meet thresholds) are not carried out by unscrupulous treatment operators. However, it could be part of a quality standard for further treatment or could be applied to the most hazardous components only such as: Hg, Cd or PCBs or for CFCs.

10.5.3 Alternatives (instead of Treatment Rules) (2.5.3)

Description/ Type of Incentives

The options in this section were devised as possible alternative ways of ensuring proper treatment of WEEE without the need for the treatment requirements of Annex II in the WEEE directive

Option 5.3.1 Developing BAT
Option 5.3.2 Industry standards
Option 5.3.3 Monitoring and enforcement
Option 5.3.4 Measure removal efficiencies but don't enforce.
Option 5.3.5 Coverage by other legislation
Option 5.3.6 Criteria lists for technologies, outlets
Option 5.3.7 Criteria list to promote reuse components/ whole appliances
Option 5.3.8 Cover removal by licensing/ permit

Impacts/Advantages, Disadvantages

Option 5.3.1 Developing BAT,
Option 5.3.2 Industry standards

The aim of the standards option is to allow the Industry itself to establish its own guidance on proper treatment of certain items of WEEE. For example, CECED, the WEEE Forum and EERA have developed standards for the collection, transport and treatment of HC cooling and freezing appliances. These have received a number of favourable statements from stakeholders and could lead to widespread adoption. It is understood that agreed industry standards are in the process of being developed for other WEEE items. An advantage of this non-regulatory approach is that it could facilitate the establishment of BREFs in the longer term, developed out of accepted, established industry standards, which can be dynamic in terms of promoting higher quality treatment levels over time.

The main problem is that there are no BAT reference documents (BREFs) available currently and it could take some time (>1.5 years) to establish these. Whilst BREFs could be used for permitting and authorizing approval of treatment processes etc., this option is currently impractical given the length of time that it could take to establish relevant BREFs. However, as the review of the Directive is also a long lasting process and new version will have a long existence, it is recommended to keep the legal text 'open' for such developments in the longer term.

A potential disadvantage is the difficulty in gaining 100% acceptance by all treatment operators (this also applies to Option 5.3.1. above). The reputable industry may need support (legislative or fiscal) to help discourage free riders. In any case, the legal status of such standards should be clarified.

Another major advantage is that such standards can be applied by integrally taking into account multiple environmental objectives and can balance potential contradictions between for instance resource conservation and control over hazardous materials or health and safety issues. See also the important link with Chapter 10.3: Option 3.1.2 on more dedicated recycling targets per category, Option 3.2.3 on industry standards for recycling targets definitions and Option 3.2.6 on more harmonisation. These connected issues are maybe the most important advantage of development of industry standards, as a more balanced approach is highly recommended.

Option 5.3.3 Monitoring and enforcement

The advantage of this option is that it will help to discourage free riders from operating cheaper, lower standard services. Also the positive harmonisation effect of, for instance, applying the WEEE Forum - REPTOOL was mentioned positively in this respect. However, it should be clarified as to which would be the appropriate body to perform this as it is known that the technical level on WEEE treatment is very low for many representatives and inspection personnel. The exact role of member states, the EC itself and compliance schemes should be clarified or other quicker adjustments procedures could be considered.

This is the option of policing strictly to ensure the proper treatment of WEEE items. However, this would require good harmonization across the Member States (e.g. one suggestion is that the WEEE directive should become legislation under Article 95 of the Treaty in the interests of achieving better harmonization). Monitoring and enforcement should be applied according to output streams from treatment processes. Proponents of this option tend to have interests in setting out a level playing field for all treatment operators across the EU and seeking to eliminate free-riders. It is noteworthy that many stakeholders at the Expert Workshop were in favour of this option.

Option 5.3.5 Coverage by/ linkage to other legislation

There is a general preference for simplification of legislation and the avoidance of duplication. This option could possibly be achieved through making reference to the requirements of other legislation (e.g. Waste shipment regulations, waste framework directive and hazardous waste directive requirements). A possible alternative for less legislation could be, for example, placing a ban on the landfill and incineration of WEEE, banning the export of WEEE and setting high collection targets but the cost and resource implications of the increased need for monitoring and enforcement could outweigh the benefits gained from simplification.

Option 5.3.6 Criteria lists for technologies, outlets

The aim of this option is to establish a level playing field for WEEE treatment across the EU. This could require a WEEE directive under Article 95 instead of Article 175 in order to achieve this status. Again, it is preferable to establish criteria in terms of approved and authorized outlets rather than being over-prescriptive on the technologies to be used. In addition, this option would require greater monitoring and enforcement to minimise/eliminate free-riders. In principle, this option is sensible, however, it may be difficult to implement in practice. Alternatively, it could be made part of the development of treatment standards by industry or BREFS

Option 5.3.7 Criteria list to promote reuse components/ whole appliances

The aim of this option is to set out criteria to encourage maximising the opportunities for re-use (both whole appliances and components). It may be necessary to include the certification of refurbishers, who can make the correct distinctions of which products and components are suitable for re-use. However, care will be needed to ensure that such a criteria list does not give priority to re-use where this may not be the best environmental option. Furthermore, the criteria list should not be seen to encourage suspect or suspicious ‘exports for re-use’ as a means of avoiding expensive treatment requirements.

In Chapter 10.4, we highlighted the difficulties that this option could encounter. It is clear that re-use of whole appliances does tend to auto-regulate itself before the appliance is discarded and, after the appliance is discarded, the benefits (reduction in energy and materials consumption) for a highly developed industrial economy are small (less than 1%). Thus, the impact of introducing criteria for determining whether environmentally-sound reuse is hindered would be minimal.

Option 5.3.8 Cover removal by licensing/ permit

As part of monitoring and enforcement, this option would seek to ensure that operators involved in downstream treatment / removal of WEEE items are properly licensed and should possess appropriate permits for their operations. To some extent, this is already the case where a Member State's competent body exercises control over the waste management of WEEE. The difficulties lie in establishing harmonization across the EU so that the overall aims of the WEEE directive can be achieved. However, to promote long term options for treating appliances from other Member States, this might be developed by countries in the same region working together.

10.5.4 Conclusions

Conclusions

The impacts of each of the options discussed previously have been qualitatively assessed in the table below not just in terms of environmental, economic and social aspects but also in terms of whether or not simplification of the legal framework is likely and other options or legislation is affected.

Option No.	Description	Environmental effectiveness	Cost efficiency	Other impacts/ social	Simplification (legal framework)	Other options/ legislation affected
5.1.1	Delete current requirements altogether	Very negative	Positive	Negative	Positive	RoHS
5.1.2	Delete specific (superfluous) requirements	Neutral	Positive	no change	Positive	
5.1.3	Maintain current requirements	Neutral	Neutral	Neutral	Neutral	Neutral
5.1.4	Specify removal efficiencies per entry	Positive	Negative	Neutral		
5.1.5	Introduce requirements for other (new) hazardous components	Positive	Negative	Positive	Neutral	
5.2.1	Align Annex II with ROHS & Batteries Directives	Positive	Neutral	Neutral	Positive	RoHS Batteries Dir.
5.2.2	Establish a clear definition of 'remove'	Positive	Positive	Neutral	Potentially Positive	
5.2.3	Describe treatment technologies per entry	Positive	Negative	Neutral	Negative	

Option No.	Description	Environmental effectiveness	Cost efficiency	Other impacts/ social	Simplification (legal framework)	Other options/ legislation affected
5.2.4	Before, after and part of treatment	Positive	Positive	Neutral	Negative	
5.2.5	Concentration and system limits	Potentially Positive	Neutral	Neutral	Negative	
5.3.1	Developing BAT	Positive	Negative	Neutral	Positive	
5.3.2	Industry standards	Positive	Negative	Neutral	Potentially Positive	
5.3.3	Monitoring and enforcement	Neutral	Negative	Positive	Negative	
5.3.4	Measure removal efficiencies but don't enforce.	Neutral	Negative	Neutral	Positive	
5.3.5	Coverage by other legislation	Neutral	Neutral	Neutral	Neutral	HWD, IPPC
5.2.6	Criteria lists for technologies, outlets	Neutral	Negative	Neutral	Negative	
5.3.7	Criteria list to promote reuse components/ whole appliances	Positive	Negative	Positive	Negative	
5.3.8	Cover removal by licensing/ permit	Neutral	Negative	Positive	Negative	IPPC

Table 125: Qalitative assessment of options (treatment)

The most relevant options that would lead to an improvement over the current situation are:

1. Option 5.2.2 Establish a clear definition of 'remove'.
   The clear definition of what is meant by remove is of crucial importance to WEEE treatment operators. There has been substantial time and effort spent both at European level (TAC) and at Member State level (e.g. UK DEFRA) reaching a clear interpretation of the word 'remove' in relation to Annex II. After extended consultation and agreement with all Member States, it is recommended timely that the conclusions of these efforts are now formalised in a revised Directive. However at the same time, the following can be started as well

2. Option 5.1.2 Delete specific (superfluous) requirements.
   Times have also changed since Annex II was created. Products and treatment technologies have progressed in such a way that some Annex II requirements have become superfluous (see Section 10.5.2.1). The entries for external electric cables, electrolytic capacitors and LCD screens are superfluous and/ or covered by the other entries. In the current absence of developed BAT or Industry standards, it would make sense to address these superfluous requirements in the revision of the WEEE Directive.

3. Option 5.2.1 Align Annex II with ROHS and Batteries Directives

It also follows that during this revision, consistency between this directive and the ROHS and Batteries Directives is aimed for to maintain proper alignment and consistency in EU waste legislation.

4. Option 5.3.1/5.3.2 Developing BAT / Industry Standards
   The development of Industry standards and establishment of BREFs offers a more consensus-based and non-regulatory approach to ensuring up-to-date proper treatment of WEEE especially for the long term. We therefore suggest that this development route is kept open in the legal text in the revised Directive as it means less prescriptive and simpler legislation as well as an important incentive for continuous improvement in recycling technology and quality of treatment.

10.6 Grouping of Options

Introduction

From the analysis of all individual options it is obvious that there are many interrelations. Therefore, the options with the highest environmental improvements, as well as the highest cost efficiency enhancing ones and those significantly adding to more harmonisation and simplification are discussed again in relation to each other in order to prevent conflicts between individual options and sub optimisation.

From the analysis of the scope, one of the options with the highest simplification level and allowing more focused target setting from an environmental point of view is to arrange the scope based on the collection and treatment categories instead of a product categories division (Option 1.3.1). For redefining and determining such a renewed scope, it is no longer necessary to use indicative products list right now (Option 1.1.6), but rather criteria lists (Option 1.3.2). The major benefit from this approach is that it allows achieving the desired aims of the Directive (even considering options referred to in Chapters 10.1.1 and 10.1.2) in a more differentiated way. This is not only much more in line with current collection and recycling practices in the EU27 but also with the very different types of environmental priorities per treatment category as pointed out in Chapter 8.4 (toxic control, resource conservation, energy use and other emissions). The use of different criteria based upon the (environmental aspects of the) collection and treatment categories contributes to more environmentally relevant targets for collection, recycling and recovery and treatment and thus environmental effectiveness. This can also be linked to the findings on collected amounts and stream compositions as described in Chapter 7 and the environmental and economic impact assessment of Chapter 8 which is indicating the most relevant products and materials to collect and treat. More specifically, this enables more differentiated collection targets per treatment category (Option 2.1.2) which for some categories might also be based on ‘put on market percentage (Option 2.1.3). Due to the limited amount of appliances covered by the Directive as real B2B, these categories could be removed, especially knowing all of these appliances are already taken care of by other means/ regulations/ own take-back systems and due to intrinsic value (Option 1.2.4). Besides collection targets, the definition of the scope will also influence the setting of recycling and recovery targets as well as treatment requirements per treatment category. These three items are discussed in more detail per treatment category:

10.6.1 LHHA

From an economic point of view, this category is already collected and treated due to its intrinsic value. It is also category that is relatively easy to collect through both retailer take-back and through collection points and difficult to dispose of with other domestic waste – due to its size. The high intrinsic value increases potential for leakage from official WEEE streams. Furthermore, specific recycling targets and treatment requirements will not improve environmental performance as the environmental and economic optimisation goes hand in hand:

The recycling targets are easily achieved for these appliances. However, the presence of the counterweights does influence the targets for an overall high metal content category. Basically, Chapter 8.2.1 demonstrated that recycling targets (and maybe even collection targets) are not really necessary. Taking into account the low plastics content makes that there is actually no need for a (high) target and promoting high re-application levels does not make any environmental or economic sense. Therefore, a weight based target does not form an incentive for improving treatment. With respect to technologies used both at shredding lines for electronics as well as car shredders: the environmental and economic optimisation and material recovery are going in the same direction. Summarised: there is no need for recycling targets for this category. However, when collected, reporting on the achieved recycling percentage can be useful in order to demonstrate that proper treatment is taking place, the actual level itself is then less relevant. In summary, for simplification reasons it can be considered to leave these appliances out of the Directive.

10.6.2 C&F

Similar to the Large Household Appliances, collection of Cooling and Freezing appliances is easy through both retailer take-back and through collection points. They are also difficult to dispose of with other domestic waste due to their size and weight. However, in contrast to the previous treatment category, they are very environmentally relevant in the impact assessment due to the presence of CFCs. The CFC removal is the most relevant environmental priority. Fridges and freezers are easily recognisable for separate treatment from other LHHA. Due to their environmental impacts they should be collected as much as possible and prevented to undergo the same treatment as other LHHA at least for the older CFC containing part of the stream. Recycling targets are achieved in most countries. From a weight based perspective the category is dominated by metals. However, the environmental calculations demonstrate that the first environmental priority, especially looking at ozone layer depletion and global warming, is the CFC removal and control is crucial. In this respect from an environmental point of view, having recycling targets for CFC fridges only is not the appropriate environmental incentive. For HC fridges, this is different as the burdening cooling agents are far less harmful here. For this category, proper removal of CFC should be prioritised over high recycling percentages as clearly demonstrated in Chapter 8.2.2.

10.6.3 SHHA

Small household appliances are most likely to be collected as a heterogeneous mixed stream with small equipment from other categories as indicated in Chapter 8.0.5.3. There is a high chance of leakage to domestic waste disposal. In the collection results from different Member States and systems, there are large differences in performance found. This indicates room for improvement in collection, especially for the very small appliances which are hardly found back in the collection streams. The total stream of small appliances is often not split in metal, precious metal or plastics dominated stream. It has, dependent on the collection and eventual sorting, the risk of applying recycling targets only to the total. The weight based recycling targets most difficult to achieve, especially for the subgroup of 2,7 which are usually mixed with more metal rich fraction of 1C and 3A. The environmental outcomes demonstrate (dependent on the environmental impact categories) that increasing plastics recycling for sorted plastics does contribute to higher environmental performance. However, for smaller products and mixed plastics, the plastic recycling scenario is less eco-efficient and certain technical boundaries might occur, for instance due to presence of BFRs. Large housings are easier to be recycled whereas mixed plastics recycling is more difficult. The targets are often not achieved in most of the member states. The analysis showed that the most positive option is to develop BAT / Industry standards for what represents best practice for dealing with SHHA as multiple environmental concerns have to be balanced at the same time.

10.6.4 CRT+FDP

Collection

CRTs are easily recognisable and are collected as a separate stream. Over time, amounts collected will go down to zero. Due to the lead content and concerns connected to illegal waste shipments, the collection should be maximised. A specific collection target should be made dynamic as these appliances are replaced by flat panel displays and that the total weight put on market will go down. For FDPs, the numbers placed on the market are rapidly increasing, however they hardly return as waste at the moment.

For CRT recycling, the recycling targets as applied now do already form an intention to apply recycling of CRT glass. Much more relevant is that after separation of the picture tubes, there is enough economic incentive for the time being to apply CRT to CRT glass recycling. However, environmental evidence demonstrates that the different types of recycling have very different environmental levels of re-application as displayed below in the discussion on the target definition. This indicates there is a problem with the definition of recycling as such. A more specific focus on CRT to CRT glass recycling is environmentally beneficial (as long as possible in the secondary materials market). An important finding with is that the lowest environmental preferences are also being accounted as useful re-applications and thus as recycling operations (in the past). Basically, when such options would be the cheapest solutions, they would also be accounted as a 100% recycling of the CRT glass and thus environmentally counterproductive.

LCD screens have been discussed in Chapter 10.5 as the Hg containing backlight lamps and the uncertainty on proper treatment makes that the setting of recycling targets is less relevant. However, due to the absence of proper recycling solutions and the high risk of mercury emissions from these panels point to a strict target setting for mercury removal without causing Health and Safety risk and incentives for proper treatment as the technical costs per piece or per ton will likely be very high.

10.6.5 Lamps

Similar to LCD screens, collection and recycling is very relevant in order to prevent mercury emissions. The costs of collection are high and gas discharge lamps are classified as hazardous waste. Due to the high total amount of mercury present and place on the market, collection targets should be relatively high, despite the facts that lamps are also very small items with a high likelihood of 'disappearing in the waste bin.' From Chapter 8.2.5 it can be seen that the main environmental concern is recovery of the mercury which is to be prioritised over high recycling targets.

10.6.6 Conclusions

The above findings lead to the conclusion that the diversity in environmental priorities over the various treatment categories should be addressed in much more detail than that is currently the case. Therefore, the most relevant translation of the options into targets setting is summarised in the below table for each treatment category:

	Collection target	**Recycling target**	**Specific Treatment Requirement ***
LHHA, 1A, 10	NO	NO	NO
C&F: 1B	YES	Maybe	YES: CFC's
SHHA: 2A,3A,4A,6,7 (plastic)	YES	YES: For plastic recycling	YES: NiCd from Cat. 6
SHHA: 1C, 3A (metal)	NO	NO	NO
CRT: 3B, 4B	YES	YES: For CRT glass	YES: control over Pb
FDP: 3C, 4C	YES	Maybe	YES: For LCD Hg removal
Lighting equipment – Lamps	YES	Maybe for HQ glass	YES: Hg removal

Table 126: Differentiated targets for collection, recycling and treatment

Targets for reuse should be further researched outside of the WEEE Directive and preferably included be investigated in EuP to avoid rebound effects of higher energy consumption compared to newer appliances.

Besides, the more differentiated target setting displayed above, there are other conditions for success following from the discussed options that promote a higher level of simplification and realisation of implementing the WEEE Directive in practice beyond changing the legal text as such. This is discussed in Chapter 11.

11 CONDITIONS FOR SUCCESS

11.1 Introduction

Introduction

A key aspect with all options listed and evaluated is, that in order to make an updated WEEE Directive work in practice, is that one needs to take into account the conditions for a successful implementation in practice. The research team observed the current struggles in the transposition and implementation of the Directive. Out of this observation, one can extract a renewed vision for the future of the Directive. Such a vision supports forward looking by means of formulating steps that can better lead to the aim of environmental protection in its broader meaning in a more cost-efficient way.

Options addressed in chapter 10 embrace specific items in particular areas of impact of the WEEE Directive. Options are not individual items, but are adjacent and connected to each other and are influenced by practical implications.

11.2 Main Outcomes of the Study

Outcomes

The findings so far can be summarised as:

1. The estimated collection percentages in Chapter 8.0.5, Table 56 showing the collection percentage of the total WEEE Arising, illustrates that, depending on the category, only 25% to 40% of WEEE is collected and treated. This is even assuming full implementation of the existing take-back system present, and thus excluding the delays in starting collection in many of the Member States. Although the percentages are variable per category, for WEEE as a whole, it cannot be denied that the actual collection is very low for WEEE as a whole.
2. This finding is confirmed by Chapter 10.2, Table 117: Amounts of WEEE collected. It shows large varieties in amounts collected in total. Moreover, even for various long running systems with relatively high total amounts, large differences per subcategory are found. This indicates that there is substantial room for improvement,
3. In some countries actions are taken to effectively improve collection, like the enforcement activities in the Netherlands (VROM 2005, 2007b), establishing reimbursement contracts for collection with retailers (Recupel, 2007) and enacting of a better access to collection points than 'old for new' (Norway and Switzerland). In all these cases, a significant increase in collected amounts was found,
4. One important and well-documented case is that of the Netherlands inspections authorities (VROM 2007b): Comparing the result from 2004 till 2006, the total percentage of illegal activities has decreased. At retailers, more than 60% were in violation in 2004 and only 11% in 2006. With this, the amount of collected TVs has increased by 50%. The final conclusion is that the enforcement actions were effective and the level of compliance in the chain of electronic waste collection and treatment has improved significantly. By this the risk of undesired environmental and health effects in non-OECD countries is decreased. This illustrates that besides the clear positive environmental impacts of collecting and treating

more WEEE as calculated in Chapter 8 under European conditions (see Figure 58 Environmental impacts per average piece diverted from disposal and further), there are further positive environmental impacts due to prevention of illegal waste shipment and treatment in non-OECD countries,

5. The diversity of environmental priorities is closely linked to 'environmental quality' of treatment:
   a. For category 1B, a high CFC removal is needed (Chapter 8.2.2),
   b. For the plastic dominated products in category 2, 3A, 4A, 6, 7 increasing plastics recycling brings higher environmental gains (Chapter 8.2.3),
   c. For the metal and precious metal dominated products in category 1C, 3A and 4A, optimisation in treatment focused on recovery of resources is the most environmentally beneficial route (Chapter 8.2.3),
   d. For the CRT containing appliances, promoting as long as possible, the higher re-application levels of CRT glass as well as developing other future alternatives for leaded glass is environmentally beneficial (Chapter 8.2.4),
   e. For the LCD screens, both control over the mercury content as well as recovery of the material value are environmentally relevant (Chapter 8.2.4),
   f. For gas discharge lamps, high control over the mercury content at collection and treatment is highly relevant from a toxicity perspective (Chapter 8.2.5)

In all these cases, the incentives for better treatment can vary per category and should enable adaptation to future developments and innovations in treatment technology. The current general recycling targets and Annex II treatment requirements do not take into account the above diversity and can in certain cases be environmentally counterproductive and hinder technology development.

11.3 Shortcomings of the Current WEEE Directive

Shortcomings

It is beyond any doubt that the delays in implementation and many other non-harmonised issues are not promoting higher collection and better treatment let alone the overall cost–efficiency and realisation of economies of scale. These problems cannot be solved overnight by changing the WEEE Directive's text. However, with this study, supporting the European Commission's Review, one has to look forward to how the WEEE landscape should preferably look. But before going into details, we highlight the most important obstacles at the present time to learn for the future. The three most important problems (in this order) are currently:

1. There are no financial incentives for producers to go beyond the minimal legal obligations of the collection target for certain categories – especially for those having potential high environmental impact – with relatively high take back costs (e.g. CFC appliances, LCD screens, or Lamps). Collecting more simply costs more. Furthermore, the risk that one would opt for the cheapest treatment solutions with potentially negative environmental consequences needs to be taken into account, in order to set the proper incentives to high treatment standards. Note that the economic outcomes per treatment category are differing: see Chapter 8.4.1 for the large variety in shares of respectively collection, transport, treatment and downstream recycling processes in the total. Also note that especially for the collective systems, when the Visible Fee will be abandoned in 2011/ 2013, a negative effect on the collected amounts and quality of treatment could occur. In

particular the current financing principles of Compliance Schemes rely on so called "pay-as-you-go" model (Van Rossem 2006): costs of WEEE management are allocated to producers proportionate to their market share when those costs occur". In such systems, the Visible Fee, when used, often covers not only costs for Historical WEEE, but also all WEEE arising (Oekopol, 2007), as a split of the different flows is neither possible nor sensible. The following example is taken from the explanatory guidelines of the Luxemburg Compliance Scheme Ecotrel (2006). It shows the financing model and financial impact of the Visible Fee in practice: "The producers and importers affiliated with Ecotrel, pay a recycling fee in order to finance the activities of Ecotrel. In the majority of cases, they must charge their clients with this recycling fee. This means that, in the end, producers and importers do not bear the costs of processing for WEEEs". Besides, non-compliance with the current WEEE Directive text on the use of the Visible Fee, the example illustrates two other things: At first, from an environmental and economic perspective, there is no reason to split between Historic versus New WEEE in appointing financial responsibility. Secondly, a fair split based on the actual age of the products in the return stream cannot be made and is only adding substantial costs. This will in the end be paid by consumers anyway, either as a visible fee or as part of the product price. Furthermore, there are even environmental risks and higher costs involved from differentiation between producers with a large historic market share versus relatively newcomers on the market. This is already resulting in having an increasing number of Compliance Schemes present (our count is over 140 different ones in the EU27 already), which are partially overlapping and creating gaps of products and categories not covered as well as unnecessary administrative burden. It should be noted that the "pay-as-you-go" financing models across Europe without using an artificial historic versus new split, are ensuring that any WEEE arising in a given year is being collected and treated, as the costs are shared, according to the current market share, between producers when placing new products on the market (Justel 2007).

2. Legal basis of differences in transposition is the article 175 of the Treaty, and its 'minimum requirement principle' (which allows EU Member States to go beyond the Directives requirements). These large differences in interpretations and practices per EU Member State are present and hampering the internal market, economies of scale (including real Pan-European approaches towards WEEE). Sometimes room is given to some stakeholders for running away from responsibilities (free-riding issue). Harmonization across different Member States is currently lacking in terms of scope, registering and reporting obligations, stakeholder roles, financing principles in respect of Historical or New WEEE, B2B versus B2C, treatment requirements, monitoring and enforcement standards, and many other aspects that hamper the economical, environmental and technical effectiveness of such principle within the EU market. It should be taken into account that the next citation is part of the WEEE Directive as the number 8 'whereas' and thus part of the legal text:
'The objective of improving the management of WEEE cannot be achieved effectively by Member States acting individually. In particular, different national applications of the producer responsibility principle may lead to substantial disparities in the financial burden on economic operators. Having different national policies on the management of WEEE hampers the effectiveness of recycling policies'. Unfortunately, this was not prevented in practice.

3. The EPR policy instrument is often claimed at (i) reducing waste volumes (ii) reducing waste disposal (iii) reducing hazardous content (iv) decreasing virgin material use (v) lowering pollution in production stage and (vi) increasing design for Environment (OECD 2006, Sachs 2006). This principle, and the implementation of it, has been proven to be challenging and, in

many Member States, not enforceable. This is especially the case by leaving the freedom to comply individually or collectively when the boundary conditions are not the same. This happens when there are different exemption criteria from financial guarantees, which have a substantial financial impact (EICTA 2006). The same is the case due to difficult access to WEEE (when other systems already have agreements with collection points, or in the case of different quality standards (which usually are not enforced). A long-standing principle in economics is that just as many policy instruments are needed as there are policy goals. The trade-off between strict enforcement of one policy to have a Design for Recycling impact needs to be balanced with the other policy principles, addressing the specific goals of improved waste management (OECD 2006). With regard to the Design for Recycling impact, there is no industry-wide evidence provided, on the contrary, there is no evidence that it has occurred or ever will occur as a common practice. Moreover, the two most important goals: collecting more and treating better, are in practice fully depending on consumer discarding behaviour and access to this waste. This is extremely far removed from what a producer can influence throughout control over products (which are not owned anymore). Therefore, splitting the waste management related goals and product related goals into two policy instruments should at least be considered to improve environmental effectiveness.

11.4 The Future WEEE Directive: Redefinition of Key Provisions

Future

The above shortcomings are partly related to delays and slow evolution of implementing the WEEE Directive in many member states. They are also partly because of fundamental differences between the 1996 drafting and current findings as already explained in Chapter 5. Out of all information, it is highly necessary to renew the vision of what a WEEE Directive should accomplish in relation to the aims identified above: The evidence found with this study and the expertise this study team developed over the years, leads to the conclusion that the Directive and the connected activities by stakeholders should lead to one efficient 'EU WEEE-marketplace' with similar conditions for new products put on the market as well as ongoing improvements in the collection and treatment of discarded appliances. One should therefore aim at having a situation in place that realigns the most important provisions of the Directive while encouraging the achievement of the above two goals of collecting more and treating better. Such vision should overcome the above key shortcomings of the current implementation. The way this vision can be translated in practical steps is subject to discussion: The team has identified the following areas for change:

11.4.1 Address Multi-stakeholders Responsibilities, Renewed EPR or No EPR: Two Lines of Thinking

As concluded before, the most eco-efficient way to improve take-back system performance is by maximizing collection, to improve the recycling processing and to monitor and enforce the destination of material fractions and products. How does that relate to re-arranging responsibilities and for instance to the financing part of this? The financing of WEEE has been proven to be a challenging field and the most crucial issue and not only for producers. Different stakeholders are involved in the EOL chain. Financial responsibility alone has not lead to optimisation of take-back and recycling systems from an overall societal point of view, as leverages are needed in different phases of the chain. Therefore, the following responsibilities could be re-addressed:

1. Producers should either remain primarily responsible for financing as in this way one of the stakeholders involved is primarily responsible and taking the lead in organising and developing compliance schemes. Or, another stakeholder, for example the Member State itself, or assigned and more independent compliance schemes could take this steering role instead. In the first case, producers should have the cooperation of other stakeholders for instance to gain access to WEEE as otherwise taking responsibility is not possible when the necessary means are not within reach. In the other case, the steering stakeholder should be provided with the necessary financing and means as well. Secondly, producers should increase their 'Design for Recycling' efforts where appropriate and balanced with other environmental issues, so as part of ecodesign and reduce disassembly time for products that need to be dismantled and toxic or harmful components that need to be removed prior to any further treatment like Hg backlights, asbestos, radioactive components, CFC's, etc. However such efforts are a completely different goal than the urgent need for better waste management and could, from an overall environmental perspective, they can be better addressed via another policy instrument (for instance in RoHS for hazardous components which are exempted, to have ease of removal incentives, see Chapter 11.4.3 for more details and in EuP when it comes to making an integral balance between multiple and sometimes conflicting ecodesign strategies),

2. End users/ consumers should hand in old products and avoid discarding of (small) appliances in the regular waste bin. Public education and campaigns seemed to be successful in a few EU member states. In some EU member states, specific school projects have been very successful in educating children on environmental concerns by small scale collection trials with high collection result per household). However, the low WEEE return rates are also due to the lacking awareness and may be even willingness of the consumer to actively participate in present WEEE take-back systems. Hence, awareness raising is a must almost everywhere, and it also ensures public control over take-back system performances as consumers do want to know in general what they are paying for (for instance in case of a Visible Fee),

3. Retailers should provide good accessible collection points as much as possible and they must form a much better bridge between consumers and producers, e.g. on communicating environmental effects of certain equipment. In order to minimize thresholds for consumer to hand in old products, a high density and accessibility of collection points is needed. This also includes the trade-in mechanism, not only on an old for new basis when buying new appliances but 'any old for any new' or 'any old when selling new' is recommended. In Norway and Switzerland, collecting more than 10 kg per inhabitant in 2005, have an 'any old' hand in mechanism where the end user can return old appliances to retailers without buying new equipment. Also Denmark has implemented a similar mechanism in transposing the WEEE Directive, thus going beyond 'old for new'. In addition, mandatory trade in at certified compliance schemes could limit selling products to brokers with a high chance of causing illegal exports. Evidence for this is found in the Netherlands where inspection authorities found large quantities of TV's leaving the country 'illegally' to south-east Asia due to not handing in products at certified compliance schemes by VROM (2005, 2007),

4. Municipalities: should enable cheap collection and good accessible collection points as well (when such collection points or container parks are present of course). Also, they should

avoid excessive costs for collecting WEEE as happens in some EU member states due to the fact that the responsibility of these municipalities is not addressed at all and the compliance schemes have few options. They should also avoid selling appliances to scrap brokers with the risk of implicitly promoting illegal exports,

5. Recyclers should invest in the most eco-efficient treatment technologies and try to promote high level reapplications of material fractions. Further research might be needed here in order to optimize the cost efficiency and environmental performance of different treatment options,
6. Compliance Schemes should try to maximise collection amount, in order to improve effectiveness of the system and achieve economy of scale. A reward mechanism could be used in order to ensure maximum collection of the entire stream generated by the final user. Schemes could also be made responsible for the P.R towards consumers. In addition, mechanisms should be in place that reduce overhead and additional costs for compliance schemes as well as ways that promote good quality treatment, which sometimes costs more than fulfilling 'minimum requirements'. In addition, the control and enforcement of recycling operations and products and materials streams should be addressed,
7. Finally, governments and authorities should provide clear legislative frameworks, in particular addressing key responsibilities to stakeholders and the most crucial definitions. In addition one should increase monitoring and enforcement and access to these data for public evaluation of the 'success' in place (See Chapter 11.6.2).

The logic behind the above is to address responsibilities in relation to solutions within reach of the same stakeholders.

11.4.2 Positive Financing Mechanism Options

Financing of WEEE has been proven to be a challenging field, as leverages are needed in different phases of the chain and towards different stakeholders involved. There are different possibilities, which further promote more collection and better treatment, which are only sketched here, as further research will be needed to examine the detailed implications:

1. When producers remain primarily responsible for financing:
   a. One can set higher collection targets and apply strict enforcement on whether they are obtained,
   b. The financing model can be adapted in such a way that one has to pay for appliances put on market and receive back a certain refund when collection target is achieved or a penalty in case of the opposite.
2. When producers are not directly responsible for financing:
   a. One can maintain the Visible Fee for treatment categories with a (substantial) net negative recycling value (see Figure 63, Chapter 8.4.4),
   b. One can develop a EU wide Recycling Fund, which pays compliance schemes more when more collected,
   c. Responsibility for maximum treatment lies on another stakeholder.
3. Start with grouping of regions with the (requirement to have) the same provisions and operational standards.

The main advantage by applying this, with financing based on amounts collected (differentiated?), is a clear financial incentive to collect more. Additionally, better performance gets rewarded, especially competition between schemes on this aspect as well as economies of scale being promoted. Moreover, more centralized, technical, financial and enforcement knowledge and power will be obtained. It would also help to deal with moving goods in the EU (from west to east). It could also avoid products with fees paid for as put on market, but appearing elsewhere in CE MS.

The disadvantages are that access to collection needs to be arranged in more uniform way. Differentiation might be needed to avoid cherry picking and more incentive required for smaller valuable/ more environmentally burdening appliances. Furthermore, mechanisms should be in place to avoid excessive funds to be built up or use of them to compensate other things than the intended (VROM 2007a). Transition of national compliance schemes and their funds to EU level is needed. This would be a very complex arrangement.

The main problem with the current determination of required financial guarantees is that:

- One has no clue on when appliances put on market will come back (so producers are paying in advance for their appliances but they are not sure when and if they will come back),
- One has no idea on historical WEEE arising,
- In compliance schemes or anyway difficult to assess (to set VF reflecting real cost for managing historical WEEE).

The guarantees which are currently the highest part of the overall costs, could in principle be avoided when:

1. Producers are paying on put on market basis (in advance or ‘pay as you go’),
2. Historical WEEE is financed by a visible fee as a separate stream (thus no relationship between VF and compliance fee producers are paying to compliance scheme

The easiest way still remains the ‘Pay as you go’ system, ensuring every year expenses to collect and treat all arising are met (so when there are incentives to collect even more, producers on market are always financing).

11.4.3 Design for Recycling

The basic principle for adaptation of EPR for the recycling chain was rewarding Design for Recycling (DfR). Unfortunately two boundary conditions reduce the room for effectively applying DfR, e.g. the environmental life-cycle principle as well as functionality and other legitimate requirements (besides economic considerations).

Proper Eco-Design aims a limiting of the environmental impacts over the total life-cycle and keeping the functionality demand intact. For instance (smaller) LCD monitors use less energy in the use phase compared to CRT screens, which prevails from an environmental point of view over the risks in recycling of the mercury containing backlights (let alone the ‘functionality demand’ of having flat panels like in laptops). A similar issue exists with energy saving lamps.

In Eikelenberg (2003) and Huisman (2003c, 2004b) it is demonstrated in more detail that the environmental room for improving the EOL phase of most mainstream products is very limited. This is also due to the fact that when improving end-of-life performance, the following three effects must be addressed at the same time:

1. The environmental value allocated to the materials within the product in the manufacturing stage should be decreased. This is an important principle - recycling percentages, either on a weight basis, or on environmentally weighted QWERTY basis should not be increased by 'adding more environmental load' into products at the beginning of their life cycle. Such an activity would lead to overall increase of the total environmental impacts over the life cycle. In simple words: adding more metals or energy intensive materials may increase the potential amounts to be recovered, however at the cost of environmental burdening during manufacturing. See the first arrow in Figure 65,
2. The second effect represents the second important principle for redesign. When the product under consideration is not recycled at all and for instance ends up in a landfill, the environmental impacts must not increase as well. Therefore, the environmental value connected to the 'worst case scenario' should be decreased too. This can be achieved for instance by avoiding potentially toxic materials,
3. The third effect of Figure 65 shows that a redesign activity should lead to minimizing the gap between maximum environmental value to be recovered (the 'manufacturing value' of the first bar) and the actual performance of product in the recycling scenario under consideration (third bar). In other words, the environmental value of the materials present in the product must be recovered as much as possible.

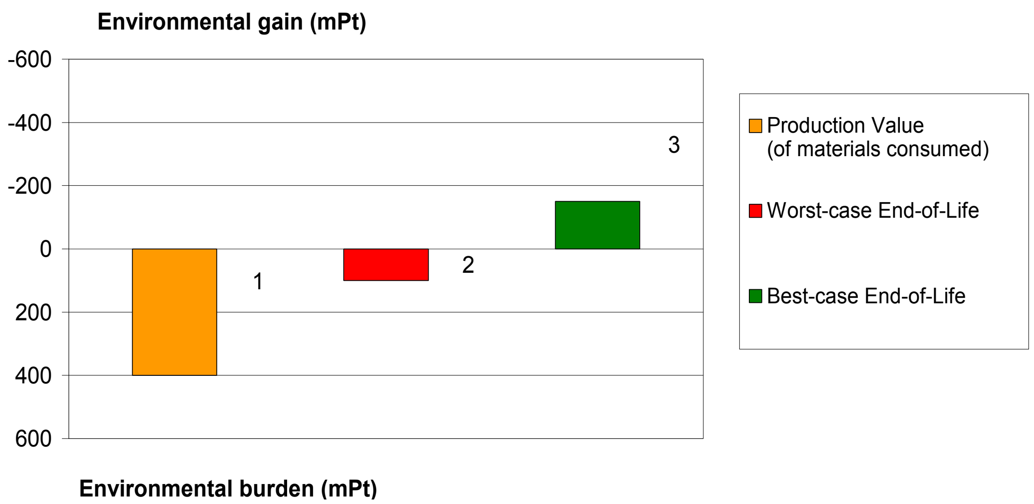

Figure 65: The three main ecodesign principles

The result of any successful redesign activity should comply with all three principles at the same time, in order to prevent higher environmental impacts of the products concerned.

On top of that many other restrictions exist like functionality and looks, cost for changing production higher than savings in recycling, reliability and safety (flame-retardants!) and other legal requirements, development time and supply chain aspects. This does not mean that there is room for improvement on the design end. For example, at the moment no good recycling solutions exist for LCD panels, both dismantling (too risky from a Health and Safety point of view) and shredding and separation (uncontrolled Hg emissions) are not ideal options. What could be done through design is to improve the 'remove-ability' of the backlights and decrease of the disassembly times for those products that are likely to be dismantled. Despite the fact that in practice the need for DfR is limited, in specific cases (Hg backlighting, batteries, products with an intrinsic need for dismantling) the disassembly and removal characteristics of truly hazardous components could be improved. With this observation, which is confirmed by recyclers, DfR basically turns into 'DtARA': Design to Avoid Recycling Accidents.

Basically, the Hg-backlights case is a perfect example why the EPR provision with regard to DfR does not work in practice. Even when being able to reduce with smart design the dismantling time of backlights, such improvements will have a potentially higher production cost, which needs to be rewarded at EOL stage. Such a reward, when changes in design steers for an individual approach, need to be paid of at EOL in individual approach. Importantly, it is not principally the collective arrangement hindering this (which make collection and transport cheaper, plus when individual arrangements would be present, the necessary sorting costs per brand would fully offset any economic benefit anyway), but rather the fact that having a cost in manufacturing, which would in theory be regained at EOL, would have a time gap of, for instance, more than 10 years (see the average product lifetimes in Chapter 7.2) Any investment made now, must therefore pay off multiple times economically to make economic sense over such a long period. This alone makes that it is very unlikely that such an investment is made by manufacturers without some sort of compensation for their efforts. Moreover, currently no one knows (including recyclers) how to treat LCD appliances on a large scale in an acceptable manner. The recycling industry is looking for ways to both recover the mercury as well as the material value in a mechanical way. One can only guess that recyclers are finding more innovative or integral ways to deal with these LCD screens in the future, which might render a design change superfluous over 10 years. One cannot predict how changes in innovation and treatment technology may develop. Finally, we must ensure that any design change for ease of remove-ability does not result in LCD screens being more susceptible to breakage during collection and transportation as this would be counterproductive overall.

Basically this example demonstrates that design requirement should not be part of the WEEE Directive. For exempted hazardous components in WEEE, it should be considered that effective removal pathways should be included in the RoHS Directive. From an overall environmental perspective, design for recycling requirements or directions, should be balanced and prioritised compared to other life-cycle stages in an integral way (f.i. with energy consumption). This should be done in order to prevent environmental rebound effects in other areas. Therefore it is recommended to include the material and component selection aspect in the EuP Directive, for instance by incorporating the energy component of material selection and expected recycling phase. Reducing weight of new products, when financing is based on weight of appliances put on market, can be an incentive in the present time, which generally speaking also makes environmental sense taking into account the ecodesign directions of Figure 65. Such considerations affect the total life cycle of products and could therefore better be part of EuP considerations.

11.5 Conclusions

Conclusions

The vision described in the previous paragraphs demonstrates how maximum environmental gain and economic efficiency can be obtained. The following items are a key element of this:

11.5.1 Make the WEEE Directive a Waste Management Framework

This includes redefinition of the aim of the Directive – towards (more efficient) waste management rather than influencing product design, as these are two rather different objectives demanding two different instruments. It also includes redefining the product oriented scope into a collection/ treatment scope. This would mean changing the current division in industry clusters into products that should undergo similar treatment to streamline monitoring and reporting and the same recycling treatment requirements per actual treatment/ collection category. Additionally, targets for reuse could also be left out of the Directive, as it would be waste oriented and reuse of appliances is per definition not referring to waste. Reuse is observed to take place only when there is an economic value remaining.

11.5.2 Enforce Provisions at EU and Member State Level

There is a clear need for a higher level of control when it comes to monitoring and enforcement of the legal provision. This implies a higher level of activity required for the European Commission, Governments and Competent Bodies of the Member States in order to ensure a level playing field for all stakeholders involved. This clear lack of enforcement on many levels is being observed:

- Registration: not all producers are registered, sometimes deliberately when penalties are lower than financial obligations,
- Financial obligations: For instance, there are no audit checks on proper addressing financial obligation in bookkeeping. WEEE can be used to level profits over multiple years and by having different bookkeeping methods for European, Asian and US producers, this causes competition distortion,
- Collected amounts and treatment: Who is responsible, and are collected streams really treated and not traded further? Is treatment under the same conditions? In addition, there are large differences in applying the Annex II requirement and reported quantities,
- Level of financial reserves of compliances schemes,
- (Illegal) Waste shipments.

Further ways to increase enforcement should be investigated. Apparently, there is in many member states a lack of technical and financial knowledge. Many SME's are not even aware of their WEEE related responsibilities. Maybe, the establishment of an EU technical competence centre would promote more technical control over operations.

11.5.3 Split Legal Framework and Operational Standards

This option/ theme includes simplifying the current legal text into a basic framework and to leave the developments of standards of working to the field itself. This is especially needed as 'times are changing' and developments in treatment and operations will continue to occur. In this respect standards should promote such developments when the results are leading to better environmental performance and increased cost-efficiency. This approach is also known to be taken by the Chinese WEEE draft regulations. It can especially be applied on:

- Art. 2: Scope,
- Art. 3: Definitions,

- Art. 5: Collection,
- Art. 6: Treatment,
- Art. 7: Recovery,
- Annex II.

Developments in recycling technology and ways compliance schemes are organised are changing over time. The future for the EU lies probably in having cross border/ pan-EU competing compliances schemes. By splitting the basic legal text and the evolving standards for operations, much more flexibility is possible. However, clearance on how to arrange the financing mechanisms is a prerequisite.

The same counts for the current Annex II and the recovery targets. They could be adjusted more easily based on technical progress or, importantly, due to rapidly changing products and new hazardous materials not yet listed. Historically considerable changes have occurred in environmental priorities like more public focus on global warming than toxic control, market prices of secondary materials and shredding and separation technology.

As a disadvantage, standards can take years and years to reach agreement.

11.5.4 Simplification and Harmonisation

The following aspects to support simplification and harmonisation substantially:

1. Allow/ prescribe EU wide registration. This option is already under investigation by the national registers themselves. However, to support this process, it could be made mandatory for registers to comply with one EU wide approved way of working in terms of reporting formats and data consistency.
2. Allow/ prescribe EU wide registration + compliance schemes: In addition to the previous option, it could be made part of the legal text that EU-wide compliance schemes should be made possible. Mechanisms to divide national versus EU-wide obligations need to be developed.
3. Dual legal basis (product oriented articles under Article 95 character): This includes making some (or all) of the articles under the Art. 95 of the Treaty. The main goal is to create a level playing field for all stakeholders involved in the end-of-life chain and, in particular, for those financially responsible for carrying out specific activities (f.i. Producers in respect of scope coverage, financing, financial guarantees or Recyclers in respect of recovery and recycling target definitions or treatment requirements). The following articles would qualify for this:

- Art. 2 Scope,
- Art. 3 Definitions,
- Art. 6 Treatment,
- Art. 7 Recovery targets,
- Art 8 (and 9?) Financing.

12 CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

It is recommended that the scope is arranged based on the occurring waste streams (5 or 6) collection categories instead of on the current product oriented Annex I and to use criteria lists for determining which products are in/ out.

The alternative ways of defining the scope of the WEEE Directive include some of the main priorities that any determination of the scope should enable:

1. Environmental relevancy and material composition,
2. Achievement of a level playing field for different stakeholders across EU, and
3. Clarification and concurrent enforcement of harmonized approach across Member States.

Any chosen approach for definition of scope needs to address both aspects at the same time. For this reason different elements should be considered at the same time, including a '95 character' to enable a harmonized application of the scope across EU.

A criteria list for the definition of the scope allows achieving the desired aims in a flexible way. The use of different criteria based upon the (environmental aspects of the) collection and treatment categories will contribute to more environmentally relevant targets for collection, recycling and recovery and treatment and thus environmental effectiveness.

Due to the limited amount of appliances covered by the Directive as real B2B, these categories could be removed, especially knowing that the majority of these appliances are already taken care of by other means/ regulations/ own take-back systems and due to intrinsic value.

Dual use products should by definition fall under B2C, unless proof is provided that they are taken care of as B2B, this should be then deducted from overall obligations and/ or financially reimbursed.

It is recommended to remove the difference between historic and new WEEE and ensure whatever financing model is used (either Visible Fee or direct Compliance Cost), that the costs of all WEEE collected in a given year is covered.

The rearrangement of the scope allows more differentiated environmental target setting for collection and recycling targets and treatment requirements. This is summarised below:

	Collection target	**Recycling target**	**Specific Treatment Requirement ***
Large Household (1A,10)	NO	NO	NO
Cooling and Freezing (1B)	YES	Maybe	YES: CFC's
Small Household: 2A,3A,4A,6,7 (plastic dominated part)	YES	YES: For plastic recycling	YES: NiCd from Cat. 6
Small Household: (1C, 3A) (metal dominated part)	NO	NO	NO
CRT containing (3B, 4B)	YES	YES: For CRT glass	YES: Control over PbO

	Collection target	Recycling target	Specific Treatment Requirement *
Flat panels (3C, 4C)	YES	Maybe	YES: For LCD Hg removal
Gas discharge lamps	YES	Maybe for HQ glass	YES: Hg removal

Targets collection, recycling and treatment *(Table 126)*

Targets for reuse should be further researched outside of the WEEE Directive and preferably included be investigated in EuP to avoid rebound effects of higher energy consumption compared to newer appliances.

Redefinition and simplification of the key provisions regarding collection and treatment is highly recommended.

As WEEE is a societal problem, it demands a societal solution where all stakeholders contribute in line with their positive influence on the solutions side. Either producers should remain primarily financially responsible and then they should be given the necessary means AND alternative financing mechanism should be investigated to reverse the current negative waste management incentive, or:

Another stakeholder, the Member States themselves, or the compliance schemes should be assigned as not being the operational body on behalf of producers, but as a more independent and separate entity. This way, both an incentive for collecting more and treating better can be maintained as well as at the same time, competition between schemes can form an incentive for cost-efficiency.

For environmental reasons, EPR with respect to Design for Recycling should be removed from the Directive and placed in RoHS for removability guidance and in EuP for overall ecodesign balancing to avoid design activities with contradictive environmental effects in different life-cycle stages.

Conditions for Success

The following conditions for success are identified:

1. Better enforcement of the key provisions at EU and Member State level,
2. Split the basic legal framework and key responsibilities from (to be developed) operational standards,
3. Enable more simplification and harmonisation throughout the EU-27.
4. Increase consumer awareness.

12.2 Recommendations

For LHHA, the Annex II removal obligations should be re-examined as over time hardly any Hg components and PCB capacitors are found. Here, further research on the compositions over time (and maybe regional differences as well) should be further investigated.

It is recommended to determine the influence of newer products and especially the transition from CFC to HC fridges and from CRT to flat panel displays on the waste stream composition and thus on the overall environmental impacts and benefits of collecting and treating WEEE. The data for LCD monitors should be improved as well as research on better treatment options for these appliances should be done.

For small appliances, it is recommended to perform further research on splitting high value products from the rest of the small appliances as is already done in practice in some countries. This could also be of relevance when prescribing recycling targets in order to improve treatment, which is preferable to promote plastic recycling, but not a proper incentive when the main environmental aim is to recover high precious metal contents.

The main findings for the CRT containing appliances are that as long as CRT back to CRT glass recycling can be done, this should be promoted over other 'useful' re-applications. This should also be reflected by recycling targets that do promote the higher levels of re-application. However, further research is needed to particularly investigate the absorbance capacity of secondary processing as the CRT production will diminish in a few years and smelters and other options have limited capacity for treatment of large amounts of leaded glass. For LCD containing appliances, options that can both enable proper control over the mercury contents as well as recovery of the valuable metal content should be developed. Further development of standards for recycling based on thorough environmental research is another next step for this as well as the other treatment categories.

For gas discharge lamps, with the main concern of a high mercury content, incentives should be focusing on collection more discarded products, as well as to achieve high mercury removal efficiency plus also promoting glass recycling at the same time.

For medium sized appliances, it is recommended to perform further research on splitting high value products from the rest of the small appliances as is already done in practice in some countries. This could also be of relevance when prescribing recycling targets in order to improve treatment, which is preferable to promote plastic recycling, but not a proper incentive when the main environmental aim is to recover high precious metal contents. Also collection alternatives for very small appliances (< 1kg) need to be researched as they are hardly handed in by consumers at the present.

Eco-efficiency Comparisons

In general it is recommended to further research the ranking of the different eco-efficiency scenarios with other impacts of environmental legislation: to compare costs and environmental outcomes in order to make derive priorities on which scenarios should be promoted first. A specific recommendation is that due the rapid technical developments in plastics recycling as well as much higher material prices than before, to re-examine various options for plastics recycling. Also more attention on the issue of keeping BFR's in plastic re-applications versus not recycling them should be further investigated. Such eco-efficiency of treatment outcomes can be compared to the analysis of diverting WEEE from disposal.

Additionally, it is recommended that the outcomes of this should be considered in a broader perspective by comparing the potential environmental benefits or risks of the WEEE Directive with EU wide or national targets for certain environmental themes like global warming, reducing toxic substances (RoHS substances), ozone-layer depletion and resource conservation. The thorough assessment and comprehensive outcomes of this study are making this possible in the near future.

13 ABBREVIATIONS

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie English: French Environment and Energy Management Agency
AGES	Alliance for Global Eco-Structuring
AMDEA	The Association of Manufacturers of Domestic Appliances
ANAIP	Confederación Española de Empresarios de Plásticos English: Spanish National Association of Plastics Industry
ANFEL	Asociacion Nacional Fabricantes Electrodomesticos Linea Blanca English: Spanish National Association of White Domestic Electrical Products
ANIE	Federazione Nazionale delle Imprese Elettroniche ed Elettrotecniche English: Italian Association of Electrical and Electronic Industry
APME	Association of Plastics Manufacturers in Europe
ASR	Auto(motive) Shredder Residue
B2B	Business to Business *(non-household)*
B2C	Business to Consumer *(household)*
BAU	Business As Usual
BAT	Best Available Technologies/Techniques
BATRRT	Best Available Treatment, Recovery and Recycling Techniques
BIO IS	Bio-Intelligence Services
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit English: German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung English: German Federal Ministry for Economic Cooperation and Development
BPEO	Best Practicable Environmental Option
BREF	BAT Reference Document
BVSE	Bundesverband Sekundärrohstoffe und Entsorgung e.V English: German Association for Secondary Raw Materials and Waste Disposal
ca.	circa
C & F	Cooling and Freezing
CE	Consumer Equipment
CED	Cumulative Energy Demand
CML	Centrum Milieukunde Leiden

CN	Custom Tariff Number
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DEFRA	Department for Environment Food and Rural Affair (UK)
DVD	Digital Video Disc/ Digital Versatile Disc
EC	European Commission
ECODOM	Consorzio Italiano Recupero e Riciclaggio Elettrodomestici *(Italian collective scheme for large household equipments)*
ECOLEC	Fundación ECOLEC *(Spanish collective compliance scheme for WEEE)*
E & E	Electric & Electronic (equipment) = EEE
EEI	Electrical and Electronic Institute, Thailand
EERA	European Electronics Recyclers Association
EHA	English: Swedish Association for Electrical Household Appliances Manufacturers
EIC	European Information Center
EICTA	European Information & Communications Technology Industry Association
ELC	European Lamp Companies Federation
ELV	End of Life Vehicle
EMPA	Eidgenössische Materialprüfungsanstalt English: Swiss Federal Laboratories for Materials Testing and Research
EOL	End-of-life
EPR	Extended Producer Responsibility
ERP	European Recycling Platform
ES	Environmentally Sound
ESR	Electronic Shredder Residue
ETC/WRM	European Topic Centre on Resource and Waste Management
EU	European Union
EuP	Energy Using Products
EUR	Euro
EWC	European Waste Catalogue
FEA	Fachverband Elektroapparate für Haushalt und Gewerbe Schweiz English: Swiss Association of the Domestic Electrical Appliances Industry
f.i.	For instance
FPD	Flat Panel Displays

FHG-IZM	Fraunhofer Institut für Zuverlässigkeit und Mikrointegration English: German Fraunhofer Institute for Reliability and Microintegration
FTMIR	Fourier Transform Mid Infrared *(spectroscopy)*
FT Raman	Fourier Transform Raman *(spectroscopy)*
GDP	Gross Domestic Product
GEIC	Global Environment Information Centre
GIFAM	Groupement Interprofessionnel des Fabricants d'Appareils Ménagers English: French Association of Large Household Appliance Producers
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit English: German Technical Cooperation
GWP	Global Warming Potential
HP	Hewlett Packard
HID	High Intensity Discharge Lamps
IA	Impact Assessment
ICER	Industry Council for Electronic Equipment Recycling (UK)
IMPEL	European Union Network for the Implementation and Enforcement of Environmental Law
InWEnT	Internationale Weiterbildung und Entwicklung gGmbH English: Capacity Building International, Germany
IPPC	Integrated Pollution Prevention and Control
IT	Information Technology
IT & T	Information Technology and Telecom
LCA	Life Cycle Assessment
LCD	Liquid Crystal Display
LHHA	Large Household Appliances
LIPS	Laser Induced Plasma Spectroscopy
LI TIR	Laser Induced Thermal Impulse Response
LIST	Large Industrial Tools
LSIT	Large-scale stationary industrial tools
LUM	Lighting Equipment – Luminaires
Med.	Medical Equipment
M & C	Monitoring and Control
METI	Japan Ministry of Economics, Trade and Industry
MFD	Multi-function devices

MIR	Mid Infrared *(spectroscopy)*
MIR AOTF	Mid Infrared Acoustic-Optic Tuneable Filter *(spectroscopy)*
MIT	Massachusetts Institute of Technology
MPW	Mixed Plastic Waste
MS	Member States
MTP	Market Transformation Programme
MSW	Municipal Solid Waste
MSWC	Municipal Solid Waste Combustion
MSWI	Municipal Solid Waste Incinerator
N.A.	Not Available
NDA	Non-Disclosure Agreement
NFR	Non-Flame Retarded *(plastics)*
NGO	Non Governmental Organisation
NiCd	Nickel Cadmium
NiMH	Nickel Metalhydrid
NIR	Near Infrared *(spectroscopy)*
NVMP	Stichting Nederlandse Verwijdering Metalektro Producten *(Dutch Take-back system)*
ODS	Ozone Depleting Substances
OEM	Original Equipment Manufacturer
ORGALIME	The European Engineering Industries Association
PhD	Latin: Philosophiae Doctor
POCP	Photochemical Ozone Creation Potential
PWB	Printed Wired (Circuit) Board
pWFD	Proposal for a revised Framework Directive on Waste
QWERTY/EE	Quotes for Environmentally WEighted Recyclability and Eco-Efficiency
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
R & D	Research and Development
REC	Regional Environmental Centre
reLCD	Liquid Crystal Display Reuse and Recycling
RoHS	Restriction on the Use of Hazardous Substances
ROS	Regionaal Opslag Station English: Regional Storage Centre
RDF	Residue Derived Fuel

RTC/P	Research and Training Centre /Programme
SDS	Sustainable Development Strategy
SENS	Stiftung Entsorgung Schweiz English: Swiss Foundation for Waste Disposal
SHHA	Small Household Appliances
SIA	Social Impact Assessment
SME	Small and Medium Sized Enterprises
SR	Shredder Residue
SS	Sliding Spark *(spectroscopy)*
StEP	Solving the E-Waste Problem Initiative
SWICO	Schweizerischer Wirtschaftsverband der Informations-, Kommunikations- und Organisationstechnik English: Swiss Association for Information, Communications and Organization Technology
SWIR	Short Wave Infrared
TAC	Technical Adaptation Committee
FL	Straight Fluorescent Lamps
Tpa	tonnes per annum
TU	Technical University
TSWR	Thematic Strategy on Waste and Recycling
TUD	Technical University Delft, The Netherlands
TV	Television
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNU	United Nations University
UNU-EHS	United Nations University Institute for Environment and Human Security
US	United States
US-EPA	United States Environmental Protection Agency
VCR	Video Cassette Recorder
VLEHAN	Vereniging Leveranciers Van Huishoudelijke Apparaten in Nederland English: Association of retailers of household appliances in the Netherlands
WEEE	Waste Electrical and Electronic Equipment
WEEP	Waste Electrical and Electronic Plastics

WFD	Waste Framework Directive
Wii	Game console
XRF	X Ray Fluorescence *(spectroscopy)*
ZEF	Zero Emissions Forum
ZVEI	Zentralverband Elektrotechnik- und Elektronikindustrie e.V. English: German Electrical and Electronic Manufacturers' Association

Material Substances

ABS	Acrylonitrile-Butadiene-Styrene
Ag	Silver
Al	Aluminium
As	Arsenic
Au	Gold
Be	Beryllium
Bi	Bismuth
BFR	Brominated Flame Retardant
Br	Bromine
Cd	Cadmium
CFC	Chloro-Fluoro Carbon
Cl	Chlorine
Co	Cobalt
CO2	Carbon Dioxide
Cr	Chronium
Cu	Copper
DecaBDE	Deca-Bromo Diphenyl Ether
Fe	Iron
FR	Flame retardant
Hg	Mercury
HC	Hydrocarbon
HCFC	Hydro chlorofluorocarbons
HFC	Hydro fluorocarbon

HIPS	High Impact Polystyrene
Li	Lithium
Mg	Magnesium
Mn	Manganese
Ni	Nickel
Pb	Lead
PC	Polycarbonate
PCB	Poly Chlorinated Biphenyls
Pd	Palladium
PE	Polyethylene High Density HD
PET	Polyethylene Terephthalate
PMMA	Polymethyl Methacrylate
PP	Polypropylene
PS (HI)	High Impact Polystyrene (see HIPS)
PUR	Polyurethane
PVC	Polyvinyl Chloride
Sb	Antimony
Sn	Tin
TBBPA	Tetrabromobisphenol–A
VOC	Volatile Organic Compound
Zn	Zinc

Country Codes

<table>
<tr><th colspan="2">Country</th><th>Code</th><th colspan="2">Country</th><th>Code</th></tr>
<tr><td rowspan="14">EU-15</td><td>Austria</td><td>AT</td><td rowspan="10">Ten 2003 AC</td><td>Cyprus</td><td>CY</td></tr>
<tr><td>Belgium</td><td>BE</td><td>Czech Republic</td><td>CZ</td></tr>
<tr><td>Denmark</td><td>DK</td><td>Estonia</td><td>EE</td></tr>
<tr><td>Finland</td><td>FI</td><td>Hungary</td><td>HU</td></tr>
<tr><td>France</td><td>FR</td><td>Latvia</td><td>LV</td></tr>
<tr><td>Germany</td><td>DE</td><td>Lithuania</td><td>LT</td></tr>
<tr><td>Greece</td><td>GR (EL)*</td><td>Malta</td><td>MT</td></tr>
<tr><td>Ireland</td><td>IE</td><td>Poland</td><td>PL</td></tr>
<tr><td>Italy</td><td>IT</td><td>Slovenia</td><td>SI</td></tr>
<tr><td>Luxembourg</td><td>LU</td><td>Slovakia</td><td>SK</td></tr>
<tr><td>Portugal</td><td>PT</td><td rowspan="2">2007 AC</td><td>Bulgaria</td><td>BG</td></tr>
<tr><td>Spain</td><td>ES</td><td>Romania</td><td>Ro</td></tr>
<tr><td>Sweden</td><td>SE</td><td rowspan="4">Other non-EU WE countries</td><td>Iceland</td><td>IS</td></tr>
<tr><td rowspan="3">United Kingdom</td><td rowspan="3">GB (UK)*</td><td>Liechtenstein</td><td>LI</td></tr>
<tr><td></td><td>Norway</td><td>NO</td></tr>
<tr><td></td><td>Switzerland</td><td>CH</td></tr>
</table>

* *country codes recommended in EU texts*

Others:

- WE: Western Europe,
- 2003 AC: 2003 Accession Countries

14 REFERENCES

A

About, Inc., A part of The New York Times Company. 2007. About: Metals.

ACR+. 2006 (guessed). Reuse - Means of prevention and preferred mode of recovery of waste.

Re-use and recycling, European Union Social Enterprises.

ADEME, Département Recyclage et Organisatioin des filières Website : www.ademe.fr or : www2.ademe.fr/servlet/KBaseShow ?sort=-1&cid=96&m=catid=14687

ADEME: Mugnier, E. et al. 2003. Implementation of waste electric and electronic equipment directive in EU 25. Final report.

AEA Technology. 2006 a. Collation of measured weights of items delivered to recycling centre.

AEA Technology. 2006 b. WEEE and Hazardous Waste: Part 2. Report produced for Defra. Oxfordshire.

AEA Technology: Savage, M. et al. (EC JRC). 2006 c. Implementation of the Waste Electric and Electronic Equipment Directive in EU 25. In: Technical Report Series. European Commission. Luxembourg.

AEA Technology. 2004 a. WEEE & Hazardous Waste. A Report Produced for Defra.

AEA Technology: Ogilvie, S. 2004 b. WEEE and Hazardous Waste. Report Produced for Defra. Oxfordshire.

AEA Technology. 1997. Recovery of WEEE: Environmental and Economic Impacts.

AKRON. 2004. Kostprijsberekening voor de inzameling van hoishoudelijke Afvalstoffen op Containerparken (Costs container parks). For Interafval. Mechelen.

ANAIP – Spanish Confederation of Plastics Industry (Confederacion Espanola de Empresarios de Plasticos). 2004. Annual Report 2003: Los plásticos en España. Hechos y cifras 2003. Madrid.

Anderson, C. 2006. Reuse - Re-use and recycling: European Union Social Enterprises. Presentation.

Anderson, E. 2005. Hazardous substances in electrical and electronic equipment (EEE) - Expanding the scope of RoHS directive. Project report. Goeteborg.

Ando. G, C. Steiner, A. Selinger, K. Shin. 2002. Automobile Shredder Residue Treatment in Japan - Experience of 95’000 t ASR Recycling and Recovery for Europe through TwinRec. Geneva.

Angerer, G., K. Bätcher and P. Bars. 1993. Verwertung von Elektronikschrott - Stand der Technik, Forschungs- und Technologiebedarf. Abschlussbericht 1993.

Ansems, A., L. Feenstra. 2002 a. Ontwikkeling verwerking afgedankte electronica, sluiten van zware metalen kringlopen. Report R2002/194, TNO Environment, Energy and Process Innovation (in Dutch). Apeldoorn.

Ansems, A., R. van Gijlswijk and J. Huisman. 2002 b. End of Life control and management of heavy metals out of electronics. In: Proceedings of the 2002 International Symposium of Electronics and the Environment. San Francisco.

AOO: Vuil, G., F. Scheiden. 2004. Kennisdocument grof huishoudelijk afval. Afval Overleg Orgaan. Utrecht.

APME (PlasticsEurope). 2006. Discover Plastics > Mayor Applications > Electrical and electronic > Environment/ waste management. Via: www.plasticseurope.org/content/Default.asp?PageID=72

APME (PlasticsEurope). 2005. Eco-efficiency of Electrical and Electronic Equipment (WEEE): end-of-life-options. Final Report. Frankfurt/ M.

APME (PlasticsEurope). 2001. Plastics. Insight into consumption and recovery in Western Europe 2000. Brussels.

APME (PlasticsEurope) - Association of Plastics Manufacturers in Europe. 2000, 2001. Plastics - A material of innovation for the electrical and electronic industry, Insight into consumption and recovery in Western Europe. Via: www.plasticseurope.org/

APME (PlasticsEurope). Characteristics plastics from WEEE.

Appliance Magazine. 2006. 15th Annual Portrait of the European Appliance Industry. (White goods sales) Statistics 2005.

Appliance Magazine. 2005. Europe Market Shares.

Association of Cities and Regions for Recycling. 2003. Management of Waste Electrical & Electronic Equipment.

Associazione Nazionale Industrie Apparecchi Domestici e Professionali. 2006. The Italian industry of household appliances in 2005. Milano.

B

BAN (Basel Action Network): Puckett, J. et al. 2005. The digital dump. Exporting Re-use and Abuse to Africa. Media release version. Seattle.

BAN (Basel Action Network): Puckett, J. et al. 2002. Exporting harm. The hight-tech trashing of Asia. Seattle.

Barret, J. (NDCEE). 2002. Demanufacturing of Electronic Equipment for Reuse and Recycling (DEER2) Task N.228, Task N.251, and Task N.302. (a Lifetime, b Overview, c Metals, d Typical weight).

Basel Convention, Mobile Phone Partnership Initiati3ve (MPPI). 2006. Guidance document on the environmentally sound management of used and end-of-life mobile phones. Prepared by the Mobile Phone Working Group. Nairobi.

BBC News. 21 December 2005. Gadget recycling foxes consumers. Via: news.bbc.co.uk/1/hi/technology/4548856.stm

Beigl, P. et al. 2004. Forecasting Municipal Solid Waste Generation in Major European Cities. Institute of Waste Management, BOKU - University of Natural Resources and Applied Life Sciences. Vienna.

BfuB - Bundesverband für Umweltberatung e.V. 2006. News. Via: www.soll.de/bula/fachthem/aktuelles/bundesverband2.htm

Biointelligence Services (BIO IS). 2006. Gather, process, and summarise information for the review of the waste electric and electronic equipment directive (2002/96/EC), [ENV.G.1/FRA/2004/0081, study no. 16]. Synthesis report - Final version, September 21, 2006. Via: forum.europa.eu.int/Public/irc/env/weee_2008/library?l=/&vm=compa

BiPRO - Beratungsgesellschaft für integrierte Problemlösungen. 2005. Study to facilitate the implementation of certain waste related provisions of the Regulation on Persistent Organic Pollutants (POPs). Final Report. (European Commission). Brussels.

Boerrigter, H. 2001. Implementation of Thermal Processes for Feedstock Recycling of Bromine, with Energy Recovery, from Plastic Waste of Electrical and Electronic Equipment (WEEE) – Phase 2: Production of Bromine Salt in Staged-gasification to Determine Technical Feasibility of Bromine Recovery. ECN-C-01-110 Report (Final version).

Boerrigter, H. 2000 a. Implementation of Thermal Processes for Feedstock Recycling of Bromine, with Energy Recovery, from Plastic Waste of Electrical and Electronic Equipment (WEEE) – Phase 1: Literature survey/status update, evaluation, and ranking of combustion, gasification, and pyrolysis based technologies. ECN-C-01-110 Report.

Boerrigter, H. 2000 b. Implementation Of Thermal Processes For Feedstock Recycling Of Bromine And Antinomy, With Energy Recovery, From Plastics Waste Of Electrical And Electronic Equipment (WEEE), Phase 1. Unit ECN Biomass of the Netherlands Energy Research Foundation (ECN)

Brusselaers, J., F.E. Mark and L. Tange. 2006. Using metal-rich WEEE plastics as feedstock/ fuel substitute for an integrated metals smelter. A technical report produced by PlasticsEurope in cooperation with Umicore and EFRA. Brussels.

Buttker, B. et al. (SVZ, tecpol, PE). 2005. Full scale industrial recovery trials of shredder residue in a high temperature slagging-bed-gasifier in Germany. Brussels.

C

Canneman, W. 2006. Logistics & recycling practice in the Netherlands.

Categorie volgens bijlage IA van de richtlijn nr. 2002/96/EG. Op de markt gebrachte elektr(on)ische apparatuur per 28-02-2007 in duizendtallen.

CECED. 2007. Producers, recyclers and take-back schemes present treatment specifications for cooling appliances containing hydrocarbons. Press release of 9 January 2007.

CECED-EERA-WF. 2006 a. Requirements for the Collection, Transportation, Storage and Treatment of Cooling and Freezing Appliances containing Hydrocarbons (HC).

CECED. 2006 b. HC factsheet. Cyclopentane HC and cyclopentane.

CECED. Annex II proposal: Amendments to Annex II of the Directive are under discussion.

CEMBUREAU - The European Cement Association Website: www.cembureau.be/

CML. 2004. Leiden University, Institute of Environmental Sciences (CML). Via: www.leidenuniv.nl/cml/ssp/index.html

COMBIDENT. 2001. EU Project BRPR-CT98-0778 (1998-2001) under Industrial & Materials Technologies Programme (Brite-EuRam III). "High Quality Plastic Materials from Electronic Wastes by Use of Combined Identification Methods and New Handling Technologies (COMBIDENT)". Synthesis Report. Brussels.

COMBINED NOMENCLATURE. 2007. Via: ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=CN_2007&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC&CFID=3619310&CFTOKEN=c706f3505eb83a96-89E4AB44-CF83-201E-B103AC5F4FD00D33&jsessionid=ee30a6795c5778497156

Correspondents. 2007. Correspondents' Guidelines No.1, "Shipments of WEEE".

Council of the European Union. June 2006. Note 10917/2006 from General Secretariat to Delegations. Review of the EU Sustainable Development Strategy (EU SDS) - Renewed Strategy. Via: esc.clubofrome.org/sharing/files/sd_strategy_2006.pdf

COWI. 2005. RoHS substances in EEE in Belgium. Final Report. Brussels.

CreaCycle GmbH, Innovative Plastic REcycling Technologies Website: www.creacycle.de/projects.html

Crowe, M. et al. (European Environment Agency, European Topic Centre on Waste). 2002, 2003. Waste from electrical and electronic equipment (WEEE) – quantities, dangerous substances and treatment methods. Copenhagen.

D

DeBenedetti, B., L. Maffia and G.L. Baldo (LCE Polito). 2006. LCA experience in the field of recycling of plastics from electronic waste. Torino.

Defense Logistics Agency. 2003. Demanufacturing Electronics, A DRMS Perspective. CTC

DEER2 Stakeholder Meeting. Largo.

Delavelle, C., D. Fayolle (AJI-EUROPE) and R. Eyssen (Japan Consult). 2005. "Caracterisation des Plastiques Contenus dans les DEEE et Etat des Lieux de la Valorisation de ces Plastiques - Rapport final". ADEME.

Defra - Department for Environment, Food & Rural Affairs. 2007. Trial to establish WEEE protocols. In association with the CIWM (EB). London.

Defra - Department for Environment, Food & Rural Affairs. 2006. Guidance on Best Available Treatment Recovery and Recycling Techniques (BATRRT) and treatment of Waste Electrical and Electronic Equipment (WEEE). Via: www.defra.gov.uk/

Defra - Department for Environment, Food & Rural Affairs, Waste Management Division. 2005. ECJ (European Court of Justice) Judgments: The definition of waste.

Deutsche Umwelthilfe. 2007. "Hamburg – Gate to the world for illegal waste exports?".

Diliautas, A. 2007. WEEE Review Study - EEE put on Market Lithuania. Email correspondence between F. Magallini, J. Huisman and A. Diliautas.

Dillon, P.S. (Dillon Environmental Associates). 1998. Potential Markets for CRTs and Plastics from Electronics Demanufacturing. An Initial Scoping Report. Chelsea Center for Recycling and Economic Development – University of Massachusetts (EEUU).

DRZ Demontage und Recyclingzentrum Wien. 2007. Unternehmensdarstellung. Wien. Via: www.drz-wien.at/109/ueb/_txtDRZ-Unternehemensdarstellung.pdf

DTI. 2007. Code of Practice for collection of Waste Electrical and Electronic Equipment from Designated Collection Facilities.

DTI. 2006 a. DTI WDA survey hazardous WEEE. Fridges, TVs and monitors.

DTI. 2006 b. WEEE Consultation Response. Summary of responses and Government response to fourth consultation on implementation of Directives 2002/96/EC and 2003/108/EC on Waste Electrical and Electronic Equipment.

DTI. 2006 c. WEEE Consultation. Final regulatory impact assessment for the WEEE Regulations.

DTI. 2005. Waste electrical and electronic equipment (WEEE): innovating novel recovery and recycling technologies in Japan. Global watch mission report.

DTI IRM. 2004. Assessment of Responses to the Third Consultation Document: WEEE and RoHS Directives. Report.

E

EBARA Environmental Engineerin Company, Aomori TwinRec plant datasheet. Via: www.ebara.ch/downloads/ebara_plant_sheet_aomori.pdf

ECOLIFE. 2003. EU Project G1RT-CT-2002-05066 (2002-2006) "Eco-efficient Life Cycle Technologies. From Products to Service Systems (ECO-LIFE-II)". Summary Report: State-of-the-Art Technology in the Electronics - Industry Innovation System.

Ecotrel. 2006. Manual for Producers and Importers, Via: http://quatrei.eu/ecotrel/data/English/enmanuelprod.pdf

E&D Milieuadvies en management BV. 1999. The ROS-plus Model. Disposal Structure for electronic and electrical equipment waste (WEEE) and domestic goods with regard to product reuse and employment. Drafted for: Trade Association Recycling Companies The Netherlands. Rotterdam.

EEA. WEEE quantities 2003.

EERA - European Electronics Recyclers Association. 2007 a. Via: www.eera-recyclers.com

EERA - European Electronics Recyclers Association: Zonneveld, N. 2007 b. Volumes in 2006 (graphs).

EERA. 2007 c. EERA response Q-list.

EERA. 2007 d. UNU Questionnaire. Category vs. Country.

EERA. (no date available). EERA volumes treated.

EHSNI - Environment & Heritage Service Northern Ireland, Producer Responsibility Unit. 2005. WEEE - Pilot Scheme Report. Belfast.

EICTA. 2007. Joint Industry position paper on the review of Directive 2002/96/EC (WEEE Directive). AeA, EICTA, JBCE. Bruxelles.

Eikelenberg, N. et al. 2003. Design for Chemical Content, Exploration of design opportunities for reducing the environmental impact of heavy metals from CE products. TNO Report number: 42/02.005599 for the IOP Heavy Metals in Consumer Electronics. Draft version and annexes. Eindhoven.

ELC - European Lighting Confederation. 2007. Data supplied by the European Lighting Confederation.

ELC. 2007 a. Let there be light WEEE PP.

ELC. 2007 b. Quick facts CSRO.

ELC. 2007 c. Response to Q-list ELC.

Elektroaltegeräte Koordinierungsstelle Austria GmbH: Holoubek, R. 2006. Zahlen/ Daten/ Fakten 2005 und 2006.

El-Kretsen AB. 2007. El-Kretsen fees and prices. El-Kretsen Product Types and Prices 01/01/2007.

El-Kretsen AB. 2005 a. Annual Report 2004-2005. Collecting and recycling of WEEE in Sweden. Stockholm. Via: www.elkretsen.se

El Kretsen AB. 2005 b. Annual environmental report 2005.

El-retur. 2004. Environmental Report 2003 [on line]. Oslo. Via: www.elretur.no/

EMPA: Hischier, R., P. Wäger and J. Gauglhofer. 2005. Does WEEE recycling make sense from an environmental perspective? The environmental impacts of the Swiss take-back and recycling systems for waste electrical and electronic equipment (WEEE). In: Environmental Impact Assessment Review 25 (2005): 525– 539. St. Gallen.

Enhance / UK Environment Agency and Axion Recycling. 2006. WEEE Flows in London - An analysis of waste electrical and electronic equipment within the M25 from domestic and business sectors.

Environment Agency, Uk, Website: www.environment-agency.gov.uk or www.letsrecycle.com/do/ecco.py/view_item?listid=37&listcatid=224&listitemid=8792

Enviros. Department of Environment, Transport in the Regions (DETR) UK. 2001. Recovery, Re-use, Recycling Targets in the Waste Electrical and Electronics Equipment Directive.

EPA - Environmental Protection Agency Ireland. 2003. Waste electrical and electronic (WEEE) collection trials in Ireland. Ireland.

EPEC: Medhurst, J. et al. 2005. Support in the drafting of an ExIA on the Thematic Strategy on the Prevention and Recycling of Waste (TSPRW). Final Report submitted by EPEC. London.

EPEE: Busch, F. 2006. EPEE Contribution to Information Gathering Exercise to Provide Information for the Review of Directive 2002/96/EC of the European Parliament and of the Council on Waste Electrical and Electronic Equipment (WEEE); Scope of cat 1. Letter to the EC DG Environment, Unit G4. Brussels.

ERA Technology Ltd: Goodman, P. 2006 a. Reliability and failure analysis. Review of Directive 2002/95/EC (RoHs) Categories 8 and 9. Interim report. For the European Commission DG Environment. Leatherhead, Surrey.

EST - Energy Saving Trust. 2006. Bread makers and juicers are 'essential' to stay in vogue.

Press release 18 December 2006. Via: www.est.org.uk/

ETC/RWM, 2007: Transboundary shipments of waste in the EU, Developments 1995-2005 and possible drivers, Draft Interim Report, Copenhagen (unpublished).

ETC/RWM - European Topic Centre on Resource and Waste Management. 2000. Waste Electrical and Electronic Equipment (WEEE). Topic Centre of European Environment Agency (EEA). Via: waste.eionet.eu.int/waste/6

EuPR - European Plastics Recyclers Association. 2006. EuPR calls upon the EU Commission and the European Parliament to initiate a Plastics Recycling Directive, PlasticsEurope published wrong data! Press release. Brussels. Via: www.plasticsrecyclers.eu/docs/press/press_EuPRcallsuponEU.pdf

European Aluminium Association. 2006. Sustainable Development Indicators Report.

European Chemical Industry Council. 2006. Recycling and disposal End of Life of products containing flame retardants. Via: http://www.cefic-efra.com/Objects/2/Files/EFRARecylinganddisposal10022006-1_00.pdf

European Commission. 2007. Impact assessment. (Int Doc ELV) Commission Staff working document. Document accompanying the Report from the Commission to the Council and the European Parliament on the targets contained in Article 7(2)(b) of Directive 2000/53/EC on End-of-Life vehicle. Brussels.

European Commission. 2006. DG Environment. Invitation to Tender DG ENV.G.4/ET/2006/0032 2008 Review of Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE)

European Commission. 2005 a. COM (2005) 666; A Thematic Strategy on the prevention and recycling of waste. Brussels.

European Commission. 2005 b. COM (2005) 667; Proposal for a Directive on Waste. Brussels.

European Commission. 2005 c. SEC (2005) 791; Impact Assessment Guidelines. Via: http://ec.europa.eu/enterprise/regulation/better_regulation/impact_assessment/docs/sec_2005_791_guidelines_annexes.pdf

European Commission. 2005 d. DG Environment. Frequently Asked Questions on Directive 2002/95/EC on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) and Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE). Brussels.

European Commission. 2005 e. Commission Staff Working Document. Annex to the Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Taking sustainable use of resources forward: A Thematic Strategy on the prevention and recycling of waste. Brussels.

European Commission. 2003. Commission Staff Working Paper – Directive of the European Parliament and of the Council on Batteries and Accumulators and Spent Batteries and Accumulators; Extended Impact Assessment. Brussels.

European Commission. 2001. Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries.

European Committee under the Government of Lithuania (ECGL). 2003. Impact assessment of implementation of Directive 2002/96/EC on WEEE in Lithuania.

European Confederation of Iron & Steel Industries (Eurofer). 2006. European Report on the Economic and Steel Market situation years 2006 and forecasts for 2007. Via: www.eurofer.org/

European Environmental Agency (EEA). 2003. Waste from electrical and electronic equipment (WEEE) - quantities, dangerous substances and treatment methods.

European IT Observatory (EITO). 2006. Tables 42 – 71.

European Parliament and Council of the European Union. 2003. Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE). In: Official Journal of the European Union of 13 February 2003. Brussels.

European Parliament and Council of the European Union. 1996. Directive 96/61/EC of the European Parliament and of the Council of 24 September 1996 concerning integrated Pollution prevention and control. In: Official Journal of the European Union of 10 October 1996 – consolidated Version of 24 February 2006. Brussels.

EUROSTAT. (no date available). European Commission Labour costs.

Ezroj, A. 2005. Reexamining PC Lifespan and Waste Forecasts Using Extensive Inventory Records and Current Shipment Numbers. Final Report.

F

Fisher, M. et al. (APC APME). 2005. Energy Recovery in the Sustainable Recycling of Plastics from End-of-Life Electrical and Electronic Products. Prepared for: 2005 IEEE International Symposium on Electronics & the Environment (2005 ISEE/SUMMIT), 16-19 May 2005, New Orleans, LA USA.

Fisher, M. et al. 2004. Energy Recovery in the Sustainable Recycling of Plastics from End-of-Life Electrical and Electronic Products. In: The 2004 International Symposium on Electronics and the Environment.

Flection: Loon, J. van. 2007 a. Pathways of assets EU and purchase to EOL, Year 2007.

Flection. 2007 b. Pathways of assets, EU and Purchase to EOL, Year 2007.

Flection: Loon, J. van. (no date available). IMM Market update 4.

Fraunhofer Institut Produktionstechnik und Automatisierung. 2005. Analysing scenarios for the recycling of HC refrigerators. Final report.

Freegard, K. et al. 2006. Develop a process to separate brominated flame retardants from WEEE polymers. Interim report 3. Published by WRAP. In: R&D Reports: Plastics. Banbury, Oxon.

Freegard, K. et al. 2005 a. Develop a process to separate brominated flame retardants from WEEE polymers. Interim report 1. Published by WRAP. In: R&D Reports: Plastics. Banbury, Oxon.

Freegard, K. et al. 2005 b. Develop a process to separate brominated flame retardants from WEEE polymers. Interim report 2. Published by WRAP. In: R&D Reports: Plastics. Banbury, Oxon.

Freegard, K. 2004. Manual Dismantling of small-WEEE. Initial report on Trial Processing of 5 tonnes of Waste Electrical Material. For Hampshire Natural Resources Trust.

Fricke, A. 2006. Markt für Müll, Neue Regeln zur Verwertung von Elektroschrott lassen spezielle Industrie entstehen. In: Deutschlandfunk Hintergrund Wirtschaft. Via: http://www.dradio.de/dlf/sendungen/hiwi/480533/

Frischknecht, R. et al. 2004 a. Overview and Methodology. Final report ecoinvent 2000 No. 1. Swiss Centre for Life Cycle Inventories. Duebendorf. Via: www.ecoinvent.ch/

Frischknecht, R. et al. 2004 b. Implementation of Life Cycle Impact Assessment Methods. Final report ecoinvent 2000 No. 3, Swiss Centre for Life Cycle Inventories, Duebendorf. Via: www.ecoinvent.ch/

Frischknecht, R. et al. 2003. Code of Practice. Final report ecoinvent 2000 No. 2. Swiss Centre for Life Cycle Inventories. Duebendorf. Via: www.ecoinvent.ch/

G

Geraghty, K. et al., SEES - Sustainable Electrical and Electronic System for the Automotive Sector. 2006. D4: Analysis and Demonstration Activity for E&E Recycling. Via: www.sees-project.net/contents/File/DELIVERABLE%20D4.pdf

German Machine Tool Industry. 2006. Contribution to the review of Directive 2002/96/EC of the European Parliament and of the Council on Waste Electrical and Electronic Equipment (WEEE).

GfK Gruppe. 2004. Nutzungsdauer nach Produktgruppen, Jahr 2004.

GIFAM - Groupement Interprofessionnel des Fabricants d'Appareils d'Equipement Ménager. 2006. Market data for France. Via: www.gifam.fr/pages/lemarche/lemarche.html

Goodman, P. 2006. Review of Directive 2002/95/EC (RoHS) Categories 8 and 9 – Final Report. ERA Report 2006-0383.

Goris, D. 2004. Verwerking van Computer Monitoren, Metallo-Chimique. (Public version in Dutch). Beerse.

Gottberg, A. 2003. Producer responsibility for WEEE as a driver of ecodesign. Case studies of business responses to producer responsibility charges. Silsoe.

Greenpeace. 2006. Toxic Chemicals in Computers (Determining the presence of hazardous substances in five brands of laptop computers), Greenpeace Research Laboratories, Technical Note 05/06, September 2006.

Greenpeace: Brigden, K. et al. 2005. Recycling of electronic wastes in China and India. Workplace and environmental contamination. Report. Amsterdam.

Gruber, F. (Umweltbundesamt). 1998. Leitfaden zur Entsorgung von Kältegeräten.

H

Hagelüken, Ch. (Umicore). 2006. PGM lifecycles and their impact on future PGM supply. IPMI Metro New York Chapter, Precious Metals Mini Seminar. New York.

Hanke M., Ch. Ihrig and D. Ihrig. 2000. Stoffbelastung beim Elektronikschrott-Recycling. Iserlohn/ Menden/ Dortmund.

Harand, M. (Bayrisches Landesamt für Umweltschutz). 2002. Umweltrelevante Inhaltsstoffe in Elektro- und Elektronikgeräten. Augsburg.

Headley Pratt Consulting. 2000. Plastics from Residential Electronics Recycling. Report 2000. A Summary Report from the Electrical and Electronics Group of the American Plastics Council [on line]. American Plastics Council, Inc. Arlington. Via: www.plastics.org

The Sunday Herald in Scotland. (1/7/2007)

Heyde, M., M. Kremer. 1998. Recycling and recovery of plastics waste as an alternative fuel in the cement industry – assessment of the energy, waste and emission balance in comparison with feedstock recycling. Fraunhofer Institut Verfahrenstechnik und Verpackung. Freising.

Hong Kong Trade Development Council. 2000-2007. Summary on the RoHS/WEEE implementation status. Via: www.tdctrade.com/alert/euweeenew.htm (As of e-mail correspondence document)

Hornberger, M., G. Janusz (Fraunhofer IPA). 2005. Analyzing scenarios for the recycling of HC refrigerators. Final Report.

Hotta, H. 2003. Recycling Technologies for Promoting Recycling-oriented Society. In: NKK Technical Review No. 88: 160-166.

Huisman, J., A. Stevels, T. Marinelli and F. Magalini. 2006 a. Where did WEEE go wrong in Europe? Practical and academic lessons for the US. In: Proceedings of the International Symposium on Electronics and the Environment. San Francisco.

Huisman, J., A. Stevels. 2006 b. Eco-efficiency of take-back and recycling, a comprehensive approach. In: IEEE Transactions on Electronics Packaging Manufacturing. Volume 29. Issue 2.

Huisman, J. 2005 a. QWERTY and Eco-Efficiency check on actual treatment of stripped monitors at Metallo – Chimique NV, Eco-efficiency check on plant measurement of treating stripped monitors in a secondary copper – tin – lead smelter.

Huisman, J., A. Stevels. 2005 b. Existing and Future Avenues for Eco-Efficient E-scrap Recycling. In: Proceedings of the International Symposium on Electronics and Environment. New Orleans.

Huisman, J. April 2004 a. QWERTY and Eco-Efficiency analysis on cellular phone treatment in Sweden. The eco-efficiency of the direct smelter route versus mandatory disassembly of Printed Circuit Boards. Written for El-Kretsen. Stockholm.

Huisman, J., A. Stevels and I. Stobbe. 2004 b. Eco-efficiency considerations on the end-of-life of consumer electronic products. In: IEEE Transactions on Electronics Packaging Manufacturing. Vol. 27, Issue 1. January 2004: 9 - 25.

Huisman, J. 2004 c. QWERTY and Eco-Efficiency analysis on treatment of CRT containing appliances at Metallo – Chimique NV, The eco-efficiency of treating CRT glass fractions versus stripped appliances in a secondary copper – tin – lead smelter, report written for Metallo – Chimique NV. Beerse.

Huisman, J. 2003 a. The QWERTY/EE concept, Quantifying recyclability and eco-efficiency for end-of-life treatment of consumer electronic products. Ph.D. thesis. Delft University of Technology. Delft.

Huisman, J., C.B. Boks and A. Stevels. 2003 b. Quotes for Environmentally Weighted Recyclability (QWERTY), The concept of describing product recyclability in terms of environmental value. In: International Journal of Production Research. Special Issue on Product Recovery. 41 (16).

Huisman, J., A. Stevels. December 2003 c. Balancing Design Strategies and End-of-Life Processing. In: Proceedings of the 2003 Ecodesign Conference. Tokyo.

Hungarian transposition of WEEE Directive. 2004. Government Decree 264/2004 (IX. 23.) On taking back waste from electrical and electronic equipment. Budapest.

I

ICER - Industry Council for Electronic Equipment Recycling. 2006 a. ICER Status Report on WEEE in the UK: Stage 2, 2006, Commercial (non-household) WEEE.

ICER - Industry Council for Electronic Equipment Recycling. 2006 b. Status report on WEEE in the UK: Stage 3, UK capacity for WEEE treatment and recycling.

ICER - Industry Council for Electronic Equipment Recycling. 2005 a. Status Report on Waste Electrical and Electronic Equipment in the UK. Interim Report.

ICER - Industry Council for Electronic Equipment Recycling. 2005 b. ICER Status Report on WEEE in the UK: Stage 1, 2005, Domestic (private household) WEEE.

ICER - Industry Council for Electronic Equipment Recycling. 2005 c. ICER Status Report on WEEE in the UK: Stage 2, 2005, Domestic (private household) WEEE.

ICER - Industry Council for Electronic Equipment Recycling. 2005 d. ICER Status Report on WEEE in the UK: Stage 3, 2005, Domestic (private household) WEEE.

ICER - Industry Council for Electronic Equipment Recycling. 2004. Materials recovery from waste cathode ray tubes (CRTs). The Waste & Resources Action Programme (WRAP). Project code: GLA15-006. In: R&D Report: Glass. Oxon.

ICER - Industry Council for Electronic Equipment Recycling. 2003. New Approach to Cathode Ray Tube Recycling. Report by ICER to the Department of Trade & Industry (DTI) UK.ICER - Industry Council for Electronic Equipment Recycling. 2000. UK status report on waste from electrical and electronic equipment.

ICT Milieu. 2007. Facts and figures. Via: www.ictoffice.nl/index.shtml?ch=MIL&id=4534

ICGPSIA - Interorganizational Committee on Guidelines and Principles for Social Impact Assessment. 1994. Guidelines and Principles for Social Impact Assessment. Via: www.nmfs.noaa.gov/sfa/social_impact_guide.htm

IERC. 2007. Questions and Answers Recharge aisbl. Hamburg.

IFEU - Institut für Energie- und Umweltforschung: Mueller B., J. Giegrich. 2005. Beitrag der Abfallwirtschaft zur nachhaltigen Entwicklung in Deutschland. Fallbeispiel Elektro- und Elektronikgeräte. UFO-Plan-Vorhaben. Endbericht. Heidelberg.

IIIEE - International Institute for Industrial Environmental Economics at Lund University. 2004. Extended Producer Responsibility as a Driver for Design Change - Utopia or Reality? Lund.

Ilse Media Groep BV. 2007. NUnl Economie: Recordverkoop platte televisies. Via: http://www.nu.nl/news/969126/37/Recordverkoop_platte_televisies.htm (07 February 2007)

IMPEL - TFS: Kraan, S., C. Nijssen, N. Dols and C. Huijbregts. 2006. Is what you see, what you get? IMPEL-TFS Verification - 2 project report. December 2004 - May 2006.

IMPEL (EU network for the implementation and enforcement of environmental law): Nijssen, C., S. Kraan. 2006. IMPEL-TFS Seaport project 2: International cooperation in enforcement hitting illegal waste shipments. Project report September 2004 - May 2006. Pörtschach.

IMPEL-TFS: Czarnomski, S., B. Webb and A. Holmes (Jill Dando Institute of Crime Science, University College London, Environment Agency England & Wales). 2005. IMPEL-TFS threat assessment project: The illegal shipment of waste among IMPEL member states. Project report. Pörtschach.

IPTS - Institute for Prospective Technological Studies. 2006. Implementation of the Waste Electric and Electronic Equipment Directive in the EU.

ISIS: Faberi, St., S. Mallone. 2004. Feasibility Study to identify the tools, actions and procedures for a cost sharing mechanism associated to the implementation of Directive 2002/96/EC on WEEE. Rome.

ISOLA Website: www.isola.be/

ISOPA - European Isocyanate Producers Association. 2005. Fact Sheet. Recycling and recovering polyurethanes – Options in Practice. Via: www.isopa.org/

ISOPA - European Isocyanate Producers Association. 2001 a. Fact Sheet: RECYCLING AND RECOVERING POLYURETHANES - Options in Practice. June 2001. Via: www.isopa.org/

ISOPA – European Isocynate Producers Association. 2001 b. Fact Sheets: RECYCLING AND RECOVERING POLYUTETHANES – Adhesive Pressin and Particle Bonding. Via: www.isopa.org/

J

Jirang, C. 2005. Mechanical recycling of consumer electronic scrap. Lulea Thesis. Lulea.

JSIM. Japanese Advanced Envisonment Equipment. Waste Treatment and Recycling Equipment: Used Appliances Recycling System. Via: www.gec.jp/JSIM_DATA/WASTE/WASTE_2/html/Doc_406.html

Jönbrink, A.-K., R. Amen (IVF). 2006. Consumer behaviour and local infrastructure. Intermediate step report for EuP study Lot 3. Task 3. Mölndal.

Jönbrink, A. K. (IVF). 2005 a. Energy using Products (EuP) Preparatory Study, TREN/D1/40-2005. Intermediate step report 1 for EuP study, Lot 3, Task 1. Mölndal.

Jönbrink, A. K. (IVF), J. Sjögren. 2005 b. Energy using Products (EuP) Preparatory Study, TREN/D1/40-2005, Lot 3, Task 2. Computers Market Information from EuP Study. Mölndal. Via: www.ecocomputer.org/

Justel D., J.A. Eguren. 2007. "WEEE Directive 2002/96/EC and Individual Producer Responsibility. An overly simplistic proposal will lead to additional costs for the citizens".

K

Kojima, M. et al. 2005. International Trade of recyclable resources in Asia.

Kreiβig J., M. Baitz et al. 2003 (PE Europe GmBH). Final Report: PVC Recovery options – Concept for Environmental and Economic System Analysis.

Kruse, H. et al. (Institut f. Toxikologie der Uni Kiel). 2000. Erarbeitung zu Bewertungsgrundlagen zur Substitution umweltrelevanter Flammschutzmittel. Band 3, Toxikologisch-ökotoxikologische Stoffprofile ausgewählter Flammschutzstoffe.

Kuehr, R., E. Williams, 2003. Computers and the Environment, Understanding and Managing their Impacts, Dodrecht.

L

LAGA - Länderarbeitsgemeinschaft Abfall. 2004. Technische Anforderungen zur Entsorgung von Elektro- und Elektronik-Altgeräten sowie zur Errichtung und zum Betrieb von Anlagen zur Entsorgung von Elektro- und Elektronik-Altgeräten. In: EAG-Merkblatt. Mainz.

LAVU AG: Ehrengruber, Ch. 2006. Financial aspects of WEEE management in upper Austria.

LCA - Life Cycle Assessment. Recycling of CFC – and HC – containing refrigerator equipment. Summary.

LCD Industries Research Committee. 2007. Environment and Safety Activities. Recycling of glass substrates. Via: http://home.jeita.or.jp/device/lirec/english/enviro/recycle.htm

LetsRecycle.com. 2006 a. £1.7m research project to tackle waste LCD televisions. News item. London. Via: www.letsrecycle.com/news/archive/news.jsp?story=6007

LetsRecycle.com. 2006 b. Industry concern as growth in glass recycling fades. News item of 6 September 2006. London. Via: www.letsrecycle.com/

Livingston, W.R., M. Babcock. Technological and economic assessment of energy conversion technologies for MSW. DTI Sustainable Energy Programmes. Via: www.michiganrecycles.org/pdf/British_Conversion_Tech_Report.pdf

López de Velasco, J. (Spanish Ministry of Environment). 2005. El Plan Nacional de Gestión de Residuos Eléctricos y Electrónicos 2006 – 2010. Proceedings of RELEC'05 - Jornadas Técnicas sobre el Reciclado de aparátos eléctrico-electrónicos. Cádiz.

M

Magalini, F. 2007. Data - WEEE Review ELC.

Magalini, F. 2006 a. EICTA transposition reply. WEEE revision questions sheet.

Magalini, F., J. Huisman. 2006 b. Compliance Key Factors of the EU WEEE Directive, How far is one from a full implementation. In: Proceedings of the 2006 International Symposium on Electronics and the Environment. San Francisco.

Mark, F.E. (Dow Chemical Europe). 2006 a. The characteristics of plastics-rich waste streams from end-of-life electrical and electronic equipment.

Mark, F.E., H, Dresch et al. 2006 b. Large scale demonstration of the treatment of electrical and electronic shredder residue - by co-incineration in the Würzburg Municipal Solid Waste Incinerator. A Technical Report by PlasticsEurope. Brussels. Via: www.isopa.org/htdocs/isopa_site/documents_ns/TECHNICAL%20REPORT.pdf

Mark, F.E. 2005. Polyurethane Energy Recovery and Feedstock Recycling Technology. A Summary Overview of Latest European Technologies. Paper given at the API (Alliance for the Polyurethanes Industry) Conference in October 2005. Via: www.isopa.org/htdocs/isopa_site/documents_ns/api2005.pdf

Mäurer, A. 2004. The CreaSolv®-Process – Technical break-through in Plastic Recycling from Electro Waste. Fraunhofer-Institut für Verfahrenstechnik und Verpackung Germany. Via: www.plasticker.com/news/showartikel_en.php?id=23&begriff=&backto=/news/fachartikel_en.php&PHPSESSID=e6654f291c7033fd6892d99ffae1039b

Mayers, K., Ch. France (Brunel, Surrey, HP). 1999. Meeting the Producer Responsibility Challenge. The Management of Waste Electrical and Electronic Equipment in the UK. Wokingham, Guildford.

MBA Polymers Austria Website: www.mbapolymers.at/content.pph?pageId=631

McLaren, J., L. Wright., S. Parkinson and T. Jackson. 1999. A dynamic life cycle energy model of mobile phone take-back and recycling. In: Journal of Industrial Ecology. Winter 1999, Vol. 3, No. 1: 77-91. Posted Online March 13, 2006.

Ministerio de Industria, Turismo y Commercio (Spanish Register). 2006 Spanish National Register for EEE put on the Market. Madrid. Via: www.mityc.es/raee

Mocigemba, D. 2006. Computer und Nachhaltigkeit. In: Das Parlament, 5 June 2006.

Morf, L. et al. 2006a. Brominated Flame Retardants in Waste Electrical and Electronic Equipment: Substance Flows in a Recycling Plant. In: Waste Management; Science Direct: 1-11. And in: Environmental Science & Technology 2005, Vol. 39, No. 22: 8691-8699. Zuerich, Bern, Regensdorf.

Morf, L. et al. 2006b. Metals, non-metals and PCB in electrical and electronic waste – Actual levels in Switzerland. In: Waste Management, 26 September 2006.

Morf, L., R. Taverna. 2004. Metallische und nichtmetallische Stoffe im Elektronik-schrott – Stoffflussanalyse. Herausgegeben vom Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Bern. In: Schriftenreihe Umwelt 374. Umweltgefährdende Stoffe Abfall. Bern.

Müller, F. 2005. Bestimmung des Schad- und Wertstoffpotenzials in schwer aufschließbaren E-Schrott-Komponenten. Diplomarbeit. Dresden.

N

NATIONAL REGISTER OF PRODUCERS PORTUGAL. 2007.
List appliances covered. Via: www.anreee.pt/inter/areaprod_equipDifEnq.asp

NCER, NERIC. 2006. NERIC Patchwork Study. A study of the State-by-State E-Waste Patchwork. An analysis of its economic and other effects on industry, government and consumers.

NDCEE: Dahlgreen, R. 2003. Component Recovery.

NDCEE: Galbraith, P., L. Maruschak. 2003. Metals Module (DEER2).

NDCEE. 2000. Demanufacturing of Electronic Equipment for Reuse and Recycling (DEER2) Technology and Demonstration Center. 2000. Mission Need Statement. Revision A. Submitted by CTC. Prepared by National Defense Center for Environmental Excellence (NDCEE). Johnstown.

Neira, J. et al. (UCSB - University of California). 2006. End-of-Life Management of Cell Phones in the United States. Group Project. Santa Barbara.

NeWET - Netzwerk „Weiter- und Wiederverwendung von Elektro(nik)geräten und ihren Teilen". 2001. Abschlussbericht der Voruntersuchung. NeWET-Bericht.

Niedersächsisches Umweltministerium (Hrsg.). 1998. Abschlußbericht des Arbeitskreises 13: "Elektronikschrott"; Kommission der Niedersächsischen Landesregierung zur Vermeidung und Verwertung von Abfällen.

NIES (National Institute for Environmental Studies): Terazono, A. 2004. Proceedings of The Third Workshop on Material Cycles and Waste Management in Asia (NIES E-waste Workshop). NIEW workshop illegal shipments & amounts. December 14th - 15th 2004. Tsukuba.

Nissen, N. 2007. Energy using Products (EuP) Preparatory Study, Standby and Off-mode Losses (Lot 6). Interim Report Version for Task 2. Berlin.

NKT Holding A/S. 2002. Annual Report 2001. Brøndby. Via: www.nkt.dk/

Nokia Corporation. 2005. Life Cycle Environmental Issues of Mobile Phones. Integrated Product Policy Pilot Project, Stage 1. Final Report. Espoo.

Nordic Council of Ministers. 1995 a. Environmental consequences of incineration and landfilling of waste from electr(on)ic equipment. Copenhagen.

Nordic Council of Ministers. 1995 b. Waste from electrical and electronic products – a survey of the contents of materials and hazardous substances in electric and electronic products. Copenhagen.

Norway. 2005. Norway's contribution to the Gathering of information on WEEE. (Imported/ collected 2005).

Nulife Glass Ltd. Ruskin Glass Centre. 2006. Stourbridge. Via: www.nulifeglass.com/

NVMP. 2007 a. Categorie volgens bijlage IA van de richtlijn nr. 2002/96/EG. Op de markt gebrachte elektr(on)ische apparatuur per 28-02-2007 in duizendtallen. Zoetermeer.

NVMP. 2007 b. List appliances covered. Via: www.nvmp.nl/index.php?option=custom&id=104

NVMP. 2006. Monitoring. In Dutch. Zoetermeer. Via: www.nvmp.nl/

NVMP. 2005. Inzamelstromen per WEEE categorie in 2005.

O

OECD(Organisation for Economic Co-operation and Development): Walls, M. 2006. EPR Policies and Product Design: Economic Theory and Selected Case Studies. Washington DC.

OECD. 2005 a. Analytical Framework for Evaluating Costs and Benefits of EPR Programmes. Prepared as part of the work programme of OECD's Working Group on Waste Prevention and Recycling. Written by Prof. Stephen Smith, University College London. London. OECD. 2005 b. Working Group on Waste Prevention and Recycling. Improving Recycling Markets ENV/EPOC/WGWPR(2005)3/FINAL.

OECD. 2004. Addressing the economics of waste. Paris.

Oeko-Institut: Dehoust, G., D. Schüler. 2007. Ökobilanzielle Untersuchung zur Verwertung von FCKW- und KW-haltigen Kühlgeräten. Endbericht. Freiburg, Darmstadt, Berlin.

Oeko-Institut: Ruedenauer, I., C.-O. Gensch. 2005 a. Eco-Efficiency Analysis of Washing machines. Refinement of Task 4: Further use versus substitution of washing machines in stock. Final report commissioned by CECED. Freiburg.

Oeko-Institut: Ruedenauer, I., C.-O. Gensch. 2005 b. Environmental and economic evaluation of the accelerated replacement of domestic Appliances. Case study refrigerators and freezers. Commissioned by CECED. Freiburg.

Oeko-Institut: Wollny, V., M. Schmied. 2000. Assessment of Plastic Recovery Options. Commissioned by the European Environmental Bureau (EEB) Brussels. Darmstadt.

Oekopol. 2007. Oekopol, IIIEE, RPA, DG ENV. Study Contract N° 07010401/2006/449269/MAR/G4, "The Producer Responsibility Principle of the WEEE Directive", Interim Report 26 April 2007 – NON PUBLISHED

Oekopol: Sander K. et al. 2004. Stoffbezogene Anforderungen an Photovoltaik-Produkte und deren Entsorgung. Umwelt-Foschungs-Plan, Endbericht. Hamburg, Leibzig.

Oeko-Recherche: Leisewitz, A., W. Schwarz. 2001 a. Formulation of proposals for measures to be taken to substitute environmentally relevant flame retardants in printed circuit boards, outer casings for IT and TV appliances and polyurethane insulation and one-component foams. Workshop reports. Im Auftrag des Umweltbundesamtes. Frankfurt/ M.

Oeko-Recherche. 2001 b. Report on the workshop "Measures proposed to substitute environmentally relevant flame retardants" arranged by the Federal Environmental Agency in Berlin. Frankfurt/ M.

Oeko-Recherche: Leisewitz, A., H. Kruse and E. Schramm. 2000. Erarbeitung zu Bewertungsgrundlagen zur Substitution umweltrelevanter Flammschutzmittel. Band 1: Ergebnisse und zusammenfassende Uebersicht. Im Auftrag des Umweltbundesamtes. Frankfurt.

Oeko-Recherche: Leisewitz, A., W. Schwarz. 2000. Erarbeitung zu Bewertungsgrundlagen zur Substitution umweltrelevanter Flammschutzmittel. Band 2: Flammhemmende Ausruestung ausgewaehlter Produkte - anwendungsbezogene Betrachtung: Stand der Technik, Trend, Alternativen. Im Auftrag des Umweltbundesamtes. Frankfurt/ M.

Oesterlie, C. 2006. Norway: Import/ Export and WEEE collected.

Ogilvie, S. 2007. Spanish National Register for EEE put on the market. Extracts: Figures in Tonnes. Via: www.mityc.es/raee

Ollila, S. (Finland Register), Senior Adviser. Pirkanmaa, Regional Environment Centre. (P.O. Box 297, 33101 Tampere. Telephone +358 20 490 4098. E-mail: susanna.ollila@ymparisto.fi).

Ollila, S. 2007. WEEE Finland quantities.

ORGALIME. 2006. ORGALIME Guide to the scope of the WEEE and RoHS directives. Brussels.

Oudhuis, A.B.J, H. Boerrigter, J.P.A. Neeft. Staged Thermal Treatment Combined with Polymetallurgical Producing Energy And Products From Waste. Netherlands Energy Research Foundation (ECN).

OVAM (with Bayens, D., T. Thewys). 2004. De kringloopcentra in het Vlaamse Gewest. Opvolgingsverslag 2004. OVAM Publicaties. Mechelen.

P

Papameletiou, D. (IPTS, EC JRC). 2000. Towards a European solution for the management of waste from electric and electronic equipment. A Report prepared by the IPTS for the Committee on Environment, Public Health and Consumer Protection of the European Parliament. Final Report. Seville.

Perchards. 2007. WEEE legislation and compliance in the 27 EU Member States. Selected aspects summarized from Perchards' online WEEE Information Service.

Peters, K. (Vlaamse minister van Openbare Werken, Energie, Leefmilieu en Natuur). 2005. Ministerieel besluit houdende vaststelling van nadere regels voor de aanrekening van de inzamelkosten op containerparken door producenten in het kader van de aanvaardingsplicht. In: Belgisch Stadsblad: 36176-38074.

Philips Consumer Electronics (CE). 1998-2007. Multiple environmental benchmark reports. Eindhoven.

Philips Consumer Electronics (CE), Environmental Competence Centre. 2006. Multiple environmental benchmarks 1998 – 2006. Eindhoven.

Platts. 2007. Newsletter Metals Week. In: Metals Week.

PRe Consultants BV. 2007 a. Simapro 7. Amersfoort. Via: www.pre.nl/

PRe Consultants BV. 2007 b. Eco Indicator. LCA Discussion list. Email correspondence between M. Ortiz and S. Ogilvie.

PRe Consultants BV: Goedkoop, M., R. Spriensma. 2000. The Eco-Indicator 99. A damage oriented method for Life Cycle Impact Assessment. Methodology Report. In: Publikatiereeks produktenbeleid. Nr. 1999/36A. Amersfoort.

PRe Consultants BV: Goedkoop, M., R. Spriensma. 1999. The Eco Indicator '99. A damage-oriented method for Life Cycle Impact Assessment. Final Report. National Reuse of Waste Research Program. Pré Consultants. Amersfoort.

PRODCOM. 2007. List. Via: ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=PRD_2007&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC&CFID=3619310&CFTOKEN=c706f3505eb83a96-89E4AB44-CF83-201E-B103AC5F4FD00D33&jsessionid=ee30a6795c5778497156

Project on PVC Waste is short of cash. In: PVC – Informstionsradet, 22 (2002). Via: www.pvc.dk/t2w_226.asp?id=110

Proventia Group. 2007. CRT Recycling Technology. Forssa. Via: www.crt-finland.fi/eng_index.html

PVC recycling Plant Stigsnaes on hold. In: PVC – Informationsradet, 8 (2005). Via: http://www.pvc.dk/t2w_284.asp?id=736&tid=20%2D12%2D2005+19%3A51%3A23

PWC (for DTI). 2002. Environmental Life Cycle Assessment and Financial Life Cycle Analysis of the WEEE Directive and its implications for the UK. Update of the WEEE Directive study. Final report.

R

Recharge. 2007. Q-list batteries in WEEE. Hamburg.

Recharge aisbl. 2006. Information for the review of the WEEE Directive 2002/96/EC Stakeholder consultation. Brussels.

Recupel asbl. 2005. Annual Report 2004 – Recupel at Cruising Speed. Brussels. Via: www.recupel.be

Recupel asbl. 2007. Impact of distribution contract on collected volume.

Recupel asbl. 2006 a. Annual Report Recupel 2005 - A new orientation, ready for the future [on line]. Brussels. Via: www.recupel.be [visited: 08/02/2007]

Recupel asbl. 2006 b. Rapport 2006. Brussels. Ordered via: www.recupel.be

RECYCOMB. 2005. EU Project CRAF-1999-71594 (2003-2005). High Quality plastics materials recycling from electronic wastes using combined Identification (RECYCOMB). Final Technical Report (2005). Non-publicly available.

Reuter, M.A. et al. 2006. Fundamental limits for the recycling of end-of-life vehicles. In: Minerals Engineering 19: 433–449. Delft.

Reuter, M.A. et al. 2005. The Metrics of Material and Metal Ecology. Elsevier B.V., Amsterdam. ISBN – 13: 978-0-444-51137-9, 706 p.

RGS 90 A/S LIFE Project Number LIFE02 ENV/DK/000155. 2005. "Innovative Demonstration Project for Chemical Recycling of PVC Waste through the Use of Termal Hydrolysis" Technical Final Report.

Risk & Policy Analysts Limited. 2001. Employment Effects of Waste Management Policies. Report for the European Commission, Directorate-General Environment.

Rose, C.M., A.L.N. Stevels. 2001. Metrics of End-of-Life Strategies (ELSEIM). Proceedings of the 2001 IEEE International Symposium on Electronics and the Environment, Denver CO, pp. 100-105.

Rotter, S., A. Janz and B. Bilitewski. (TU Berlin, TU Dresden). 2006 a. Charakterisierung elektrischer und elektronischer Altgeräte (EAG). 1. Teil: Mengenprognosen und Zusammensetzung von Kleingeräten. In: Müll und Abfall (Heft 7): 365-373. Berlin, Pirna.

Rotter, S., A. Janz and B. Bilitewski. 2006 b. Charakterisierung elektrischer und elektronischer Altgeräte (EAG). 2. Teil: Gerätekennzahlen zur Ableitung von Erfassungs- und Verwertungsstrategien. In: Müll und Abfall (Heft 8): 424-433. Berlin, Pirna.

RREUSE. 2006. Reuse - means of prevention and preferred mode of recovery of waste.

S

Sachs, N. 2006. Planning the funeral at the birth: Extended producer responsibility in the European Union and the United States. In: Harvard Environmental Law Review, Vol. 30.

Schaerlaekens, M. 2007. CRSO Quick Facts – Final ELC.

Schaik, A. van. 2004. Theory of Recycling Systems – Applied to Car Recycling. ISBN 90-9018839-8, Ph.D. thesis, Delft.

Schaik, A. van, M.A. Reuter and K. Heiskanen. 2004. The influence of particle size reduction and liberation on the recycling rate of end-of-life vehicles. In: Minerals Engineering, Vol. 17, No. 2, ISSN 0892-6875: 331 – 347.

Schischke, K., L. Stobbe (Fraunhofer IZM). 2006 a. Guidance for Product Case Assessment. For: Seico Epson corp. EuP Preparatory Studies, Lot 4. LP-S6500. Berlin.

Schischke, K., L. Stobbe (Fraunhofer IZM). 2006 b. Guidance for Product Case Assessment. For: Seico Epson corp. EuP Preparatory Studies, Lot 4. Picture Mate 100. Berlin.

Schischke, K., L. Stobbe (Fraunhofer IZM). 2006 c. Guidance for Product Case Assessment. For: Seico Epson corp. EuP Preparatory Studies, Lot 4. Stylus Pro 4800. Berlin.

Schischke, K., L. Stobbe (Fraunhofer IZM). 2006 d. Guidance for Product Case Assessment. For: Seico Epson corp. EuP Preparatory Studies, Lot 4. V100 Photo. Berlin.

Scholte, A. 2002. Static and dynamic modelling of the metal cycles involved in lead-free soldering. Graduation report. Department of Applied Earth Sciences, Delft University of Technology. Delft.

Schott AG (Germany). 2002. Panel Glass for Re-melting.

Scientific Generics (SG). 2003. EPI Study Final Report for CECED. Presentation EPI 2003.

Secretariat of the Basel Convention, Mobile Phone Working Group. 2006. Guidance document on the environmentally sound management of used and end-of-life mobile phones. Nairobi.

Sims Group Ltd. 2007. Sims-Group.com. News item. Via: www.sims-group.com/mirec/solutions/en_crt-treatment_sc.asp

SituationPublishing Ltd. 2007. The Register, Reghardware. News item. UK. Via: www.reghardware.co.uk/

Sleinotaite-Budriene, L. (European Committee under Government of the Republic of Lithuania). 2003. Impact Assessment of implementation of Directive 2002/96/EC of the European Parliament and of the Council on Waste Electrical and Electronic Equipment (WEEE) in Lithuania. Summary.

Slijkhuis, Ch. et al. (MBA Polymers). 2006. Electronic Equipment: Plastics Recycling. Material recovery vs. energy recovery. Kematen/ Ybbs.

Society of Plastics Engineers (SPE). 1999. Annual Recycling Conference 1999. Via: www.plasticresource.com/

Spriensma, R., C. Alvarado and M. Goedkoop. 2002. LCA soldering materials. Report for Philips and Alpha Fry Technology. Amersfoort.

Srocka, M. 2005. Materialzusammensetzung und Verwertungspotentiale von mülltonnengängigen Elektro- und Elektronikaltgeräten. Diplomarbeit am Institut für Technischen Umweltschutz Fachgebiet Abfallwirtschaft der TU Berlin. Berlin.

Stapel, O (Witzenhausen Institut GmH). 2003. Chancen und Risiken der EU-Elektronikschrott-Richtlinie (WEEE) für Sozialbetriebe und Werkstätten für behinderte Menschen. Witzenhausen.

Stobbe, L. January 2007. Energy using Products (EuP) Preparatory Study. Preparatory Studies for Eco-design of Energy-using Products. Task 2 Interim Report for EuP Preparatory Study Lot 4: Imaging Equipment. Berlin.

Stobbe, L. 2006 Energy using Products (EuP) Preparatory Study. Interim Task Report for EuP Preparatory Study Lot 5: Televisions. Berlin.

Streicher-Porte, M. 2006. SWICO/S.EN.S, the Swiss WEEE recycling system, and best practices from other European systems. In: Proceedings of the International Symposium on Electronics and the Environment. San Francisco.

Streicher, M. 2005. Batchversuch Elektrorecycling Winterthur, October, November 2005.

Streicher-Porte, M. et al. 2005. Key drivers of the e-waste recycling system: Assessing and modelling e-waste processing in the informal sector in Delhi. In: Environmental Impact Assessment Review 25 (2005): 472– 491.

SUREPLAST. 2001. EU Project BRPR-CT98-0783 "Development of multipurpose industrial units for recycling of plastic wastes by on-line pattern recognition of polymer features (SUREPLAST)". Final Report.

SVZ Website. Via: www.svz-gmb.de/

SWICO Environmental Commission. 2006. Recycling guarantee. Activity report. Zuerich.

SWICO - Swiss Association for Information, Communication and Organisational Technology. 2006. Activity Report 2005 [on line]. SWICO Environmental Commission. Zurich. Via: www.swico.ch/ [visited: 08/05/2007]

S.EN.S - Swiss Foundation for Waste Management. 2006 a. Rapport d'activité 2005 [on line]. Ed. Hediger, R., K. Siegfried and P. Poldervaart. Zurich. Via: www.sens.ch/ [visited: 08/02/2007]

S.EN.S - Swiss Foundation for Waste Management. 2006 b. Fachbericht der technischen Kontrollstelle TK-SENS 2005 [on line]. Zurich. Via: www.sens.ch/ [visited: 08/02/2007]

S.EN.S - Swiss Foundation for Waste Management. 2005. Annual Report 2004 - System exactly on track. Ed.: Hediger, R., K. Siegfried and P. Poldervaart. Zurich. Via: www.sens.ch/

StEP – Solving the E-Waste Problem Website: www.step.-initiative.org

T

Technical Advisory Committee (TAC). 2006. Unofficial note of the Technical Adaptation Committee on the WEEE and RoHS Directive, Brussels.

TAC, Working Group. 2005. Guidance document of the TAC for WEEE and RoHS on interpretation of the Annex II of the WEEE Directive.

TAC. 2002. Guidance document Annex II and article 6.1 of 2002/96.

Tange, L., J. Brusselaers and Ch. Hagelüken. 2006. Eco-efficient solutions for flame retardant containing, mixed plastics – Metals WEEE, in particular resource recovery at an integrated metal smelter. Eurobrom ICI-IP – EFRA, Via: forum.europa.eu.int/Public/irc/env/weee_2008/library?l=/recycling_techniques/brusselaers_fr2006/_EN_1.0_&a=d

Tartler, D.C. 1994. Analytisch-chemische Behandlung von elementreichen Verbundmaterialien und Möglichkeiten ihrer stofflichen Verwertung am Beispiel Elektronikschrott.

Tecpol - Technologieentwicklungs GmbH. 2006. Plastics-rich end-of-life waste from electrical and electronic appliances can be recycled at SVZ. Tecpol homepage, news archive, 19.01.2006. Hannover. Via: www.tecpol.de/en/archive/news/06_01_19svz_acceptance.html

Terazono, A. et al. 2006. Current status and research on E-waste issues in Asia. In: J Mater Cycles Waste Manag (2006) 8:1–12.

TNO-MEP (Tromp, Tempelmann). 2001. Asbest in WEB. Apeldoorn.

Tojo, N. 2004. Extended Producer Responsibility as a Driver for Design Change - Utopia or Reality? Doctoral Dissertation at Lund University (IIIEE). Lund.

Truttmann, N., H. Rechberger. 2006. Contribution to resource conservation by reuse of electrical and electronic household appliances. In: Resources, Conservation and Recycling. Science Direct: 2-14. Vienna.

Tukker, A. et al. (DG JRC). 2006. Environmental Impact of Products (EIPRO). Analysis of the life cycle environmental impacts related to the final consumption of the EU-25. Main report. EPTS/ESTO Project. In: Technical Report Series. European Commission.

Tukker, A., H. de Groot et al. 1999. Chemical Recycling of Plastics Waste (PVC and other resins). TNO Report. TNO Institute of Strategy, Technology and Policy for European Commission, DG III. The Netherlands.

U

U.S. Geological Survey (USGS): Kempthorne, D., M. Myers. 2007. Mineral Commodity Summaries 2007. Washington.

U.S. Geological Survey (USGS). 2006. Minerals Information.

UK Market Transformation Programme (MTP). Via: www.mtprog.com/

UNCTAD, UNESCAP. 2005. Environmental requirements and market access for developing countries: The case of electrical and electronic equipment (EEE). Unedited background paper of the UNCTAD-UNESCAP Workshop 'Exchanging National Experiences among the Principal Exporting Developing Countries - Environmental Requirements and Market Access for Electrical and Electronic Goods, UN Building, Bangkok, 25-27 May 2005. Bangkok.

United Nations Economic Commission for Europe. 1991. Protocol to the 1979 Convention on long-range transboundary air pollution concerning the control of emissions of volatile organic compounds or their transboundary fluxes.

University of California Riverside. 2006.Technology Evaluation and Economic Analysis of Waste Tire Pyrolysis, Gasification and Liquefaction. Via: www.ciwmb.ca.gov/publications/tires/62006004.pdf

Urcelay,C. 2006. Utilizaciòn de combustibles alternativos en las fabricas de cemento. Technical Paper presented in Congreso Nacional de Medio Ambiente (CONAMA 8), 27 Nov. To 1 Dec. 2006. Madrid. Via: www.conama8.org/

V

Van der Wel, H. Internal Philips LCA database (CFT-02-US)

Van der Rossem, C., N. Tojo and T. Lindhqvist (EEB). 2006 a. Lost in transposition? A study of the implementation of Individual Producer Responsibility in the WEEE Directive.

Van der Rossem, C., N. Tojo and T. Lindhqvist. (Internationella Miljöinstitutet). 2006 b. Extended Producer Responsibility. An examination of its impact on innovation and greening products. Report commissioned by Greenpeace International, Friends of the Earth and the European Environmental Bureau (EEB).

Van Nes, C.N. 2003. Replacement of Durables, Influencing the replacement frequency through product design, Ph.D. Thesis Rotterdam.

VDZ - Verein Deutscher Zementwerke e.V. 2001. Umweltdaten der Deutschen Zementindustrie. Duesseldorf.

Vehlow, J., B. Bergfeld, H. Hunsiger and K. Jay. 2002. Recycling of bromine from plastics containing brominated flame retardants in state-of the-art combustion facilities. Technical Report. Brussels. Via: http://ec.europa.eu/environment/waste/stakeholders/industry_assoc/ebfrip/annex6.pdf

Vehlow, J. et al. (Forschungszentrum Karlsruhe). 2000. Thermal Treatment of E+E Waste Plastics. In: Waste Management and Research 18 (2000): 131-140. Karlsruhe, Horgen.

Verhoef, E. 2004 a. The ecology of Metals. Dissertation.

Verhoef, E.V., G.P.J. Dijkema and M.A. Reuter. 2004 b. Process knowledge, system dynamics and metal ecology. In: Journal of Industrial Ecology. 8(1/2).

Verhoef, E.V., G.P.J. Dijkema and M.A. Reuter. 2003. Knowledge, waste management and metal ecology. Accepted for the XXII International Mineral Processing Congress, 28 September – 3 October 2003. Cape Town.

Vernon, J., C. George (Risk & Policy Analysts Ltd.). 2001. Employment Effects of Waste Management Policies. Final Report, prepared for EC DG ENV. Norfolk.

VHK (Van Holsteijn en Kemna BV). November 2005 a. Methodology Study on Eco-design of Energy Using Products (MEEUP): Product Cases Report. Report by VHK for the European Commission.

VHK (Van Holsteijn en Kemna BV): Kemna, R. 2005 b. Ecodesign of Energy-using Products. Methodology Study Eco-Design of Energy-using Products (MEEUP). EuP EcoReport: Inputs.

VHK for European Commission.

VHK (Van Holsteijn en Kemna BV). 2007 a. Eco-Design of Energy using Products. In: EuP EcoReprt: Inputs. Assessment of Environmental Impact.

VHK (Van Holsteijn en Kemna BV). 2007 b. A Portrait of the Household Appliance Industry and Market in Europe. Interim EuP report for LOT 13: Domestic Refrigerators and Freezers, and LOT 14: Domestic Dishwashers and Washing Machines. Energy using Products (EuP) Preparatory Study for the European Commission.

VHK (Van Holsteijn en Kemna BV): Kemna, R. et al. 2005 c. MEEUP (Methodology Study Eco-Design of Energy-using Products). Final Report. For the European Commision. Delft.

VHK (Van Holsteijn en Kemna BV): Kemna, R. et al. 2005 d. Methodology Study Eco-Design of Energy-Using Products (MEEUP). Product Cases Report. Client: European Comission. Delft.

Von Roll Inova. References – Thermal waste treatment plants. Via: www.vonrollinova.ch/site/english/dokumentation/pdf/VRI_RI_waste_treatment_0701.pdf

VROM-Inspectie. 2007 a. Neveneffecten van producentenverantwoordelijkheid in het afvalstoffenbeleid. Eindhoven.

VROM-Inspectie. 2007 b. Dutch Inspectorate of Housing, Spatial Planning and the Environment. Het beeld verhelderd. Handhavingsactie 2006 op de export van afgedankte elektrische en elektronische apparaten (in Dutch). Eindhoven, 2007.

VROM-Inspectie, 2007 c: The Clearer Picture - Enforcement action in 2006 on exports of waste electrical and electronic equipment, Eindhoven.

VROM-Inspectie: C. Huijbregts et al. 2005. Buiten beeld. Export van afgedankte elektrische en elektronische apparaten. Eindhoven.

W

Walk, W. 2004. Approaches to Estimate Future Quantities of WEEE. Forschungszentrum Karlsruhe GmbH, Institut für Technische Chemie. Karlsruhe.

WEEE Forum: Gabriel, R. 2006. Benchmarking collective take back systems. INSEAD Seminar. Fontainebleau.

WEEE Forum: Gabriel, R. 2005. Key figures on amounts & costs for the year 2005. Copy of WEEE Forum. Vienna.

Wenzel, H., M. Hauschild and L. Alting. 1997. Environmental Assessment of Products. Volume 1: Methodology, tools and case studies in product development. Chapman and Hall. London.

Wichmann, H. et al. 2002. Wert- und Schadstoffpotentiale von elektronischen Bauteilen. In: Fortschritt-Berichte VDI (Verein Deutscher Ingenieure) : Reihe 15, Umwelttechnik ; 239. Duesseldorf.

Wicks, M. WEEE Consultation, Final regulatory impact assessment for the WEEE Regulations.

Widmer, R. et al. 2005. Global perspectives on e-waste. In: Environmental Impact Assessment Review 25 (2005): 436–458.

Wilkinson, S., N. Duffy. 2003. WEEE Collection Trials in Ireland. Project reference 2001-WM/MS-M1. Final Report, prepared for the Environmental Protection Agency by Clean Technology Centre, Cork Institute of Technology. Wexford.

Williams, A. et al. 2006. Left on the scrapheap? The WEEE Directive and social sustainability. Via: www.brass.cf.ac.uk/uploads/caweeessAW0603.pdf

Williams, E., R. Kuehr, 2003. Today's Markets for used PCs - And Ways to enhance Them, in: Kuehr, R., E. Williams, 2003. Computers and the Environment, Understanding and Managing their Impacts, Dodrecht, p.197-209.

WR3A - World Reuse, Repair and Recycling Association. 2005. Total USA Electronic CRT Repair and Recycling, Including Exports. Draft Sub Report to EPA. Preliminary estimates by R. Ingenthron/ WR3A.

Waste and Resources Action Programme (WRAP ROTATE). 2006. "Assessing the impact of promotion and education programmes on recycling participation". Oxon.

X, Y, Z

Ylä-Mella. 2004. Recovery of WEEE in Finland.

Zhang, S., E. Forssberg. 1997. Mechanical separation oriented characterization of electronic scrap. In: Resources, Conservation and Recycling, Nr. 21.

3g. 2005. Press release of 29 August 2005. Via: www.3g.co.uk/

List of Relevant Legislation

For relevant EU waste legislation also see http://ec.europa.eu/environment/waste/index.htm

Other related legislation	Number	Abbreviation
Waste Electrical and Electronic Equipment	2002/96/EC	WEEE
Restriction of the Use of certain Hazardous Substances	2002/95/EC	RoHS
Proposal for WEEE and RoHS + explanatory memo	COM 2000/347	
Waste Framework Directive	75/442/EEC	WFD
Codified Directive on Waste	2006/12/EC	WFD
Revision Proposal of the Waste Framework Directive	2005/667/EC	pWFD
Hazardous Waste Directive	91/689/EEC	HWD
Non-hazardous waste Directive	2001/118/EC	NHWD
Hazardous Waste List	2000/532/EC	HWL
Integrated Pollution Prevention and Control describing Best Available Technologies	96/61/EC	IPPC (BAT)
Thematic Strategy on Waste	COM 2005/666	TSW
Transboundary Shipment of Waste (old) (new)	259/93/EEC 1013/2006	TBSW old TBSW new
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal		BC
Disposal of PCB's and PCT's	96/59/EC	
Incineration of dangerous waste	94/67/EC	
Mercury in ambient air	2004/107/EC	
Battery directive	91/157/EC	
Metallurgical treatment facilities emissions	84/360/EC	

Emissions of incineration	84/360/EC, 2000/76/EC	
Asbestos	83/447/EC	
VOC-regulations, governs substances that deplete the ozone layer	Regulation 2037/2000	
External electric cables (green paper)	COM 2000/469	
Radioactive substances	96/29/Euratom	

Interview List

Compliance Schemes
ADEME
Ambilamp, Spain
Asekol, Czech Republic
Asimilec, Spain
El Retur AS
El-Kretsen AB, Sweden
ERP
NVMP, Netherlands
UFH, Austria
WEEE Forum
WEEE Ireland

Industrial Associations
AeA Europe
AFEC - Asociación de Fabricantes de Equipos de Climatización (Association of Air Conditioning Equipment Manufacturers), Spain
ANIE, Producer Association, Italy
ANIMA, Producer Association, Italy
CECED
CECED Poland
CECED Slovakia
CECIMO
CELMA
EDMA
ELC
Orgalime
TIE (Toy Indstry Europe)

Producers
Alcatel-Lucent
BSH Bosch & Siemens Hausgeräte, Germany
Cisco (Systems + Linksys) + Scientific Atlanta
CISCO, UK
Dell
DeLonghi, Italy

Electrolux
EPSON Europe
Ericsson AB, Sweden
Fagor Electromesticos
Fagorbrandt
Fujitsu Siemens Computers, Germany
HP
IBM
Intel Corporation
JVC
JVC Scandinavia AB
JVC Technology Centre Europe GmbH, Germany
Kodak
Lexmark France
Lexmark International, France
LG Electronics Europe
Mattel
Motorola
Osram
Panasonic Europe Ltd
Panasonic Europe, Germany
Philips Lighting
Philips Medical, Netherlands
Samsung Electronics, UK
Sanyo
Siemens
Sony Europe
SonyEricsson
Toshiba Europe, Germany
Vivid Imaginations

Recyclers, Refurbishers
EERA
Flection International b.v., The Netherlands
MBA Polymers, Austria
Metallo-Chimique N.V., Belgium
Microsoft Ireland Operations Limited
RECHARGE
RECUPEL
SIMS – Mirec
Umicore Precious Metals Refining, Belgium

TAC Members, Ministries of Environment
DEFRA UK
DG Quality and Environmental Evaluation - Spanish Environment Ministry, Spain
Environment Agency, UK
Environmental Protection Agency (EPA), Irland
Ministry of Environment of Estonia

Ministry of Environment of Poland
Ministry of Environment of the Czech Republic
Ministry of Environment of the Republic of Lithuania
Ministry of Environment of the Slovak Republic
Ministry of Environment, Spatial Planning and Energy of Slovenia
National Register of Producers – Austia
National Register of Producers - Czech Republic
National Register of Producers – Denmark
National Register of Producers – Estonia
National Register of Producers – Finalnd
National Register of Producers – France
National Register of Producers – Hungary
National Register of Producers – Ireland
National Register of Producers – Latvia
National Register of Producers – Lithuania
National Register of Producers – Portugal
National Register of Producers – Slovakia
National Register of Producers – Spain
National Register of Producers – Sweden
TAC Member – Austia
TAC Member – Belgium
TAC Member – Denmark
TAC Member – Estonia
TAC Member – Germany
TAC Member – Slovakia
TAC Member – Sweden
TAC Member – UK
VROM Inspectorate, The Netherlands

Consultancy & Research
BIO Intelligence Service S.A.S., France
Energy and environmental advice centre, Ireland
ICER - Industry Council on Equipment Recycling, UK
RAL
TU Berlin
TU Vienna

Municipalities & NGOs
Council of European Municipalities and Regions
Devon County Council, UK
EEB
Norfolk County Council, UK
VVSG, Belgium

Others
AERESS, Spain
AIRES, Spain
Arçelik AS, Turkey

Association Infobalt EPA, Lithuania
BAG Arbeit, Fachgruppe Gebrauchtwaren und Recycling, Germany
Belgium RESSOURCES FEDERATION, Belgium
BKN, Netherlands
BT Communications Ireland Limited, Ireland
B-Ticino
Candy, Italy
Carnival Trading Co Ltd t/a Cloney Audio, Ireland
Cherry GmbH, Germany
Deutsche Telekom AG T-Com, Germany
Ecological Recycling Society, Greece
Ecopal, Ireland
EKOKAARINA, Finland
Electro-Coord, Hungary
Electrorecycling, Spain
Elmet S.L.U., Spain
EMC
ENVIDOM - Association of producers of electrical appliances for recycling, Slovakia
Esaote S.p.A., Italy
Eurobrom
Fédération Envie, France
Indesit Company, Italy
Itumic oy, Finland
JDSU Deutschland GmbH, Germany
KATHREIN-Werke KG, Germany
KVK Federation, Belgium
Led lighting Concepts Ltd
LEtERA – Latvia
Lidacel Ltd, Ireland
Lumicom, UK
Max Bahr Holzhandlung GmbH& Co KG, Germany
Mentor Lighting Ltd
Meyer Electrics (Ireland) Ltd
Netcontrol Oy, Finland
Netgear
Ökomat Psc., Hungary
Phibsboro Electrical Wholesalers Ltd
PlasticsEurope
Recilec SA, Spain
REMA System
RepaNet, Austria
Schneider-Electric SAS Hungarian Branch
Screenway Oy, Finland
Sean Dunne & Co, Ireland
SEH Computertechnik GmbH, Germany
SEKY - network, Finland
Service d'hygiène - Ville de Luxembourg
Techdata Europe GmbH, Germany

TOS Holdings LTD (T/A TOS Distribution LTD)
TQC Ltd., Ireland
Whirlpool, Italy
Zeos, Slovenia

SME Panel Responses

SME Panel responses Austria
SME Panel reponses Belgium
SME Panel responses Denmark
SME Panel reponses France
SME Panel reponses Germany
SME Panel responses Ireland
SME Panel reponses Italy
SME Panel responses Lithuania
SME Panel reponses Luxemburg
SME Panel responses Norway
SME Panel reponses Poland
SME Panel responses Portugal
SME Panel reponses Romania
SME Panel responses Schweden
SME Panel reponses Spain

15 ANNEXES

Please see separate document on Annexes.