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Extended Producer Responsibility as a Driver for Design Change - Utopia or Reality?

Tojo, Naoko

2004

Link to publication

Citation for published version (APA):
Tojo, N. (2004). *Extended Producer Responsibility as a Driver for Design Change - Utopia or Reality?* [Doctoral Thesis (monograph), The International Institute for Industrial Environmental Economics]. The International Institute for Industrial Environmental Economics.

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Naoko Tojo

Extended Producer Responsibility as a Driver for Design Change - Utopia or Reality?

Doctoral dissertation

the international institute for industrial environmental economics
Lund University, Sweden

Extended Producer Responsibility as a Driver for Design Change – Utopia or Reality?

Doctoral Dissertation, September 2004

Naoko TOJO

The International Institute for Industrial Environmental Economics
Internationella miljöinstitutet

The painting, "Moment", is an artwork of Galina Nikitina. A study trip to Ukraine in September 2003 provided me with an opportunity to encounter the painting. It was hanging on the wall of a very cosy pub, and somehow attracted me immediately. With coincidences and help of friends, I was also able to meet the painter. Galina is from Crimea, a peninsula embraced by the Black Sea. She is an art student in the Kiev Academy of Art. It was the collection of her works as well as two of her friends that was decorating the bar that particular evening. "Moment" is now brightening my flat in Lund. For me, it signifies change in circulation: 万物流転 (banbutsu ruten: everything flows, turns and changes). Things circulate in nature, in beauty, with trees, flowers and water… closed loop, open loop, integration…and much more.

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Published in 2004 by IIIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
Tel: +46 – 46 222 02 00, Fax: +46 – 46 222 02 10, e-mail: iiiee@iiiee.lu.se.
Printed by KFS AB, Lund.

ISSN 1402-3016
ISBN 91-88902-34-x
ISRN-LUTMDN/THME-04/1012-SE

Acknowledgements

My first and foremost gratitude is directed to Thomas Lindhqvist, my supervisor and the person that first brought me to the world of EPR in 1998. Without his guidance, support, trust, patience and much more, this thesis would not be here. Thomas, it is difficult to express in words – or in any other way – my gratitude. I am also very grateful to Philip Peck, who helped me tremendously in the latter and the most difficult part of my Ph. D journey. Thank you for reading through my unfinished drafts, and providing me with valuable insights. My gratitude is also directed to Chris Ryan, who helped me set the direction of my research.

The two research works that constitute the core of this thesis were financed by Stiftelsen Svenskt Kretslopp, a research fund of Lansförsäkringar Miljö AB. I am sincerely grateful to the generous support provided by the SSK. A special thanks is directed to Tomas Tengå, Camilla Grunditz and Gunilla Ahlman for your continued interests and support throughout the research period.

I have been very fortunate to be able to participate in the important work on EPR carried out by OECD. I would like to express my cordial gratitude to Ms. Claudia Fénérol for providing me with the invaluable opportunity.

It is the OECD work that provided me with a rewarding opportunity to work with Gary Davis, who, together with Thomas, are my "EPR" God fathers. Gary, thank you very much for uplifting me. I would also like to express my gratitude to Lars Hansson, who has made economics somehow a little bit more approach-able for me during the second project with the OECD. Discussing with you itself was an invaluable learning experience.

The Centre of my universe for the last 6 years has been IIIEE. I truly think it is a unique and exciting working place/home. Needless to say, it is the people that I have encountered here that make IIIEE so special. My cordial thanks to you all for being an integral part of the IIIEE family! Tareq, Oksé, Andrius, Murat, Zina, Mats, Kristofer, Rasa, Agi, Raquel, Åke, Lin …. I cannot list all that is on my mind, but I hope you feel my gratitude when you read this.

Bea, Carl, Lena and Casper: my cordial thanks for reading my draft and provided me with your insights! Hope you see their reflections in the final

version! Karin, Yvonne, Gerd and Åsa, thank you for all of your help in the formal Ph. D procedures.

Throughout my Ph. D work, I have been blessed with the opportunities of meeting with a number of inspiring people in various fields. My gratitude is directed to all the interviewees who kindly took their time despite their busy schedule. Your inputs constitute the core "ingredients" of this thesis. Besides the formal research interviews, interactions with people involved in EPR enhanced my understanding tremendously. My sincere gratitude is directed to the people I encountered in these opportunities and especially to: Kees Veerman, Clare Lindsay, Garth Hickle, Morishita san, Reid, Kjetil, Petrus, Jim, Julie, Beverley, Iza, Sara, Alex and Ted.

I also would like to thank people in the Global Environmental Forum and ICLEI, where I first got an opportunity to work in the area of environment. A special thanks to Hirano san, Nakadera san, Sakamoto san, Mitsuta san, Kaminokawa san and Judy for your continued support.

Yuuko chan, Fusa san, Tomo san, Neil sensei, Hana chan, Risa chan, Nakada san and Satoshi kun: thank you for continuing to be so good friends.

Nu-kun, my cordial thanks for everything – sharing and accommodating the differences through humour, music, laughter, trust and much more.

Last but not least, I would like to express my sincere gratitude to my parents, brothers and their families for constituting a solid and continuous foundation of my life.

Naoko Tojo

Lund, September 2004

Executive summary

Background and purpose

Despite its significant achievements of material affluence, convenience and comfort, modern industrial society has not been free from negative side effects. Many of these negative effects are due to unsustainable patterns of production and consumption. *Extended Producer Responsibility (EPR),* a concept that aims to improve total life cycle environmental performance of product systems, can be regarded as a founding principle to guide a shift towards a society based on sustainable production and consumption.

EPR incorporates several distinctive features considered to be important for effective environmental policy making. It prioritises *prevention* over end-of-pipe solutions. Instead of focusing on point sources such as production sites, it seeks to reduce the overall environmental impacts of products and the systems surrounding them throughout their *life cycle*. Without prescribing what should be done, EPR aims to prevent environmental problems at source via the provision of *incentives* for changes at the design phase of a product's life. Incentives are provided via delegation of *responsibility* to manufacturers.

Since the 1990s, the concept of EPR has been incorporated into the environmental policies of a growing number of governments, especially those of OECD countries. To date, these policies have predominantly addressed end-of-life management. By extending responsibility related to end-of-life management to manufacturers, an EPR programme aims not only to improve the end-of-life management *per se*, but also to provide incentives to manufacturers to design products that generate less environmental impacts at the end-of-life phase. Provision of responsibility is intended to link the *upstream* (design phase) of the product's life cycle with *downstream* (end-of-life management).

Despite the theoretically envisioned environmental improvements *upstream*, the focus of most governments, as well as entities that run EPR programmes, has been on the improvement of end-of-life management rather than promotion of design change. EPR programmes have often been introduced by government as a way of creating a new source of revenues for waste management. Implementation of EPR programmes requiring participation of new actors has been perceived to be difficult. Moreover, upstream changes can take various forms, and it is difficult to measure the

overall achievement in reducing environmental impacts. These challenges as well as the relatively short implementation period upon which to base evaluation may explain the shortage of research on the effectiveness of EPR programmes in inducing upstream changes. This is especially true for programmes addressing complex, durable products such as electrical and electronic equipment (EEE) and cars.

In relation to upstream changes, an issue increasingly discussed is the application of so-called individual or collective responsibility when implementing EPR programmes. In essence, *individual responsibility* means that manufacturers are responsible for the end-of-life management of their own products. *Collective responsibility* suggests a situation where producers of the same product group fulfil their responsibility for the end-of-life management of their products together regardless of brand. While an EPR programme based on individual responsibility is assumed to provide more incentives for design changes than one based on collective responsibility, individual implementation is perceived to face various administrative and institutional challenges. Research on the form and/or effectiveness of individual and collective responsibility is limited, and the understanding of individual and collective responsibility varies. The perception of the challenges, combined with the lack of clarity of what individual responsibility actually means in practice, has discouraged adoption of EPR programmes that enhance possibilities for individual implementation.

With this background in mind, this thesis has the purpose of *facilitating the formulation of EPR programmes which lead to the promotion of overall environmental improvement of product systems and are practically implementable.*

In order to achieve this purpose, the thesis presents two studies that examine *whether* EPR programmes exert tangible influence on upstream changes, and *the manner* in which the producers should fulfil their responsibility in order to obtain incentives for upstream changes. The thesis primarily investigates *mandatory* EPR programmes that include *take-back requirement* and address *durable, complex products* – EEE, cars, batteries.

The first study investigates the effectiveness of the *presence* of *mandatory* EPR programmes for complex products in inducing upstream changes. It pursues the following questions:

What measures have been undertaken by manufacturers in order to reduce environmental impacts from the end-of-life phase of their products?

In light of other influencing factors, what role does the presence of EPR legislation play in providing incentives for environmentally conscious design in order to promote life cycle environmental improvements of complex products and product systems?

The second study examines the implementation mechanisms of existing EPR programmes for complex products, and compares individual versus collective responsibility. It works from a premise of the superiority of individual implementation in inducing upstream changes, based upon practical and academic views. The study addresses the following questions:

What are the responsibilities that are assigned to producers in existing EPR programmes, and how do producers fulfil them?

Do producers implement their responsibility individually, and if so, in what manner?

What are the essential components of a viable implementation of individual responsibility?

The work presented in this thesis is based upon research work of the author since 2000, the primary findings of which can be found in Tojo (2001a), Tojo (2003). The materials from two additional studies (Tojo, Lindhqvist, Davis, 2003 and Tojo & Hansson, 2004) are also used to supplement the findings presented in this thesis.

Analytical framework

The aforementioned research questions are addressed with approaches widely employed in evaluation research on government intervention.

EPR policy instruments are categorised as: *administrative, economic* and *informative instruments*. Based upon the conceptual understanding of EPR as well as the current implementation practices, *intervention theory* for a prototype EPR programme is developed. Based on the understanding of EPR upon which this thesis is written, total life cycle environmental improvement of product systems is selected as the ultimate goal of the EPR programme. The actual implementation of EPR programmes is compared against the intervention theory. Three immediate outcomes are identified as measuring points. These are: 1) upstream changes, 2) development of downstream infrastructure and 3) establishment of feedback mechanisms between upstream and downstream actors.

With regard to evaluation criteria, the first study presented in this thesis primarily examines the *environmental effectiveness* of EPR programmes. Environmental effectiveness is investigated from two viewpoints: 1) whether the outcomes are in accord with the goals of an intervention (*goal-attainment* evaluation) and 2) whether the outcomes are produced by the intervention (*attributability* evaluation). The effectiveness evaluation is supported by the examination of whether the goals of an intervention are reflected in the intervention itself (*relevance*), and the degree to which the intervention receives support from the citizens and affected actors (*legitimacy* or *political acceptability*). Other criteria, such as economic efficiency and democracy, are beyond the scope of this study despite their importance. The second study investigated the actual manner of implementing the requirements related to downstream operations, in search of concrete ways of implementing individual responsibility (*implementation* evaluation). It is based on the assumed superiority of individual responsibility in inducing design changes (*environmental effectiveness*). The focus of the second study is directed to the involvement of manufacturers in downstream operations.

Research methodology

Recognising the innovative nature of the outcomes of EPR programmes as well as existence of other factors influencing the outcomes of the programmes, the research work took a *naturalistic, qualitative* approach. As a way of organising the research, a *multiple, instrumental case study* approach was taken.

21 manufacturers of EEE and cars in Sweden and Japan served as cases for the first study. *In-depth open-ended interviews* with environmental personnel within the respective manufacturers during 2000-2001 constituted the primary source of the study, supplemented by a review of relevant documents, academic articles and interviews with government officials and experts. The study examined the actual measures undertaken by the manufacturers in order to reduce environmental impacts from the end-of-life phase of their products, and factors influencing the undertaking of such measures.

Utilising the intervention theory for a prototype EPR programme, the occurrence of some of the immediate outcomes mandated by and/or envisioned in EPR programmes, as well as how and why they occur, were investigated. These immediate outcomes include *upstream changes*, *development of downstream infrastructure* and development of *feedback mechanism* between the

upstream and the downstream. The primary focus was upon upstream changes (*design change in new products* and measures that facilitate the change), while the other two were examined as vehicles to achieve the upstream changes through EPR legislation. The assumed underlying logic was that allocation of responsibility to producers concerning the end-of-life management of their products provides incentives to incorporate consideration of the environmental impacts of their products in their design strategies.

At the time of the interviews, all but one of the most relevant EPR programmes (EPR legislation for EEE and cars in Japan, Sweden and EU) were still under development or were enacted but had not come into force. This situation provided the author with an opportunity to examine the influence of the *anticipation* of the *mandatory* EPR programmes in inducing upstream changes. The anticipatory behaviour of manufacturers was also studied by examining the actions taken by the manufacturers in the past, and factors that triggered such actions. The findings of the first study provided empirical support to the assumption underlying the second study – the superiority of individual responsibility in inducing design changes. The findings are also utilised in the analysis of the second study.

The second study examined the implementation practice of 5 EPR programmes (EEE in Japan, the Netherlands and Switzerland, batteries in the Netherlands and Switzerland) during 2002-2003. *Publicly available documents* of various types, as well as *in-depth open-ended interviews* with actors involved in downstream operations provided primary data.

In order to capture the characteristics of the respective programmes, the activities constituting the implementation of downstream requirements are broken down into smaller elements from two perspectives. With regard to the activities that were envisioned in EPR programmes, they were divided into *collection* and sorting of the discarded products, environmentally sound *recovery*, as well as *monitoring and enforcement* of these activities. Meanwhile, it sought to distinguish *who* was fulfilling the three elements of responsibility – *physical, financial and informative* –, and *how* these responsibilities are fulfilled. Once the functions and the type of responsibilities fulfilled by producers in the respective programmes were identified, how these tasks were carried out *individually or collectively* in concrete terms was examined. The comparative analysis of the five studies, together with the findings from the first study, was used to systematise various forms of individual implementation of EPR programmes.

In addition to the aforementioned two studies, the author participated in two other research projects that examined the implementation practice of more than 20 EPR programmes, and attended various meetings and conferences related to EPR programmes. These activities provided the author with additional valuable insights and knowledge on various aspects of EPR programmes that contribute to this work.

Findings from the two studies

The first study investigated the *environmental effectiveness* of the presence of mandatory EPR programmes. The *goal attainment evaluation* within the first study indicates that the immediate outcomes envisioned in EPR programmes have indeed arisen. Upstream measures, both in terms of reduction of hazardous substances and enhancement of source reduction of material use, reuse and recycling, have been undertaken in the two industry sectors in both countries. Further, the development of downstream infrastructure is under way. In some cases, manufacturers established their own collection and recovery infrastructure, while in others, collective implementation is anticipated. Moreover, direct communication between the designers and recyclers/dismantlers has been occurring in various ways, and the recyclability of products has been tested.

The analysis indicates that while the reduction of use of hazardous substances has been undertaken by virtually all the manufacturers, the level of activities in areas of reduction of material use, reuse and recycling varies. In general, the more control the manufacturers have over the downstream infrastructure, the more likely it is that measures belonging to the higher ladder of resource efficiency will be taken. The study also revealed anxiety among manufacturers concerning the development of downstream infrastructure. The manufacturers feared that the current development does not enable the distinction of their products from products of similar types. It means that their upstream efforts may not be adequately rewarded.

Design for end-of-life has also been integrated into other environmental design strategies. When competing with other environmental priorities, careful consideration has been made so as not to increase the environmental impacts incurred during other phases of the life cycle in favour of design changes that facilitate end-of-life management. Moreover, design for end-of-life has not been perceived as the most important area to work within the manufacturers' overall design strategies. These practices indicate that upstream changes that aim to reduce environmental impacts from end-of-

life would be a "push" rather than a "threat" to the overall environmental improvement of product systems.

With regard to the *attributability evaluation*, a clear linkage was observed between the undertaking of these measures and the introduction of EPR legislation. Among various other factors that influence the manufacturers' undertaking of upstream changes, literally all the manufacturers interviewed acknowledged influence from EPR legislation on their efforts to reduce product environmental impacts. Among the policy instruments, *material restrictions* and *reuse and recycling requirements* have directly driven the undertaking of upstream measures. It was found that *take-back requirements* not only facilitate the development of downstream infrastructure, but also the establishment of communication paths between downstream and upstream. Responsibility allocated to producers for the end-of-life management of their products effectively induced the incorporation of changes reducing impacts in product design. However, manufacturers felt that the upstream changes required an accompanying downstream development for component reuse and increased use of recyclable materials.

The study also indicated the importance of legislation when considering various perceived obstacles, such as costs associated with reducing the environmental impacts from the end-of-life management of their products, and/or the lack of customer demands on design for end-of-life. Despite the societal concern on end-of-life management, manufacturers consider that it has not been translated into consumers' willingness to pay for the products with less environmental impacts at the end-of-life phase. Accelerated actions occurred after the emergence of the EPR legislation in Japan, in contrast to voluntary design guidelines on end-of-life management, indicated the strength of legislation in taking concrete measures that may require substantial initial costs. The contrast between the design guidelines and EPR legislation also demonstrates the role of take-back requirements in effectively linking downstream and upstream.

Finally, the first study revealed that the manufacturers took a range of *anticipatory* actions in light of upcoming legislation.

The findings from the second study, combined with the practices of individual producers discussed in the first study, indicate that there exist a variety of implementation mechanisms that incorporate the element of individual responsibility. The analysis of these implementation practices

indicates that individual implementation that enhances environmental performance of products in practice means the following.

A *producer* bears an *individual financial responsibility* when *he/she initially pays* for the end-of-life management of *his/her own products*. A producer bears an *individual physical responsibility* when 1) the *distinction* of the products are made at minimum by *brand*, and 2) the producer has the *control over the fate of their discarded products*, with some degree of involvement in the organisation of the downstream operation. When the products are physically handled together, the distinction of the *properties* of the products, including their features on end-of-life management, should be made. A producer is responsible for aggregation and provision of the property of his own products and product systems (*individual informative responsibility*).

The distinction of products does not require physically separate handling of products. It was found that identification of products can be made in various stages of downstream operations. The manner of distinction – actors involved in the distinction, the roles of producers and the like – also vary. Factors that affect the selection of the form of individual implementation include: end-value of the products, the feasibility and ambition of the producers to establish its own downstream infrastructure, types of end-users, the existence of other producers that share the same level of ambition regarding the end-of-life management of their products and the like.

From the viewpoint of promoting upstream changes, what matters most is whether or not the producers, not consumers, pay the actual cost of recycling. Even when consumers pay flat fees irrespective of brand, there exists a mechanism for producers to pay for the recycling of their own products. When the fee is visible, differentiated fees that reflect the degree of design for end-of-life would enhance the communication of the end-of-life property of the products to consumers. The experiences of EPR programmes for packaging suggest the possibility of differentiated fees. However, the properties of complex, durable products pose practical difficulties in actualising the correspondence between the size of the fee they pay and the actual recycling costs.

Finally, the analysis indicates that there are a number of important roles that collective bodies, such as PROs (producer responsibility organisations) and industry associations, have been playing/have potential to play. These roles include: securing the quality of collection and recovery activities, collection

and provision of information, identification of free riders in co-operation with the government and producers and the like.

Conclusions

In conclusion, it is held that this work provides empirical evidence that the presence of EPR legislation is a tangible factor that promotes upstream changes for the enhancement of the total life cycle environmental impacts of product systems. Among the policy instruments, material restriction and reuse and recycling requirements directly address upstream changes. Further, take-back requirements have been effective in encouraging manufacturers to develop downstream infrastructure, and in taking into account the environmental impacts of the end-of-life management of products at the design phase.

The analysis also indicates the role of legislation, both actual and anticipated, in inducing changes that are socially beneficial especially when these changes are not directly mirrored in the changes of the preference of consumers, and/or require initial high cost. A degree of certainty with the content of the legislation facilitates the manufacturers' undertaking of actions at an earlier stage.

The empirical evidence discussed above supports several assumptions underlying EPR programmes. Firstly, that provision of downstream requirements induces the establishment of feedback mechanisms between downstream and upstream of the product's life cycle. Related to this is that an EPR programme based on individual responsibility provides more incentives to upstream changes than the one based on collective responsibility. Another assumption endorsed by this study is that anticipation and actual mandatory requirements is a powerful tool to induce changes. The existence of various measures taken prior to the actual introduction of legislation suggests the importance of including the anticipatory behaviour of the addressee when evaluating an intervention.

In light of various practical approaches, individual implementation should be considered first. Producers should be provided with opportunities to explore alternative solutions as to when and how they would like to distinguish their products. In light of global market of products, it is desirable that products carry the information necessary for distinction of their properties, by way of, for instance, marked components.

From the viewpoint of design change, allocating *individual financial responsibility* to the producers for historical products is limited. Historical products can be financed in a manner suitable for the respective society. However, the physical involvement of the producers would provide them with learning opportunities with regard to design for end-of-life. An early indication of upcoming EPR legislation is deemed helpful in order to provide the producers with motivation to begin their engagement with downstream operation at an early stage.

In order to secure the quality of recycling activities and eliminate illegal dumping and export while enhancing the sound development of product reuse, the situation surrounding the second-hand market should be explored further.

While the importance of gaining legitimacy in society when introducing an intervention cannot be underestimated, the enhancement of environmental quality should not be compromised. For instance, consideration of the interests of actors that have been involved in the end-of-life management prior to the implementation of EPR programmes should be accompanied by the actual measures of enhancing the environmental quality of their activities.

As a closing comment, further research is required in the area of individual implementation, second-hand markets, product innovation, material efficiency, and application of the EPR principle in phases of the product's life cycle other than end-of-life. All of these would contribute to the application of the EPR principle in a manner that further guide the shift towards sustainable production and consumption.

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CHAPTER

ONE

1. Introduction

1.1 Background

Material affluence, convenience and comfort have now become affordable for the middle class in industrially developed countries. This can be regarded as one of the phenomena that characterises the 20th century.[1] The industrial revolution and automation, technological advances, the prevalence of civil society, the dominance of the market economy and the universal endorsement of the ideology of economic development regardless of the differences in other political ideologies are among a number of inter-related factors that have contributed to this achievement.

Meanwhile, the current life style of the majority of the population in industrial countries has led to excessive production and consumption. Excessive, in light of the quantity of products and services that are beyond those satisfying the basic needs combined with the failure of distribution of wealth,[2] and of the carrying capacity of the earth. The consequences of this

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1 As of 2002, more than 80% of the population in industrial countries (e.g. 85% in the United States and Canada, 89% in Western Europe, 95% in Japan) belonged to the "consumer class", that is, people whose incomes exceed 7000 USD of purchasing power parity (an income measurement adjusted for the purchasing power in local currency). The consumer class in developing countries are growing as well. For example, as of 2002, 239.8 million, 121.9 million, and 57.8 million people (19%, 12% and 33% of the local population) belonged to the consumer class in China, India and Brazil respectively. In terms of absolute number of people belonging to the consumer class, these countries rank themselves in the top 2, 3 and 7 nations of the world (Gardner, Assadourian and Sarin, 2004, p.7).

2 For example, the world annual expenditure on makeup is approximately 18 billion dollars, while elimination of hunger and malnutrition of the world is believed to be achievable by the addition of 19 billion dollars. In 2000, more than 60% of private consumption occurred in North America and Western Europe, where less than 12% of the world's population live (Gardner et al., 2004, p.6-10).

pattern of production and consumption, coupled with the absence of adequate physical and economic infrastructure to link the design phase (upstream) and the end-of-life management (downstream) of products include the continuous increase in waste generation, in terms of both quantity and variety and the inefficient use of natural resources.[3] To make matters worse, the current global economic and political structure often brings the most unwanted "by-products" of the modern society, such as hazardous waste, to developing countries or to economically worse-off communities within industrial nations. Inadequate treatment of the toxic substances often conducted in poorly equipped facilities has caused health and environmental hazards in these communities (Puckett et al., 2002). Ironically, the majority of the populations in these communities have not even enjoyed the benefits the products offer before they become waste.

Concerns about the environmental impacts that the industrial society exerts on the earth became increasingly recognised in the latter half of the century. This was manifested in the publication of *Silent Spring* by Rachel Carson in 1962, the 1972 Stockholm Conference on the Human Environment, and the debate surrounding the *Limit to Growth* to name but a few. The 1972 Conference not only triggered the birth of a number of international environmental treaties but also enhanced actions for protection in various nations.

Environmental policy making in the past few decades has appeared to follow several general trends. One is the prioritisation of preventative measures over so-called end-of-pipe approaches. The wide recognition of the notion of *source prevention* among environmental policy makers is manifested in, among other things, the concept of cleaner production[4] and the waste management hierarchy.[5]

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[3] Despite various efforts, between 1990 and 2000 the municipal waste generation per capita in OECD countries increased by 6% (509 to 540 kg) on average, while the total volume increased by 14% (from 530 to 605 million tonnes) (OECD, cited in de Tilly, 2004, p.23-26).

[4] UNEP (2001), stressing the importance of prevention, defines the overall concept of cleaner production as follows. "Cleaner Production is the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner Production can be applied to the processes used in any industry, to products themselves and to various services provided in society." It further provides definitions for its application to production processes, products and services respectively, as follows (UNEP, 2001).

Secondly, the necessity of dealing with the environmental problems throughout the entire life cycle of a product (*life cycle thinking*), as opposed to focusing merely on controlling environmental impacts from point sources, such as production facilities, has become evident.[6] Despite the importance of reducing environmental impacts from production facilities, this approach has been widely criticised as it risks shifting the problem from the production sites to somewhere else. Considering the environmental impacts of the entire life cycle of products – from raw material extraction to end-of-life management – aims to avoid the risk of shifting environmental impacts from one media to another or from one part of a life cycle to another.

The third trend has been a shift from the so-called command-and-control approaches to non-prescriptive, goal-oriented approaches. The traditional administrative instruments (often referred to as command-and-control approaches) – for instance permitting – have been useful in ensuring a minimum environmental quality (if enforced effectively). However, they have been criticised for often not providing industries with incentives for continuous improvement (Barde, 1995; OECD, 1997; Kemp, 2000; Heaton, 2000). Along with source prevention and life-cycle thinking, attempts to incorporate *incentive mechanisms* for industries to continuously improve their products and processes was yet another element that characterised environmental policy making in the 1990s.

It is in this context that the concept of extended producer responsibility (EPR) emerged. The concept is based on *life cycle thinking,* and aims to *prevent* environmental problems *at source* by providing *incentives* to producers that

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For production processes, *Cleaner Production results from one or a combination of conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process.*

For products, *Cleaner Production aims to reduce the environmental, health and safety impacts of products over their entire life cycles, from raw materials extraction, through manufacturing and use, to the 'ultimate' disposal of the product.*

For services, *Cleaner Production implies incorporating environmental concerns into designing and delivering services.*

5 The concept is adopted in, among other things, the EU 1996 general strategy of waste, "which respects the hierarchy of prevention, re-use, recycling, recovery of materials, energy recovery and final disposal" (European Parliament, 1996).

6 It is argued that life cycle thinking is now institutionalised within the environmental policy making communities (Heiskanen, 2002).

emerges from an extension of responsibility. EPR can be considered as one of the foundations for a shift from a society characterised by excessive production and consumption towards a more sustainable one. First defined as an environmental protection strategy in Sweden in 1990, the term extended producer responsibility, as well as legislative and voluntary measures incorporating the concept, has spread worldwide, especially in the OECD countries (Tojo, Lindhqvist, Davis, 2003).

Thus far, these measures, referred to as EPR programmes,[7] have primarily taken the form of extending the responsibility of producers to the end-of-life management of their products. The underlying idea is not only to improve the end-of-life management practice *per se*, but also to provide producers with incentives to incorporate the consideration of environmental impacts from downstream in their designs. Incorporation of the environmental impacts of the respective phases of the product's life cycle and the inclusion of end-of-life management at the design phase should, in the long run, lead to total life cycle improvement of products.

It is the influence of EPR programmes in inducing the design changes mentioned above that constitutes the theme of this thesis. It explores the influence of existing EPR legislation in providing incentives to the producers to reduce environmental impacts from the entire life cycle of products and the systems surrounding the products. Findings from two research projects conducted between the winter of 2000 and the summer of 2003[8] constitute the main empirical material underpinning the thesis. The materials from two additional studies (Tojo, Lindhqvist, Davis, 2003 and Tojo & Hansson, 2004) are also used to supplement the findings presented in this thesis.

The remainder of this chapter continues with an introduction of EPR (Section 1.2). It subsequently discusses EPR and design change, the theme of this thesis (Section 1.3), which leads to the establishment of an overall purpose of the research (Section 1.4). Section 1.5 sets the scope and limitations for the content addressed in this thesis. After a short

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7 The term "EPR programme" refers to a programme that contains one or more EPR-based policy instruments (see Section 1.2.4 and 2.1.5), implemented with different levels of coerciveness (see Section 1.2.5).

8 Tojo (2001a) and Tojo (2003).

introduction of terminology used in the thesis (Section 1.6), the final section introduces the structure of the remaining parts of the thesis.

1.2 Extended Producer Responsibility

This section aims to introduce a profile of extended producer responsibility (EPR). It discusses the development of the concept, its rationale and the intended outcomes as well as its practical application, reflecting upon both what is inherently drawn from the concept and what is happening in practice. The understanding presented in this section serves as a foundation of the discussion throughout this thesis.

1.2.1 What is extended producer responsibility?

The term "extended producer responsibility", as well as its concept as a preventative environmental protection strategy was first used and defined by Lindhqvist in a report for the Swedish Ministry of the Environmental and Natural Resources in 1990 (Lindhqvist and Lidgren, 1990).[9] The English translation of the definition reads as follows (Lindhqvist, 1992).

> *Extended Producer Responsibility is an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product. The Extended Producer Responsibility is implemented through administrative, economic and informative instruments. The composition of these instruments determines the precise form of the Extended Producer Responsibility.*

As discussed in the introduction, the emergence of the concept reflected several general trends in environmental policy making. These trends are the prioritisation of *preventative* measures over end-of-pipe approaches, enhancement of *life cycle thinking* and a shift from the so-called command-and-control approach to a non-prescriptive, goal-oriented approach. It aims

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[9] Elements of the concept could be identified in some policy instruments that were formulated before the birth of the terminology and its definition. Examples include management of packaging and packaging waste in Germany and the Netherlands, deposit-refund systems for beverage containers in Sweden, some states in the United States and the like. However, people engaged in the development of these instruments did not perceive EPR as a guiding concept for these policy instruments at that time.

to incorporate *incentive mechanisms* for industries to continuously improve their products and processes.

These three features relate to another fundamental element of the concept: making producers the primary actor responsible for the entire life cycle of their products. A principal rationale for allocating responsibility to producers is their capacity to make changes *at source* in order to reduce the environmental impacts of their product throughout its life cycle. It is essentially the producers that decide the features of the products they manufacture at the design phase of the products.

Making the decision at the design phase of the products is also related to *life cycle thinking*. Focusing on the reduction of the environmental impacts of only one part of the products' life cycle risks merely shifting the problem from one phase of the life cycle to another without reducing or eliminating the problem. Making producers responsible for the phases of product's life cycle with which they did not have links before – such as the end-of-life phase – also provides them with incentives to consider various issues surrounding the products in these phases. Among other things, these issues also include the environmental impacts generated from the respective phase of the life cycle and the costs of reducing these impacts. Producers have the possibility to incorporate these issues together with other design considerations. If the utilisation of the design change necessitates change in the infrastructure surrounding the product, it is in the producers' own interests to make changes in the infrastructure. Assigning responsibility primarily to one actor would avoid the situation where everyone's responsibility becomes no one's responsibility (Lindhqvist and Lifset, 1997). Moreover, in the policymaking and enforcement process it is practically easier to address producers who are relatively easy to identify than, for example, consumers.

The allocation of responsibility to producers by no means suggests that producers are morally "bad". Various actors in the product chain, not the least consumers, certainly gain benefits from product whose end-of-life management have negative environmental consequences. The concept supplements the polluter pays principle, which essentially requires polluters to pay for the pollution they generate. The focus of the polluter pays principle has been mainly on pollution from the production facilities and has lacked the mechanisms to provide incentives to the producers to consider environmental impacts generated outside of their production facilities (Davis, 1998; Davis 1999). Instead of stretching the word "polluter" in the

polluter pays principle, EPR explains the allocation of responsibility on producers with their capacity to prevent problems at source, even when the production *per se* may not be the largest source of pollution in the entire life cycle (Davis, 1998). In addition, the current implementation of EPR programmes often charge the costs associated with end-of-life management of products to the beneficiaries of products, that is users, which is in line with the polluter pays principle (Section 1.2.2).

The concept has, until now, primarily been incorporated in measures relating to the end-of-life management of products. Meanwhile, the understanding of what EPR encompasses varies, mainly 1) on its purpose and 2) on life cycle phases of products to which the responsibility of the producers are extended. Some understand it as a concept that primarily helps improve the situation surrounding waste management (VROM, 1998; Shiota, 1999). This understanding reflects the application of the concept to date. Others find that the concept has wider purpose and consider it as one that guides environmental improvement of products and systems surrounding the products throughout their life cycle (Lifset, 1993; Davis, 1998; Lindhqvist, 2000). Some consider that the extension of the responsibility of the producers under the concept is limited to the post-consumer phase of products' life (Shiota, 1999; OECD, 2001). Others suggest that the extension is not limited to end-of-life management of products, but to various parts of the products' entire life cycle (Davis, 1998; Lindhqvist, 2000).[10]

Another important development in the understanding of the concept is the positioning of EPR within the ladder of governmental policy making. Rather than one of the policy instruments manifesting itself as a take-back scheme, deposit refund system and the like, EPR is increasingly recognised as a policy principle underlying a range of preventative environmental policies (Davis, 1994; Lindhqvist, 2000; Kroepelien, 2000; Tojo, 2001a; Communication from the Commission COM(2003)301 final; de Tilly, 2004).[11]

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[10] Detailed description on the development of the concept of EPR and definitions given by different people and organisations can be found in Lindhqvist (2000, p.29-63).

[11] More discussion on the development of EPR concept as a policy principle can be found in Tojo, Lindhqvist and Dalhammar (2004).

In this thesis, following the definition of Lindhqvist (2000, p.154), EPR is understood as:

> *…a policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the product's life cycle, and especially to the take-back, recovery and final disposal of the product.*

This definition captures the full potentials of what an EPR programme can achieve, including the upstream changes. That is, the design changes of products and product systems. The definition provides room for the extension of the manufacturer's responsibility to the various parts of product life. Understanding EPR as a policy principle instead of a policy instrument not only strengthens the power of the concept in policy making process, but also captures various mixes of instruments implemented with different level of coerciveness as EPR programmes (see Section 1.2.4 and 1.2.5). Moreover, promotion of total life cycle environmental improvements of product systems is arguably one of the integral components in the shift towards sustainable production and consumption.

1.2.2 Intended outcomes of EPR programmes to date

Based on the aforementioned understanding of EPR, the responsibility of producers can be extended to various parts of the products' life. In practice, EPR programmes have to date extended the producer's responsibility to end-of-life management of products, which is often referred to as the "weakest link" for the producers in the product chain (Kroepelien, 2000, p.166). In this case, the extension of the manufacturer's responsibility means shifting part, or all, of the responsibility for the end-of-life management of products from tax payers, waste management authorities and conventional waste dealers to manufacturers. Based on the aforementioned understanding of EPR, this shift may bring multiple, inter-related benefits for society, linking and affecting the various phases of the product's life cycle.

With regard to waste management, an EPR programme helps to reduce the financial and physical burdens upon waste management authorities. They have often suffered from the inadequacy of existing waste management facilities and technologies for dealing with waste streams that are increasing both in terms of volume and variety. The elimination of toxic substances at source, or at least the separation of components using toxic substances from the rest of the waste stream can reduce the risk of health hazards and environmental damage caused by inappropriate waste management.

Separation of toxic substances from the rest of the waste stream can also reduce the cost of waste management. Manufacturers' expertise and knowledge about their products can be communicated to the waste managers (Lifset, 1993). The involvement of private actors tends to increase the efficiency of waste management practice, such as better logistics for transportation, especially when it is not subsidised. Some view the introduction of an EPR programme as a breakthrough that allows the privatisation of waste management, which had been monopolised by local governments (Tarasti, 1998; Jobin, 1997). Demand for separation and recycling created by the EPR programmes may also induce the development of separation/recycling technology.

If consumers realise that they pay for the end-of-life management, they may become more sensitive to throwing away an old product.[12] This may lead to a reduction in waste generation. It may also help create a wider demand and supply for second-hand products. Moreover, it is a way of charging the costs associated with end-of-life management of product to the beneficiaries of the product, instead of leaving the burden to tax payers. This leads to the implementation of the polluter pays principle on products outside of the production facilities, as discussed in Section 1.2.1.

The establishment of infrastructure for separate collection and the recovery of discarded products under EPR programmes would not only help improve waste management practice *per se*, but would also enhance possibilities for closing material loops. It also increases opportunities for manufacturers to actually re-obtain the products and/or components for their own reuse and recycling. Sufficient and steady supply of recycled materials with high quality would help create demand for the recycled materials (Lee, 2002; Peck, 2003). Without such infrastructure, manufacturers' efforts towards design for reusability and recyclability would be in vain.

Further, becoming responsible for the end-of-life management of their products financially and/or physically should force manufacturers to be more aware of the issues related to the end-of-life management of their products. A rational manufacturer would presumably try to find a way to minimise the costs associated with end-of-life management by changing the

---

[12] Making consumers pay for their waste has been perceived as one way of providing consumers with incentives to generate less waste. It is manifested in a growing use of so-called "pay-as-you-throw" systems, where consumers pay for waste management depending on the weight and/or size of the waste.

design of their products (both in terms of structure and material use) (Peck, 2003). The establishment of this feedback loop from the downstream (end-of-life management) to the upstream (design of products) is the core of the EPR principle that distinguishes EPR from a mere take-back system (Lindhqvist, 2000).

Just as the establishment of infrastructure, the impact of the design change of products may not be limited to the prevention or reduction of environmental problems related to waste management. Improved design for end-of-life, coupled with infrastructure for separate collection and recovery, would facilitate closing part or all of the material loops. This would provide motivation to lift the value of materials that come to the downstream (Peck, 2003), thus contributing to the improvement of resource efficiency (productivity). A manifestation of the changes of the product system can be found in the shift from selling products to selling the function that a product can provide to his/her customers, referred to as a product service system.[13]

Consequently, the intended outcomes of EPR programmes to date, inherently drawn from the aforementioned understanding of the EPR concept can be manifold. One is the improvement of waste management practice *per se*, in terms of both the reduction of environmental impacts and increased economic efficiency. Others include various intermediate steps towards life cycle environmental improvement of product systems. These steps can take varying forms such as closing of material loops, enhancement of design for environment and the like. There are no distinctive borders between these outcomes and one outcome may influence another. Measures that lead to these outcomes can also be diverse and inter-related with each other. Examples of such measures include: upstream changes, such as design change of new products, communication with suppliers and the shift from selling products to selling functions. It can also take the form of the development of infrastructure and technologies downstream, for instance, separate collection and recovery and the development of dismantling/separation/recycling technologies. Another example is the development of a feedback mechanism between the upstream and the downstream. Figure 1-1 illustrates a conceptual pathway through which the

---

[13] Further information on the potentials and implementation of product service system can be found in, for example, Mont, Oksana. (2000). *Product Service Systems*. AFR-report 288. Stockholm: Swedish Environmental Protection Agency. Stockholm.

introduction of an EPR programme implemented to date may achieve its intended goal.

The aim of the environmental improvement mentioned above is the core reason why manufacturers of the final product (original equipment manufacturers: OEMs) are selected as the primary actor to be responsible. Among the actors in the product chain, it is the manufacturers who are regarded to have the highest capacity to prevent problems at source by changing the design of their products/product systems. In almost all the existing EPR programmes importers are assigned the same responsibility as domestic manufacturers in order to cover both domestically produced products and imported products. For the remainder of the thesis, the term "producers" will include both domestic manufacturers and importers.

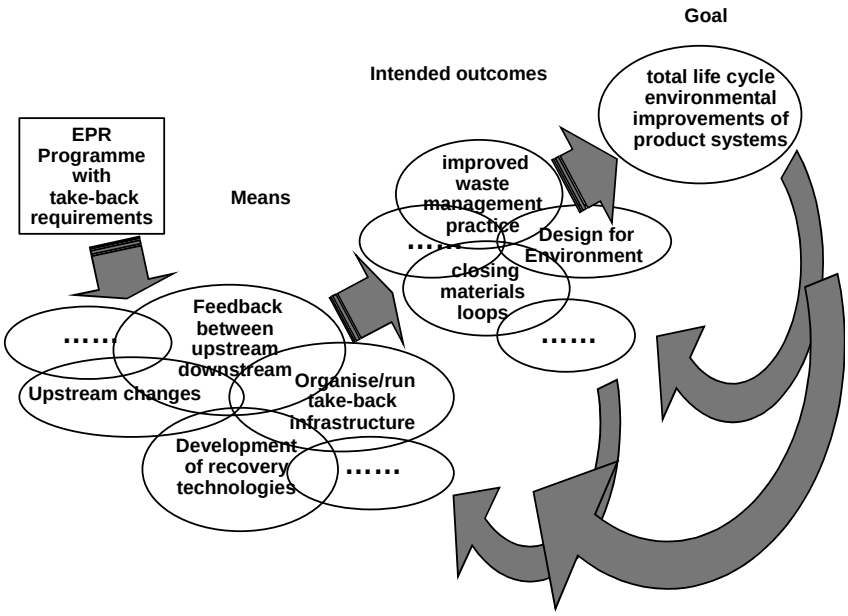

Figure 1-1: EPR programmes implemented to date and pathways to achieve its intended goal

1.2.3 Type of responsibilities

The extension of the responsibilities to the manufacturers varies between EPR programmes, both in terms of *types* of responsibility, as well as *activities* to be fulfilled within EPR-based policy instruments.

Lindhqvist (1992) categorised the types of responsibilities as liability, economic (financial) responsibility, physical responsibility, informative responsibility and ownership, as found in Figure 1-2. The respective types of responsibility are described as follows (Lindhqvist, 1998).[14]

> ***"Liability*** *refers to a responsibility for proven environmental damages caused by the product in question. The extent of the liability is determined by legislation and may embrace different parts of the life-cycle of the product, including usage and final disposal.*
>
> ***Economic responsibility*** *means that the producer will cover all or part of the costs for e.g. the collection, recycling or final disposal of the products he is manufacturing. These costs could be paid for directly by the producer or by a special fee.*
>
> ***Physical responsibility*** *is used to characterise the systems where the manufacturer is involved in the actual physical management of the products or of the effects of the products.*

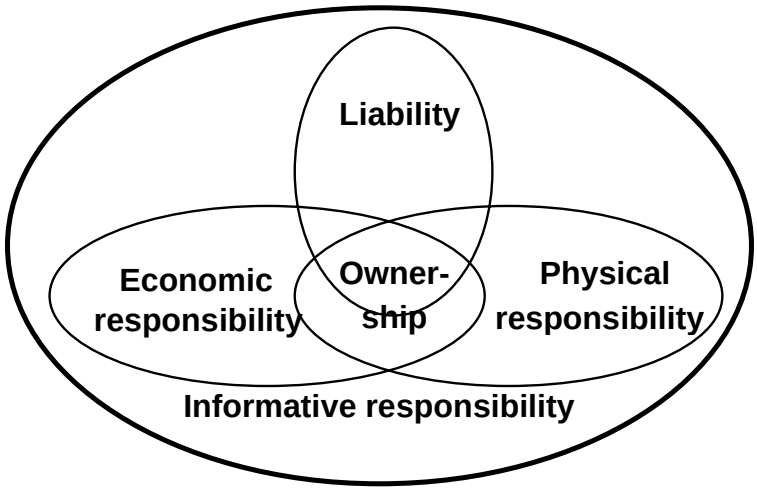

Figure 1-2: Model for Extended Producer Responsibility (Lindhqvist, 1992)

[14] For other typologies, see, for example, Lifset (1992, p.34), Davis (1999, p.103) and OECD (2001, p.53-54). In this thesis, the term "financial responsibility" is used instead of economic responsibility.

> *The manufacturer may also retain the* ***ownership*** *of his products throughout their life cycle, and consequently also be linked to the environmental problems of the product.*
>
> ***Informative responsibility*** *signifies several different possibilities to extend responsibility for the products by requiring the producers to supply information on the environmental properties of the products he is manufacturing".*

Producers may retain their *ownership* in a product service system (see Footnote 13). As suggested in Lifset (1992, p.35), the concept can also take the form of *liability*, such as hazardous waste collection and disposal liabilities and hazardous waste remediation liabilities. The concrete application of the remaining types of responsibility – *physical, financial* and *informative* – is discussed further in the remainder of the thesis.

The types of activities that producers need to undertake in order to fulfil their responsibility differ from one programme to another. This is discussed further in the remainder of the thesis, particularly in Chapter 5.

1.2.4 Multiple policy instruments

The EPR principle can be implemented through administrative instruments, economic instruments and informative instruments (Lindhqvist, 1992, p.2).[15] Examples of EPR-based policy instruments found in and/or discussed in relation to EPR programmes that extend responsibility of the producers to the end-of-life management of their products are summarised in Table 1-1. The examples provided are not exhaustive, especially considering the full potential of the application of the EPR principle that is yet to be explored (Section 1.2.1).

As discussed in Section 1.2.3, the responsibilities assigned to the producers in EPR programmes can be categorised into physical, financial and informative (Lindhqvist, 1992). Among the instruments listed above, producers may have physical and/or financial responsibility for carrying out the tasks described in the administrative instruments. Some of the economic instruments place financial responsibility upon producers at least initially, as found in advance disposal fee systems. Others may increase or reduce the financial burden of the producers when implementing administrative instruments, examples of which respectively include material taxes and

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[15] The typologies of policy instruments as well as on level of coerciveness in Section 1.2.5, is further discussed in 2.1.5.

subsidies. Informative responsibility corresponds with the tasks given in the informative instruments.

Table 1-1: Examples of EPR-based policy instruments

Administrative instruments	Collection and/or take-back of discarded products, substance and landfill restrictions,* achievement of collection, reuse (refill) and recycling targets, fulfilment of environmentally sound treatment standards, fulfilment of minimum recycled material content standards, product standard, utilisation mandates**
Economic instruments	Material/product taxes, subsidies, advance disposal fee systems, deposit-refund systems, upstream combined tax/subsidies, tradable recycling credits
Informative instruments	Reporting to authorities, marking/labelling of products and components, consultation with local governments about the collection network, information provision to consumers about producer responsibility/source separation, information provision to recyclers about the structure and substances used in products

* Some exclude substance and landfill bans from EPR-based policy instruments.
** Utilisation mandates refer to the situation where producers should achieve certain reuse and /or recycling targets, but do not have to use them within their own activities.
Source: adopted from Lifset (1992), OECD (2001), Stevens (2004), Walls (2004).

An EPR programme typically consists of more than one EPR-based policy instrument. For example, a manufacturer is given the task of taking back a discarded product that he/she has produced (*take-back requirement*). This requirement may be combined with an introduction of a *deposit-refund* system in order to give incentives to the consumers to bring back products to an appropriate collection point. A manufacturer may also be required to *label* material composition of components and to provide *information* to the recyclers regarding the content and structure of their products. These recyclers must meet certain *treatment standards*. Some of these policy instruments may be incorporated in the revision of existing legislation governing waste management or the establishment of supplemental legislation developed in addition to an EPR programme.

In virtually all the EPR programmes, the exact combination of these instruments varies, as evident from a number of studies.[16] However, the

[16] See, for example, Rydén (1995), OECD (1996), Davis (1997), Fishbein (1997), Vanthournout (1998), OECD (1998a), OECD (1998b), Tojo (2000), Lindhqvist (2000), Türk (2001), Tojo (2001a), Kim (2002), Langrová (2002), and Tojo (2003), Tojo et al. (2003) and Tojo & Hansson (2004).

widely considered EPR programmes to date include, at minimum, a take-back requirement of post-consumer products.

1.2.5 Level of coerciveness

With regard to the level of coerciveness, many of the existing EPR programmes have been based on legislative measures (*mandatory*). However, EPR can, and has been implemented through other mechanisms as well. These include *negotiated agreements* between government and industry (OECD, 1996, p.27-30), and *voluntary initiatives* by industries. For instance, many of the existing EPR programmes require producers to take-back discarded products, while the same has also been undertaken voluntarily by individual companies as part of their business strategies (see, for example, Kerr, 1999; Fishbein, 2000). Likewise, the introduction of deposit-refund systems are often mandated, but voluntary systems have existed as well.[17] Eco-labelling schemes are a manifestation of voluntary provision of environmental information.

In most of the existing EPR programmes, concrete ways of achieving the requirements set forth under the respective instruments are in principle left to the manufacturers. This allows the manufacturers to be innovative and to select the most efficient way of achieving the required results. It also takes the burden of prescribing requirements away from the legislative authorities who may not have the best knowledge of such ways (OECD, 1997, p.27).

1.2.6 Products covered by EPR programmes

Considering the understanding of the EPR principle and the broad range of EPR-based policy instruments discussed in Section 1.2.1 and 1.2.4, virtually all products may be the objects of an EPR-based policy instrument. The existing programmes that contain take-back requirements cover product

---

[17] A classical example includes beer and sake bottles in Japan. In a simple case, a hairdresser in Japan provided customers with points equivalent to 30 JPY (20 Euro cents) per empty container for shampoos, conditioners and other hair-treatment materials. The conversion was made with the exchange rate of 1 000 JPY = 6.95 Euro (Forex, 2003). The same exchange rate is used throughout this thesis. The points can be used immediately as part of the payment for haircuts and other services, or purchase of new products. Also, a brewery in Riga established a unilateral deposit-refund system for large beer bottles (Plavinskis, 2002, August 2).

groups such as packaging materials, batteries, end-of-life vehicles, solvents, paper, tyres and electrical and electronic equipment (EEE).

The characteristics of the products that have been covered by the EPR programmes include those contributing to high volume in the waste stream, those that are large or difficult to manage and/or contain substances that are potentially damaging to human health or the environment. Meanwhile, they can be categorised between non-durable products – for example packaging materials and primary batteries – versus durable products, such as EEE and cars. They can be also categorised between simple product, such as packaging materials and complex products, for instance EEE and cars (Tojo et al., 2003).

1.2.7 Individual vs. collective responsibility

Concerning the implementation mechanisms of take-back and other requirements related to the downstream operation, a notable distinction could be made with regard to the degree of co-operation among the producers in fulfilling their responsibility. This distinction is often referred to as individual versus collective responsibility. In essence, if a producer takes responsibility for the end-of-life management of their own products (*individual responsibility*) or producers in the same product group together fulfil their responsibility for the end-of-life management of their products regardless of the brand (*collective responsibility*). The significance of this issue was manifested, among other things, in the lengthy discussions during the development of the EU Directive on waste electrical and electronic equipment.[18]

However, there is diverse understanding of what is meant by collective and individual responsibility in reality. Some assume individual responsibility as the situation where individual producers establish their own collection and recycling infrastructure (Yamaguchi, 2002, December 12; Veerman, 2003, April 9). Others argue that the term only refers to individual financial responsibility, where producers bear the cost for the end-of-life management of their own products (Skotteheim, 2001, October 30; Ferrigno, 2003). Ferrigno (2003) further argues that individual financial responsibility does

[18] Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), officially published in February 2003. The content of the WEEE Directive is discussed further in Section 4.1.1.

not necessarily require the physical management of discarded products on individual basis. Fishbein (2001, December 14) considers that producers have individual responsibility when the fees producers pay for their products reflect the actual costs of end-of-life management.

The distinction touches upon a fundamental question surrounding EPR: in which manner should producers fulfil their responsibility in order to create incentives for design change? Industries, government and experts generally assume that an EPR programme based on individual responsibility would promote design change more than one based on collective responsibility.[19] If producers need to take care of discarded products similar to their own irrespective of brand, there are little or no incentives to spend extra resources enhancing their product design to reduce environmental impacts from end-of-life. If the responsibilities were distributed among the brands without considering the difference of the environmental properties of the products, producers who work harder to reduce environmental impacts from their products would end up subsidising the producers who did not make such efforts.

On the other hand, there is also an assumption that the implementation of a programme based on individual responsibility would face more administrative challenges than based on collective responsibility. For instance, Veerman (2003) suspects that individual implementation would result in duplicated infrastructure for end-of-life management and increased transport. Some recyclers fear that the establishment of recovery facilities by individual producers would threaten the job of existing recyclers (Lindhqvist, 2004, May 15). Complex, durable products, such as cars and EEE, have features that are assumed to make it difficult for the producers to pay in accordance with the environmental impacts their products exert at the end-of-life. The longevity of such products creates uncertainty regarding the actual duration of the product use, the development of future recycling technologies and of the markets of recycled materials and the like. The number of components and materials used within one product raises the level of uncertainty even more. Minute differences in the "greenness of the products" and a relatively small share of recovery costs within the cost of end-of-life management makes it dubious if such difference in price is significant enough to send signals to producers (Veerman, 2004). A system

[19] See, for example, ENDS (2001, May 11), ENDS (2002, February 15), Joint Press Statement (2002), Ferrigno (2003), Lindhqvist and Lifset (2003) and Electrolux (2004).

based on individual responsibility necessitates a supplemental system to handle the so-called orphaned products: products whose producers cease to operate in the market. It also requires consideration of the treatment of historical products, the products that were put on the market before an EPR programme. It is feared that the identification of free-riders is more difficult under individual systems than it is under collective systems. Finally, systems based on individual responsibility are assumed to make the transaction costs of various actors high and the system more expensive to operate (Bornand, 2002, March 28).

The perceptions of these administrative difficulties have raised scepticism in the feasibility of individual implementation in practice, despite the general acknowledgement on the superiority of individual responsibility in theory with regard to promoting design change (Veerman, 2002, December 11; Lindsay, 2002, December 11). The discussion of the issue is complicated by the lack of clarity in what an individual responsibility means in practice.

1.3 EPR and design change: why this research?

As discussed, among the actors involved in the different parts of a product's life cycle it is the producers who ultimately determine the properties of their products through design. They are in the position to make changes *at source*, thus preventing or reducing problems before they occur. Incorporation of environmental impacts at the design phase of the products also facilitates the reduction of the impacts from the *entire life cycle*. In this respect, the strength of the concept of EPR lies in its potential to induce design change by providing *incentives* to the producers.

However, the focus of most governments, as well as entities that run EPR programmes, has been on the efficient end-of-life management of the discarded products rather than the promotion of design change.

The relatively strong association of EPR programmes to waste management issues can be one explanation for the intense focus on the improvement of end-of-life management practices. In fact, the introduction of an EPR programme has often been considered by the government, at least in part, as a way of creating a new source of revenue for waste management without having to raise taxes. Walls (2004) pointed to the difficulties of pursuing design changes through EPR programmes from the economic efficiency point of view and stressed the difficulties of having multiple goals in one

policy. Her view is echoed by some actors running EPR programmes who argue that running an efficient take-back system alone is complicated enough (Bornand, 2002, March 28; Hediger, 2002, March 28).

Indeed, the implementation of an EPR programme *per se* has been perceived to be difficult. Prior to the introduction of mandatory EPR programmes, the involvement of producers in the end-of-life management of their products was limited. Implementation of an EPR programme requires a change of systems surrounding the end-of-life management programmes, and affects various actors in society. The interests of actors who have been involved in the existing end-of-life management often affects the formulation of an EPR programme, as well as the actual manner of implementation (Tojo & Hansson, 2004). Differences in the types of products covered by an EPR programme, in geographical, cultural and social context and in the number and size of manufacturers and importers are among the factors that make it practically impossible to have one solution that can be applied in all contexts.[20]

In addition to these difficulties is the challenge of measuring the environmental improvement occurring in the entire life cycle of product systems. As discussed in Section 1.2.2, EPR programmes implemented to date can in theory induce various changes, both upstream, such as design change of products, and downstream – development of infrastructure for sorted collection and recovery – and between (development of feedback mechanism between upstream and downstream). An EPR programme, at least in theory, aims to provide manufacturers with incentives to continuously improve the environmental performance of the entire product system. By leaving the means of achieving the goals to private actors, the concept encourages innovative solutions. Unanticipated changes are likely to occur with this approach, making it difficult to determine which changes should be considered. When unable to determine the boundary of changes to be examined, grasping the aggregated environmental effects of these

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[20] Experiences of these different programmes can be found in, Rydén (1995), Robinson (1996), Davis (1997), Fishbein (1997), Lindhqvist and Vanthournout (1998), OECD (1998a), OECD (1998b), Tojo (2000), Lindhqvist (2000), Türk (2001), Kim (2002), Langrová (2002), Tojo et al. (2003) and Tojo & Hansson (2004). OECD, in light of the rapid take up of the concept among many OECD Member states, has been organising a series of projects, looking at different aspects of EPR programmes since 1994. The findings of these workshops, which summarise the experiences of OECD Member States, are found in OECD (1996), OECD (1999), OECD (2001), OECD (2003a) and OECD (2004).

changes would be even more challenging. Setting a reasonable boundary as well as determining an appropriate way to weigh the identified environmental impacts, would be of paramount difficulty as experienced in various life cycle assessment (LCA) studies. The challenge increases when the programme has not been implemented long and is still in the transition period. In the transition period, various solutions would be tested to explore optimal solutions. Not everything would be carried out in the most environmental and cost effective manner. Efforts to move from one system to another may temporarily generate environmental impact. Even if measurements can be made, it would be misleading to judge the effectiveness of an EPR programme based on the absolute environmental impact during the transition period.

Likewise, measuring upstream changes is a formidable task. As mentioned, it would be difficult to anticipate all types of changes in advance, especially in the case of complex products. Environmental effects could be measured in part by utilising the requirements incorporated in many of the existing EPR programmes, such as collection, reuse and recycling targets, restriction of hazardous substances, and the like. For instance, theoretically the degree of reduction of hazardous substances could be found by whether and by how much manufacturers undertake such measures. However in practice, especially in the case of complex products, even manufacturers themselves have been struggling to grasp all the materials contained in their products, as discussed further in this thesis.

The achieved collection/reuse/recycling rate could capture only one part of the enhancement of resource efficiency, and attributing the achievement to upstream changes would be challenging. Separate collection from the rest of the waste stream has mostly to do with participation of consumers and improved logistics. In the long run however, the amount of products separately collected can be used as an indication of source reduction. Achievement of reuse/recycling targets would be a combination of both upstream – such as change of materials and design for disassembly – and downstream changes, for instance improvement of recycling technology. In the case of durable products, currently achieved reuse/recycling rates may have little, if anything, to do with the upstream changes presently taking place. The implementation period of the programme for complex, durable products, such as EEE and cars has been rather short.[21] It is difficult to find

[21] Some of the early EPR legislation for EEE in Western Europe and Asia came into force in the latter half of the 1990s. The same holds for cars, except for a deposit-refund like

the effect of upstream changes that have occurred after the introduction of legislation in the achieved reuse and recycling rate.

The difficulties of measuring upstream changes are reflected in the limitations of setting up targets concerning upstream changes that are measurable within EPR programmes. This makes it difficult to grasp and communicate upstream changes achieved by an EPR programme. It becomes even more difficult when the producers in a country are mainly importers. In this case, the changes are taking place outside the national border where an EPR programme takes place.

Furthermore, as discussed in Section 1.2.7, the individual implementation of an EPR programme, despite its perceived potential to provide incentives to producers, is considered to be difficult to organise. The understanding of collective and individual responsibility is diverse, and thus complicates the discussion on the positive and negative aspects of the respective implementation mechanisms.

Challenges facing the implementation of an EPR programme *per se*, together with the difficulties of grasping upstream changes induced by an EPR programme, may have discouraged government officials and implementing bodies to explore the possibilities for the enhancement of upstream changes. This is despite the fact that few would argue against the positive effect that an EPR programme could theoretically exert on design change.

These challenges, together with a relatively short implementation period, may explain the shortage of research on upstream changes. Apart from studies on EPR programmes for packaging,[22] very little research has been conducted to evaluate the influence an EPR programme has made on the design of products and product systems (upstream changes). This is especially true of EPR programmes for durable, complex products, such as electrical and electronic equipment (EEE) and vehicles. Likewise, a shortage

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system in Sweden, which started in 1975. An overview of the legislative development of EPR programmes for cars and EEE in OECD Member countries can be found in Tojo et al. (2003).

[22] Examples of such studies include case studies on German Packaging Ordinance and Dutch Packaging Covenant, as well as a study on Norwegian Packaging Covenant (OECD, 1998b) (OECD, 1998a) (Røine, 2001). Duales System Deutschland (DSD), the prominent organiser of the EPR programmes for packaging in Germany, also has accumulated data on the overall reduction of the consumption of packaging materials.

of research on the issue of individual versus collective responsibility was pointed out, for example, at the 2001 OECD Seminar on EPR.[23]

Reflecting upon the very rationale of an EPR programme, it is of paramount importance to examine whether an EPR programme can indeed provide the incentives to producers to undertake design changes that enhance the environmental performance of entire product systems. Furthermore, clarification of the meaning of individual and collective responsibility, and the examination of whether potentials for individual implementation exist is clearly required for the improvement of EPR programmes that facilitate upstream changes.

1.4 Purpose

The purpose of this thesis is *to facilitate the formulation of practically implementable EPR programmes that lead to the promotion of overall environmental improvement of product systems.*

The thesis seeks to fulfil this purpose by investigating 1) *whether* EPR programmes exert tangible influence on design change (*effectiveness* evaluation), and 2) *the manner* in which the producers should fulfil their responsibility in order to obtain incentives for upstream changes (*implementation* evaluation). Two studies have been conducted to address these two issues.

The first study investigates the effectiveness of the *presence* of *mandatory* EPR programmes for complex products in inducing upstream changes. It pursues the following questions:

What measures have been undertaken by manufacturers in order to reduce environmental impacts from the end-of-life phase of their products?

In light of other influencing factors, what role does the presence of EPR legislation play in providing incentives for environmentally conscious design in order to promote life cycle environmental improvements of complex products and product systems?

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[23] OECD Seminar on Extended Producer Responsibility, EPR: Programme Implementation and Assessment, Paris, 13-14 December 2001.

The second study examines the implementation mechanisms of existing EPR programmes for complex products, and compares individual versus collective responsibility. It works from a premise of the superiority of individual implementation in inducing upstream changes, based upon practical and academic views. The study addresses the following questions:

What are the responsibilities that are assigned to producers in existing EPR programmes, and how do producers fulfil them?

Do producers implement their responsibility individually and if so, in what manner?

What are the essential components of a viable implementation of individual responsibility?

1.5 Scope and limitations

Among various EPR programmes, this work primarily investigates *mandatory* programmes for *durable, complex products* (electrical and electronic equipment: EEE, cars, batteries) that at least contain a *take-back requirement* as one of the policy instruments. Take-back requirements are among the most well-used EPR-based policy instruments to date, and are often based on legislation. A mandatory programme means that it requires, in principle, all the companies within the same industry to fulfil the responsibilities assigned to them. Whether all the companies have to conduct certain tasks or if it is limited to those who wish to do so has large implications on the manner of implementation. Apart from the shortage of research in this area, incorporating incentive mechanisms for design change in an EPR programme for durable, complex products is assumed to be more challenging than for non-durable, simple products (Tojo et al., 2001). The longevity and complexity of the products present new challenges especially in the implementation of take-back requirements, which are not experienced in the case of, for example, packaging.

Among the EPR programmes that belong to the categories mentioned above, programmes were selected as cases for two separate studies. The details of the selection of these studies are described further in Chapter 3.

Among the various environmental improvements of product systems an EPR programme may address, the thesis focuses on the measures related to the design phase of new products (*upstream changes*). The superiority of prevention at source over end-of-pipe solutions and the assumption that

upstream changes can bring forward a shift towards sustainable production and consumption, as well as shortage of research, endorses this focus.

As a consequence of the difficulties in measuring the changes in a quantitative manner, an alternative way of examining upstream changes is required. The author tries to identify actual upstream changes currently undertaken by the *manufacturers*. Design improvements that incorporate consideration of the environmental impacts generated at the end-of-life phase of the product (*design for end-of-life*), as well as the changes in product systems, both of which are deemed to lead to overall environmental improvement of product systems, are examined. Examples of design for end-of-life include dematerialisation, selection of materials that are non, or less toxic and/or easy to recycle, changes to the structure of products that ease disassembly and thereby enhance upgrading, component reuse, material recycling and the like. Measures that are taken in relation to these design changes, such as communication with suppliers, are also considered. Changes in product systems in this context principally refer to the development of infrastructure that enhances the closing of material loops, thereby making the design change meaningful. The latter includes measures such as establishment of separate collection and recovery systems for the products under the programme, of feedback mechanisms between upstream and downstream and the like. The examples of the changes given above are by no means exhaustive. In this work, having these examples as plausible changes in mind, the author seeks to capture what is happening around the two areas as much as possible. The approaches used in this process are discussed further in Chapter 2 and 3.

The potential for EPR programmes to provide incentives for upstream changes can be explored from various angles. This thesis will examine the following two issues: the impacts of the *presence* of EPR programmes and the manner of the *implementation* of take-back requirements, in relation to upstream changes.

It has been noted that the anticipation of government intervention may substantially influence the behaviour of the addressee of the intervention (Ashford, 1979, p.164; Vedung, 1997, p.20; Kemp, 2000, p.36). An in-depth case study of an EPR programme for EEE in Japan shows that in 1999, two years before the legislation came into force, manufacturers had already started to re-design their products to ease their end-of-life management (Tojo, 2000). Bearing in mind the presence of these initiatives, the author

further investigates whether and how design for end-of-life is incorporated in the product development process in the *presence* of EPR programmes.

Some argue that design for end-of-life may compete with design requirements for other environmental improvements. The logic is that promotion of design for end-of-life may not necessarily lead to the total life cycle environmental improvement of product systems.[24] An assertion often made with input from life cycle assessments is that environmental impacts from the end-of-life management phase of complex, durable products, such as EEE and cars, is relatively low in comparison to the impacts of other phases, particularly the use phase.[25]

However, while recognising these arguments, the conventional valuing process of life cycle assessment studies tends to focus on energy use and CO_2 emissions and pay less attention to other types of impacts, such as toxicity of materials. Considering that significant impacts found in the end-of-life management phase of these durable, complex products relates to the type of materials used, it is feared that these studies underestimate such impacts. Moreover, promotion of design for end-of-life does not necessarily mean that it discourages the other aspects of design for environment. Rather, the concept of EPR is intended to give incentives to producers to integrate factors such as environmental impacts from end-of-life management in the design requirements. Examination of whether, and in what manner, manufacturers of products consider environmental impacts of various phases of the life cycle of their products at the design phase, constitutes one part of the effectiveness evaluation.

Another important aspect of the effectiveness evaluation is whether the intended changes take place due to the intervention. Once the occurrence of upstream changes are confirmed and identified, this work examines whether one could *attribute* these initiatives to the *presence* of EPR programmes.

As discussed in Section 1.2.3 and 1.2.4, the manner in which the concept of EPR is incorporated in an environmental policy, as well as the form of its

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[24] See, for example, Ryan (1998). An example is plastics in cars, which meet the requirement of light-weighting, thus reducing energy use from the use phase of the car. On the other hand, plastics have been a primary source of problem for end-of-life management as a major component of auto shredder residue, which poses threat to landfills both in terms of quality and quantity.

[25] See, for example, Toyota (1998, p.19) and NEC (1999, p.14).

implementation, differs from product to product and from country to country. The varied formulation of EPR programmes as well as the room of choice an EPR programme typically given to producers in achieving the requirements leads to various implementation mechanisms. As noted before, an important implication to design change is assumed to be whether the producers *implement* the take-back requirements *individually* or *collectively*. Systematic exploration of the *implementation* of existing EPR programmes especially from the angle of individual or collective responsibility, constitutes an important part of the thesis. Typologies for responsibilities and policy instruments presented in Section 1.2.3 and 1.2.4 are utilised to clarify exactly what requirements are mandated to producers in the respective programmes. This is discussed further in Chapter 3.

1.6 Terminology used in this thesis

For the remainder of this thesis, the term *EPR programme* indicates a programme based on the EPR principle and includes at least take-back requirements, implemented with different degrees of coerciveness.

Producers include domestic manufacturers of the final products, as well as professional importers of these products.

Upstream changes in this thesis mean design changes in new products to reduce environmental impacts from end-of-life management and measures that facilitate such design changes.

Design for end-of-life means design changes that primarily aim to reduce environmental impacts from the end-of-life phase of a product's life cycle.

Recovery includes any activities that facilitate the closure of material loops, including reuse of components, disassembly of products, material and chemical recycling and energy recovery.

1.7 Outline of the thesis

Chapter 2 establishes the analytical framework of this thesis. It first introduces some of the basic elements of research on the evaluation of government intervention, including evaluation criteria, the use of the intervention theory and the like. The next section applies what was discussed in the first Chapter, namely the concept and components of an

EPR programme to the respective elements of the analytical framework discussed in the first section. The application leads to the establishment of an evaluation framework for an EPR programme. The dimensions of the EPR programmes examined in this thesis – the effectiveness and implementation evaluation of EPR programmes for complex products, concentrating on immediate changes – are highlighted in the final section.

Chapter 3 describes the methodological approach of this thesis. It first discusses the general approach applied to all the research work used within this thesis, that is, qualitative, naturalistic evaluation based on multiple, instrumental case studies. The subsequent two sections describe the specific methods taken in two research projects, which are the primary "ingredients" for this thesis. In these two sections, the selection of cases, data collection methods and approaches used for analysis and interpretation are introduced. These two studies constitute the primary content of Chapters 4 and 5. The approaches taken for the rest of the research activities, which serves as supporting materials of the two research projects, are briefly described in the final section.

Chapter 4 presents an effectiveness evaluation of EPR programmes. With a view to examining whether the presence of EPR programmes lead to the promotion of total life cycle environmental improvement of product systems for complex products, it investigates the achievement of some of the intermediate steps toward this final goal. These intermediate steps are upstream changes, development of downstream infrastructure and the development of feedback mechanisms between the upstream and the downstream. Interviews with 21 manufacturers of EEE and cars in Japan and Sweden constitute the main part of the study.

As a background to the analysis, the content of six EPR programmes whose presence was most relevant to the manufacturers of EEE and cars in Japan and Sweden is briefly presented. The subsequent two sections present an analysis of the main findings from the cases. The second section starts with a brief introduction of the primary focus areas upon which the manufacturers interviewed have been putting their efforts related to environment. The remaining part of the second section summarises the actual upstream measures taken by the manufacturers in order to reduce environmental impacts from downstream at source, as well as other measures mandated by and/or envisioned in the implementation of EPR programmes to date. The third section presents the analysis of factors that either promote or hinder the undertaking of such measures.

Utilising the findings presented in the second and third section the fourth section first evaluates whether the three immediate outcomes envisioned in an EPR programme indeed occur. It subsequently discusses the roles of the EPR programmes in inducing such outcomes. The chapter ends with a short summary of the essential findings.

Chapter 5 presents the second evaluation, namely the implementation of requirements related to the downstream operation of EPR programmes. It first examines the implementation practice of five cases – EPR programmes for EEE and batteries – from the viewpoint of individual and collective responsibility. The study breaks down the downstream operation of EPR programmes into seven elements. These elements are physical management, financial mechanism and the informative management of collection and recovery activities and the monitoring and enforcement of these activities. Actors in charge of these activities, as well as the manner in which they perform these activities, are described. Based on the investigation, a comparative analysis of the five programmes is presented in the second section. The third section seeks to systematise the understanding of individual responsibility. It suggests the practical manners in which EPR programmes can be implemented individually. The essential findings of the chapter are presented in the end.

The final chapter starts with a summary of the contribution of this thesis. It subsequently reflects upon the findings of the studies in light of the overall understanding of the concept of EPR. Some recommendations for policy makers in formulating and implementing EPR programmes are made. The thesis closes with suggestions for future research.

CHAPTER

TWO

2. Analytical framework

This chapter establishes an analytical framework for investigating the research questions set forth in Section 1.4. It introduces some of the basic components of the research on the evaluation of government intervention, and subsequently makes further reference to environmental intervention (Section 2.1). The combination of these elements establishes the foundation of an analytical framework for this thesis. Section 2.2 applies the prototype of an EPR programme to the respective building blocks of the foundation. The combination of these applications establishes an analytical framework for this thesis. The dimensions of the EPR programmes examined in this thesis are highlighted in the final section (Section 2.3).

2.1 Evaluation of environmental intervention

Exploring whether, to what extent and how a public intervention[26] meets its objectives has been one of the topics widely addressed in the field of evaluation research (Rutman, 1977, p.16; Vedung, 1997, p.37; Bemelmans-Videc, 1998, p.1; Weiss, 1998, p.5; Rossi, Freeman, Lipsey, 1999, p.5). It therefore seems useful to look at the conceptual basis of whether and how an EPR programme (a type of public intervention) and its implementation achieve upstream changes (intended outcome) within the knowledge accumulated in evaluation research.

This section starts with the brief presentation of some of the key concepts applied for evaluation of government intervention. These elements include the understanding of evaluation of public intervention, what is evaluated against which criteria, the use of intervention theory and the classification of

[26] Public intervention is "a generic term for government action or government measures" (Vedung, 1997). In this thesis, it is used as an umbrella term that includes public policies and public programmes as well as elements of these policies and programmes (policy instruments and tools). The terms government intervention and intervention are used interchangeably.

policy instruments (Section 2.1.1. - 2.1.5). The section does not intend to provide a comprehensive overview of evaluation research. Rather, it extracts ideas from this rich field of knowledge that the author wishes to borrow to form the foundation of the analytical framework of this thesis.

The substantive areas subject to public intervention are diverse. These include welfare, public health, education, criminal justice, environment, transportation, trade and foreign affairs, to name but a few (Vedung, 1997; Solomon, 1998; Weiss, 1999). The contexts in which the respective policies are applied also vary, with examples being geographic coverage (local, regional, national, international), socio-economic features of the areas, relation between the public and private sectors and the like. These differences necessitate the selection and adaptation of evaluation research designs and methodologies that suit the nature of the evaluand (Patton, 1987; Weiss, 1998).

The last two sections discuss the development of environmental policy evaluation in light of mainstream evaluation research. Special features of environmental interventions and some additional evaluation criteria are discussed, focusing on such policy's role in driving continuous efforts towards reduction of environmental impacts.

2.1.1 Evaluation of public intervention

In essence, "evaluation is the process of determining the merit, worth and value of things" (Scriven, 1991, p.1, cited in Vedung, 1998, p.2). Indeed, "evaluation is an elastic word that stretches to cover judgements of many kinds" (Weiss, 1998, p.3).

Evaluation of public interventions can be dated back to the 17th century, although the development of systematic evaluation research is relatively recent. Systematic evaluation of public intervention started in the beginning of the 20th century mainly in the field of education and public health, which represents the origin of contemporary evaluation research of government intervention (Weiss, 1998, p.10-15; Rossi et al., 1999, p.9-20).

One feature of the evaluation of public intervention widely accepted among the researchers in the field is that it is an applied social science, employing a repertoire of social science research methods and methodologies (Weiss, 1998, p.5; Clarke & Dawson, 1999, p.2-3; Rossi et al., 1999, p.20-22). Another characteristic is the intention of evaluation research. The primary

purpose of evaluation research is not to discover new knowledge as most basic science does, but to facilitate decision-making regarding the future of an evaluand (Patton, 1986, p.14; Clarke & Dawson, 1999, p.2). The type of decision-making can be roughly divided into two classes: continuation or termination of the evaluand, or improvement of the evaluand. Scriven (1967) termed evaluation which primary aims to facilitate the decision-making of the former *summative* evaluation, while that of the latter, *formative* evaluation (cited in Clarke & Dawson, 1999, p.7).

Despite these commonalities, understanding of the evaluation of public intervention varies. This reflects varying values as to what is important and the various debates in this field in the development process (Patton, 1986, p.67-68, p.345-347; Alkin, 1990; Vedung, 1997; Clarke & Dawson, 1999, p.1-63).

One of the major areas of disagreement among social science researchers is on the two divergent paradigms, so-called *quantitative* and *qualitative* approaches (Patton, 1987, p.20-22; Weiss, 1998; p.82-87; Clarke & Dawson, 1999, p.35-63). Their implication to the understanding of the nature of reality (ontology) and the nature and limit of knowing something (epistemology) aroused fierce debates on which methodological approaches should be employed in evaluation. Summative evaluation, which primarily aims at determining the essential effectiveness of the evaluand, typically seeks to draw causal inferences between the intervention and the outcome. This type of evaluation tends to take a quantitative approach, trying to measure "relative attainment of predetermined clear, specific and measurable goals" (Patton, 1987, p.15). On the other hand, the formative approach whose focus is on the improvement of the evaluand has a stronger emphasis on qualitative methods (Patton 1987, p.18; Clarke & Dawson, 1999, p.18). The implication of this debate will be discussed further in Section 2.1.4 and in Chapter 3.

As discussed, one of the distinctive features of evaluation is its purpose: utilisation of its findings in order to improve the evaluand or to decide whether the implementation of the evaluand (intervention) should be continued. Despite this very intention, one of the main challenges facing evaluation has been that the findings of evaluations were not well utilised when deciding the fate of intervention. Criticisms and frustrations felt by both providers and users of evaluations furthered the discussion on how an evaluation can be better utilised (Patton, 1986, p.10-14; Alkin, 1990, p.19-

78). The emphasis on utilisation is reflected in, among other things, the following definition provided by Patton (1986, p.14).

> *Program evaluation is the systematic collection of information about the activities, characteristics, and outcomes of programs for use by specific people to reduce uncertainties, improve effectiveness, and make decision with regard to what those programs are doing and affecting.*

The necessity of making the evaluation useful for its potential areas of application, along with the varying nature of the intervention and situations surrounding the conduct of evaluation, are among the factors that make the methodological choice of the evaluation rather flexible.

Meanwhile, it has been recognised that the use of evaluation is not, and does not have to be, limited to immediate use (decision-making concerning the future of the evaluand). Patton (1986), when discussing the afore-mentioned definition, distinguishes between evaluation and evaluation research. Acknowledging that the utility, generalisability, scientific rigour and relevance of the findings to specific information users vary, he puts "relatively greater emphasis on generalisability, causality and credibility within the research community" when referring to evaluation research (Patton, 1986, p.15). In contrast with the findings that are used directly for the future decision or action surrounding the evaluand (instrumental use), the findings of evaluation research are used conceptually thus generating knowledge (Patton, 1996, p.132). In the case of evaluation research, no decision or action is expected to happen regarding the evaluand (Patton, 1996, p.132). The findings are instead used for enlightenment purpose, contributing to the knowledge building in general (Weiss, 1990, p.177; Patton, 1996, p.132; Chen, 1996, p.124).

Another distinction can be made concerning the inclusion of ex-ante assessment in the evaluation. Vedung (1997, p.3) defines evaluation as

> *…careful retrospective assessment of the merit, worth and value of administration, output and outcome of government interventions, which is intended to play a role in future, practical action situation.*

He argues that the inclusion of ex-ante assessment is against the historical development of evaluation research, where demand was made on the assessment based on empirical data on the results of intervention, as opposed to the analysis of planned intervention (Vedung, 1997, p.7). This is in contrast with the approaches of economists, and the understanding of

prominent North American evaluators. For example, Rossi et al. (1999, p.2) suggests that a comprehensive evaluation "covers the need for the program, its design, implementation, impact and efficiency".

2.1.2 Dimensions to be evaluated

When conducting an evaluation of public intervention, some political scientists view public administration as a system that consists of input, conversion and output (Vedung and Román, 2000, p.10). *Input* in this context means the various forms of resources (monetary, physical, human) and motivations behind the intervention, for instance needs and goals of intervention, that enter into the *conversion,* under which an appropriate intervention (*output*) is developed. The *Conversion* process involves various people who contribute to the development of the intervention. What happens when the output reaches the addressees of the output (intervention) is expressed as *outcomes*. The outcomes include not only the immediate actions taken by the addressees, but virtually all the consequences that resulted from the output (intervention). The stage encompassing output and outcome is where the intervention is *implemented.*

The schematic map of this process is summarised in Figure 2-1.

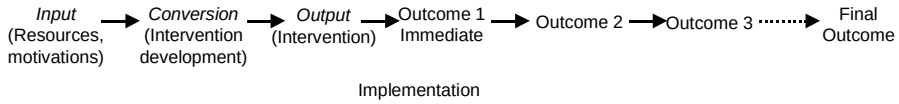

Figure 2-1: The system model adapted to government intervention evaluation (adapted from Vedung, 1997, p.5)

In addition to the intended *outcomes*, the traditional area of focus in evaluation research, *implementation process* (also referred to as process, operation, and the like) has been another dimension of the intervention typically discussed in evaluation literature (Chen, 1996; Vedung, 1997, p.209-245; Weiss, 1998, p.4-5). Some literature also included input as well as the intervention itself as the object of evaluation (Rossi et al., 1999, p.23; Hildén et al., 2000, p.16-19).

2.1.3 Evaluation criteria

Evaluation necessitates some measures against which the value, merit and worth of an evaluand can be determined. Criteria commonly found include effectiveness and efficiency (Chambers et al., cited in Clarke & Dawson, 1999, p.14; Vedung, 1997, p.37-91, p.247-260; Weiss, 1998, p.3-4; Rossi et al., 1999, p.22). Bemelman-Videc (1998, p.7-8) suggests effectiveness, efficiency, legality and democracy as "dominant" evaluation criteria for public policies.

The effectiveness and efficiency criteria are measurement of outcomes and are "substantive", while legality and democracy criteria assess the manner in which the intervention is formulated and implemented and are thus "procedural" (Vedung, 1997, p.35). Another criterion which affects/is affected by the degree to which an intervention meets these four criteria is legitimacy (Bemelmans-Videc, 1998, p.4). The equality and equity criteria may concern outcomes and/or process of interventions, depending on "equality in what" is under consideration (Sen, 1992; Hirai, 1995). The relevancy criterion addresses the linkage between the needs in society and the goals of the intervention.

The *effectiveness* criterion was traditionally the most dominant criteria in evaluation practice (Vedung, 1997, p.37-83). It concerns whether and by how much the goals of the intervention have been attained. This can be considered from two viewpoints: 1) whether the outcomes are in accord with the goals (*goal-achievement* measurement), and 2) whether the outcomes are produced by the intervention (*attributability* assessment) (Vedung, 1997: 37-39).

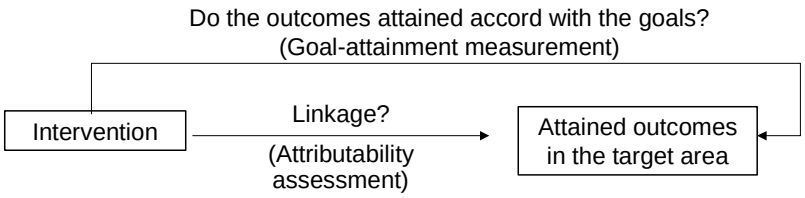

Figure 2-2: Effectiveness evaluation (adapted from Vedung, 1997)

The challenges facing these two types of effectiveness evaluations include: 1) capturing of outcomes that do not occur in the target area, 2) the nature of

outcomes and 3) the competing factors influencing the outcomes in the target area.

The outcomes of an intervention are not limited to those that occur within the areas addressed in the intervention (Vedung, 1997, p.49-59). Some of these outcomes, both positive and negative, may be anticipated, while others may not (Vedung, 1997, p.49-59). An intervention may also produce unanticipated positive and negative effects within the target areas (Rutman, 1977, p.21; Vedung, 1997, p.49-59; Weiss 1998, p.57, p.126-127). Outcomes that occur outside of the target areas – which are referred to as "side effects" by Vedung (1997, p.49) – cannot be captured when the evaluation concerns only the goals of the programme. Even when the outcomes occur in the targeted area, these may not be tangible and/or diverse and may take a long time to occur (Fitz-Gibbon & Morris, 1996, p.179). Recognition of these various effects together with the difficulties of identifying the programme goals were among the factors that have promoted the qualitative approach in the evaluation research (Patton, 1986).[27]

> *"We knew that human behaviour was rarely if ever directly influenced or explained by an isolated variable" (Deutscher, 1970: 33, quoted in Patton, 1987: 18).*

Apart from a public intervention, a number of other factors exert causal impact upon the behaviour or conditions that the public intervention seeks to modify (Vedung: 1997, p.182-183) (See Figure 2-3).

Gysen, Bachus and Bruyninckx (2002) suggest four types of causal connections between the causes and effects: 1) necessary and sufficient causes, 2) necessary but not sufficient causes, 3) sufficient but not necessary causes and 4) contributory causes. In the case of contributory causes, "X is neither a necessary nor sufficient cause of Y, but changes the likelihood that Y occurs" (Gysen et al., 2002, p.9). Establishment of the attributality becomes most difficult in the case of contributory causes.

The effectiveness evaluation mentioned above concentrates on the outcomes and linkage of the outcomes and the intervention, regardless of costs (Vedung, 1997, p.83). On the other hand, *efficiency* criterion considers the outcome in relation to the resources that were used. Two widely used

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[27] Further discussion of various types of models for evaluating effectiveness, including the methods of identifying the goals of the intervention, can be found in, for example, Vedung (1997, p.35-82) and Rossi et al. (1999, p.94-98).

ways of measuring efficiency include *cost-effectiveness* analysis, where the outcomes of an intervention expressed in substantive terms are compared against the costs, or *cost-benefit* analysis, where the outcome translated into monetary terms are compared to the costs (Rossi et al., 1999, p.366; Vedung, 1997, p.86-87)

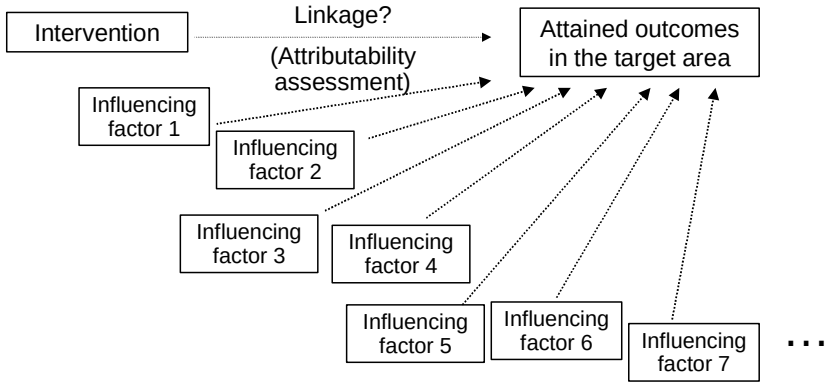

Figure 2-3: Competing factors that may impact the outcome the intervention intended to achieve

Among the procedural criteria, *legality* refers to "the degree of correspondence of administrative action in designing and implementing" interventions "with the relevant formal rules as well as with the principles of proper (administrative) process" (Bemelmans-Videc, 1998). The relevant formal rules can fall in categories ranging from constitution and international agreements which the nation signs and/or ratifies, to various substantive and procedural laws that govern the content and process of law making and its application. The principles of proper administrative process include *equity* (fairness) and *equality* in application, justness in the motivation of administrative decision and the like (Hirai, 1995; Bemelmans-Videc, 1998, p.7).

The *Democracy* criterion concerns "the degree to which the administrative actions in designing and implementing" interventions "correspond with accepted norms as to government-citizen relationships in a democratic political order" (Bemelmans-Videc, 1998, p.8). Also referred to as *representativeness,* for instance in Vedung (1997), this criterion concerns issues

such as public participation, consultation and information provision as well as the effective power the elected officials possesses in the decision making process (Bemelmans-Videc, 1998, p.8).

Legitimacy or political acceptability concerns the degree of actual support given to a government intervention by the citizens and their organisations. All of the four criteria mentioned above affect the level of legitimacy (Bemelmans-Videc, 1998, p.8). In turn, the attained level of legitimacy influences the actual enforcement of an intervention (Barde, 1995, p.206) and its effective implementation in reality (van der Doelen, 1998; Bemelmans-Videc, 1998, p.8).

The meaning of *equality* varies, depending on equality in terms of what is under question. For instance, one considers equality to be an allocation of goods that takes into consideration the distribution of goods among the respective parties prior to the intervention (subjective equality). The aimed outcome in this case may be that the distribution of goods after the intervention is the same for everyone. Another may consider equality to be the situation when everyone receives the same opportunity (opportunity equality). Others may regard allocation of goods in proportion to the efforts made in advance to gain the goods as equal (relative equality).[28] Attaining equality on one issue, for instance, opportunity equality, may not necessarily lead to the equality in others, such as subjective equality (Sen, 1992). In some context, the terms *equity* or *fairness* are used to indicate the same as some categories of equality mentioned above.

Finally, *relevancy* criterion examines whether the goals of an intervention actually address the needs in society that are intended to be tackled by the intervention (Hildén et al., 2000, p.18). It can also examine whether the goals of an intervention is reflected in the output (intervention itself).

Figure 2-4 summarises the respective dimensions of public interventions to be evaluated and the criteria used for these evaluations, framed in the input-output model.

It should be noted that the literature on formative evaluation, where the main focus is the improvement of an intervention by understanding the

[28] Further analysis of various categories of equality as well as their implication to policy making can be found in Sen (1992), Hirai (1995).

whole phenomenon surrounding the intervention, tends not to suggest a set of established criteria. This may be a reflection of the formative evaluation research approach where the researcher is encouraged to look at the phenomena without pre-fixed ideas as to what decisive variables affect the implementation and what the outcome of an implementation may be.

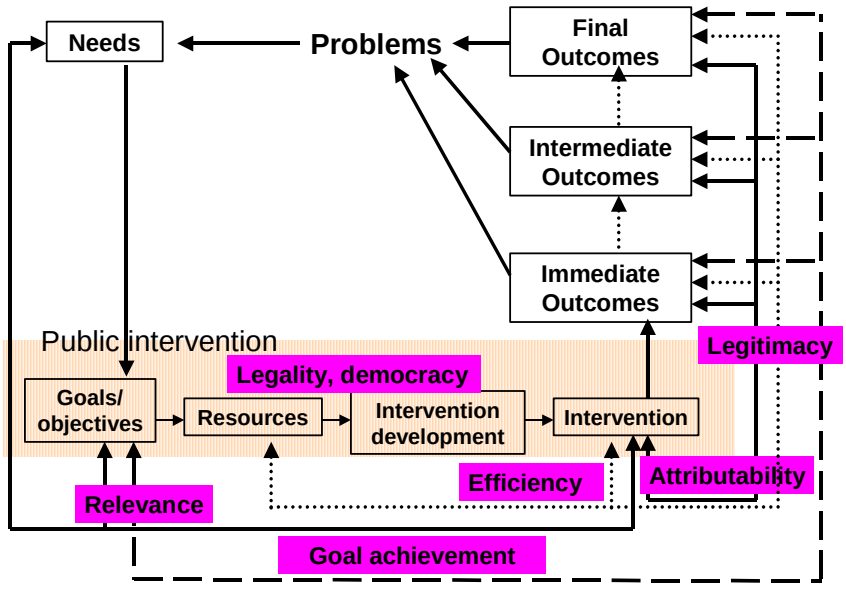

Figure 2-4: A model for evaluation of public intervention (adapted from Hildén et al., 2002 and Kautto & Similä, 2002)

2.1.4 Intervention theory

The importance of the role of theory in evaluation has been stressed by a number of evaluators (Chen, 1990; Weiss, 1997, p.1; Clarke & Dawson, 1999, p.30-34). The term theory in this context has a broader meaning than what is usually used in social science. It is "presumptuous in its appropriation of the word" (Weiss, 1997, p.2) or "grandiose" (Rossi et al., 1999, p.98)" if the term is considered "to mean a set of highly general, logically interrelated propositions that claim to explain the phenomena of interest" (Weiss, 1997, p. 2). Rather, it is a conceptual model or a blueprint specific to the evaluand, consisting of a set of beliefs and assumptions as to

how the intervention is expected to work (Weiss, 1997, p.2; Rossi et al., 1999, p.98).

Intervention theory refers to "all empirical and normative suppositions that public interventions rest upon" (Vedung, 1997, p.301).[29] The suppositions concern both the goals of the intervention and the process of achieving the goal (Chen, 1990, p.43; Vedung, 1997, p.138). Regarding the latter, it is a chain of assumptions through which an intervention, step by step, is supposed to achieve what was originally designed to achieve. It is "a model, theory, or philosophy about how the program works; a model, theory, or philosophy which indicates the causal relationships supposedly operating in the program" (Fitz-Gibbon & Morris, 1996, p.178).

Reconstruction of an intervention theory means to put together, in sequence, events and changes that should occur in order for the intended outcomes to take place (Vedung 1997, p.138-144; Weiss, 1998, p.55-70, Rossi et al., 1999, p.99-116). The exercise of constructing the intervention helps to make the implicit assumptions underlying the intervention explicit, and provides an opportunity to scrutinise the validity of such assumptions (Weiss, 1996, p.174). If an intervention is based on a theory, model or philosophy, the intervention theory could be reconstructed to conform to the theory, model or philosophy (Fitz-Gibbon & Morris, 1996, p.179; Weiss, 1997, p.5; Chen, 1997, p.2). Other sources of information that could be used for the reconstruction of an intervention theory include documents on the intervention, the intuitions and experiences of the designers of the intervention, prior research, logical reasoning and the like (Weiss, 1997, p.5; Chen, 1997, p.2).

The constructed theory can serve as a conceptual model against which the actual intervention is compared. It assists in identifying the events and changes that are deemed essential for the attainment of the intended outcomes (Vedung, 1997, p.144; Rossi et al., 1999, p.98). These events and changes serve as candidates of questions and variables to be examined in the evaluation (Fitz-Gibbon & Morris, 1996, p.181; Vedung, 1997, p.138-146).

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[29] Evaluation researchers have used various terminologies to express more or less the same as intervention theory, such as programme theory (e.g. Weiss, 1998; Rossi et al., 1999), program theory of action (Patton, 1986), policy theory (Hoogerwerf, 1990, quoted in Vedung, 1997) and the like. In this thesis the term intervention theory is used due to its capacity of capturing government intervention of all levels such as policy, programme, policy instruments and tools.

Examination of the occurrence of these events and changes is a practical way of assessing whether the intervention is taking/took place in the manner that was originally envisioned. It facilitates the systematic comparison of several interventions based on the same concept and contributes to the advancement of knowledge (Fitz-Gibbon & Morris, 1996). Using the pathways suggested by the theories and investigating whether the outcome take place in a manner envisioned by the designer of the intervention also helps replication of the intervention in other contexts. In contrast to looking solely at the intervention and the outcomes, examination of the pathways elucidates how the outcomes either take place or fail to take place. The pathways that link the intervention and the intended outcomes are often not limited and thus multiple intervention theories can be considered (Vedung, 1997, p.139; Weiss, 1998, p.55-70; Rossi et al., 1999, p.98-117).

Fitz-Gibbon and Morris (1996) further suggest that use of intervention theory may be particularly appropriate when 1) the intervention is based on a particular theory, model or philosophy and 2) the intended outcomes may occur over a long time frame and are not measurable with a degree of precision. Weiss (1997, p.14) indicates that theory-based evaluation "has the advantage of producing interim markers of progress that are logically tied to ultimate outcomes." Kautto and Similä (2002) demonstrated the potential of using intervention theory in the retrospective evaluation of recently introduced interventions, whose outcomes had not occurred when the evaluation was performed. They evaluated the occurrence and content of outputs, which were considered to be the preconditions to the achievement of the outcomes according to the intervention theory of the evaluand.

2.1.5 Programme and policy instruments

The author has been using the term "public intervention" in order to capture all types of government actions and measures. Among these, public programmes, including EPR programmes, are made up of a number of public policy instruments. On top of the contextual differences, the composition of programmes often varies, which further challenges systematic comparison and assessment. Decomposing a public programme into its components (policy instruments) can clarify the perceived function of the respective policy instruments and facilitate the comparison of public programmes.

The understanding of policy instruments varies. Hoogerwerf (1989), with his very broad understanding, defines instruments as "everything that is used by or through a government to attain the policy objectives" (quoted in Gysen et al., 2002, p.8). The European Environment Agency (EEA), which include instruments within input, also shares this broad understanding, suggesting that inputs are "the resources dedicated to the design and implementation of a measure" (EEA, 2001, p.19). On the other hand, Vedung (1998, p.98) defines it as "the sets of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change", specifying the purpose of using these instruments (Gysen et al., 2002, p.8). It concerns "output", that is, the intervention itself.

Vedung (1998) categorises these "output" policy instruments into regulations, economic instruments and information (Vedung, 1998, p.29-41). Likewise, Van der Doelen (1998, p.133) categorises policy instruments into judicial, economic and communicative groupings. Lindhqvist (2000, p.154), in discussing the instruments by which the EPR principle can be implemented, suggested administrative, economic and informative instruments. The rationale for the typologies presented below, though using different terms, are essentially the same.

Among the three, *administrative instruments* cover various measures that concern fulfilment of certain tasks, such as achievement of a certain recycling rate, elimination of the use of certain substances and prohibition of landfilling. When mandated via legislation, it makes the target entities seek to achieve certain tasks or refrain from doing certain things, in accordance with that which is demanded in the legislation (Vedung, 1998, p.31-32; van der Doelen, 1998, p.132). Unless exemption is granted, the target entities have no choice but to obey. The term "regulations" (Vedung, 1998), "judicial control model" (van der Doelen, 1998), "regulatory instruments" or "mandatory instruments" essentially refer to these mandatory administrative instruments. However, economic instruments – for instance tax and subsidies – and informative instruments, such as labelling requirement and provision of certain information, are often mandated by law. Thus, the author chose to use the term "administrative instruments."

Economic instruments generally provide monetary incentives – subsidies, refund and the like – when the addressees carry out tasks that the instrument wishes to promote, or disincentives such as tax, when the addressees do not fulfil the required actions (Vedung, 1998, p.32; van der Doelen, 1998, p.132). The crucial difference between administrative instruments and economic

instruments is that in the former, when mandated by government, the addressee has no choice but to fulfil the task, while in the latter, the addressee has the freedom of carrying out the tasks or not.

Informative instruments, or information, concern the collection and provision of information, and are used with the assumption that, people behave differently when they have better information and understanding. Also referred to as "moral suasion", it seeks to influence people "through the transfer of knowledge, the communication of reasoned argument, and persuasion" (Vedung, 1998, p.33).

From the perspective of level of coerciveness, policy instruments can be categorised between mandatory and voluntary. The addressee of the *mandatory* instruments is required to fulfil the tasks laid down in legislation, while the private actors can set up the goals themselves and strive to achieve them via *voluntary initiatives*. Between these two exists, for instance, *negotiated agreements*, where the government and private actors form a contract, in which the government typically agrees to refrain from enforcing legislation on condition that the private actors achieve a certain goal. Establishment of a negotiated agreement may also lead to the development of legislation.

Mandatory measures should be used when government wishes to achieve universal compliance (Vedung & van der Doelen, 1998, p.107). Indeed, one of the differences among mandatory requirements, negotiated agreements and voluntary initiatives is the degree of participation of companies within the particular industry in fulfilling specific tasks. Mandatory measures address all the companies that meet certain criteria – for example, the type of products they produce, the size and so forth – while in the case of voluntary initiatives, the selection for participation is in principle left in the hands of individual companies. Negotiated agreements lie in between, as non-participation of a company in an agreement often means fulfilment of tasks stipulated in legislation on its own. When more than a certain portion of companies within the same industry begins to take measures that initially require extra resources, free-rider problems occur.

Some instruments address several layers of actors (Vedung, 1998, p.35-37). For example, in a mandatory deposit-refund system for aluminium cans, the initial targets are the economic actors, for instance fillers and sellers, who need to set up a system to collect the deposit when selling a product and provide the refund when a consumer returns the can. Consumers, the second target, are provided with the incentive to bring back the empty can

to the appropriate collection points. In such cases, the classification concerning the level of coerciveness is made depending on the basis of the introduction of the instruments.

2.1.6 Evaluation of Environmental Intervention

Environmental problems have various characteristics that make the evaluation of government interventions particularly challenging. The problems have multiple and scattered sources. Both time-wise and geographically, there is often a large distance between the sources of the problem and when and where the impacts occurred (Mickwitz, 2003, p.416-418). They involve a number of actors, especially when solutions are sought at the source of the problems rather than at end-of-pipe (Weale, 1992, cited in Gysen et al., 2002, p.10). There are also uncertainties in the knowledge surrounding causes and impacts. Among various cause-effect relationships, environmental interventions are often one of the *contributory causes,* and establishing attributability to the outcome is most difficult (Gysen et al., 2002, p.9).

An environmental intervention often comprises of a number of policy instruments (OECD, 1997, p.96). The respective policy instruments may address different actors, or influence the same actors in different ways. The packaging of the instruments and the context to which the intervention is applied differ from one intervention to the other.

The aforementioned nature of the environmental problems and the characteristics of environmental interventions pose a challenge to the application of a standardised approach to conducting an evaluation of environmental intervention (Knaap & Kim, 1998; Gysen et al., 2002; Mickwitz, 2003). However, the interest and need for evaluating environmental interventions has been increasing, and though short in history and with fragmented concepts and approaches, it has been practiced by a number of disciplines (Knaap & Kim, 1998; Mickwitz, 2003, p.415).

It is interesting to note that most of the evaluations on environmental policy have not explicitly linked their works to the existing works on the evaluation of other social programmes (Knaap & Kim, 1998). For example, OECD (1997, p.24), as a background to their conduct of a project on evaluation of effectiveness and efficiency of economic instruments, states: "…there is little tradition in policy evaluation…. Ex post policy evaluation is less common in other policy fields, including environmental policy, although

some initiatives can be recorded". Knaap and Kim (1998) reflect upon the conditions surrounding environmental politics and point out the strong inclination to an ex-ante, economic evaluation of environmental studies in the United States, while process and outcome (effectiveness) evaluation is scarce. As Mickwitz (2003, p.416) suggests, applying mainstream evaluation tools to the environmental policy evaluation may be natural to the evaluation researchers, but is not necessarily the case in reverse.

The existing literature on environmental policy evaluation suggests various evaluation criteria. Barde (1995) suggests the following aspects to be examined: environmental effectiveness, economic efficiency and political and administrative aspects (distributional effects, acceptability and simplicity). The aforementioned study of OECD (1997, p.89-98) suggests the following: environmental effectiveness, economic efficiency, administrative and compliance costs, revenues, wider economic effects, dynamic effects and innovation and soft effects. EEA suggests that effectiveness, relevance, efficiency and utility criteria can answer the question as to whether the results of an intervention are satisfactory (Gysen et al., p. 4). Field and Field (2002) indicate efficiency and cost effectiveness, equity, incentives for long-run innovation, enforceability and agreement with moral aspects as evaluation criteria. Mickwitz (2003), in his efforts towards building a framework for environmental policy evaluation indicates the following: relevance, impact, effectiveness, persistence, flexibility, predictability, efficiency, legitimacy, transparency and equity.

While many of these criteria, such as effectiveness, efficiency, relevance, equity, legitimacy and transparency are common to general evaluation criteria (discussed in Section 2.1.3), there are some that are particular to the evaluation of environmental intervention. Among those, the criterion on innovation is discussed further, due to its relevance to this thesis.

Stimulation of innovation, or *dynamic effects* criterion can be said to be a reflection of the development of environmental policy, as discussed in Section 1.2.1. Innovation is defined as the point of time when a "newly discovered material or a newly developed technique is being put into regular production for the first time, or when an organised market for the new product is first created" (Mensch, 1979, p.123, cited in Grübler, 1998, p.23). Along with its perceived economic inefficiency, a criticism often found in conventional environmental interventions, was their limitations in continuously providing incentives to industries to achieve higher environmental performance beyond what was prescribed in legislation (OECD, 1997, p.125; Heaton,

2000, p.8). Thus, this criterion examines whether an environmental intervention binds industries to take only a fixed solution or encourages industry to continue to cultivate a range of better solutions aimed at reducing the environmental impacts from their activities. Reflecting the criticism, the 1990s observed the increased use of economic and informative instruments along with non-prescriptive, goal-oriented administrative instruments.[30]

2.1.7 The roles of mandatory environmental interventions

As discussed in the previous section, the necessity and importance of interventions to enhance environmental innovation has been widely acknowledged. Among the research in this field, an issue that could be of special relevance to this thesis is the effectiveness of certain types of mandatory administrative instruments in enhancing innovation.

While there has been a growing trend to leave the initiatives of environmental improvement in the hands of industries, the effectiveness and efficiency of voluntary initiatives in actually achieving the desired goal for society has been questioned (OECD, 2003b). Indeed, along with the political difficulties of introducing economic instruments that effectively reduce environmental impacts, the strength of well designed mandatory administrative instruments in forcing the desired shifts has long been recognised by scholars (Ashford, Heaton, Priest, 1979; Barde, 1995; Porter & van der Linde, 1995; Norberg-Bohm, 2000; Ashford, 2002). The characteristics of mandatory administrative instruments that are perceived to induce continuous environmental improvement include: flexibility in implementation, incorporation of market mechanism, stringency, adequate timeframe for implementation of innovative solutions, provision of long-term frames, certainty and the like (Ashford et al., 1979; Porter & van der Linde, 1995; Kemp, 2000; Norberg-Bohm, 2000; Rennings, Hemmelskamp, Leone, 2000; Field & Field, 2002). In this regard, the strengths of anticipated

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[30] According to the OECD (1997), the number of economic instruments used in the eight best-documented countries in 1992 was some 25% higher than in 1987. Relevant examples of informative instruments include eco-labelling schemes, first started in Germany in 1978 (ENDS, 2003, January 21) and now found in more than 42 countries (Global Ecolabelling Network, 2004), introduction of PRTR (pollution release and transfer register) and the like. The use of instruments that aim to change the behaviour of the addressees by providing more information or providing economic incentives, instead of demanding specified actions, can be explained also from the necessity for policy makers to attain legitimacy (Vedung, 1998; van der Doelen, 1998).

legislation in inducing changes has been also discussed (Ashford et al., 1979, p.164; Vedung, 1997, p.20; Kemp, 2000, p.36; Filed & Field, 2002, p.187). The necessity of stronger legislation is also acknowledged by the industry (ENDS, 2004, January 30). As mentioned earlier, the use of mandatory instruments is required when the government wishes to ensure the fulfilment of tasks by all the targeted actors (Vedung & van der Doelen, 1998, p.107).

Empirical studies on the effects of interventions on environmental innovation, especially those with mix policy instruments, has, however, been scarce (Rennings et al., 2000, p.7; Hildén et al., 2002, p.23).

2.2 Evaluation of EPR programmes

This section has the objective to apply a prototype of an EPR programme into an evaluation framework. Namely, it reconstructs intervention theory of an EPR programmes and puts them in the evaluation framework presented in Section 2.1.3.

2.2.1 Intervention theory for an EPR programme

As discussed in Section 2.1.4, when evaluating an intervention, the reconstruction of its intervention theory can be useful in various ways. It clarifies the intended outcomes of the intervention, and the elucidation of processes through which intended outcomes are achieved. Once the assumptions concerning the pathways to the intended outcomes envisioned via intervention are made explicit, some of the events constituting the pathways can be selected as data-collection points for evaluation. Whether, how and why these events occur would indicate or not whether the intervention is taking place in accordance with the intervention theory. Instead of striving to capture the entire phenomenon related to the intervention, the evaluator can have his/her primary focus on the selected events. Identification of these events and their examination are especially useful when the ultimate outcomes envisioned in the intervention is of long-term nature and/or difficult to measure.

The author finds the use of intervention theory helpful for the evaluation of EPR programmes for complex products, the primary evaluands of this thesis. Although the intervention theories for the respective EPR programmes examined vary in detail, they are based on the common

concept of EPR. The evaluands can be compared against what EPR theoretically envisions. As discussed in Section 1.2, the ultimate goal of the EPR programmes derived from the EPR principle is total life cycle environmental improvement of product systems. However, this is very difficult to measure and the implementation period of EPR programmes for complex products is rather limited (Section 1.3). Nonetheless, there are some distinctive intermediate outcomes that are deemed crucial for the total life cycle environmental improvement of product system, and these can be selected as the data-collection points for evaluation.

Figure 2-5 presents an intervention theory[31] for a prototype mandatory EPR programme, concentrating on the assumed sequence of events to happen. It is primarily based on the understanding of the concept of EPR, EPR-based programmes and respective instruments as discussed in Section 1.2. Taking note of the diverse instruments used in EPR programmes and what they address, the intervention theory seeks to suggest how the respective instruments found in existing EPR programmes (Section 1.2.4) might affect the occurrence of respective events.

Among the series of events that are assumed to take place in order to attain the intended outcomes, direct actions of the addressee in order to fulfil the take-back requirements put forward in the EPR programme – for instance collection, take-back, reuse/recycling and environmentally sound treatment of discarded products – are referred to as downstream requirements. Downstream requirements, together with design change and feedback between upstream and downstream, are perceived to be the immediate outcomes.

The constructed theory has the following scope and limitation.

Firstly, it concentrates on the pathways to the *intended outcomes* that are inherently drawn from the understanding of EPR presented in Section 1.2.1, that is, design change of products and product systems/source reduction (upstream changes) and improved waste management practice (downstream changes). Intervention theories addressing the *side effects* of these instruments, even though some of them are predictable, are not included. Adding all the side effects would unnecessarily complicate the already complex figure.

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[31] In this document, a package of the range of pathways that are envisioned to reach the final outcome driven from the conceptual understanding of EPR will be called an intervention theory of an EPR programme.

However, the side effects and intervention theories behind them will be considered in the evaluation when these side effects exert considerable influence to the occurrence of intended outcomes.

Secondly, only those steps deemed crucial in bringing forward the intended outcomes are presented. The assumptions regarding how these steps would take place are not included in the figure presented, although they will be included in the analysis in the subsequent chapters.

Thirdly, the intervention theory suggests the intended linkage between the respective instruments and events (which in a sense are the goals of the instruments), but does not include the underlying assumptions for these instruments to reach these events. For example, a deposit refund system is assumed to provide incentives to consumers to bring back products to appropriate collection points (as suggested with the arrow from "deposit refund system" to "increased collection of discarded products).[32] The assumption that consumers' behaviour is influential is not included in the figure. As mentioned, such exclusions have to be made in order to simplify the already complex intervention theory.

Fourthly, not all the policy instruments are used in one EPR programme. In fact, some of the instruments, such as advance disposal fee systems and end-user pays systems cannot be used for the same type of products simultaneously.[33] In some programmes, reaching a certain refillable target releases the producers from introducing a deposit-refund system. Rather, the intention of the intervention theory presented in Figure 2-5 is to show how the respective instruments play their parts in achieving the intended outcomes of an EPR programme. Meanwhile, EPR-based policy instruments are not limited to those included in the diagram. Among the list of instruments, those that are included in the case studies discussed in this thesis are selected.

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[32] The deposit refund systems referred here are those where consumers are reimbursed with a refund when bringing back a post consumer product and packaging.

[33] However, some programmes used advance disposal fee systems for part of the products covered under the same programme, while using end-user fees for others (e.g. EPR programme for EEE in Switzerland). The challenges facing this type of implementation will be discussed further in Chapter 5.

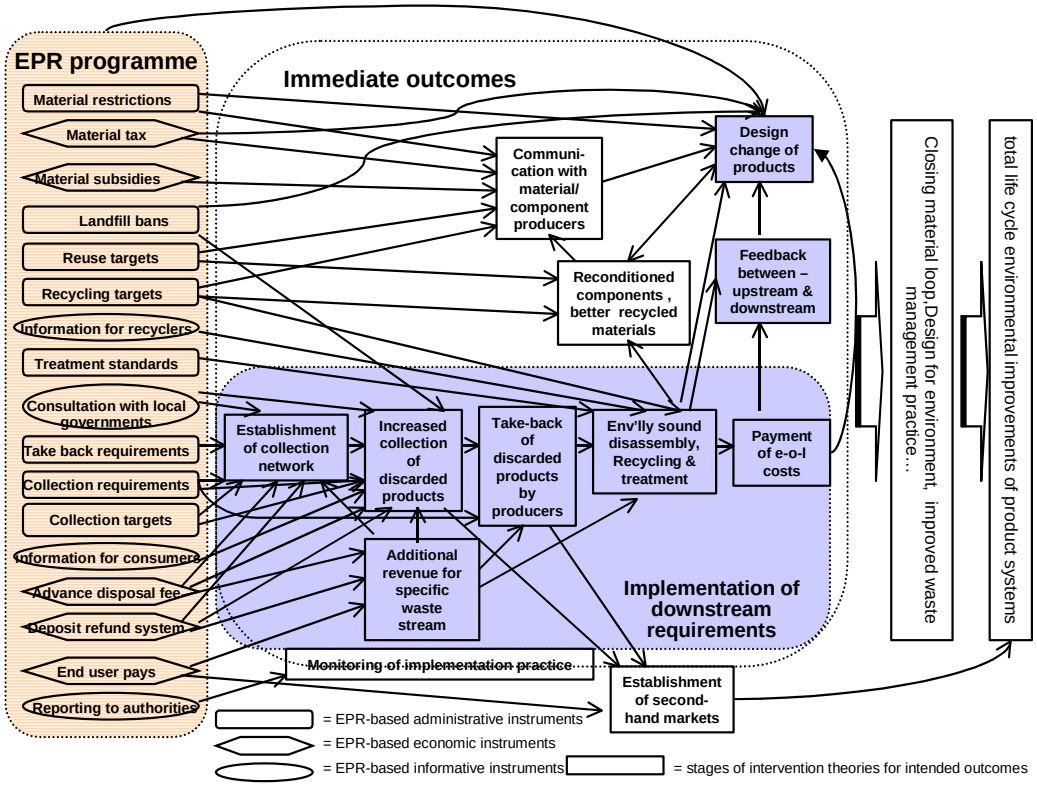

Figure 2-5: Intervention theory of an EPR programme (concentrating on the pathway to intended outcomes)

Fifthly, an important dimension regarding the implementation of downstream requirements and its implication to the intended outcome (upstream changes) includes the types of responsibility the producers fulfil (physical, financial or informative responsibility), as well as the manner in which they are fulfilled (individual versus collective responsibility) (Section 1.2.3 and 1.2.7). Whether, and how the events suggested in the presented intervention theory take place, are examined from these two angles. Section 1.2.7 introduced the discussion surrounding individual versus collective responsibility and its implications upon design change. There is a general assumption that *an EPR programme based on individual responsibility would promote design change more than that one based on collective responsibility*. On the other hand, there is also an assumption that individual implementation would face more administrative challenges and pose more of a burden to producers than collective implementation. The assumed challenges are summarised in Box 2-1.

Box 2-1: Perceived challenges facing individual responsibility

Duplicated infrastructure for end-of-life management
Increased transports
Job of existing recyclers threatened
Difficult to make the producers pay in accordance with the degree of design for end-of-life (complex, durable products) due to the properties of these products
Doubt in cost differentiation due to minute difference in the "greenness of the products", small share of recovery cost within the cost of end-of-life management
Orphaned and historical products
Difficulties in identifying free-riders
Higher transaction costs and expensive operations

EPR programmes make use of a number of policy instruments that address the same actors simultaneously, may introduce them at different times, and may address different actors in different manner. As will be discussed in Chapter 3, the entanglement of various policy instruments pose limitations to the evaluation of single policy instruments within an EPR programme.

However, together with the identification of different types of responsibilities that the producers and other economic actors bear, breaking

down an EPR programme into its components may help the systematic comparative analysis. Moreover, clarification of the potential influence of the respective instruments to various assumptions in the intervention theory helps identify the portion of the instruments that the evaluation should put its primary focus upon. For example, it may help identify which elements of the programme should be reinforced when developing or revising a programme.

2.2.2 Evaluation framework for an EPR programme

Figure 2-6 presents the application of the reconstructed intervention theory of an EPR programme into the evaluation framework of public interventions, as found in Figure 2-4.

When examining the implementation of an EPR programme, the objects to be examined are not the direct actions of the government – for instance, provision of social services, education, information, issuance of permit, taxation and the like – as is generally found in public policy literature (Vedung, 1997, p.209-245; Weiss, 1998, p.57-58; Rossi et al., 1999, p.109-113). Rather, it is industries that are the primary actors implementing EPR programmes. The focus here is on how the industry is implementing the assigned responsibility in order to meet the requirements set forth in the programme. Thus, the implementation of the programme is regarded as the immediate outcome.

2.3 Focus of this thesis

As discussed in Section 1.3, an evaluation of whether or not an intervention based on the EPR principle actually promotes the total life cycle environmental improvement of product systems faces various challenges. The changes the implementation of an EPR programme may induce would be complex, occurring in various parts of the life cycle of product systems with different time scales and involving various actors. In this thesis, a few *immediate outcomes* related to *upstream changes* undertaken by the *manufacturers* have been selected for the parts of EPR programmes to be evaluated. It is an evaluation *research*, in that it is conducted to contribute to the building of knowledge of general nature. Through the evaluation of selected EPR programmes, the author seeks to test whether the assumptions underlying the EPR programme hold. The selected immediate outcomes can be clustered into:

- upstream changes: design changes of products and measures that facilitate the design changes undertaken;
- the development of downstream infrastructure: measures related to separate collection, disassembly/dismantling of products, reuse/recycling/final treatment of components/materials, all conducted in an environmentally sound manner; and
- the development of feedback mechanism between the upstream and downstream.

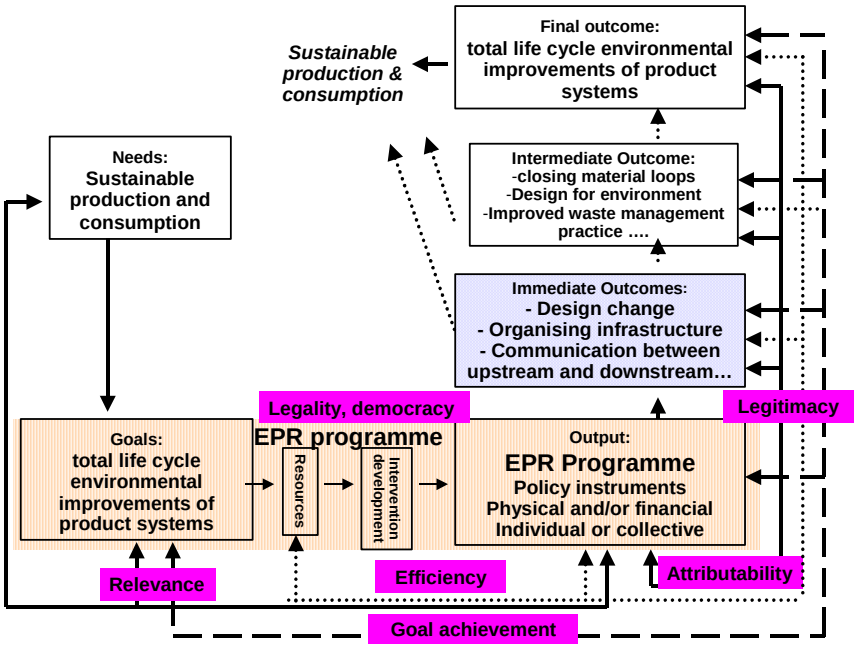

Figure 2-6: A model for the evaluation of an EPR programme, based on its intervention theory

In light of the priority on prevention instead of end-of-pipe solutions, primary attention is paid to the upstream changes while the other two measures are discussed in connection to the upstream changes. As found in the intervention theory of a prototype EPR programme (Figure 2-5), the three outcomes are mandated by/envisioned in EPR programmes. They are deemed to be among the essential events that should occur in order for an EPR programme to reduce environmental impacts from the end-of-life management of products, which would also lead to the envisioned goal

inherent from the EPR principle. Other immediate outcomes, both anticipated and unanticipated, are discussed when they exert influence on the occurrence of the three types of changes in focus.

Amongst the criteria against which an EPR programme can be evaluated (Figure 2-6), the immediate outcomes mentioned above are assessed primarily against the *environmental effectiveness* criterion. Goals other than environmental improvement are discussed only when these compete with the attainment of environmental goals.

Two separate studies related to the environmental effectiveness of the immediate outcomes constitute this thesis. The first study concerns the environmental effectiveness of the presence of EPR programmes. It examines the content of the three immediate outcomes listed above observed in the EEE and car manufacturers in Japan and Sweden in the presence of EPR programmes in the two countries, as well as in EU *(goal attainment* evaluation). Through the study of factors that facilitate the occurrence of these outcomes, the role of EPR programmes is discussed in light of various other factors, in promoting upstream measures (*attributability* evaluation).

The second study systematically investigates the actual implementation of EPR programmes, from the viewpoint of individual versus collective responsibility (*implementation* evaluation). The study examines five existing programmes with the assumption of the superiority of individual responsibility in inducing design change. Thus it is a formative, implementation evaluation, conducted with the aim to improve the implementation practices of EPR programmes. The applications of the respective types of responsibilities – physical, financial, informative (Section 1.2.3) – for activities constituting end-of-life management (collection, recovery, monitoring and enforcement) in five EPR programmes are examined with the view to elucidating the actual implementation mechanism taken by the producers. The assumptions concerning the challenges facing individual responsibility are also examined.

The two studies are *ex-post* in that they evaluate whether or not the outcomes observed so far are in line with what has been envisioned in theory. For the first study however, the interventions themselves, except for one, have not come into force.

The changes envisioned in the EPR programmes are of an innovative nature (Lindhqvist, 2000, p.155; Stevens, 2004, p.215). Examination of the environmental effectiveness of the EPR programmes thus corresponds with that of innovation stimulation. In this regard, consideration is given to the roles of mandatory instruments in inducing innovation, as well as the correspondence with the characteristics of instruments that have been perceived to induce innovation (Section 2.1.7).

With regard to the other evaluation criteria, the author takes a normative stance and assumes the *relevance* of the objective (total life cycle environmental improvement of product systems) to the needs (sustainable production and consumption).

Relevance of the output to the objectives and *legitimacy* (*political acceptability*) are discussed to the extent relevant to the environmental effectiveness evaluation. The author does not touch upon the *equality/equity* criteria, as it is difficult to determine the respective policies aims to achieve equality on what ground. The criteria of *legality* and *democracy* criteria are also outside the scope of this study due to their focus on the outcomes instead of the development and implementation of the intervention by the *policy makers*.

Thus the focus of this thesis is to ascertain whether or not the intervention incorporating the EPR principle actually contributes to the theoretically assumed environmental improvement. The author seeks evidence of the attainment of the immediate outcomes, while setting the cost issue aside. The incorporation of multiple policy instruments with various variables that affect the outcomes makes it challenging to establish assumptions that reflect the reality. Similar to LCA studies, cost benefit analysis often faces challenges in determining the system boundary. The differing responsibilities allocated to producers in the respective programmes examined in this thesis, as well as lack of access to the reliable data, poses challenges to the straightforward comparison of costs between the programme.[34] Reflecting the general trend of the evaluation of environmental interventions (Section 2.1.6), higher attention has been paid to the economic assessment of the EPR programmes than the achievement of environmental benefits *per se*. Moreover, as discussed in Section 1.3, EPR programmes for complex products examined in this thesis are generally still in their infancy and are in

[34] The author faced similar problems when evaluating the implementation of EPR programme that have longer implementation period (Tojo et al., 2003).

transition to a system based on a more closed-loop industrial paradigm. When a society moves from one system to another, the overall environmental effectiveness, as well as the economic efficiency, may not be optimal during this transition phase. It is therefore difficult to make any fair judgement of the economic efficiency at present. Thus, despite its importance, the economic efficiency of the EPR programmes is beyond the scope of this thesis.

Figure 2-7 highlights the focus of this thesis. The examination is further discussed in detail in the following chapters.

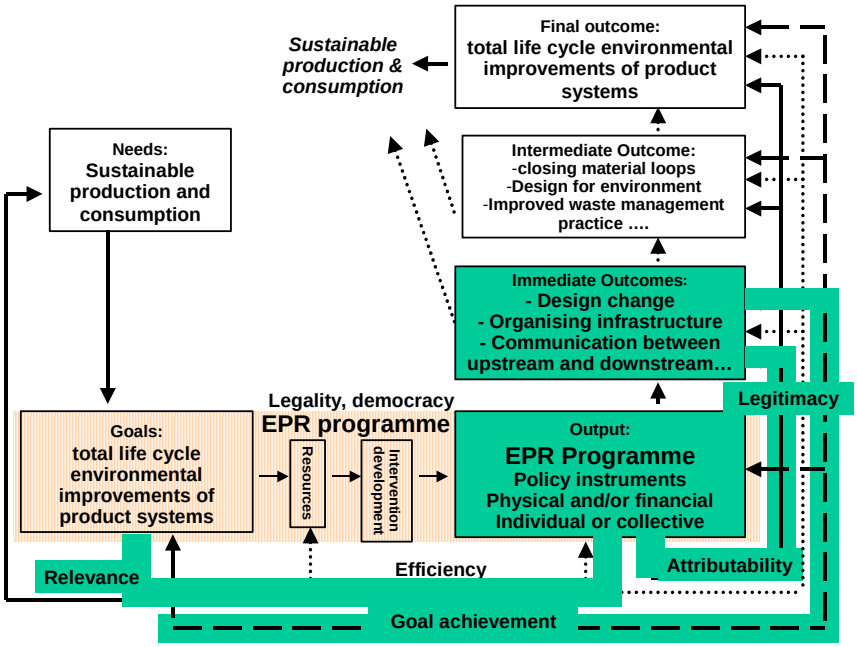

Figure 2-7: Focus of this thesis

CHAPTER

THREE

3. Methodology

This chapter describes the methodological approach applied to this research work. The primary portion of the materials utilised within this thesis are taken from two research projects the author was engaged in between the winter of 2000 and the summer of 2003. It first discusses the basic approach common to both these projects and the activities around them – qualitative, naturalistic evaluation based on multiple, instrumental case studies (Section 3.1). The subsequent two sections describe the specific methods taken in two of the research projects, including the selection of cases, data collection methods and analysis and interpretation. The content of these studies constitutes the primary materials addressed within the subsequent chapters. The approaches taken for the rest of the research activities, which serve as supporting materials of the two research projects, are described in Section 3.4.

3.1 Approaches common to this research work

As discussed in the preceding chapter, evaluation research has traditionally focused on assessing whether the intended *outcome* was actually attained and the degree to which the intervention contributed to the attainment (Vedung, 1997, p.37-39; Yin, 2003, p.xi). This so-called effectiveness (goal-attainment) evaluation tends to be summative. It typically takes a hypothetical-deductive approach, conducted in the form of experimental design, which requires "specification of main variables and the statement of specific research hypotheses before data collection begins" (Patton, 1987, p.15).

A criticism directed at the quantitative, hypothetical-deductive approaches is its inability to capture phenomena that do not fall under these pre-determined variables and hypotheses. Determination of specific intended outcomes, a prerequisite for measuring the effectiveness, is a challenge facing evaluation of many of the social interventions that may have a variety of outcomes (Patton, 1987, p.8-19). Moreover, the possibility of conducting a rigid experimental or quasi-experimental design in an evaluation of social

intervention is limited (Clarke & Dawson, 1999, p.51). While quantitative approaches at their best can show the attainment of the outcome, they rarely touch upon why and how the outcome occurs (Weiss, 1970, cited in Clarke & Dawson, 1999, p.55). These are among the shortcomings of quantitative research that, accompanied by the enhancement and recognition of the validity and reliability of qualitative research techniques, led to the wider use of a qualitative research approach (Weiss, 1998, p.252-253; Clarke & Dawson, 1999, p.33-63).

The qualitative evaluation approach is based on naturalistic inquiry, in that "the evaluator does not attempt to manipulate" the intervention and the actors affected by it for the purpose of the evaluation, as an experimental design does (Patton, 1987, p.13). The logic behind the qualitative approach is inductive, in that "the evaluator attempts to make sense of the situation without imposing pre-existing expectations on the program setting" (Patton, 1987, p.15). Instead of hypotheses the issues, questions and search for general patterns guide inductive analysis (Patton, 1987, p.15). A classical inductive approach is goal-free evaluation, where the evaluators gather qualitative data on actual programme impacts without being bound by the predetermined goal (Patton, 1987, p.15; Vedung, 1997, p.69-62).

Although these two streams of thoughts were initially antagonistic, it has been recognised that it is a matter of selecting the approach suitable for the type of evaluation that should be conducted (Patton, 1987, p.14; Weiss, 1998, p.82-87; Clarke & Dawson, 1999, p.35-63). Taking a qualitative approach is appropriate in such evaluation situations where:

- The interventions have complex, individualised outcomes. Predetermining intended outcomes to be measured in advance have high risks of overlooking other unanticipated outcomes that need exploration and monitoring;
- the evaluands are still under development, and the intention of the evaluation is program improvement (formative) and/or to facilitate more effective implementation;
- the emphasis is on the understanding of the evaluand, rather than the measurement of the outcome;
- the intention is to study the detailed, descriptive information about the intervention; and/or

- the evaluation intends to capture the larger context of programme implementation and development (Patton, 1987, p.13-42; Weiss, 1998, p.82-87, p.252-253).

Reflecting upon the features of the evaluand (EPR programmes) and the type of evaluation conducted (effectiveness in upstream changes, systematic exploration of implementation, factors affecting the implementation), the author generally based the research in this thesis on qualitative, naturalistic approaches.

Upstream changes of an EPR programme may occur in varying forms. Anticipated changes include material substitution, component substitution, design for disassembly, establishment of communication system with recyclers, the shift from selling products to selling functions and the like. Due to the innovative nature of the programme, unanticipated outcomes are likely to emerge. Instead of attempting to measure outcome in quantitative terms, finding out what measures have been taken and searching for general patterns without prefixing the variables shows promise as a method for capturing unexpected outcomes.

Difficulties of assessing the "attributability" of the outcomes, which is in fact the main focus of the effectiveness study of this thesis, also contribute to the selection of this approach. As discussed in Section 2.1.6, environmental intervention often serves as a contributory cause with regard to the results it intended to achieve (Gysen et al., 2002, p.9). It is also the case with the upstream changes an EPR programme intends to induce. Various factors can influence product design, ranging from customers' demands for quality and safety to regulatory measures regarding restriction of use of certain materials.[35] By its nature, the degree of causality cannot be easily measured quantitatively, if at all. Through naturalistic inquiry the author has tried to understand how the evaluand, in light of various other factors, influences upstream changes, instead of striving to establish internal validity by use of a quantitative, experimental approach.

Implementation of EPR programmes varies from country to country, and from product to product. The primary purposes of exploring the implementation process are to understand what is happening and to seek potential improvement so that the implementation of the EPR programme

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[35] See, for example, Hall (2001).

leads to upstream changes. The naturalistic approach is thus well suited for this evaluation situation.

Meanwhile, "human reasoning is sufficiently complex and flexible that it is possible to research predetermined questions and test hypotheses about certain aspects of a program while being quite open and naturalistic in pursuing other aspects of a program" (Patton, 1987, p.62). The author, reflecting upon the previous research on EPR programmes, began the research projects with several questions in mind while also trying to explore various other aspects that may present themselves when searching these predetermined questions. The author moves back and forth between exploring the evaluand and "engaging in data collection for purposes of verification and replication" (Patton, 1987, p.63). Likewise, the author moves back and forth between the parts and the whole (Patton, 1987, p.63). Efforts have been made to maintain attention on the specific aspects of the evaluand (upstream changes), while exploring what is happening with the evaluand as a whole. The result presented in this thesis focuses on the parts, but the approach is more naturalistic than quantitative in order to gain a better picture of the whole.

As a way of organising the research, the study took a *multiple, instrumental case study* approach. The case study approach is chosen, as the phenomenon under investigation (EPR programmes and their influence on upstream changes) is complex and consists of variables that cannot be isolated (Yin, 2003, p.xi). It is an approach well used in evaluation research (Yin, 1994, p.15; Stake, 1995, p.xii; Weiss, 1998, p.261), and the use is not limited to process evaluation, but is also open for outcome evaluation (Yin, 2003, p.xi). Taking this approach is considered to be "particularly valuable when the evaluation aims to capture individual differences or unique variations from one programme setting to another, or from one programme experience to another" (Patton, 1987, p.19). In an *instrumental* case study, the aim is to use the findings of the cases for something other than an understanding of the case itself such as to obtain insights into the research questions or contribute to a general understanding (Stake, 1995, p.3). The focus is on the research questions, which should be explored through the cases, not the case *per se* (Stake, 1995, p.16). Multiple instrumental case studies make it possible to rely not on single, but on multiple sources of evidence (Stake, 1995, p.4; Yin, 2003, p.xi). It allows identification of both similarities and differences emerged in varying contexts (Yin, 1994, p.44-51; Stake, 1995, p.74-79).

The cases were selected based on purposeful sampling (Patton, 1987, p.51). That is, the principle underlying the selection of cases was that they were deemed to be rich in information and had high potential for learning opportunities (Patton, 1987, p.51-60; Stake 1995, p.4-7). The EPR programmes selected for the respective studies, as well as the reasons for these choices vary, as explained in the subsequent sections.

3.2 Study 1: Evaluation of the presence of EPR legislation

The first study, conducted over the period of October 2000 to June 2001, investigated *the role of presence of EPR legislation, in light of other factors, in providing incentives for environmentally conscious design in order to reduce the environmental impacts from complex products and product systems.*

3.2.1 Case selection

Manufacturers of two product groups, *electrical and electronic equipment (EEE)* and *vehicles,* in two countries (*Japan, Sweden*) were selected as cases.

Both EEE and vehicles share some common features: they are complex, durable products, contain hazardous substances and are manufactured and marketed globally. Meanwhile, they differ in aspects such as the maturity of products and existence of actors involved in the end-of-life management prior to the implementation of EPR programmes. The similarities and differences allow the analysis of a "particular subgroup in depth" (homogeneous sampling), while extracting "important shared patterns which cut across cases" (variation sampling) (Patton, 1987, p.53-54; Yin, 1994, p.44-51). Another reason for selecting these product groups was the lack of research on the effectiveness of EPR programmes in influencing the design of these products, as has been described above. Moreover, the author's familiarity with EPR programmes for EEE from her previous research[36] was deemed useful in understanding the context.

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[36] The author had an opportunity to write a master's thesis on EPR programmes for EEE in 1999, based on the four pieces of EPR legislation for EEE (Japan, the Netherlands, Sweden and EU), and a regulation on end-of-life management for EEE in Denmark, which did not incorporate the concept of EPR. The findings of the study are found in Tojo (2000).

The rationale for selecting Sweden and Japan included 1) the presence of EPR programmes, 2) existence of relatively large manufacturers of both industries and 3) accessibility of data. In both of these countries, EPR regulation for electrical and electronic equipment came into force in 2001.[37] Sweden enacted an EPR regulation for vehicles in 1997,[38] while the introduction of an EPR regulation for vehicles had also been discussed in Japan (see Section 4.1).

With regard to legislation, apart from the national legislation of Sweden and Japan, the three EU directives governing end-of-life management of the product groups under this research[39] were included. The basis for the inclusion of the EU directives was their perceived influence on the formulation/revision of national legislation of the member states of the European Union, as well as on the manufacturers both in and outside Europe.

The interviews with manufacturers, which constitute the main data for the study, were conducted mainly during the period of December 2000 to February 2001.[40] Except for the legislation for end-of-life vehicles in Sweden which had a 3-year history of implementation, at that time all legislation was either still under development/discussion[41] or waiting to

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37 Tokutei Kateiyou Kiki Saishouhinka Hou [Specified Home Appliance Recycling Law]. (1998, No. 97), Japan, and Producer Responsibility for Electrical and Electronic Products Ordinance, 6 April 2000. (SFS 2000:208), Sweden.

38 Ordinance on Producer Responsibility for Vehicles, 23 October 1997 (SFS 1997.788).

39 Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles. OJ L269, 21/10/2000 p.0034-0043 (ELV Directive). Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on the waste electrical and electronic equipment (WEEE). OJ L37 13/02/2003 p.24-39 (WEEE Directive). Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. OJ L37 13/02/2003 p.19-23 (RoHS Directive). At the time of the research, the proposals for these two directives, presented by the Directorate General Environment of the European Commission, were discussed.

40 Telephone interviews with two Swedish manufacturers were conducted in June, although the initial contact was made at the same time as the rest of the manufacturers.

41 The WEEE Directive, the RoHS Directive, a regulation on the end-of-life vehicles in Japan, and a regulation on personal computers in Japan.

come into force.[42] The timing allowed the author to examine the anticipatory behaviour of the manufacturers, that is, the *expectation* of EPR legislation and its effectiveness on the design change. The anticipatory behaviour was also explored by asking what the manufacturers have done and what were the reasons behind their actions.

3.2.2 Data collection

The following methods were used to collect data for the study: 1) in-depth open-ended interviews with manufacturers, 2) open-ended interviews with experts and government officials, 3) review of various printed documents and Internet sources and 4) follow up communications with the interviewees. This allowed the triangulation of data in two ways: data triangulation and methodological triangulation (Patton, 1987, p.60-61; Yin, 1994, p.91-94).

Primary data, mainly of qualitative nature, was collected by way of *in-depth interviews* with the personnel working in the companies within the scope of the research and the materials provided by the interviewees.

Representatives of a total of 13 EEE manufacturers (9 in Japan and 4 in Sweden) and 8 automotive manufacturers (5 in Japan and 3 in Sweden) were interviewed. These manufacturers sell final products to the market (original equipment manufacturers: OEM), not components (criteria sampling). Among manufacturers that meet these criteria, those interviewed were selected based on the contact possibility and the availability of the interviewees in the timeframe for the study. The list of interviewees, their positions at the time of interviews, the timing of the interviews as well as the main products of the companies are summarised in Appendix 1.

Except for two interviews via telephone, all the interviews were conducted in person. Prior to conducting the interview, initial contact was made via e-mail to personnel working in the field of the environment in the interviewed companies. In the initial contact, the general purpose and focus area of the research was explained together with a request for introduction to the personnel working in the areas that were relevant to the research.

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[42] Specified Home Appliance Recycling Law in Japan came into force on 1 April 2001, and Ordinance on Producer Responsibility for Electrical and Electronic Products in Sweden came into force on 1 July 2001.

Once the contacted companies agreed to participate in an interview, a list of issues to be addressed was sent, as found in Box 3-1. The list was sent to interviewees prior to the interview, in order to facilitate the smooth and efficient conduct of interviews. The list of issues also served as an *interview guide* during the actual interviews. Except for interviews of car manufacturers in Sweden, which were developed with a colleague, the same interview guide was used for all.

Box 3-1: Interview guide (list of the issues explored during the interview)

1. Focus areas to reduce environmental impacts from products/product system
   1) In terms of life cycle phase? (i.e. extraction of raw material, design, production, sales, use, end-of-life, transportation)
   2) In terms of environmental aspect? (quantity of material used, types of material/substances used, energy use, noise, odour, others)
   3) Tools used to come up with/identify these areas)
2. Measures taken in relation to end-of-life management of the products
   e.g. take-back of the products, status of product/material reuse, recycling and final disposal, physical and financial infrastructure for such system (individual or collective), feedback and communication between design section and end-of-life management section and design changes/system changes that facilitate end-of-life management
3. Factors that promote/facilitate the undertaking of measures in relation to end-of-life management
   e.g. customers' demands (consumers or business customers, or both), differentiation from competitors, economic benefit, regulatory requirements, pressure from society, retailers, or others, corporate social responsibility, industry associations and trend of the industry, top management commitment/company policy, personnel's individual awareness and others
4. Factors that hinder to take such measures
   e.g. cost, lack of regulatory pressure, lack of top management commitment, lack of available technology; lack of demand from customers/retailers/society and others
5. Measures that are taken to create a closed-loop society/economy and promoting/hindering factors surrounding such measures
   e.g. shift from product sales to functional sales

The intention of the first question (focus area) was to understand the relative importance of the issue of end-of-life management for the

companies interviewed.[43] The second question (measures taken with regard to end-of-life management of their products) was a prelude to the rest of the interview. It was considered difficult to understand the promoting/hindering factors surrounding the measures taken by the companies without knowing the actual measures. The author gained some knowledge on the actual measures through previous research (Tojo, 2000), supplemented by information on the website of the interviewees, newspapers, professional magazines, academic articles and the like. Thus, the aim of the question was to confirm the validity of such information and to gain and update knowledge on the current practices of the company as well as the past achievements. Clarification of the manner in which some of these measures are/would be taken, such as physical and financial infrastructure for take-back, reuse, recycle and final disposal, were also perceived to help understanding of the (envisioned) implementation process and its implication to design change. Clarification of the (envisioned) implementation process was also deemed useful to elucidate what issues to look at in the subsequent study, as further discussed in Section 3.3. Some of the examples given – such as communication between the design section and end-of-life management section, design changes/system changes that facilitate end-of-life management – were part of the intervention theory for the outcome of EPR programmes. Namely, these are the activities that were assumed to happen in order to bring about upstream changes that lead to the overall environmental improvement of the product system.

The third and fourth questions (factors influencing the measures taken in relation to end-of-life management of their products) constituted the core of the interview. Examples were given so that the interviewees could understand what the author hoped to gain from the questions.[44] As suggested by Patton (1987, p.127), in order to establish *neutrality* regarding the content of what the interviewer may say, the issues included in the list were not concentrated on the EPR legislation. Rather, they broadly covered factors surrounding the design and end-of-life management of products addressed in the research. It was suspected that allowing the interviewees to freely discuss various influencing factors, rather than asking the influence of legislation straightforwardly, would help grasp the relative importance of

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[43] However, sometimes the intention was mistaken, and interviewees started to talk more about the overall environmental measures, or issues regarding LCA, rather than the end-of-life management issues.

[44] With regard to examples given here see, for example, Hall (2001, p.21).

EPR regulations in promoting design change among other influencing factors. Learning the various factors that affect measures taken for end-of-life management would also help the author to understand the linkage and complexity of such factors and provide a broader view in understanding the role of an EPR programme.

It has been argued that the ultimate manifestation of the EPR concept is for producers to retain the ownership of a product until the end of the product's life (See Section 1.2.2 and 1.2.3). The final question was posed to see if such an idea had been discussed within the company and to learn how they viewed the possibility of incorporating such measures.

The interviews had durations spanning from 30 minutes to 3 hours, depending on the availability of the interviewees. The number of interviewees that were present at the same time varied from 1 to 4. In some cases, separate interviews were conducted for different personnel. One interview with an EEE manufacturer in Japan was conducted together with a person working in an environmental section in another EEE manufacturer. The interviews with automobile manufacturers in Sweden were conducted together with a colleague. The author alone conducted the remainder of the interviews. Apart from two interviews via telephone, all interviews were recorded.

The interviews addressed a list of issues outlined in the interview guide, as found in Box 3-1. The interview did not follow any particular order, but rather, following the approach of Patton (1987, p.111), the list was utilised to make sure that all relevant issues were covered. Some follow-up questions not necessarily in the guide were also made. When asking for the factors influencing design change (issue 3 and 4), particular care was taken to mention various competing factors together with legislation. This so-called illustrative examples format was taken following Patton (1987, p.128), in order to establish neutrality. Moreover, when it was difficult to cover all the issues in the interview, due, for example, to time constraints, the author concentrated on issues 3 and 4. These two issues not only constitute the core of the study, but are also the most difficult to gain from other sources such as the environmental reports of companies.[45]

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[45] Indeed, some interviewees, when discussing measures taken by the companies (issue 1 and 2), used their environmental reports.

As mentioned, prior to the interview information on the companies, on their environmental activities and on the development of relevant legislation was reviewed. Gaining some knowledge about the practice of the interviewees as well as context surrounding the interviewee allowed the author to triangulate the information during the interview. Meanwhile, it helped the author to concentrate on the core issues (factors influencing the design change) when conducting the interview.

The information gathered from the manufacturers was complemented by open-ended interviews with experts related to the research field (product policy, environmental product design) and personnel in relevant governmental agencies. Government reports, newsletters, newspapers, academic articles, and professional magazines were also reviewed in order to obtain further understanding.

3.2.3 Analysis and interpretation

After the interview, each recorded interview was transcribed. The author's colleague transcribed and co-interviewed two car manufacturers in Sweden, while the author transcribed the remainder of the interviews. The quotations together with the written materials gained at the interviews, were reviewed. Following the approach suggested by, for example, Stake (1995, p.74-79), they were organised in accordance with the five issues sent in advance and then summarised. Especially with regard to the issue number 3 and 4 (factors promoting /hindering measures regarding end-of-life management of their products), the author tried not to be bound by the examples given for the respective issues (inductive analysis), as suggested by Patton (2002, p.453-454). Transcriptions and/or summaries were sent to the interviewees to confirm whether or not the author had understood the interviewees correctly. Follow-up questions were sent via e-mail for clarification and confirmation.

The primary focus of the interview was the presence of EPR programmes, without going deeply into the actual content of the respective legislation – type of policy instruments used – and implementation. However, through the interviews some of these issues turned out to be of relevance to upstream changes. These issues were also added to the analysis and interpretation. Moreover, findings that come under issue number 5 (measures for creating a closed-loop society/economy, and factors influencing such measures) are categorised together with design changes of product systems (issue 2) and factors influencing the changes (issue 3 and 4).

As suggested by authors such as Yin (1994, p.44-51) and Stake (1995, p.74-79), the summaries of the respective interviews were then aggregated, in order to aid the search for both general patterns and differences. The interviews were interpreted by identifying the common phenomena observed among companies of the same country and industry group, as well as the phenomena observed in specific companies. Measures undertaken by the *manufacturers* are of primary concern of this study, and those conducted by other actors – for instance component manufacturers, recyclers and second-hand shops – if not in collaboration with manufacturers, are not discussed. Regarding the factors influencing measures undertaken in relation to design for end-of-life, the common phenomena found in different companies were clustered. The author sought to cluster the factors in various ways and examined whether these differences affect the interpretation. The number of companies that suggested the respective factors belonging to the same cluster was counted, and these factors were listed from most to least commonly found. That is, quotations from the interviews, of qualitative nature, were aggregated in a quantitative manner. The ranking of the factors provides one way of illuminating the relative importance of EPR legislation amongst various other influencing factors.

Meanwhile, quotations from the interviews were carefully examined to understand *how* identified factors promote or hinder the undertaking of measures concerning end-of-life management. The linkages of different factors were considered in order to understand the role of EPR programmes in relation to other factors. Quotations from the interviews also helped in considering reasons for similarities and differences, both within the same industry group – companies manufacturing the same types of products – as well as between different industry groups – automobile manufacturers and EEE manufacturers.

Interviews with experts and written documents were used to triangulate the content of the interview data, mainly of factual nature such as content of the legislation mentioned by the interviewee, concrete measures taken by the industry and the like.

From this interpretation, conclusions were drawn regarding whether an EPR programme, in light of other factors, provides tangible incentives for environmentally conscious design to the manufacturers of EEE and automobiles. The findings of the studies served as a starting point as well as being additional evidence for the second study.

3.3 Study 2: Evaluation of the implementation of EPR programmes

The second study, conducted between March 2002 and June 2003, had a premise of the superiority of individual implementation in inducing upstream changes. It explores the concrete manner of implementing EPR programmes by addressing the following three research questions.

- *What are the responsibilities that are assigned to producers in existing EPR programmes, and how do producers fulfil them?*
- *Do producers implement their responsibility individually and if so, in what manner?*
- *What are the essential components of a viable implementation of individual responsibility?*

3.3.1 Case selection

The following five EPR programmes for two product groups, implemented in three countries, were selected as cases:

- EPR programmes for electrical and electronic equipment (EEE) in Japan, the Netherlands and Switzerland.
- EPR programmes for small consumer batteries in the Netherlands and Switzerland.

With regard to the product group, EEE was selected due to its high relevance to the issues of individual vs. collective responsibility. This was manifested in the intensive discussion in the development of the EU WEEE Directive. The selection could be considered as typical case sampling, as suggested by Patton (1987, p.54). It is also the primary product group the author has been looking into in her research on EPR programmes. Items in both product groups (EEE and small consumer batteries) have common characteristics such as containment of hazardous substances and/or valuable resources, durability, and diversity (homogeneous sampling). Meanwhile, there are also differences such as the number of producers, the maturity of the products, size of the products, period of coverage in EPR programmes and the like (variation sampling). Exploring the experiences of EPR programmes for batteries was thus seen to provide useful insights into the issues surrounding the implementation of EPR programmes for EEE. It is also an opportunity to study EPR programmes for batteries *per se* on which

the information is rather limited despite its relatively long history of implementation.[46]

Among other things, the choice of countries was based on actual implementation period (homogeneous sampling) and the difference in the means of allocation of responsibility and implementation (variation sampling).

3.3.2 Data collection

Data was collected both through a *review of official documents* and *in-depth, open-ended, interviews* of various actors involved in the formation and implementation of EPR programmes.

Legislation that mandates EPR programmes mentioned in the previous section, as well as basic information regarding how the systems actually work, was collected from the Internet homepage of governments, existing academic and trade journals, articles and newsletters. Information gained through desktop research was substantiated and triangulated by interviews with actors conducted in March 2002 (Switzerland), December 2002 – January 2003 (Japan) and April 2003 (the Netherlands). Interviews in person were supplemented by telephone interviews, as well as contacts via e-mails.

Interviewees included 5 government officials, 4 representatives from 2 manufacturers of the studied product groups, representatives of 7 organisations that coordinate/fulfil producers' responsibility on producers' behalf, 2 recyclers, 1 representative of a retailer organisation, 1 local government official, 1 representative of an association of waste management issues in local governments and 1 expert. The author used *interview guides*, the content of which varied depending on the interviewees. The list of interviewees, the timing and setting of the interviews are summarised in Appendix 2.

Information was collected primarily to understand what is happening in the respective programme as suggested by authors such as Patton (1987) and Stake (1995). In data collection, attention was paid to the following issues:

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[46] The shortage of reliable information on the EPR programmes for batteries was one of the challenges facing the author's previous research (Tojo et al., 2003).

- What activities take place within the EPR programme implementation related to the downstream infrastructure?
- What policy instruments constitute the particular EPR programme, and how do they relate to the activities?
- Who is responsible for the respective activities, and what types of responsibility do they bear?
- Among the activities where producers are responsible, how do they fulfil their responsibilities (individual or collective responsibility)?
- What are the perceptions of actors in the system regarding individual and collective responsibility?

In order to capture the characteristics of the respective programmes, the activities constituting the implementation of downstream requirements were broken down into smaller elements from two angles. With regard to the activities envisioned in EPR programmes (Figure 2-5), they were divided into *collection* and sorting of the discarded products, environmentally sound *recovery*, as well as *monitoring and enforcement* of these activities. Separate analysis of these activities was intended to clarify the content of EPR programmes.[47] Meanwhile, following the typologies suggested by Lindhqvist (1992) (Section 1.2.3), the author tried to distinguish *who* is fulfilling the three elements of responsibility – *physical, financial and informative* –, and *how* they are fulfilling them. This methodology has been useful in further clarifying how an EPR programme works.[48]

Once the functions and the types of responsibilities fulfilled by producers in the respective programmes were identified, the author examined how these tasks are carried out *individually or collectively* in concrete terms.

When identifying the actors and their responsibility, the relationship of the actors was investigated, with a view to investigate the potentials for various forms of individual/collective implementation and to learn the content and extent to which the actors communicate with each other.

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[47] See, for example, Tojo (2000), Lindhqvist (2000), Langrová (2002), Kim (2002), Tojo et al., (2003) and Tojo & Hansson (2004).

[48] Similar approach is used in, for example, Vanthournout (1998), Tojo (2000), Langrová (2002), Kim (2002) and Tojo & Hansson (2004).

3.3.3 Analysis and interpretation

Interviews conducted in person in Switzerland and the Netherlands were transcribed,[49] while telephone interviews were summarised. Furthermore, transcriptions and/or summaries were sent to some of the interviewees to confirm whether the author understood the interviewees correctly. Follow-up interviews was made via e-mail to some of the interviewees for clarification and confirmation.

The interview materials, as well as printed documents and web-based resources, were sorted in accordance with the issues presented in the previous section. The implementations of the five EPR programmes were systematically described, distinguishing the activities, type of responsibilities, actors responsible and the concrete manner of implementation.

Based on the findings from the respective programmes, a comparative analysis was made discussing the advantages and disadvantages of the individual and/or collective implementation of the respective tasks.

The comparative analysis, together with the findings from the first study then led to the systematisation of various forms of implementation of EPR programmes individually. Clarification of the meaning of individual responsibility in practice was made.

3.4 Other supporting studies

In addition to the two studies whose methodological approaches are described above, various opportunities were utilised to investigate the implementation of EPR programmes during the doctorate study period (maximum variation sampling). The most prominent ones include two studies commissioned by OECD conducted in August-November 2001 and in August-November 2002 respectively. [50] In these two studies, implementation practices of more than 20 EPR programmes for packaging, EEE, cars and batteries in selected OECD Member states were examined from various angles.[51] The attendance in conferences and meetings related

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[49] Except for two interviews in Switzerland where the tape recorder was not available.

[50] The findings of these two studies are found in Tojo et al., (2003) and Tojo & Hansson (2004).

[51] The first study, entitled "EPR Programme Implementation: Institutional and Structural Factors", evaluated the results of the implementation of EPR programmes for packaging,

to EPR programmes provided the author with invaluable opportunities to obtain insights from people that have varying interests in and experience with issues related to EPR programmes.[52] These people include government officials, industry representatives, academics, representatives of non-governmental organisations and the like. Furthermore, supervision of six masters' theses on the related topics enhanced the author's knowledge and understandings.

Findings and insights obtained from these activities are utilised in the overall analysis and interpretation of the two studies.

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batteries, cars and EEE. The results examined include: the achievement of collection, reuse and recycling rates, the stimulation of innovation, the costs of implementation, soft effects and approaches to overcome free-riders and historical and orphaned products. The study then examined the factors affecting the results of the programmes, such as characteristics of the products, type of enforcement, allocation of responsibility, financial mechanism, establishment of requirements, systems surrounding the products and the awareness and perception of affected actors in the society. The second study, entitled "Political Economy for Implementing EPR-based Policy Instruments", analysed the implementation of EPR programmes from the following angles: government institutional factors, institutional factors among firms, characteristics of products, physical and financial implementation mechanisms, transaction and administrative costs and competition and trade.

52 The conferences and meetings related to EPR where the author attended as a presenter since winter 2000 include two organised by OECD, four by universities in Lithuania, Sweden and the United States, seven by non-governmental organisations in Brussels, Canada, the United States, China and Hong Kong, one by a Swedish research foundation and one by the Ministry of Economy, Trade and Industry (METI) in Japan.

CHAPTER

FOUR

4. Presence of EPR legislation and design change

As discussed earlier, based on the author's interpretation of the EPR principle, the ultimate goal of an EPR programme is to promote total life cycle environmental improvements of product systems. Evaluation of the final outcome of a recently introduced EPR programme poses various challenges (see Section 1.3). Thus, utilising the intervention theory of a prototype EPR programme, the author investigated whether the presence of EPR programmes would lead to the achievement of some of the predicted intermediate outcomes.

One of these intermediate steps is upstream change. That is, *design changes in new products* to reduce environmental impacts from end-of-life and measures that facilitate these design changes. It is the effectiveness of EPR programmes in inducing these upstream changes that is the primary theme of this chapter.

As a background to the analysis, EPR programmes that are most relevant to the cases (manufacturers of EEE and cars in Japan and Sweden) are first briefly presented (Section 4.1). In addition to the EU directives and the national EPR legislation for EEE and cars, reference is made to other policy measures, such as legislation that aims to promote environmentally conscious design. This is limited to the extent necessary to understand the analysis and interpretation.

The subsequent two sections (4.2 and 4.3) present an analysis of the main findings from the cases. These serve as the "ingredients" of the effectiveness evaluation presented in Section 4.4.

Within 4.2, Section 4.2.1 briefly introduces the primary areas upon which the manufacturers interviewed focused their efforts related to environment. The discussion of the focus areas facilitates the understanding of the relative importance of the environmental impacts of end-of-life management for the

respective manufacturers interviewed. Section 4.2.2 subsequently summarises the actual upstream measures taken by the manufacturers in order to reduce environmental impacts from downstream at source, as well as other measures mandated by and/or envisioned in the implementation of EPR programmes to date. The undertaking of these measures itself serves as evidence of the attainment of immediate outcome of an EPR programme, as further discussed in Section 4.4.1 (*goal attainment* evaluation).

Section 4.3 presents the analysis of factors that either promote or hinder the undertaking of such measures. The presentation of the overview of the factors facilitates the understanding of the role of EPR legislation in light of other factors. This topic is considered separately in Section 4.4.2 (*attributability* evaluation).

The final section summarises the essential findings from the study.

Figure 4-1 indicates the scope of this chapter, as well as the issues discussed in the respective sections.

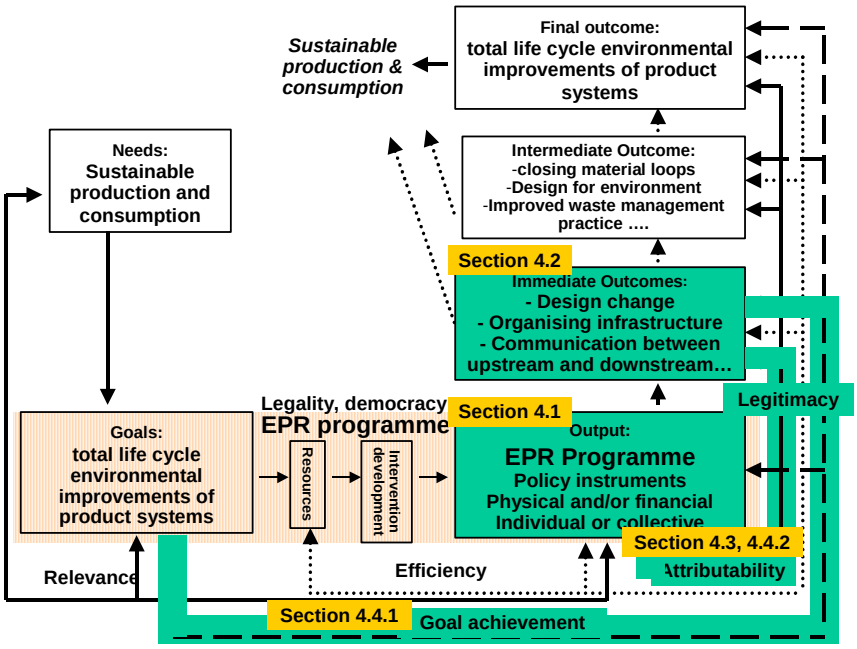

Figure 4-1: Issues discussed in the respective sections of Chapter 4

The findings of cases (Section 4.2 and 4.3), the essential "ingredients" for the analysis, constitute a substantial part of this chapter. Figure 4-2 to Figure 4-9 provide a brief overview of the content of Section 4.3. Readers who wish to familiarise themselves with the results of the evaluation without going through details can pass over Section 4.2, peruse the figures in Section 4.3 and then may resume reading from Section 4.4.

4.1 Status of the respective EPR programmes

This section provides an overview of legislation for end-of-life management of EEE and automobiles in Japan, Sweden and the European Union. The outline of the legislation is given, concentrating on the issues that are most relevant when analysing the reaction of the industries. Policy instruments used in the legislation are highlighted in italics.

4.1.1 EPR legislation for EEE

EPR legislation for EEE in Japan

Specified Home Appliance Recycling (SHAR) Law, Japan

The Specified Home Appliance Recycling (SHAR) Law in Japan, which was enacted in 1998 and fully came into force in 2001, is the second EPR programme in the country that legally assigns part of the responsibility for the end-of-life management of products to producers. The scarcity of final disposal sites,[53] the increase of EEE in the waste stream[54] and the inadequacy of existing treatment plants for handling EEE were the main driving forces for the enactment of the Law.

Under the programme, producers (manufacturers and importers) of four large electrical home appliance categories (TV sets, refrigerators, air

[53] As of April 2001, the remaining capacity of the final disposal sites was estimated to be 3.8 years for industrial waste and 12.2 years for municipal waste (national average) (MOE, 2003b; MOE, 2003e).

[54] The total weight of the discarded refrigerators, air conditioners, washing machines and TV sets was estimated to be 574 029 tonnes in 1994, while in 1998 the estimation went up to be 723 354 tonnes (MHW, 1999).

conditioners, and washing machines)[55] are required to take back their discarded products (*take-back requirement*), dismantle them and recover the components and material that can be reused or recycled (*recovery requirement*) (Article 17, 18, SHAR Law). The Ministerial Order sets differentiated reuse and recycling rate requirements of between 50 to 60% by weight for respective products (Article 4, Ministerial Order). This should be fulfilled by product reuse, component reuse, and material recycling with a positive monetary value (*reuse and recycling rate target*) (Article 2.1, SHAR Law). Producers should also establish regional aggregation stations,[56] where the discarded products collected by retailers and other actors are brought in (Article 17, SHAR Law). The Ministerial Order under the Law also makes it mandatory to collect and treat specific ozone depleting substances used as refrigerant media in refrigerators (Article 3, Ministerial Order). Environmentally sound treatment of printed circuit boards as well as the Cathode Ray Tubes in TV sets is required through the revision of another law, the Waste Management Law (*treatment standards*). Moreover, the Revised Law for Promotion of Effective Utilisation of Resources gave additional obligation to producers regarding design and material use. This will be further described in the following section.

Retailers, who have previously taken back approximately 80% of the four types of electrical home appliances (MHW and MITI, 1998) are, from 2001, required by law to take back old products when they sell similar new products and products that they themselves sold (*collection requirement*) (Article 9). As a back up for small manufacturers and importers and for products whose producers disappear (orphaned products), designated legal entities will conduct these duties on their behalf. Similarly, products coming from remote areas or whose retailers disappeared will be collected by local governments and designated legal entities (Article 8, 33.1-33.3).

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[55] The product categories covered by the legislation are determined by the government ordinance. They should be home appliances that meet all of the following four criteria: 1) difficult to be recycled under existing facilities and technologies possessed by local governments, 2) contain valuable resources that can be recycled and the cost for recycling is economically feasible, 3) whose design or selection of raw materials or components by the manufacturers exert a great influence on the recyclability and 4) be delivered mostly by retailers so that smooth take-back by retailers can be secured (Article 2.4).

[56] Regional aggregation stations are also referred to as regional storage stations or regional transfer stations. In this thesis, the word "regional aggregation station" is used.

End-users bear the responsibility of covering the costs for the end-of-life management of the products they discard (*end-user pays*) (Article 6, 11, 19, SHAR Law). In the meantime, retailers, local governments, manufacturers and importers must announce in advance the fee for collection, take-back, recovery and treatment (Article 13, 20, 34).

Revised Law for Promotion of Effective Utilisation of Resources

The Law for Promotion of Effective Utilisation of Resources (in short, the Recycling Promotion Law), enacted in 1991, generally promotes various measures that improve recycling. Under the law, manufacturers of specific product groups are advised to take various types of measures. For instance, manufacturers of large electrical home appliances that are now governed under the SHAR Law should take measures to facilitate design for ease-of-disassembly and recycling. Other measures advised include marking that facilitate separate collection of steel cans, material recycling of glass bottles, paper and the like.[57]

Even though the Recycling Promotion Law came into force and efforts on design change were made, the need to take measures for waste reduction and for efficient use of natural resources continued. Thus, together with the introduction of several other related laws, a revision of the Recycling Promotion Law came into force in April 2001 with its core being the promotion of the 3R (reduce, reuse, recycle) principle.[58]

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[57] With regard to large home appliances, the Industrial Structure Council under MITI developed a guideline that advised the industry to 1) improve material use, structure and ease of disassembly, 2) conduct assessment at the design phase taking into consideration the aspects suggested in 1) and 3) disseminate information and improve technology that would facilitate promotion of the use of recycled materials. For further description of the former law see, for instance, Tojo (2000, p.26).

[58] From 2000 to 2001, various legislation regarding the creation of a closed loop society was discussed, enacted or revised and came into force in Japan. This includes the coming into force of the Basic Law for Establishing the Recycling-based Society in January 2001, recycling laws for individual product groups such as food products and building materials, revision of the Recycling Promotion Law and the coming into force of the Law on Promoting Green Purchasing in April 2001. Together with the legislation and regulations that already existed, such as the Basic Environment Law, the Packaging Recycling Law and the SHAR Law, nine laws that directly promote the creation of a closed-loop society emerged.

The revision includes the specification of five areas where certain measures should be taken and the type of products/industry that fall under each area. Among these five areas, those that are relevant to EEE are the following.

1) Waste reduction through promotion of less material use and greater longevity of products (Article 18)
   Target: products that create large volumes of waste stream at the end of their life

2) Reuse of components and material recycling (Article 16, 21)
   Target: a) products whose parts and material can be reused or recycled
   b) industries whose products contain components that can be reused in a new product

3) Collection and recovery of end-of-life products by industries (Article 26)
   Target: products whose producers could collect and recover (reuse or recycle) their products when they come to the end-of-life phase

According to the Ministerial Order, the Ministry determines product groups that fall into the categories mentioned above. Personal computers, copier machines and large electrical home appliances (four appliances covered by the SHAR Law plus micro wave ovens and laundry dryers) have been included in the products whose application should be discussed under the following category: personal computer: 1, 2a and 3, copier machines: 2a and 2b, large electrical home appliances: 1 and 2a.

Requirements set in the areas under 1 and 2 are mainly related to design and material use of products. Examples for such requirements are: design for upgradability and longevity (1), reduction in the number and quantity of components (1), use of common parts (1), use of recycled materials (1 and 2b), establishment of repair networks (availability of repair parts and technicians, co-operation with retailers, etc.)(1), increase of remanufacturing (use of recovered components) (2a), development of plans for use of recovered components (2a), design for ease-of-disassembly and ease-of-replacement (2b), consideration to safety issues (1 and 2), conduct of assessment (1 and 2), use of packaging material giving similar consideration as products (1 and 2) and the provision of information (1 and 2).

The requirements for products falling into the category of area 3 (personal computers) have been discussed at the sub committee of the Industrial Structure Council under the Ministry of Economy, Trade and Industry (METI). From April 2001, manufacturers and importers of personal

computers have been required to set up a system for the collection and recovery of personal computers used in business. They could charge their customers for the fee necessary to fulfil this obligation (*end-user pays*). At the time of the research, the take-back requirements had not come into force for personal computers from private households. Disagreement regarding the financial mechanism was among the reasons why the introduction of the latter was postponed (Yamauchi, 2000, December 21). The take-back requirements for the computers from private households, accompanied an *advance disposal fee* system, started in October 2003.

Unlike the SHAR Law which made producers responsible for take-back itself, the wording on the Recycling Promotion Law says that producers are to voluntarily collect and recover their products. Some experts feared that these subtle differences in the wording might affect the strength of the legislation (Morishita, 2001, June 26).

EPR legislation for EEE in Sweden

In Sweden, the Ordinance on Producer Responsibility for Electrical and Electronic Products came into force on 1 July 2001. The aim of the Ordinance is "to create a driving force for producers to develop less environmentally burdensome products and simultaneously to achieve environmentally appropriate handling" (Regeringskansliet, 1998). The driving forces behind the legislation appear to be the concerns towards use of hazardous substances and efficient use of resources (Liljelund, 2000).

The Ordinance covers a wide range of products. They are categorised into ten groups: 1) household appliances, tools and garden equipment (except for refrigerators and freezers),[59] 2) IT (information and technology) and office equipment, 3) telecommunication equipment, 4) television, audio and video equipment, 5) cameras and photo equipment, 6) clocks and watches, 7)

[59] The exclusion of the refrigerators and freezers was due to the law addressing ozone-depleting substances, which led to the establishment of the collection and recovery system by local governments. Transposition of the EU WEEE Directive, which is due by 13 August 2004, requires these products as well as vending machines to be incorporated in the scope of the Swedish legislation.

games and toys, 8) lighting equipment, 9) medical equipment and 10) laboratory equipment (Section 4.1, Annex).[60]

Under the Swedish legislation, producers refer to professional manufacturers, importers and retailers. They are responsible for take back of an old product free of charge whenever they sell a similar new product (*take-back requirement*: old-for-new, one-for-one) (Section 5.1). They can either take back the product in the shops where they sell new products, or at a designated area upon consultation with local governments (Section 8). Once the products are taken back, producers must ensure that these discarded products are handled in an environmentally sound manner (*treatment standards*) (Section 9). If requested by the concerned municipality, producers have to consult with the municipality about the way of fulfilling their duties or present a detailed plan (*consultation with local governments*) (Section 13). They also have the following informative responsibility: information to 1) households and others about the new responsibility (*information for consumers*) (Section 10) and 2) pre-treatment plants about the content of EEE (*information for recyclers*) (Section 11). Finally, they are obliged to *report to the authority* as to how they fulfil their duty.

In the meantime, based on the Section 24-25 of the Public Cleansing Ordinance, a statute was issued by the Swedish EPA making it mandatory for discarded products to be treated at certified treatment facilities (*treatment standards*).[61]

EPR legislation for EEE in EU

Two EU directives related to waste EEE exist: one regarding producer responsibility for take-back, recovery and environmentally sound treatment of waste EEE (WEEE Directive). The other regarding restriction on the use of hazardous substances (RoHS Directive).[62] Officially proposed by the

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60 The Ordinance shall not apply to EEE in vehicles where the Ordinance on Producer Responsibility for Cars is applicable.

61 The Public Cleansing Ordinance (SFS1998: 902), Sweden.

62 These two directives were developed by DG (Directorate General) Environment of the European Commission. In May 2000, DG Enterprise drafted a directive on the impact on the environment of EEE. Often referred to as the Design Directive, this proposed directive mandated procedures that manufacturers of EEE had to follow with regard to product development. Further, it was suggested since 2002 that the Design Directive be incorporated in the Framework for Eco-Design of End Use Equipment, followed by the

European Commission in June 2000 after years of debate, the two proposed directives were, at the time of the interviews, going back and forth between the European Parliament and the Council of Ministers for their amendments and approvals.[63] The two directives officially came into force on 13 February 2003.

The WEEE Directive stipulates that its first priority is "the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste." The purpose also includes the improvement of "the environmental performance of all operators involved in the life cycle of" EEE, such as producers, distributors and consumers and especially those involved in the end-of-life management of EEE (Article 1, WEEE Directive). Meanwhile, the purpose of the RoHS Directive is to harmonise the legislation on material restrictions among EU Member states, and "to contribute to the protection of human health and the environmentally sound recovery and disposal of" WEEE (Article 1, RoHS Directive).

Products covered under the WEEE Directive are: 1) large household appliances, 2) small household appliances, 3) information technology (IT) and telecommunication equipment, 4) consumer equipment, 5) lighting equipment, 6) electrical and electronic tools (with the exception of large-scale stationary industrial tools), 7) toys, leisure and sports equipment, 8) medical devices (with the exception of all implanted and infected products), 9) monitoring and control instruments and 10) automatic dispensers (Article 2.1, Annex IA, WEEE Directive). At the time of the interviews, the products covered under the proposed RoHS Directive were still under discussion. In the end, among the 10 product categories covered under the WEEE Directive, 8) medical devices and 9) monitoring and control equipment were excluded from the initial implementation of the RoHS Directive, while electrical light bulbs and luminaries in households were added (Article 2.1, RoHS Directive).

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final incorporation in the framework directive on eco-design requirements for energy using products (EuP Directive) (ENDS, 2000, May 2; ENDS, 2002, November 7; ENDS, 2003, August 7).

63 See, for example, Council of the European Union (2001), European Parliament (2001a), European Parliament (2001b), ENDS (2001, May 16) and ENDS (2001, June 7).

The WEEE Directive requires producers to meet relatively high recovery targets by 31 December 2006. These are differentiated depending on the categories mentioned above. Substantial portions of these recovery targets should be achieved by component, material and substance reuse and recycling (*reuse and recycling rate targets*) (Article 7.2).[64] Member States shall ensure that the entities engaged in recycling, reuse and treatment shall have a permit stipulated in the general EU Directive on Waste.[65]

The Directive requires member states to achieve the collection target of 4 kg per person per year from private households by 31 December 2006 (Article 5.5). Member states should set up a system that enables private households to hand in WEEE at least free of charge (Article 5.2). Among these, retailers should accept an old product free of charge when they sell a similar new product (old-for-new) (Article 5.2 (b)). As for business waste, producers or third parties acting on their behalf should set up systems for the collection (Article 5.3). When the interviews were conducted, the collection target was moving between 4 and 6 kg.[66]

With regard to financial responsibility, the final WEEE Directive distinguishes between historical and new products (those put on the market before and after 13 August 2005) and between sources (from private households and from businesses). Namely, each producer has financial responsibility for the collection, treatment, recovery and the environmentally sound disposal of waste from their own products that are generated from private households and gathered in the aggregation stations. Producers may fulfil this responsibility individually, or by joining a collective scheme (Article 8.2). Meanwhile, the existing producers are collectively responsible for historical products from private households (Article 8.3). The provision concerning financing of business waste, which was separated from WEEE from private households, was revised in 2004.[67]

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64 Differentiated recovery rate of 70 and 80% by weight, and component, material and substance reuse and recycling rate of 50 to 75% is mandated.

65 Council Directive75/442/EEC of 15 July 1975 on waste. OJ L 194, 25/07/1975 P. 0039-0041.

66 See, for example, European Parliament (2001b), COM (2003) 301 final, ENDS (2001, February 6),ENDS (2001, May 16) and ENDS. (2001, June 7).

67 The EU WEEE Directive that came into force in February 2003 (Directive 2002/96/EC) stipulates that the financial responsibility for the discarded products from non-household consumers, which are put on the market after 13 August 2005, are to be

It should be noted that when interviews were conducted, the distinction between new and historical products had not been made. In fact, the issue of individual versus collective responsibility, as well as who should be responsible for historical and orphaned products were among the issues most heavily debated.[68] The timing when the producers must fulfil their responsibility was changing as well.

In addition to these responsibilities, the Directive requires producers to provide treatment plants with information on the different EEE components and materials, the location of dangerous substances in EEE (*information for recyclers*) (Article 11). The marking of new products, suggesting that WEEE should be collected separately from the rest of the household waste, is also required (*information for consumers*) (Article 10.3).

The RoHS Directive prohibits the use of lead, mercury, cadmium, hexavalent chromium and two brominated flame retardants (polybrominated biphenyls: PBB and polybrominated diphenylethers: PBDE) from 1 July 2006, although there are certain exemptions (*material restrictions*) (Article 4.1-4.2). When the study was conducted, the timing of the prohibition was moving between 2004 and 2008[69] and what should be restricted was under debate. The final RoHS Directive contains a provision that allows Member states that have already taken measures to restrict the use of these substances to maintain such measures until their adoption of the RoHS

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borne by producers (Article 9 Paragraph 1). For the historical products (those put on the market before 13 August), the provision states that producers shall bear financial responsibility for the end-of-life management unless the Member States make the non-household consumers partly or fully responsible (Article 9 Paragraph 2). According to the Commission, this implies individual responsibility for both historical and new products for business waste (Commission Proposal COM (2003)219 final). It was perceived to put relatively heavy burden on producers that had large market share in the past when compared to the new players in the market. Thus, the Commission made a proposal to amend this clause. The amendment was adopted in the beginning of 2004. The amendment applies old for new rules to producers with regard to financial responsibility of historical products, while the cost of end-of-life management of the discarded products that are not replaced by similar new products will be born by the consumers (Article 1 Paragraph 3-4, Council Directive 2003/108/EC). For new products (put on the market after 13 August 2005), the amendment of 2004 retains the same clause as the Directive that came into force in 2003. (Article 1 Paragraph 1, Council Directive 2003/108/EC)

68 See, for example, ENDS (2000, October 19), ENDS (2001, January 8) and ENDS (2001, February 23).

69 See, for example, ENDS (2000, December 6) and COM (2003) 301 final.

Directive on 1 July 2006 (Article 4.3). However, this provision did not exist at the time when the interviews were conducted.

4.1.2 EPR legislation for end-of-life vehicles

EPR legislation for end-of-life vehicles in Japan

Approximately 5 million cars annually come to the end-of-life in Japan (Industrial Structure Council, 2001). Existing dismantlers and scrappers have historically have handled these end-of-life vehicles rather smoothly. With their high content of metals, end-of-life vehicles have had positive monetary value, and the system works naturally based on market mechanism. However, concerns on the continuation of conventional end-of-life management of cars have been raised by challenges such as: 1) hazardous substances in auto shredder dust such as lead, 2) pressing scarcity of final disposal sites, and 3) increase of disposal costs due to increases in disposal fees to the landfill (MITI, 1997).[70]

An initial policy response was the original Recycling Promotion Law of 1991, which specified cars as products whose manufacturers should strive for, among other things, promotion of design change for end-of-life management. Based on the legislation, the Japanese Automobile Manufacturers Association (JAMA) developed a "Product Assessment Guideline for the Promotion of Recycling" in 1994. Further, MITI developed and announced "Recycling Initiatives for End-of-life Vehicles" in May 1997, which was to serve as a guideline for proper recovery of end-of-life vehicles. Voluntary in nature, the Initiative was an "integrated policy package that systematically combined related legislation, guideline and the like" (JEMA, 1998). The Initiative achieved certain improvements, such as the establishment of higher recycling rate targets and targets for reduction on the use of lead, the establishment of systems for the collection and destruction of ozone depleting substances and the collection of air bags (Industrial Structure Council, 2001).

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[70] The revised Waste Management Law in 1996 put more stringent requirements on the disposal sites where auto shredder dust could be landfilled. This led to the increase of landfill cost, and further scarcity of landfill space. Consequently, concern on the increase of illegal dumping and improper treatment had risen even more (MITI, 1997).

However, these measures did not resolve the problems of waste generation (final disposal of shredder waste), and concerns about the increase of illegal dumping had arisen. The situation subsequently became worse due to the decrease of the value of recovered metals in the market. Consequently, in the revised Recycling Law of 2001, cars are categorised in Area 1 and 2b described in Section 4.1.1.

Furthermore, when the study was conducted, a separate piece of legislation to further deal with the problems mentioned above was discussed in the Automobile Recycling Working Group of the Industrial Structure Council under METI.[71] The interim report published in April 2001 by the Working Group proposed the enactment of legislation, the content of which is described below.

The Legislation would make manufacturers and importers responsible for take-back and proper treatment/recycling of ozone-depleting substances used in the air conditioners of cars, air bags and shredder waste (*take-back and recovery requirement*). Car dealers (retailers) and repair shops would be responsible for accepting the end-of-life vehicle, for handing it to treatment plants that receive permits from the government, for provision of a traceable receipt and for confirming proper treatment. Dismantlers, shredders and recyclers of auto shredder dust would be responsible for recovery of usable components and recycling of metals, while requesting manufacturers and importers to take back air bags, ozone depleting substances and auto shredder dust (Industrial Structure Council, 2001).

As for the financial mechanism for the take-back and proper treatment/recovery of air bags, ozone depleting substances and auto shredder dust, various proposals have been made. In the meantime, the financial mechanism to put an *advance disposal fee* on top of a new product was gaining ground (Nippon Keizai Shinbun, 2001; Morishita, 2001, June 26).

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[71] The re-organisation of the government structure in 2001 made the following changes to the governmental agencies related to this thesis. The Environmental Agency became the Ministry of the Environment (MOE). The section in charge of waste management within the Ministry of Health and Welfare was incorporated into MOE. The Ministry of International Trade and Industry (MITI) became the Ministry of Economy, Trade and Industry (METI).

It was anticipated that a draft regulation would be presented to the Diet in spring 2002. The largest anticipated hurdle was the opposition from the existing scrappers (Morishita, 2001, June 26).

The legislation was enacted in July 2002 and will fully come into force in January 2005. The content of the legislation remained the same as what was proposed in the interim report. Additionally, *recovery rate targets* of more than 30% after 2005, 50% after 2010, and 70% after 2015 for auto shredder dust are set (METI & MOE, 2003a).[72] With regard to the financial mechanisms, the legislation stipulates that the first buyer pays an advance disposal fee at the purchase of a new car with the fee being pooled in a common recovery fund until the purchased car is discarded. For the existing 76 million cars in the market, the users should pay the fee when mandatory check-up of cars takes place.

EPR legislation for end-of-life vehicles in Sweden

In 2000, 159 000 passenger cars came to their end of lives in Sweden (BIL Sweden, 2001). A deposit-refund like system for cars was introduced in 1975 to deal with the problems of littering and scrappers' improper treatment of materials such as engine fluids. The system has been successful in reducing the problem of littering, and in improving scrapping by providing scrappers with economic compensation for ensuring environmentally appropriate treatment (Lindhqvist, 2001, p. 9). However, the scheme was criticised for not providing incentives to car manufacturers to incorporate consideration for end-of-life management of their cars at the design phase (Lindhqvist, 2001, p. 7).

In 1997, an EPR system was introduced via legislation as a replacement of the conventional deposit-refund system, the Ordinance on Producer Responsibility for Cars. It makes manufacturers and importers of cars responsible for accepting end-of-life vehicles free of charge if the cars have been registered for the first time after 31 December 1997 (*take-back requirement*) (Article 2). Cars that were put on the market before that date would continue to be covered by charges on new cars. Manufacturers and importers also became responsible for the establishment of a system that took care of end-of-life vehicles, regardless of their age (*establishment of*

[72] According to METI & MOE (2003a), this is equivalent to 95% reuse and recovery rate target of the whole vehicle by 2015.

infrastructure) (Article 3). A reuse and recycling target of 85% to be achieved by 2002 was set, which will be extended to 95% from 2012 (*reuse and recycling rate target*) (Article 7). In December 2000, the Ordinance was amended to incorporate parts of the then newly born EU Directive (Lindhqvist, 2001, p.10-11).

EPR legislation for end-of-life vehicles in EU

Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles (ELV Directive) stipulates as its objective to lay down "measures which aim, as a first priority, at the prevention of waste from vehicles and, in addition, at the reuse, recycling and other forms of recovery of end-of life vehicles and their components so as to reduce the disposal of waste, as well as at the improvement in the environmental performance of all of the economic operators involved in the life cycle of vehicles and especially the operators directly involved in the treatment of end-of life vehicles" (Article 1).

The Directive addresses vehicles and end-of-life vehicles, including their components and materials. It requires member states to encourage manufacturers to work on design for end-of-life, to use less hazardous substances, and to increase the use of recycled materials (Article 4.1). It also prohibits the use of lead, mercury, cadmium and hexavalent chromium after 1 July 2003 (with specified exceptions) (*material restrictions*) (Article 4.2(a)).

The economic operators shall set up collection systems with adequately available collection facilities (*establishment of collection infrastructure*). The vehicles shall be transferred to authorised treatment facilities and specific guidance given regarding the treatment operation (*treatment standards*). Member states shall establish a system where receiving certificates of destruction is a condition for de-registration of the end-of life vehicles (Article 5.1 -5.3).

The last holder and/or owner must be able to hand in the vehicle, free of charge, to an authorised treatment facility even when the vehicles have no value or a negative market value. Moreover, member states shall "take the necessary measures to ensure that producers meet all, or a significant part of the costs of the implementation of this measure" (Article 5.4). This

requirement applies to cars that are put on the market from 1 July 2002 and to any cars put on the market from 1 July 2007 (Article 12.2).[73]

The Directive sets the minimum reuse and recycling rate requirement of 85% by weight, 80% of which should be fulfilled by reuse and recycling by January 2006 with the exception of cars that were produced before January 1980.[74] The requirements subsequently go up to 95% (reuse and recycling rate) and 85% (reuse and recycling) by January 2015 (*reuse and recycling rate targets*) (Article 7.2).

In addition, there are standards for component and material coding (*labelling requirements*), and producers must provide treatment plants with dismantling information (*information for dismantlers*) (Article 8).

4.2 Measures taken by manufacturers

This section presents the analysis of the concrete measures taken by the interviewed manufacturers of EEE and cars in Japan and Sweden. The interviews focused upon measures taken to reduce environmental impacts from their products and product systems. It first describes the focus areas within overall strategies of the companies to reduce environmental impacts from products and product systems and the measures to identify such areas (Section 4.2.1). This corresponds mainly to the aggregated findings on the issue 1 of the interview guide presented in Box 3-1.

Section 4.2.2 summarises the actual upstream measures taken by the interviewed companies in relation to reducing the environmental impacts from the end-of-life management of their products, as well as other measures mandated by/envisioned in the EPR programme to date (issue 2 of the interview guide). The latter measures include the development of downstream infrastructure, the development of feedback mechanisms between downstream and upstream and the like. The rationale of EPR programmes currently introduced is to extend the responsibilities of manufacturers to the end-of-life management of their products in order to provide the manufacturers with incentives to take into account

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[73] This is not the case when "the end-of life vehicle does not contain the essential components of a vehicle, in particular the engine and coachwork, or contains waste which has been added to the end-of life vehicle" (Article 5.4).

[74] The requirements go down to 75% (reuse and recovery) and 70% (reuse and recycling).

environmental impacts generated from the end-of-life management of their products. Therefore, although the focus of this chapter is upstream changes, activities occurring downstream or between downstream and upstream are also discussed in order to understand the linkage between these different measures. As discussed in Section 2.3, these measures constitute part of the intervention theory of a prototype EPR programme.

Interviews with the manufacturers, as well as the materials provided from them, such as environmental reports, internal presentations and guidelines are the sources of the information presented in this section, as well as Section 4.3, unless otherwise mentioned. Measures/visions presented here are those implemented/discussed at the time of the interview. Due to the confidentiality of the obtained information and requests from some interviewees, references to individual companies/interviewees are not made. Findings from the respective product sectors in the two countries are presented separately.

As mentioned in the introduction of this chapter, readers who wish to familiarise themselves with the results of the evaluation without going through the details can find the synthesis of the findings in this section in Section 4.4.1 (page 148). Figures in Section 4.3 (page 114) provide an overview of the findings regarding the factors influencing the manufacturers' undertaking of upstream changes.

4.2.1 Focus areas

EEE manufacturers in Japan

The majority of the interviewed manufacturers produce a wide range of products, from large and small home appliances, personal computers, telephones and copying machines to elevators, switch boards, satellites and the like (see Appendix 1). Therefore, focus areas, both in terms of the life cycle of products and environmental aspects, vary from products to products.

Environmental product assessment procedures have been put in place in all the nine manufacturers interviewed,. Evidence of life cycle thinking was found in all the firms, and has been incorporated into the assessment procedure. Three common assessment areas found in all the nine

manufacturers include 1) energy efficiency, 2) reduction of hazardous substances and 3) resource efficiency and recyclability.[75] Some companies also include information disclosure as part of the assessment area, while others discuss it as an important measure to be taken. Combination of different tools, including life cycle assessment (LCA), checklists, design guidelines, recyclability assessment and the like, are used to evaluate environmental performance of products from different angles. Some companies started environmental product assessment as early as 1991, while others started in the latter half of the 1990s.

All but one of the companies interviewed have established specific standards for "green" products within the assessment areas mentioned above. In general, these standards take into consideration the content of existing and anticipated legislation, Type 1 eco-label criteria, environmental performance of suppliers, superiority to competitors, access to information, company's own environmental policy and the like. The content of standards, as well as the process of making the judgement, differ from company to company. Seven companies put a label on these environmentally superior products, while one company distinguishes these products internally in the registration system.

Regarding energy efficiency, the result of LCA studies conducted with CO_2 emissions as a proxy for total life cycle impact are used to identify the phases of the life cycle that have high impacts.[76] Large home appliances, personal computers, copying machines are among the products whose CO_2 emissions are highest at the use phase.[77] A number of interviewees mentioned the linkage between the improved energy efficiency of the use phase of these products and consumers' direct economic interests as a factor that propels

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[75] The word "recyclability" here encompasses broad issues, as discussed further in this section as well as in Section 4.2.2.

[76] Use of LCA as a tool to select suppliers has been difficult, as the suppliers were reluctant to disclose information. Either they do not have requested information, or they are afraid of being abandoned by their customers (i.e. producers). At the moment, average data from the same industry group (e.g. steel industry, electricity provider, etc.) could be obtained through the respective industry associations. However, it was anticipated that the legislation on PRTR (pollution release and transfer register) would facilitate information gathering from the individual suppliers instead of getting an average figure from the industry associations (See Section 4.2.2).

[77] It has been noted, however, that in the case of personal computers the energy consumption is higher in the material and component manufacturing and production phase of the life cycle than use phase. For further discussion, see Plepys (2004).

them to work on this issue. Other promoting factors mentioned by the majority of interviewees include the Kyoto Protocol to the UN Framework Convention on Climate Change, followed by a revision of national legislation on energy efficiency based on the "top runner approach".[78]

The other two areas (reduction of toxic substances, resource efficiency and recyclability) are both related to upstream measures that address environmental impacts from end-of-life management and are discussed further in Section 4.2.2.

EEE manufacturers in Sweden

The types of products manufactured by the respective companies vary, from medical equipment, mobile telephone systems to large and small household equipment, computers and mobile phones (see Appendix 1). Therefore, focus areas both in terms of phases of the life cycle of products and environmental aspects differ from company to company.

All the interviewed manufacturers have practiced environmental product assessment based on life cycle thinking. However, the procedures for the assessment and the tools used vary. For example, in one company an environmental design guideline is used as a handbook, while specific environmental criteria is integrated in the product specification phase. As a way of determining focus areas to work on another company uses a rating system. The process of rating comprises an assessment of compliance with: 1) relevant legislation, 2) different national standards such as eco labelling scheme and 3) goals set up by the company. One interviewee mentioned the combination of life cycle assessment, material impacts assessment and the experiences of designers as tools to identify focus areas. According to an interviewee from another manufacturer, a corporate environmental plan, containing among other things instructions to designers and relevant legislation, has been a "bible" for the designers. Areas to look at mentioned by the interviewees include energy, material use (related to both resource extraction and end-of-life management, among other things), acoustics, packaging and water consumption. Referring to their LCA studies, some interviewees mentioned that their primary focus area has been energy

[78] In a "top runner approach", a manufacturer that has the highest technological standard within the same industry becomes the legislative standard of the industry. The rest of the industry must meet the standard equivalent to the "top runner" manufacturer in a given time frame.

consumption. According to one interviewee, reduction of electricity costs for the consumers has made it easy to "sell" the improvement in energy consumption.

Commenting on the companies' role as OEMs and extensive outsourcing practices, some interviewees stressed the importance of working with suppliers as an important factor for their design for environment strategies. This issue is discussed further in Section 4.2.2.

Car manufacturers in Japan

All the interviewed companies regard the emissions and energy consumption (fuel efficiency) during the use phase as important areas to work on. Rigorous efforts have been made on the development of alternative fuels and drive systems, for instance fuel cells, adhesive fuel compatibility, electric cars and hybrid cars, as well as engines. A few interviewees mentioned legislation in various countries, as well as demand from consumers as the driving factors in their efforts. With regard to the method of identifying focus areas, a few interviewees referred to an LCA tool developed by the Japan Automobile Manufacturers Association. Other manufacturers commented on their own LCA studies. Issues on end-of-life management and the use of toxic substances within components have become more prominent since the beginning of the 1990s. Apart from those related to manufacturing, other issues suggested include the mode of transport of the products (new cars), various impacts at the production phase, noise at the use phase and the like. One interviewee mentioned that the Product Planning Division of the company had been selecting the focus areas, taking into account the necessity of dealing with various competing properties and costs associated with them.

Car manufacturers in Sweden

Just as the case with the Japanese manufacturers, emissions and fuel consumption during the use phase were mentioned as important areas to work with. Legislation on the emission requirements in various countries, increasing awareness of climate change and demand from customers were mentioned as factors explaining the importance of these issues. For example, an interviewee from a truck manufacturer mentioned that their customers, for instance manufacturer of a product who uses trucks for transportation of his/her products, when identifying transportation as one of the important environmental aspects to work on in their products' life,

requested the truck manufacturer to increase fuel efficiency and thus reduce CO_2 emission. As a way of achieving this, the use of materials that contributes to light-weighting, such as aluminium, thermoset plastics with glass fibres and thermoplastics, was mentioned. Environmental impacts from the production phase, such as avoidance and treatment of waste, avoidance of hazardous substances such as lead and organic tin as well as use of clean paint shops, were also mentioned as important aspects. One interviewee found importance in the reduction of environmental impacts at production sites from the viewpoint of keeping a good relationship with local communities. Improvement of indoor climate and the reduction of substances that may induce allergic reaction was another focus area for a truck manufacturer in order "to attract best drivers".

Meanwhile, measures to reduce environmental impacts from end-of-life management have been implemented for some time, as discussed further in the subsequent section. One interviewee, reflecting upon their advancement in design for end-of-life and the relative cost it requires to be "good" in this area compared to the cost to be "good" in the area of fuel efficiency, commented as follows: "… we … think that fuel economy is not important, emissions are very important, recycling is important but not to that extent…" He considered their work on recycling as a potential "profile booster". All the manufacturers interviewed have lists of restricted substances that should be phased out/reduced.

4.2.2 Measures related to design for end-of-life

This section discusses two types of measures taken by manufacturers of the respective four groups (EEE and car manufacturers in Japan and Sweden). The first type of measures concern design changes that primarily aim to reduce the environmental impacts from end-of-life management of new products. The other measures are mandated by/envisioned in EPR programmes implemented to date other than upstream measures, such as development of infrastructure for collection and recovery, communication system between upstream and downstream and the like.

EEE manufacturers in Japan

Upstream measures

As discussed in the previous section, the reduction of the use of hazardous substances as well as enhancement of resource efficiency and recyclability, are two of the main areas that the interviewed manufacturers have been working on with regard to the environmental improvement of their products and product systems.

Measures concerning the reduction of the use of hazardous substances generally have taken the forms of 1) checking and controlling substances included in their products and 2) in-house research and development.

The former has typically started with the development of a list of hazardous substances that should be banned, restricted or controlled. Substances in the list include relevant national as well as international legislation, complemented by the substances decided by respective companies. The list has been communicated internally as well as to the suppliers of materials and components through purchasing. Namely, all the interviewed companies have developed a green procurement guideline for their suppliers. The requirements in the guideline generally consist of the environmental quality of suppliers' activities, such as the implementation of environmental management systems, and the environmental properties of their products, including the use of listed substances. A comprehensive database for the companies was under development, which would enable designers to directly access the information obtained from the suppliers. The database of one company enables the designers to assess the degree of toxicity of the products based on the selected components and materials.

The efforts of developing such databases are coupled with the development of information management systems for toxic substances at manufacturing facilities, required by PRTR (pollution release and transfer register) legislation that came into force in 1999.

Many challenges were faced when gathering information from suppliers. One interviewee mentioned that when they had started to ask suppliers, many of the suppliers did not have the required information. It was especially difficult for component suppliers that purchase materials and parts used in the components. According to another interviewee, the PRTR legislation enhanced the information management on the use of toxic

substances from suppliers. It also helped to gather information from suppliers on other environmental aspects such as energy use.

Meanwhile, intensive research and development has been conducted on the elimination/reduction of hazardous substances such as lead, halogen compounds, hexavalent chromium, as well as ozone-depleting substances. Examples include development of lead-free solder, halogen-free flame retardants, chromium-free metal plates, coolant and foaming agent free of ozone-depleting substances and the like. Among which, the development of lead-free solders was most referred to by the interviewees. A number of interviewees mentioned the timing when the companies intended to completely eliminate the use of lead-based solders or to reduce its use by half. Table 4-1 summarises the type of development, the number of companies interviewed that mentioned such efforts in their environmental reports, and examples of commercial application and stated targets found in the reports.[79]

Meanwhile, the enhancement of resource efficiency and recyclability has been addressed through, for example, reduction of material use, prolongation of products' life, ease of disassembly, reuse and recycling of components and materials and the use of recycled materials. Apart from these measures directly related to the products, all the companies interviewed have been striving for reduction of packaging. The majority of the companies interviewed have integrated the design categories related to resource efficiency and recyclability into their product assessment tools. Some companies specifically link these categories to 3R (reduce, reuse, recycle), the core of the revised Recycling Promotion Law of 2001 (Section 4.1.1). In addition to integration into product assessment tools, some companies have developed special tools to assess issues surrounding end-of-life management, such as ease of assembly/disassembly, recyclability of selected materials and the costs associated with it. Two manufacturers developed specific tools and/or policy for design for end-of-life around 1993, while two more developed specific tools in 1998-9. Two more commented on the tools for design for end-of-life in their environmental report from 1998 and 2000 respectively.

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[79] Developments mentioned in the table, as well as others, may well have been undertaken without being stated in environmental reports. Likewise, examples of commercial applications and stated targets are by no means exhaustive. However, the appearance of these efforts on the environmental reports seems to suggest that the respective companies consider it important to communicate these efforts to the public.

Table 4-1: Examples of measures taken in relation to elimination/reduction of hazardous substances by EEE manufacturers in Japan

Type of Development	No. of companies*	Examples of commercial application / stated targets (as of 2000)**
Lead-free solders	9	• Large computers (since 1989), head-phone stereos and portable MD players (tin and silver based) • Lap-top computers, 8mm cameras, washing machines and air conditioners (tin, silver and copper based) • Application in video player (tin and copper based) • Complete elimination by the end of 2002, by March 2003, by the end of 2003 • 50% reduction by the end of 2002 • 50% reduction for the products sold in 2001, compared to 1997 level
Halogen-free flame retardants	8	• Covers and printed circuit boards of personal computers and TV sets • Internal cover of air conditioners and washing machines • Application of silicon based flame retardants in personal computers, liquid crystal display monitors and projectors • Elimination of PBB and PBDE by September 2000
Elimination/ Reduction of PVC	7	• PVC-free cables, metal plates, TV covers • 50% reduction from cables by 2001 compared to 1997 level • Complete elimination by March 2003
Substitution of Ozone-depleting substances	4	• Hydrocarbon cyclopentane as a foaming agent instead of HCFC-141b • HFC R410 in air conditioners • Reduction of use of HCFC-141b by 94% • Complete elimination of HCFC by December 2004
Elimination/ Reduction of Chromium VI	3	• Application of chrome-free metal plates in all the products from 2001 • Chrome-less metal plates in personal computers, telephone exchange stations • Chrome-free audio tapes

Source: Fujitsu (2000), Hitachi (2000), Matsushita (2000), Mitsubishi (2000), NEC (2000), Ricoh (2000), Sharp (2000), Sony (1999), Toshiba (2000).
* The number of interviewed companies that mentioned measures related to the respective development in their environmental report in 2000.
** Examples are not exhaustive.

Measures taken to reduce material use include miniaturisation and light-weighting of products were found in the cases of personal computers and mobile phones. Concerning prolongation of products' life, modular design and component reuse, design for upgradability, reconditioning of products and remanufacturing are among the typical measures taken. Primary examples of the latter have been found in companies producing office equipment. For example, 60% by weight of all the materials used in a 1997 model of a copying machine consisted of reused components taken from the 1993 model. Modular design that would allow the reuse of components from the current models in future products, though challenging, was also initiated. A producer of computers also started to collect components from old rental products as spare parts in 1999. Collection and reuse of toner cartridges has been one of the common initiatives taken by manufacturers of printers. One interviewee commented on the difficulties of guaranteeing the quality of reused components. According to another interviewee, design for upgradability between different generations, especially between the current model and future model compared to between the past model and current model, has been difficult due to the longevity of the products.

Typical design changes for ease of dismantling and enhancement of recyclability include reduction of the number of components, design for disassembly, use of metal instead of plastics, unification of the grade of plastics, increased use of recycled plastics in new products and the like. All of these measures would contribute to the shortening of dismantling time[80] and increase the potential for reusing/selling parts/recycled materials, leading to cost reduction/increased profitability associated to end-of-life management. Table 4-2 summarises examples of criteria and concrete measures taken under the respective assessment categories related to products, found in the environmental reports of the companies interviewed.

As manufacturers interviewed were OEMs and did not have technological expertise on materials, they need to co-operate with material suppliers. For instance, one company started to work together with material suppliers and research institutes to develop recyclable plastics. Another collaborated with a steel board manufacturer and developed chrome-free board.

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[80] Two companies explicitly mentioned the reduction of dismantling time as one of their targets.

Table 4-2: Examples of criteria and concrete measures taken to enhance resource efficiency and recyclability by EEE manufacturers in Japan

Assessment categories	Examples of criteria and concrete measures (concrete measures in parentheses)*
Reduction of material use	• Light-weighting (e.g. 10% reduction by reducing 9 components in air conditioners) • Material reduction (e.g. 35% reduction of copper wire used in the compressor of air conditioners by adopting concentrated winding system) • Miniaturisation (e.g. lap-top computers, mobile phones)
Prolongation of products' life	• Modular design/component reuse (e.g. copying machines, interior of trains, toner cartridges) • Upgradability (e.g. provision of upgrading service for personal computers) • Reconditioning (e.g. copying machines) • Remanufacturing (e.g. copying machines) • Ease of repair and maintenance (e.g. securing spare parts, structure that is easy to disassemble)
Ease of disassembly /separation	• Unification of materials (e.g. use of PS for components as well as for screws. Abolishment of use of composites of metal and plastics in TV sets) • Reduction of number of components and screws (e.g. by 22% in 2000 compared to 1997 models in TV sets; from 81 to 66 in video camera, by unifying components) • Reduction of assembly steps (e.g. from 3500 steps to less than 2000, copying machines) • One-direction disassembly (e.g. washing machines) • Use of standard screws (e.g. TV sets) • Design for disassembly (e.g. disintegration of battery from the main body of mobile phone) • Use of screws instead of glue (e.g. TV cabinets)
Recyclability of materials	• Unification of materials (e.g. use of magnesium alloy for TV cabinets and personal computers: 6 companies, standardisation of types and grades of plastics: 5 companies, e.g. from 1200 types to l09 in 1999) • Labelling of plastics (6 companies) • Development of stickers that can be melted together with plastics • Increased use of metals • Metallic painting • Development of "eco-polica", a type of plastic with low-flammability which can be recycled more than 5 times and produce no dioxin • Use of recycled plastics (e.g. 30% in copying machines, 20% in specific computers)

Source: Fujitsu (2000), Hitachi (2000), Matsushita (2000), Mitsubishi (2000), NEC (1999), NEC (2000), Ricoh (2000), Sharp (2000), Sony (1999), Toshiba (2000).
* Although more than one examples were found for most of the criteria, only one or a few examples are given to illustrate the measures.

Other measures

In addition to measures directly related to the design change of their products, all of the manufacturers interviewed had been striving to establish collection and recovery infrastructure for their products discarded from the final users. This had also led to the enhancement of communication between recyclers and designers.

With regard to large electrical home appliances, prior to the enactment of the SHAR law in 1998 a few manufacturers interviewed initiated experimental projects to assess and enhance the ease of disassembly and recycling. These projects were conducted internally or in collaboration with existing skilled recyclers. Apart from the individual efforts, the Association for Electric Home Appliances conducted a few experiments for all of its members, using technologies that some of their leading member companies had obtained (Tojo, 2000).

In order to fulfil the requirements in the SHAR law, producers gathered together and developed two groups. One group consists of manufacturers who agreed on utilising the existing infrastructure as much as possible. For collection, they had a large number of retailers selling their brand products, and decided to utilise these retailers for take-back obligation. Likewise, except for the plants that they manage themselves, as discussed below, they made contracts primarily with existing recyclers and worked with them. The other group consists of manufacturers who agreed on establishing their own recycling plants and recycle their end-of-life products themselves.

All the manufacturers of large appliances interviewed belong to one of the two groups. Within their group, they have co-operated with each other in the establishment of regional aggregation stations, take-back networks as well as recovery and treatment facilities. However, each manufacturer manages at least one treatment plant, which is also true of the manufacturers that agree on utilising the existing infrastructure as much as possible. By doing so, the companies try to compile and communicate information from the downstream to the upstream, accumulate knowledge on recovery technology and grasp the actual cost for recovery and environmentally sound treatment of their discarded products.

The SHAR Law came into force on 1 April 2001. When the author conducted the interviews in December 2000 and January 2001, the interviewed manufacturers had either already started the recovery operation or were at the stage of testing plants for full operation in April 2001. A

company that established a plant in 1999 pointed to the benefits of gaining various information from their recycling plant. For example, a 3-day seminar was held for designers, inviting lecturers from the recycling plant and letting designers experience the dismantling of a discarded product.

While the fee for take-back, recovery and treatment announced by the large manufacturers (all interviewed companies belong to this group) turned out to be the same, smaller manufacturers and importers have given different fees. However, the interviewees producing large home appliances mentioned that the fees set up for recovery were far beneath the actual costs. The details of the actual collection and recovery infrastructure of the large home appliances are discussed further in Section 5.1.1.

Concerning computers, some producers had started take-back of computers from business users even before the revised Recycling Promotion Law came into force, with the cost born by the users. The companies that produce personal computers but not electrical home appliances had started developing their own recycling plants relatively early.[81] For example, one of the computer manufacturers established the first recovery centre in 1995 and has been running 5 recovery centres nationwide since 1997. In addition to regular communication via Intranet, the exchange of information between recycling plants and product design department has been taking place by way of periodical meetings among the personnel involved.

Known as one of the most advanced product areas for their efforts of closing the material loops, companies producing office equipment have been striving for the establishment of a collection and recovery network as an integral element to enhance recovery activities. One company has established an information system that connects the necessary data for the development of upgradable products, the improvement of recyclability and the optimisation of distribution system that combines upstream and downstream. The manufacturer established 9 recycling plants and 18 collection sites nationwide.

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[81] All prominent household appliance manufacturers in Japan also produce personal computers. An interviewee from a computer manufacturer mentioned that the company would like to be ready with infrastructure when the large home appliances are ready with their infrastructure. When the large home appliance manufacturers established their collection and recovery network for large home appliances mandated by the SHAR Law, they would be automatically be ready for personal computers. The computer manufacturer wished to avoid the disadvantage of being late in developing the downstream infrastructure.

EEE manufacturers in Sweden

Upstream measures

Among the upstream measures taken by the Swedish EEE manufacturers in relation to decreasing the environmental impacts from end-of-life management of their products, a focus area appeared to be the reduction of hazardous substances. Similar to the situation in Japan, measures include checking and controlling the substances contained in the materials and components provided by the suppliers, as well as in-house research and development.

The majority of the interviewees referred to the lists of substances the respective companies try to have control over. The list of restricted substances in one company consisted of regulated substances and those that were not yet regulated but the company believed would be regulated. In another company, in addition to hazardous substances, valuable substances such as silver and gold were also included.

All the interviewees referred to their efforts on communication with suppliers. One interviewee showed the author an extensive database where suppliers themselves could place the requested information (type of substances used in the components/ materials and its quantity). Another emphasised the importance of engaging the purchasing department as a top priority in communicating the restricted substance list to the material and component suppliers. The majority of the companies interviewed faced challenges in obtaining information from suppliers. When referring to their struggles in communicating back and forth with their suppliers, one interviewee mentioned the development of an international standard of making material declarations.

Alternatives for restricted substances have been pursued within the manufacturers as well. Examples include the phasing out of halogenated flame retardants, lead-based solders and ozone depleting substances. In one company, corporate wide projects to work on the development of lead-free solder and halogen-free printed circuit boards have been taking place, with the aim of using lead free solder for 80% of their products by the year 2002. An interviewee from another company mentioned their efforts to introduce non-chlorinated hydrocarbons as refrigerant. Development of alternatives in co-operation with suppliers has not been conducted much.

Concerning enhancement of reuse, a home appliance manufacturer established a refurbishment plant for products damaged during the production, transportation or packaging process. About 5000 products have been brought to the refurbishment plant annually and then sold in the market at a lower price after being repaired. According to the interviewee from the manufacturer however, the aim of the initiative has been "to reduce the scrap in the production, and to obtain control over the stream of damaged products", rather than to explore future recovery possibilities. Due to the relatively long life span of products and the rapid increase of efficiency, the company decided not to refurbish products older than 3 years. Feedback from the refurbishment plant to manufacturing site was expected to occur, but not to the design section of the company.

With regard to component reuse, specific components of mobile phone systems have been reused as spare parts for the same machine in other countries. In some cases, the entire mobile phone system is reused in another location. Likewise, after being dismantled by a recycler, some parts of X-ray machines are sent back to the manufacturer for reuse. However, the reuse of most of the medical parts has faced challenges, as the destinations of the products are geographically scattered (95% of the products are exported outside of Sweden).

Half of the companies interviewed commented on their efforts to enhance recyclability by way of reducing the variety of materials used, for instance standardisation of plastics. The other two mentioned that they have been trying to assess the recyclability of their products with recyclers. Design for ease of disassembly was not mentioned. In fact, one company explicitly mentioned that, except for some parts that need to be separated such as compressors and electronic components, it is not worth designing their products for disassembly. The discarded products would be put into a shredder and the materials would be sorted.

Other measures

In the case of mobile phones, in 1997 prior to the enactment of the legislation, major mobile phone manufacturers selling their products in Sweden conducted a pilot project for take-back and recovery. The aims behind the project were: 1) to grasp how the take-back/recovery of mobile phones should be organised so that the manufacturers can present it to the authorities and 2) to accumulate knowledge within the industries themselves as to how to conduct take-back/recovery in an efficient manner.

In this project, the mobile phone manufacturers co-operated with a major recycler in Sweden, a company organising transports, and a number of retailers. The retailers accepted the mobile phones when they were brought back to them. Once the accepted discarded mobile phones come to a critical mass, retailers called a transport company. The transport company would collect the discarded phones when they passed by the vicinity of the retailer and brought them to the recycling company. The recycler separated the respective components/materials of the mobile phones (plastics, printed circuit boards, displays, metal and batteries) and tested the recyclability of each of the components/material as well as what could be undertaken to improve the recyclability. Of these materials, batteries are taken care of in accordance with legislation governing batteries. Plastics were either used as energy or tested for recyclability. Extensive communication took place between the recycler and the producer, which contributed to design for end-of-life, especially in terms of material use. Due to the successful outcome of the pilot project, the manufacturers decided to continue the system.

Meanwhile, in order to cope with the up-coming EPR legislation in Sweden, a common system was developed in co-operation of various industry associations that would be affected by the legislation. The organisation that runs the system is called El-Kretsen. El-Kretsen helps to fulfil the responsibility allocated to manufacturers, importers and retailers in Sweden by running the physical infrastructure as well as fulfilling some of the requirements given to producers on their behalf, such as negotiation with municipalities.

Manufacturers of mobile phones also joined the El-Kretsen system, but they have some concerns about participating. Namely, mobile phones are easy to return and have high end-value and are therefore easier to recycle economically compared to other products. The manufacturers of mobile phones would wish to pay in accordance with the feature of their products in relation to recovery operation, which may not be easily achieved under the El-Kretsen system. One of the manufacturers established its own recovery workshop within their companies to collect data in order to be able to negotiate with the recyclers on equal terms.

A manufacturer of other products mentioned that the company had been considering the establishment of two systems, one with El-Kretsen and the other on its own. The intention was to make it as easy as possible for their customers to return their obsolete equipment and thereby increase the amount of obsolete equipment that would be collected and recycled. The

company, operating worldwide, has been collaborating with recyclers in different parts of the world to minimise environmental impacts from the entire life cycle depending on the recovery technology available locally.

Due to the profit gained from recovery, take-back and recovery of larger products, such as X-Ray tubes, has been taking place for a long time. Regarding medical equipment, information on the content of the hazardous substances as well as their locations in drawings had been given to the recyclers. A pilot project for the collection and recovery of mobile phone systems was initiated in Autumn 2000 in Europe, utilising the logistics to install new mobile phone system. The end-of-life mobile phone system was to be brought to a recycler via a warehouse. Though not started at the time of the interview, the company intended to use the information gained from recyclers with regard to the recyclability of their products. The company also planned to expand this take-back service to the United States and Japan.

Car manufacturers in Japan

Upstream changes

Several initiatives by individual companies were taken before the problems regarding auto shredder dust became prominent. For instance, one of the manufacturers established a shredding company as early as 1970 anticipating that without consideration of end-of-life management, there would be a day where automobiles as commodities would not circulate smoothly within the society.

However, except for such cases the automobile manufacturers had little contact with their products once they reached the end of their lives. It was not until the early 1990s, when improper treatment of industrial waste and scarcity of final disposal sites became a major social concern that industries and the government started to look at the problems.[82] In the meantime, faced with the difficulties of selling recycled metal with high price due to the lowering market price and higher costs for landfill, scrappers and shredders started to appeal to the upstream by requesting measures to be taken by manufacturers.

[82] One of the unfortunate incidents that triggered the discussion was the illegal dumping on an island called Teshima, which lead to a terrible degradation of environment of the region, and damages to local economy. The auto shredder waste was dumped on the island for years by a company, which claimed that it would compost biodegradable waste.

Sensing the urge to deal with the problems, the Japan Automobile Manufacturers Association (JAMA) started to raise end-of-life management issues as one of the primary areas for the association to work on. Based on the "Recycling Initiatives for End-of-life Vehicles" developed by MITI in May 1997 (see Section 4.1.2), JAMA developed the "Voluntary Action Plan". Under the Action Plan, new cars produced after 2002 should be more than 90% recyclable. Apart from what is used in car batteries, the amount of lead in new cars should be reduced by half by the year 2000 and by one-third by 2005, when compared to 1996 level.[83] The reuse and recycling rate of end-of-life vehicles should be more than 85% from 2002 and 95% from 2015. The amount of auto shredder waste brought to final disposal sites should be from 2002 less than three-fifth compared to 1996 levels and less than one-fifth from 2015. The Action Plan also included a guideline for assessment and calculation of the recyclability rate and suggested actions to be taken to facilitate environmentally sound end-of-life management.

Measures taken by the manufacturers with regard to upstream changes mainly concerned the enhancement of component and material reuse, recycling, the reduction of use of hazardous substances and the use of recycled materials.

Regarding hazardous substances, all the manufacturers interviewed referred to the reduction of the use of lead in their products. Some referred to the target set up in the JAMA's Voluntary Action Plan, while others set up their own targets. The majority of the manufacturers interviewed achieved the reduction target (50% of the 1996 level) by 1999. Other substances mentioned include cadmium in paint, hexavalent chromium on metal plates, mercury and chlorinated substances. Two manufacturers mentioned their green procurement initiatives. The interviewees from one of the two manufacturers mentioned the difficulties facing complex component manufacturers in tracking down the materials used in the components.

One interviewee referred to the general change in the relation between component suppliers and Japanese car manufacturers. In the past, individual car manufacturers in Japan had their own suppliers for all the components of their cars. The general attitude of the manufacturers was to produce everything from 1 to 10. The "bond" between the respective manufacturers

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[83] As of 1996, the average amount of lead used in cars sized between 1 500–2 000 cc was 1850 g (JAMA, 1998).

and their component suppliers had diminished. Manufacturers started to purchase from whoever could supply the most inexpensive components that met their specifications and component manufacturers started to supply their products to whoever wished to purchase them. Collaboration with suppliers that have advanced technology in product development still occurs, but the suppliers no longer depend on one specific car manufacturer. Instead of trying to do everything themselves, the respective manufacturers started to allocate their resources on selected areas while outsourcing the development of other areas.

In addition to measures already taken to ease repair, such as oil change and parts repair, design for disassembly and separation and the selection of materials that are more easily recyclable began. Examples of design for dismantling include reduction of the number of screws, unification of materials used in one component, such as use of polypropylene (PP) in instrumental panels, unification of several components into one (also found in instrumental panel) and the like. With regard to material use, a measure commonly found was the increased use of thermoplastics, such as PP and thermo plastic olefin. The unification of the grades of PP as well as marking of plastics, was also widely adopted. One of the manufacturers succeeded in developing thermoplastics that can be recycled for the same purpose (recycling instead of down-cycling),[84] while having other properties such as durability and mouldability. The same manufacturer also started to use polyurethane and fibres recovered from auto shredder dust as noise buffer in new cars. Another interviewee mentioned that their strategy was to increase the use of thermoplastics commonly used among a wide range of industries. Instead of developing its own plastics, he pointed out that taking this strategy was due to the challenge of taking-back their own products and shredding them separately from the rest of the end-of-life vehicles.

With regard to component reuse and recycling, by collaborating with existing dismantlers one of the manufacturers interviewed established a network for spare parts. Another manufacturer had initiated refurbishment and sales of second-hand parts under the brand name of its daughter company. An interviewee of a different company commented on the existing second-hand market for spare parts and on the difficulties of quickly finding second-hand spare parts. It was estimated that second-hand spare parts constitute only 3 percent of the entire spare parts in Japan.

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[84] Further discussion on recycling instead of down-cycling can be found in Peck (2003).

Another challenge was how to guarantee the qualities of recovered parts. In order to issue guarantees, two manufacturers interviewed had established a system for reconditioning selected spare parts.

A prevailing form of material recycling was the recycling of bumpers to internal parts, such as undercover, engine cover, trunk and the like. Some manufacturers had overcome the challenge of peeling the paint applied on bumpers with small environmental burden and cost, and started to recycle bumpers into bumpers. Other parts used for material recycling include instrumental panels, carpets, instrumental ducts, glass and the like. One manufacturer established a system of collecting glass from end-of-life vehicles and recycling it for glass wool. The idea was developed together with a neighbouring dismantler and glass manufacturer.

Apart from the materials recovered from the cars themselves, materials from other products, such as PET bottles, plastics on the roofs of greenhouses and glass from construction waste, have been used in cars.

Other measures

Interaction between the downstream and the upstream began taking place. One of the interviewees shared his experience of visiting more than 300 recycling facilities both within and outside Japan to learn the conventional practices as well as to find out the best measures that a manufacturer could take. Some of the manufacturers started investigating the possibility of collaborating with the existing dismantlers. For example, the work of one company was initiated by visiting dismantlers in various part of Japan, which among other things led to the establishment of a network for spare parts. The company has also been developing dismantling techniques that are relatively inexpensive, and introduced these techniques to dismantlers. The information on such techniques has been supplied via newsletters. A pilot plant on recovery technology was established in Kanazawa-ku, Kanagawa that was freely accessible. Two interviewees mentioned that they themselves, as well as designers, had visited skilled dismantlers and asked their opinions concerning design for dismantling.

The interviewee from a truck manufacturer commented on the higher metal content in trucks compared to cars, which makes the end-of-life value rather high. However, the percentage of the materials that become auto shredder waste at the end-of-life of trucks had not been grasped by anyone. At the time of the interview, JAMA was planning to examine the situation.

Car manufacturers in Sweden

Upstream measures

In the beginning of the 1990s, BIL (the Swedish Car Manufacturers and Wholesellers Association) created an ad-hoc group to understand and discuss car recovery. ECRIS emerged six to twelve months later and was created as a co-operation between different partners (a car manufacturer and some car scrappers). It presented additional information covering the technical and economic aspects of car scrapping and recycling. In the end, together with ECRIS the group in BIL came to an agreement with the Swedish Government to work on a full-scale test of car recovery. The ECRIS project continued for four years. One interviewee pointed out the benefits their competitor gained by involving their designers in the project.

Reduction of the use of hazardous substances, design for dismantling and recyclability were among the areas Swedish car manufacturers interviewed had been striving for.

Concerning the reduction of hazardous substances, all three manufacturers interviewed had developed and used lists of substances that they wished to phase out. They provided the suppliers with the lists as part of the product specifications. One interviewee mentioned that the list would be included in the drawings and technical specifications. Concerning the substances that they would wish to phase out, another interviewee mentioned that they requested the suppliers to provide them with information on the quantity of the substances on the list as well as the supplier's action plan to eliminate these substances. Regarding the manner of verifying the information provided by suppliers, one mentioned that their engineers were involved in the design and development of most of their components and would know what substances would be used. For the components developed by the suppliers, a statement was made concerning the quantity and the parts containing the restricted substances. Laboratory tests had been conducted for some components, but this could not be done for all products. One interviewee mentioned the challenges facing the suppliers when obtaining information on the materials and parts they used from their upstream suppliers.

At the time of the interviews, the car industries in Europe were developing a common data base system called IMDS, where their suppliers put required information such as substance use. Once completed, individual

manufacturers would be able to receive information on materials constituting the components of each car through the database.

One of the manufacturers mentioned that their cars had been developed in much closer collaboration with suppliers than ever before. This close co-operation became especially important with the shorter timeframes for developing new car models (from 14 years to 4-5 years) required in recent years. Previously, everything was designed within the company, their specification were provided to a number of potential suppliers and the most cost efficient supplier was appointed. Another interviewee commented on the constraints of having to select the supplier at an early stage of product development in order to collaborate with them.

With regard to the design for dismantling, the decrease of dismantling time was mentioned by both car manufacturers as an important element to work on. Factors affecting the dismantling time include uniformity of materials, marking of materials, fastening and separation techniques, contamination in the components and the like. One interviewee mentioned that the company had fair knowledge on dismantling time and some on the recyclable materials and costs associated with it.

In order to avoid paying dismantlers unnecessary high price for recovery, manufacturers had established/were establishing an internal workshop. In one company, test cars and cars used in the crash test laboratory would be dismantled in the workshop. This would bring them multiple benefits. Firstly, they could learn about time and cost for dismantling, the methodology and equipment that should be used and the like. This may also enable designers to learn about design for end-of-life. Further, the company would not have to collect from dismantlers components that are still confidential. The company also investigated the possibility of reconditioning some parts.

Concerning the reuse of components, one manufacturer reconditioned the old components taken out from the used cars and was selling them as reconditioned parts under their brand name. Another manufacturer involved a big dismantling company in the management of reused components and had relied on the dismantler to supply some spare parts whenever necessary. Prior to this arrangement, used components had been reused for a long time (15 years or more) under the co-operation with dismantlers and recyclers. An interviewee from another company said they did not have much knowledge regarding what parts had been re-sold. The company discussed if

they should be involved in helping the dismantlers with the sales of used parts, as it would compete with the sales of new components.

The enhancement of the recyclability of their components was another element that the interviewees found it necessary to work on. Apart from metals, which constitute 75% of the weight of the car, the rest of the materials coming from the cars had been shredded and sent to landfills as auto shredder residues. The existing recycling activities for these materials had been mostly down-cycling, for instance use of glass in construction materials. One manufacturer conducted a pilot project with their suppliers where several types of materials were scrapped in batches. These materials were transported, shredded and grinded, and were used by some suppliers to make parts such as wheel housing and interiors. Materials gathered in this project were those easily taken from the cars such as polypropylene. One interviewee mentioned their efforts to use recycled plastics in bumpers, but was not sure how successful they had been in doing so. The truck manufacturer interviewed commented on the high metal content in trucks and that they were "better off" than the car manufacturers in that they had relatively little to get rid of.

Manufacturers could coordinate and co-operate in the use of standard materials to enhance recycling either indirectly (via suppliers) or directly (between manufacturers). The car manufacturers association at the European level (ASEA) stated as a policy to co-operate with each other around recovery issues as well as design for recycling, because it is regarded as the only way to reduce costs associated with end-of-life management. However, it was still at the discussion level at the time of the interviews and nothing concrete had been decided.

Other measures

Companies that participated in the project with BIL and/or ECRIS mentioned above had kept good contacts with some car scrappers. An example of collaboration included the evaluation of recycling methods for different parts. The exchange with the scrappers was reflected in their design guidelines, covering issues such as what would make it easier to scrap the cars, to take out parts, to use fewer tools and to take less time in overall dismantling. Dismantlers' ergonomics was another issue to be considered. At the time of the interview, an interviewee from another manufacturer mentioned that the company had contact with about 50 car dismantlers in

Sweden. The dismantlers were invited to a joint meeting with car manufacturers and importers in Sweden twice a year.

To fulfil the obligation posed by the Swedish EPR legislation, instead of involving in the car dismantling practice themselves, car manufacturers established a normal business relationship with dismantlers and collaborated with them. When discussing the trend of manufacturers buying up dismantlers at that time, two interviewees mentioned that the lucrative part of the dismantling business had been the reselling of reused parts. One interviewee shared an experience of trying to enter the market of reused parts and consequently ending up having the whole dismantler business against them. He mentioned it as one reason the company had decided to co-exist with the recyclers and not to enter into business around end-of-life management.

BPS (BIL Producentansvar Sverige AB: BIL producer responsibility Sweden) coordinated the network of dismantlers and listed up skilled dismantlers (75 out of 800 existing dismantlers in Sweden were on the list at the time of the interviews). The list facilitates the contracts made between manufacturers and dismantlers on an individual basis.

It was anticipated that in practice, very similar dismantling operation would most likely be carried out for cars produced by different manufacturers. For example, bumpers and fuel tanks would be taken off from all the cars to achieve 85% reuse and recycling target, instead of taking the bumpers from one brand and the fuel tanks from another. A manual for dismantling was compiled by all the manufacturers and provided in the form of a CD.

For the cars sold after 1 January 1998, the manufacturers allocate for the future dismantling cost in a separate fund within the company. A figure given by one manufacturer was 1 300 SEK (143 Euro) that was set aside for recycling.[85] This is the estimation of the cost that would be necessary to achieve the 85% reuse and recycling rate. The main part of the cost would be drainage of fuels, oils and oil filters, catalytic converters and so forth, while the main cost driver is the dismantling time. The rest of the cost would be transport from the dismantler to the shredder, but metals may pay for the costs for shredding and transport.

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85 With the exchange rate of 1 SEK = 0.11 Euro (Forex, 2004).

4.3 Factors influencing measures related to design for end-of-life

This section presents the analysis of different factors influencing the manufacturers' undertaking of the measures discussed in Section 4.2.2. As mentioned in 3.2.3, factors either promoting or hindering the measures taken by the respective manufacturers interviewed were extracted from the interviews. The author subsequently explored the similarities and differences among the companies in the same industry group (EEE or cars) in the same country (Japan or Sweden), and clustered the factors that are similar.

In the following sections (Section 4.3.1 to 4.3.4), the respective factors that are inter-related with each other are presented. Starting from those mentioned by the largest number of companies to those mentioned by one company. The number of companies that mentioned the respective factors are summarised in the figures in the respective sections. These figures (Figure 4-2 to Figure 4-9) provide a brief overview of the content of Section 4.3.

Just as in the previous section, interviews with the manufacturers, as well as the materials provided by them, such as environmental reports, internal presentations, guidelines and the like, are sources of the information presented in this section, unless otherwise mentioned.

The primary purpose of studying these factors is to understand the relative importance of the presence of EPR legislation in inducing upstream changes to reduce environmental impacts in the downstream of the product chain. Thus, the comments from interviewees surrounding the legislation are described in detail. The rest of the factors are described to the extent necessary for the appreciation of the role of EPR programmes in promoting design for end-of-life, as well as total environmental improvement of the life cycle of product systems.

All the interviews in Japan were conducted in Japanese, and in Sweden in English. The author has translated the quotations from the interviews in Japan presented in this section.

4.3.1 EEE manufacturers in Japan

Promoting factors

Various factors that promoted design for end-of-life were mentioned by the interviewees from nine EEE manufacturers in Japan, as summarised in Figure 4-2.

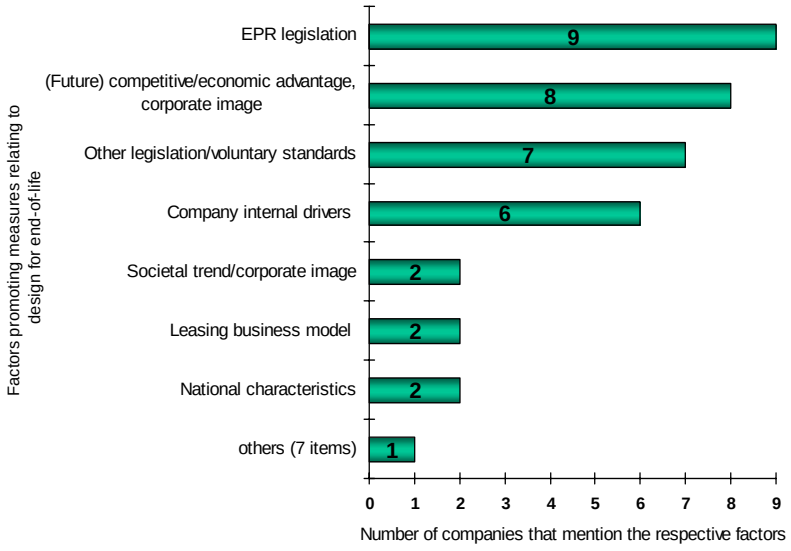

Figure 4-2: Factors promoting undertaking of measures related to design for end-of-life for Japanese EEE manufacturers

EPR legislation

All the manufacturers interviewed suggested upcoming legislation, both Japanese and EU, based on the EPR principle as one of the elements they considered in developing their new products and/or establishing infrastructure for collection and recovery of the discarded products.

All the interviewees that produce one or more of the four appliances covered by the SHAR (Specified Home Appliance Recycling) Law referred to the impacts the enactment of the SHAR law has had in promoting design for the environment.

Already at the time of the interview, a few interviewees mentioned that the anticipated raise of the reuse and recycling rate requirements urged them to begin working on design changes of new products and to equip recycling plants with technologies that could achieve the higher recycling rate. With regard to the four appliances initially covered by the SHAR Law, 60-70% recycling by weight could be achieved by recycling metals. However, they would have to find ways to recycle plastics in order to achieve 80% recycling. As the OEMs do not have the expertise on the materials (plastics) themselves, they "need to start early in order to meet the upcoming recycling requirements." Another interviewee, commenting on the strong influence of the original Recycling Promotion Law of 1991 mentioned "the SHAR Law promoted the industry to think how they could design products that could be recycled in the future".

Several interviewees commented on the effects of legislation upon the development of the infrastructure for collection and recovery. One interviewee mentioned that it would be crucial to establish an infrastructure where discarded products could be collected and recycled and mentioned that the SHAR Law in Japan was a good starting point to establish such infrastructure. "Even if we make all the efforts to make our products easy to dismantle and eliminate the use of hazardous substances, it means nothing after all if the system for collection and recycling doesn't exist." He further mentioned the positive side effects of design change for end-of-life management. Due to the improvement in ease-of-disassembly, it became easier to replace a part when a product came to a repair shop thus reducing the cost for consumers.

The strength of the establishment of such an infrastructure was recognised by the manufacturers that produce other EEE, but not the four large appliances, but other EEE. One computer manufacturer commented several times that by establishing the take-back network as well as recovery facilities for the four large appliances, these manufacturers would have no problem in dealing with take-back of additional products, such as computers. This fact urged the manufacturer to develop their collection and recovery network prior to the finalisation of EPR legislation for personal computers.

Referring to the establishment of the company's own recycling plant, one interviewee mentioned that the company thought "it is the obligation of us manufacturers, in accordance with the spirit of the legislation, to establish our own recycling plants and operate such recycling facilities". When asked if the company would consider such activity without legislative measures he

replied, "we have been moving by looking at the development of legislation. The development of the social infrastructure with the aim of creating a closed-loop society would not have come this far". The manufacturer established and started operating their own recycling plant as early as May 1999 (two years before the legislation came into force) and established various measures to facilitate communication between the recycling section and design section so that the designers can reflect upon the issues of end-of-life management when designing a product.

Two interviewees suggested that people working in the recovery facilities have been highly aware of the price with which the recycled materials can be sold. Namely, there would be a vast difference between the situation where they had to pay for the recovered material to be taken by recyclers/further disposed of, and the situation where recycled materials could be sold, even when it was as cheap as one yen per kg. "Perhaps people start to consider what they can do to reduce one yen of recycling cost per component." In relation to the possibility of selling recycled materials, one interviewee suggested that the Law might expand the markets for recycled materials. The comment was supplemented by the comment of his colleague, who said that for the virgin material suppliers to survive they may start to take back their materials and recycle them themselves.

An interviewee suggested there was more room for the development of leasing and rental business through the introduction of SHAR Law. As the SHAR Law would require end-users to bear the disposal cost, end-users might try to find ways to avoid discarding the appliances. In return, such business styles would help manufacturers to grasp data during the use phase of the products.

Several interviewees mentioned that they considered the SHAR Law as minimal requirements and that they should strive to go further. One manufacturer emphasised that they were going ahead of the legislation. One interviewee, while recognising the role of the legislation in promoting certain measures undertaken, stressed that environmental measures in general should be taken on a voluntary basis.

One of the manufacturers that produce computers but not the four appliances covered by the SHAR Law mentioned that for the computers the requirements that would be put via the revised Recycling Promotion Law had significant meaning. "For us working in the environmental department,

along with the influence of consumers, the impact of legislation is big, especially the revised recycling law and green purchasing law".

Several interviewees commented on the "3R" (reduce, reuse, recycle) the core concept of the revised Recycling Promotion Law. One interviewee mentioned that if they "would comply with the law, the question is how to incorporate the 3R principle into our business strategy. That would probably lead to differentiation. Without that, it would be difficult to survive in the next century." The manufacturer, as well as several others, incorporated 3R as a basis for their product development.

An interviewee from the copying machine manufacturer mentioned that copying machines became one of the targeted products of the revised Recycling Promotion Law not because the legislators wanted to put restrictions on them, but rather to have them as "a symbol of something that is going well". "Up until now, it was good enough to take measures when we can, but" the revised Law would give copier machine producers "an obligation to compile information and report" to the authorities. The impact of the legislation would be limited to the time that these reporting obligations would take.

Concerning the two directives in Europe, a number of producers referred to their impact, especially with regard to material bans. As mentioned in Section 4.2.2, a number of Japanese manufacturers had been working vigorously on the development of lead-free solders that were "triggered" by the proposed RoHS Directive. "It is really amazing that the conventional ratio of lead" in solder "that has 2000 years of history is changed within a matter of a few years." "It is moving like this because there is a restriction, but it would not happen voluntarily."

An interviewee raised a question to the reaction of the Japanese industry regarding the legislative development in Europe. "The industries in Europe should be the first one to raise voices towards the information (legislation) dispatched from Europe. Nowadays, Japanese industries start to raise voices before Europe." Another interviewee suggested that the advancement of Japanese industries in the development of lead-free solders might have lead to the postponing of the deadline in the RoHS Directive from 2004 to 2008 (which, in the end, became 2006).

A number of manufacturers interviewed incorporated the contents of the various legislation in their product assessment criteria along with other standards such as eco-labelling criteria.

(Future) competitive/economic advantage, corporate image

Interviewees from six manufacturers linked their work on design for end-of-life with present and/or future competitive advantage.

A number of companies mentioned use of company's internal eco-labels. The issuance of such labels would require the fulfilment of strict criteria set in their product assessment, which in some companies include the first class among the products produced by competing manufacturers. When asked if this did not lead to awarding labels too easily one interviewee replied, "it is too shameful to put a label that does not have the highest quality among the products in the market." The internal criteria, communicated in the form of company's own eco-labels, were a manifestation of considering design for end-of-life as an issue of competition.

An interviewee expressed their efforts on end-of-life as a future investment. "It would be better to put money at the upstream now than having to hustle once the products come back in the future… In 5-10 years, something like extension of producer responsibility will be routed in the society. If we work on it in advance, the life cycle cost in the end would be lower."

Two other manufacturers referred to the enhancement of corporate image as one reason to work on issues regarding the environment, which include end-of-life management. However, another interviewee expressed the struggle of using issues that are difficult to quantify, such as corporate image, as an argument to spend extra resources.

Other legislation and voluntary standards

Apart from legislation based on the EPR concept, seven manufacturers commented on how other legislation, as well as voluntary standards such as eco-labelling schemes, promoted their efforts on design change to reduce impacts from end-of-life management of their products.

Several interviewees mentioned that the original Recycling Promotion Law of 1991, which required environmental product assessment of four large home appliances, prompted design for end-of-life. As one interviewee put it,

"the assessment requirement" which included aspects on end-of-life management "in the 1991 Recycling Legislation was the Number one factor" that promoted their activities on design for end-of-life. "The emergency of the legislation made a difference in the area of packaging, light-weighting, resource efficiency, and so forth."

Several interviewees mentioned the effect of the PRTR (pollution release and transfer register) legislation in Japan that came into force in April 2000. The substances covered by the legislation were utilised for the manufacturers' green procurement programme and put informative requirements to their suppliers. This influenced design for end-of-life, especially in terms of reduction of the use of toxic substances and obtaining information on the material use.

A few manufacturers suggested that the Law on Promoting Green Purchasing in Japan that came into force in April 2001 promoted design for end-of-life. One manufacturer mentioned that requirements set by governmental agencies would be incorporated as criteria for their product assessment. Other legislation that relate to products produced by manufacturers, such as the Waste Management Law, has been used as criteria for their product assessment as well.

Two manufacturers mentioned that they had been incorporating eco-labelling standards in their internal criteria for green products.

Company internal drivers

A total of six companies commented on various drivers within the company that facilitate undertaking of measures to reduce environmental impacts from the end-of-life of their products.

Several manufacturers expressed the significance of the top management commitment. An example is: "Ever since the President become involved in the environment, our struggles of 4-5 years in the past was achieved by one word. It spread the message across the company." One interviewee mentioned the inclusion of environment as evaluation criterion for the achievement of the divisions of the company, which, among other things, would affect the salary of the managers of the respective divisions.

Several interviewees suggested raising the awareness of designers on environmental issues as an important factor that influenced design change.

As one way of enhancing the awareness for designers and providing them with motivation on design for end-of-life, a number of companies commented on the use of aforementioned company's internal eco-labels.

Societal Trend

A few interviewees mentioned that the general societal trend, including the development of various legislation in recent years, has helped raise the awareness of the designers as well as top management. The societal trend has also made the designers more aware of the importance of incorporating environmental consideration. "Things seem to have changed pretty much in the past one year." "Not so long ago, there was a time when it was very difficult to make designers realise that they must consider environment. However, it is becoming rather good now."

Leasing business model

A few manufacturers who provide some of their products to their customers via leasing services suggested such approaches facilitated design for end-of-life, and the enhancement of infrastructure to take-back their products.

National characteristics

One interviewee mentioned yokonarabi, or the tendency to do the same as others, as a reason the Japanese industries work vigorously on issues around end-of-life management of their products. Namely, "the company would look at what others are doing" and try to strike a balance as to how much they should spend on a certain issue, such as end-of-life management. On one hand, unless profitable, they would not want to spend too much. Conversely, they do not want to fall behind what others are doing. According to the interviewee, "in the case of Japan, this does not lead to delay in taking actions, on the contrary, things start to move forward faster." The interviewee further commented that this tendency has lead to a voluntary restriction. For instance, even when the phase-out time limit set by the proposed RoHS Directive became 2008 instead of 2004, none of the companies would say that they would stop using lead in solder in 2006 when others were setting their elimination target for 2002.

Another interviewee commented on the law-obedient nature of Japanese companies.

Others

One interviewee expressed that it is the *corporate commitment towards society* that is the reason they are working on design for end-of-life as well as being involved in actual end-of-life management.

Another interviewee mentioned the fact that they had started *the establishment of recovery infrastructure earlier* had helped them to gain knowledge about the operation and thus helped them increase the economic efficiency of the end-of-life management of their products. He also commented on the *reduction of valuable materials in products*. Namely, a computer used to contain a significant amount of valuable materials such as rare metals. As the size of an individual product has also become smaller and smaller, the use of such materials within the product has been reduced. In order to operate the recovery as economically as possible, it became necessary to design a product so that the cost of end-of-life management is minimised. This became evident by feedback from the company's recycling plants.

When asked why the company started to establish a recovery network as early as 1995, one interviewee speculated that it was perhaps necessary to handle the large discarded computers that were provided to their customers in the form of rental. The *request of corporate customers* who had green procurement guideline also motivated the company to integrate end-of-life consideration into their product design.

One interviewee referred to the *geographical uniqueness* of the Japanese market. In the case of products they sell, Japanese manufacturers supplied 70% percent of the products worldwide. "These manufacturers have retailers, transport companies as well as the manufacturing plants. In this sense, it is very feasible" to establish infrastructure that enhances the closure of material loops. *Collaboration with material suppliers* who had been enthusiastic about recycling had been helpful for one manufacturer.

One interviewee commented on the high *technological potentials* many of the Japanese companies possess. "There are many technologies that are in the drawers and have not been used", these are waiting to be utilised when demand for these technologies become high enough.

Hindering factors

Figure 4-3 summarises obstacles experienced by the nine Japanese EEE manufacturers interviewed in taking measures to reduce environmental impacts of the end-of-life management phase of their products.

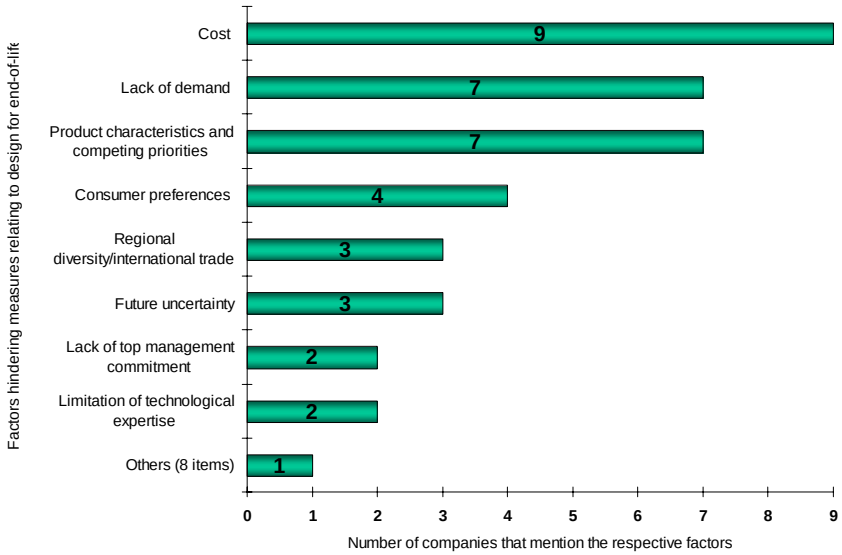

Figure 4-3: Factors hindering the undertaking of measures related to design for end-of-life for EEE manufacturers in Japan

Cost

All the manufacturers mentioned issues related to costs as limitations. A number of interviewees mentioned that in many cases, replacing a material or a component more suitable for recycling without increasing the cost had been challenging. Likewise, the technology may be available, but the company faces limitations in using it due to the high cost of commercialisation. When discussing the potential of shifting from selling products to services, the lower price of new products was raised as a hindering factor. Likewise, management of the collection and recovery infrastructure for reuse components would be more expensive than producing new components.

Several interviewees mentioned the difficulties of running a business where economic rationality did not exist. Namely, the existing recovery operation would not enable economically feasible recycling, especially when the reuse and recycling requirements increase.

One interviewee mentioned that the company would wish to "establish a system worldwide to take back and recycle" all the products manufactured by them. However, doing so would lead the manufacturer to bankruptcy immediately.

Another interviewee commented on the intangible nature of working on design for end-of-life. Even when efforts the company take may lead to the enhancement of the corporate image, it may not be directly connected to the increased sales of new products in a tangible manner.

Lack of demand

The majority of the interviewees mentioned that although the awareness of the general public regarding environment was improving, it had not become strong enough to put a demand on issues such as the recyclability of materials used in a product. Several interviewees also mentioned that in a situation where price and environmental improvement compete, most of the consumers would go for products with lower price. "It is not because it is good for the environment that they buy. Price comes first." Unlike other environmental issues, such as energy consumption that has higher potentials for influencing the consumers' purchasing behaviour due to the direct connection to the electricity bill, recyclability has not been strongly linked to the price consumers have to bear.

Product characteristics and competing design priorities

A number of interviewees referred to the dilemma between two requirements posed towards manufacturers: enhancement of energy efficiency and reuse of components. The speed of the advancement of technology around energy efficiency would make the reuse of a component from the old products in a new product more environmentally burdensome than using an entirely new product. This is especially the case with products with long life such as large home appliances, as well as with products with rapid technological improvements such as computers. Miniaturisation and dematerialisation of products also often hinders components reuse. One manufacturer commented on the difficulties of promoting reduce and

recycle for durable products that they produce, as it would compete with the sale of new products.

Some products may change the type of materials used completely illustrated by TV sets whose monitors had been shifting from cathode ray tubes to liquid crystal displays. Despite the efforts made on the recycling of leaded glasses from cathode ray tubes, it is not certain whether cathode ray tubes will be produced in the future.

An interviewee, referring to the initiatives of unification of plastic materials by automobile industry, commented on the wide range of products the company produce that require different consideration.

Consumer preferences

Several interviewees attributed the relative slow development of the markets of green products to some of the characteristics of Japanese citizens. They mentioned the Japanese people's preference of something new, which leads to discarding products that may still be usable and purchasing a new one. In the case of remanufacturing, "in the West, it is quite possible to sell products with recycled parts. In Japan, acceptability of such products in the market would be very low." The majority of the interviewees seemed to have the perception that the Japanese consumers have a lower level of environmental awareness when compared to Europe.

Another interviewee commented on the high requirement Japanese consumers put on the safety and reliability of products when compared to Europe. Giving an example of fire accident and use of brominated-free flame retardants he commented, "in Europe, it would be acceptable to produce TV sets that have the possibility of fire accident if the percentage is one out of 2 million. In Japan, one accident and all the top management would be fired."

Regional diversity/international trade

As mentioned above, one of the manufacturers has the vision of establishing a universal system for recovery. However, differences in local conditions, such as existing infrastructure and division of the roles in the society, would not allow the company to do so. Another interviewee showed frustration on the differences of legislation among nations and difficulty that manufacturers were faced with to meet with all the different requirements.

"Generally, Japan, the United States and Europe are facing similar issues, and are moving at the same speed, but the content of laws that deal with the issues are all different."

With regard to the reuse of components, one of the interviewees pointed out the legislative barriers when exporting their products. For example, export of a product to the United States that contains reused components requires attachment of a document that clarifies which parts of the products consist of used components.

Future uncertainty

As the SHAR Law did not come into force at the time of the interviews, a number of producers showed concern about the uncertainty regarding the number of products collected and the economic inefficiency that may occur due to the lack of products taken back. When asked about the reuse of some parts from the old products, one interviewee mentioned that without knowing how many could be collected, it would be easier to manufacture products with new parts than with parts collected from the returned products. Another interviewee commented on the difficulty of selecting materials for the new products in light of the development of recycling technology by the time durable products come to the end of their lives.

As mentioned, when the interviews were conducted, the provisions of the EU WEEE and RoHS Directives were not finalised. An interviewee expressed his frustration about the difficulties in selecting measures in light of uncertainties concerning the final requirements.

Lack of top management commitment

A few interviewees mentioned insufficient understanding among the top management regarding the design for end-of-life or environment in general. Consequently, financial and human resources have not been properly allocated.

Limitation of technological expertise

As OEMs, the manufacturers interviewed lack expertise in developing materials and components that ease end-of-life management. In relation to this, a few interviewees mentioned that their components and materials manufacturers were often not aware of the new development surrounding

the manufacturers. Despite this perception of the manufacturers, the initiatives of some Japanese material manufacturers to eliminate hazardous substances have been reported (Nakanishi, 2001). They considered environmental differentiations as their competitive edge against their fellow competitors abroad (Nakanishi, 2001). It is interesting to note that a Swedish manufacturer commented that in the beginning the Japanese suppliers were the only suppliers that could provide them with halogen free circuit board.

When discussing their achievement of their lead-free solders, one interviewee warned that many of the competitors mentioned only solders without talking about the lead used on components connected together by the solders. The OEMs could work on the solders at the assembly plan, but it would take a while for the components suppliers to find alternatives for lead.

Others

One of the interviewees stressed that measures related to environment in general should be taken on a voluntary basis. He criticised the *lack of knowledge among the policy makers* regarding the actual situation facing manufacturers.

One of the interviewees commented on cases where it was difficult to advertise the environmental characteristics of their products. This was due to the *strong position their customer* historically had and to the preference of the customer to wait until all of the suppliers are ready to sell similar products (*yokonarabi*). According to the interviewee, the preference of the policy makers on *yokonarabi* was also reflected in the formation of the SHAR Law. The requirements in the law were set at the level that could be met by most of the manufacturers instead of leaving behind one that was lagging.

An interviewee pointed out the *dilemma some local governments* may face with regard to collection. The SHAR Law appointed the retailers as the primary actor responsible for collecting discarded products from consumers. The interviewee said that this might jeopardise the popularity of the head of a local government if promotion of convenient waste management service was included in his/her commitment in the election campaign.

4.3.2 EEE manufacturers in Sweden

Promoting factors

Factors that provide positive impacts on the four EEE manufacturers interviewed in Sweden in taking measures to reduce the environmental impacts from the end-of-life management of their products is summarised in Figure 4-4.

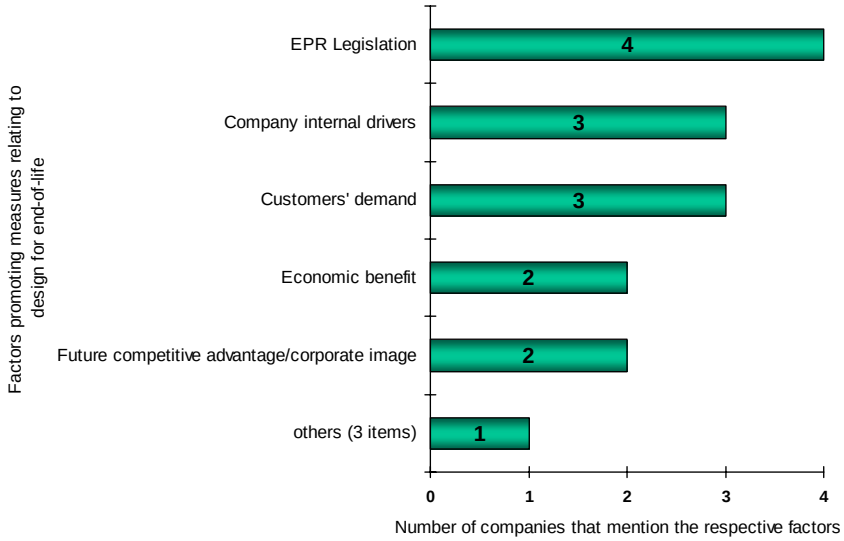

Figure 4-4: Factors promoting the undertaking of measures related to design for end-of-life for Swedish EEE manufacturers

EPR legislation

With different nuance, all the interviewees commented on the effect of the EPR legislation on upstream changes.

One of the interviewees mentioned that threat of legislation had been the strongest driving force for design for end-of-life, including the Swedish Ordinance on Producer Responsibility for Electrical and Electronic Products that came into effect half a year after the interview was conducted. Examples of comments from different interviewees from different companies include: "I am working for design for recycling and that work is very much driven by the WEEE Directive," "Why working on lead-free solders? Because we have corporate goals, but why these corporate goals?

One thing is because of Producer Responsibility legislation in Europe…. That is the main reason."

Several interviewees echoed the effects of the EU RoHS Directive, as found in the quotation above. Meanwhile, concern was expressed regarding the lengthy discussion around the Directive, which was still at the stage of proposal at the time of interview.

With regard to legislative measures as such, one of the interviewees said that compared to a voluntary measure the existence of a regulatory requirement would make it much easier for him to convey a strong message that it is necessary to take measures regarding design for end-of-life.

However, concerning the Swedish EEE legislation it should be noted that one interviewee explicitly mentioned that the legislation would not stimulate design change, due to the manner in which the responsibility was allocated to the producers (one-for-one, old-for-new). The company commented on the effects of legislation on certain aspects of company's design-for-environment strategy such as banned and restricted substances.

Another company stressed that they were very well prepared for the legislation, and suggested they were anticipating it. Commenting on the fact that all the products they produce had been taken back in Europe, he said, "It is done for environmental reason, and they know that the regulation is coming".

Company internal drivers

The majority of the interviewees mentioned that the strong commitment of their top managers towards the environment, as well as the corporate culture to support environmental work had been the driving force for them to promote design for end-of-life. One interviewee also commented that it is part of the company's strategy on design for the environment. After discussing the introduction of their take-back programme due to EPR legislation, another interviewee mentioned that they also tried to expand the take-back service to countries not subject to EPR legislation because they were a "*responsible company* for the environment."

Customers' demands

Several interviewees mentioned that the request of consumers promoted design for end-of-life. In one company, end-of-life management had been identified as one of the focus areas to work on through communication with customers. Apart from communication with corporate customers, different types of communication tools had been used from web-based surveys to discussions in customer advisory boards.

One interviewee stressed the significance of the demands placed by their business customer. The company's customer requirements on material declaration had led the company to press similar demand upon their own suppliers. Another interviewee commented on the high environmental awareness of customers in Scandinavia. Some big purchasers, such as building companies, requested information on substances inside of their products and environmental product declaration.

Economic benefit

Several interviewees mentioned that some of the products they manufactured had high material value, thus reuse and recycle made sense economically. As one interviewee put it, "It is not for environment. It is for cost. It is more expensive to buy these than reuse them."

Future competitive advantages/corporate image

A few interviewees suggested potential competitive advantages the companies might gain through their current work on design for end-of-life. Admitting the low demand from consumers at the moment, one manufacturer mentioned that customers would appreciate their work in the future. Another interviewee said, "If we have a competition within the recycling part, it will be worthwhile to design a product that is suitable for recycling". One interviewee commented on their investigation regarding the possibility of functional sales. That is, to shifting from selling products to selling function. The company viewed it as one way of differentiating themselves from its competitors.

Also mentioned was the importance of keeping their image as an environmentally conscious company.

Others

One interviewee mentioned that *governments' green procurement policy* had been a major driving force. When asked about the motivation behind their work on the development of hazardous substances, another interviewee mentioned that along with EPR legislation and customer demands they "look at the *general environmental issues in the industry*". One interviewee considered their efforts on design for end-of-life as a way of *avoiding risks* in the future.

Hindering factors

As summarised in Figure 4-5, interviews with four EEE manufacturers in Sweden also revealed the difficulties facing the undertaking of measures to reduce environmental burden from the end-of-life management from their products.

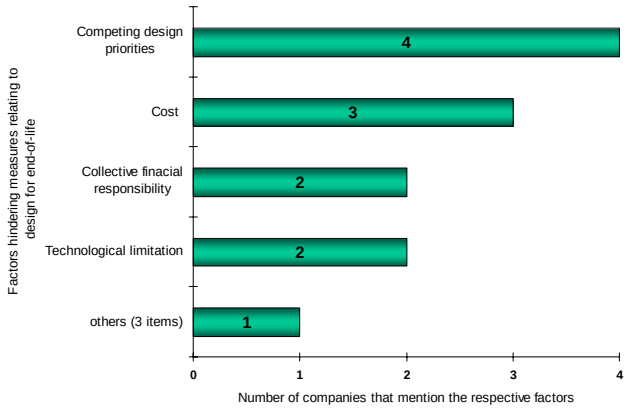

Figure 4-5: Factors hindering the undertaking of measures related to design for end-of-life for Swedish EEE manufacturers

Competing design priorities

All the interviewees raised the issue of conflicts among the different features a product should possess. In the case of products with long life cycle such as washing machines and refrigerators, rapid technological advancement in the area of energy efficiency conflicts with the reuse of components taken from old equipment. One interviewee mentioned that the necessity of being the front-runner in technological development postponed their work on environment. In some cases, use of certain substances, such as brominated

flame retardants is required by some national legislation for safety reasons, while being phased out in other countries.

Cost

Cost associated with the measures was another factor mentioned by the majority of interviewees that expressed difficulties in their undertaking of upstream changes. One interviewee mentioned that because the plastic industries hold down the price of virgin plastics, it had been difficult to justify the use of recycled plastics that would be more expensive than using virgin plastics. Another interviewee also shared the difficulties of convincing designers to select environmentally benign materials without being able to justify it economically. Discussing the demand from their corporate customer, an interviewee commented on the up-front costs required to develop new technologies and the potential necessity of having to bear the cost instead of reflecting it in the price of the products.

Collective financial responsibility

A few of the interviewees pointed to the necessity of establishing a system where producers could become responsible for their products individually. They give an example of the use of non-halogenated hydrocarbons as an alternative refrigerant to hydrofluorocarbons (HFCs). Although non-halogenated hydrocarbons are better for environment, it requires an additional cost to introduce it. The manufacturer would nevertheless consider using non-halogenated hydrocarbons if they could take their products back, because then the recovery procedure would be less costly. However, if the collective financial responsibility were to be implemented, the manufacturer's efforts to use non-halogenated hydrocarbons would become useless. Another interviewee also shared their hesitance in joining a collective system for various types of products due to the relatively high precious metal content in their products.

Technological limitation

Several manufacturers commented on the limitation of technological solutions, including the recycling of plastics, durability of components against high temperature and the like.

Others

At the time when the interviews were conducted, the two EU Directives on EEE were still under development. While considering the legislation as an important driving force, one interviewee criticised the *uncertainty surrounding the legislation*. Changes in the requirements appearing on the draft had caused confusion among designers as to what material could be used, and what should be avoided.

Emphasising the importance of the demand from customers in promoting environmental measures, one interviewee commented on the *lack of demand from customers* on the issue of recycling: "recycling is maybe not that much of a customer driven issue. I think it is easier to communicate hazardous materials and energy consumption."

An interviewee shared an experience of difficulties in requesting their suppliers to change their components when the *relative volume* of components the manufacturer *purchased* from their supplier was *small*. Using the metaphor of chicken and eggs, he said that suppliers "do not start to produce large volumes if they do not have enough requirements… Then it becomes rather *expensive*. As it is expensive, industry may not place orders. When they start to produce large volumes, the price starts to go down."

4.3.3 Car manufacturers in Japan

Promoting factors

Figure 4-6 summarises what the interviewees from five car manufacturers in Japan commented on as factors that induce their undertaking of measures related to the environmental improvement of end-of-life management of their products.

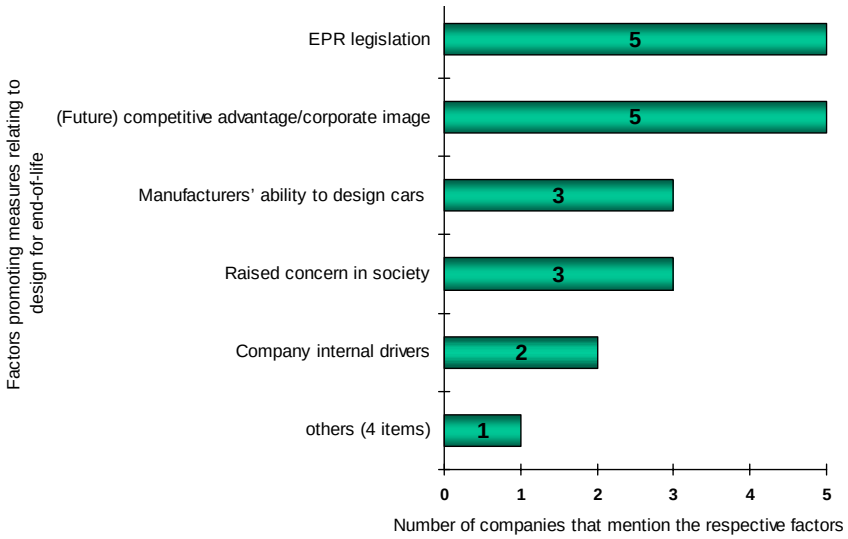

Figure 4-6: Factors promoting undertaking of measures related to design for end-of-life for Japanese car manufacturers

EPR legislation

All the manufacturers referred to the EU ELV Directive, with somewhat different distinctions. The majority of the manufacturers referred to the significance of the restriction on hazardous substances as an important driving force for their undertaking the phasing out of substances on the lists. One interviewee mentioned that they had been striving to develop alternatives prior to the legislation and that the Directive served as a justification to allocate monetary and human resource to further such efforts. Several interviewees referred to the reuse and recycling requirements of 95% set by the ELV Directive. "In order to go this far, the need to incorporate issues concerning the end-of-life phase at the design phase is very large." He said that the same would hold true to the legislation in Japan, which was under development at the time of the interview.

Commenting on some roles of the 1991 original Recycling Promotion Law, the Voluntary Initiatives issued by JAMA and the like, one of the interviewees mentioned that for people working on the actual measures the presence of legislation mandating the undertaking of some measures would facilitate their work much better. The "guideline" type of policy measures

had not been convincing enough to secure monetary and personal resources to undertake measures to achieve issues stated in the wish list. As another interviewee put it: "domestically, the Recycling Promotion Law was established in 1991. However, they were like targets that would be desirable to achieve, with no punitive clauses." On the other hand, finding the legislation as something that they need to meet by all means, some commented on the preference of voluntary initiatives rather than via legislation.

(Future) competitive advantage/corporate image

Several companies referred to competition with other manufacturers. One mentioned that the company "would like to be at the top among the industries manufacturing the same type of products". Another interviewee, while explaining the dilemma of balancing the costs and development of new technologies mentioned, "new technology would be, if it could be incorporated in new products, a new competitive edge."

Enhancement of corporate image was also referred to as a promoting factor for some manufacturers to strive for environmental issues, including design for end-of-life. One interviewee referred to the inclusion of environmental issues in the ranking of companies.

Manufacturers' ability to design cars

Several interviewees referred to the knowledge their companies have on their products as manufacturers. The manufacturers have a responsibility as "the one who knows most". One of the interviewees mentioned that manufacturers should be responsible for taking concrete measures and not just for covering costs. "Because manufacturers know about their cars, information should be provided with regard to, for instance, how to dismantle a car properly, how to extract oil most definitely without spilling it around the parts so that parts can be used again, which of the parts have commonality and so on."

Others mentioned that they would fulfil their responsibility by using their expertise in their area, which is to design their cars to be suitable for recovery. "The responsibility of a car manufacturer is to manufacture a car that is easy to recycle. This responsibility cannot be delegated to anyone else, and it is a task that must be carried out" by a manufacturer.

Raised concern in society

Several interviewees referred to the increased concern on illegal dumping of auto shredder residues as manifested in the incident of Teshima. One of the interviewees mentioned that there had been a "necessity to develop new technologies of the time, as environmental performance becomes one of the social requirements." If the end-of-life management "becomes a social problem, some kind of reaction will definitely come from society. So we should move forward so as to be able to cope with it."

Company internal drivers

A few interviewees referred to the strong top management commitment of their company as a promoting factor. One of them said that since he had started to work on the environment five years before, "the President always talks about environment."

Others

An interviewee mentioned that they would like to be at least at the same level as their competitors (*yokonarabi*). , Although without sanctions, the *original Recycling Promotion Law in 1991* was mentioned as a factor that promoted some measures such as material marking to be undertaken. One of the interviewees referred to the *inherent nature of a technician and a manufacturing company* as a driving force. "Development of new technology is the lifeline for both." One interviewee mentioned that it is manufacturers *corporate social responsibility* to work on the issues of end-of-life management.

Hindering factors

Meanwhile, car manufacturers in Japan shared a number of issues that had posed challenges to the undertaking of measures to reduce environmental impacts from the end-of-life management of products, as summarised in Figure 4-7.

Cost

All the manufacturers interviewed found extra costs to be a hindering factor for the further undertaking of measures to reduce environmental impacts from end-of-life management of their products. For manufacturers, "development of technologies means development of technologies with

minimised cost." Technological solutions might exist for the achievement of a very high recycling rate, but they could only be applied once the cost associated with the application of the technologies became reasonably low. Several interviewees commented on the high transportation costs required for component reuse and material recycling in comparison to relatively low prices of virgin plastics.

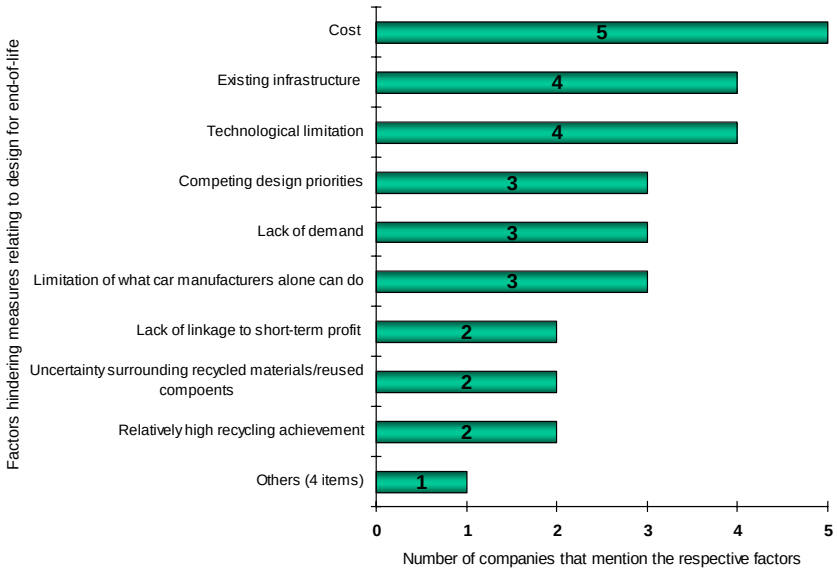

Figure 4-7: Factors hindering undertaking of measures related to design for end-of-life for Japanese car manufacturers

Existing infrastructure

All the interviewees mentioned that they had not been familiar with the situations surrounding their products at their end of lives.

A number of interviewees expressed the difficulties of entering the end-of-life management phase of their products, for which an infrastructure comprising of approximately 5000 dismantlers and 1140 shredders existed. The manufacturers and these downstream actors – often expressed as "artery industry" and "vein industry" respectively – had little, if any, business relations with each other. As an interviewee put it, "after decades

when car manufacturers had not touched the vein industry, it is difficult to impose ourselves in their business."

One interviewee mentioned that establishing a system solely by the manufacturers would have been the most efficient and less expensive. Securing the enhancement of the environmental performance of the existing actors would pose more challenges than establishing a new system by the producers. However, that would harm the livelihood of these existing downstream actors. Another interviewee mentioned that it would be a significant loss for society to lose the infrastructure that had been functioning in accordance to the economic principle. One interviewee suggested the necessity of the government in providing assistance to these existing actors.

In relation to the existing infrastructure, an interviewee commented on the difficulties of establishing a system where cars manufactured by one producer would be scrapped separately from the others (*individual physical responsibility*). When discarded cars are treated together, all the plastics, regardless of their quality for recycling, would end up in the same pile of auto shredded residues and would make the efforts of car manufacturers to strive to develop high quality plastics in vain.

Technological limitation

Interviewees also commented on the technological limitations. "Not everything could be recycled." Moreover, even when a material could technically be recycled to the same components, this might exert significant environmental impacts. In fact, some interviewees raised questions as to whether recycling or reuse was always an environmentally preferable option. An example raised by a few interviewees was their efforts to use materials constituting the bumpers collected from old products as materials for new bumpers. Scrapping the paints put on the old bumpers, a process required in order to achieve "bumper to bumper" recycling, would exert very high environmental impacts. However, as discussed in Section 4.2.2, a few manufacturers had developed a technology that enabled them to peel the paint mechanically without any chemicals.

Competing design priorities

Related to technological limitations, the majority of the interviewees discussed various other design features that may compete with design

changes primarily aimed at design for end-of-life. One interviewee gave an example of the limited application of lead-free solders in the electronic components in cars. Due to the necessity to bear heat and vibration, the requirement for reliability should be higher for the electronics in cars than the electronics used in households. The example of "bumper to bumper" recycling mentioned in the previous section was another example a few manufacturers raised.

Lack of demand

The majority of the interviewees mentioned that they had not felt demand from the consumers regarding design for end-of-life of the cars. As one interviewee put it, "it is not like a car cannot be sold unless the recyclability goes up at the expense of increase of price. Neither is it the case that customers are willing to buy cars because the recyclability goes up. That is, in one sense, why the issue of recycling is lagging behind among the measures taken in the company." When it was explained that the components consisted partly of recycled materials, personnel in the marketing department in another company warned the interviewee that the reaction of the customers could be "reduce the price if you use garbage".

Limitation of what car manufacturers alone can do

Being OEMs, the manufacturers do not possess all the expertise to develop materials and components on their own. One interviewee mentioned that it had not been easy to force the company's suppliers to develop materials preferable for recycling, as such demand "would not be based on the economic principles". Involvement of plastic manufacturers would be helpful in cultivating markets for recycled plastics, instead of trying to search for the demand by car manufacturers alone.

Similarly, some interviewees expressed their frustration on receiving all the responsibility, including financing of the system and development of infrastructure, without having the control over all the activities. Related to the existing downstream actors, one interviewee commented that the manufacturer's influence on downstream actors would be rather limited. He emphasised the role of government as a consensus builder where conflicting interests exist, rather than a lawmaker. Commenting on the limitation of manufacturers' ability in achieving the measures required to reduce downstream environmental impacts, another interviewee suggested that the government should provide support to the manufacturers.

Lack of linkage to short-term profit

One interviewee expressed his frustration on the lack of understanding within the company on the importance and necessity for research and development with long-term consequences, which had lead to "chronic lack of human resources." Another commented that environmental work in general had the tendency not to be linked directly to short-term profit, thus less appreciated within the company.

Uncertainty surrounding recycled materials/reused components

Several interviewees pointed to the necessity to cultivate the markets for the materials recovered from cars. Reflection was also made on the difficulties of recycling plastics used in the cars currently taken back. When discussing the possibility of achieving component reuse, an interviewee expressed his concern on the varying market conditions under which their cars were sold. Similarly, another interviewee commented on the difficulties of using recycled materials in a constant manner without knowing how much of a part of a car that can be used for recycling would come back and by what time. He also referred to the long-life span of cars, the rapid development of technologies, and the uncertainty surrounding the possibility of recycling the materials constituting old cars for the same purpose in new cars.

Relatively high recycling achievement

A few interviewees pointed out the fact that 75-80% of their products have been recycled based on the economic principle already, quite a high recycling rate when compared to most other products. While acknowledging the necessity of reducing the rest of 20-25% to be sent to landfill, they questioned the large burden of achieving it on their own.

Others

The *preference of Japanese consumers to new products* was raised as a hindering factor to promote component reuse. An interviewee expressed his frustration at the *lack of understanding of the legislator* regarding the actual situation surrounding end-of-life management of cars. Another pointed out the *deficiency of domestic law* concerning transport of recycled materials, and the cumbersome process for transport companies to obtain permissions in order for them to carry materials that do not have positive monetary value.

One interviewee also commented on the possible challenges posed by the *contradiction between the increase of recycling rate and market competition.* Considering the situation where all the cars are treated together regardless of the brand, it would be more efficient for dismantlers and shredders for all the producers to take similar actions when compared to the situation where individual manufacturers impose different treatment. However, having all the manufacturers take the same actions would be against free market economy.

4.3.4 Car manufacturers in Sweden

Promoting factors

Figure 4-8 summarises factors discussed by a total of seven interviewees from three manufacturers in Sweden that promote the undertaking of measures to reduce environmental impacts from end-of-life management of their products.

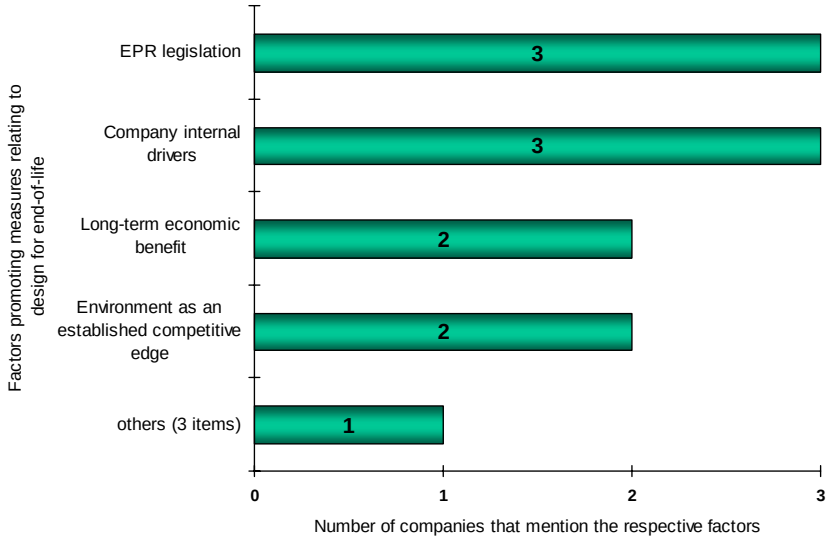

Figure 4-8: Factors promoting undertaking of measures related to design for end-of-life for Swedish car manufacturers

EPR legislation

All the manufacturers commented on the influence of EPR legislation in promoting design for end-of-life. An interviewee argued that the emergence of EPR had provided justification to conduct life cycle costing and incorporate the environmental costs from the entire life cycle of their product because that obliged them "to pay for the end-of-life vehicle." He also hoped that the legislation would help raise the awareness of their customers on the issues of end-of-life management. "They would realise that they could buy a vehicle that is more recyclable." A truck manufacturer mentioned that, although the EU ELV Directive had not covered their products, they had been following it closely and were trying to fulfil the content of the Directive.

A few of the interviewees expressed their view of legislation as a good mechanism to convince people to work on issues such as end-of-life management. As two interviewees put it: "You will always get a fairly good acceptance when you force legislation." "I think it is much more easy to communicate now, as there are clear rules set for this."

When asked for the reasons why the company had started to work on recycling issues, an interviewee commented that the trigger was a growing concern on the landfill issues appearing in the form of legislation and/or as a social concern. He regarded legislation as a reflection of social concern.

Company internal drivers

Interviewees from all three companies commented on drivers existing within the respective companies. One mentioned that environment was the company's core value. Another interviewee suggested that the relatively high awareness of their colleagues on environmental issues in general had facilitated their undertaking of measures within the company. He also commented on the change he observed of the attitude of young designers. As he put it, "you had a lot of … elderly designers … that were less interested in listening to" the environmental "arguments… and all of a sudden you get a lot of new people coming from university having heard everything about environment in the education… So, the reception of the message is much better now than 5 years ago." Another company included the achievement of recyclability as one criterion when evaluating their product profiles.

Long-term economic benefit

One interviewee argued that although using more expensive materials that could achieve higher recycling rate would be costly in the first 10-15 years, the company might be better off in the long run. When discussing various measures the company had been undertaking in order to reduce dismantling time, another mentioned that they believed striving for design for end-of-life would eventually lead to cost reduction.

Environment as an established competitive edge

All the three manufacturers interviewed had merged with other car manufacturers outside of Sweden – Volvo car with the Ford Group, Saab with General Motors and Volvo Truck with two other truck companies. Interviewees from two manufacturers mentioned that next to safety issues, environment had been one of their strengths within the large group of car manufacturers. There existed an expectation from the companies in the respective groups to utilise the environmental expertise of the manufacturers interviewed. Meanwhile, the manufacturers themselves wished to position themselves as the leader on, among other things, environmental issues. They had been sharing their experiences regarding environmental measures taken in the past. One interviewee mentioned that most of the questions he received from the rest of the companies in the group are issues they had dealt with some time ago.

The "branding" of the companies as environmentally superior had supported the undertaking of environmental measures within the company, including design for end-of-life. Meanwhile, it could be rather time consuming to answer all the questions from the group companies.

Others

One interviewee mentioned that the *evolution of discussion in other countries* such as Germany was a trigger for the manufacturers in Sweden to establish a working group within the car industry association on car recycling issues. Another interviewee considered that compared to other environmental issues concerning cars, fuel efficiency and emissions, becoming the leader on *recycling issues involves relatively small cost*. Reflecting upon the amount of work that had been put on recycling issues already, he argued that they should further their work on recycling and use it when marketing their products.

In some cases, the fact that the manufacturer *purchased a relatively large portion of the suppliers' commodities* enabled them to exert significant influence on suppliers. Merging with other car manufacturers at time facilitated this process. However, the manufacturers interviewed also suffered from the reverse, as discussed further in the next section on hindering factors.

Hindering factors

Car manufacturers in Sweden also discussed a number of obstacles that posed challenges to their undertaking of measures related to design for end-of-life, as summarised in Figure 4-9.

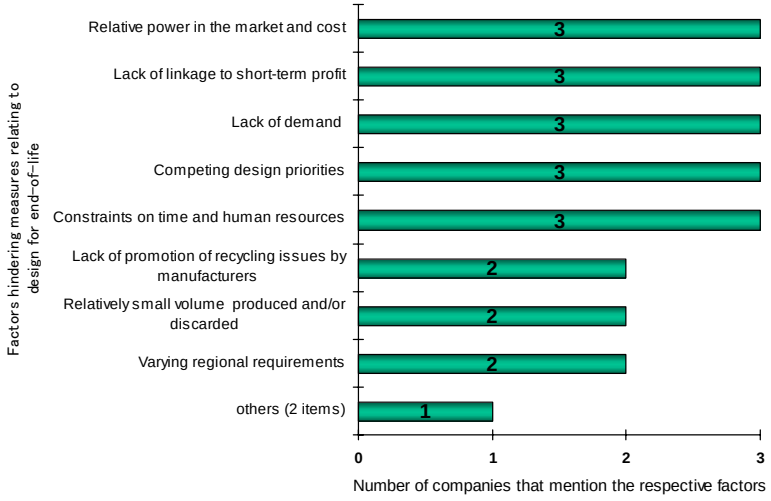

Figure 4-9: Factors hindering undertaking of measures related to design for end-of-life for Swedish car manufacturers

Relative power in the market and cost

Whether the demand the manufacturers place upon their suppliers would be fulfilled and at what price depends on the importance of the respective manufacturers as customers in the eyes of the suppliers. All of the manufacturers encountered difficulties in influencing their suppliers to

change the components produced in accordance with their specification without a large increase of costs. However, as discussed in the previous section, merging with other manufacturers would most likely improve the situation and provide manufacturers with more negotiation power when dealing with their suppliers.

Lack of linkage to short-term profit

Another factor perceived to be a challenge by all the manufacturers interviewed was the lack of direct linkage between design for end-of-life and short-term profit. In one of the companies interviewed for example, at the time of the interview, only the upfront cost was considered in the cost calculation. The relation between selection of materials and their relative recyclability, for example, had not been incorporated in the cost calculation. This brought purchasers' attention to the components and materials that were cheapest, regardless of the cost reduction that could be achieved at the time of disposal. The relatively long life span of the cars had been among the main reasons that made it difficult to incorporate costs associated with end-of-life management at the design phase.

Lack of demand

Demand for design for recycling from consumers had been perceived to be lacking. As one interviewee put it, the "customer today does not buy a car that is very recyclable. He buys a car that has low fuel consumption in the first place." According to their customer survey, "recycling or recyclability is very far down the list when considering to buy a new vehicle."

Competing design priorities

Different features that the manufacturers would wish to include in their products, including other features related to environment and features that do not concern environment, conflict with design for end-of-life.

Among the design requirements related to environment, an example given by one interviewee was the use of steel versus lighter materials. Use of steel would make it easy and inexpensive to recycle but would make the car heavier. An interviewee commented that it " is probably a more important priority today to make cars lighter to get the fuel consumption down than it is to make them recyclable at the highest extent." The fact that the cars currently produced by the company have relatively high metal content may

also contribute to the necessity of working more on fuel efficiency than recycling. Another manufacturer echoed the priority on fuel efficiency and emission.

One interviewee mentioned that among other requirements such as quality and safety, environment "does not have teeth" in his company. He also mentioned that when looking purely from an environmental point of view, end-of-life management might not be the most important thing to deal with. When discussing the company's internal product development project, another interviewee stated that recyclability was one of the objectives of the project along with quality, durability, strength and the like. The key in this process would be to ensure that the product developers do consider all these objectives.

Constraints on time and human resources

One interviewee expressed his frustration on the *time constraint* in achieving desirable changes, giving the examples of development and implementation of the EU ELV Directive. "…However enthusiastic you are, you need to realise that you need time to do things. If you get the time and … the proper specification, I can't see any problems… Most of what we know today as problems, I'm sure, will be solved in time."

When discussing their potentials of becoming the centre of excellence on environment within their group companies, another interviewee commented on the shortage of time and human resources. Despite the availability of knowledge, it takes too much time to communicate this expertise to the rest of the companies in the group while developing their own capacity. He also compared environmental issues with safety issues, which had a longer history than environmental issues. He pointed out that despite various improvements in the past 10 years, it might take some more time for environmental issues to be really integrated into product development.

When discussing their on-going efforts of obtaining information on the hazardous substances contained in components from suppliers, one interviewee suggested that incompletion of the initiative was due to a lack of capacity.

Lack of promotion of recycling issues by manufacturers

In relation to the lack of demand from the public, manufacturers admitted that the promotion of recycling issues had not been carried out compared to other environmental profiles of the cars, such as fuel efficiency. Considering the fact that demand for cars with low fuel consumption was created by manufacturers' promotion, demand could be boosted by increased communication on end-of-life management issues to the consumers. Otherwise, it would be difficult for the consumers to "know that they actually could demand a more recyclable car."

Relatively small volume produced and/or discarded

An interviewee from the truck manufacturer commented on *the very small number of their products that would be scrapped within Europe*, as most of the old trucks are exported to places such as Eastern Europe, North Africa and South America. For example, the number of cars scrapped annually in Sweden would only be a couple of hundred. This would make the end-of-life management issues a lesser priority in developing new cars. It would also make it challenging for truck manufacturers to take the lead in cultivating possibilities to close the material loops. Another interviewee commented on the relatively small volume of cars produced in Sweden, which would make it challenging "to make anything really good with regard to the material chain." One interviewee also commented that the *size of individual car scrap industries were too small* to make recycling a good business.

Varying regional requirements

Some interviewees commented on the various regions of the world where their products had been sold, and the difficulties of meeting diversifying requirements set up in the respective regions. Giving an example of requirements on fuel emissions, one interviewee commented that they had difficulties in developing different model that suit the respective requirements due to the small number of the products sold in the respective regions.

Others

While acknowledging the roles legislation had played in promoting design for end-of-life, an interviewee expressed his frustration in being "*obliged to pay for* something in a chain of operations where" they did *not have control.*

Another interviewee referred to the *relatively high recycling rate* cars had been achieving without any regulations and suggested that trying to go beyond that level would mean more cost for consumers. An interviewee also commented that the *geographical distance* between the dismantling plant and the designers and the *time* associated with it has made it difficult for designers to communicate directly with dismantlers.

4.4 Interpretation of the findings

In this section, the findings presented in the preceding sections are interpreted with the aim of evaluating the effectiveness of the presence of EPR programmes in inducing upstream changes. The section first discusses whether the upstream changes, which are deemed to be essential in bringing forward the ultimate goal of an EPR programme did indeed occurr (*goal attainment* evaluation) (Section 4.4.1). It also reflects upon one of the criticisms that is posed against EPR programmes. That is, the efforts of reducing environmental impacts from the end-of-life management of their products may have adverse effects on the impacts from other part of the product life. This relates to the potential of the EPR programmes currently implemented in achieving their ultimate goal: total environmental life cycle improvement of product systems. Section 4.4.2 considers the role of the presence of EPR legislation, in light of other influencing factors, in promoting the undertaking of the upstream changes in order to reduce the environmental impacts from complex products and product systems (*attributability* evaluation).

4.4.1 Goal attainment evaluation

Have the interviewed manufacturers of EEE and cars in Japan and Sweden undertaken the upstream measures in order to reduce environmental impacts from downstream? If so, what are these measures? What are the other measures undertaken as mandated by/envisioned in EPR programmes? How have they been conducted? How do the different measures relate to each other? Why have the manufacturers decided to take such measures?

This section synthesises the findings on the existence and the content of measures undertaken by the respective industries in the two countries, highlighting the similarities and differences. The measures are categorised into three, as follows.

- Upstream changes: design changes in new products to reduce environmental impacts from end-of-life management and measures that facilitate these design changes undertaken before/during the design phase.
- Development of downstream infrastructure: measures related to separate collection, disassembly/dismantling of products, reuse/recycling/final treatment of components/materials, all conducted in an environmentally sound manner.
- Development of feedback mechanisms between the upstream and downstream.

Subsequently, it reflects upon the similarities and differences of measures found between the two industries and between the two countries as well as the linkage between the different measures. It also discusses why manufacturers have undertaken the respective measures in the manner they have chosen, utilising in particular the findings presented in Section 4.3. Finally, it discusses the influence of upstream measures for end-of-life management on the total life cycle environmental improvement of product systems.

Synthesis of the findings

Upstream changes

Among upstream changes, literally all the manufacturers of EEE and cars in Japan and Sweden that the author interviewed started to consider environmental impacts from the end-of-life phase of their products when designing these products. Life cycle thinking is prevailing in all cases. Environmental product assessment of various types has been conducted in order to decrease the overall environmental impacts from the product's life cycle, including the end-of-life phase. The design tools utilised to identify the focus area include design guidelines, LCA, material impact assessment and the like. In addition to these tools that concern the environmental impacts from the entire life cycle, some Japanese companies have developed tools that primarily assess the recyclability of products.

Design changes of new products to decrease environmental impacts from the end-of-life management of their products principally concern 1) reduction of hazardous substances and 2) design change that facilitate

source reduction, increased reuse/recycling of products, components and materials.

Measures related to reduction of hazardous substances

All the manufacturers interviewed have been making efforts to reduce hazardous substances from their products. A number of manufacturers developed a checklist of hazardous substances with different degrees of restrictions, for instance ban, phase-out and control. In one case, precious metals are also included in the list. Vigorous efforts have been made to communicate the lists to their suppliers and to gather information on substances contained in the materials and components. Databases that enable the designers to use the information provided by the suppliers have been developed by a number of manufacturers interviewed. Some of the databases also incorporate functions to aggregate environmental impacts of the selected combination of materials and/or components. Gathering information from the suppliers was a challenge facing a number of manufacturers, especially when the suppliers have further tiers of suppliers behind them. Car manufacturers in Sweden commented on the development of a database shared by car manufacturers in Europe. The initiative would reduce the transaction costs both for manufacturers and suppliers. Some interviewees also pointed out the importance of the involvement of purchasing departments in facilitating the phasing out of hazardous substances. Channelling the communication path would also contribute to the reduction of transaction costs for suppliers.

In addition to communicating the lists of substances, substances used in components have been controlled through product specification. Some manufacturers collaborate with their suppliers to phase out certain substances from their components and develop alternatives. Collaboration with suppliers in general seems to take place more in the case of cars than EEE. An interviewee of a Japanese car manufacturer pointed out that the Japanese manufacturing industry in general has been moving from collaborating with suppliers to providing the suppliers with product specification, while two Swedish car manufacturers commented on the opposite move.

Furthermore, the manufacturers themselves have been conducting research to explore alternative solutions to those containing substances to be phased-out. The most often-stated efforts among the EEE manufacturers interviewed in both countries are the development of lead-free solders and

halogen-free printed circuit boards. Reference to the development of alternatives to ozone-depleting substances and greenhouse gases was also prevailing among the manufacturers who use these substances, such as those of refrigerators and air conditioners. A measure referred to by all Japanese car manufacturers interviewed was the phase-out of lead from different parts of the cars, except for car batteries that already had an established system for collection and recovery. A few Japanese car manufacturers referred to concrete in-house research and development activities concerning the phase-out of restricted substances, while the Swedish car manufacturers did not.

Enhancement of source reduction, reuse/recycling

A measure that comes to the top of the hierarchy of resource efficiency and/or waste management is dematerialisation. Dematerialisation of a product means a reduction in the absolute quantity of materials used per product. Examples of dematerialisation measures taken by the EEE manufacturers in both countries include material reduction and light-weighting of parts of medical equipment, air conditioners and washing machines, miniaturisation of lap-top computers and mobile phones. Car manufacturers in both countries also strive for light-weighting by shifting the types of materials used such as the use of aluminium instead of steel. When discussing their dematerialisation, some EEE manufacturers mentioned the added value apart from environmental gains, such as consumer convenience and space saving. In the case of cars, the principal objective for light-weighting is improvement of fuel efficiency and not necessarily material conservation. Nonetheless, reduction of the input of material resources would be in principle positive from resource efficiency point of view.[86]

Measures related to the enhancement of reuse/recycling of products, components and materials have been also widely undertaken by the manufacturers interviewed. However, the degree of efforts made and the type of measures undertaken varies.

[86] A concern often raised in this regard is that dematerialisation may induce increased purchase of new products and most likely increased disposal of obsolete products even though these products could still function properly. The topic, however interesting, is beyond the scope of this thesis and is not discussed further.

At least at the first glance, upstream measures aiming to reuse the product itself contribute to reduction of material input at source and seem to be preferable options. However, the undertaking of such measures by manufacturers has been rather limited. The few examples identified are the reconditioning of copying machines and mobile telephone systems, and design for upgradability initiated by some computer manufacturers. Refurbishment of "young" products damaged either at the production or transportation phase conducted by a Swedish manufacturer of large and small home appliances is another example. A Japanese EEE manufacturer mentioned that design for disassembly has facilitated repair, thus helping to prolong product life.

Apart from design for upgradability by a few computer manufacturers, these examples concern products within the same generation. A number of EEE manufacturers in both countries argued that the longevity of products, coupled with rapid development of technologies, poses challenges making the reuse of old products an environmentally preferable option. The threshold year given by a Swedish manufacturer was 3 years. As found in the comment of a Japanese EEE manufacturer, the promotions of reuse also conflicts with sales of new products.

Among the car manufacturers, one Japanese interviewee commented on the establishment of a second-hand sales division in the early 1970s while others did not comment on their measures on product reuse.

Meanwhile, some manufacturers interviewed have been undertaking/have initiated upstream measures related to component reuse. Measures undertaken by the EEE manufacturers include the remanufacturing of copying machines, reuse of toner cartridges, reuse of components of computers, mobile phone systems and large medical equipment and the like. Components of computers and mobile phone systems are used as spare parts while the primary destination for the rest is new products. With regard to cars, a Swedish manufacturer has been reconditioning their spare parts and selling them under their brand name, while two Japanese manufacturers initiated the same process. The two Japanese manufacturers have also started to establish networks with existing dismantlers and are involved in the sale of second-hand components. A Swedish manufacturer commented on their trial of entering the spare part business and its failure due to the interests of dismantlers who were in the business. The manufacturer later established a contract with one dismantler who handles spare parts on their behalf. A few Swedish manufacturers commented on the relatively large

profit margin in the spare parts market. A few manufacturers commented on the guarantee of function of spare parts as a challenge. In some cases, the reconditioning of the spare parts and resale under the brand names of the producers has been a solution.

Concerning design for disassembly, Japanese EEE manufacturers as well as car manufacturers in both countries have been taking a number of measures to ease the disassembly process. Examples include unification of materials, reduction of the number of components and screws, reduction of assembly steps, one-direction disassembly, use of standardised screw, use of screw instead of glue and the like. A motivation mentioned by a number of interviewees was the reduction of disassembly/dismantling time. Except for a manufacturer of medical equipment, Swedish EEE manufacturers did not comment on their efforts on design for disassembly. One Swedish EEE manufacturer explicitly mentioned that, except for some parts that need to be separated, it is not worth designing their products for disassembly. The discarded products would be put into a shredder, and materials would be sorted.

A common measure undertaken by most of the manufacturers interviewed to enhance recyclability is to harmonise the types of plastics constituting their products and mark the plastics.

Most of the EEE and car manufacturers in both countries have chosen to use thermoplastics that are commonly used for various purposes, such as PP, polyethylene, PET and harmonise the grades within these thermoplastics. Once recovered, these plastics could be used for the same purpose as the original (recycling), or for products/parts with lower quality demand (down-cycling). Recycled plastics from other products are used as well. Meanwhile, a few manufacturers (one car manufacturer and one EEE manufacturer in Japan and one car manufacturer in Sweden) developed specific thermoplastics that do not degrade as easily as other thermoplastics, while meeting other specifications such as durability, mouldability, resistance to heat and coldness and the like. The two Japanese manufacturers commented that when recycled, they intend to use these high-quality plastics for the same purpose as the original. For some products such as computers and TV sets, plastics were replaced with magnesium alloys to enhance recyclability while keeping weight low.

Development of downstream infrastructure

The development of infrastructure downstream, including collection of their discarded products, dismantling/disassembly, reuse/recycling of components/materials and final treatment, and transportation between the respective stages, took varying paths. The similarity and differences are highlighted below.

All the Japanese EEE manufacturers interviewed that produce large home appliances established at least one recycling plant on their own. Because of the necessity of covering the entire country, the manufacturers formed two groups and collaborate with each other within the respective groups. These two groups established separate regional aggregation stations to which retailers, who are by law responsible for collection from consumers, bring the discarded products produced by the manufacturers belonging to the respective groups separately. At the time of the interview when the legislation still had not come into force, some recycling plants established by the manufacturers were already in operation while others were still in the pilot phase.

Meanwhile, two computer manufacturers and one copying machine manufacturer interviewed in Japan respectively established their own nationwide collection network and recycling plants. The collection network and recycling plants have facilitated upstream measures discussed in the previous section such as component reuse, remanufacturing and reconditioning.

Among the Swedish manufacturers, the producer of medical equipment had previously established its own collection and recovery system due to the profit gained from recovery. At the time of the interviews, the take-back and recovery system for mobile phone systems was going through a pilot phase with a vision of covering all the EU countries and to later expand its service to the United States and Japan. Similar to the situation of the Japanese manufacturers of copying machines and computers, the collection and recovery system has been utilised for component reuse and recycling.

In addition to the initiatives on mobile phone *systems*, the Swedish mobile phone manufacturer interviewed, together with other mobile phone producers, conducted a pilot project of collection and recovery of mobile phones in 1997 prior to the enactment of the legislation. Meanwhile, in order to fulfil the national EPR legislation for EEE, various industry associations of EEE whose members would be affected by the legislation

established a common system, run by an organisation called El-Kretsen. Despite some concern, the mobile phone manufacturers also joined the system. Their main concern was that by being part of a large system they might need to subsidise the recovery of products whose recovery costs are higher than for mobile phones. The manufacturers of large and small appliances, as well as computers, also joined El-Kretsen system. In the case of the computer manufacturer, at the time of the interview it was considering establishing another infrastructure with its own partner to facilitate collection from both business and private households.

The El-Kretsen system had not started its operation at the time the interviews were conducted. It was in the process of establishing the entire logistic system, including the negotiation with local governments concerning the location of collection points, and the like.

At the time of the interviews, the Japanese EPR legislation for cars was in the process of development. The downstream infrastructure for cars was as it used to be: end-users bring the cars to the dealers, who take them to existing dismantlers and scrappers. The foreseen downstream infrastructure would be collective. Local dismantlers would collect the discarded cars, regardless of the brand, and then treat the cars together. An interviewee from the manufacturer that developed plastics of higher quality expressed his concern on the difficulties of separating the recovery operation and/or differentiating the recovery costs from their competitors.

At the time when the interviews were conducted, only the Swedish EPR legislation for cars had come into force. BPS, an organisation specialised in the EPR within the Swedish car association, has listed skilled dismantlers (75 out of 800 existing dismantlers in Sweden at the time of the interviews) as a recommendation for the manufacturers. The Swedish car manufacturers interviewed selected their dismantlers from the list provided by BPS and have made contracts with the respective dismantlers individually.

Some car manufacturers in both countries also have contracts with selected dismantlers concerning the management and sales of old parts as spare parts.

Development of feedback mechanisms

Various efforts have been made by the vast majority of the manufacturers interviewed to receive feedback from downstream actors, such as

dismantlers and personnel in the recycling plants. Similar to the development of the downstream infrastructure, the development and forms of feedback mechanisms between the downstream and the upstream is diverse among the manufacturers interviewed.

Prior to the enactment of the SHAR law in 1998, individual manufacturers of large home appliances interviewed in Japan, as well as the Association of Electric Home Appliances, initiated various experimental projects for the enhancement of the recovery of their products. The results of these experiments facilitated knowledge building on design for end-of-life within the respective companies. As the time when the SHAR law was to come into force drew closer, the communication between downstream and upstream seemed to be enhanced. One manufacturer, who started to run its recycling plant as early as 1999, established a database that connected data taken from the recycling plant and the designers. Among other things, these data includes the actual price/cost for various recycled materials to be sold/ handled. Another manufacturer established a centre dedicated to the design for end-of-life. A number of interviewees commented on the experiences of designers in dismantling their own products.

Due to the existence of large computers in the past, the two computer manufacturers in Japan established at least one recycling plant rather early. An interviewee commented that the knowledge they had accumulated provided them with some advantage in organising their activities efficiently. As well as periodical meetings in person Intranet has been among the communication means used to connect the upstream and the downstream. Concerning the copying machine manufacturer, the development of upgradable products, the improvement of recyclability and the optimisation of distribution systems that connect the downstream and the upstream, have been the three elements that serve as a foundation of their information system.

The situation surrounding the Swedish EEE manufacturers interviewed varies. The mobile phone company utilised its involvement in the industry-wide project and has continued its communication path with the recycler engaged in the project. It also established its own internal recovery workshop to gather data. Concerning the mobile phone systems, the interviewee foresaw that communication paths would be developed between recyclers and designers. Operating worldwide, the computer manufacturer has been collaborating with recyclers in the respective parts of the world and making the best of the recycling technology locally available to minimise the

environmental impacts from the total life cycle. The manufacturer of medical equipment provided information on their products to their recyclers. Whether they obtained any information from the recyclers or not was not mentioned.

The majority of car manufacturers in Japan have been proactively communicating with the dismantlers. An interviewee from one manufacturer visited more than 300 recyclers, located domestically and abroad to learn about the existing practices. The manufacturer has been developing dismantling and treatment technologies that are relatively inexpensive and providing information on these technologies to dismantlers through newsletters. Another manufacturer visited local dismantlers and started to collaborate on glass recycling. The communication between the truck manufacturer interviewed and dismantlers was not referred to.

Both of the Swedish car manufacturers commented on the ECRIS project, a collaborative project between car manufacturers and recyclers. One manufacturer commented on the extensive participation of the designers of another manufacturer. The communication between the recyclers participating in the ECRIS project and manufacturers continued. One manufacturer commented on the interaction with dismantlers that they had contracts with at the time of the interview. There are also biannual meetings between manufacturers and dismantlers. Due to the small number of trucks that stay in Sweden until the end of their lives, the truck manufacturer had not had much interaction with the dismantlers. However, they have provided the dismantlers with guidelines for dismantling. The car manufacturers in Europe had developed a common CD-Rom with dismantling instructions.

In addition to receiving knowledge from the recyclers, some producers in both industries in the two countries have provided the dismantlers/recyclers with information on their products such as location of hazardous substances, manner of dismantling, types of materials used and the like.

Reflection upon the synthesised findings

The synthesis of the findings suggests that the manufacturers of EEE and cars in Japan and Sweden have indeed been undertaking various upstream measures to decrease environmental impacts from the end-of-life management.

The measures to reduce hazardous substances from the products as well as the types of concrete measures taken, resemble each other between the EEE manufacturers in the two countries. The fact that the majority of the interviewees mentioned the WEEE Directive and the RoHS Directive as one of the main drivers for their efforts to eliminate the substances may explain the similarities.

In addition to the in-house research and development activities commonly found among EEE manufacturers in the two countries, a prevailing measure found in both industry sectors was the use of lists of restricted substances and communication of the lists to the suppliers. Through communication of the lists, manufacturers interviewed seem to aim not only at reducing the hazardous substances used in their products, but also at gaining knowledge of the materials used in their products in general. The second aim can be explained from the increasing demand of information provisions related to environment. Apart from PRTR legislation that concerns the substances used at manufacturing sites, the perceived expectation from the society on environmental communication via environmental reports,[87] environmental product declarations and the like may be serving as a driver for companies to obtain information from the suppliers. The widely accepted life cycle thinking may have encouraged manufacturers to obtain information from their upstream as much as possible.

Communicating the lists to suppliers may also provide signals as to what would be demanded from the manufacturers in the future. It may the opportunities for suppliers to explore alternatives, and may facilitate the gradual acceleration of the actions by suppliers, which is perceived to be relatively slow by some EEE manufacturers in both countries. The seemingly weakened connection between the suppliers and OEMs, as pointed out by a Japanese car manufacturer, may also urge the component and material suppliers to strive for the development of environmentally superior materials and components.

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[87] Recent years have seen the rapid enhancement of environmental communication via environmental reports in Japan, both in terms of quantity and in quality. Some of the triggering events include the establishment of the Environmental Reporting Network among the companies working on the environmental reports in 1999, the publication of the guideline for environmental reports by the Ministry of the Environment in 2001, annual awarding of superior environmental reports since 1999 to name but a few. The movement has been influenced by the international trend of environmental reporting, as manifested in the Global Reporting Initiative.

A number of interviewees in both countries pointed out the limitation of the OEMs alone in making desired upstream changes. An important factor influencing the component and material manufacturers' efforts to reduce the use of hazardous substances is the power relation between the material and component suppliers and manufacturers.

Reduction of hazardous substances was also an area where demands do exist from customers. In fact, the very limited demand from customers felt by two of the three Swedish manufacturers is related to hazardous substances. The higher relevance to human health as compared to recycling, may explain the demand from customers on this issue.

For manufacturers, efforts to eliminate hazardous substances within components and materials, such as brominated flame retardants, also facilitate recycling. It would lift up the value of recycled materials, and help manufacturers meet higher recycling targets. In this respect, it is worth mentioning that an EEE manufacturer and a car manufacturer in Sweden have undertaken voluntary efforts to eliminate substances (beryllium and PVC respectively (van Rossem, 2001; Lindhqvist, 2004, August 5). They have undertaken these efforts in order to enhance recycling, even though the legislation does not prohibit them to use these substances.

In general, with regard to enhancement of source reduction of material use, reuse and recycling, the measures in the higher ladder of resource efficiency/waste management hierarchy – dematerialisation, product and component reuse – have not been undertaken as much as those in the mid ladder (design for recycling). One reason could be the relative easiness of taking measures in the mid ladder such as harmonisation of plastics, than those in the upper ladder, for instance complete change of products. Another reason could be the form of requirements they should meet in legislation, especially with regard to source reduction. Reduction of the absolute quantity of material per product that would be eventually discarded cannot be measured in, for example, collection or recycling rate requirements. On the other hand, the innovative nature of product development and the lack of expertise among policy makers, among other things pose challenges for policy makers to set requirements on source reduction concerning the material use. In fact, the provision of prescriptive requirements in this regard may conflicts with the very necessity of an environmental policy to enhance innovation.

With regard to the product and component reuse, a common characteristics observed among the manufacturers that have started to reuse their products and components is that they have established infrastructure to take back their products and/or components after their use. In other words, they have *individual physical downstream infrastructure* for their products. As well as upcoming EPR legislation, the value of the products and components has facilitated the establishment of collection and recovery infrastructure. Concerning controls, existing downstream actors and their interests could pose hindrance when manufacturers, who had not dealt with the end-of-life management of their products before, started to have control over it. Although the economic efficiency could be higher when manufacturers themselves establish their own downstream infrastructure, co-existence with the existing actors has been the solutions found in both countries. Consideration on the interests of existing actors may increase political acceptability within society and help the smooth enforcement of EPR programmes. However, the enhancement of the environmental performance should accompany the operations of the existing actors.

The uncertainty and lack of control over the downstream infrastructure was referred to as a limiting factor by some manufacturers to further their efforts on component reuse, and other types of design for end-of-life. Some interviewees argued that their efforts towards the reduction of environmental impacts from their products would be economically in vain unless cost differentiation was made depending on the end-of-life environmental features of their products.

Closely related to the component reuse is design for disassembly. The relatively small efforts of the Swedish EEE manufacturers on design for disassembly may be partly a reflection of the global markets of their products and uncertainty surrounding the downstream infrastructure in the respective destinations. One stated that they minimise their efforts on the design for disassembly to the components that need to be separated, while leaving the rest to be shredded. The Japanese EEE manufacturers producing similar products would have faced similar challenges. In fact, the operation at the recycling plant at the time when the interview was made was in principle the same as what the Swedish manufacturer described. The establishment of their own infrastructure within Japan may have provided them with more reasons to strive for design for disassembly. A reason commonly given by the Japanese EEE manufacturers concerning their efforts on design for disassembly, as well as for car manufacturers in Sweden and Japan, was to minimise the dismantling time. In the case of Japanese

EEE manufacturers and Swedish car manufacturers, their individual involvement with recovery activities may have made the linkage between the dismantling time and costs explicit.

The longevity of the products and rapid technological development was another limitation related to product and component reuse commonly discussed. Some interviewees argued that the enhancement of material efficiency via product/component reuse and prolongation of products' life would compete with enhancement of energy efficiency. In this regard, dematerialisation, when involving reduction of size of the products and components, may also hinder component reuse. Moreover, some interviewees argued that the longevity of products might make the materials used in the products technologically obsolete, even when the materials currently have higher possibility for recycling. Due to the change of products, some materials for example cathode ray tubes glass, may not be used at all in the coming years.

The fact that the most common measures undertaken by the manufacturers has been the use of thermoplastics commonly used across various industries, the harmonisation and marking of the types of plastics may be the reflection of these constraints.

Despite the existence of the communication paths between the upstream and the downstream concerning the concrete design changes, concern existed on the feedback in monetary terms, especially among the manufacturers whose products would be treated together with those of other manufacturers. Frustration over the payment for something that they do not have much control over, as expressed by some car manufacturers, may be a reflection of this concern.

The preceding discussion suggests that the undertaking of measures by the manufacturers interviewed to enhance resource efficiency, reuse and recycling relates closely to the control the respective manufacturers have on the end-of-life management of their products. Namely, parallel to the upstream measures, the downstream infrastructure should be established to effectively close the material loops. Moreover, in order for the manufacturers to receive incentives to continuously improve their products, their end-of-life management should be somehow distinguished from the rest of the products. The distinction between brands poses challenges when the discarded products are treated together.

Design for end-of-life in light of other environmental consideration

How has the advancement of design for end-of-life, as discussed in this chapter, affected the environmental considerations made to the rest of the life cycle of the product system?

Various factors hinder the author from responding to this question in quantitative terms. Three of the four systems investigated were still not fully implemented. The geographical and temporal boundary of the system to be compared is not easily defined. Moreover, comparison of different types of environmental impacts such as energy use or toxicity poses challenges, as experienced in LCA studies.

However, the manner in which the manufacturers interviewed consider environmental impacts from the end-of-life management of their products suggests that it is unlikely that consideration of environmental impacts from the rest of the life cycle of the products would be neglected. Criteria related to end-of-life management of their products are integrated within the broad environmental assessment categories. The very fact that the majority of the manufacturers interviewed found the competing design requirements as hindering factors for design for end-of-life make it evident that environmental impacts of various types from various phases of the life cycle are considered in their design strategy. Also noticeable was the strong demand from consumers as well as policy makers concerning other environmental priorities. Considering that they have stronger "push" in these issues, it is not likely that the manufacturers, when pursuing design for end-of-life will compromise other environmental qualities that are perceived to bring more tangible benefits. As discussed by some interviewees, design for end-of-life has brought upon benefits to other phases of the life cycle, such as ease of repair.

Therefore, from the practice found so far, the author considers that the inclusion of end-of-life management consideration to the product design has been a positive step towards the total life cycle improvement of product systems.

4.4.2 Attributability evaluation

The analysis presented in Section 4.3 reveals that literally all the manufacturers interviewed have considered the content of the EPR

legislation in their undertaking of upstream measures and other measures mandated by/envisioned in EPR programmes. The finding is a clear indication that the EPR legislation has had a tangible influence on the manufacturers' undertaking of such measures. Meanwhile, there exist a number of other factors including internal drivers of companies, (future) competitive advantage and corporate image and the like, that are perceived to facilitate the undertaking of such measures. The manufacturers interviewed also commented on various factors that pose a challenge, for instance lack of demand, cost and competing design priorities, against taking measures to decrease the environmental impacts from the end-of-life management of their products.

In this section, the role of EPR legislation in light of these factors is examined from three angles. Firstly, it discusses how the content of an EPR programme, that is, the respective policy instruments, influences the manufacturers' undertaking of upstream measures. Secondly, the role of legislative measures as compared to voluntary measures is considered. Finally, reflecting upon the timing of the interviews, the author discusses how the anticipation of legislation has affected the behaviour of the manufacturers.

EPR-based policy instruments

As discussed in Section 4.4, all the manufacturers interviewed have been making efforts to reduce the use of hazardous substances in their products. The legislation that the vast majority of the interviewees referred to, such as WEEE Directive, RoHS Directive, ELV Directive and SHAR Law, includes the substances targeted by the manufacturers – lead, halogenated compounds, ozone-depleting substances and the like. This indicates the effectiveness of *material restriction* as a policy instrument.

Some may argue that once these substances are taken away there is no need to strive for collection and recovery of the products, at least not for the purpose of preventing the hazardous substances from spreading into nature via waste. However, it should be noted that the restriction often accompanies a number of exemptions, often due to technological limitations. Moreover, there exist many more hazardous substances that are not restricted by existing legislation. Further, guaranteeing the compliance of the elimination of hazardous substances faces challenges, especially in the case of complex products. Complete elimination of hazardous substances from complex products would be very rare, if it ever happens.

A number of Japanese manufacturers commented on the original Recycling Promotion Law of 1991, which, among other things, provided guidance to the manufacturers of large home appliances and cars to conduct environmental product assessment. The guidelines and manuals that were developed under the legislation included end-of-life management. A number of manufacturers interviewed did start to develop procedures for environmental product assessments that incorporated end-of-life management in 1991. However, the magnitude of design changes that occurred based on these assessments is not clear. Comments of the interviewees from the EEE manufacturers that the products currently taken back are not designed for recycling suggest that the efforts made in the 1990s were limited. The development of recycling assessment tools in a few companies around 1998, various examples given in the environmental reports from 1998 to 2000 on the harmonisation of materials and design for disassembly and the initiation of green procurement all indicate the acceleration of efforts in the late 1990s. Several car manufacturers also commented on the limited activities that occurred based on the 1991 Recycling Promotion Law.

The limited effect of the 1991 Recycling Promotion Law could be explained in part by its voluntary nature, as discussed further in the next section. Another explanation could be the lack of linkage to the downstream. In contrast, EPR legislation, by making the producers involved in end-of-life management in various ways, seems to have provided better reasons for producers to investigate features of their products that ease end-of-life management.

Indeed, as discussed in Section 4.4.1, the existence of proper downstream infrastructure to provide the manufacturers with feedback and effectively close the material loops is an indispensable part of an EPR programme. Otherwise, the manufacturers' efforts upstream may be in vain. A concrete policy instrument that would facilitate the development of downstream infrastructure is *take-back requirements*. As commented by a Japanese EEE manufacturer, the development through the policy instruments has enabled the manufacturers to close the loops in at least some parts of the world. As a Swedish car manufacturer argues, the extension of responsibilities also facilitates the inclusion of end-of-life management costs when calculating the total life cycle costs of products.

With the exception of a few interviewees who already had some contact with downstream actors (recyclers, dismantlers), the communication between the

manufacturers and these downstream actors had been very limited. The interviews with the manufacturers revealed that the requirements posed by the EPR programmes, especially in relation to *reuse and recycling*, triggered the communication. The manufacturers also organised an internal workshop for disassembly/dismantling and recycling, in order to provide information to their designers, while obtaining information about the dismantling time. With its direct link to cost for many manufacturers, reduction of dismantling time seems to be an important driver.

The majority of the car manufacturers as well as some EEE manufacturers in Japan also referred to *reuse and recycling rate requirements*. The harmonisation of plastics and the switch from plastics to more recyclable materials such as magnesium alloy are among the efforts to increase the recycling rate of their products. The recycling rate requirements also facilitate the reduction of the hazardous substances from the components. The Japanese EPR legislation for large home appliances would only regard the materials that have positive or zero monetary value to be included as reused/recycled components/materials. In other words, unless the materials are reused/recycled in their own new products or are to be sold/taken for free, the recovered materials would not be counted as reused/recycled materials. This would encourage manufacturers to use materials that have market value when recycled. Indeed, despite the fact that the rule that the end-user pays for the collection and recovery of discarded products was introduced for large home appliances in Japan, a few manufacturers interviewed commented on their efforts on making their products "worth one yen more". Individual producers must announce the recovery costs in advance. Though the initial fees announced by prominent producers turned out to be the same, the size of the fees was considerably lower than the estimated actual recovery costs.

As commented by a few car manufacturers in both countries, rather high recycling rates have already been achieved by the existing infrastructure. However, it is the part that is currently not economically feasible to recycle, and that also exerts various environmental impacts at the end-of-life management phase that is addressed by the EPR legislation.

In this regard, the importance of *recycling and treatment standards* incorporated in the respective legislation should be noted. Stringent standards would enhance the environment and health standard of the recycling and treatment operations. It may bring skilled and advanced dismantlers/recyclers to advantageous positions, while posing challenges to weak dismantlers. Some

Japanese car manufacturers commented on the rather socially disadvantageous positions these dismantlers had been in. One discussed the necessity of the government to provide support to the weak dismantlers, while another has been developing some tools and technologies that would be affordable for these dismantlers in order to enhance the environmental performance of these dismantlers and thereby avoid the creation of social problems. As discussed in the previous section, consideration to the interests of existing actors may enhance legitimacy when introducing legislation. However, legitimacy in the societal condition should be carefully balanced with the long-term goal of the legislation.

When the *individual* producers establish their own networks for the *physical* management of the products (collection, take-back and recovery) as in the case of Swedish manufacturers of medical equipment and mobile phone systems, Swedish car manufacturers and Japanese EEE manufacturers, it may be relatively easy to establish communication paths with recyclers. Establishment of its own downstream network also enhanced component reuse and recycling, as discussed in Section 4.4.2. This indicates the importance of formulating an EPR programme that facilitates individual implementation.

Another important mechanism for manufacturers to receive feedback and change design to enhance the end-of-life management feature of their products is the payment of cost associated with the end-of-life management of their products (*financial responsibility)*. The frustration expressed on this end occurs when products are *physically* handled *collectively* and environmentally superior and non-superior products are treated together, resulting inthe upstream efforts of the producers being made in vain. Needless to say, if treatment is conducted altogether regardless of the environmental properties of the materials, such as thermoplastics of different quality and lead-free and lead-containing solders, the environmental gain from the recycling side will diminish. Moreover, the producers fear that the reward of making upstream changes in financial terms would not be provided. Frustration was also expressed by some Japanese car manufacturers regarding the EU ELV Directive, concerning the obligation of their payment despite their lack of control. This suggests the necessity of introducing a system that enables the respective manufacturers to pay for the end-of-life management of their own products.

Legislation versus voluntary measures

Except for the Swedish EEE manufacturers who perceived demands from their customers in at least some aspects of design for end-of-life, consumer demand as a driving factor is non-existent. In fact, the majority of the interviewees from Japanese EEE manufacturers and Swedish and Japanese car manufacturers perceived the lack of demand as a factor hindering their undertaking of upstream measures. As an interviewee from a Swedish car manufacturer put it, legislation often emerges from the necessity felt in society. Despite the lack of demand from consumers, a handful of interviewees from Japanese EEE manufacturers, Swedish car manufacturers and the majority of Japanese car manufacturers, found the concern existing in society as a driving force. Likewise, the majority of the manufacturers interviewed commented on the corporate image and the competitive advantage, including its potential in the future, and as promoting factors. The fact that they associate their undertaking of upstream measures that reduce environmental impacts with competitive gains also suggests that the manufacturers sense the needs from society. This may indicate that even when the society at large finds necessity in dealing with a problem, which is translated into, among other things, a form of legislation, it does not automatically correspond with the preference of consumers.

A handful of manufacturers commented on their strong preference of a voluntary approach to legislation. Some also mentioned that they would take these measures anyway and emphasised that they take measures ahead of legislation in order to reflect the needs of society. However, the effectiveness of voluntary measures without enforcement is often limited, as illustrated in the example of the 1991 Recycling Promotion Law. In the case of Japanese car manufacturers, apart from the Recycling Promotion Law, the "Recycling Initiatives for End-of-life Vehicles" was also developed by the MITI, which served as the basis for the Voluntary Action Plan put together by the JAMA. These voluntary initiatives incorporated the content of relevant legislation and guidelines (JAMA, 1998). The Voluntary Action Plan also seemed to play the role of a benchmark as found in the reference to the Plan with regard to, for instance, the reduction of lead. However, their role as a whip may be questionable, especially when a company lacks strong internal drivers to take measures on end-of-life management. In some cases, the presence of legislation creates internal drivers as found in the incorporation of legislative requirements in the manufacturers' own green standards. One interviewee commented on the vague status of the voluntary initiatives and the difficulties of obtaining resources to undertake measures unless required by legislation. The enactment of EPR legislation for cars

itself may be regarded as a manifestation of the limitation of voluntary measures.

In addition to lack of demand, all but one interviewee considered that cost associated with the undertaking of measures hindered the actions they would otherwise wish to take. Indeed, various measures that need to be undertaken would require additional resources, at least at the initial phase. It may take some time before the new system established becomes efficient and would offset the investment. Together with the lack of demand from society, the additional costs would make it very difficult for manufacturers to take measures despite the necessity from a societal point of view. Without the "push" by legislation things would move very slowly, if at all. As a manufacturer commented, they cannot always take measures that do not bring them back incomes. The presence of legislation justifies the allocation of additional resources in order to further cultivate the technology that exists but has not yet been commercialised.

Although not discussed in the interviews, voluntary measures also often suffer from free-riders. When looking at the experiences among the OECD countries to date, a voluntary initiative taken across the industry has mostly lead to the introduction of mandatory programmes by government. Observed reasons include the free-rider problem and the apparent ability to achieve higher collection, reuse and recycling rates with mandatory programmes, particularly those with targets for collection and recovery (Tojo et al., 2001). Limitation of voluntary measures was also pointed out in OECD (2003b).

Anticipated legislation

At the time of the interviews, EPR legislation for EEE in Sweden and Japan was enacted but did not come into force. The EU ELV Directive had come into force at the EU level but was waiting for transposition by national governments. The two EU directives for EEE were still at the stage of proposal, and the legislation for cars in Japan was under discussion. It was only the EPR legislation for cars in Sweden that had come into force.

Despite that, the manufacturers had taken various actions to cope with the requirements set forth in the respective legislation that affects their design strategies. Indeed, the actions among the Japanese EEE manufacturers had already started when the author first studied their measures in 1999. Some interviewees, for instance a medical equipment manufacturer and a car

manufacturer in Sweden, when referring to their earlier initiatives explicitly commented on their anticipation on up-coming legal requirements. The undertaking of these actions indicates the influence of anticipated legislation.

Some legislation, for instance cars in EU and Sweden, clearly states that the reuse and recycling rate requirements will increase from 85% to 95% in 2015. EEE manufacturers in Japan also anticipate the increase of reuse and recycling rate from 50-60% to approximately 80%. The majority of the manufacturers who commented on the reuse and recycling rate requirements were discussing the achievement of the higher requirements. An early indication of the changes with certainties seems to facilitate the preparation of the industry. Similarly, the Swedish truck manufacturer interviewed mentioned that they watched very closely the movement and requirements of the EU ELV Directive, even though they are not subject to the Directive. They anticipated that similar requirements might be imposed on them in the future.

Some interviewees, while acknowledging the strength of the legislation *per se* in inducing changes, criticised the uncertainty of the content of the RoHS Directive. The uncertainty in the substances to be restricted/exempted and the timeframe a manufacturer could use in making changes, could make it difficult to decide upon the design strategy. On the other hand, if the requirements move from more restrictive to less restrictive, having the more restrictive one in the beginning may prepare manufacturers more to take measures. Referring to the changes of the timing in the RoHS Directive from 2004 to 2008,[88] some Japanese EEE manufacturers commented that they would continue to strive for the earlier date in order to be as good as their competitors.[89]

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88 In the end it became 2006.

89 Kemp (2000), when discussing the importance of the threat of legislation even suggests that it may not be necessary for the law to actually come into force in order for innovative measures to occur. The author disagrees. The threat of legislation should be accompanied by actual legislation in the end, otherwise it would send confusing signals to the manufacturers. As found in the folktale of a boy and a wolf, it would reduce the credibility of the action of the government.

4.5 The essential insights of the study

The study presented in this chapter aims to evaluate the *effectiveness* of EPR legislation in providing incentives for environmental conscious design in order to reduce environmental improvement from complex products and product systems. 21 manufacturers of EEE and cars in Japan and Sweden were selected as cases for the evaluation.

Utilising the intervention theory of a prototype EPR programme, the occurrence of some of the immediate outcomes that are assumed to happen from the concept of EPR, as well as how and why they occur was investigated. These immediate outcomes include *upstream changes*, *development of downstream infrastructure*, and the development of a *feedback mechanism* between the upstream and the downstream. The focus among the three was upstream changes (*design change in new products* and measures that facilitate such measures), while the other two were examined as assumed vehicles to achieve the upstream changes through EPR legislation. The assumed underlying logic is that allocation of responsibility to producers concerning the end-of-life management of their products provides them with incentives to incorporate consideration of the environmental impacts of their products in their design strategy.

The study investigated whether the immediate outcomes mentioned above have occurred (*goal attainment evaluation*), and if so, what roles the EPR legislation played in the occurrence of these outcomes (*attributability evaluation*).

Concerning the *goal attainment evaluation*, the analysis of the findings from the 21 manufacturers of EEE and cars in Japan and Sweden indicates that these immediate outcomes have indeed been happening. Upstream measures, both in terms of reduction of hazardous substances and enhancement of source reduction of material use, reuse and recycling, have been undertaken in the two industry sectors in both countries. The development of downstream infrastructure is under way. In some cases, manufacturers established their own collection and recovery infrastructure, while in others, collective implementation is anticipated. Direct communication between the designers and recyclers/dismantlers has been occurring in various manners. The manufacturers themselves have also tested the recyclability of their products.

While virtually all the manufacturers have undertaken the reduction of use of hazardous substances, the level of undertaking regarding the source

reduction of material use, reuse and recycling varies. In general, the more control the manufacturers have over the downstream infrastructure, the more likely it is that measures belonging to the higher ladder of resource efficiency will be taken. The study also revealed the anxiety of some manufacturers concerning the development of downstream infrastructure. The manufacturers feared that if their products were not distinguished from the rest of the products of similar types, their upstream efforts might not be adequately rewarded in financial terms.

Design for end-of-life has been integrated into other environmental design strategies. When competing with other environmental priorities, careful consideration has been made so as not to increase the environmental impacts from other phases of the life cycle in expense of design for end-of-life. Moreover, design for end-of-life, despite the growing recognition of its importance, has not been perceived as the most important area to work with in the manufacturers' overall design strategies. These practices indicate that upstream changes that aim to reduce environmental impacts from end-of-life are a step towards the total life cycle environmental improvement of product systems.

With regard to the *attributability evaluation*, a clear linkage was observed between the undertaking of these measures and the introduction of EPR legislation. Among various other factors that influence the manufacturers' undertaking of upstream changes, literally all the manufacturers interviewed acknowledged some positive influence of EPR legislation in their efforts to reduce the environmental impacts from their products. Among the policy instruments, the *material restriction* and *reuse and recycling requirements* have directly affected the manufacturers' undertaking of upstream measures. Take-back requirements not only facilitate the development of downstream infrastructure, but also the establishment of communication paths between the downstream and the upstream. The responsibility allocated to the producers concerning the end-of-life management of their products effectively induced the incorporation of end-of-life environmental impacts in product design. However, especially with regard to component reuse and use of higher-grade recyclable materials, manufacturers felt that the upstream changes required the accompanying downstream development.

The study also indicated the role of legislation in light of various perceived obstacles such as costs associated with reducing the environmental impacts from the end-of-life management of their products, as well as lack of customer demands on design for end-of-life. Despite societal concern about

end-of-life management, manufacturers considered that it has not been translated into the consumers' willingness to pay more for the products with less environmental impacts at the end-of-life phase. In contrast to the voluntary design guidelines on end-of-life management, the accelerated actions occurred after the emergence of the EPR legislation in Japan indicating the strength of legislation in taking concrete measures that may require substantial initial costs. The contrast between the design guidelines and EPR legislation also suggested the role of take-back requirements in effectively linking the downstream and the upstream.

When the interviews to manufacturers were conducted, all but one piece of legislation was still under development or waiting for to come into force. Nevertheless, the manufacturers had undertaken various measures to cope with the legislation before the legislation actually came into force. A degree of certainty with the content of the anticipated legislation facilitates the manufacturers' undertaking of actions in advance.

The presence of three of the immediate outcomes, together with the attributability of these outcomes to the presence of EPR legislation, indicates that two of the assumptions underlying mandatory EPR programmes hold true. One is that provision of downstream requirement induces the establishment of feedback mechanisms between downstream and upstream of the product's life cycle. The other assumption supported by this study is the role of mandatory requirements in inducing changes.

Moreover, the fact that manufacturers started to search for implementation mechanisms of downstream requirements in order to be rewarded for the efforts they made upstream supports the assumption concerning individual versus collective responsibility. That is, an EPR programme based on individual responsibility provides more incentives to upstream changes than the one based on collective responsibility.

In sum, the study provides empirical evidence that an EPR programme is a tangible factor that promotes upstream changes that would lead to the enhancement of the total life cycle environmental impacts of the product system. It also indicates the roles of legislation in inducing changes that are preferable from a societal point of view, especially when these changes are not directly mirrored in the changes of the preference of consumers and require initial high cost.

An important issue that has become clear is the manufacturers' anxiety concerning the implementation of the downstream infrastructure. The subject, individual versus collective responsibility, is the theme of the next chapter. It examines whether the existing implementation mechanisms incorporate elements of individual responsibility and if so, how the actual manners of implementation look like.

CHAPTER

FIVE

5. Implementation of EPR programmes and design change

One of the main findings from Chapter 4 is an empirical confirmation that the effective undertaking of preventative measures facilitating the closing of material loops requires the parallel development of downstream infrastructure. Moreover, manufacturers have started to search for a mechanism to be incorporated in the downstream infrastructure that would somehow reward their efforts on upstream changes. This serves as evidence to support the underlying assumption concerning the individual versus collective responsibility. That is, individual implementation of downstream infrastructure promotes upstream changes more than collective implementation (See Section 1.2.7).

This Chapter, taking a normative stance that the aforementioned assumption on the superiority of individual responsibility holds, examine the implementation of the requirements related to downstream operations in the existing EPR programmes. As illustrated in Figure 2-5, implementing downstream infrastructure envisioned in an EPR programme would involve a number of activities such as *collection* and sorting of discarded products, environmentally sound *recovery*, *monitoring and enforcement* of these activities and the like. Various actors may be involved in *physical* management, which may require different *financial* mechanisms and *information* management. Debates on individual versus collective responsibility do not always clarify which part of responsibility is under question. Moreover, the difference of the combination of policy instruments within the respective EPR programmes, national context, types of products and the liberty of the manufacturers in selecting the implementation mechanisms, among other things, would diversify implementation practice. Meanwhile, there is a prevailing assumption that individual implementation faces more administrative challenges than collective implementation.

In this chapter, as discussed in Section 3.3.2, the author aims to systematise the discussion of individual versus collective responsibility by breaking

down the activities in the downstream infrastructure envisioned in an EPR programme into smaller elements. Element 1 to 7 in Table 5-1 indicate these components which were described in the preceding paragraph.

Table 5-1: Elements of the activities in the downstream infrastructure envisioned in an EPR programme

Type of responsibility	Activities			
		Collection	Recovery	Monitoring & Enforcement
	Physical management	Element 1	Element 4	Element 7
	Financial mechanism	Element 2	Element 5	
	Information management	Element 3	Element 6	

As discussed in Section 3.3.1, the implementation practices of five selected EPR programmes (EEE in Japan, EEE and batteries in the Netherlands and Switzerland) are explored to obtain concrete pictures of the actual implementation of the respective elements (Section 5.1). The presentation of the studies seeks to provide answers to the following questions:

- What is happening within the respective elements of the programme?
- Who is responsible for the respective elements, and how do they fulfil their responsibility? What challenges have they been confronted with, and how have they overcome these challenges?
- What policy instruments constitute the respective EPR programmes, and what are their implications regarding the fulfilment of the respective elements?
- Among the elements where producers are responsible, how do they fulfil their responsibility (individual or collective responsibility)?
- What are the perceptions of actors in the system regarding the implementation practice and individual and collective responsibility?

Based on the information obtained through the case studies, a comparative analysis is made, that discusses the advantages and disadvantages of the individual and/or collective implementation of the respective elements (Section 5.2). The comparative analysis is utilised to explore the following question: what does it mean to practically implement EPR programmes

individually? This question is discussed in Section 5.3. The final section provides essential findings from the study.

Figure 5-1 indicates the scope of this chapter, as well as the issues discussed in the respective sections.

In this chapter, the term "implementation" means implementation of downstream infrastructure envisioned in an EPR programme, unless otherwise mentioned.

The first section of this chapter contains a detailed description of the implementation practices of 5 EPR programmes, which are essential materials for the analysis. Readers who wish to familiarise themselves with the findings without going through details can pass over this section and resume reading from Section 5.2 (page 243). Readers who wish to know only the analysis of the findings can proceed from Section 5.3 (page 265).

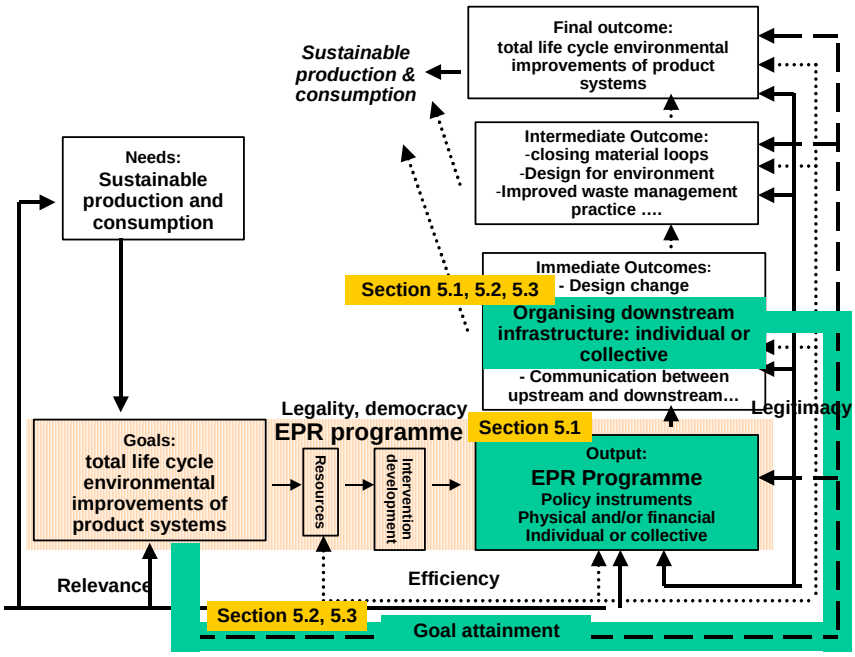

Figure 5-1: Issues discussed in the respective sections of Chapter 5

5.1 Description of cases

This section describes the implementation of the five EPR programmes, which are EPR programmes for electrical and electronic equipment (EEE) in Japan (Section 5.1.1), the Netherlands (Section 5.1.2) and Switzerland (Section 5.1.3) and for small consumer batteries in the Netherlands (Section 5.1.4) and Switzerland (Section 5.1.5).

Each section includes a brief introduction of the programme, followed by the description of concrete activities and actors involved in the seven elements introduced in the previous section (see Table 5-1).

Among the activities, *collection* refers to all the activities that are necessary for the discarded products to be brought to recycling plants. *Recovery* encompasses disassembly of products, reuse of components, material and chemical recycling and energy recovery of materials. Collection and recovery are looked at from three dimensions: the *physical management* of the discarded products, the *financial mechanism* behind the collection and recovery activities and the collection and provision of *information* on these activities. The sections *monitoring and enforcement* discuss issues such as measures to secure quality of collection and recovery activities to identify free-riders and make them participate in the system and to prevent illegal export and dumping. It also supplements that which was discussed in the information-related dimension of collection and recovery.

Reflecting the aim of this work, attention is given to the roles of the producers in the system, and in particular the manners in which producers fulfil their responsibilities.

5.1.1 EPR programme for EEE in Japan

The Specified Home Appliance Recycling Law that came into force on 1 April 2001 in Japan, is the basis of an EPR programme for four large home appliances: large TV sets, washing machines, air conditioners and refrigerators. The main driving forces for the development of the Law were the pressing scarcity of final disposal sites, the increase of EEE in the waste stream and the inadequate capacity of existing treatment plants (mainly managed by local governments) together with the growing use of EPR programmes abroad.

In a separate legislation, Revised Law for Promotion of Effective Utilisation of Resources, producers of personal computers are required to establish a take-back and recycling system for personal computers. Following the introduction of the take-back from businesses in April 2001, producers of personal computers are, from 1 October 2003 required to take-back personal computers from households. The allocation of responsibility in the case of producers of personal computers is different, reflecting the dissimilarity between the four large appliances and the personal computers (type of customers, distribution channels, existing infrastructure, etc.). However, the focus of the discussion is on the programme for large home appliances.

The main actors in the Japanese EPR programme for EEE include producers, which formed two groups (Group A and Group B), retailers, local governments, consumers (end-users), designated legal entities, the Association for Electric Home Appliances (AEHA) and two government bodies, which are the Ministry of Economy, Trade and Industry (METI) and the Ministry of the Environment (MOE).

Collection

Physical management

The following activities are required for the discarded products to reach recycling plants: 1) collection of discarded products from household to regional aggregation stations and 2) transport of discarded products from regional aggregation stations to recycling plants.

Collection from households

Retailers are the primary actors responsible for collecting the end-of-life products from household to regional aggregation stations. Upon request of the consumers, the retailers are responsible for accepting a) an old appliance when selling a similar new product (old-for-new), and b) an old appliance that they themselves have sold.

Municipalities and *designated legal entities* collect the products not collected by the retailers. The government appointed the Association for Electric Home Appliances (AEHA) as a designated legal entity. With regard to collection, designated legal entities collect products from remote areas in response to

the request of municipalities governing the area or of local residents themselves.

The total number of products collected in the first year of implementation was 8 538 000 (April 2001-March 2002) while the figure for the second year (April 2002-March 2003) was 10 147 000 (see Table 5-3 for details). The legislation does not set any collection target.

It has been pointed out that the number of the products collected and handled under the system established by the producers actually constitutes only 40 to 50% of the entire flow of products estimated to be discarded (Tasaki, 2004). This will be discussed further under sub-section "Monitoring and enforcement" of Section 5.1.1.

Transport of discarded products from regional aggregation stations to recycling plants

Unless the products are reused, retailers, municipalities and designated legal entities must bring the discarded products to the regional aggregation stations established by the producers.

Producers have the obligation to establish regional aggregations stations and transfer the discarded products to recycling plants. Prominent Japanese manufacturers established two groups, referred to as Group A and Group B, and companies within the two groups co-operate with each other in fulfilling their tasks.[90] As of May 2003, Group A consists of 16 companies while Group B consists of 14 companies (AEHA, 2003c). Producers that put a limited number of products on the Japanese market may delegate their tasks to designated legal entities.[91] Currently, 29 producers belong to the last category.

[90] As of 2001, Toshiba and Matsushita Electric leading Group A, together hold roughly 30% of the market share of air conditioners and TV sets,and 40% of refrigerators and washing machines. The market share of Hitachi, Sanyo, Mitsubishi, Sharp and Sony, five of the prominent members of Group B, is 35% for air conditioners, 30% for TV sets and more than 55% for refrigerators and washing machines. Figures taken from Hosoda (2004).

[91] According to the Ministerial Order, manufacturers or importers who manufactured/imported less than 900,000 air conditioners/TV sets or less than 450,000 refrigerators/washing machines may delegate their physical responsibility to designated legal entities.

As of May 2003, both Group A and Group B established 190 regional aggregation stations respectively, covering all areas in Japan (AEHA, 2003d). In terms of types of regional aggregation stations, Group A established a substantial number of regional aggregation stations (close to one third) directly at recycling plants, while most of the regional aggregation stations of Group B are transport companies (AEHA, 2003d). Retailers, municipalities and designated legal entities must bring the products manufactured by manufacturers belonging to the respective groups. Products belonging to the producers who delegate their tasks to designated legal entities come to the regional aggregation stations set up by Group B.

A recent incident showed the obligation of retailers to transport the discarded products to the regional aggregation plants was not always complied with, as discussed further under the sub-section "Information management" of this section.

Financial mechanism

It is the *end-users (consumers)* who pay for the collection at the time of disposal (end-user pays). Those who are physically responsible for collection must announce the size of the fee. The majority of the fees per item set by the retailers have been between 500 and 2 500 JPY (3.5-17.4 Euro)[92], while in some cases, the set fee is more than 3 100 JPY (21.6 Euro).[93] In one of the groups, the fee also covers the management of the regional aggregation stations (Takaashi, 2003, May 23-24). The cost associated with the physical responsibility of the producers (establishment of regional aggregation stations and transport of discarded products from the regional aggregation stations to recycling plants) is covered within the recovery fee and discussed in the next section.

Information management

Those who are physically responsible for collection (retailers, municipalities, designated legal entities) must announce the fees in advance. According to

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92 With the exchange rate of 1 000 JPY = 6.95 Euro (Forex, 2003). The same exchange rate is used throughout this chapter.

93 The percentage of the products whose collection fee is more than 3 100 yen is 12% for air conditioners and refrigerators, 6% for TV sets, and 5% for washing machines (METI, 2001).

the survey conducted by METI right after the law came into force, 324 of the 328 major retailers announced the fee. According to the law, retailers must inform the consumers of the fee in advance by putting posters on the walls. Retailers where the author visited in winter 2000-01 put small posters on the walls, providing information about the law to the consumers. Some municipalities also provide information on the new law to the residents via, among other things, brochures.

According to the law, producers must announce the location of the regional aggregation stations in daily newspapers. They are also found on the homepage of the Association for Electric Home Appliances (AEHA).

In order to hand in the products an end-user wishes to dispose of, he/she has to purchase a recovery ticket at the time of disposal. The recovery ticket, or manifest, serves not only as a receipt for end-users, but also as a carrier of information. From the time of issuance, information such as date of the issuance, identification of the end-users, retailers/designated legal entity, regional aggregation stations to which the product is transported, the type and the model of the product and its producer will be added to the manifest. The manifest enables the end-user and other actors involved in the chain of end-of-life management to trace the fate of the discarded products.

In the beginning of 2004, it was found that some of the discarded products whose recovery fee was paid by end-users were being sent abroad for export as second-hand products instead of being sent to recycling plants. A transport company who was sub-commissioned to transport the discarded products took away the recycling tickets put on the discarded products. The violation was discovered when the transport company who directly received the commission from retailers noticed the delay in receiving the manifest back from the sub-contractor. After this incident occured, METI required the top 30 large retail chains to confirm whether the discarded products they received from their customers have been indeed recycled. The result of the inquiry revealed that out of approximately 14.99 million discarded products, the final destination of approximately 78 000 of products could not be traced (Nagao, 2004).

Some argue that the incident highlighted, among other things, the limitation of the SHAR Law in enhancing the reuse of products (Nagao, 2004, Ishiwata, 2004).

Recovery

Physical management

Producers have the responsibility to recycle their products either themselves or to delegate their responsibility to a third party. In the initial phase, they need to achieve differentiated reuse and recycling rate targets on weight basis, which are 60% for air conditioners, 55% for TV sets and 50% for refrigerators and washing machines. The reuse and recycling rate must be achieved by reuse of components or material recycling. Only the recycled materials that have positive or zero monetary value can be included when calculating the reuse and recycling rate. Products whose producers cease to operate in the market (orphaned products) are recovered by the *designated legal entity*.

Producers also have to collect the ozone depleting substances used as coolant in refrigerators. They also need to treat printed circuit boards within products in a manner specified in the Waste Management Law.

As mentioned in sub-section "Collection", the prominent producers established two groups, and companies within the respective groups co-operate with each other in fulfilling their tasks. It is said that companies in Group A tend to utilise existing recycling plants and aim to achieve the recovery level stipulated by the law, while companies in Group B aim to establish their own recycling plants, carry out recovery themselves and strive to achieve higher reuse and recycling rates.[94] The general direction of the respective groups is reflected in the actual result as well (see Table 5-3). However, all the prominent manufacturers in both groups have established and manage at least one recycling plant themselves in order to facilitate communication between the upstream and downstream and to grasp the actual recovery costs.

As found in Table 5-3, in the first year of implementation, approximately 8.3 million products, corresponding to 319 000 tonnes, were recycled. The figure increased to 10.1 million products or 387 000 tonnes in the second year.[95] The achieved reuse and recycling rates for all the four products

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[94] As found in Chapter 4, anticipation of higher mandatory recycling rates in the future is one of the reasons to strive for the achievement of recycling rate higher than the level currently mandated.

[95] The figures translate to 2.5 kg per capita in the first year, and 3.0 kg per capita in the second year. The calculation is based on the population of 127 291 000 as of October 1

exceeded the reuse and recycling rate requirement stipulated by the law. Orphaned products constituted roughly 5% of the recycled products.

Among the separated materials, the decrease of markets for cullet from the Cathode Ray Tubes (CRTs) has been feared (Takaashi, 2003, May 23-24; Miyasaka, 2002). The shift of production facilities from Japan to China in recent years, combined with the ban of export of cullet to China, has made the demand for recycled cullet very low (Takaashi, 2003, May 23-24; Miyasaka, 2002). Restriction of the use of brominated flame retardants makes it difficult to find use of plastics containing the brominated flame retardants (Takaashi, 2003, May 23-24).

Financial mechanism

Just as for collection, *end-users (consumers)* must pay the recovery fee announced in advance by the individual producers/designated legal entities. The size of the fees is summarised in Table 5-2. End-users pay the recovery fee by purchasing a recovery ticket, referred to as a manifest, either at the retailers or at post offices. The recovery fees collected by retailers or post offices are transferred on monthly basis to the recovery ticket centre, a body administrating the money flow. The recovery ticket centre is established within AEHA. AEHA then transfers the money to the individual producers (AEHA, 2003a).

Table 5-2: The size of the recovery fees in Japan

	Air conditioners	TV sets	Refrigerators	Washing machines
Size of the fee	3 500-4 490 JPY (24.3- 31.2 Euro)	2 700-3 615 JPY (18.8-25.1 Euro)	4 600–5 600 JPY (32.0-38.9 Euro)	2 400-3 280 JPY (16.7-22.8 Euro)

Source: AEHA (2003b).

It turned out that all the prominent manufacturers announced the same recovery fee (the lower end of the fee found in Table 5-2). However, the level of the announced fee is considerably lower than the estimated recovery costs under municipal waste management systems (Tanaka, 2001). It is also

2001 and 127 435 000 as of October 1 2002 respectively (Statistics Bureau, 2003a; Statistic Bureau, 2003b).

lower than the level of fee set by the designated legal entity (the higher end of the fee found in Table 5-2) that recycles orphaned products as well as the products delegated by smaller manufacturers. Among the manufacturers who delegate the task of recovery to the designated legal entities, some set the same level of fees as the prominent manufacturers (Seki, 2002, December 26). These manufacturers cover the gap between the fee set by the designated legal entities and the fee set by the prominent manufacturers (Seki, 2002, December 26).

The recovery fee collected is used for the transportation from the regional aggregation stations to the recycling plants, recovery itself and administration of these activities. In the case of Group B, a fee per item that was differentiated among the four product groups was set for transportation. Out of the recovery fee collected from the end-users, producers in Group B pay the amount decided for the respective products multiplied by the number of treated products to the system organised by the producers. If the recovery fees collected from the end-users do not cover the operation, the individual producers must pay for the rest (Takaashi, 2003, May 23-24; Seki, 2002, December 26).[96]

One of the producers in Group B mentioned that within the company, the recycling plant currently bears the costs exceeding what the recovery fees collected from the end-users can cover. However, for the products that are developed now, the cost would be borne by the manufacturing plant. The manufacturing plants thus consider 1) personnel costs at the recycling plant (how long does it take to dismantle products), 2) expected revenue from the recovered materials and 3) disposal costs (for the materials that cannot be recycled and/or the materials the recovery of which should be paid). (Takaashi, 2003, May 23-24).

Information management

As mentioned, *individual producers* and *designated legal entities* must announce the size of the recovery fee in advance.

As discussed, the manifest (recovery ticket) that must be purchased at the time of the disposal serves as a receipt for end-users as well as a carrier of

[96] The financial mechanism for the companies of Group A was unavailable to the author for reasons of commercial confidentiality.

information. Once the discarded products reach the recycling plants, the information contained in the manifest allows each recycling plant to keep track of not only the total number and weight of the received products, but also the brand, type and the model of each product that comes into the plant (Takaashi, 2003, May 23-24).

Individual producers must keep records of some aspects of recovery such as the total weight of the recycled products, the total weight of components and materials reused or recycled and the amount of ozone depleting substances collected and/or destroyed. The result achieved by the individual producers has been posted on the website of the respective companies. AEHA compiles the information presented by the individual producers. The producers are also obliged to keep records of the entities that either purchases the components and materials reused or recycled, or take them for free.

Table 5-3 summarises the result of collection and recovery of four large appliances covered under the Specified Home Appliance Recycling Law in the fiscal years 2001 and 2002.

Monitoring and enforcement

As discussed in the previous section, once the products are returned to retailers or to a designated legal entity, the manifest system is used to follow the discarded products.

The information contained in the manifest, as well as the obligation of the *retailers* and *producers/designated legal entities* to keep the receipt for three years after issuance enables *end-users* to trace whether, where and in what manner the products they discarded are recycled. It also makes it possible for producers/designated legal entities to grasp the number and the type of products collected and recycled and in which plant. The producers/designated legal entities are obliged to keep records of the information.

As mentioned earlier, AEHA was appointed as a designated legal entity. Apart from its supporting role – collection from remote areas, recovery of orphaned products and products of delegated by small producers, administration of recovery ticket and money flow and the like – AEHA has the task to collect and disseminate information of the system, and to secure the sound implementation of the whole system.

Table 5-3: Results of the EPR programme for EEE in Japan (Apr 2001-Mar 2003)

	Air conditioners	TV sets	Refrigera-tors	Washing machines	Total
Fiscal year 2001 (April 2001-March 2002)					
Number of products came to the regional aggregation stations	1 334 000	3 083 000	2 191 000	1 930 000	8 538 000
Number of orphaned products	34 577	205 376	138 130	80 234	458 317
Number of products recycled	1 301 000	2 981 000	2 143 000	1 882 000	8 307 000
Total weight of the products treated (tonnes)	57 634	79 978	127 596	54 041	319 249
Total weight of the products recycled (tonnes)	45 019	58 814	76 359	30 783	
Achieved reuse and recycling rate in average (%)	78	74	60	57	
Fiscal year 2002 (April 2002-March 2003)					
Number of products came to the regional aggregation stations	1 636 000	3 520 000	2 565 000	2 426 000	10 147 000
Number of orphaned products	40 784	227 478	167 409	95 684	531 355
Number of products recycled	1 624 000	3 515 000	2 556 000	2 409 000	10 104 000
Total weight of the products treated (tonnes)	72 009	95 134	148 662	71 053	386 858
Total weight of the products recycled (tonnes)	56 739	72 110	91 006	42 967	
Achieved reuse and recycling rate in average (%)*	79	76	61	60	
Achieved reuse and recycling rate by some companies in Group A (%)**	76	68	59	58-59	
Achieved reuse and recycling rate by some companies in Group B and designated legal entity (%)***	80	80-81	62	61	
Reuse and recycling rate required by law (%)	60	55	50	50	

Source: METI & MOE (2002), METI & MOE (2003b), AEHA (2002), AEHA (2003e), Matsushita (2003), Mitsubishi (2003), Sanyo (2003), Sanyo Air Conditioner (2003), Sharp (2003), Sony (2003), Toshiba (2003)

*The reuse and recycling rate should be achieved by component reuse and material recycling and the recovered components/materials have to have zero or positive monetary value.

**Results achieved by Toshiba and Matsushita, two of the leading companies in Group A.

***Results achieved by Mitsubishi, Sanyo, Sharp and Sony, four of the leading companies in Group B.

The result of the recovery activities of the respective manufacturers have been submitted to the government and also collected by AEHA. The aggregated information has been published both by the government and by AEHA. The national government may order the submission of the records

and may inspect the facility if deemed necessary. Information was not found on whether parties other than the producers themselves have conducted any inspection on the recycling activities.[97]

It was feared that that end-user pays system would discourage the end-users to hand in the products to the paths envisioned by the SHAR Law. Indeed, the size of fees that end-users must pay for collection and recovery amounts to a minimum of 2 400 JPY (16.7 Euro) to close to 10 000 JPY (69.5 Euro).

Municipalities carry out the monitoring of illegal dumping, and the figures are aggregated by MOE. The situation in 276 municipalities, representing 21% of the national population were monitored in the fiscal year 2001, while in the fiscal year 2002 a total of 2 392 municipalities (89% of the population) were monitored. Apart from the initial few months after introducing the legislation, the percentage of the illegal dumping as compared to the number of discarded products has been less than 2 % (MOE, 2003a). The government perceived that in comparison to the situation prior to the introduction of the legislation, the increase of illegal dumping has not been as significant as had been feared (MOE, 2003c; MOE, 2003d). However, when examining the absolute number, the increase was more than 27 000 between the fiscal year 2000 and the fiscal year 2002 (MOE, 2003a; MOE, 2004).

As mentioned in sub-section "Collection", in addition to illegal dumping a study has suggested that more than half of the products estimated to come into the waste stream have not been handled in the systems established in accordance with the SHAR Law.[98] The vast majority are believed to have been exported abroad (53% in the case of TV sets). The study also showed that the destination of a substantial number of the discarded products estimated[99] is unclear (Tasaki, 2004).

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97 METI and MOE, in their press release in 2002 and 2003 that announced the result of the implementation, mentioned that the system is generally working well.

98 According to the study, when breaking down to the respective product categories, the percentage of the discarded products coming back to the EPR systems in 2001 was 38% for TV sets, 54% for refrigerators, 51% for laundry machines, and 33% for air conditioners. Even with the conservative estimate of the number of products discarded, only 51% of the total products came into the system (Tasaki, 2004).

99 6% in the case of TV sets, 29% for the refrigerators and washing machines and 34% for air conditioners.

5.1.2 EPR programmes for EEE in the Netherlands

Among the member countries of the European Union, the Disposal of White and Brown Goods Decree[100] in the Netherlands was the first national law for EEE that incorporated the concept of EPR and has been implemented.[101] Problems arising from the high toxic substance content in incineration ash[102], the fact that some EEE have been included in the list of Priority Waste Stream in the National Environmental Policy Plan and having producer responsibility as one element of the waste policy are the driving forces behind the Decree.

Among the wide range of products covered by the Decree, on 1 January 1999 the collection and recovery of large home appliances – refrigerators and freezers, washing and drying equipment, TV sets and the like – and ICT (information and communication technology) and office equipment started. The collection and recovery of the rest of the appliances (various small household appliances) began a year later (1 January 2000).[103]

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[100] White and brown goods are "the assortment of electric and electronic domestic appliances and office equipment" (VROM, 1999). White goods include various large and small household appliances such as refrigerators and freezers, air conditioners, washing machines, dishwashers, stoves, cookers and microwaves. Brown goods, also referred to as consumer electronics or entertainment (audio/visual) equipment, include products such as TV sets, digital cameras, video cameras, stereos, CD players, DVDs and the like. The Dutch legislation covers not only these products but also other types of EEE including, among other things, ICT and office equipment (= grey goods) (see footnote 103). In this document, the terms "brown goods", "consumer electronics" and "entertainment equipment" are used interchangeably.

[101] Efforts had been made to conclude a voluntary agreement between the government and industry since 1991 but it failed, which led to the introduction of the legislation (Veerman, 2003, April 9; Vonkeman, 2003, April 8).

[102] For instance, according to the calculation conducted by the Netherlands Organisation for Applied Scientific Research (TNO) it is expected that the bromide content in bottom ash and fly ash can be reduced by 90% and the copper content by 40-50%, if separate collection of small white and brown goods is achieved (VROM, 1999).

[103] Product categories include 1) large and small white goods, 2) large and small brown goods, 3) ICT and office equipment (e.g. computers; paper printing equipment, telecommunication equipment), 4) electric and electronic household tools (e.g. handsaws, drills, garden equipment), 5) musical instruments, 6) toys and 7) other electric and electronic household appliances (e.g. sewing, knitting and embroidery machines, heating and hot water apparatus and fans). (Adapted from VROM, 1999; and NVMP, 2002).

In response to the decree, two structures were developed: NVMP[104] and ICT Milieu. Representatives of the branch organisations that consist of manufacturers and importers of white and brown goods constitute NVMP, while ICT Milieu coordinate the collection and recovery of ICT and office equipment. The organisations that carry out and coordinate the fulfilment of the responsibility of producers, often referred to as producer responsibility organisations (PROs), play instrumental roles in the actual implementation of the EPR programme for EEE in the Netherlands.[105]

Other important actors in the Dutch EPR programme for EEE include: the Dutch solid waste association representing the waste management division of municipalities (NVRD), a retailers' organisation, the Ministry of Housing, Spatial Planning and the Environment (VROM), consumers and recyclers.

In some product groups such as ICT and office equipment, business waste constitutes a substantial portion of the waste flow. Although the systems that the author investigated deal mainly with the waste stream from households, reference to the business waste is made wherever it is relevant for the discussion on individual versus collective responsibility.

Collection

Physical management

In the case of products from private households, activities required for the discarded products to reach recycling plants in the Netherlands include: 1) collection of discarded products from households to regional aggregation stations, 2) sorting at the regional aggregation stations and 3) transport of discarded products from regional aggregation stations/retailers to recycling plants (Veerman, 2003, April 9; NVMP, 2002; Vonkeman, 2003, April 8; Goorhuis, 2003, April 9).

Collection from households

[104] Stichting Nederlandse Verwijdering Metalektro Producten, meaning the Dutch Association for Disposal of Metalectro Products.

[105] Development of a collective system, especially for the white and brown goods, was a coincidence of experience with the battery recycling, and the emergence of people who managed to establish agreements with the branch organisations, and with the industries behind the branch organisations (Veerman, 2003, April 9).

With regard to collection from households, *retailers* are obliged to collect an old product when selling a new product (old-for-new), while the *municipalities* are responsible for collecting the remainder.

Different perceptions have been found with regard to the collection process. According to the representative of the retail association, the old-for-new collection service for large home appliances was already a business practice prior to the introduction of the legislation and acceptance of appliances free of charge has been implemented smoothly (Veenstra, 2003, March 31). On the other hand, a representative of a municipality mentioned that some retailers have neglected the responsibility for collection by giving consumers a discount instead and have suggested to the consumers that municipalities would collect the old products (Veershoor, 2003, April 10). This has created the problem of littering on the streets as the consumers who cannot wait for the collection service provided by the municipalities simply discard the products.[106]

In addition to a home collection service, consumers can bring the products to municipal collection points (Vershoor, 2003, April 10; Goorhuis, 2003, April 9).

Challenges associated with the collection of small appliances have been commonly recognised (Veerman, 2003, April 9; Vershoor, 2003, April 10; Goorhuis, 2003, April 9, Veenstra, 2003, March 31; NVMP, 2002). The retailers are reluctant to collect small appliances. In fact, the retail association does not promote consumers to bring back end-of-life products to retailers (Veenstra, 2003, March 31). According to the retailers, bringing back old products to retailers is something that consumers are not used to, and they perceive collection of small appliances to be the role of municipalities (Veenstra, 2003, March 31). The retail association has suggested that the government should utilise collection facilities in shopping centres instead of stores in order to promote separation of small EEE from the municipal waste stream (Veenstra, 2003, March 31). Shopping centres already have facilities for separate collection of items such as glass, paper, cardboard, textiles and the like (Veenstra, 2003, March 31). On the other hand, some

[106] After the introduction of the legislation, the City of Rotterdam received in total of 4300 phone calls from the citizens in one year requesting them to get rid of refrigerators on the street (Vershoor, 2003, April 10). The number was perceived to be high by the local authority. The author does not have information on the situation prior to the introduction of the legislation.

local governments try to make it attractive for retailers to collect small appliances by way of, for instance, putting an artistic collection box in shops (Vershoor, 2003, April 10). In the City of Rotterdam, the municipal official would also like to establish collection points at schools and supermarkets (Vershoor, 2003, April 10).

According to Dutch law, producers are responsible for take-back and recovery of the products collected by the retailers, municipalities and repair companies. In reality, in order to avoid unnecessary traffic and to increase efficiency, NVRD (the association representing the waste management department of municipalities) and NVMP (PRO for white and brown goods) agreed to establish *regional aggregation stations* (Goorhuis, 2003, April 9; Vonkeman, 2003, April 8). In mid 2003, there were 65 regional aggregation stations where the discarded products from more than 500 municipalities and 18 000 retailers were gathered (NVMP, 2002b). All the products covered under the Dutch EPR programme for EEE (white and brown goods as well as ICT and office equipment) were gathered here (Goorhuis, 2003, April 9). All the regional aggregation stations have identical contracts with the NVMP and ICT Milieu (Goorhuis, 2003, April 9).

The municipalities collect 80% of the products that come to the regional aggregation stations (Veerman, 2003, April 9). Retailers have the possibility of either bringing the collected products to the aggregation stations or having them collected by the PROs at their shops (ICT Milieu, 2003; Vonkeman, 2003, April 8). However, when the discarded products contain valuable components such as laundry and drying machines, the retailers bring them to specialised recyclers instead of to the aggregation stations (Vonkeman, 2003, April 8; Veenstra, 2003, March 31).[107]

In order to avoid the overflow of discarded products at the municipal collection points, NVMP and NVRD made a "gentleman's agreement" to direct retailers to bring the collected products directly to the regional aggregation stations. However, sometimes retailers bring the collected products to municipal collection points instead of regional aggregation stations. This obliges the municipalities to empty their collection containers more frequently, creating some frictions between the industry and the municipalities (Goorshuis, 2003).

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[107] Unlike the Japanese programme, the retailers do not have the legal obligation to bring the collected products to the regional aggregation stations.

In general, it is perceived that municipalities wish to keep their responsibility for collection. The national government also would rather maintain the responsibility for collection to local government instead of transferring it to producers.[108]

Sorting at the regional aggregation stations

Discarded products taken to the aggregation stations are sorted into five categories: 1) cooling and refrigerating equipment such as refrigerators, freezers and air conditioners, 2) large white appliances for example washing machines, ovens and dish washers, 3) TV sets, 4) all other brown and white equipment for instance sewing machines, microwaves, shavers and toothbrushes and 5) and ICT and office equipment (Goorshuis, 2003). NVMP and ICT Milieu provide containers for the respective categories (Vonkeman, 2003, April 8; Huizinga, 2003, April 11). Separation at the regional aggregation stations does not make any distinction between brands. Some of the large retailers, called *distribution centres,* serve the same role as the regional aggregation stations. Instead of bringing the products to the aggregation stations, they are equipped with containers and sort the discarded products that are brought to them (Vonkeman, 2003, April 8).

Regional aggregation stations sometimes also serve as a refurbishment plant (Vershoor, 2003, April 10).[109] However, a representative of NVMP mentioned that once the products come to the regional aggregation stations, they should all be brought to the recycling plants (Vonkeman, 2003, April 8).

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[108] As the interviewee from the Dutch Ministry of the Environment put it, "When you have a producer responsibility also for collection, we should make a situation where the producers can set up their own collection system. And when this situation is there, as the government we would have many problems with local community systems, and that is something we did not want. So that's why we choose to make local authorities responsible for collection."

[109] A personnel of Waste Management Department of the City of Rotterdam guided the author to the regional aggregation station, consisting of a building and a place with a number of containers. The building accommodated various types of discarded products and was newly built for the EPR programme for EEE. It was in this building that the refurbishment was taking place. A site next to the building was a place where a number of containers were located, partly under the roof and partly in the open air. The discarded products of similar types, as discussed above, were segregated into various containers provided by NVMP and ICT Milieu. Strictly speaking, it may be so that it is only the containers that are regional aggregation stations under the contract with NVMP and NVRD.

Some of the challenges at the regional aggregation stations include theft, especially ICT equipment, and health problems of workers who need to carry heavy equipment. In order to improve the latter, the regional aggregation stations are structured in such a way that allows the use of lorries and fork lifts (Vershoor, 2003, April 10).

Transport to the recycling plants

When a container becomes full at the regional aggregation stations, the transport companies contracted with the respective PROs pick it up within two working days upon notification and send it to the recycling plants, and an empty container is brought in as a replacement (Vonkeman, 2003, April 8). Retailers can also have contracted transport companies pick up the collected WEEE and bring them to recyclers (Vonkeman, 2003, April 8; ICT Milieu, 2003).

As of 2001, 87% of the products that reach the recycling plants contracted with NVMP come from the regional aggregation stations (NVMP, 2002). The rest come directly from the retailers, including the distribution centres (Vonkeman, 2003, April 8).

The Dutch legislation does not have any collection targets, although once the EU legislation is transposed, it will be subjected to the annual collection targets of 4 kg per inhabitant from private households. The collection rate achieved by the two collective systems in 2002 (excluding the products directly taken back by the individual producers) was 4.8 kg per person per year (Veerman, 2003, June 5). The result of collection for some product categories is found in Table 5-5.

Discarded products from non-households

In the case of ICT and office equipment, there are more professional users than private users and collection by retailers on old-for-new basis is limited. (Huizinga, 2003, April 11; Veenstra, 2003, March 31).[110] Apart from having the products taken back from retailers on old-for-new basis, the consumers may also make an arrangement with the producers to take back their

[110] Retailers collect approximately 10% of the total WEEE from non-household users (Huizinga, 2003, April 11).

products. Alternatively, products can be transported directly from the end-users (business) to recyclers as business waste as well (ICT Milieu, 2003).

Financial mechanism

Retailers must take back products *free of charge* from household on old-for-new basis. With regard to white and brown goods, retailers receive the compensation of 10% of the recovery fees (Veenstra, 2003, March 31; NVMP 2002).[111] Concerning ICT and office equipment, all the costs are integrated in the price of the products and thus retailers do not receive any compensation.[112]

Legally speaking, *municipalities* have the *possibility of charging* both private households and retailers.[113] In reality, most of the municipalities are taking back the products from private households free of charge. Introduction of a waste fee based on weight in many municipalities makes the situation slightly confusing (Veerman, 2003, April 9).

Despite the legal possibility, there was an agreement between NVMP and NVRD to enable retailers to bring back products free of charge to the municipal collection points (Goorhuis, 2003, April 9). In reality, when a retailer brings collected products to the municipal collection points instead of regional aggregation stations, some municipalities charge the retailer (Veenstra, 2003, March 31). This is not in line with the agreement between NVMP and NVRD and makes the retailers unhappy (Goorshuis, 2003; Veenstra, 2003, March 31). However, bringing the products to the municipal collection points also violates the "gentleman agreement" between NVMP and NVRD.

When retailers and municipalities bring the products to the regional aggregation stations, the cost of transportation is borne by retailers and

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111 As the NVMP stopped collecting fees from some of the products, they are currently paying the amount that is equivalent to 10% of the fee.

112 Most of the customers of ICT and office equipment are professionals (business), the equipment (e.g. printers, copying machines) is traded directly between the manufacturers and customers. Exceptions are mobile phones and personal computers.

113 The transposition of EU legislation should enable both private households and retailers to bring back the products to the collection system established for WEEE free of charge, provided that they are discarded from private households (Article 5 Paragraph 2).

municipalities respectively (Goorhuis, 2003, April 9; Vonkeman, 2003, April 8).

The municipalities and the producers share the cost of the operation of the regional aggregation stations. The producers enjoy the convenience of setting up collection systems, while the municipalities also acquire some benefit. Because the responsibility of sorting is gone, they need less space and personnel. At the moment, the municipalities are paying a fee per inhabitant (average 0.16 Euro), while the producers are paying per kg of products (0.08-0.132 Euro). According to a representative of NVRD, the contribution is more or less equal. The amount of payment is different from one station to another and is differentiated depending on issues such as the efficiency of the activity at the station, the collection activities at the respective regions, the type of the respective regions for instance countryside or city, and the like (Goorhuis, 2003, April 9).

The cost for transportation of discarded products to the recycling plants from regional aggregation stations/and retailers are borne by NVMP or ICT Milieu.

In the case of brown and white goods, costs associated with collection are paid through the recovery fees collected from the consumers at the purchase of a new product. Costs associated with transportation and management of the regional aggregation stations constitute roughly 40% of the current expenditure (Bonkeman, 2003; NVMP, 2002b). For the ICT equipment, the collection and logistic cost is about 50% of the total cost (Huizinga, 2003, April 11).

When a product is discarded from business end-users while not accompanying the purchase of a similar new product from a retailer, the producers do not have the obligation to receive the discarded product free of charge (ICT Milieu, 2003). Transposition of the EU WEEE Directive may affect this financial mechanism.

Information management

Actors involved in informing households about how they can discard their products include municipalities and producer responsibility organisations (PROs) (NVMP, 2003; Goorhuis, 2003, April 9; Vershoor, 2003, April 10). The information tools that NVMP uses include leaflets, TV commercials, websites, posters at bus stops and free telephone services. NVMP also

provides leaflets and newsletters to the retailers. 10% of the recovery fee is used for the provision of information (NVMP, 2002).

The information as to how much EEE is still discarded in the municipal waste stream has been difficult to grasp (Veerman, 2003, April 9; Vershoor, 2003, April 10). The reliability of data taken from a sample municipal waste stream is much lower than the data for batteries (Veerman, 2003, April 9). In the last decade, the City of Rotterdam conducted two projects to investigate the content of the waste stream, and they consider conducting another one again (Vershoor, 2003, April 10).

Recovery

Physical management

As mentioned, the discarded products that reached the regional aggregation stations are sorted into five categories. These products are sent to the specific recyclers with whom the two collective systems have contracts. At present, four recovery companies with seven plants have a contract with NVMP, while ICT Milieu has a contract with 1 recovery company with two sites (NVMP, 2003; Huizinga, 2003, April 11).[114] The small streams of products (10-15%) are sent directly from the retailers to the recyclers (Goorhuis, 2003, April 9; Huizinga, 2003, April 11; NVMP, 2003).

Brown and white goods taken back in the collective scheme (NVMP) are recycled without identification of brand. On the other hand, until 2002 the brand name and weight of respective ICT and office equipment taken back in the collective scheme were registered before they were recycled (Huizinga, 2003, April 11; Zwart, 2003, April 11).

The differentiated recovery targets for diverse product categories are specified in the notification, which is presented by the PROs and approved by the government. In the case of brown and white goods, instead of establishing different recovery targets for all sorts of products, NVMP agreed with the government to have uniform recovery targets for the respective four categories they separate: 75% for cooling and freezing equipment, 73% for large white goods, 69% for TV sets and 53% for other

[114] ICT Milieu used to have contract with two recyclers, but the smaller one merged into the bigger one (Huizinga, 2003, April 11).

white and brown goods (NVMP, 2002). The Dutch government has been active in having this type of target setting as the standard at the EU level (Veerman, 2003, April 9).

As found in Table 5-5, all the recovery targets for white and brown goods have been met during the first 3 years of implementation.[115] However, it should be noted that in the Netherlands energy recovery, as used in cement kilns for example, is also regarded as recovery.

Apart from the discarded products delivered by the two collective systems, recyclers also contract directly with individual producers. For example, a representative of Mirec, a recovery company that has a contract with NVMP for the recovery of TV sets, mentioned that this constitutes roughly 60% of their business in the Netherlands, while the remaining 40% are contracts with individual producers (Zwart, 2003, April 11).[116] Contracts with individual producers often involve extensive discussion with people in the environment, procurement and logistic departments (Zwart, 2003, April 11). Products brought to the recycling plants are often prototypes of new models or products that were rejected during the production process (Zwart, 2003, April 11). Mirec also offers a refurbishment service (Zwart, 2003, April 11). In the case of Recydur, another recycler who takes care of half of the small appliances collected by the collective system, 5-10% of their business is directly contracted with ICT producers (van Kalkeren, 2003, May 28).

Among the recycled materials, the shortage of markets for plastics and glass from CRTs has posed challenges (Zwart, 2003, April 11; van Kalkeren, 2003, May 28). Plastics contained in the products currently coming back are mixed and of low quality. Although efforts have been made,[117] it has been

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[115] With regard to the ICT and office equipment, government and industry did not agree on the recycling target. However, the target stated in the guideline for notification published by the government was 65%. As of 2001, the achieved recovery rate for ICT and office equipment was about 90% (Veerman, 2003, June 5).

[116] Mirec has recycling plants in five other countries. The rough ratio between the business with collective arrangement and individual waste stream in the respective countries is as follows: Germany: 30% collective (from municipalities) and 70% individual, Sweden: 80% collective and 20% individual, UK, France and Italy, 100% individual. At the time of the interview, there was no legislation in place in UK and France (Zwart, 2003, April 11).

[117] Recydur has a contract with a company that cleans the mixed plastics and sorts PS (polystyrene), which gives a recycling rate of 51% (van Kaleren, 2003).

difficult to identify reliable plastic recyclers.[118] Glass in CRTs is a new market, and Mirec is still seeking for different possibilities with producers (Zwart, 2003, April 11).

The government prefers a collective system. "It is very difficult to get the brand appliances back to the brand. When somebody makes a separate system, all appliances have to be separated for this brand." "You cannot simply extract the products of a particular brand, and the brand must have an agreement with the collective system on a way of handling their products." The government also fears that it creates more transport movement, which is "environmentally very unfriendly" (Veerman, 2003, April 9).

The introduction of the EPR programme for EEE created a steep increase in the volume of products that came into the recovery industry. This provides opportunities for large-scale recyclers, who have the capacity to double or triple their operations in accordance with the demand from the market. Meanwhile, smaller recyclers tend to disappear or to join the system of a bigger recycler (Zwart, 2003, April 11). Adjusting the capacity to the demand from the market also poses challenges (Zwart, 2003, April 11). As the collective systems made contracts with a very limited number of recyclers, those who did not acquire a contract experienced serious financial difficulties and ended up bankrupt or having to close part of their operation (Zwart, 2003, April 11; van Kalkeren, 2003, May 28). For instance, there were four or more companies who recognising the possibilities and were ready to recycle CFC containing equipment. "Everyone thought that they would get part of the share once the legislation was enacted. In the end, only one got a contract." (van Kalkeren, 2003, May 28).[119] Meanwhile, the recyclers anticipated that the introduction of the EU WEEE Directive and its clause on individual responsibility would bring them new business opportunities (van Kalkeren, 2003, May 28).

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[118] As The Group Director of Mirec put it, "There are a lot of promises and very few implementation of these promises. All the stories on the plastics are 70% stories and 30% reality" (Zwart, 2003, April 11).

[119] Apart from the refrigerators and freezers, NVMP made contract with more than one recycler to spread the risk. "We decided that we pay a little bit more, but not to depend entirely on one recycling company". (Vonkeman, 2003, April 8).

Financial mechanism

Different financial mechanisms have been used by the two collective systems. In fact, the disagreement upon a suitable financial mechanism was one of the reasons why two separate systems emerged in the Netherlands (Huizinga, 2003, April 11).

Producers of white and brown goods

Producers of white and brown goods decided to finance the system with *visible, fixed, advance disposal fees* without differentiating between brands. It was influenced partly by the shift in the market share of some of the major producers in the Netherlands.[120] All the producers supply an independent body working with NVMP with information on the number of products put on the market on bi-monthly basis, which is then used to determine the recovery fee (Vonkeman, 2003, April 8).

The financial system used by NVMP is now a combination of pay-as-you-go (pension) system and up-front fees for the new products used for future recovery (Veerman, 2003, April 9; Vonkeman, 2003, April 8).[121] NVMP would wish to keep the visible fee until 2011 as allowed in the EU WEEE Directive, to finance all the historical waste coming back both now and in the future and to collect the visible fee collected before 2011 (a and c in Figure 5-2). Meanwhile, new appliances will be sold from 2005, which also start to come back (b in Figure 5-2). Visible fees will also finance the recovery of the new appliances that come to the waste stream before 2011. From 2011, there will be a need to finance the new waste with either an invisible fee or in other ways (Veerman, 2003, April 9).

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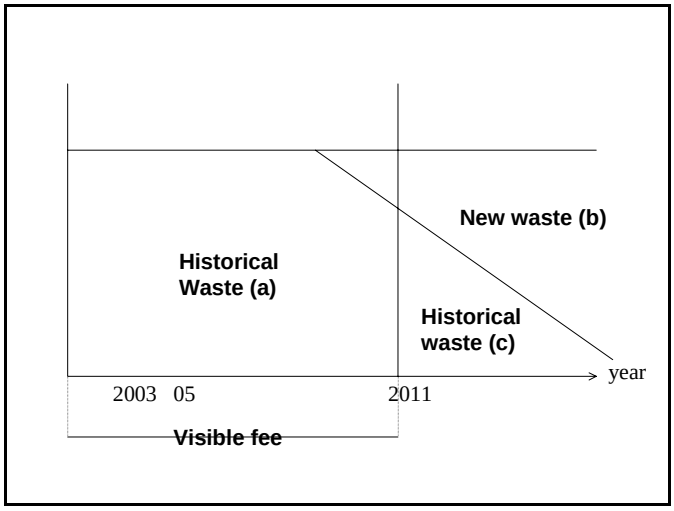
[120] The decrease of Philip's market share from 60-65% of TV sets 15 years ago to 30-35% now and the increase of market share of Sony's from zero to approximately 40%, made it difficult for Philips to accept individual responsibility. When implementing the regulation, Philips and Sony made an agreement to have a visible fixed fee, which made it unnecessary to have an individual system. Sony agreed because of the visible fixed fee. With the visible fixed fee there will not be any cost for the industries themselves, it can be put to the consumers directly (Veerman, 2003, April 9).

[121] The intention in the beginning was to have a pay-as-you-go (pension) system, but the accumulation of a large reserve necessitated justification. Use of the reserve for future recycling of historic waste was the reason NVMP gave as to how they could come to an agreement with their member companies (Veerman, 2003, April 9).



Source: Figure drawn by Kees Veerman, Ministry of Housing, Spatial Planning and the Environment, at the interview with the author

Figure 5-2 Financial mechanism of NVMP and its use of visible fee, the Netherlands

The fixed visible fee has been criticised by the competition authority (Veenstra, 2003, March 31; Veerman, 2003, April 9). The issues raised by the competition authority include 1) the fact that the fee is fixed and is not negotiable and 2) the feasibility of the visible fee system is questionable (Veerman, 2003, April 9). The accumulation of the large reserve was also criticised by the industry.[122] As mentioned above, this led NVMP to change their argument. The issues still exist, but it is perceived that the competition authority will withdraw the charge as the upcoming EU Directive allows the use of a visible fee until 2011 (Veerman, 2003, April 9).[123]

[122] The size of the reserve in 2000 was more than 65% of the expenditure in the first year, as opposed to nothing in the case of ICT Milieu (ENDS, 2001, February 22; Mayers, 2002). Two miscalculations contributed to the development of the reserve: 1) the number of the EEE units actually collected was lower than estimated and 2) the actual cost of recycling was lower than estimated (Veerman, 2002, December 11).

[123] Retailers in general do not like visible fees, as they cause customers' confusion. They would like to have just one price for a product, which would include different types of tax and recycling fees. In reality, not all the retailers use visible fees (Veenstra, 2003, March 31).

As shown in Table 5-4, there are several products from which the NVMP are collecting recovery fees, but there are several others for which they no longer plan to collect fees, at least not for some time. The accumulation of the large reserve, due to the uncertainties they had prior to the implementation, makes it unnecessary to collect fees from all the products (Vonkeman, 2003, April 8). The fees collected from some appliances can be used for the recovery of other appliances (cross financing) (Veerman, 2003, April 9).

Table 5-4: The size of the advance disposal fees for different items under NVMP system

Product categories	Fee (unit: Euro)
Cooling and freezing equipment	17
Large white goods	5
TV sets	8
DVD players	3
Frying pans, vacuum cleaners, coffee makers, power tools, sewing machines	1
Remaining products	None

Source: NVMP (2002)

NVMP established five separate foundations for different product categories (white goods, brown goods, power tools, ventilation systems, and the rest of the small appliances) and they cross finance within these five respective product categories. So far, the five foundations have not come to an agreement to cross finance across the five groups (Vonkeman, 2003, April 8; Veerman, 2003, April 9).

NVMP does not require any membership fees, which contribute to the reduction of so-called free-riders (in this case, producers who sell products without paying the advance disposal fees in accordance with their market share). (Vonkeman, 2003, April 8). Currently, members of NVMP sell roughly 98% of the volume of products put on the market (Veerman, 2003, April 9).

Producers of ICT and office equipment

On the other hand, producers of ICT and office equipment finance the system with an invisible fee. The main reasons producers chose to have an invisible fee system include: the high proportion of business customers, the

preference of producers to have flexibility in choosing where in the product chain the cost is allocated, the difficulty of determining the recovery fees and the objection among their members towards forming a fund (Huizinga, 2003, April 11).

Until 1 January 2003, individual producers received a monthly invoice directly from the recycler based on the weight of the recycled products. In addition to their own products, producers also covered the cost of orphaned products and products of free-riders (producers who avoid paying the recovery costs by not registering themselves on the system), which was allocated to the respective producers in proportion to the weight of the recycled products.[124] However, it turned out that in the first year of implementation orphaned and free-rider products constituted 44% of the total volume of products processed under the collective system, which doubled the cost for the participating producers. However, by mid 2003 it was reduced to 30-31 %, out of which about 25% were orphaned products (Huizinga, 2003, April 11).

In order for a producer to participate, he/she needs to pay a rather expensive membership fee to the branch organisation. Due to the high membership fee, some producers prefer to establish an independent system instead of joining the system (Veerman, 2003, April 9).[125] This may have contributed to the free-rider problems.

From the beginning of 2003, the financing system changed to the allocation of cost based on the current market share (Huizinga, 2003, April 11; Zwart, 2003, April 11). The recovery cost for IT equipment, paper printing equipment and telecommunication equipment was then allocated to individual producers in proportion to the weight of the respective products

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[124] According to the law, municipalities are responsible for the recycling of orphaned products and the products of free-riders. However, in order to distinguish the orphaned products and products of free-riders from the rest, the products should be sorted at the municipal collection points. The producers considered that it would be cheaper to take the whole flow of the products, including the orphaned and free-rider products and share the cost among themselves, rather than having municipalities sort at the municipal collection points and pay for it (Huizinga, 2003, April 11).

[125] The membership fee for ICT branch organisation depends on the number of employees. The size of the fee ranges from 1 875 Euro for producers with the 0 to 10 employees to 35 625 Euro for producers with more than 1 500 employess (Veerman, 2003, June 5).

put on the market (no cross subsidising).[126] The existence of parallel importers and the difficulty in identifying the producers, the change in the proportion of the market share among the member companies, the existence of nameless brands and the difficulty for the individual companies in predicting the recovery costs were among the reasons that induced the change (Huizinga, 2003, April 11).

As 50% of the cost associated with end-of-life management is required for logistics and only the remaining portion for recovery can be influenced by the makeup of the product, the coordinator of ICT Milieu was rather sceptical if the Dutch EPR legislation drives design change (Huizinga, 2003, April 11).

Information management

NVMP and ICT Milieu gather the results of the recovery from all the contracted recyclers. The two organisations are required to report the results to the government (Veerman, 2003, April 9; NVMP, 2003). Currently, an auditing company monitors the mass balance of the operations at the recycling plants (van Kalkeren, 2003, May 28; NVMP, 2002). However, the auditors do not verify a number of parameters. For example, whether the recovery procedure reported by the recycler is the same as what actually happens.

Table 5-5 summarises the result of collection and recovery of white and brown goods under the NVMP system in the first three years of implementation. With regard to the small household appliances, it is only the total weight of the mix of these appliances that is available to grasp the general picture. However, recyclers are requested to periodically check the number of respective items contained in the flow in order to figure out the status of collection of individual items (van Kalkeren, 2003, May 28).[127]

[126] As the system is aimed at products discarded by consumers, the producers need to register only those weighing less than 35 kg (Huizinga, 2003, April 11).

[127] In the case of Recydur, they separate the 5% samples of incoming products into different categories on monthly basis (Kalkaren, 2003).

Table 5-5: Results of the Dutch EPR programme: white and brown goods (January 1999-December 2001)

Year		Cooling & freezing equipment	Large home appliances	TV sets	Small home appliances
1999	Amount collected	460 000 items	136 000 items	192 000 items	2 500 tonnes
	Recovery rate achieved %	79	74	75	–*
2000	Amount collected	550 000 items	272 000 items	296 000 items	5 420 tonnes
	Recovery rate achieved %	86	74	78	64
2001	Amount collected	608 000 items	346 000 items	300 000 items	9 450 tonnes
	Recovery rate achieved %	85	74	80	60
Recovery rate requirement %**		75	73	69	53

Source: adapted from NVMP (2002).

* The decree started to cover small appliances in 2000.

** Recovery by energy recovery as used in cement kilns, for instance can be counted as recovery in the Netherlands.

Monitoring and enforcement

As mentioned above, the cost of management of all the WEEE coming to the two collective systems is initially covered by the producers who transfer it to consumers in the form of advance disposal fees (white and brown goods) or allocate it somewhere in the product chain (ICT equipment). Identifying the free-riders and making them participate is of great importance in order not to impose competitive disadvantage upon participating companies.

Initially, the enforcement agency of the Ministry of the Environment visited the companies that the government knew were not participating in the collective systems (Veerman, 2003, April 9). A few months after the implementation, a system was established where the respective collective systems and the enforcement agency worked together (Veerman, 2003, April 9). The collective systems first notify the non-participant of his/her legal obligation and then introduce him/her to the collective system (Vonkeman, 2003, April 8). If the company does not establish its own end-of-life management system and still does not participate, the collective systems report the company to the government, which is followed by a visit from government staff to the company (Veerman, 2003, April 9). A rather severe

sanction by the enforcement agency was perceived to be effective in making the companies comply.[128]

This collaboration led to a significant increase of participants. In the case of ICT Milieu, the number of participating companies increased from 75 to 162, which reduced free-rider products to less than 10% (Huizinga, 2003, April 11). NVMP "normally have problems with" 10 free-riders per year (Vonkeman, 2003, April 8) and as mentioned earlier, approximately 98% of the volume currently put on the market are products of NVMP members (Veerman, 2003, April 9). Free-rider problems through electronic commerce are not perceived to be a concern at the time of the interview, as the volume of products purchased via the Internet is relatively small (Veerman, 2003, April 9).

As mentioned, the monitoring of recovery activities has been performed by the collective systems, which hire an auditing firm. Although this reporting procedure is perceived to be working well by the government and PROs, it has been argued that it is necessary to have an independent body monitor the recovery activity as well as where the recycled materials go (Zwart, 2003, April 11). It is feared that a lack of monitoring would encourage unwanted export of waste, and lead to unfair competition among recyclers.[129] The requirements set forth in the upcoming EU WEEE Directive would give more stringent control over these issues if implemented as stated.[130]

With regard to the export of electronic waste or components of electronic waste, there was a concern for cooling appliances because of the ban on the

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[128] The enforcement agency can impose a maximum of 15 000 Euro as an initial penalty. This has been applied for approximately 10 times so far. The penalty could also go up for further violation. It is also possible to bring the violator to court (Veerman, 2003, June 5).

[129] As The Group Director of Mirec put it, "…we are quite sure that some competitors try to avoid to work themselves, just put the appliances in containers and ship them to wherever in the world" (Zwart, 2003, April 11).

[130] The Managing Director of Recydur, one of the recyclers, mentioned that upon the implementation of the WEEE Directive they will require all the buyers of the materials to report back to Recydur 1) percentage of the material recycled, 2) percentage of the material recovered and 3) where the materials go, and make it a condition to have contract with Recydur (van Kalkeren, 2003, May 28). In the case of Mirec, the author was told that apart from plastics and materials that have been commodities such as irons, they know the destination of the components/mix metals/hazardous materials and how they are treated (Zwart, 2003, April 11).

trade of CFC containing appliances. Many efforts have been made to enforce this rule since the regulation was implemented in 1992, The government regards that the enforcement was rather successful. However, the government considers that it cannot do much with regard to the export of other appliances, despite the recognition that a significant amount is exported. As long as the appliances are exported as reusable products, the government cannot regulate the export under waste regulations (Veerman, 2003, April 9).

5.1.3 EPR programmes for EEE in Switzerland

The involvement of EEE producers in the recovery activities in Switzerland started before 1990. At that time, producers of IT and office equipment had individual systems where producers took back their own products from their business customers (Bornand, 2002, March 28). Meanwhile, S.EN.S (Stiftung Entsorgung Schweiz) the Foundation for Disposal in Switzerland, which organises and checks the quality of recovery activities, initiated a voluntary system for collection and recovery of refrigerators (Hediger, 2002, March 28; Bornand, 2002, March 28). All the large distributors and a number of manufacturers supported and participated in this initiative (Hediger, 2002, March 28).

Early in the 1990s, producers of ICT equipment started to receive requests from their customers to have all the old products collected regardless of the brand. The producers consulted with their industry association, SWICO (Swiss Association for Information, Communication and Organisation Technology) to seek a solution. This led to the introduction of the Recycling Guarantee Programme in 1994 (Bornand, 2002, March 28). The development of the EU Directive and the perception within the industry that proactive involvement might be advantageous, may also explain the movement (Tellenbach, 2002, March 27). In 1996, the activities of S.EN.S were expanded to cover the whole range of household appliances (Hediger, 2002, March 28).

The Ordinance on the return, the taking back and the disposal of electrical and electronic appliances (ORDEA), as came into force on 1 July 1998, was developed reflecting the existing private initiatives. Limitation upon incineration capacity in Switzerland and the desire to contain hazardous substances in EEE are among the reasons why the government decided to introduce the legislation (Ardiot, 2002, March 27). The industry welcomed the legislation as it would provide a legal framework to the respective actors

involved in collection and recovery activities and create a level playing ground (Tellenbach, 2002, March 27; Bornand, 2002, March 28, Hediger, 2002, March 28). The Ordinance is also appreciated for its conciseness (Hediger, 2002, March 28; Bornand, 2002, March 28). Although somewhat limited compared to the Dutch and the EU legislation, the Ordinance covers a wide range of EEE.[131] Thus the product categories covered under the two voluntary systems have been expanded.

SWICO Environmental Commission (SWICO) and S.EN.S are the two main actors who coordinate and "hold responsibility over the whole system" (Bornand, 2002, March 28). As an industry association for ICT and office equipment, SWICO is involved in the end-of-life management of ICT and office equipments as well as consumer electronics. S.EN.S is an organisation that coordinates end-of-life management activities. It has a contract with producers and distributors and manages mainly white goods. The two organisations co-operate and coordinate their activities with each other (Bornand, 2002, March 28; Hediger, 2002, March 28). Other important actors involved in the implementation of the EPR programme include recyclers, distributors, consumers, inspectors and governments.

Collection

Physical management

There are three main channels through which discarded EEE from end-users reach the recycling plants in Switzerland: 1) via *retailers*[132], 2) via *collection points* and 3) *direct collection by producers*. The Swiss Ordinance explicitly gives

[131] As of February 2000, appliances subject to the Swiss Ordinance include 1) entertainment electronics = brown goods (TV sets and other image receiving equipment, audio visual equipment) 2) ICT and office equipment 3) refrigerating and freezing equipment and other large and small household appliances = white goods and 4) PCB containing ballasts. The products that are not subjected to the legislation include industrial electronics, large telecommunication equipment (e.g. telephone exchanges), lavatory and measuring equipment, tools, garden machinery, built-in household machinery (e.g. boilers), accessories, appliances in vehicles, aircrafts and ships, toys and musical equipment (adapted from SAEFL, 2000).

[132] The term "retailers" is used interchangeably with terma such as distributors, point of sales and dealers.

end-users the obligation to return WEEE to retailers, producers, recovery facilities or collection points.[133]

Collection through retailers

Retailers are obliged to accept discarded products from consumers (end-users) that they normally stock. The obligation is regardless of brands, and is not limited to the acceptance on old-for-new basis.

S.EN.S already has a large membership of retailers, including some of the major retail chains in Switzerland (Hediger, 2002, March 28). With regard to SWICO, retailers automatically become part of the system as long as they deal with products that SWICO's members import or produce (Bornand, 2002, March 28). Together, they have participation of more or less all the distributors in Switzerland (Bornand, 2002, March 28).

The obligation on retailers may create a situation where retailers that are conveniently located for consumers receive a larger number of products than they sell, while discount stores in suburbs manage to sell well without having to take back. However, this unbalanced distribution of responsibility among retailers has not been perceived as a problem (Hediger, 2002, March 28)

In addition to end-users bringing back the end-of-life products themselves, there is also a home pick up service, utilised mostly for large appliances. Furthermore, there is a business practice of old-for-new take-back service in which the products are delivered to the consumers.

As of 2001, 45% of the products under the SWICO system (covering ICT and office equipment, mobile phones and graphic industry) came back through retailers (SWICO, 2002). The figure increased to 58% in 2002, reflecting the inclusion of consumer electronics, such as TV sets, VCRs and audio equipment in the system since 1 January 2002 (SWICO, 2003a) (see Figure 5-3).

Once products are collected, retailers can have transporters deliver collection boxes, which are filled, and picked up by the transporters within

[133] Inclusion of this obligation was triggered by the intervention of the producers. "...we said, you can't tell the producers to take back the products and not to involve the consumers." (Bornand, 2002).

24 hours. The collected products are then delivered to the recyclers that have a contract with S.EN.S and/or SWICO (Hediger, 2002, March 28; SWICO, 2003a). The transporters have contract with S.EN.S and/or SWICO and are coordinated centrally.[134]

Apart from collective collection regardless of brand, a few manufacturers have a special contract with S.EN.S, so that their products are separately collected and come back to them.[135] Under the SWICO system, retailers themselves can also reuse/resell the used products, which as of 2002 constitute 5-7% of the products that the retailers accept.

Collection through collection points

Apart from retailers, private households can also bring WEEE to the collection points. Approximately 300 collection points have been established by S.EN.S and SWICO (Hediger, 2002, March 28; SWICO, 2002).

As of 2002, 24% of the products under the SWICO system (covering ICT and office equipment and consumer electronics) are received at these collection points (SWICO, 2003a) (see Figure 5-3). Some of the products are taken back from end-users with home pick-up service.

Products coming to the collection points are sent directly to the recyclers that have a contract with SWICO/S.EN.S.

Direct collection by the producers

As shown in Figure 5-3, apart from the channel via retailers and collection points there has been a constant flow of products that are handled directly by producers. As of 2001, before the consumer electronics were included, this volume constituted 36% of the IT and office equipment covered under

[134] Concern has been shown about the fact that SWICO contracted with only one company to arrange all the transports. Having only one company may reduce the cost, but also make the system less flexible for different producers. In the case of S.EN.S, it was said to allow for more room for flexibility, allowing individual producers, for example, to use the transport service that they have used before (Rissotti, 2002).

[135] Examples of such companies include Jura, a manufacturer of coffee machines and V-Zug and Miele, a manufacturer of large appliances such as washing machines, refrigerators and tumblers (Hediger, 2002, March 28). See footnote 140 for more information about the operation of Jura.

the SWICO system. This represented 44 out of 203 companies, referred to as A-participants. The figure in 2002 dropped to 18% or 43 out of 250 companies, reflecting the inclusion of consumer electronics in the scheme as well as the increased use of small and medium-sized equipment and decrease of large-scale equipment (SWICO, 2003a).

The signatories of the SWICO system can negotiate the price with the recyclers as they wish, but only with the recyclers selected by SWICO to secure the quality of recovery.

Roles of municipalities

The Swiss legislation does not allocate any specific responsibility to the municipalities. In fact, it intentionally did not put additional burdens on the municipalities, neither physically nor financially (SAEFL, 2000). The disposal of WEEE is no longer allowed within municipal waste (SAEFL, 2000). However, municipalities play a role, for example, in collecting illegally dumped products, which can be brought to retailers or collection points. (Hediger, 2002, March 28). In addition, they could apply to offer collection points, could collect a few times per year or do nothing except to provide information to consumers (Hediger, 2002, March 28; SAEFL, 2000).

Figure 5-3 summarises the amount of collected products under the SWICO system from the respective paths. As of 2000, approximately 40 000 tonnes was collected in the S.EN.S system.[136]

The Swiss Ordinance does not set any collection targets. The government made an estimation that the total number of discarded products amounts to 110 000 tonnes (SAEFL, 2001a). When comparing to the number collected through the two systems, this suggests a significant amount of products are disposed improperly. It was feared that consumers' lack of knowledge on the system had led to the disposal of small EEE in the municipal waste stream (ENDS, 2000, July 13). The manager of S.EN.S posed questions to this figure.[137]

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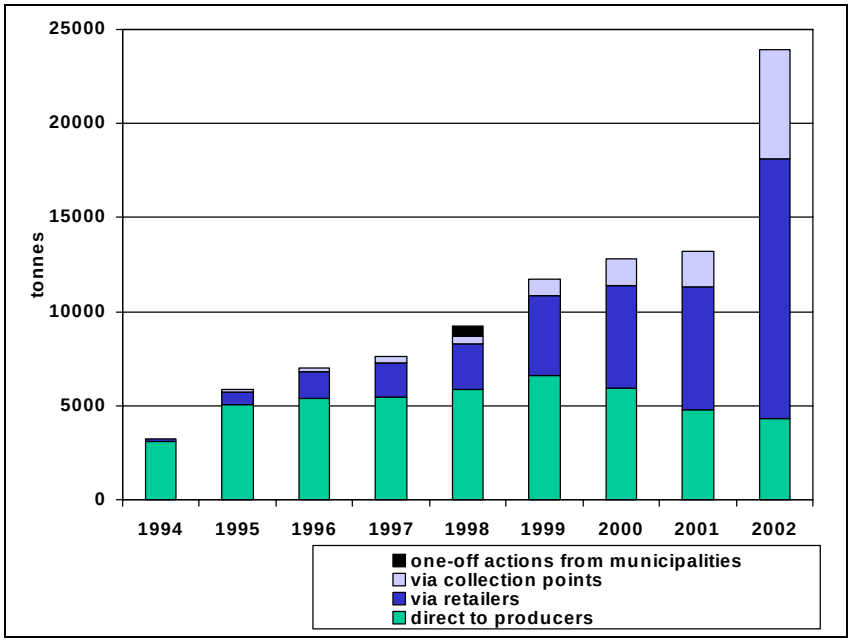
[136] The figure includes part of the products under the SWICO system, as many of the recyclers they use are the same (Hediger, 2002, March 28).

[137] According to the manager of S.EN.S, S.EN.S is aware that 10-15 000 tonnes of products are recycled in recycling plants which are outside of their contract (Hediger, 2002, March 28). This still suggests that more than 40 000 tonnes of products disappear somehow.



Source: adapted from SWICO (2001) and SWICO (2003a)

Figure 5-3 Collected amounts from different paths under the SWICO system, Switzerland

Financial mechanism

At the time of the interviews, the financial mechanism of the EPR programme for EEE in Switzerland was in transition. Namely, some of the voluntary initiatives, such as those for refrigerators and home appliances began with an *end-user pays* system, while systems for others, for instance IT and office equipment, started with an *advance disposal fee* system[138]. This led to confusion among *consumers*, as they could sometimes hand in products free

Considering that landfilling of EEE is no longer allowed in Switzerland, it is difficult to explain what happens to the remaining 40 000 tonnes (Hediger, 2002, March 28). Export of second-hand products, together with the disposal of small EEE in the municipal waste stream is a partial explanation for the difference in figures (Türk, 2001).

138 In Switzerland, the term "advance recycling fee" has been used. In this document, the term "advance disposal fee" is used as it is commonly used for other EPR programmes and represents the same as advance recycling fee in Switzerland.

of charge, while on other occasions they needed to pay. The legislation introduced in 1998 did not specify the financial mechanism (ENDS, 2000, July 13; Bornand, 2002, March 28; Ardiot, 2002, March 27).

When the interview was conducted, a change in legislation was proposed to ascertain that the consumers have the possibility to return products free of charge (Ardiot, 2002, March 27). Meanwhile, free-of-charge acceptance, financed by the advance disposal fee paid at point of sales, has been gradually introduced to different product groups from IT and office equipment in 1994 (voluntary initiative organised by SWICO) to white goods in 1 January 2003. The differentiated timing for introduction of the advance disposal fee system reflects the timing when the producers of the respective product categories committed to work on end-of-life management (Bornand, 2002, March 28). Table 5-6 summarises the existing end-of-life management system for the respective product categories and the timing of the introduction of the advance disposal fee system.

Due to the mandate provided by the legislation, retailers do not receive any compensation (Hediger, 2002, March 28). Management of the *collection points*, as well as *transportation* from collection points and retailers to recycling plants, are financed by the advance disposal fees collected at the purchase of new products. Under the SWICO system, as of 2002, 2% of the overall expenses were used for the management of collection points, while 12% was used for transportation (SWICO, 2003a).

The advance disposal fee does not finance home pick-up services. Although it is up to the retailers to decide, S.EN.S has recommended that 25 CHF (16 Euro)[139] per item be applied (Hediger, 2002, March 28).

The following section on "Recovery" discusses the size of the fee for the respective products, as well as the management of the collected fee.

Information management

The Swiss Legislation does not allocate responsibility for information provision with regard to collection. SWICO made a brochure available in stores and introduces consumers to the system. The brochure includes

[139] With the exchange rate of 1 Swiss Franc = 0.63 Euro (Forex, 2003). The same exchange rate is used throughout this chapter.

information such as where to hand in the products, the size of the advance disposal fees and the like (Bornand, 2002, March 28). Information is also available from the homepage of SWICO and S.EN.S.

SWICO has been auditing the practice of collection points since April 2001. Among other things, they check if products are taken back free-of-charge (Bornand, 2002, March 28). The audit of the collection points is discussed more in sub-section "Monitoring and enforcement".

Table 5-6: Existing systems and introduction of an advance disposal fee system for the respective product categories, Switzerland

Product categories	Existing system prior to the advance disposal fee system	Introduction of an advance disposal fee system	Organiser
IT and office equipment	Individual systems by manufacturers	1994	SWICO
Refrigerators	Voluntary collection systems by manufacturers and retailers since 1991	2003	S.EN.S
Mobile phones	These items have been collected and recycled when the consumers bring back the products since 1996 under the S.EN.S system, but until the advance disposal fee system was introduced, end-users in principle had to pay.**	1999	SWICO
Graphical industry (digital/analog/video cameras)		2000	SWICO
Telephone equipment		2001	SWICO
Consumer electronics		2002	SWICO
Large and small white goods		2003	S.EN.S
Garden, construction and hobby equipment*		planned	S.EN.S

Source: SWICO (2003a), Hediger (2002), Bornand (2002).
* Swiss Ordinance does not cover these product categories.
** The Swiss legislation obliges end-users to bring back WEEE, and retailers and producers have been (until the revision came into force to make it free of charge) only responsible for accepting the products that are brought to them and for recycling them properly.

Recovery

Physical management

The Swiss Ordinance establishes a general requirement of having the appliances treated in an environmentally tolerable way with state-of-the-art technologies. In particular, it requires 1) components containing hazardous substances to be treated separately, 2) cathode ray tubes and metal containing components to be recycled and 3) organic chemical components not recycled, including plastic casings, to be incinerated in an appropriate incineration facility. The government provides detailed instructions in the Guideline for the legislation regarding the recovery of specific products and their components. There is no recovery target.

At the recycling plants, the products collected from retailers and collection points are treated together without being separated in accordance with the brand (Bornand, 2002, March 28; Hediger, 2002, March 28).

The white goods collected under the S.EN.S system are sent to 20 recyclers that are currently contracted by S.EN.S. These recyclers receive governmental permits, as well as the licenses from S.EN.S, which set a more stringent standard than the one specified by the government. Apart from refrigerators, which are brought to three specific recyclers that have the capacity to treat ozone-depleting substances, the recyclers themselves decide which products they recycle. As discussed earlier, the recovery of refrigerators started in 1991 and the scope was expanded to other EEE in 1996 (Hediger, 2002, March 28).

Likewise, the products under the SWICO system are sent to 15 recyclers that have contracts with SWICO. SWICO divides Switzerland into 22 geographical areas, and every two years it asks recyclers to make offers. The 15 recyclers that currently have a contract with SWICO were selected from those who made offers, and they receive both government permits and SWICO's own licenses. Once the recycler is assigned to one area, he/she will receive all the products collected within this area by the SWICO network for two years. With regard to disassembly, the recyclers normally work together with social institutions such as prisons or working places for handicapped people (Bornand, 2002, March 28).

Some of the recyclers are licensed and contracts by both S.EN.S and SWICO (Hediger, 2002, March 28; Bornand, 2002, March 28).

As mentioned in sub-section "Collection", individual producers also accept a substantial flow of products directly from the end-users and bring them to the recycling plants (A-participants). The participants of SWICO must bring the products to the 15 recyclers that are licensed and contracted by SWICO, "because these 15 are controlled by us, and we want to make sure that the recycling is done properly." (Bornand, 2002, March 28). Thus far, SWICO has not encountered a situation where participants of SWICO bring their products to recyclers other than those that are licensed by SWICO (Bornand, 2003, June 9).

Apart from this flow, 10-15 000 tonnes of products are recycled in recycling plants that do not have a contract with S.EN.S (Hediger, 2002, March 28).

The capacity of the Swiss recyclers is more than enough to handle discarded products generated within Switzerland (Bornand, 2002, March 28; Hediger, 2002, March 28). The recyclers are investing for the future, looking at the market opportunity that may arise with the introduction of the EU WEEE Directive (Bornand, 2002, March 28). The fact that upon the establishment of the contract with SWICO, all products collected in the respective areas through their system are brought solely to the contracted recyclers is perceived as posing a threat to the rest of the recyclers (Ardiot, 2002, March 27; Rizzotti, 2002, August 12).

If recyclers abroad fulfil the same quality standard as set in Switzerland and obtain permits from the Swiss government, they would be potential candidates for licensed recyclers (Hediger, 2002, March 28; Bornand, 2002, March 28). In order for the recycler to obtain a permit, the Swiss exporter must apply to the government showing, in essence, the consent from the importing country and from any transit countries, the contract and a document that certifies that the standard of the recovery activity to be the same as Switzerland. Currently, all the recyclers are in Switzerland, although some components and materials within the products that cannot be recycled in Switzerland, such as printed circuit board and copper, are treated abroad (Hediger, 2002, March 28; Bornand, 2002, March 28; Ardiot, 2002, March 27). Some of the main destination countries include Germany, Belgium and the Netherlands (Hediger, 2002, March 28; Bornand, 2002, March 28). The government is concerned about the effect of potential participation of recyclers abroad on domestic recyclers (Ardiot, 2002, March 27).

With regard to the recycled materials, all the materials find destinations, often in new products (in the case of metals and glass) Plastics are the

exception to this. However, the share of plastics within the returned products is increasing due to the growing production of printers and personal computers. In Switzerland, it has been forbidden to reuse plastics that contain brominated flame retardants, thus they have been incinerated. Even when the plastics do not contain brominated flame retardants, the challenge is to compete with the cheap and quality-assured virgin plastics. In order to facilitate recycling, some producers have started to use metals instead of plastics, even if the production cost is more expensive (Bornand, 2002, March 28).

The reuse of white goods is limited (Hediger, 2002, March 28). There is a very narrow second-hand market in Switzerland, and most of the second-hand products are likely be exported (Hediger, 2002, March 28). However, as mentioned in sub-section "Collection", a few manufacturers can request their products to be separated from the rest of the waste stream and remanufacture them. One of such manufacturers, Jura, produces coffee machines.[140]

On the other hand, some of the producers of ICT and office equipment collect their own equipment (A-participants) with the intention of either reusing the whole equipment or reusing its components. The volume of the reused equipment is steadily increasing, from 500 tonnes in 1994 to 2 100 tonnes in 2002 (SWICO, 2003a).[141] However, SWICO forbids recyclers to reuse and resell equipment/components that are brought to the recycling plants under the collective system (Bornand, 2003, June 9).

Financial mechanism

As mentioned in the section on Collection, there used to be two streams of financial mechanisms: end-user pays system for white and brown goods and an advance disposal fee system for ICT and office equipment. As of 2003, fixed advance disposal fees financed end-of-life management of all the products covered under the legislation.

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[140] Operating within Switzerland, Jura established a system where they collect all of their products back through retailers. Consumers can bring back the discarded products to any retailers that sell coffee machines. Once dismantled, those components who went through quality control are reused as replacement for those used in the market (von Arx, 2004, August 10). See also footnote 135.

[141] The figure includes the reuse of both by producers and by retailers (Bornand, 2003, June 9).

Advance disposal fee system and determination of the size of the fee

Apart from making it less confusing for consumers and complying with the revision of the legislation, various other advantages have been perceived to be achieved by the advance disposal fee system. It would be more difficult to have the consumers pay at the time of disposal than when selling a new product. It also releases the municipalities from charging taxpayers, and encourages consumers to separate from the municipal waste steam/reduce littering. When the EU WEEE Directive is implemented, Switzerland cannot be isolated. From the producers' point of view, there is no additional cost, as the advance disposal fees paid by the consumers finance end-of-life management (Hediger, 2002, March 28; Bornand, 2002, March 28).

There are different possibilities in setting the level of the fee (Bornand, 2002, March 28). Two types were chosen for the Swiss system. For IT, office and graphics industry equipment, the fee is paid based on the price of the product published by the producers before discount. The fee for consumer electronics is determined per product/product system. The Environmental Commission of SWICO, which consists of 10 of their 200 members, makes the final decision on the size of the fee as well as other activities of the SWICO Recycling Guarantee. The current size of the fees is found in Table 5-7 and Table 5-8.

In order to calculate the recovery fee the collective systems need to know: 1) the amount of products that are to be collected, 2) the cost for recovery and 3) the amount of products they sell. The number of products collected is estimated by looking at the import figures for the last 10 years. Recovery cost is estimated from the current actual recovery cost. The sales figure has been taken from the import figures of all the products (Bornand, 2002, March 28).

The size of the fee has not been differentiated between brands. Differentiation of the size of the fees based upon on the degree of design for end-of-life has been discussed, but not implemented (Bornand, 2002, March 28; Hediger, 2002, March 28). The author sensed a strong conviction among people in charge of the collective systems that having a good recovery system is complicated enough, and the system does not drive design for environment (Bornand, 2002, March 28; Hediger, 2002, March 28). Most of the producers in Switzerland are in fact importers, and it is perceived to be less likely for the producers to reflect upon the recovery activities in Switzerland when they manufacture products in another country (Bornand, 2002, March 28). The relatively small size of the fee within the

price of the product would make it difficult to give consumers an incentive to select the products that have less environmental impact at the end-of-life management phase.[142]

In order to make it simple for consumers, the advance disposal fees for the products covered under different EPR programmes in Switzerland (EEE, batteries and packaging) have been combined (Bornand, 2003, June 9). Consumers pay the combined fee, and SWICO pays the global sum to the organisation that manages the fund for the collection and recovery of batteries (Bornand, 2002, March 28).[143] This constitutes 5% of the expenditure in 2002 (SWICO, 2003a). Likewise, 15% of the advance disposal fee is for packaging materials (Bornand, 2002, March 28).

Table 5-7. The size of the advance disposal fees for IT, office and graphics industry equipment in Switzerland (unit. CHF, [Euro])

List price for end-users* (without VAT)	Electronic office equipment/ graphic industry equipment (without VAT)	IT equipment (without VAT)
0 – 250 [0 – 157.5]	0 [0]	0 [0]
251 – 1 000 [158.1 - 630]	5 [3.2]	5 [3.2]
1 001 – 3 000 [630.6 – 1 890]	20 [2.6]	7 [4.41]
3 001 – 6 000 [1 890.6 – 3 780]	50 [31.5]	10 [6.3]
6 001 – 15 000 [3 780.6 – 9 450]	100 [63]	20 [12.6]
15 001 – 30 000 [9 450.6 – 18 900]	200 [126]	50 [31.5]
30 001 – 60 000 [18 900.6 – 37 800]	350 [220.5]	100 [63]
60 001 – 150 000 [37 800.6 – 94 500]	500 [315]	250 [157.5]
150 001 – 600 000 [94 500.6 –378 000]	1 000 [630]	500 [315]
> 600 000 [>378 000.6]	1 500 [945]	1 000 [630]

Source: SWICO (2002).
*list price published by the producers before discount.

[142] In fact, in this instance, the end-user pays system is considered to be more effective in making the difference clear to the consumers than the advance disposal fee system (Hediger, 2002, March 28).

[143] See Section 5.1.5 for more information as to how the system for battery collection and recovery works.

Table 5-8: The size of the advance disposal fees for entertainment, photographic and professional equipment and white goods in Switzerland (unit. CHF, [Euro])

Product categories	Fee (incl. VAT)
TV sets/video projectors >65cm (incl. rear projection)	30 [18.9]
TV sets/video projectors <65cm (incl. video beamers)	15 [9.5]
Full radio and DVD systems incl. Speakers, key boards (audio-acoustic equipment)	10 [6.3]
VCRs, DVDs, satellite receivers	5 [3.2]
Camcorders	5 [3.2]
Audio and Hi-Fi equipment, speakers	5 [3.2]
Portable equipment incl. Consumer electronics in cars, cameras and other small equipment	2 [1.3]
Digital cameras	2 [1.3]
Analogue cameras	1 [0.6]
Professional TV studio cameras, audio and video recorder, professional projectors, sound mixers that costs more than 10 000 CHF [6 300Euro]	20 [12.6]
Large home appliances category 1 (e.g. refrigerators, freezers, air conditioners, dehumidifier)	40 [25.2]
Large home appliances category 2 (e.g. ovens, dishwashers, heaters, cookers, tumble driers, washing machines)	25 [15.8]
Large home appliances category 3 (e.g. knitting machines, small washing machines, refrigerators)	15 [9.5]
Small home appliances category 1 (e.g. boilers, stream cleaners, microwave ovens, sewing machines, sauna heaters)	7[4.4]
Small home appliances category 2 (e.g. electric wok, rice cookers, fondue heater)	3 [1.9]
Small home appliances category 3 (e.g. toasters, hair cutters, clocks, toothbrushes)	1 [0.6]

Source: SWICO (2002), SWICO (2003b), SWICO (2003c), S.EN.S (2002)

The distributors must state in their receipt that the price the consumers are paying includes an advance disposal fee. The size of the fee can be visible or invisible to consumers. This has been difficult to enforce, and there has been many discussions between manufacturers and distributors (Hediger, 2002, March 28).

Management of the fee

In principle, the retailers pay the fee to producers when purchasing new equipment, consumers pay the fee to the retailers when purchasing new equipment and the producers set aside the fees (Bornand, 2002, March 28).

Under the SWICO system, producers can either keep the advance disposal fee in their individual accounts (A-participants) or transfer them into the common account managed by SWICO (B-participants) (Bornand, 2003, June 9).

A-participants (43 out of 250 companies as of 2002) have part of their products taken care of under the collective system organised by SWICO, while they take back part of the used equipment directly from the end-users and bring them to one of the licensed recyclers themselves. Concerning the former category of products, SWICO periodically checks the ratio the products manufactured or imported by the respective brands. The producers pay the recycling cost in proportion to the products currently recovered. The recovery costs of the discarded products brought in by the manufacturers themselves are paid directly to the recycler. In both cases, recovery costs are paid from the respective companies' separate account. A periodical audit is made to ensure that the respective companies secure the separate account (Vanderstraesten, 2004, April 22).

On the other hand, B-participants have SWICO take care of the products of the B-participants collectively, and also let SWICO organise the financial management for them as well (Bornand, 2003, June 9).

Under the S.EN.S system, the producers pay the fee to the fund every three or six months, depending on the form of individual contracts (Hediger, 2002, March 28).

The fee collected is used only for the products currently collected (pension or pay-as-you-go system). Unless products are separated at the collection phase, there would be no distinction between brands. Thus, all the historical and orphaned products are covered under the system (Hediger, 2002, March 28; Bornand, 2002, March 28).[144] Electronic commerce has not been perceived as a threat to the system (Hediger, 2002, March 28).

As of 2002, 71% of the total expense of 28.44 million CHF (17.9 million Euro) was used for recovery (SWICO, 2003a). SWICO pays recyclers one average price per kg for all the six categories, which stays the same for the respective product category during the contract period of two years

[144] 35-40% of the products that are currently coming back are orphaned products (Bornand, 2002).

(Bornand, 2003, June 9). Depending on the volume, the price differs among the recyclers, (Bornand, 2003, June 9). "We want to keep it simple, knowing that the real cost for recycling of a copier, compared to a handy, is different. But why should we care about that" (Bornand, 2002, March 28). The fund is financing the whole system regardless of types of products (cross financing).

The recovery fee for IT and office equipment has been lowered twice, in 1995 and 1998 (Bornand, 2003, June 9). However, the expenditure in 2001 was more than the size of the revenue and therefore the fee should be increased (Bornand, 2003, June 9).

Meanwhile, one of the A-participants, who have individual accounts, mentioned that a substantial reserve has been accumulated. While acknowledging the caution of SWICO's management, he commented that it was a pity not to be able to use part of the reserved money for other environmental activities (Vanderstraesten, 2004, April 22).

Information management

Both SWICO and S.EN.S have a stringent monitoring system on recovery activities. They require recyclers to keep records of their own activities, and to document the material flow (inputs and outputs) much more precisely than as required by the government. Recyclers must also keep track of the destination of the components and recycled materials and the method of treatment of these materials. EMPA, the Swiss Federal Laboratory for Materials Testing and Research, serves as an independent control office for SWICO, and also monitor the recycling plants that have a contract with S.EN.S (Bornand, 2002, March 28; Hediger, 2002, March 28).

The monitoring and controlling of the recovery activities is discussed further in the following section. The information of the overall recovery activities can be found on the homepage and in the annual reports of SWICO and S.EN.S.

Monitoring and enforcement

As mentioned earlier, both SWICO and S.EN.S have a rigid monitoring system both for collection and recovery activities. As the Chairman of the SWICO Environmental Commission puts it "it makes no sense to say that you are responsible and send the product somewhere. You must have control" (Bornand, 2002, March 28). Likewise, S.EN.S describes its work as

" to check the quality of the collection points, to secure that the equipment which has to be recycled is to be transported to our recycling facilities" and to "check the quality of recycling" (Hediger, 2002, March 28).

As the first step, the recyclers must obtain a disposal permit from the government. It is the Canton government who is responsible for issuing the permit within its jurisdiction, provided that it is proved in the application made by the recycler that the recycler has the appropriate technology and personnel to meet the standards set by the government.

The recyclers contracted with S.EN.S and SWICO must be able to meet higher requirements than those required by the government. As mentioned in the previous section, EMPA, an independent control body, works both for S.EN.S and SWICO as an auditor. They check the recovery activities at least once a year. Special attention is given on the material flow and destination of the components and recycled materials, and methods of treatment in the destination (Bornand, 2002, March 28; Hediger, 2002, March 28). EMPA also monitors disassembly facilities (Bornand, 2002, March 28). By March 2002, two licenses had to be taken away, while two other recyclers decided to return the license as they stopped their activities (Bornand, 2002, March 28).

In addition to recovery activities, the management of the collection points has also been audited. The dimensions the collection system check include: 1) if the products are taken back free of charge, 2) if the materials are stored in locked areas and 3) if it is easy for consumers to bring back products (Bornand, 2002, March 28). Since January 2003, they are also checking issues such as the origin of the products as well as if the SWICO and S.EN.S process (acceptance, storage and transport) has been coordinated without trouble (SWICO, 2003a). The audits led to the closure of three collection points, while the performance of the rest of the collection points was ranked between satisfactory and very good (SWICO, 2003a). Although not yet organised, establishment of a system to monitor the practice of the retailers had been planned as well (Hediger, 2002, March 28).

Approximately 90% of the market is covered by the coordinated activities of S.EN.S and SWICO (Hediger, 2002, March 28). Free-riders have not been perceived to be a threat to the system as "it is only benefit for the producers to participate" (Bornand, 2002, March 28). The problems with free-riders is

perceived to be dealt by the government (Bornand, 2002, March 28), and establishment of legislative framework helped increased the participation.[145]

The Swiss EPR programme for EEE addresses the issue of export explicitly, both at the legislative level and in practice.[146] A substantial part of the legislation is devoted to export, where it prescribes, among other things, what may be exported and what procedure is required to export it and the form of tracking required. As the Chairman of the SWICO Environmental Commission puts it, "The government did not want the export of WEEE as a result of this obligation" (Bornand, 2002, March 28).

As mentioned earlier, as of now SWICO and S.EN.S have contracted only with recyclers in Switzerland. Both SWICO and S.EN.S have stringent requirements for the recycling plants with regard to the destination of the materials and components and their treatment. Control of export is also regarded as an important role of the government (Bornand, 2002, March 28).

From the interview, the author received the impression that the two collective systems have a strong commitment to keep all the products that come under their system under control. It has not been very clear what is still outside of their system, what grip the government has and what actions have taken by the government.

5.1.4 EPR programmes for batteries in the Netherlands

The Decree of 31 January 1995 laying down rules for the collection and processing of spent batteries (Batteries Disposal Decree) provides the legal basis for the implementation of an EPR programme for batteries in the Netherlands. Came into force on 1 March 1995, the Decree was developed

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[145] As the manager of S.EN.S put it "without legislation, it is hard, for a private initiative, to get more than 50-60% of the market" (Hediger, 2002, March 28).

[146] In most of the nations where EPR programme for EEE has been introduced, the issue of export is addressed in other regulations and is not included under the scope of the EPR programme.

as a means of implementing the EU Directive on batteries and accumulators containing certain dangerous substances.[147]

The Decree covers both primary and secondary (rechargeable) batteries that weigh not more than 1 kg. In response to the introduction of the Decree, in 1995 nine major importers of batteries in the Netherlands established a foundation, Stichting Batterijen (STIBAT), which serves as a collective body (PRO) to implement the EPR programme on behalf of producers. Apart from the system established and managed by STIBAT, Battrex, an importer of special batteries used mainly by business, had established its own collection and recovery system prior to the introduction of the legislation.

STIBAT is the principal actor in organising the whole EPR programme for batteries in the Netherlands. As of 2001, 653 producers, of whom more than 90% are importers, participate in the STIBAT system (STIBAT, 2002b; Broers, 2003, April 8). Other important actors in the system include municipalities, retailers, schools, campsites, recyclers and consumers.

In this thesis, the system established by Battrex is described to the extent that is relevant for the discussion of collective versus individual responsibility. Apart from issues surrounding collection and recovery of batteries, the Decree stipulates the restriction of sales of batteries containing certain hazardous substances. The final part of this section introduces some of these mandates that are related to design change.

Collection

Physical management

In principle, the responsibility for collection of batteries starts "from the border of the municipalities" in the Netherlands (Broers, 2003, April 8). However, in order to achieve the mandated recycling rate set in the Decree efforts have been made by the producers to collect via retailers, schools and campsites (Broers, 2003, April 8). There are also batteries within discarded appliances, such as EEE. All the batteries collected are then brought to a central depot. In addition to the system organised by STIBAT, Battrex has

147 Directive No.91/157/EEC of the Council of the European Communities of 18 March 1991 on batteries and accumulators containing certain dangerous substances. OJ L 078, 26/03/1991 p. 0038-0041.

its own independent collection system (Struijk, 1992: Vick, 2004, August 18).

Collection by municipalities

Collection of batteries from households has been performed under the small-scale chemical waste (KCA) system, part of a source separation system of the municipal waste stream that existed prior to the introduction of the Battery Disposal Decree. When the Decree was introduced, the municipalities were perceived as wishing to keep the responsibility for collecting batteries.[148] However, municipalities have also appreciated the collection paths established by STIBAT.[149]

The collected batteries are further consolidated by approximately 16 professional collectors that have contracts with STIBAT, and are brought to the central depot in Ermelo (Broers, 2003, April 8; Langrová, 2002). The percentage of the batteries collected through this venue is unclear, as the professional collectors are collecting batteries not only from the municipalities but also from retailers and some business end-users (Broers, 2003, April 8).

Collection other than municipalities

Finding the KCA system in municipalities to be insufficient to meet the collection requirement set by the legislation, STIBAT started to investigate other collection paths. Since 1998, they have established almost 10 000 collection points at retailers, primary schools and campsites (Broers, 2003, April 8).

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[148] Prior to the introduction of the Decree, a draft was presented on 23 November 1993. The producers and retailers wanted to retain the responsibility for collecting batteries with municipalities. The Association of Netherlands Municipalities also shared this preference (VROM, 1995). The stated reason was that batteries are the most known products that fall under the category of small-scale chemical waste (KCA) and that bringing batteries out of the scope of KCA system would make it difficult for municipalities to communicate this system to the citizens (Broers, 2003, April 8).

[149] For example, in the city of Rotterdam, the municipal official has shown their willingness to identify some of the local retailers that have not been part of the STIBAT system and encourage these retailers to participate (Verschoor, 2003).

Reflecting upon the preference of consumers found in their survey,[150] STIBAT started to recruit the participation of retailers in collecting spent batteries in 1998 (STIBAT, 2002b). Their targets have been the major retail chains that sell batteries including supermarkets, photo shops, do-it-yourself shops, and toy shops (Broers, 2003, April 8). The participating retailers are provided with a collection bin and a box that can be put within the bin. When the box is filled, a logistical service company will come and pick it up within 5 working days upon informing STIBAT, and replace the box with an empty one (Broers, 2003, April 8). Spent batteries are collected by professional collectors who then bring them to the central depot, while others are sent directly to the central depot (Broers, 2003, April 8).

In 1998, STIBAT also started to collect batteries at primary schools in the Netherlands (STIBAT, 2002b). The school receives points for every kg of batteries collected (Broers, 2003, April 8). With the accumulation of various numbers of points, they can acquire various prizes that can be used at the school (Broers, 2003, April 8). Close to 3200 schools participated in the collection programme in 2001, contributing with the collection of 322 tonnes, or 17% of the batteries collected under the STIBAT system (STIBAT, 2002a).

In addition to these two venues, STIBAT also started a programme at campsites, where many batteries are used due to the lack of electricity connection. Approximately 500 campsites currently participate in the collection programme. From the campsites and schools, collected batteries are directly sent to the central depot without going through professional collectors (Broers, 2003, April 8).

Collection from discarded appliances

As long as they are removable, the Decree also covers the batteries within appliances. When the batteries are sorted at the recycling plants, they are eventually sent to the STIBAT system (Zwart, 2003, April 11; Van Kalkeren, 2003; Vonkeman, 2003, April 8; Broers, 2003, April 8). There has been a discussion as to who should be responsible for built-in batteries (Broers,

[150] The survey conducted by STIBAT in March 2002 showed that more than 90% of the consumers said they always (65%) or usually (26%) hand in spent batteries instead of throwing them in the municipal waste stream. They also believe it is environmentally friendly to do so. When asked where they would want to bring the batteries, the place people referred to most was supermarkets (Broers, 2003, April 8; STIBAT, 2002).

2003, April 8). STIBAT sort and recycle them provided they are removed from the appliances and handed in to their system (Broers, 2003, April 8).

Sorting at the central depot

All the batteries brought from the paths mentioned above are hand-sorted into less than 10 streams at the central depot in Ernelo. In order to keep track of the incoming batteries, the process starts with the weighing of batteries (Broers, 2003, April 8).

The main starting point for sorting is separation of batteries that can be recycled: that is, what type of batteries the contracted recyclers can take. They first pick up the larger types, whose size and shape make it possible to distinguish what chemicals they contain. The sorting of round cells follows and lithium and nickel-cadmium batteries comes after that. Putting the batteries under a small machine enables one to distinguish between mercury-containing and mercury-free batteries: those that glow are the ones without mercury.[151]

STIBAT previously used an automatic sorting machine (Broers, 2003, April 8; Vershoor, 2003, April 10). However, use of the machine ceased as the size of the machine as too large for the amount of batteries collected in the Netherlands (Broers, 2003, April 8). Sorting between brands has not been performed.

As found in Table 5-9, the achieved collection rate has been above 70% since 1998, falling short of the requirement set in the Decree (80% by 1 January 1996 and 90% by 1 January 1998). STIBAT, in their third statement, where it expressed their plan of means of fulfilling the responsibility given by the legislation, set up the reuse and recycling rate of 80% by January 2008 (STIBAT, 2002b; Broers, 2003, April 8).[152] Differences in the calculation method, as well as in the coverage of the type of batteries, makes it difficult

[151] The manufacturers of mercury-free batteries started to put a special coating around the batteries, so that the batteries can be distinguished easily (Broers, 2003, April 8). Originally, the manufacturers used to argue that mercury-free batteries could not be sorted, which would make recycling costs very high.

[152] With regard to the 3rd statement, refer to sub-section "Information management".

to compare the result between different countries, for instance with Switzerland (See Section 5.1.5). [153]

Table 5-9: The result of collection of batteries in STIBAT system, the Netherlands

Year	1998	1999	2000	2001
Amount collected in STIBAT system (tonnes) (a)	2 533	1 849	1 856	1 876
Amount found in the municipal waste stream (tonnes) (b)*	845	805	675	823
Total amount discarded (tonnes) (a + b)	3 378	2 654	2 531	2 699
Collection rate (%) a/(a + b)	75	70	73	70

Source: STIBAT (2002a).
*The amount of batteries found in the municipal waste stream is figured out by separating batteries contained in a sample municipal waste, which is undertaken six times a year (Veeman, 2003; Broers, 2003, April 8).

In the case of Battrex, it took advantage of its rather limited distribution paths and the fact that half of their customers are business customers, and established a collection system through their retailers (Struijk, 1992). There have been cases when batteries dealt with by Battrex are mixed in the STIBAT collection paths, and vice versa (Langrová, 2002). The quantities of batteries misplaced in the respective two systems have not been perceived to be significant, thus the two systems have recycled the batteries that come into the respective systems (Langrová, 2002). The two systems have been cooperating rather well (Broers, 2003, April 8).

Financial mechanism

Municipalities finance the collection of batteries that come under the KCA (small-sized chemical waste) system. The rest of the activities involved in collection: that is, provision of bins and boxes at retailers, schools and campsites, transport from municipalities, retailers, schools and campsites to the central depot, logistics arrangement for the transport, sorting at the central depot are all financed by the fee collected from the producers. As the

[153] The method of calculating the collection rate has been changed from the methods that use sales figures to one using estimation of the amount discarded (Langrová, 2002). The current method of calculating the collection rate is the weight of batteries handled by the STIBAT system or similar when compared to the weight of batteries discarded in the municipal waste stream, measured through sampling (STIBAT, 2002b).

fee is also used for the recovery of batteries, the size and the mechanism of managing the collected fee is discussed in sub-section "Recovery" below.

Participating retailers are compensated with convenience, for instance provision of bins and boxes, pick-up service upon request and with publicity – having their names on the brochure and homepage of STIBAT. They do not receive monetary compensation.[154] Apart from receiving prizes for the students, schools receive environmental education programmes which can be utilised by school teachers (Broers, 2003, April 8).

With regard to the batteries separated from appliances at the recycling plant, the transportation to the STIBAT system is not financed by STIBAT.

In the case of Battrex, they provide the collection service to the retailers free of charge. It is only when a very large amount of batteries is discarded from business users that they charge for transportation (Vick, 2004, August 18).

Information management

Collection from the household has been perceived to be the most difficult task (Broers, 2003, April 8). Apart from making it convenient for consumers to bring back batteries by establishing additional collection points with retailers, schools and campsites, different efforts have been made to inform the consumers of the system and of the environmental benefits of sorting batteries (Broers, 2003, April 8). Approximately 50% of the budget of STIBAT is spent on information campaigns (Veerman, 2003, April 9).

The aims of collecting batteries at school are two-fold: educating the children to take care of batteries, and through children, educating their parents. STIBAT provides educational programmes that teachers at school can utilise. They also run a painting contest for students and have made a card game, using the paintings of the winners (Broers, 2003, April 8).

Having a large collection bin with the logo of STIBAT with retailers and campsites makes the STIBAT system visible. The existence of the bins in

[154] There was also a perception that retailers have benefited from participating in the STIBAT system as the retailers, despite the fact that they are not legally responsible, receive spent batteries from the consumers. "…the shops also have to get rid of the battery waste. They have to bring them to a collector, and the collector may ask for money..." (Broers, 2003, April 8).

campsites may also help remind the consumers of the necessity of handing in spent batteries that they keep at home (Broers, 2003, April 8). Brochures, leaflets and posters are provided at the participating retailers (Langrová, 2002).

In addition to information to consumers, producers also have the obligation to provide the government with information as to how they are planning to implement their responsibility. As an organisation that implements the responsibility of producers on their behalf, STIBAT has been making joint statements. The statement should be approved by the government and upon approval must be implemented. STIBAT must also report the result of the implementation to the government every year.

Recovery

Physical management

When STIBAT started the programme in 1995, it was difficult to find recyclers who had the capacity to recycle batteries, due to the lack of demand in the market at that time. The number of recycling companies has increased a little since then. Except for some of the zinc-carbon and alkaline batteries recycled in one company, Nedstaal in the Netherlands, currently all other batteries are recycled abroad (France, Switzerland, Belgium and Germany). Some of the recycling companies recycle only batteries, while others are smelters who have battery recycling as a part of their business (Broers, 2003, April 8).

In order for STIBAT to recycle batteries abroad, they need to obtain a permit from the government, who provides the permit only when the batteries are recycled, not incinerated or disposed without recycling (Broers, 2003, April 8).

Financial mechanism

As mentioned earlier, the activities of STIBAT are financed by the fee collected from the producers, paid per amount of batteries they put on the Dutch market (advance disposal fee system). At the moment, STIBAT categorises the batteries into 6 types, the parameter being weight and the distinction between rechargeable and non-rechargeable batteries (Broers, 2003, April 8). As found in Table 5-10, apart from the button cells, the current size of the fee is differentiated in accordance with weight but not

between rechargeable and non rechargeable. There is no differentiation of the fee between brands.

It is up to the individual producers to decide if the fee is visible to consumers or not. In reality, most of the producers are considered not to have visible fees. When the system was started, STIBAT asked the producers to make the fee explicit on the bill with the aim of acquainting the consumers with the STIBAT system. However, the government competition authority did not allow STIBAT to force companies to have a visible fee on the grounds that it would hinder the freedom of the enterprise to negotiate (Broers, 2003, April 8).

Table 5-10: The size of the advance disposal fees in STIBAT system, the Netherlands (as of June 2002)

Type of batteries	Size of the fee (in Euro, excl. tax)
Batteries weighing up to 50 grams	0.02
Batteries weighing 51-150 grams	0.06
Batteries weighing 151-250 grams	0.13
Batteries weighing 251-500 grams	0.27
Batteries weighing 501-750 grams	0.40
Batteries weighing 751-1 000 grams	0.54
Button cells	0.003

Source: STIBAT (2002).

The collected fee is managed in a pension (pay-as-you-go) system. STIBAT experienced an establishment of a large reserve in the beginning. However, at the time of the interview the size of the reserve had come down to zero (Broers, 2003, April 8).

Information management

As a means of monitoring the overall activities, which are part of the responsibility of producers stipulated by law, STIBAT keeps track of the recycling process that the respective recyclers use, the outcome of recycling (recycled materials), as well as the destination of the recycled materials (Broers, 2003, April 8). As mentioned earlier, they must report the result of monitoring to the government. The result can be also found in their annual report.

Producers must mark the batteries that contain specified heavy metals exceeding the level stipulated in the Decree.[155] The requirement is applied also to the producers of batteries that are used within EEE and other appliances. In the case of the latter, unless the producers provide details of the heavy metal content as well as the method of its safe disposal, use of such batteries within the products is prohibited. Instructions on how to remove batteries from products also have to be given by the producers.

Monitoring and enforcement

As mentioned above, producers must monitor collection and recovery activities, and report the result of monitoring back to the government.

With regard to collection, as mentioned in connection with the collection rate, STIBAT has a contract with a specialised company who check the amount of batteries contained in the sample municipal waste 6 times a year (Broers, 2003, April 8; Veerman, 2003, April 9).

STIBAT visits the recyclers on regular basis and makes sure if the permit the recyclers receive from the government is still valid. As has been mentioned, in order to obtain the permit from the government the activities of the recyclers have to be recycling. So far, the quality of the recyclers has not been a problem. However, sometimes the permit of the company has expired, which has lead STIBAT to stop transport of batteries for some months (Broers, 2003, April 8).

As mentioned in the beginning, the member companies increased from nine in the beginning to more than 600. Importers of various products that contain batteries contributed to the large increase (Broers, 2003, April 8).

Other material related restriction

Apart from the collection and recycling requirement, the law prohibits activities "to manufacture, import, make available to other or keep in trade stocks alkaline batteries containing more than 0.025%" of mercury by weight (Article 2). Exceptions are those that are used in extreme conditions.

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[155] The batteries whose heavy metal content has to be marked include: the alkaline batteries that contain more than 0.025% of mercury by weight, the rest of the batteries that contain more than 25mg of mercury, batteries that contain more than 0.025% of cadmium per weight and those that contain more than 0.4% of lead by weight.

In this case, the use of up to 0.05% of mercury is allowed (with the marking, see footnote 155). Button cells are also excluded from this material restriction. Batteries must be easily removable from appliances.

5.1.5 EPR programmes for batteries in Switzerland

In Switzerland, retailers have been responsible for accepting the discarded batteries for a long time. Up until 1991, the collected batteries were exported to Eastern Germany and dumped. In 1991, the government stopped giving export licenses, which had been very easy to obtain before that. The movement of the government coincided with the development of a battery recycling plant in Switzerland.[156]

Restriction of exporting batteries for recycling resulted in a sharp increase in the recycling costs from 0.35 CHF (0.22 Euro) per kg to 4 CHF (2.52 Euro) per kg. Moreover, the fact that responsibility of the retailers to accept the spent batteries was not restricted to old-for-new basis or to those the retailer himself had sold before, created a situation where some retailers received many batteries, while others did not. Together with the increase of price, this started to disrupt the market and retailers who used to pay for recycling can no longer afford to do so (Jordi, 2002, March 27).

Retailers could bring the batteries to the producers, who would have faced the same challenge as the retailers. In order to cover the cost of recycling, producers decided to introduce, on a voluntary basis, an advance disposal fee system and established a cooperative called BESO, which later became INOBAT.[157] They made a contract with Ernst and Young, who ran the fund on behalf of INOBAT (Jordi, 2002, March 27).

In order to deal with the free-rider problem while increasing the collection rate at the same time, INOBAT and the government both agreed that it is necessary to make not only the acceptance but also the disposal mandatory (Jordi, 2002, March 27). The Amendment was made to the Ordinance related to Environmentally Hazardous Substances, which came into force on 1 October 1998. Due to a struggle to determine which organisation should

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[156] It was a joint venture of the Canton and Central government, Migros, which is one of the largest retailer chains in Switzerland and a private company (Jordi, 2002, March 27).

[157] Interesseorganisation Batterieentsorgung (interest organisation for end-of-life management of batteries).

actually run the system, the actual implementation started on 1 April 2001 (Jordi, 2002, March 27).[158] In the end, it was decided that Ernst and Young should continued its task of running the system on behalf of producers.

INOBAT, which commissioned the operation to Ernst and Young, is an integral actor that coordinates the collection and recycling activities. Retailers, recyclers and consumers also play a vital role in implementation.

Although the legislation covers different types of batteries, this section focuses on the primary and secondary batteries that are less than 5 kg and used for civil purposes (not in the army or civil defence), unless otherwise mentioned.[159] Material restriction in batteries, as well as their sales in Switzerland, is introduced to the extent relevant to design change.

Collection

Physical management

Just like the EPR programme for EEE, the law stipulates that the *consumers (end-users)* are responsible for bringing back spent batteries to a retailer or for handing them in to a collection point. Although some collection points have been established, for example, by communities, they are not very common. It is mostly via the *retailers* that spent batteries are collected.

Retailers have the obligation to accept free of charge any spent batteries that are discarded from consumers, regardless of a new purchase (old-for-new), brand or if they themselves had sold the batteries or not. At the moment, all the batteries are collected without sorting the different types (Jordi, 2002, March 27).

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[158] Among other things, the legislation stipulates that the system should be run by a private organisation who has the running period of maximum five years. Apart from Ernst and Young, who had been managing the voluntary system, there was another organisation that aspired to run the system, which led to a rather severe conflict between the two organisations that lasted for two years (Jordi, 2002, March 27).

[159] For example, dealers who sell lead batteries weighing more than 5 kg must accept the batteries sold by them. However, there is no mandate for producers to pay an advance disposal fee.

However, retailers are not obliged to participate in the INOBAT system, which poses challenges to INOBAT.[160] As part of their effort of providing consumers with convenience and increasing the visibility of the system, INOBAT is ready to provide retailers with collection boxes as well as the transportation of collected batteries to the recycling plant. Among other things, Migros, a large retail chain that has 30-40% of the market share of batteries, participates in the INOBAT system.[161] However, there are many other retailers who were not aware of their responsibility and ignored the offer from INOBAT.[162]

With regard to batteries within EEE, the batteries are taken out at the recycling plants of the EEE and are sent to the recycling plant of batteries.

Before legislation came into force, transportation from the retailers to the recycler was organised by the retailers themselves. Now it is part of the task of INOBAT.[163] Retailers can call the transporters who have a contract with INOBAT, and ask them to pick up the spent batteries. Pick up is to occur within 10-14 days. In order to enhance the cost efficiency, INOBAT has contracted with several transporters that are working in different communities, instead of having one transport company. The transportation service should be provided to all the retailers regardless of whether they are using the materials provided by INOBAT or not (Jordi, 2002, March 27).

As shown in Table 5-11, the collection rate of batteries in Switzerland has been approximately 60%. In the case of Switzerland, instead of the amount disposed, the amount sold is used as a denominator when calculating the

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160 Hanspeter Jordi, who has been in charge of running INOBAT (including the period when it was voluntary), pointed out four weak points in the system, which are: 1) lack of incentives for consumers to bring back, 2) lack of convenience for consumers to collect at home, 3) limited participation of retailers and 4) lack of experience in managing the transportation from the retailers to the recycling plant (Jordi, 2002, March 27).

161 It could be noted that Migros has been proactive in battery recycling and even provided some resources for the establishment of a recycling plant in the early 1990s. See footnote 156.

162 When INOBAT contacted 10 000 retailers asking if they would like to receive the collection box, only 400 replied (Jordi, 2002, March 27).

163 The law stipulates transportation of the spent batteries as one of the items that may be financed by the advance disposal fee, which is managed by INOBAT. As an appointed private organisation, INOBAT has the task of managing the fee as well as organising the activities that should be covered by the fee.

collection rate (Buser, 2002, March 27; Langrová, 2002) (see footnote 153).[164]

Table 5-11: The result of collection of batteries in Switzerland

Year	Consumption (sale) (tonnes)	Amount collected (tonnes)	Collection rate (%)
1993	3888	2240	58
1994	3700	2240	60
1995	3700	1980	54
1996	3700	2220	60
1997	3700	2018	55
1998	3700	2210	60
1999*	3700	2400	65
2000	3800	2376	63

Source: BESO, in SAEFL (2001b).
* Figure estimation by SAEFL.

Financial mechanism

When retailers wish to use the collection box provided by INOBAT, they will receive them free of charge. Advance recycling fees finance the manufacturing and provision of collection box, as well as the transportation of spent batteries from retailers to recyclers and the logistical arrangement behind it (Jordi, 2002, March 27).

The size of the advance disposal fees, as well as the management of the fee is discussed in sub-section "Recovery".

[164] In Switzerland, the way of calculating the collection rate of nickel-cadmium batteries changed in 2002. In the past, the amount of batteries collected was compared to the amount of batteries sold in the same year. From 2002, the amount of batteries collected is compared to the average of the amount of batteries sold in the same year and two previous years. According to a government official in charge of collection and recycling of batteries, the recycling rate went up from approximately 60% in 1998 to roughly 80% in 2002. He considers that the change may have to do with the change in calculation methods, rather than the actual increase in the amount of nickel-cadmium batteries collected (Back, 2004, March 16-18).

Information management

Various information campaigns have been made in order to encourage the consumers to bring back spent batteries, utilising media such as commercials on TVs and cinemas, posters, bags, stickers and brochures (Jordi, 2002, March 27). The strategy for the consumers has been to establish a notion that it is abnormal to throw away a spent battery together with other municipal waste (Jordi, 2002, March 27).[165] Visibility of the programme in shops would make it easy for consumers to identify the shops that accept the batteries. INOBAT spent 1.5 million CHF (945 000 Euro) for information campaign per year. With repetition twice, it will be 4 million CHF (2.52 million Euro) in 3 years (Jordi, 2002, March 27).

Even when the retailers do not use the materials provided by INOBAT, they a legal obligation to display a "prominent notice",[166] so that consumers are informed of 1) their obligation of returning the spent batteries, 2) the fact that the recycling fee is included in the batteries they currently purchase[167] and 3) the possibility of returning the spent batteries to shops.

Retailers can find the telephone numbers of the transportation companies on the homepage of INOBAT (Jordi, 2002, March 27).

Recovery

Physical management

All the batteries collected are sent to Batrec AB in Wimmis, the only recycling plant in Switzerland. All the batteries are recycled in this plant except for nickel-cadmium batteries which are recycled in France and lead-acid accumulators (Buser, 2003, November 18). According to the manager of INOBAT, Batrec has a very sophisticated recycling facility, and the

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165 Examples of pictures found on the brochure include a young nice-looking lady having an unwrapped raw fish in a handsome handbag, dirty shoes in a toaster, and the like.

166 Wording used in the legislation. It also says "Advertising for batteries and accumulators shall draw the attention of consumers to the obligatory return of used batteries and accumulators" (Subsection 32 para 2, Annex 4.10).

167 Prior to the introduction of the legislation, INOBAT recommended the retailers to make the recycling fee visible. Some retailers such as Migro, did show the fee outside of the batteries. The legislation mandates the price of a product to be communicated to the end-user include the recycling fee. (Jordi, 2002, March 27; Buser, 2003, November 18).

achieved recycling is 99% "clean" (Jordi, 2002, March 27). No distinction between brands is made (Jordi, 2002, March 27).

The fact that there is only one company does not allow competition. There are companies outside of Switzerland offering recycling services to INOBAT. However, export is only allowed provided that the plant abroad has the same standard as in Switzerland and currently none of the recyclers abroad have the same level of facility as Batrec (Jordi, 2002, March 27).

There was previously another plant called Recymet, in Aclens, Switzerland. Due to the limited amount of batteries collected in Switzerland and the relatively high price that hindered the companies from attracting imports of spent batteries, the two plants suffered from over capacity.[168] In the end, the two companies merged, and only Batrec is left (Jordi, 2002, March 27; Langrová, 2002).[169]

Financial mechanism

Advance disposal fees finance recycling as well as activities surrounding collection, such as information provision and transportation and provision of collection boxes to retailers/bags to consumers. The fee is universal per weight regardless of the types of batteries and regardless of brand. From the universal figure determined per kg of batteries stipulated in legislation, INOBAT determines the size of the fee of the respective types of batteries using the average weight of the batteries belonging to the same type (Jordi, 2002, March 27).

Upon the introduction of legislation, the fee level was raised from 3.2 CHF (2.02 Euro) per kg to 4.8 CHF (3.02 Euro) per kg. The increase in the cost of recycling from 4.75 CHF (2.99 Euro) per kg to 5.4 CHF (3.40 Euro) per kg, as well as additional tasks surrounding collection that should be covered by the advance disposal fee is perceived to necessitate this steep increase (Jordi, 2002, March 27). The government now determines the cost for recycling, which used to be determined through negotiation between

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[168] STIBAT, who organises the Dutch EPR programme for batteries, are now exporting batteries for recycling to Batrec (STIBAT, 2002a).

[169] Even when there used to be two recycling companies, the companies were subsidised by the government due to over capacity. Thus "after the merger of those two, we have no market, and before we had no real market" (Jordi, 2002, March 27).

INOBAT and the recycling plant. Likewise, the size of the fee is determined by law and should be between 2 to 7 CHF (1.26-4.41 Euro) per kg of batteries.

The cost is perceived to be very high and has been criticised by the producers (Jordi, 2002, March 27). However, the fact that there is only one company in Switzerland and that export of batteries for recycling is only allowed when the exporting countries have a standard as high as Switzerland made it inevitable for INOBAT to have Batrec recycle the batteries (Jordi, 2002, March 27; Langróva, 2002).[170] According to the manager of INOBAT, compared to the 99% cleanness that can be achieved by Batrec, other countries can achieve only 90% cleanness (Jordi, 2002, March 27).[171] As mentioned earlier, the only exception is nickel cadmium batteries. As the recycling cost for nickel cadmium batteries in France is cheaper than the cost of the rest of the batteries recycled at Batrec, INOBAT receives some refund from Batrec (Jordi, 2002, March 27).

INOBAT asks every company to inform them of the number of the respective types of batteries he/she puts on the market on monthly basis.[172] Based on this, the total amount of payment is calculated (Jordi, 2002, March 27).

As mentioned in the previous section, efforts have been made to coordinate the payment of the advance disposal fee for batteries and for EEE. SWICO, one of the organisations managing the EPR programme for EEE, pays to INOBAT for all the batteries contained within products (Bornand, 2002, March 28; Jordi, 2002, March 27).

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[170] As the manager of INOBAT put it, "That is a political dimension. That was the first time that people did this (building a battery recycling plant with high technology), and it is clear that it costs very much..... the canton and the government paid for that, so we can say, we pay so that the plant does not go bankrupt." (Words in parenthesis added by the author) (Jordi, 2002, March 27).

[171] The manager of INOBAT mentioned that the cost for recycling is said to be only 1CHF (0.63 Euro) per kg if the achievement of cleanness would be 90% (Jordi, 2002, March 27).

[172] In fact, the duty for producers to inform the organisation running the system, in this case INOBAT, of the quantities of the respective types of batteries is stipulated in the legislation.

Information management

Apart from their reporting obligation to INOBAT (see footnote 172), producers are obliged to report to the government the quantities of the respective types of batteries put on the market annually. Recyclers also have to report to the government, on an annual basis: 1) the quantity of small nickel-cadmium rechargeable batteries (weighing less than 1 kg) that are recycled, stored or exported by them and 2) the same for the rest of the batteries, whose end-of-life management is financed by the mandatory advance disposal fees.

Section 3 of the Swiss legislation on batteries entitled "information", allocates various informative responsibilities to the producers. The legislation mandates labelling of the name of the brand and for batteries that contain heavy metals more than the level determined by the law[173], information on the heavy metal content and the way of its disposal should be available on the products or their packages. In the case when batteries are fixed in products, information on the heavy metals and their disposal should be included in the instruction for the products.

Monitoring and enforcement

As mentioned earlier, the problem with free-riders was the starting point of introducing the legislation. According to the manager of INOBAT, introducing a mandatory system did improve the situation, although there is more to be achieved (Jordi, 2002, March 27). INOBAT is aware of the producers who are selling big batteries. The difficulty has been to capture the importers of products that contain batteries such as EEE and toys. Notifications from the competing producers often help identify the free-riders.

With regard to the export of nickel cadmium batteries, there is a tracking system that makes it possible to trace the destination, recycling activities and the result of recycling.

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[173] The batteries containing more than 0.025% of cadmium by weight or 0.4% of lead by weight or more than 25 mg of mercury per cell. The types of batteries whose heavy metal content must be marked are the same as the one stipulated in the Dutch legislation, except for the alkaline batteries that contain more than 0.025% of mercury by weight. See footnote 155, as well as the last sub-section of this section.

In cases where the retailers do not participate in the INOBAT system, it is questionable whether, and/or how the informative responsibility given to them is enforced.

Other material related restriction

Just as with the Dutch legislation, Swiss law prohibits the import of alkali-manganese batteries containing more than 0.025% of mercury by weight with the exception of those that are used in extreme conditions. In such instances, use of mercury up to 0.05% is allowed. Button cells are excluded from the restriction. It also prohibits the import of carbon-zinc batteries that contain more than 0.01% of mercury or 0.015% of cadmium by weight. A governmental official commented on the visit of a group of Japanese battery manufacturers when Switzerland inaugurated the legislation on material restriction. He mentioned that despite the relatively small size of the country and the size of the market for the manufacturers, the restriction did compel manufacturers that were large enough to send a delegation to Switzerland (Tellenbach, 2002, March 27).

Section 5 of the legislation discusses the recycling of small nickel-cadmium rechargeable batteries. Namely, from 2004 cadmium content within small nickel-cadmium batteries in household waste shall not exceed 3 000 kg per year.[174] The law stipulates that if this cannot be achieved, a mandatory deposit-refund system could be introduced. According to the calculations made by the Federal Agency for the years 2002 and 2003, the target value was likely to be respected in 2004, making further steps towards a mandatory deposit-refund system unnecessary (Back, 2004, March 16-18).[175]

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[174] The Ordinance on Substances stipulates that from the year 2001 onwards, the Federal Agency decides annually whether the target value can be achieved.

[175] According to a government official in charge of the legislation, the intention of the phase-out provision is to put pressure on the market to enhance the recycling rate. According to their calculation method (the average of the amount of nickel-cadmium batteries sold in 3 years minus the amount collected, multiplied by 0.16), 3 000 kg corresponds to roughly 80% recycling rate. He considers that "the complete phasing out of nickel-cadmium accumulators is not feasible in a small country like Switzerland, unless the EU takes steps towards this goal" (Back, 2004, March 16-18).

5.2 Comparative analysis of the programmes: individual versus collective responsibility

Based on the investigation of the implementation mechanisms of the five EPR programmes provided in the previous section, this section discusses the advantages and challenges for producers to implement their tasks in a collective and/or individual manner. Just as in the previous section, with recognition of the different activities that constitute the implementation of EPR programmes, separate analysis is made for the three activities: *collection*, *recovery* and *monitoring and enforcement*. Likewise, the responsibility for collection and recovery are looked at from three angles: *physical, financial* and *informative*.

The analysis focuses on the roles of the producers and the implementation of such roles in the programmes. Thus discussion of the roles of the other actors (central and local government, retailers, recyclers) is limited to the extent that is relevant to the individual and/or collective implementation of the roles of producers.

The primary reason why the focus of this implementation evaluation is individual versus collective responsibility is its assumed strong link to upstream changes. Thus, issues that were found in the implementation that the author considers may have implications to upstream changes are also discussed, regardless of their linkage to individual versus collective responsibility.

As mentioned earlier, what is meant by the terms "individual responsibility" and "collective responsibility" varies in practice and in literature. The analysis of this section is based on the following understanding: a producer has an *individual responsibility* when he/she takes responsibility for the end-of-life management of his/her own products. When producers of the same product group together fulfil their responsibility for end-of-life management of their products regardless of the brand, these producers have *collective responsibility*. Using this categorisation, the author seeks to clarify the differences among various systems in incorporating individual responsibility and/or collective responsibility.

Although the analysis is mainly based on the five programmes examined in this study, reference to other programmes and initiatives are made when this is appropriate to illustrate an argument.

5.2.1 Collection

Physical responsibility

Although the implementation mechanism for collection varies among the five EPR programmes investigated, it generally consists of three steps: 1) collection from end-users, 2) sorting of the collected products and 3) transportation of the collected products to the recycling plants.

Collection from end-users

In all the programmes studied, actors other than producers such as retailers, municipalities, collection points, schools and campsites are involved in the collection from end-users.

With regard to the collection from *private households*, the involvement of the producers in this activity is limited. However, in the case of the two programmes for batteries and the Swiss programme for EEE, producers are actively engaged in encouraging these actors to participate in collection, establishing collection points, providing collection bins and the like. Under the two programmes for batteries, producers are by law responsible for collection (Switzerland) or for achievement of collection target (the Netherlands). In all the three cases, it is the body that carry out the task of the producers on behalf of producers collectively (producer responsibility organisations: PROs) involved *(collective physical responsibility)*. In the case of the Japanese programmes for large home appliances, the brands and models of discarded products are distinguished when *retailers* receive them from *end-users*.

On the other hand, a significant flow of used products, the collection of which from end-users is organised by *individual producers*, was also identified (*individual physical responsibility*). Examples include producers of ICT equipment in Switzerland and Japan and Battrex, an importer of special batteries in the Netherlands. The end-users of these products are typically *businesses*.

Organising the collection of used products from scattered sources (private households) is perceived to be one of the most challenging tasks, especially

when the size of the products is small (batteries, small EEE).[176] However, it should be noted that as a way of collecting personal computers from households, one of the producers (IBM) started to accept used products sent to them by postal service (IBM Canada, 2001). The same mechanism has been considered as one of the collection paths in the upcoming Japanese programme for personal computers from household.[177] Likewise, producers of nickel-cadmium batteries utilise the postal service for direct collection from end-users (Fishbein, 1997).

Sorting of the collected products

In the Swiss EPR programme for batteries, all the batteries collected go to one recycling plant and are sorted at the plant. In the rest of the EPR programmes, all the products collected from *private households* are sorted prior to being sent to the recycling plants. Discarded products can be sorted between the product categories and/or between brands.

Discarded products have been sorted between the product categories in, for example, the Dutch EPR programme for EEE and batteries. In both cases, sorting is coordinated by the respective PROs *(collective physical responsibility).*

Under the Japanese EPR programmes for four large appliances, the prominent producers formed two groups. The two groups established separate collection points. Thus, the brands of the discarded products are distinguished and are sent to the respective regional aggregation stations (*individual physical responsibility*).

In the Swiss EPR programme for EEE, products with specific brands have been sorted upon request of these brands. The sorted products are sent back to producers instead of being sent to recyclers (*individual physical responsibility*).

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[176] Difficulties of collecting small appliances have been also experienced in Norway, where EPR programmes for EEE came into force in 1999. For example, the annual collection of mobile phones was 25000, while annual sales were about 1.5 million (ENDS, 1998, March 16; ENDS, 2000, August 21). It was also mentioned that small appliances, such as toothbrushes, drills, toys, alarm clocks and hair dryers, suffered low collection rates (ENDS, 2000, August 21).

[177] IBM Canada accepts all the computers regardless of brand. Under the Japanese system, if a consumer chooses to use the postal service, he/she has to send the product to the manufacturer of the product (brand specific).

A number of interviewees involved in running the collective systems mentioned the difficulty of sorting the products by brand. The challenges often mentioned included space and cost. If all the producers request physical sorting by brand at the regional aggregation stations, collection centre and/or retailers, it is not difficult to foresee the limitation in space. However, the examples in Switzerland suggest that sorting of a limited type of products at the retailers/collection points should be possible, at least in a small scale. Alternatively, producers can set up separate collection sites as found in the case of producers in Japan.

However, when there is only one collective body for a certain product group in the country, the strong negotiating power of the body often makes it difficult for producers to establish alternative solutions. For example, a company that provides services related to the collection and recovery of used ICT equipment in Sweden[178] wishing to establish an alternative collection system requested consultations with municipalities.[179] However, the consultations were refused, on the grounds that a PRO that represents the majority of EEE producers had already established collection depots. After 9 months of strenuous communication efforts to the municipalities, as well as consultation with the national environmental agency, some of the municipalities finally started to respond and came to an agreement with the company. The company has now established 100 collection points where the products of their members can be returned separate from the rest of the WEEE stream (Gulvik, 2003, June 11).

With regard to the products from *businesses*, the collection has been mainly organised by *individual producers*. In the case of the Swiss EPR programme for ICT equipment, the collection is partly conducted collectively. In fact, it was one of the main reasons why the producers wished to have an industry-wide system.

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[178] Reflecting the frustration of some of the manufacturers of ICT equipment in Norway with regard to the solution proposed by their industry association, a company called Eurovironment was established. When the EPR programme for EEE in Sweden was introduced, the company expanded its business to Sweden. Having producers of ICT equipment as their main members, the company in essence tries to provide services related to the collection and recycling of used products in a manner that reflects the environmental objectives of the respective members (Gulvik, 2003).

[179] The Swedish EPR legislation for EEE requires producers to consult with local governments when setting up a collection system.

The three EPR programmes for EEE examined have subtle differences concerning the timing and authority given to the respective actors to determine whether a product is sent to second-hand market or should be disassembled and recycled. In the Japanese programme, it is when an end-user brings a product he/she wishes to discard to a retailer and pays for the recovery fee. In this case, it is in principle the end-user who decides whether the product should be discarded or reused, instead of retailers who have more experience in judging whether the products could be reused or not (Ishiwata, 2004). Consequently, or at least in theory, retailers must bring all the products that end-users hand in as discarded products to the regional aggregation stations.

In the Dutch programme, the products would be labelled as "no longer to be reused" when the products reach the regional aggregation stations. As mentioned, in reality, the author came across a situation where refurbishment of products was indeed taking place, either at the regional aggregation station or right next to it. In this case, there is an opportunity where the reusability of a product is examined in the eyes of professionals. The information as to how common this type of arrangement is across the Netherlands is not available.

In Switzerland, when receiving discarded products, retailers could examine and decide if it is reusable or not. The products collected via other routes are most likely not examined and sent directly to the recyclers. The recyclers are not allowed to reuse the products sent to them.

In all these systems, the primary intention for restricting reuse is to have control over the discarded products to prevent illegal dumping or export of waste under the name of second-hand products. Another intention, as found from the comments by some Japanese manufacturers prior to the enforcement of the legislation, is to secure sufficient quantity of materials coming into the recycling plant, and thus help ensure scale economy of recycling (Tojo, 2000, see also Chapter 4). In the meantime, it is difficult to argue against the circulation of second-hand products so long as they are still usable, either as they are or pursuant to repairs.

Transportation to the recycling plant

In all the programmes studied, once the used products are collected from *private households*, producers are responsible for the arrangement of all (both of the programmes for batteries, programme for EEE in Switzerland) or

part (from the regional aggregation stations in programme for four large appliances in Japan and the Netherlands) of the transportation. Except for the Japanese system, the respective PROs coordinate the logistics of the transportation *(collective physical responsibility)*. In the case of Japan, the respective groups contract with the regional aggregation stations, who coordinate the transportation on their behalf. Products of different brands within the same group are sent together (*collective physical responsibility*).

Transportation to the recycling plant is naturally coordinated by the respective producers in the case of products from *businesses,* for which the individual producers directly coordinate collection *(individual physical responsibility)*. In fact, products directly collected by the producers may not necessarily be taken to the recyclers (a few cases within the Swiss programme for EEE). The whole equipment and/or components can be refurbished and resold without reaching the recycling plants.

Transportation becomes economically and environmentally efficient if a certain amount of volume is transported together. The fact that businesses often discard a relatively large number of products at one time – for instance 50 personal computers from the whole floor instead of 1 personal computer from a household – facilitates collection by individual producers. Unless the products are sorted, it is practically impossible for individual producers to physically handle the transportation of their own products. However, even when products are physically handled together, producers can still organise the transport of their own products as long as the brands of the discarded products are distinguished.

Financial responsibility

Allocation of financial responsibility with regard to the collection more or less corresponds to the allocation of physical responsibility of the producers. Exceptions are the compensation to the actors involved in collection, either in monetary term, such as to retailers in the Dutch programme for white and brown goods, or in provision of other incentives, as found in the awards given to schools in the Dutch programme for batteries.

In terms of individual versus collective responsibility, most of the activities that are physically handled collectively are also financed collectively (*collective financial responsibility*). Likewise, the financing of the activities of individual producers, for instance sorting of products of specific brands in the Swiss system for EEE and collection and transportation of ICT equipment from

businesses, is financed individually *(individual financial responsibility)*. In the case of the Japanese programme for four large appliances, one of the groups determines the unit price for transportation for the respective products, and the individual producers finance the transportation cost in proportion to the number of products transported. The cost for transportation is not differentiated between brands.

As the costs of collection do not differ greatly between products of similar type when the products are collected together, differentiation of the collection cost per unit of products between brands is not necessary.

Informative responsibility

Regardless of their involvement and legal obligation in the collection from end-users, producers are involved in providing information to the consumers of the system. Although they are not legally responsible, the PRO for the Dutch system for white and brown goods is active in providing information. The same holds for the Swiss system for EEE, though to a lesser extent. In the case of the two programmes for batteries, a significant amount of resources is allocated to the public information campaigns.

Regarding the result of their collection activities, when products are collected irrespective of brands, the PROs gather the information and report to the government as well as to the general public. Individual producers of large home appliances in Japan announce the result of their activities (collection and recovery) on their homepage every year. The industry association for large home appliances also aggregates and announces the information on collection on monthly basis. In the case of producers of ICT and office equipment in Switzerland, their PRO – SWICO – provides information on the activities of both producers under the collective system and producers having their own systems.

Provision of information upon the system through collective bodies, such as PROs or industry associations, is rather effective as the message to the *private households* concerning collection is, in principle, the same for the individual producers. Provision of information by individual producers on the packaging of the products, for example, would be helpful and is certainly necessary when introducing an individual collection system.

With regard to the results of collection, the actors who actually handle the tasks would most likely have best access to information about their activities.

When the PROs are the primary actors to contact them, as is the case in collective systems, it is practical and efficient that the PRO provides information on its activities on behalf of producers. Even when producers fulfil their responsibility in an individual manner, the collective bodies can play a role as an intermediate body to aggregate information. This may also help establish a standard for the definition of certain type of data, such as calculation of collection rate.

All the programmes examined seem to have kept rather good records concerning the discarded products that come into their systems. As manifested in the case of EEE, one challenge is the information on products that do not enter the EPR system. This will be discussed further in Section 5.2.3.

5.2.2 Recovery

Physical responsibility

In the case of the four European systems, discarded products that are transported to the recyclers collectively are not sorted between brands and are recycled together (*collective physical responsibility)*. The brand name and weighing of the equipment were distinguished in the case of ICT equipment under the Dutch collective system, although the recovery itself was performed for all brands together. The PROs do not allow the recyclers to reuse and refurbish equipment brought to them via the collective systems.

When the collection from the end-users is organised by individual producers and discarded products are brought to the recyclers directly, as found in part of ICT and office equipment in Switzerland and Battrex in the Netherlands, this stream of product is recycled separately from the others (*individual physical responsibility)*. Some of the recyclers provide refurbishment services as well, thus equipment and/or components can be recovered for reuse at the recyclers (Zwart, 2003, April 11). As found in the case of Jura, the manufacturer of coffee makers in Switzerland, products can be also refurbished without involving recyclers.

In short, unless products are collected separately from the consumers, products are currently recovered collectively.

Under the Japanese system for home appliances, prominent individual producers established and have been running at least one recycling plant on

their own (*individual physical responsibility*). The products that are not recycled at their own plants are recycled at the plants run by other producers belonging to the same group (as discussed earlier, the producers formed two groups), or in some existing recycling plants. Utilising the manifest system (tracking card with receipt), the distinction of the brand names, models and weight is made prior to the recovery of the products. However, so far the actual recycling process is the same for all products regardless of brands. At present, once the equipment arrives in a recycling plant, the equipment/components are not refurbished.

Two positive influences are perceived when individual producers themselves run at least one recycling plant, as is the case in Japan for EEE (*individual physical responsibility).* One is the establishment of good communication paths, as observed in Chapter 4. Moreover, with regard to products that are manufactured now, some companies have started to make the production site finance the cost of recovery that cannot be covered by the fee (Takaashi, 2003, May 23-24).

The other positive influence is competition among producers with regard to the advancement of recycling technologies (Takaashi, 2003, May 23-24). At the moment, the fee that end-users pay at the time of disposal barely covers the actual cost for recovery such as running the facility, paying for the materials that cannot be recycled and the like. The fee must also cover the cost of transportation from the aggregation points. As the size of the fee is already rather high, it is difficult to raise it further. Improvement of recycling technology is regarded as a measure to cut the costs (Takaashi, 2003, May 23-24).

The establishment and management of recycling plants by producers does not necessarily mean the replacement of existing recycling plants. On the contrary, when highly skilled recyclers already exist in the market, their expertise can be utilised. In fact, prior to the implementation of the legislation, a handful of Japanese manufacturers conducted a number of recovery experiments with some of the existing recyclers (Sony, 1999; Matsushita, 1999). Some of these recyclers became their official recyclers as well. As discussed in Chapter 4, a similar situation is found in the case of car manufacturers in Sweden.

However, making the recovery activity economically viable necessitates a certain volume of products. In fact, one of the primary concerns of the Japanese producers prior to the implementation of the legislation was

whether enough products are collected to make their recovery activities economically viable. When the size of the producers differs substantially, the relative burden on the respective producers may result in disadvantages to small and medium-sized producers. Also, the possibility for importers to communicate with the recyclers would be limited when compared to domestic manufacturers.[180] Thus, having individual producers running their own recycling plants would not always be a viable solution.

Another form of *individual physical responsibility* would be for the individual producers to make direct contracts with the recyclers to recycle their own products, as found in the case of ICT equipment in Switzerland and part of EEE in the Netherlands and Japan. It was also the practice for some car manufacturers in Sweden (Chapter 4). As seen in the example in the Netherlands, it is possible for recyclers and producers to communicate intensively in the process of developing a contract. Having proto-types as well as rejected products recycled with close communication with a recycler would give producers excellent opportunities to examine the new models from the angles of reusability, ease of dismantling, recyclability of the materials, value of recycled materials and the like.[181]

Implementation of physical responsibility in a collective manner has the advantage of making recovery more economically viable, especially when the flow of products from individual producers is small. It also has the advantage of covering all the products, including historical and orphaned products. However, when only one collective body exists in a country and it makes contracts with only one or a limited number of recyclers, the rest of the recyclers may go out of business. On one hand, if the collective body is committed to strive for higher recovery quality, its involvement contributes

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[180] For example, an interview with a Swedish car importer selling cars produced by some Japanese manufacturers revealed that despite their intention of being an environmentally conscious company, they do not wish to put their efforts in interacting with recyclers. As a solution, the Swedish car importer has started to purchase a recycling insurance to guarantee the recycling of cars they currently sell, as discussed at the end of sub-section "Financial mechanism" of this section. A counter interview with the Japanese manufacturer confirmed that they do not get information concerning recyclability of their cars from their agent in Sweden (Tojo, 2001b). This is in contrast with the interaction the domestic car manufacturers in both countries have with domestic recyclers, as discussed in Chapter 4.

[181] In this sense, the author found it a little strange that the Swedish EEE manufacturer that has a refurbishment plant for rejected products (discussed in Section 4.2.2) mentioned that they had not considered acquainting their designers with the information available from the refurbishment plant.

to the enhancement of the level of the overall recycling industry (see Section 5.2.3). Conversely, when only one or few recyclers exist in the market, it creates a monopolistic situation, which would hinder the technological development of the recycling industry in the long run. As found in the Swiss system for batteries, having only a limited number of recyclers makes recycling more expensive.

Sorting at the recycling plant is technically feasible, but it would require extra manpower, thus making it more expensive (Zwart, 2003, April 11). However, when the products contain components that have different environmental properties, sorting of these components prior to recycling would be a preferable option from an environmental point of view. As found in Chapter 4, the producers would wish to see the difference in the invoice they receive as well. The usefulness of sorting could be limited when the producers are small importers who have little market share in the country, and the recycling fee in proportion to the price of the product is limited.

As mentioned earlier, under the Japanese programme for large home appliances, the manifest system allows the manufacturers to keep records of the brand and models treated in the respective recycling plants. This would make it possible to calculate the exact recycling cost for individual products (Takahashi, 2002). In the future it may be possible to establish a system where the information related to design for end-of-life, for instance material properties and recyclability of all the new products are registered and transferred to the recycling plants. Battery producers devised a method to distinguish mercury-free batteries from the rest. Likewise, EEE manufacturers may be able to develop a standardised system to identify the products that contain/do not contain certain types of materials. It could be enhanced to a system where merely by checking the model of products, costs for recovery could be calculated. This may be one way of having a collective physical system while also having an individual financial system.

Finding application for some of the recycled materials such as glass and plastics are problems identified in all the three programmes for EEE. The limitation in providing constant supply of certain recycled materials is one of the reasons identified hindering the development of the markets for the recycled materials. As found in the case of cars in Sweden and packaging in Norway, PROs could play a role in cultivating the demand for recycled materials (Kim, 2002; Lee, 2002). Moreover, the implementation of EPR

programmes could facilitate constant supply of higher quality recycled materials (Peck, 2003).

Financial responsibility

In the two programmes for batteries, all the physical management and information management that is conducted by the respective PROs are financed by advance disposal fees. The fees are visible to consumers in Switzerland and can be visible or invisible in the Netherlands. In both of the programmes, the size of the fee is not differentiated between brands, nor is it differentiated depending on the property of the batteries, with the exception of button cells (*collective financial responsibility*). The unit fee is determined based on the weight of the battery in question. Under the Swiss programme for batteries it is the law that determines the size of the fee. The fee is managed as a pension (pay-as-you-go) system. An exception is Battrex in the Netherlands, who collect batteries separately (*individual physical and financial responsibility*).

Visible, flat, advance disposal fees finance the Dutch programme for white and brown goods and most of the Swiss programme for EEE implemented by the respective PROs. The size of the fee is differentiated between the product categories but not between brands, nor between the properties of the products (*collective financial responsibility*). Cross financing between different types of products are found. The fee is managed as a pension system.

On the other hand, the Dutch programme for ICT and office equipment previously had a system where individual producers paid in proportion to the weight of the products currently recycled. Although the fee did not necessarily reflect the degree of design for end-of-life, the producers did pay for the recovery of their own products, and the system had an element of *individual financial responsibility*. The programme has now introduced a new system, where individual producers pay in proportion to the weight of products they currently put on the market. The fee has been invisible to consumers, and is collected from individual producers to cover the actual cost of recovery, thus no reserve has been made.

Some of the producers of ICT and office equipment in Switzerland who handle collection on their own and have direct contracts with recyclers, pay the same advance disposal fee as the rest of the producers of ICT and office equipment in Switzerland. However, instead of transferring the fee to the common account, they keep the fee in their own account and pay for

recovery from their account. The fee in the account can play the role of a guarantee while the actual recovery cost would depend on the contracts that the respective producers make directly with the recyclers (*individual financial responsibility*). For their products handled together with the products manufactured by other producers, they pay to the common system in proportion to the quantity of their product. The latter system is similar to the Dutch programme for ICT and office equipment as it was until 2003. In the case of Switzerland, a periodical sampling is used to determine the proportion. In the Dutch programme, all the products coming to the plant were weighed. In the Swiss system, the account within the company, audited periodically, serves as a guarantee. There was no guarantee the Dutch system.

The Japanese EPR programme for four large appliances has an end-user pays system. *Individual producers* determine the size of the fee and thus it also has an element of *individual financial responsibility*.

Apart from the Dutch and part of Swiss programme for ICT and office equipment, none of the systems whose physical operation is managed collectively had an individual element in their financial mechanism. The simplicity and low cost are two of the assets of a collective financial system that a number of the interviewees pointed out. Further, as the system does not make a distinction between brands, it covers both orphaned and historical products.

However, the system has the drawback of not being able to reward the producers of the products whose environmental impacts surrounding end-of-life management is lower than their competitors. In fact, there was a strong conviction among the people that run and/or support a collective system that EPR programme does not promote design change (Veerman, 2003, April 9; Bornand, 2003, June 9; Vonkeman, 2003, April 8; Hediger, 2003; Huizinga, 2003, April 11). The funds in the collective systems are managed as pension systems, and some of the systems, such as the Dutch programme for white and brown goods and for batteries experienced an accumulation of a large reserve. Moreover, when there is only one collective body for a certain product group in the country, the body's monopolistic behaviour becomes a concern. As discussed in Section 5.2.1, it often makes it difficult for individual firms to establish an alternative system and serves as a significant market entry barrier. Additionally, claims that a collective solution is less expensive than an individual solution may not always be well grounded, especially when there is only one solution in a country. For

example, with the emergence of an alternative solution, the industry association for ICT equipment in Norway cut the proposed budget of implementing an EPR programme by 90% (Lohre, 2003, June 11).

Individual financial responsibility is perceived to have the advantage of providing incentives to the producers to strive for design change by differentiating the recovery fee depending on the actual recovery cost of the respective products. It also encourages manufacturers to find the most cost-efficient solutions to collect and recover their end-of-life products. However, complexity of the products in terms of structure and material use, durability and uncertainty regarding the future recovery costs and its technology, complexity of managing the fund, non-coverage of orphaned products, lack of future guarantees, minute differences in the "greenness of the products" and the relatively small share of recovery cost within the entire cost covered by the fee are some of common challenges often mentioned as a hindrance to its implementation.

It should be noted that in the study of the implementation of five EPR programmes, different types of financial mechanisms, which have the element of individual financial responsibility, are identified. The financial mechanism of the respective fee systems varies in terms of who initially pays for recovery, how the recovery cost is determined, how it is financed, the types of physical implementation mechanism they have, and the like. Among them, the author seeks to ascertain how the challenges mentioned above are dealt within three programmes as examples: the Dutch programme for ICT and office equipment until 2002, part of the Swiss programme for ICT and office equipment, and the Japanese programme for large home appliances. Additionally, the author also tried to identify other advantages or disadvantages of the respective systems.

In the Dutch programme for ICT and office equipment, until 2002 the producers were paying the recovery cost based on the weight of the products currently coming back. Making it weight-based made the calculation of the recovery cost simple and clear. Payment for products currently coming back makes it unnecessary to consider any future uncertainties. Further, there was no fund building. However, orphaned products and products of free-riders turned out to be much more a serious problem than the producers had originally thought. Having the existing actors pay in proportion to the discarded waste/new products put on the market was the solution chosen, along with a vigorous effort to identify free-riders and compel them participate in the system. It was unnecessary to keep

a guarantee, as the existing members participating in the system finances the recovery cost of products currently coming back. However, the system faced challenges such as the unpredictability of recovery costs and an unfair division of responsibility between producers that had a large market share in the past and those who have a large market share now. Moreover, the weight of the products does not necessarily represent the environmental profile of the product.[182] The fact that the recovery cost constitutes only half of the total cost makes the producers reluctant to reflect "greenness" of the products on the size of the fee.

Some participants of the Swiss programme for ICT and office equipment have been keeping the fees collected from consumers in their own accounts. They handle part of their products on their own and the remainder under the collective system. With regard to the products the respective producers handle themselves, negotiations are made directly with recyclers. It is most likely that the degree of design for end-of-life is reflected in the recovery cost. As the fee currently collected is used for the products currently recycled, future uncertainty does not have to be considered. Individual producers have their own account, and the incoming fee is used to finance the current recovery cost. Thus, management of the fund is not complex. Difference in the design for end-of-life between the product produced by the account holder and his/her competitors can be looked at by how much more does he/she have to add to the account to finance recovery or how much surplus remains in the account. Overall, this system contains elements that provide signals to the producers of the degree of end-of-life management of their products, while still being rather simple. Although the fee collected is not linked to the recovery of the product with which the fee is paid, the fact that the producers can grasp the recovery costs would help producers make a stronger linkage between upstream and downstream. The costs for orphaned products are covered by the collective system. The participants who keep their own account would contribute by paying in proportion to the quantity of products found in the collective system in their periodical sampling. The accumulated reserves in the account, which cannot be used for other purposes, serve as the guarantee.

Under the Japanese programme for large home appliances, producers announce the recovery fee for products that end-users may wish to discard.

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[182] As the product group was limited to ICT and office equipment and a distinction between computers, mobile phones and copying machines was made, the weight-base fee had an element of differentiation, reflecting the actual recycling costs.

All the prominent producers announced identical fees, which are not calculated for different product models. However, just as with the Swiss system, individual producers set the collected fee aside and these producers pay for recovery.[183] Together with the actual management of recycling plants, this helps to establish a good communication channel between the upstream and downstream portions of the product's life cycle. The use of the end-user pays systems eliminates the problem of uncertainty caused by the durability of the products and the coverage of orphaned products and products of free-riders. However, end-user pays systems risk inviting the illegal dumping/discarding of the used products in municipal waste.

Table 5-12 summarises the characteristics of the three systems where producers bear individual financial responsibility and a system incorporating collective financial responsibility. For the latter, the Dutch programme for white and brown goods is used as an example.

It should be noted that even when the actual recovery cost corresponds with the amount of money paid by producers, it might not be reflected in the fee paid by the consumers. This is especially the case when fixed visible disposal fees are determined, either by a PRO, as found in the case of ICT equipment in Switzerland or by producers themselves (large home appliances in Japan). As discussed earlier, in the case of the latter, it may not be a problem at present, due to the relatively low fee as compared to the actual recycling costs.

In all three systems with individual financial responsibility examined here, the fees are designed to cover the cost for current recovery. It should be noted that in some of the EPR programmes incorporating individual financial responsibility, such as for cars in Sweden and Japan, the recovery cost paid by the consumers upon the purchase of a new product is saved for the future recovery fee of the product purchased (See Section 4.1.2).[184] The

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[183] The author does not have information on whether and how the respective producers calculate the recovery costs of individual products.

[184] In the Swedish system, the recovery cost for the new products is integrated in the price of the new products and thus it is invisible to consumers. The recovery cost collected from the consumers could be managed by the individual producers in a separate account, or could be managed by a third party. Individual producers can decide on the size of the fee, which should be approved by the tax authority. In reality, with the exception of two manufacturers, the producers use the calculation method recommended by BIL (Swedish Car Manufacturers and Whole sellers Organisation). In the case of Japan, individual

key feature of the system is the linkage between the recovery fee and the recyclability of the respective product models. Such approaches are perceived to facilitate design change. Some of the concerns raised on these systems include the non-coverage of historical products, complexity of managing the fund in the case when a common fund is established, lack of guarantee when individual producers set aside the future recovery costs and difficulties in calculating future recovery costs. Regarding the historical products, the Swedish EPR programme for cars has an advance disposal fee system running in parallel for the old cars, while in Japan the recovery fee will be charged for the old cars when a mandatory annual checking is conducted. Just as with the Swiss and Japanese programme for EEE examined above, the difference between the actual recovery cost and the recovery fee will be borne by the producers in both of the programmes for cars. A computer manufacturer in Sweden that utilises an alternative system (see Footnote 178) also set aside some money for each new product sold for future recycling within the company (Albers, 2004, August 19-20).

Use of insurance as an individual financial mechanism for EPR programmes for durable products has been offered as an alternative in Sweden. So far some of the car importers and manufacturers of woodcutting machines have utilised this system, and its application to other products has been discussed (See footnote 180). Among other things, use of insurance, will eliminate the problems of orphaned products. However, considering all the variables (future recycling costs, hazardous substances in the product, products' life time, the reinsurance costs, the estimated capital yield) it is likely to be difficult to differentiate premium costs depending on the environmental characteristics of the products, as has been advocated. Moreover, the existence of the third party in the middle may hinder the communication between producers and recyclers (Tojo, 2001b).

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producers announce the recovery fee, which is put on top of the new products as visible fees. The collected recovery fee will be pooled in a public fund.

Table 5-12: Summary of the characteristics of three systems incorporating individual financial responsibility, and one system incorporating collective financial responsibility

	Dutch programme for ICT and office equipment (until 2002)	Swiss programme for ICT and office equipment (separate account)	Japanese programme for large home appliances	Dutch programme for white and brown goods
Who initially pays for recovery?	Individual producers	Partly individual producers, partly PRO	Individual producers	PRO, on behalf of producers
How is it financed?	Invisible fees	Visible advance disposal fees, eual to the size of other producers	End-user pays: recovery fees announced by individual producers	Visible advance disposal fees
Does the recovery cost paid by the individual producers reflect the degree of design for end-of-life?*	Not necessarily, as the payment was based on weight of the products currently recycled (see footnote 182)	When negotiated directly with the recyclers, most likely yes. When taken care of by PRO, no.	Cannot be judged from the information available	No: flat advance disposal fees determined by the PRO.
Do the fees consumers pay reflect the degree of design for end-of-life?*	Unnecessarily: depends on how the producers internalise the cost of recovery	No, as flat advance disposal fees are determined by the PRO.	Not under the current implementa-tion	No: flat advance disposal fees determined by the PRO.
Account management	Separate account not mandated (managed within the company)	Separate account within the company, periodically audited	Separate account not mandated (managed within the company)	Collective accounts managed by the PRO
Coverage of recovery cost (current and/or future)	Current	Current, reserve in the account can be used for future	Current	Current and future
How is the uncertainty of future recovery dealt with?	Unnecessary to consider	Unnecessary to consider	Unnecessary to consider	Reserve and adjustment of the size of the fee

	Dutch programme for ICT and office equipment (until 2002)	Swiss programme for ICT and office equipment (separate account)	Japanese programme for large home appliances	Dutch programme for white and brown goods
Complexity of fund management	No fund	Rather simple, as it is an individual account	None, as there is no fund	Accumulation of high reserve has been a concern
Coverage of orphaned products	Yes: the existing producers share the cost in proportion to the amount of products recycled	Yes: contribution to the collective programme in proportion to the amount of company's products currently collected in the collective system	Yes: end-users	Yes
Future guarantee	Unnecessary, as the existing producers cover the cost for products coming back now	The reserve accumulated in the account may serve as de facto future guarantee	Not necessary: end-user pays	The reserve accumulated in the account may serve as de facto future guarantee
Physical responsibility for recovery (collective or individual)	Collective	Part of the products collective, part of the products individual	Individual	Collective
Other challenges	Unpredictability of the recovery costs, unfair share of burden between producers whose market share changed significantly.		Concern regarding illegal dumping	The system is not perceived to promote design for end-of-life, Monopolistic behaviour

* "The recovery cost paid by the individual producers" refers to the payment the individual producers make directly to the recycling plants or to the fund organised by the collective body. The payment made directly to the recycling plants does not necessarily correspond with the size of the fees set on individual products, especially when the size of the fee set on individual products is not differentiated.

Informative responsibility

When the producers implement both physical and financial responsibility in a collective manner (the two programmes for batteries, the Dutch programme for white and brown goods, the Swiss programme for EEE), information regarding the recovery activities is also gathered and communicated collectively (*collective informative responsibility)*. The PRO for the Dutch programme for ICT and office equipment also reports the activities of its members on their behalf, although the role of the PRO is limited to coordination (*collective informative responsibility*).

Under the Swiss system, SWICO, the PRO for ICT and office equipment, also aggregates the information on the activities of the individual companies and presents it together with the activities of the rest of their participants (who are under the collective system). In the case of the Japanese programme, individual producers announce the result of their activities on their homepage every year. The industry association for large home appliances also announce the aggregated result. As mentioned in Section 5.2.1, the collective body can play an important role in aggregating the information, presenting it, and making it comparable. It may become especially important in the systems where producers implement their responsibility in an individual manner.

5.2.3 Monitoring and enforcement

In all the EPR programmes studied, efforts have been made in areas to: 1) secure quality of collection and recovery activities, 2) monitor and control various types of illegal export and dumping and 3) identify free-riders and make them participate in the system. In all the areas, among the private actors, PROs and industry associations play an important role.

Secure quality of collection and recovery activities

In cases where physical and financial responsibility is implemented collectively, the PROs have been playing instrumental roles in securing the standard of the activities surrounding end-of-life management. The most significant programme in this regard can be the programme for EEE in Switzerland, where the two PROs set a more stringent standard than the government and monitor the activities of recyclers on annual basis by a third party. They also keep track of where the recycled materials go and how they are treated. Additionally, they check how the collection centres are run.

However, it should be noted that leaving the responsibility for monitoring entirely to the collective body raises some concerns. Keeping the cost of recovery low is one of the mandates of the PROs, which may conflict with quality of recovery. In some cases, such as the programme for EEE in the Netherlands, it is the industry that should make a proposal as to how to monitor their activities. Likewise, it is unclear how the recovery activities and the recycled materials sold from the recycling plants are to be monitored under the Japanese system. Even when a third party such as an accounting firm is involved in the verification process, the question still remains unless the issues to be verified are determined by bodies other than the PROs themselves (Zwart, 2003, April 11).

As mentioned, elements of the producers of ICT and office equipment in Switzerland coordinate the collection and recovery activities themselves. One of the conditions these producers must meet is making contracts with the recyclers that receive licenses from the PRO. In principle, the author finds the quality control to be an important role that the PRO can play. A similar approach is taken in the EPR programme for cars in Sweden. The Swedish car association select the recyclers that have sufficient recycling standards, and recommend their members to contract these recyclers (Section 4.2.2).

In the case of the Swiss programme for EEE, the stringent quality control that the PRO has provides an example of a method that is very effective in keeping the quality of recovery high. Additionally, it would make it difficult for recyclers that are licensed by the government but not by the PRO to continue their business. It also limits the choice of producers who may have different levels of ambition with regard to the environment. However, without knowing the capacity of the government to monitor and enforce, it is difficult to judge the appropriateness of the choice of the PRO in restricting the possibility of their members to choose the recyclers.

A challenge illustrated in the 3 programmes for EEE was the necessity of controlling the activities to secure the quality, especially surrounding collection, which may hinder product reuse. Considering the vague line between product reuse and illegal export and dumping, the importance of having a good control over the system cannot be underestimated. It seems that reliable information is scarce concerning the current situation surrounding second-hand market (Tasaki, 2004; Kojima, 2004, April 22; Veerman, 2003, April 9). Investigating further into the current status of

second-hand market may be the first step in identifying the areas of further actions.

Illegal export and dumping

In relation to the quality control, it is essential to monitor and prohibit illegal export, either as second-hand products or components or materials to be recycled. Illegal export can threaten the environment and health of people in the importing counties if recovery activities are performed under lax environmental and health standard, a situation frequently observed. Moreover, it makes it difficult for a domestic recycling industry trying to keep to a high standard to compete. PROs can play a vital role in keeping track of the material flow, even after the materials leave the recycling facilities, as found in Switzerland. In fact, reporting on the recovery activities of some of the developing countries under poor conditions seemed to make the Swiss PRO even more determined to make sure that the products of their members will not be found under such conditions.

An even more difficult task is the control of the discarded products that do not reach the system put up by the producers. For example, in Japan, taking advantage of the reluctance of consumers to pay a rather expensive disposal fee at the end of the product life, some business start to offer take-back service free of charge or at a very low price.[185] Some of them may go to second-hand shops. However, some may be illegally dumped in nature or exported. For consumers, it is difficult to distinguish how their products would be treated. Prior to the introduction of the EPR programme, some individuals ran a shadow business with such export or dumping. It had been feared that these people might start to visit private households to pick up products as they can no longer obtain them from retailers or municipalities (Tojo, 2000). Apart from information campaign, the role of producers and PRO is limited in this area. As mentioned, further information in this area is needed.

Free-riders

The fact that legislation comes into force is certainly not enough to make all the relevant actors participate. Recognising the limitation of the capacity of

[185] During the stay of 2 months between December 2002 and January 2003 in Japan, the author found a notice, advertising the free take-back several times in the mailbox.

the government, reporting by the fellow competitors (producers) is the first step commonly found to identify free-riders. After the identification, the enforcement – making the free-rider participate in the system, unless he/she has its own collection and recovery system – is the role of government, as found in the Dutch EPR programme for EEE.

5.3 The meaning of individual implementation

As well as their comparative analysis, the examination of the five EPR programmes illustrates how the individual and collective implementation of different EPR programmes could be systematically analysed, utilising the established typologies of responsibilities and activities in previous research. Additionally, examination of the five cases, as well as the findings from the study presented in Chapter 4, elucidate the various manners in which individual implementation is practiced in the existing systems.

In this section, the author aims to first analyse situations where the implementation practices found in the case studies presented in this chapter and in Chapter 4 have the elements of individual responsibility. Through the illustration of the variation of implementation in practice, assorted practical approaches to implement individual responsibility are suggested. Based on the analysis, the author seeks to indicate what it requires to implement individual responsibility in reality. The issues of historical products as well as the roles of collective bodies are also discussed in light of individual implementation.

5.3.1 Varying forms of implementing individual responsibility

Individual physical and financial implementation takes various forms, dependent on 1) when and how the discarded products are distinguished from the rest and 2) how the producers involve themselves in the downstream operation.

In the following section, the author presents the various patterns identified in the studies categorised based on the timing of when the products' brand is distinguished.

Distinction when collecting from end-users

In some cases, the brands of the products are distinguished already when the products are collected from/handed in by consumers. Table 5-13 summaries the examples identified in the studies.

Table 5-13: Examples of individual responsibility (1): distinction at end-users

Products (countries)	The manner of collection and distinction	Arrangement with recovery facilities	Manner of payment by consumers
Copying machines (JP)	Taken back by the producer or a service company	Recovered in the company's own facility	Cost internalisation
Computers used in offices (NL,CH, JP), large professional EEE (SW)	Taken back by the producer/contracted party	Producers make direct contracts with recyclers. In the case of CH, recyclers must have license from the PRO.	Internalised in the price of new products (NL, SW), flat visible advance disposal fees (CH), end-user pays (JP)
ICT equipment (SW, NO)	Taken back from offices by an intermediary company Establishment of separate collection points for private households by an intermediary company	An intermediary company takes care of recovery in accordance with the request of the producers	Cost internalisation
Computers from private households (JP)	Sent back to the producer via postal service	Recovered in the company's own facility	Historical products: end-user pays, new products: individual visible advance disposal fee
Cars (SW, sold after 1998)	End-users bring the cars to dismantlers enlisted by the respective producers.	Producers make direct contracts with recyclers. An insurance company have contracts with recyclers for some importers.	Internalised in the price of new products
Large home appliances (JP)	Collection by retailers. End-users purchase recycling tickets issued by the respective brands.	Recovered in the company's own facility, or producers make direct contract with other producers and recyclers	End-user pays
Batteries for business users (NL)	Collected from end-users at specific dealers	The Producer makes direct contracts with a recycler.	Cost internalisation For large quantity, end-user pays

* CH = Switzerland, JP = Japan, NL = the Netherlands, NO = Norway, SW = Sweden

As found, the users of many of the products are businesses, but measures to collect products of specific brands from private households also exist. Some of the products (large professional EEE, copying machines) have high end-values while others do not. The manner in which products of specific brands are collected varies, with different degrees of involvement by end-users. In general, the products are picked up from business-users while the involvement of end-users increases in the case of from private households. The manner of payment by consumers varies, including cost internalisation, flat visible advance disposal fees, individual visible advance disposal fees, and end-user pays. Likewise, individual manufacturers have varying degree of involvement in the organisation of the collection and recovery operation. Some domestic manufacturers establish their own recovery plants, while others have contracts with recyclers. As well as the arrangement with the recovery facilities, collection from end-users is organised either by the producers themselves, or out-sourced to the third party. However, what is common is that all the producers have control over the management of their products.

Distinction at intermediary collection points

The products can be also sorted by brand once they are collected from consumers and aggregated at intermediary collection points. Intermediary collection points include retailers, regional aggregation stations, municipal collection points, collection facilities of actors contracted by producers and the like. Examples identified in the studies are summarised in Table 5-14

Despite the rather negative perception of some of the interviewees that run collective systems, sorting at the intermediary collection points has been operated in various ways. One solution is the establishment of separate collection points by a group of companies who wish to have a separate system, as found in the case of ICT equipment manufacturers in Sweden and Norway and manufacturers of large home appliances in Japan. This enables the companies to enjoy an economy of scale with regard to transport and management of collection points, while giving them larger potentials for having control over their own products. Meanwhile, special arrangement can be made with retailers. As found in the case where the brands of discarded products are distinguished when collected from end-users, the degree of involvement of individual producers in organising the collection and recovery operation varies. Often the operation is outsourced to third parties. However, the producers have control over the fate of their products. The manner of payment by consumers differs from one case to another.

Table 5-14: Examples of individual physical and financial responsibility (2): distinction at intermediary collection points

Products (countries)	The manner of distinction	Arrangement with recovery facilities	Manner of payment by consumers
Coffee machines (CH)	Separated from the rest of WEEE by retailers, arranged by the PRO.	Recovered in the company's own facility	Flat visible advance disposal fees
ICT equipment (SW, NO)	Sorting at the separate collection points by an intermediary company upon request	An intermediary company takes care of recovery in accordance with the request of the producers.	Cost internalisation .
Large home appliances (JP)	Retailers, municipalities and designated legal entities bring the discarded products into two regional aggregation stations depending on the brands.	Recovered in the company's own facility or producers make direct contract with other producers and recyclers.	End-user pays

* CH = Switzerland, JP = Japan, NO = Norway, SW = Sweden

Distinction at recovery facilities

A few cases were identified where the brand names of discarded products collected and transported together to recovery facilities are distinguished at the plants, as summarised in Table 5-15.

In the examples given above, the physical management of the products is performed collectively. Namely, at least under the current operation, all the discarded products go through the same recovery process. However, the brand names – and in the case of Japanese manufacturers the models of the products as well – are distinguished prior to the recovery operation. The involvement of the producers in collection and recovery activities decreases, especially in the case of the ICT producers in the Netherlands and Switzerland. However, they have a mechanism of grasping the products that reach the recovery plants.

In the systems presented above, the degree of design for end-of-life has not been reflected in the amount paid by the producers. However, it suggests

the possibility of distinguishing between the brands and models of products at the recycling facilities.

Table 5-15: Examples of individual physical and financial responsibility (3): distinction at recovery facilities

Products (countries)	The manner of distinction	Arrangement with recovery facilities	Manner of payment by consumers
ICT equipment (NL, until the end of 2002)	The brand names and the weight of the respective products were recorded.	PRO makes the overall arrangement. The recycling facility sent an invoice to the respective producers in accordance with the total amount of discarded products recycled.	Cost internalisa-tion
Large home appliances (JP)	The manifest attached to each product distinguishes the brand name and the model of the respective products.	Recovered in the company's own facility or producers make direct contract with other producers and recyclers.	End-user pays
ICT equipment (CH)	Periodic samplings take place to find out the average amount of products taken back manufactured by the respective brands.	PRO makes the overall arrangement. Producers pay in proportion to the amount of their products to the PRO.	Visible flat advance disposal fee

* CH = Switzerland, JP = Japan, NL = the Netherlands

Reflection upon the current practices

As seen, the examination of the current implementation of five EPR programmes indicates that individual physical responsibility could start at various stages of the downstream operation. Factors that affect the timing include: end-value of the products, feasibility and ambition of the producers to establish its own downstream infrastructure, types of end-users, existence of other producers that share the same level of ambition regarding the end-of-life management of their products and the like.

The implementation practices also indicates a variety of potentials for conducting physical operation together, while paying for the cost of end-of-life management of their own products. The distinction can be made at the

recycling facility as well as in previous stages of downstream operation. For example, if a recovery facility can conduct different types of recovery activities, sorting of products by brand and property can be done at the recovery facilities. If the differences in the property of the products, the ambition level of the producers and the like requires the use of different recovery facilities, sorting can be done at intermediate collection points. As found, the distinction can be also made when the products are collected from end-users.

5.3.2 Operational meanings of individual responsibility

Reflecting the analysis presented in the previous section, the author seeks to clarify what individual responsibilities mean in reality, utilising the typology of responsibility proposed by Lindhqvist (1992) – *physical, financial* and *informative* (see Section 1.2.3). As has been argued, the reason for pursuing individual responsibility is to provide producers incentives for upstream changes. The following discussions explore the meaning of individual responsibility from the angle of the provision of such incentives to the producers.

Individual and collective financial responsibility

Producers pay for the end-of-life management of their products when they take care of their products on their own and finance the operation within the internal budget, as found in the case of copying machines and computers in Japan, for instance. It can also take the form of paying the recovery costs of their products to the party who takes care of the discarded products on their behalf, as seen in the programmes for cars and large professional EEE in Sweden and part of ICT equipment in Switzerland.

Ultimately, the cost for end-of-life management is borne by consumers. In some cases, it is invisible – for example cars in Sweden – while in others, it is paid in the form of advance disposal fees, as is the case with part of ICT equipment in Switzerland. In the latter example, the size of the advance disposal fees is at present the same regardless of brands. The accumulated fees are used for the recovery of products currently taken back. In this sense, there is no correspondence between the fee a consumer pays and the actual recycling cost of the product. However, individual producers pay for the actual recycling costs.

Even when the recovery cost is internalised and used for future recycling, a certain amount should be set aside as guarantee, as practiced in the programme for cars in Sweden. Due to the longevity of the products, it is questionable whether the actual recycling costs in the future and the amount set aside correspond with each other. Compensation to the consumers when the actual recycling cost is lower than the amount charged to consumers is a formidable task. Likewise, regardless of the visibility of the fee it is next to impossible to recharge the consumers for recovery fee even when the actual recycling cost is higher than what was charged to them.

It is convenient when the consumers pay differentiated fees (visible or invisible) that reflect the degree of design for end-of-life. An example can be found in the fee system for packaging waste in Germany. DSD (Duales System Deutschland), the organiser of the system has set up the fee system that reflects the type of materials, weight and number of items used in packaging (DSD, 2001, p.15). However, in the case of durable, complex products, it is difficult to actualise the correspondence between the end-of-life management cost charged to consumers and actual end-of-life management costs regardless of the visibility. The longevity of the products makes it difficult to predict the development of recycling technology, markets for recycled materials, and the like. The number of components and materials used within one product makes the prediction even more difficult.

However, what matters most in terms of promotion of upstream changes is how producers pay for end-of-life management. In this regard, despite the discrepancy between what consumers pay and the actual recycling costs, the fact that the producers pay for the actual recycling cost of their products instead of a common fee regardless of the brand can be considered as the best solution available.

The author regards that a *producer* bears an *individual financial responsibility* when *he/she initially pays* for the end-of-life management of *his/her own products*. When a group of producers pay for the end-of-life management of their products regardless of brands, their *financial responsibility* is *collective*.

Individual and collective physical responsibility

If *individual physical responsibility* is to mean the physical handling of the discarded products that enables a producer to bear *individual financial responsibility*, how can such responsibility be implemented?

Individual physical responsibility and *collective physical responsibility* can be distinguished from two angles. One is the *distinction of* the products from the rest of the products of similar kind and the other is the degree of *producers' control* over the fate of their discarded products.

With regard to the first item, the distinction of the products of a specific brand can take various forms. For example, the products can be physically separated from the rest of the discarded products, as found in the case of coffee machines in Switzerland. In some cases, the products of different brands are located and handled together, although the brands are distinguished from each other. An example is the handling of large home appliances in Japan.

What aspects of the products should be distinguished in order for a producer to pay for the actual recycling cost is dependent on how the physical handling of the product takes place. At the minimum, the *brand* of the products should be distinguished. When the products are physically handled together, distinction of the *properties* of the products becomes necessary. What property should be distinguished varies, depending on the rest of the physical operation. Reflecting upon the rationale of individual responsibility, it would be desirable when the properties relating to the design for end-of-life, for instance use of materials and methods of disassembly, are distinguished. Considering the global destinations of the products and the practical difficulties in establishing a comprehensive end-of-life infrastructure worldwide, it would be useful when the products carry with them the information on these properties.

Concerning the second item (producers' control over the fate of their products), the producers have a fair degree of control when they themselves are engaged in the recovery activities (copying machines, computers and large home appliances in Japan). However, in order to have control over their products, producers are not necessarily involved in the actual physical management of their products after use. Just as with any other business operation, the producers may outsource their physical responsibility to, for example, recyclers (cars and large professional EEE in Sweden), and transport companies (large home appliances in Japan) and the like. Moreover, the arrangement with these actors can be also outsourced and performed by entrepreneurs (ICT equipment in Sweden and Norway) or collective bodies (coffee machines in Switzerland).

Even when a product is physically separated, there are cases where producers do not have control over their products. One example is the separation of products for reuse organised by actors who wish to sell the products on the second-hand market.

From the discussion above, the author considers that a producer bears an *individual physical responsibility* when 1) the *distinction* of the products are made at minimum by *brand* and 2) the producer has the *control over the fate of their discarded products* with some degree of involvement in the organisation of the downstream operation. When the products are physically handled together, the distinction of the *properties* of the products, including their features on end-of-life management, become necessary. A *collective physical responsibility* is taken when 1) products of similar kind are physically handled together regardless of the brand and 2) the handling is rest in the hands of a third party, such as PRO.

Individual and collective informative responsibility

The distinction of the brands and the properties of the products require information from the producers. Allocation of informative responsibility depends on *who is in the best position to collect and provide the information* that should be provided.

Despite the difficulties they may face in obtaining information from upstream, producers are still in the best position to aggregate information of their products. In fact, it is in principle their obligation to know the properties of their products. In this regard, producers have *individual informative responsibility* with regard to the collection and provision of information concerning their *products* and *product systems,* such as the location of hazardous substances, types of materials used, the routes through which the components and materials reach their production sites and the like. They are to have the ultimate responsibility for the quality of the information they provide. Just as individual physical responsibility, producers can co-operate in the aggregation and provision of information, as found in the case of car manufacturers that aggregate dismantling manual.

Meanwhile, various information, such as the operation of an EPR programme, location of collection points, the results of the programme and the like, can be useful when aggregated in a coordinated manner. While producers have such information, they should co-operate in providing such information. A third party, such as a PRO, an industry association and the

like can carry out the aggregation and provision of such information (*collective informative responsibility*).

5.3.3 Implications to current and future implementation

How can the current and future implementation of an EPR programme be looked upon in light of the clarified meaning of individual responsibilities?

Individual implementation should be considered first

In light of a variety of approaches suggested in the previous section, the envisioned EPR programme should allow producers to pursue individual implementation. As discussed, individual implementation does not mean separate physical operation of downstream infrastructure. Various intermediary actors – entrepreneurs, transport companies and collective bodies in existing systems – can carry out the physical operation on behalf of a group of producers. However, possibilities should exist for individual producers to distinguish their products from the rest. The current implementation practice suggests that it is feasible to operationalise the individual physical and financial responsibility and from various points of the downstream operation.

In addition to what has been identified in the studies, producers have started to explore various possibilities. For example, in response to the EU WEEE Directive, a group of EEE producers has been seeking for a solution to establish a European-wide recycling network based on individual responsibility (ENDS, 2002, December 16; Sony Europe, 2003; Electrolux, 2004; Vanderstraesten, 2004, April 22). They have been among the strong advocate of individual responsibility during the development of the WEEE Directive (ENDS, 2000, April 20; ENDS, 2001, June 14).

As long as a discarded product carries with it information regarding its properties, various types of distinction can be made. When producers wish to distinguish products, a technological solution for distinction often exists. This is exemplified in the development of a device that has enabled the distinction between mercury-free batteries and mercury-containing batteries. As a way of carrying the information related to end-of-life management, EEE manufacturers in Finland and Japan respectively started to experiment with the feasibility of using information system that utilised magnetic tags (Kirkkomäki, 2004, March 26; Takada, 2004). The experiment in Japan indicated the increase in the recycling rate by 8%, due to the availability of

information about the materials used in various parts of EEE (Takada, 2004). In fact, it is not necessarily crucial to have an additional carrier of information. As has been practiced by the producers, marking on components may suffice the need. As discussed, reflecting upon the global market of the products, the marking of materials should be continued regardless of the development of other types of information carrying and receiving technologies within one country.

Historical products and individual responsibility

EPR programmes examined in this thesis cover durable, complex products. There still exist a number of products in the market that were manufactured and sold before the legislation was introduced. Even when they become responsible for the end-of-life management of these historical products, the producers cannot modify the properties of these so-called historical products, including their end-of-life features. Thus, allocating *individual financial responsibility* to the producers is limited from the viewpoint of design change. The efforts in this sense should be made on environmentally effective and economic efficient collection and recovery. Historical products can be financed in a manner suitable for the respective society.

The physical involvement of the producers would provide them with learning opportunities with regard to design for end-of-life. Often a new idea on design is not developed theoretically but from actual practices and observation. As discussed in Chapter 4, physical involvement of producers enhances the communication between the upstream and the downstream. An early indication of upcoming EPR legislation is deemed helpful in order to enhance the interaction between the upstream and the downstream and provide the producers with motivation to incorporate the consideration of end-of-life management in their design strategies as soon as possible.

The roles of collective bodies in light of individual implementation

There are a number of important roles that collective bodies, such as PROs and industry associations, have been playing/have the potential to play. One of the most significant roles found in some of the existing programmes such as cars in Sweden and EEE in Switzerland, is securing the quality of collection and recovery activities. It would be practically very difficult for individual producers, especially when they are importers, to examine the skill of the recyclers and the environmental and health standard the respective

recyclers adhere to. Another important role found in a number of systems is the collection and provision of information about the system as well as status of implementation to various actors, including governments, consumers and producers themselves. Their work on the exploration and establishment of collection points that are convenient for end-users have also leads to the increased collection of used products, as observed in the programme for batteries in the Netherlands and EEE in Switzerland.[186] The collective bodies have also contributed to the identification of free riders, in co-operation with the government and producers as practiced in the programmes for EEE in the Netherlands.

The main role that has been played by the PROs – fulfilment of producers' responsibility on their behalf – will most likely continue, not least for small and medium-sized producers. However, their collective implementation should not hinder the development of alternative solutions. As mentioned, the collective body can explore ways for individual implementation depending on the wishes of their members. The existence of such examples in Switzerland, as well as the initiatives of an entrepreneur in Sweden and Norway, suggest that diversification in the operation is feasible.

5.4 Essential insights from the study

The examination of five EPR programmes for EEE and batteries from the viewpoint of individual versus collective responsibility combined with the practices of individual producers discussed in the previous chapter, indicates the existence of a variety of implementation mechanisms that incorporate the element of individual responsibility. Utilising the existing practices and typologies of responsibilities found in previous research, the author seeks to systematise the understanding of individual responsibility.

The rationale for pursuing individual responsibility is to provide incentives for producers to strive for enhancing the environmental performance of the total life cycle of their products. In light of this objective, and reflecting the current practices, the meaning of practical individual responsibility can be expressed as follows.

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[186] However, it should be noted that collection from consumers could be enhanced not only by provision of convenience and information, but also by provision of monetary incentives. The success of a number of deposit refund system in achieving high recycling rates serve as evidence (Lindhqvist, 2000; Tojo et al., 2003)

A *producer* bears an *individual financial responsibility* when *he/she initially pays* for the end-of-life management of *his/her own products*. A producer bears an *individual physical responsibility* when 1) the *distinction* of the products are made at minimum by *brand* and 2) the producer has the *control over the fate of their discarded products* with some degree of involvement in the organisation of the downstream operation. When the products are physically handled together, the distinction of the *properties* of the products, including their features on end-of-life management, should be made. Producers bear the *individual informative responsibility* for the aggregation and provision of information concerning the properties of their product and product systems.

The distinction of products does not require the physically separate handling of products. Existing practice suggests that the distinction of products can be made in various stages of the downstream operation. The timing found in the current practice includes the point when the end-user discard the products, at the intermediary collection points and at the recovery facilities. The manner of distinction – actors involved in the distinction, the roles of producers, and the like – also varies. Factors that affect the selection of the form of individual implementation include the end-value of the products, feasibility and ambition of the producers to establish its own downstream infrastructure, types of end-users, existence of other producers that share the same level of ambition regarding the end-of-life management of their products and the like.

From the viewpoint of promoting upstream changes, what matters most is whether or not the producers, not consumers, pay the actual cost of recycling. Even when consumers pay flat fees irrespective of brand, there exists a mechanism for producers to pay for the recycling of their own products. When the fee is visible, differentiated fees that reflect the degree of design for end-of-life would enhance the communication of the end-of-life property of the products to consumers. The experiences of EPR programmes for packaging suggest the possibility of differentiated fees. However, the properties of complex, durable products pose practical difficulties in actualising the correspondence between the size of the fee they pay and the actual recycling costs.

In light of various practical approaches discussed above, individual implementation should be considered first. The producers should be provided with opportunities to explore alternative solutions as when and how they would like to distinguish their products from the rest. In light of global destination of products, it is desirable that products carry with it the

information necessary for distinction of their properties, by way of, among other things, marking on components.

Allocating *individual financial responsibility* to the producers for historical products is limited from the viewpoint of design change. Historical products can be financed in a manner suitable for the respective society. However, the physical involvement of the producers would provide them with learning opportunities with regard to design for end-of-life. An early indication of upcoming EPR legislation is deemed helpful in order to provide the producers with motivation to incorporate consideration on of end-of-life management in their design strategies as soon as possible.

There are a number of important roles that collective bodies, such as PROs and industry associations, have been playing/have potentials to play. These roles include: securing the quality of collection and recovery activities, collection and provision of various information, identification of free riders in co-operation with the government and producers and the like.

CHAPTER

SIX

6. Conclusions

The two studies presented in Chapter 4 and 5 investigated the governmental programmes that incorporate the concept of EPR from a number of angles. These studies were conducted with the intention of contributing to the understanding of EPR programmes designed to promote total life cycle environmental improvement of product systems. The first section of this concluding chapter summarises how the thesis has added to the knowledge in the field of EPR and environmental policy-making in general. Reflections upon the findings of the studies from the angle of the total life cycle environmental improvement of product systems are presented in the second section. The subsequent section provides a few recommendations for policy makers. The thesis concludes with suggestions on a few research areas that could be explored further.

6.1 What did the thesis add?

The author considers that the findings in this thesis add the following knowledge in the development of EPR programmes, and environmental policy in general.

- It provides empirical evidence that the presence of EPR programmes is a tangible factor that promotes upstream changes leading to the total life cycle environmental improvement of product systems. Among the policy instruments, material restriction and reuse and recycling requirements directly address upstream changes. Take-back requirements have been effective in encouraging manufacturers to develop downstream infrastructure, and in incorporating the environmental impacts of the end-of-life management of products in design strategies.
- It also highlights the role of legislation in inducing changes that are preferable from a societal point of view, especially when these changes

are require initial high cost and/or not directly mirrored in the changes of the preference of consumers.

- It demonstrates that manufacturers take various measures to cope with legislation, before the legislation actually comes into force. A degree of certainty of the content of legislation facilitates the manufacturers' taking actions at an earlier stage.
- It provides empirical evidence that supports two of the assumptions underlying EPR programmes. One of the assumptions is that the provision of downstream requirements induces the establishment of feedback mechanisms between the downstream and upstream of the product's life cycle. The other assumption endorsed by this study is the role of mandatory requirements in inducing changes.
- It also provides evidence to endorse the assumption that an EPR programme based on individual responsibility provides more incentives to upstream changes than one based on collective responsibility.
- It elucidates various forms of individual implementation practices in the existing systems and how the assumed administrative difficulties of individual implementation have been overcome in practice.
- It suggests one way of systematising the understanding of individual versus collective responsibilities. Utilising the existing practices and typologies of different types of responsibility, the author proposes that individual physical responsibility requires 1) a distinction of the brands and the properties of the products and 2) a producer control over the fate of the discarded products manufactured/imported by them. Implementation of the individual physical responsibility mentioned above should enable producers to implement individual financial responsibility, which means that producers pay the actual recycling cost of their own products. A producer is responsible for aggregation and provision of the property of his own products and product systems (individual informative responsibility).
- It provides an example of utilising the intervention theory in the evaluation of policies that have not come into force or have a short implementation time, and whose ultimate outcome is difficult to evaluate in the immediate future.

6.2 Reflection upon the studies

Legislation and policy instruments

The first study on the manufacturers of EEE and cars in Japan and Sweden indicated various upstream changes that have been occurring in order to reduce environmental impacts from the end-of-life management of products. It also revealed that the requirements in the EPR legislation in the respective countries, as well as the European Union, most of which had not come into force at the time of the study, have exerted a tangible influence on design strategies. In situations where design for end-of-life had been initiated prior to the emergence of EPR legislation, the legislation has accelerated the process. As indicated by the comment of a Swiss policy maker in the second study, legislation can provide a rather strong signal internationally despite the relative size of the source country.

Among the policy instruments used in the EPR programmes examined in this thesis, it is the mandatory administrative and informative instruments that have been predominantly exerting influence on the undertaking of measures aiming to reduce environmental impacts from the end-of-life management of products. This work has highlighted the effectiveness of goal-based, mandatory administrative instruments, such as material restrictions and recycling rate targets. Mandatory informative instruments addressing manufacturers, for instance information to recyclers, consumers, reporting to the authorities have either had general compliance or the organisations are in the process of preparing for compliance. In contrast, the compliance of mandatory informative instruments addressing retailers, in particular the provision of information to the consumers, has been more varied. The lack of collection targets, the number of actors that are subject to compliance and the type of information that should be provided, are among the factors that may explain the relative difficulties of the enforcement related to retailers. The selected economic instruments used in EPR programmes – advance disposal fee, end-user pays, deposit-refund system – influence consumers' participation.

Importance of upstream changes and the producers' involvement in downstream operation

The importance of the upstream changes cannot be overemphasised, not least when considering the global markets of the products covered by the EPR programmes. As pointed out by some of the manufacturers

interviewed, in many parts of the world the infrastructure for the end-of-life management of products has not yet been developed. The economically valuable parts of the products would most likely be reused, but there is a high risk that the remaining portions would not be taken care of thus posing environmental and health hazards to the final destinations of these products. Prevention at source – reduction of the use of toxic substances, development of products that are easy to upgrade and repair, and/or use of materials that have higher potentials for recycling – should be aimed for as much as possible.

However, the efforts that could be taken upstream face various challenges including technological limitation, costs and the like. It is unrealistic to expect that the various hazardous substances in the products would be eliminated all at once, especially in the case of complex products consisting of a large number of components. Despite the significant effect of mandatory material restrictions, the materials covered by legislation are limited. A number of chemical substances used within products whose effects are unknown are not subject to existing legislation. Moreover, even when the upstream changes have been initiated or accelerated, there still exists a vast majority of the products currently in use that will be discarded, especially those with long life, that have been designed with little, if any, consideration of the environmental impacts from their end-of-life phases. Nonetheless, it is encouraging that voluntary efforts have been made to eliminate hazardous substances from their products with a view to enhance recycling, as found in the case of car and EEE manufacturers in Sweden.

The existence of these historical products, as well as the challenges facing the complete elimination of hazardous substances upstream, is one of the factors that necessitates the development of downstream infrastructure. This will facilitate the reduction of the environmental and health risks from these products and enhance resource efficiency. Another factor reinforced by the study is to make the most of the upstream changes made on new products. For society in general, as well as for manufacturers who put efforts in changing their products, separate collection and recovery of the discarded products that have less hazardous substances and higher possibilities for reuse and recycling is desirable.

The study provided clear empirical evidence that assuming responsibility for the end-of-life management of their products strengthens the link between the upstream and downstream actors. An initial step has been to learn about the issues related to the end-of-life management of their products and to

figure out what changes are needed, including the cost associated with the changes. A handful of interviewees also commented on their consideration on whether and how the upstream changes would provide economic advantages downstream. Had it not been for the responsibilities assigned to the producers, it is unlikely that they would start considering how much it would cost to handle their products at the end of life. In general, the more efforts a manufacturer puts into on the upstream changes related to end-of-life management of their products, the higher their business interests become to establish a system downstream where their efforts provide them with business advantages. Perhaps the necessity of having the business advantage in a tangible manner is even higher in the case of design for end-of-life, as the demand from the market has been perceived to be lower than for other environmental impacts such as energy use and emissions. The number of interviewees that commented on this issue supports this assumption. In order for the producers to receive incentives for continuously striving to reduce environmental impacts of their products from the end-of-life phase and in light of the current lack of market signals, some signal should be provided from the downstream.

Concrete manner of individual implementation

Individual implementation of producer responsibility downstream, an approach widely perceived to have advantages in linking upstream and downstream actors, has been considered to be more difficult to exercise. However, the second study which investigated the implementation of five EPR programmes as well as the manufacturers' undertaking of measures found in the first study, indicates that varying forms of individual responsibility exist. It also suggests that physical management of products can be organised in various ways, just as there exist a multiple ways of transporting new components and products can be organised. A crucial first step for individual implementation is the *distinction of the brands of the products.*

Categorisation of existing implementation practices suggests that distinction of the brands of products can take place at different stages of end-of-life management, and in various manners. With regard to timing, when utilising the existing practices, it can take place at the point of disposal by end-users, at intermediary collection points and/or at the recovery facilities.

One way of having individual implementation is to physically handle the discarded products of a certain brand separately from the rest of the products. This has typically been the practice when individual manufacturers

have established their own recovery facilities. Such practice is often linked to the business strategy of the manufacturer and may not be feasible for all types of products and producers.

However, individual implementation does not require individual producers to establish and manage their own recycling plants. What is required is 1) a distinction of the brands and the properties of the products and 2) a producer control over the fate of the discarded products manufactured/imported by them. With regard to the first, the existing practices have already shown the possibility to identify the brands and distinguish their properties. What is required is to carry information with the product concerning its properties. The method of carrying such information can take various forms. The current practice of information provision, such as marking of materials and location of substances, can be enhanced. Such enhancement of the marking system is of great importance, considering the global markets of the products covered under EPR programmes. Another can be the attachment of an information carrying media to a product. Various technological solutions, including the use of radio frequency identification tags, have been explored, and can be developed further. Just as the battery manufacturers decided to develop a device to make it possible to distinguish between mercury-free and mercury-containing batteries, technological solutions will emerge as long as the manufacturers wish to distinguish their products from the rest.

With regard to the involvement of producers, they should be able to outsource the downstream operations, provided that they have control over the fate of their products. A number of manufacturers may have contracts with the same entrepreneur, and may share the same logistical network. Distinction of the brands and features is a necessary condition that enables *producers* to pay the actual recycling costs of their products (*individual financial responsibility*). If, for instance, producers have to pay based on the weight, the type of materials used in the products and the number of items, dematerialisation, a superior form of waste reduction at source, may be encouraged. It is already happening in the area of packaging.

It is convenient when the consumers pay differentiated fees (visible or invisible) that reflect the degree of design for end-of-life. However, in the case of durable, complex products, regardless of the visibility, it is difficult to actualise the correspondence between the end-of-life management cost charged to consumers and the actual end-of-life management costs. The longevity of the products makes it difficult to predict the development of

recycling technology, markets for recycled materials and the like. The number of components and materials used within one product makes the prediction even more difficult. However, what matters most in terms of promotion of upstream changes is how producers pay for end-of-life management. In this regard, despite the discrepancy between what consumers pay and the actual recycling costs, the fact that the producers pay for the actual recycling cost of their products instead of a common fee regardless of the brand can be considered as the best solution available. From the viewpoint of design change, what is important is how the producers pay, instead of the size of the fee that consumers pay and the manner of payment. Considering the integral role the consumers play in source separation, how to encourage them to bring the end-of-life products to the right paths requires attention.

As discussed in Chapter 5, with regard to historical products, allocating *individual financial responsibility* to the producers is limited from the viewpoint of design change. It also faces the problems of retroactive legislation. The end-of-life management of historical products can be financed in a manner suitable for the respective societies. Nonetheless, the importance of properly manage the historical products should not be forgotten, especially considering that the environmental impacts they exert. Regardless of financial responsibility, the physical involvement of producers would provide them with learning opportunities with regard to design for end-of-life. It enhances the communication between the upstream and the downstream, as discussed in Chapter 4. An early indication of upcoming EPR legislation is deemed helpful in promoting the interaction between the upstream and the downstream.

Total life cycle environmental improvement and individual responsibility

In all the European systems examined in the second study, the substantial flow of discarded products has been handled by a limited number of PROs (producer responsibility organisations). As discussed, there was a strong conviction among the people who are managing the systems, as well as some government officials, that EPR programmes address waste and not product design change. The focus in this case would be to organise an end-of-life management infrastructure for the products they handle that is environmentally sound and economically efficient. As discussed above, the establishment of an end-of-life management structure that effectively separates the products from the rest of the waste stream and recycles them

in an environmentally sound manner is of paramount importance. Meanwhile, as manifested in the widely recognised waste management hierarchy, few would disagree with the necessity of preventing the problem at source as much as possible in order to reduce the environmental impacts from the end-of-life management practices. In the view of the author, the very rationale for the extension of responsibility to the producers is their capability to prevent problems at source. This thesis has already established that manufacturers have indeed started to respond by making upstream changes. However, as some manufacturers interviewed expressed, they fear that their efforts would not be rewarded if their products are not somehow distinguished from other products that have not been designed to reduce environmental impacts from the end-of-life management. The initial steps taken by the producers with the presence of EPR programmes should be continuingly enhanced. In light of viability of individual implementation, approaches based on individual responsibility should be pursued further.

As some interviewees of the second study expressed, some countries do not have many domestic manufacturers. Some empirical findings presented in this study indicate that actual communications between importers and recyclers occurs less frequently when compared to domestic manufacturers and recyclers. In fact, the interviews also revealed that even domestic manufacturers tend to communicate with dismantlers and recyclers existing locally, and regard the geographical distance between the dismantlers and the designers as a hindering factor for upstream changes. Meanwhile, some manufacturers also expressed their desire to establish worldwide take-back networks and/or gain feedback from the downstream in financial terms. The actual willingness would most likely differ depending on the ambitions of the producers, the degree of efforts they put on the end-of-life management, the quantity of products they sell in the respective export markets and the like. However, the possibilities of incorporating elements of individual responsibility should not be disregarded from the beginning.

Concerning the development of downstream infrastructure, the interests of existing actors within the infrastructure could exert substantial influence, as manifested in the EPR programme for cars in Japan. Enhancing the environmental and health quality as well as the efficiency of the existing activities while utilising the existing expertise may not always go hand in hand. Selecting only a few recyclers in the country or regions, as found in the Dutch and Swiss EPR programmes for EEE, may jeopardise the sound development of the recycling industry due to the lack of competition. A possible alternative could be having an industry organisation check and

recommend the appropriate and skilled recyclers, while leaving it to the producers to make contracts with them as found in the Swedish EPR programmes for cars, and part of the Swiss programme for EEE. Apart from the private actors, local governments, who traditionally have been in charge of waste management, have contradictory aspirations concerning the extension of producers' responsibility to the end-of-life management. On one hand, they would like to acquire extra resources for waste management and recycling. Conversely, they would not wish to give away the employment opportunities under their control. The impact of this influence is found in, for example, the Dutch EPR programmes for EEE and batteries, where local governments retained their authority in collecting discarded products from private households.

As reflected by a number of interviewees, until waste management started to become a societal concern and EPR programmes emerged, the interaction between the actors in the upstream and the downstream was very limited. The participation of the upstream actors is still in its infancy and is in transition. What is perceived to be the most economically and politically feasible and environmentally effective option at present may not be the best option in the long run. In this respect, it may be important not to rush with one solution with high investment and be fixed with it. For example, the capacity of recycling plants may accelerate recycling while overlooking the opportunities for component reuse, as found in the dilemma facing incineration plants in many developed countries. While recognising the necessity of considering what is practically possible at present, what is desirable to be achieved in the long term should not be forgotten when developing the road map.

From both studies, it was noticed that in general, the measures in the higher ladder of resource efficiency/waste management hierarchy, such as dematerialisation, product and component reuse, have not been undertaken as much as those in the mid-ladder, for instance design for recycling. The lack of individual downstream infrastructure, the interests of existing actors, the difficulties of setting up legal requirements, competing design priorities and characteristics of products are among the reasons found from the first study. The findings from the second study suggest that individual implementation does not necessarily enhance component reuse. For example, the Japanese manufacturers of large home appliances have mechanisms that allow them to take back their own products, at least in part. However, the current practice concentrates on the recycling of materials. One reason may be the fact that the products currently taken back

are historical products designed without consideration for end-of-life management may be one reason. It could also be because of the competing environmental requirement, which includes, among other things, the rapid development of energy efficiency. It will be interesting to see how things develop in the next 10-15 years. When the development of identification mechanisms continues, the reuse of components may be enhanced as well. Standardisation of components between manufacturers may also take place.

Manufacturers should consider various other priorities, both within environmental issues and outside, when developing their products. The undertaking of upstream measures and the development of downstream infrastructure discussed above could be in conflict with other priorities. The comments of the majority of the manufacturers on the potential dilemma surrounding the competing priorities, as well as the demand from the consumers and policy makers concerning other environmental priorities, seem to suggest that environmental improvement at the end-of-life management phase would not be likely to supersede other environmental priorities. Thus, the parallel undertaking of upstream changes and development of downstream infrastructure can be considered as a positive step forward towards the total life cycle environmental improvement of product systems.

However, as exemplified in the second study, a substantial amount of products that are estimated to be discarded do not enter the EPR systems. As discussed, data surrounding the second-hand market seems to be very scarce. The fine line between the second-hand products and discarded products, longevity of the products and rapid technological development that makes some aspects of new products environmentally superior and the uncertainty surrounding the downstream infrastructure when the products are exported are among the factors that make it difficult to decide what would be optimal from the environmental point of view. The relatively low price of second-hand products also makes it affordable for people with lower incomes to purchase the second-hand products and enjoy their utility. When producers have established their own take-back network that incorporate refurbishment, as found with the manufacturers of copying machines in Japan and of coffee makers in Switzerland, product reuse is, at least in part, conducted by the manufacturers. The situations surrounding these products are easier to grasp. However, it is at present an exception. Concerning the export of second-hand products, establishment of EPR programmes in the importing countries could be a solution. The

professional importers of second-hand products could be regarded as one category of producers.

This thesis concentrates on the EPR programmes addressing the end-of-life management of complex products. However, as has been discussed in the beginning of the thesis, the EPR principle can be applied not only to the end-of-life phase but also to the other phases of the life cycle of product systems. The full potential of the application of the EPR principle is yet to be explored.

6.3 Recommendation for policy makers

The author would wish to recommend the following considerations to be incorporated in the formulation of EPR programmes:

- In light of the importance and the initiation of upstream changes and the existence of various solutions, an EPR programme for new products should be established in such a way that producers seek to implement their responsibility individually in the first place. In the case of EPR programmes for durable products, a special system might be introduced for historical products in the transition period.
- There can be further exploration of the alternative roles of collective bodies such as the enhancement of the quality of recycling, the identification of free-riders, information management, provision of back-up system for small and medium-sized producers and the like.
- In order to secure the quality of recycling activities and eliminate illegal dumping and export while enhancing the sound development of product reuse, the situation surrounding the second-hand market should be explored further.
- While the importance of gaining legitimacy in society when introducing an intervention cannot be underestimated, the enhancement of environmental quality should not be compromised. For instance, consideration of the interests of actors that have been involved in the end-of-life management prior to the implementation of EPR programmes should be accompanied by actual measures to enhance the environmental quality of their activities.

6.4 Suggestions for the future research

As discussed, most of the EPR programmes examined in this thesis are still in their infancy. It may prove useful to follow up on how they develop, especially with regard to the enhancement of the linkage between the upstream changes and the downstream infrastructure. The implication of on-going efforts of developing marking systems, such as utilising the radio frequency identification tag, as well as initiatives of some producers, can be explored further. The existing cases of individual implementation, as identified through the study, should be investigated in depth in order to explore potentials of implementing individual responsibility and make such potentials visible.

The current situation of the second-hand market, including exports, as well as the influence of EPR programmes on the situation and vice versa, requires investigation. The situation surrounding the second-hand market should be considered when developing an EPR programme. In the case of exports, the implication of considering the professional importers of second-hand products as one category of producers can also be explored.

As discussed in the beginning, various changes in the EPR programmes are of an innovative nature. It will be useful to examine the different types of changes and to analyse them from the angle of product innovation.

Current implementation of EPR programmes does not seem to be very effective in inducing the changes that enhance the upper layer of resource efficiency. Policy instruments that facilitate such measures need further investigation.

Going beyond the current application of the EPR principle, it is important to explore how the concept could be utilised in phases of the life cycle of product systems other than end-of-life management, as well as the implication of the application to the total life cycle environmental improvement of products. Among other things, these potentials include taking the information management of what is in the products further. One of the measures undertaken by the majority of the manufacturers interviewed was to gather information from material and component suppliers concerning the materials constituting the respective materials and components. It would be interesting to investigate further into how the information is collected and utilised. The comparison of the perception of the receivers and the provider of the information would facilitate the

collection of what type of information should be prioritised. In this instance, the use of policy instruments that facilitate information provision and collection could also be investigated.

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Abbreviations

AEHA	Association for Electric Home Appliances
BPS	BIL Producentansvar Sverige AB (an organisation in charge of EPR programme for cars with the Swedish car manufacturer and wholesaler association)
CRT	cathode ray tube
EEA	European Environment Agency
EEE	electrical and electronic equipment
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
HFC	hydrofluorocarbon
ICT	information and communication technology
INOBAT	Interesseorganisation Batterieentsogung (the Swiss PRO for batteries)
IT	information technology
JAMA	Japanese Automobile Manufacturers Association
MHW	Ministry of Health and Welfare
MITI	Ministry of International Trade and Industry
METI	Ministry of Economy, Trade and Industry
MOE	Ministry of the Environment
NVMP	Stichting Nederlandse Verwijdering Metalektro Producten (the Dutch PRO for white and brown goods)
NVRD	vereniging voor afval- en reinigingsmanagement (the Dutch solid waste association representing the waste management division of municipalities)
OECD	Organisation for Economic Co-operation and Development
OEM	original equipment manufacturer
PBB	polybrominated biphenyls
PBDE	polybrominated diphenylethers
PET	polyethylene terephthalate
PP	polypropylene
PRO	Producer Responsibility Organisation

PRTR	pollution release and transfer register
RoHS	restriction of hazardous substances
S.EN.S	Stiftung Entsorgung Schweiz (Foundation for Disposal in Switzerland)
SHAR Law	Specified Home Appliance Recycling Law
STIBAT	Stichting Batterijen (the Dutch PRO for batteries)
SWICO	Swiss Association for Information, Communication and Organisational Technology
VROM	Ministry of Housing, Spatial Planning and the Environment
WEEE	waste electrical and electronic equipment

Appendix 1: List of interviewees for the study presented in Chapter 4[187]

EEE manufacturers interviewed in Japan

Manufacturer (main products)	Time & date	Name and position of the interviewee
Fujitsu Limited (ICT equipment, software services, electronic devices)	15:00-17:30, 18-Dec-00	Harada, Yoshiharu. General Manager, Center of Promotion of Environmental Technology, engaged in environmental business Takayama, Haruo. Eco-design Promotion Section, Center of Promotion of Environmental Technology
Hitachi, Limited (ICT equipment, power and industrial systems, electronic devices, household appliances)	10:30-12:00, 11-Jan-01	Yokoyama, Hiroshi. General Manager, Corporate Environmental Policy Office
Matsushita Electric Industrial Corporation, Ltd. (IT equipment, industrial devices, consumer equipment, household appliances)	10:00-13:00, 26-Dec-00	Januki, Nobuo. General Manager, Corporate Environmental Affairs Division Ueno, Takayoshi. Human Environment Development Center
Mitsubishi Electric Corporation (satellites, semi conductors, ICT equipment, household appliances)	10:00-12:00, 18-Dec-00	Takahashi, Tetsuya. Assistant Manager, Strategic Planning, Corporate Environmental Management Planning Department
NEC Corporation (ICT equipment, sofetware, electronic devices)	13:15-15:00, 22-Dec-00	Saita, Masayuki. Environmental Product Manager, Environment Management Division Seki, Toshinori. Environment Management Division

[187] Further information on the company, as well as the concrete setting where the interviews were held, can be found in Tojo (2001a, p.19-26).

Manufacturer (main products)	**Time & date**	**Name and position of the interviewee**
Ricoh Company, Ltd. (Copying machines, ICT systems, photographic equipment)	10:00-12:00, 21-Dec-00	Ohno, Yukihiro. Department Manager, RE Technology Department, Recycling Business Division, Imaging System Business Group Sugiyama, Takao. Assistant Manager, Environment Programme Planning Group, Environmental Sustainability development office, Corporate Environmental Division Nagatsuna, Shinji. Engineer, RE Technology Department, Recycling Business Division, Imaging System Business Group
Sharp Corporation (audio visual equipment, household appliances, ICT equipment, electronic components)	15:00-17:00, 26-Dec-2000	Madono, Hideaki. Department General Manager, Green Products Planning Department, Environmental Protection Group Otsuki, Katsuhiro. Assistant Manager, Green Products Planning Department, Environmental Protection Group Ohta, Kenzo. Assistant Supervisor, Environmental Planning Department, Environmental Protection Group Shirataki, Masaru. Assistant Supervisor, Environmental Planning Department, Environmental Protection Group
Sony Corporation (audio visual and IT equipment, electronic devices)	16:00-17:00, 9-Jan-01	Tada, Hiroyuki, Manager, Planning Office, Corporate Environmental Affairs
Toshiba Corporation (audio vidual, ICT equipment, household appliances, various business equipment)	15:45-17:00, 11-Jan-01	Shimoi, Yasunori. General Manager, Environmental Protection and Recycling Planning Center Ryomoto, Kenichiro. General Manager, Department of the Electrical Home Appliances Recycling Promotion, Corporate Life Electronics Marketing Department

EEE manufacturers interviewed in Sweden

Manufacturer (main products)	Time & date	Name and position of the interviewee
AB Electrolux (powered appliances for kitchen, cleaning and outdoor use)	14:00- 23-Jan-01	Sundström, Henrik. Vice President, Group Environmental Affairs
	15:30-16:15 23-Jan-01	Seres, Stina. Project Manager, Environment and Sustainable Development
Dell Computer AB (IT hardware)	14:30-15:00, 21-Jun-01*	Pripp, Lena. European Environmental Manager, EMEA Environmental Affairs
Ericsson (mobile phones and other communication systems and tools)	8:30-12:30, 23-Jan-01	Trankell, Richard. Environmental Management, PDC Systems, Operational Development and Procurement, Ericsson Radio System AB
	15:30-16:15, 25-Jun-01*	Rydberg, Anders. Environmental Coordinator, Product Development, Ericsson Mobile Communications AB
Siemens-Elema AB (medical equipment)	16:00-17:00, 23 Jan-01	Alkemar, Kjell. CEO, Safety and Environment Manager

* conducted via telephone.

Car manufacturers interviewed in Japan

Manufacturer (main products)	Time & date	Name and position of the interviewee
Fuji Heavy Industries Limited (small and light cars, trains, engines, bus bodies, airplanes)	13:30-16:00, 10-Jan-01	Kimura, Takaaki. Chief, Corporate Environment Promotion Office Kano, Satoshi. General Manager, Material Research Division, Subaru Technology Department Ohtake, Takaaki. Chief, Material Research Division, Subaru Technology Department Yamaashi, Shunji. General Manager, Division of Environment and Safety Technology, Subaru Technology Department
Isuzu Motors Limited (trucks, buses, recreational vehicles, engines)	10:30-11:15, 19-Dec-00	Kasai, Junichi. Manager, Materials Development Section, Vehicle Research and Experiment Department, Engineering Research and Experiment

Manufacturer (main products)	Time & date	Name and position of the interviewee
Mazda Motor Corporation (cars)	10:00-14:00, 27-Dec-00	Kita, Tatsuya. General Manager, Technology and Planning Division, Product Development Department Nakano, Takahiro. Chief, Environment and Safety Planning Office, Technology and Planning Division, Product Development Department
Nissan Motor Corporation, Ltd. (cars, business vehicles and other transportation devices)	13:30-15:00, 11-Jan-01	Kanesaki, Nobukazu. Manger, Government Affairs and Planning Group, Environmental and Safety Engineering Group, Environmental and Safety Engineering Department Himeno, Yoshiharu. Chief, Recycling Promotion Division & Service Promotion Department
Toyota Motor Corporation (cars)	10:00-12:00, 22-Dec-00	Ogasawara, Mikio. Project General Manager, Environmental Affairs Division

Car manufacturers interviewed in Sweden

Manufacturer (main products)	Time & date	Name and position of the interviewee
Saab Automobile AB (premium cars)	13:00-13:45, 31-Jan-01	Swanér, Bo. Director Environment & Public Affairs, Corporate & Products Communications
	13:00-15:30, 31-Jan-01	Halvarsson, Joakim. Project Leader ELV, Safety and Regulatory Affairs, Technical Development Lindberg, Lillemor. Vehicle Integration ECM, Materials Technology, Technical Development
Volvo Car Corporation (passenger cars)	10:00-12:00, 7-Feb-01	Liljenroth, Ulf. Manager Recycling, material and DfE, Complete Vehicle, Environment
	13:00-14:30, 7-Feb-01	Johannesson, Staffan. Technology & Communication, Complete Vehicle, Environment
Volvo Truck Corporation (trucks and total transport solution)	9:00-11:00, 31-Jan-01	Lindkvist, Lars. Environmental Cordinator, Features Complete Vehicle Willkrans, Rolf. Environmental Co-ordinator, Corporate Communications

Appendix 2: List of interviewees for the study presented in Chapter 5

In many cases, after the initial interview, follow-up inquiries were sent to verify the understandings. Among these follow-up communications, only those that led to obtainment of additional information are mentioned in the footnote of the respective tables.

Interviews in Japan

Organisation	Time & setting	Name and position of the interviewee
Keio University	16:00-17:00, 7-Jan-03, personal interview	Hosoda, Eiji. Professor of Economics
Mitsubishi Electric Corporation	22-Apr-03, 23-24-May-03 interview via e-mail*	Takahashi, Tetsuya. Strategic Planning, Corporate Environmental Management Department
NEC Corporation	10:00-11:30, 26-Dec-02, personal interview	Saita, Masayuki. Environmental Product Manager, Environment Management Division Seki, Toshinori. Environment Management Division Takada, Environment Management Division. NEC Corporation

* Takahashi, Tetsuya (Tetsuya.Takahashi@hq.melco.co.jp). (2003, April 22). *Recycling law in Sweden.* (2003, May 23). *About Specified Home Appliance Recycling Law.* (2003, May 24). *About the fee setting in the Specified Home Appliance Recycling Law*. E-mail to Naoko Tojo (naoko.tojo@iiiee.lu.se).

Interviews in the Netherlands

Organisation	Time & setting	Name and position of the interviewee
ICT Milieu (PRO for ICT & office equipment)	14:30-16:00,11- Apr-03, personal interview	Huizinga, Annetje (in charge of environmental issues within the ICT branch organisation)
MIREC (recycler)	10:00-12:00, 11 Apr-03 personal interview	Zwart, Johan. Group Director
NVMP (PRO for white and brown goods)	10:00-12:00, 8-Apr-03, personal interview	Vonkeman, Bert. managing director

Organisation	Time & setting	Name and position of the interviewee
NVRD (solid waste association representing municipalities)	16:00-17:00, 9-Apr-03, personal interview	Goorhuis, Maarten. Senior Sector Manager
Recydur BV (recycler)	14:50-15:45, 28-May-03, telephone interview, follow-up E-mail*	Van Kalkeren, Bart. Director
Raad Nederlandse detailhandel (the Dutch retail organisation)	15:00-16:00. 31-Mar-03, telephone interview	Veenstra, Sjoerd
Roteb (Waste Management Department of the City of Rotterdam).	14:00-17:00, 10-Apr- 03, personal interview	Vershoor, Peter.
STIBAT (PRO for batteries)	14:00-16:00, 8-Apr-03, personal interview	Broers, Sander. Operational manager
VROM (Ministry of Housing, Spatial Planning and the Environment)	10:00-12:30, 9-Apr-03, personal interview, follow-up E-mail**	Veerman, Kees. Deputy Commissioner

* van Kalkeren, Bart (b.kalkeren@recydur.nl). (2003, May 28). *Re: thank you: summary of the interview*. E-mail to Naoko Tojo (naoko.tojo@iiiee.lu.se).
** Veerman, Kees (kees.veerman@minvrom.nl). (2003, June 5). *Re: thank you: summary of the interview and additional questions*. E-mail to Naoko Tojo (naoko.tojo@iiiee.lu.se)

Interviews in Switzerland

Organisation	Time & setting	Name and position of the interviewee
INOBAT (PRO for batteries)	08:45-10:00, 27-Mar-02, personal interview	Jordi, Hanspeter
S.EN.S (Foundation for Disposal in Switzerland)	10:00-12:00, 28-Mar-02, personal interview	Hediger, Robert, CEO
SWICO (Swiss Association for Information, Communication and Organisational Technology)	16:00-18:00, 28 March 2002, personal interview. Follow-up E-mail*	Bornand, Peter. Chairman, Environment Commission
Swiss Agency for the Environment, Forests and Landscape	13:30-15:00, 27-Mar-02, personal interview	Ardiot, Amélie. Waste Management Division

Organisation	**Time & setting**	**Name and position of the interviewee**
Swiss Agency for the Environment, Forests and Landscape	10:30-11:30, 27-Mar-02, personal interview. Follow-up e-mail**	Buser, Hansjörg. Waste Management Division.
Swiss Agency for the Environment, Forests and Landscape	16:00-16:30, 27-Mar-02, personal interview	Frey, Beat. Industrial Waste Section
Swiss Agency for the Environment, Forests and Landscape	10:00-12:00, 12-Aug-02, personal interview	Rizzotti, Natalie. Student Intern
Swiss Agency for the Environment, Forests and Landscape	15:30-16:00, 27-Mar-02, personal interview	Tellenbach, Mathias. Head. Industrial Waste Section

*Bornand, Peter (pbornand@swico.ch). (2003, June 9). *Re: Summary of your interview, additional questions.* E-mail to Naoko Tojo (naoko.tojo@iiiee.lu.se).
** Buser, Hansjörg (Hansjoerg.Buser@buwal.admin.ch). (2003, November 18). *AW: A report on EPR programmes.* E-mail to Naoko Tojo (naoko.tojo@iiiee.lu.se).

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Oksana Mont
Product-service systems: Panacea or myth?
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Philip Peck
Interest in Material Cycle Closure? Exploring evolution of industry's responses to high-grade recycling from an Industrial Ecology perspective
IIIEE Dissertations 2003:2

Zinaida Fadeeva
Exploring cross-sectoral collaboration for sustainable development: A case of tourism
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Virtual Mobility and Pollution Prevention: The emerging role of ICT based communication in organisations and its impact on travel
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Green Concurrent Engineering: A model for DFE Management Programmes
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Kaisu Sammalisto
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e-Learning for the Environment: Improving e-learning as a tool for cleaner production education
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Håkan Rodhe
Preventive Environmental Strategies in Eastern European Industry
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Pia Heidenmark
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Desta Mebratu
Strategy Framework for Sustainable Industrial Development in sub-Saharan Africa
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Peter Arnfalk
Information technology in pollution prevention: Teleconferencing and telework used as tools in the reduction of work related travel
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Thomas Parker
Total Cost Indicators: Operational Performance Indicators for managing environmental efficiency
IIIEE Dissertations 1998:2

Kent Lundgren
Förnyelsebara energibärares nuvarande och framtida konkurrenskraft - föreställningar om konkurrenskraft
IIIEE Dissertations 1998:1

Lars Hansson
The Internalization of External Effects in Swedish Transport Policy: A Comparison Between Road and Rail Traffic
IIIEE Dissertations 1997:2

Mårten Karlsson
Green Concurrent Engineering: Assuring Environmental Performance in Product Development
IIIEE Dissertations 1997:1

Erik Rydén
Car Scrap: Throw it Away or Make it Pay?
IIIEE Dissertations 1995:2
Also available in Swedish: Bilskrot: möjlighet eller miljöhot?
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Naoko
Tojo

Extended Producer Responsibility as a Driver for Design Change – Utopia or Reality

Policies based upon Extended Producer Responsibility (EPR) aim to reduce the environmental impacts of products across their entire life cycle. The intent is to induce design changes in products and thus reduce impacts at source. This, by provision of incentives to producers through an extension of responsibility. Since the early 1990s, a number of countries have incorporated the concept of EPR into policy related to end-of-life management of selected product groups. The incorporation of incentive mechanisms for design change in an EPR programme is, however, perceived to face various challenges, especially for durable, complex products.

This thesis presents two sets of in-depth evaluation studies conducted in search of EPR programmes, which incorporate the theoretically envisioned incentive mechanisms in practice. Based upon firm evidence from the studies, it argues that the presence of mandatory EPR programmes do provide positive impacts for the environmental design strategies of manufacturers. This is especially true when implementation is based upon forms of so called *individual responsibility* where individual producers assume responsibility for the end-of-life management of their own products. Further, this work suggests a range of concrete implementation mechanisms for individual responsibility and highlights the essential components of such approaches.

IIIEE Dissertation 2004:2
The International Institute for
Industrial Environmental Economics
Lund University, Sweden
ISSN 1402-3016
ISBN 91-88902-34-x
ISRN-LUTMDN/THME -04/1012-SE

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