Exploring determinant factors for effective end-of-life vehicle policy: experiences from European end-of-life vehicle systems

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Exploring Determinant Factors for Effective End-of-Life Vehicle Policy

Experiences from European end-of-life vehicle systems

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Abstract

Vehicles, symbolic goods of modern society, cause serious environmental impact in their end-of-life phase owing to present end-of-life treatment practice and abandonment in nature. The enormous volume of vehicle waste, and accompanying environmental impacts, encourage seeking an environmentally effective policy solution to control the problem of end-of-life vehicles. This thesis is an attempt to explore and discuss the determinant factors, which may contribute to the development of effective and efficient end-of-life vehicle policy. Five European countries were studied: the main focus was on legislation, use of various policy instruments in systems, and financial mechanisms. Based on the experiences of the selected cases, the thesis identified several factors that influence the success or failure of the ELV system. These are: the extended producer responsibility; role of authorities; collection, and recycling and recovery targets; proper deregistration policy; sustainable financial mechanisms; cooperation among actors; wise use of regulatory requirements; and importance of monitoring. Discussion on these determinant factors, which are extracted from in-depth research on the selected end-of-life vehicle systems, may provide better understanding of the end-of-life vehicle issues and contribute to a sustainable end-of-life vehicle policy making.

Executive Summary

Mass production and consumption, in part, enhances the development of modern societies. However, one of their final outcomes has been a dramatic increase in the amount of waste. Sustainable waste management is gaining more attention nowadays due to the fact that land available to handle waste is limited and because of the adverse impacts of waste on environment and human health. The life cycle approach and waste management hierarchy are broadly accepted as sustainable measures for waste management. The main focus of sustainable waste management is the prioritisation of waste prevention and minimisation over final disposal.

Vehicles, symbolic goods of modern society, are complex products, which contain many different materials and components and have a relatively long life span. Compared to many other types of products, the recycling rate of cars is higher due to its high metal content. However, the environmental impact of cars, especially from non-recycled parts of vehicles, cannot be underestimated. End-of-life vehicles (ELVs) contain hazardous substances and components such as spent oils, solvents, heavy metals, organic toxics, and ozone depleting substances. Therefore, the improper treatment of these hazardous components at recycling sites and abandoned vehicles in nature causes serious environmental impacts and danger to human health.

There are 8 to 9 million vehicles discarded annually within the European Union alone. This results in around 9 million tonnes of waste created per year. This enormous volume of vehicle waste and the accompanying environmental impacts pushed several countries to set up policies to control the problem of end-of-life vehicles. At the EU level, the EU End-of-Life Vehicles Directive came into force in 2001 and requires member states to transpose it to their national law. The directive asks for limitation of the use of hazardous substances in new vehicles, sets certain recycling and recovery targets, and demands for control of recycling facilities in order to reduce the environmental impact from end-of-life vehicles (ELV).

This thesis is an attempt to develop a clear understanding of the issues related to end-of-life vehicles, and to explore the determinant factors for effective and efficient ELV policy. Several cases of ELV policies in European countries were studied in depth. In these case studies, more focus has been given to legislation, use of various policy instruments in systems, and financial mechanisms. Based on extensive study of various literature sources on sustainable waste policy, relevant policy instruments, and policy criteria, the author developed an analytical framework to examine selected ELV systems on individual base. In-depth case studies have been conducted through secondary data collection from various sources such as websites, books, journals, and valuable unpublished reports from various interviewees and correspondents. By emails and telephone communications, primary data collection was also extensively followed in order to clarify unclear information, to gain inside stories, overall, and to achieve in-depth research.

The main findings from cases studies are:

- Sweden has been dealing with problems related to ELV since 1975. Underlining the first owners pay principle, a car-scrapping fee and a premium system are applied in order to prevent abandoned vehicles in nature and to finance recycling costs. In 1997 when the producer responsibility scheme was introduced, it accelerated the improvement of the system under producer supervision. The physical and financial responsibility that producers bear, stimulate waste prevention at the design phase. This responsibility has also led to the creation of producers' networks that have enhanced

recycling performance, and contributed to increased rates of recycling and recovery. This also led to the improvement of recycling facilities;

- In the Netherlands, the private body, Auto Recycling Nederland BV, is managing a recycling fund. The sources of the fund are the advance waste disposal fees collected from first vehicle owners. This financial mechanism is based on the pay-as-you-go principle. High recycling premiums are paid to different contracted recycling operators in order to ensure high-quality ELV recycling;

- Germany established a system to deal with end-of-life vehicles based on voluntary agreements between car producers and the Government. Additionally, it supplemented these agreements with the End-of-Life Vehicle Ordinance of 1997. The producer responsibility is limited, so the last vehicle owner also bears responsibility for financing this ELV system. Together with weak enforcement of deregistration policy and its following documentation requirement for the last owners at the local governmental level, the last owner pays system enhances the generation of abandoned vehicles in nature. On the other hand, the producer responsibility and the threat of expansion of responsibility stimulate car producers to improve recyclability and to participate in the dismantling sector;

- In France, several industrial sectors and the Government signed the Accord Cadre on End-of-Life Vehicles, the master agreement. As an initiative action to organize the system, manager-distributor companies were established in order to organize a proper recycling chain for end-of-life vehicle treatment. Still, improper treatment such as direct shredding of untreated vehicles is widely occurring in end-of-life vehicle recycling chains. Lack of proper laws and supportive governmental policy create such difficulties; and

- In the UK, the ACORD agreement was made among various recycling actors and car producers in 1997. Self-commitments for the better performance by each respective actor are the outcome of the agreement. However, there is no arrangement for promoting a proper recycling chain for ELVs. At present, a wide range of improper treatment practices continues. For example, a direct shredding process with untreated vehicles is practiced. Enhanced by the absence of proper laws, and wider room for exempting poor recycling facilities, the last owner pays system causes serious environmental problems as an increased number of vehicles are abandoned in nature.

From the experiences of the selected cases, car producers and authorities are identified as the most important actors. Car producers have an essential role not only in terms of improvement of waste prevention, but also in organising the recycling network through their allocated physical and financial responsibility. Besides the conventional producer responsibility, which often is limited to production and user phases of products, the producer responsibility has been extended to the end-of-life phase, which is defined as the Extended Producer Responsibility (EPR). Different level of applications of EPR examined in selected ELV systems proves that EPR can enhance the progress of ELV system in an environmental effective and efficient manner.

In addition, authorities are important actors in terms of designing and enforcing basic policies to facilitate the system. Commitment of authorities, presence of legislation and the level of enforcement affect the general success of the system.

In addition to EPR and the role of authorities, several other factors are identified. These include:

- Target setting for collection, and recycling and recovery. The author suggests establishing the definition of collection, collection rate and target, which leads to collection of data, which is essential for gaining a clear overview of the ELV flow. A separate use of recycling and recovery targets is preferable for reaching an optimal level of recycling. High target setting seems to stimulate relevant actors to promote cooperation and further to stimulate innovation;

- The importance of proper deregistration policy is discussed. The use of a certificate of destruction, together with scrapping authorisation significantly improve the control of ELV flows ending up to proper recycling chain; and

- Sustainable financial mechanisms are extensively discussed. Based on experiences of the selected systems, 'free take-back system' (car producers pay) seems to be the most preferable option. This leads the producers' interaction with dismantlers, also stimulates two-way effort (from dismantlers and producers) for the reduction of recycling costs, and it may thus reach higher economic efficiency of ELV systems. In contrast, a last owner pays system is defined as the least favourable option for sustainable financial mechanism for ELV system.

Other factors such as cooperation among actors and importance of monitoring system, and benefits from the use of certain requirements, are also discussed. Detailed discussion on these determinant factors, which are extracted from case studies, will provide better understanding of the ELV issues and contribute to a sustainable ELV policy.

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1. Introduction

1.1 Background

Due to the massively growing amount of waste, following the economic growth of modern society, waste policies have adopted the concept of 'Sustainability'. Sustainable waste management shifts the focus of waste policy from an end-of-pipe approach to a life cycle approach, tackling the waste issue in the design phase of products. As an overarching principle, the waste management hierarchy is broadly accepted as a basis for sustainable measures in waste management. The main focus of sustainable waste management is the prioritisation of waste prevention and minimisation over final disposal.

Vehicles, symbolic goods of modern society, are complex products, which contain many different materials and components and have a relatively long life span. Owing to high content of metal components in vehicles, by weight 70 to 75 per cent of an ELV, much of the material is recycled. The high recycling value of ELVs results in the wide establishment of recycling markets.

The major environmental impact is from the non-recycled parts of ELVs, around 25-30 per cent, and containing hazardous substances and components such as spent oils, solvents, heavy metals, organic toxics such as brominated flame-retardants, and ozone depleting substances[1]. Dismantlers or scrap yards are often very small businesses and most of them are poorly equipped. Depollution of ELVs by these is often not done or is poorly done. Further, proper storages have not been built. Therefore, hazardous substances and contaminated parts of ELVs are improperly disposed with severe damage to environment during the process. Without proper depollution, cars wrecks can become contaminated and problems transferred to shredders. Contaminated wrecks make it difficult to recycle materials and result in more automotive shredder residue (ASR). Today ASR is considered as hazardous waste in many countries.

In addition to the serious environmental impact from poor performance of treatment facilities, the abandoned ELV in nature is another issue of concern due to its impact on environment and general safety. One reason for abandoned cars is that sometimes the last owner, who holds an ELV with negative value, may leave it in nature instead of paying a treatment cost. Also, in case of a high transportation cost, which exceeds the ELV value, last owners may abandon their vehicles in storage or in nature.

In order to tackle the environmental problems of ELVs, many countries have attempted to develop different policy frameworks in order to secure proper management system for ELVs. The existing ELV systems show some successes and drawbacks. Therefore, it is interesting to look into a number of ELV systems presently running, in order to gain knowledge of flaws and virtues from these systems.

1.2 Purpose

The purpose of this research is to explore important factors that facilitate developing an effective and efficient end-of-life vehicle policy, aiming at three main goals: (1) waste prevention; (2) increase of reuse, recycling and recovery of ELVs; and (3) improvement of environmental performance of recycling facilities. In order to reach the purpose, the author examines several existing ELV systems and analyses their strengths and loopholes. It is important to mention that the analysis of these case studies is not aimed to compare systems, but to learn from different experiences in order to identify and bring out discussion about determinant factors that influence the success of a system.

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1 Lindhqvist, Thomas. (2001). *Extended producer responsibility for end-of-life vehicles in Sweden*. IIIEE research Report. Lund: IIIEE, Lund University.p.3.

Following the purpose of the thesis, the following research questions should be answered:

- Who are the most important actors and what are their roles in making the ELV policy successful?

- What types of policy instruments should be used and how, in order to steer relevant actors to reach the goals?

- What are the important factors to create a sustainable financial mechanism for the ELV system?

1.3 Scope

The thesis is limited to a study of existing ELV systems with three main focus areas: (1) legislation; (2) system in practice; and (3) financial and economic mechanisms.

Rationale for choosing focus area

In most cases, the existence of legislation, and the way that it is written, affect an overall policy design. Whether legislation complies with the waste management hierarchy, in the light of sustainable waste policy, is important to examine.

A study of the ELV system in practice, such as how systems are designed, how they actually operate, more specifically, what types of policy instruments are used, and how these influence the roles and behaviour of respective actors, is the second focus. Such in-depth studies on systems in practice will hopefully provide an insight into the effectiveness and efficiency of the ELV systems.

Not only the environmental effectiveness that a system reaches, but also the economy of a system is important. Thus, the author chose to look at financial and economic aspects of the ELV system, especially focusing on how the financial mechanism of a system is arranged. This will lead to identification of several elements that provide certain understanding on the efficiency and financial sustainability of a system.

Other aspects, such as soft effects, competition, market impact, trade issues, etc. could have been included in the study. However, the author excluded those aspects in order to be able to concentrate on three areas of prime important in the view of the author.

Selection criteria for case countries

The selection of countries was based on several criteria. First, the author attempted to eliminate external variables that may influence actors' behaviour. As vehicles are trade goods at the international scale, the degree of international pressure may affect car producers. Thus, the author selected European countries, which received the same impetus from the upcoming EU ELV Directive during the last ten years. Second, among European countries, the author further selected the ones with longer implementation periods, in order to examine the outcome, or the direction and the degree of progress of a system. Third, the author attempted to examine as many different types of policy instruments as possible. Thus, diversity of system elements was a selection criterion. In addition to this set of criteria, the suggestions made by Karin Kvist, environmental advisor at BIL Sweden, was also taken into account for the selection of the case countries.

Based on such criteria, Sweden, the Netherlands, Germany, France and the UK were chosen. The author looked into different features of the selected systems in order to build a meaningful analysis. Overall, features of each country-system are summarised as follows:

- Sweden has a long history of ELV regulations dating back to 1975. A car scrapping fee/premium have been used. Since the producer responsibility scheme was introduced in 1998, two parallel systems are running;

- The Netherlands started to re-organise the ELV system in 1995. Based on a voluntary agreement with the Government (initiated in 1993 and started in 1995), a private company, ARN, is organising and managing the ELV system. The first owner pay principle is applied for the financing;

- Germany started to set up an ELV system after 10 years negotiation with industry. The Voluntary Pledge (voluntary agreement) and its supplemented Ordinance on ELV came into force in 1997. The limited producer responsibility was applied so that recycling costs are divided in parts among last owners and producers. It is important to mention that Germany recently transposed the EU ELV Directive into the national law, the ELV Act of 2001. According to this ELV Act, the producer responsibility is expanded. However, the outcome is not possible to examine, owing to the short period of implementation. Thus, the study is focusing on the running system that is influenced by the voluntary agreement and the ELV Ordinance;

- France has organised the ELV system according to the Accord Cadre on ELVs, a voluntary agreement, since 1993. The Manager-Distributors (MD) system was set up in order to develop a proper treatment chain for ELV recycling. Initiated by dismantlers, recyclers, and especially shredders, MDs are facilitating the physical flows of ELVs collected from car dealers to proper recycling chains. The car producers show a lean attitude to the MD system; and

- UK has started developing an ELV policy based on the ACORD agreement among relevant recycling industries. Besides self-commitment to conduct environmentally sound management, there is no specific system arrangement for ELV recycling.

1.4 Limitations

There are four major limitations that the author faced during the research: limited accessibility to information; limitation to information credibility; language limitation; and time limitation.

First, the author faced difficulty in collecting information and data. The information that was needed for analysis sometimes did not exist or was difficult for the author to obtain, mainly owing to confidentiality issues.

Second, it is difficult for the author to judge reliability among the information, when faced with inconsistency in the data collected. Similarly, when the author has received certain information, sometimes it was difficult to judge whether it is based on perceptions or based on actual fact.

Third are language limitations. Some of the essential or important information was written in the national languages of these countries, most of which the author lacks knowledge. The author has tried to use different web translators to translate the original documents. Also, with help from colleagues and the supervisor, the author managed to extract essential information. However, the author might have missed valuable information.

Time limitation is also an essential limitation that the author faced, forcing a strict scope for the thesis work.

1.5 Methodology

The thesis is approached with different types of research methods: (1) review of literature on sustainable waste policy and environmental problems and relevant issues of ELV, in order to develop criteria for system evaluation; (2) study of ELV systems in the five selected countries from secondary data; (3) personal communication with various persons involved in ELV issues as primary data collection; and (4) analysis of the compiled information.

Review of literature on sustainable waste policy

Theoretical studies on the concept of sustainable waste policy and its essential backbone principle, the waste management hierarchy, were conducted in order to broaden the author's knowledge in the area of waste policy. This study included how waste policy has evolved from the end-of-pipe approach to a life cycle approach in order to match the concept of sustainable development. Together with this theoretical study, several documents on different implementations of sustainable waste policies in various countries were reviewed, in order to understand the practical aspects of the theory. However, this review is not presented in the thesis due to the limited length of the thesis and also considering the scope of the thesis.

A literature review on policy instruments, which promote sustainable waste policy, was extensively undertaken. This helped the author to understand the advantages and disadvantages of the use of different policy instruments, together with different characteristics. Taking into consideration that the existing policies and their policy instruments, which are used in different ELV cases, are fairly young, their outcomes may be premature and difficult to examine. Therefore, an in-depth study on different policy instruments helped the author to be aware of and to foresee the potential outcomes of the policy instruments actually applied in the case studies. Further, it helped the author to undertake the analysis.

Several essential characteristics of a sustainable waste policy will be of great concern, when choosing policy instruments. Therefore, a literature study on such characteristics, which are already widely developed by various researchers, was employed.

A study on environmental problems and issues of ELVs was undertaken, in order to develop criteria for evaluation of ELV systems. In addition, characteristics of various actors involved in ELV recycling, together with specific real obstacles related to ELV system, were studied. Such studies helped to select and prioritise criteria for examining the ELV systems. Finally, the selected criteria are limited to the most appropriate and important ones in the view of the author.

Study on the ELV systems of four selected countries (secondary data collection)

Once the selection was made, different types of secondary data and information were collected. The main sources of data were: published articles and documents by various authors; website information of respective organisations, companies, and governmental authorities; statistic data from the Internet, from statistic institutes and authorities; unpublished articles and presentation materials from companies and governmental authorities; and annual reports from various organisations and car producers.

Interviews with various persons involved in ELV issues (primary data collection)

Along with secondary data collection, the author conducted personal communication with various stakeholders in order to: clarify information; gather in-depth information; search for hidden information such as the number of abandoned vehicles; and also to hear different opinions from these stakeholders. Such primary data collection was made intensively through emails, and sometimes through telephone conversations with various people that are involved in the ELV issue, such as personnel in governmental authorities, car producers associations, dismantlers and shredder organisations, car industries and also researchers, who have conducted studies on ELV issues.

The selection methods to choose contact persons were:

(1) Several key contact persons in Sweden were recommended to start with by the author's supervisor, who already researched and had been closely involved in ELV issues and its policy making in Sweden;

(2) During the research on ELV systems from secondary information, the author identified stakeholder groups in different countries. The author has approached these stakeholder groups via email with individualised questionnaires. Considering the responses to the author's emails, further continuous communications were made with contact people. Telephone communications also took place. The benefits of telephone interviews included perceptions beyond mere information and earning more information through personal voice conversation. Sometimes, telephone contacts were the only possible primary channel to identify the person in charge of this issue within identified stakeholder groups;

(3) The 'snow ball' contact method, whereby the first contact person recommends another person etc., was also applied.

Analysis of the compiled information

Three different types of analysis were carried out: (1) analytic discussion on the findings of each case study system in practice and its financial and economic mechanism; (2) general system analysis based on the selected criteria - environmental effectiveness; economic efficiency; monitoring; and stimulation of innovation – to conclude each case study; and (3) general analytical discussion on determinant factors for effective and efficient ELV policy. From examining case studies and analysing their systems, the author identified important factors that affect the outcome of a system. Three sources helped guide the author to develop determinant factors and bring up interesting discussion on these factors. These are '*EPR Programme Implementation: Institutional and Structural Factors' by Tojo, N., Lindhqvist, T., and Davis, G. (2001)*, '*Extended Producer Responsibility: A Guidance Manual for Governments' by OECD (2001)*, and '*Analysis of EPR policies and legislation through comparative study of selected EPR programmes for EEE' by Tojo, N. (1999).*

1.6 Structure of the thesis

The thesis consists of ten main chapters, including this first introduction chapter. In Chapter 2, the concept of sustainable waste policy and its overarching principle, the waste management hierarchy, are presented. Also a wide range of policy instruments in the context of sustainable waste policy and several characteristics of such a policy are reviewed, in order to build the knowledge on the theoretical aspects of sustainable waste policy.

Chapter 3 focuses on developing policy evaluation criteria for the case study analysis. Thus, general understanding of the ELV recycling chain, characteristics of involved recycling sectors, general environmental problems from ELVs, and some difficulties and barriers that ELV systems face, are presented. Since selected cases are all representing European countries, information on the EU ELV Directive is presented. Even though the ELV Directive was not considered as a guiding legal framework or benchmark for the selected cases, the information in the ELV Directive helped the author to develop evaluation criteria. Taking into account the background information related to the ELV issue, several criteria were selected and presented.

In Chapter 4 to Chapter 8, in-depth information on each ELV system of the five selected countries is provided. With each case study presents existing legislation, presently running ELV system, and financial mechanism are presented. However, the structure and the style of describing the systems are designed differently for each case. Due to the different level of information and the ranges in use of policy instruments in the case countries, the author selected the most suitable design style for each chapter.

Chapter 9 presents and discusses determinant factors for effective ELV policy that the author has identified during the research on the case studies. The last chapter includes the conclusion.

2. Sustainable Waste Policy

2.1 Sustainable Waste Management

Countries used to see their prosperity and development from economic growth perspective. This quantitative economic development is mostly coupled with environment degradation. The Rio summit puts an end for seeing development as only economic dimension, and gives a new concept of development with qualitative dimension in society and the environment. This is abstracted in the concept, 'Sustainable Development'. The concept of sustainable development is defined as 'the development that meets the needs of the present without compromising the ability of future generations to meet their own needs'[2]. Sustainable development integrates long-term aspects of economic, social, and environmental systems. It requires that societies make wise use of resources so as to protect the environment and at the same time, maintain high and stable economic and social levels far-off the irrational economical growth solely.

Here, the true challenge of sustainable development lies in putting the theory into practice. For the last few years, the concept of sustainable development has been dominating all different policy areas. In particular, it gives enormous impact on environmental policy.

Before the introduction of sustainable development, waste policy, in general, had been focusing on management of disposal facilities. However, waste policy in the context of sustainable development, aims at an integrated and holistic approach to manage waste problems. Sustainable waste management can be defined as management of waste in a manner that conserves both natural and man-made resources and averts ecological risks. Environmental sustainability also requires the production of more value from recovered waste materials and energy, the consumption of less energy and the production of fewer emissions to air, water and land[3]. In light of the sustainable development concept, waste management has evolved from focusing on the improvement of final disposal facilities to applying an integrated approach to tackle the waste problem throughout the product's lifecycle. For instance, the waste policy at the EU level covers from the licensing scheme for waste facility operators to the application of the lifecycle approach. Thus, there is a need to take account of overall environmental damage of products, including not only their final stage but also their design stage, where damage can be alleviated.

It is through the waste management hierarchy that sustainability is presented on a practical level in the area of waste policy. It has been a key principle for the implementation of sustainable waste management. In the waste management hierarchy (Figure 1), prevention and reduction of waste at source are the most favourable options and are at the top of the ladder of the hierarchy. Anything that cannot be prevented or minimised should be reused, or recycled to the optimal level. These approaches should be prioritised over energy recovery and final disposal of waste. Sustainable waste resource programs focus on the upper and middle parts of this hierarchy.

- **Waste prevention**: is applied at source. A proper product design will facilitate waste elimination. In addition, waste prevention can involve process of modification or change, adopting new technology or using alternative materials as substitutes.

- **Waste reduction**: After waste prevention, waste reduction is the most favourable option. It also involves redesigning of products by reducing materials, looking into more efficient ways

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[2] World Commission on Environment and Development. (1987). *Our Common Future.* Oxford: Oxford University Press. p. 43

[3] White, P., Franke, M. & Hindle, P. (1994). *Integrated solid waste management: a lifecycle inventory*. London, England: Blackie Academic & Professional.

of using these materials, implementing new processes and technologies and replacing disposable products with reusable and durable ones.

- **Reuse**: It is reusing products in its original form, which avoids excessive consumption of resources and waste generation. Reuse can also involve using products for different purposes.

- **Recycling**: When reuse can no longer be carried out, the materials should be recycled back into similar products or become secondary raw materials for production of new products. Generally to produce new products from recycled materials consumes less energy and spares the environment from further abuse and degradation through extraction of virgin materials.

- **Recovery**: Energy recovery can be a viable option after reduction, reuse and recycling have been fully explored and waste generation can no more be avoided. It involves incineration of wastes and recovers latent heat energy of materials. Heat energy can then be converted into other useful forms like electricity.

- **Disposal**: When there will be no other appropriate solutions and where no further value can be recovered from wastes, waste disposal is the least preferred option. The leftover waste has to be treated and disposed properly to protect environment, human health and to ensure safety[4].

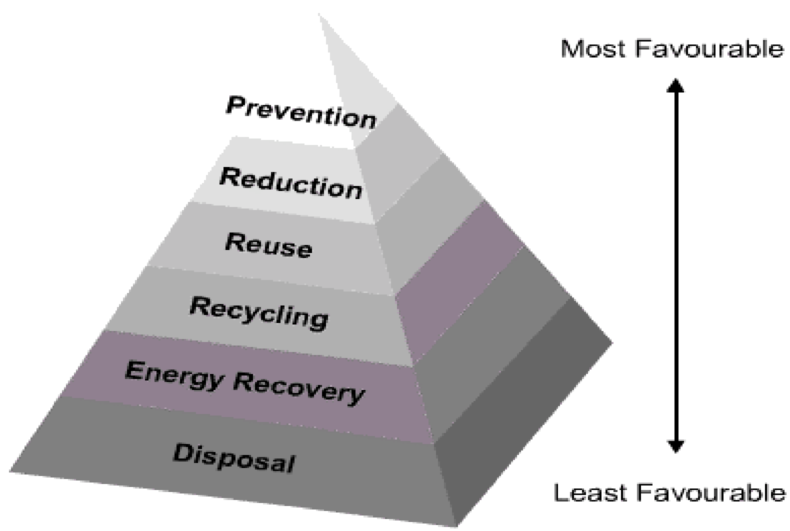

Figure 1. Waste management hierarchy.

The ultimate objective of sustainable waste management is to minimise negative impacts from waste on the environment and human health by employing all possible waste management practices and technologies, especially those, which address reduction, reuse, recycling and energy recovery in addition to landfills[5]. However, it is clear that technology alone cannot solve waste problems to reach the goal of sustainable waste management. There are many other factors that affect sustainable waste management. One of which is public participation. How to stimulate and encourage public participation in waste management is a part of design of the waste policy.

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[4] Recycling and Waste Minimization Resources in South Australia. (n.d.). *The solid waste management hierarchy*. [Online]. Available: http://www.wastecom.sa.gov.au/wmc/FactSheets/hierarch.html [2002, September 03]

[5] Tammemagi, Y. (1999). *The Waste Crisis*. New York, USA: Oxford University Press, Inc. p. 33.

2.2 Sustainable Waste Policy Instruments

Policy instruments are measures designed to help meeting the objectives of policies. It is important for a government to have a method for selecting proper instruments[6]. Since a good selection of policy instruments will more likely lead to the success of policies. There is a wide range of policy instruments applied in environmental policy. A study on existing instruments and their potential influences will provide valuable information to select potential policy instruments for sustainable waste policy.

A classical categorisation of policy instruments is regulatory, economic and informative instruments. OECD (2000) manual uses the term, 'suasive' instead of informative, which are instruments that are used to persuade, exhort, and educate[7]. Long (1999) divides environmental policy instruments into three: directive-based regulations, incentive-based, and information-based instruments[8]. The use of these policy instruments can be on mandatory or voluntary base.

Mandatory Approaches

Mandatory approaches are commonly used in environmental policies. Governments use them to set up legal mechanisms such as regulations, ordinances and to enforce legislations. These are mostly used to directly influence activities of various actors. Mandatory approaches are considered to be effective. In addition, by providing clear guidelines how to perform and enforce certain regulations with sanction power, mandatory approaches can lead to effective improvement of actors' performances.

It is very important to mention that governments considering the establishment of a mandatory programme must first identify whether appropriate level of authorities exist[9]. The failure of mandatory approach often comes from a lack of enforcement, even if the legal framework is designed well.

Voluntary Approaches

Voluntary approaches cover a wide variety of arrangements. They range from industry-based to government-based initiatives. These include:

- Unilateral commitment by industry;
- Agreements achieved through direct bargaining between polluters and victims;
- Agreements negotiated between industry and public authorities;
- Voluntary programmes developed by public authorities to which individual firms are invited to participate[10].

An invasive use of voluntary approaches in environmental policy is recently observed. Increasingly, company specific or sector-wide commitments to participate in environmental policies are emerging. For instance, the European Commission supports voluntary approaches in a 1996 communication. It points out several benefits and advantages, which are summarised below.

- *Encouragement of proactive approach by industry*: Dialogue and negotiation on 'what to do' and 'how to do' encourage open and pro-active attitude of industry. Moreover, negotiation processes can lead to common understanding of environmental problems and mutual responsibilities. This implies persistent partnership between authorities and industries.

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[6] OECD. (2000). *Strategic waste prevention: OECD reference manual.* [Online]. Available: http://www.olis.oecd.org/olis/2000doc.nsf/c5ce8ffa41835d64c125685d005300b0/c12568d1006e03f7c125692e004f054a/$FILE/00081387.PDF [2002, July 12].

[7] OECD. (2000). *Strategic waste prevention: OECD reference manual.*

[8] Long, B. (1997). An overview of tools and strategies for environmental management. *In Eco 1997 International Congress*, 24-26 February. OECD. Paris.

[9] OECD. (2001). *Extended Producer Responsibility: A Guidance Manual for Governments*. p. 33.

[10] OECD. (2001). Extended Producer Responsibility: A Guidance Manual for Governments. p. 33

- *Cost-effectiveness:* It gives industries freedom to find cost-effective solutions and to adapt them to specific situations. Such flexibility also encourages creative and innovative solutions, which might not only reduce compliance costs but also entail spin-off benefits including competitive advantages.

- *Faster achievement of objectives*: An average time between a proposal for an environmental directive and its adoption, and its additional transposition by the states, takes long period of time. Thus, voluntary and cooperative agreement might be quicker so that it is a more effective way of action to achieve objectives[11].

However, there are some risks by a voluntary approach, especially when it is used as the only policy approach to form agreements between governments and industries. For example, open-ended negotiations or discussions about commitments may not lead to substantial action and are often seen as postponement of effective policy measures[12].

Regulatory instruments

Regulatory instruments compel relevant actors to carry out certain activities by means of prohibition, restrictions or obligations. In terms of waste policy, several types of regulatory instruments can be identified. Examples of these are:

- *Technical standards for production, recycling, and recovery processes*: Stringent end-of-pipe control regulations generate high cost for industry, especially costs related to final disposal. Thus, to stimulate implementation of waste minimisation measures at earlier production stages gives benefit in cost reduction. Minimum technical standards for all waste recycling facilities are necessary in order to prevent waste being transported to less expensive plants that use lower level technologies[13].

- *Product bans and restrictions:* Product bans have often been implemented to stimulate waste prevention and minimisation[14].

- *Licenses*: License schemes oblige waste facility operators to hold a license to ensure the fulfilment of certain environmental standards and rules.

Economic instruments

Economic instruments are designed to provide economic incentives to relevant actors to perform certain activities, in particular, to implement or stimulate good environmental performances.

A wide range of economic instruments has been used. In terms of sustainable waste policy, economic instruments can alter the value of some elements of waste process, allowing decisions to be made that reflect the full social costs of particular activities[15]. This approach can be described as internalising the external costs and benefits associated with the waste process. Among the wide range of economic instruments, there are several examples relating to waste policy:

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[11] EU Commission. (1996). *Communication from the commission to the council and the European parliament on environmental agreements*. p. 8.

[12] EU Commission. (1996). *Communication from the commission to the council and the European parliament on environmental agreements*. p. 8.

[13] OECD. (1997). *Waste minimisation in OECD member countries*. ENV/EPOC/PPC(97)15/REV2. p. 18.

[14] OECD. (1997). *Waste minimisation in OECD member countries*. p. 19.

[15] Van Beukering, P.J.H., and Brander, L.M. (2001). *Policies to promote the waste management hierarchy.* Institute for Environmental Studies, Amsterdam. The Netherlands. [Online]. Available: http://130.37.129.100/english/o_o/instituten/IVM/pdf/w00-41.pdf [2002, August 23]

- *Charges and taxes*: Charges and taxes can be levied at various stages of waste process. These include product charges, collection charges, disposal charges, and emissions charges.

- *Subsidies and other types of financial support (such as tax reductions):* All types of financial support can encourage environment-friendly behaviours. For example, they may reward waste prevention and recycling.

- *Tradable rights/permits (to produce a certain amount of waste):* Rights to pollute are tradable to allow reductions in polluting activity to be undertaken at the lowest cost.

- *Deposit-refund systems:* A deposit for a potential waste product can be paid by a purchaser, who can claim a refund after returning the waste product. In this way, the product keeps value, even if it has become useless to the agent that bought it, thereby preventing uncontrolled dumping. It is recognised that this tool is only applicable to a small part of the waste stream[16].

The main consideration to use economic instruments relates to the set amount. To find out reasonable and effective level of the price of an economic instrument is crucial. A too low price will not bring an expected outcome and a too high price will drop its economic efficiency.

Informative instruments

Informative instruments educate or persuade relevant actors, who lack awareness, to perform certain activities. It is considerably more difficult to predict their effects. However, informative instruments are increasingly used. In terms of waste policy, labelling of material contents and corporate reports on recycling provision, etc. are identified as informative instruments.

Selection of Policy Instruments to Meet the Needs

A wide range of contextual variables will influence how instruments are assessed for their appropriateness to particular needs. These variables may include administrative laws, procedures, available government resources, structure of industry, level of economic development and trends in public values and democratic processes[17].

In order to measure appropriateness of the use of selected policy instruments, several factors should be taken into consideration. OECD (2000) presents four factors, which are worth to mention[18]. First, not only selecting type of instruments, but also allocating responsibility to various levels of government will influence the final outcome of a policy intervention. It is necessary to vertically integrate governmental actions from national to local level.

Second, selection and preference of certain policy instruments always involve trade-off issues. Corresponding to policy aims, preference for instruments will be determined. For instance, for greater predictability, regulatory instruments may be preferred. However, for long-term innovation and for political acceptability, voluntary or incentive-based instruments may be beneficial.

Third, selection of instruments needs to be put into the broader context. Since waste generation occurs throughout a chain of material uses and economic activities, policy instruments should not be selected only to regulate a disposal phase. Throughout a recycling chain, for example, to include a design phase of products and a production phase by selecting different policy instruments that are suitable to different actors and activities should be concerned.

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[16] Van Beukering, P.J.H., and Brander, L.M. (2001). *Policies to promote the waste management hierarchy.*

[17] OECD. (2000). *Strategic waste prevention. OECD reference manual.*

[18] Factors are adapted by the author from OECD. (2000). *Strategic waste prevention. OECD reference manual.*

Instruments that appear to be well suited may end up producing less-than-optimal results. For example, operating permits may not result in desired effects when the permits themselves are poorly written. In such case, on-going monitoring can help to find out the reasons why function of permitting does not bring the expected outcome. Therefore, to carefully understand an outcome of policy instrument in different angles will help seeking a good selection of policy instruments, which will eventually bring desirable outcome.

2.3 Characteristics of Sustainable Waste Policy

OECD guideline on the use of policy instruments in environmental policy suggests a set of criteria, which includes environmental effectiveness, economic efficiency, comparison of scope and effectiveness among other types of instruments, equity, administrative feasibility, concordance with institutional framework, and political and social acceptability[19]. Field (1997) has similarly suggested criteria and added incentives for long-run improvements[20]. Börkey and Leveque (1998) present a set of criteria such as environmental effectiveness, economic efficiency, administration and compliance cost, wider economic effects, soft effects, dynamic effects and innovation, and viability and feasibility referring to political and social acceptance[21]. Other types of criteria that have been discussed by various authors are transparency, monitoring, and enforcement.

From the literature review on evaluation criteria, several important criteria are presented below.

Environmental Effectiveness

Environmental effectiveness is the most common and the most important criteria for environmental policy. It is achieved if a system fulfils its purpose, goal(s), and objective(s) established[22]. It measures to what extent a certain policy reaches its goal(s) and objective(s). By looking at the gap between target(s) based on the goal(s) and outcome(s) after policy implementation[23], effectiveness can be measured. Implementation should primarily be judged on a basis of performance, for example, reduction in the amount of waste sent to final disposal, or improvement of new product design[24].

Economic Efficiency

Theoretical literature is fairly clear as to what is generally meant by the cost-effectiveness of a system[25]. The economic efficiency poses questions on its policy capacity to reach environmental objective(s) and target(s), and also minimise related costs at the same time[26].

What are the costs of implementing a system such as its set-up cost, running cost, administrative cost, and so on? What are the costs of compliance for producers, and how are they passed on? A review of transaction and transition costs at certain points could provide a better indication of long-term cost[27].

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19 OECD. (2000). *Strategic waste prevention. OECD reference manual.*

20 Field, Barry. C. (1997). *Environmental economics*: In introduction. 2ed. USA:McGraw-Hill.

21 Börkey, P. And Leveque, F. (1998). *Voluntary approaches for environmental protection in the European union.* OECD Environment Directorate. ENV/EPOC/GEEI(98)29/FINAL.

22 OECD. (2001). *Extended Producer Responsibility: A Guidance Manual for Governments*. p. 99.

23 Börkey, P. And Leveque, F. (1998). *Voluntary approaches for environmental protection in the European union.*

24 OECD. (2001). *Extended Producer Responsibility: A Guidance Manual for Governments*. p. 99.

25 European Environment Agency (EEA). (1997). *Environmental Agreements: Environmental Effectiveness*. Environmental Issues Series No.3-Vol.1.

26 Börkey, P. And Leveque, F. (1998). *Voluntary approaches for environmental protection in the European union.*

27 OECD. (2001). *Extended Producer Responsibility: A Guidance Manual for Governments*. p. 99.

Administration and Compliance Cost

This criterion is for whether the implementation of a system has been smooth and efficient. Administration and compliance costs are defined as composed costs that public bodies bear when applying regulations. For example, what are the costs of executing and enforcing a programme? What are the costs of informing and training relevant actors and public bodies for a system?[28]

Stimulation of Innovation

Ideally, an environmental policy instrument will affect the speed and direction of industry's evolution. Even if it is difficult to clearly define innovation, policies should encourage relevant actors to move forward to develop innovative ideas, while taking consideration of long-term dynamic situation. Field (1997) mentions this in a slightly different manner, which is that certain policy instruments give strong incentives for relevant stakeholders to find new and innovative ways of reducing the environmental impacts[29]. Opschoor, de Savorinin and Vos (1994) added that *'Innovation must then be seen as the outcome of a complex process within a structure of co-operation'*[30]. Depending on, for example, the level and type of innovation and the parties involved, different policy instruments may provide different stimuli, which lead to different outcomes[31].

Concordance with institutional framework

Conformity with institutional framework is a criterion to measure to what extent policy instruments fit into existing policy frameworks[32]. For instance, it should be considered whether there is concordance with institutional frameworks at the local, national, and/or international levels.

Social and Political Acceptability

It is also important to what extent policy instruments are expected to achieve political and social acceptance. A level of public participation can be measured. In order to achieve social and political acceptance, several elements such as transparency, equal distribution of benefits to all relevant actors and different equity issue should be considered.

Monitoring

In order to measure progress of improvement after introducing certain policy instruments, monitoring functions is an essential method. There are two types of monitoring. A public body performs monitoring in most cases. However, recently self-monitoring by industries has drawn attention. The process of self-monitoring increases the awareness of involved actors and can be an important educational tool[33].

Self-monitoring requires the availability of reliable and affordable monitoring methods. It also relies on integrity and capability of source to provide accurate data. It must also include enterprises'

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[28] OECD. (2001). *Extended Producer Responsibility: A Guidance Manual for Governments*. p. 99.

[29] Field, Barry. C. (1997). *Environmental Economics*.

[30] Opschoor, de Savornin and Vos. (1994). *Managing the Environment: The Role of Economic Instruments*.

[31] EEA. (1997). *Environmental agreements: environmental effectiveness*. Environmental issue series No.3. Vol.1, Copenhagen, Denmark.

[32] EEA. (1997). *Environmental agreements: environmental effectiveness*.

[33] OCED. (2000). *Environmental compliance and enforcement in the NIS: A survey of current practices of environmental inspectorates and options for improvements*. Twelfth meeting of the EAP Task Force. 18-19 October 2000. CCNM/ENV/EAP(2000)87.

responsibility to take sufficient steps to ensure accuracy of data collection[34]. How to give incentives to relevant actors to conduct self-reporting systems can be the main issue.

Transparency

Transparency helps political acceptability and trust building for policy. It also facilitates coordination among different actors. Transparency can be seen whether the process of developing a system is transparent and objective, and whether a system is running transparently[35].

Soft effects

Soft effects refer to various possible effects in terms of attitude changes and awareness, capacity building, and generation and diffusion of information. Aggeri & Hatchuel (1996) stressed an outcome of collective learning, especially when stakeholders face uncertainty on an environmental problem[36].

Wider economic effects

Costs and benefits that are linked to environmental policy instruments other than pollution abatement, administration and compliance costs may inter alia stem from impacts on the price level, competition, trade impact, or income distribution.

Taking into consideration different aspects and characteristics of policy instruments, a choice of policy instruments in the most proper manner can be a challenge. It should be firstly considered what are the purpose and the aim of policy instruments, and then certain criteria can be prioritised to choose policy instruments for desirable outcomes.

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[34] OCED. (2000). *Environmental compliance and enforcement in the NIS: A survey of current practices of environmental inspectorates and options for Improvements*.

[35] OECD. (2001). *Extended Producer Responsibility: A guidance manual for governments*. p. 99.

[36] Aggeri F. (1999). *Environmental policies and innovation: a knowledge-based perspective on cooperative approaches*. Research Policy 28, p. 699-717.

3. Policy framework for End-of-Life Vehicles

End-of-life vehicles (ELVs) are complex goods including many different components and also contain hazardous substances. On one hand, recycling markets for certain ELV components have been widely established, while, on the other hand, ELVs have been considered as one of sources to cause serious environmental problems. The major impact of ELVs comes from non-recycled parts of ELVs, which are around 25-30 per cent, and which contain hazardous substances and components, such as spent oils, solvents, heavy metals, organic, and ozone depleting substances[37].

This section provides general information on ELVs, consisting relevant actors and their relating environmental problems, policy approaches to deal with the ELV issue with special focus on the European case. Such background information, the author believes, will help to choose certain criteria to examine existing ELV systems.

3.1 Environmental Problems of End-of-Life Vehicles

3.1.1 The End-of-life System

Last owner

At a certain moment, a car owner is no longer able to extract additional use value from his vehicle. Hence, he disposes his car and the car becomes an ELV. Two situations of disposal can be distinguished: one is when the car is worn out after a life span of ten to fifteen years, and another one is when the car is declared as total loss after a major accident. In the former case, the car might have failed to pass a regular vehicle safety test, or costs for repair are prohibitively expensive. In case of such premature end-of-life vehicles (PELVs), their lifetime of cars can be substantially less than ten years, whose value of certain individual parts and components exceeds a scrap value of its metal contents. It offers attractive opportunities to car dismantlers. In the case of worn-out vehicles, disposal can be more problematical because these vehicles represent merely the scrap value of their metal content. If a last owner has to pay the recycling cost for such ELVs, his financial burden can be one of motivations to abandon his car in nature.

Car dismantling

Most ELVs enter the processing system via a car dismantler. Car dismantlers play an important role in ELV treatment system for two reasons. First, the car dismantler disassembles parts and components that can generate value in the second-hand market. Second, they remove some parts in order to facilitate subsequent shredding, as well as for safety reasons. Some car dismantlers separate ELVs to various metal fractions prior to selling wrecks to shredders. Cast iron from engines and aluminium are separated because these metals have a higher value in a scrap metal market.

Despite their important role, there is relatively little information on the car dismantling industry. Several causes can be mentioned. First, the industry is not well organised. Only a small fraction of all car dismantlers are organised in an industry association. Second, a relatively large part of car dismantling industry operates in illegal ways. Such car dismantlers do not have a legally required operating license, or, if they do have such licenses, they do not operate according to their terms of the license. Finally, a clear definition of the car dismantling industry is difficult to give; many repair shops, scrap metal firms undertake such dismantling activities.

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[37] Lindhqvist. T. (2001). *Extended Producer Responsibility for end-of-life vehicles in Sweden*. p. 3.

Shredding

After parts and components have been extracted from ELVs, wrecks are sold to shredder companies or scrap metal traders for metal recovery. There are several steps identified: shredding ELV; magnetic separation of ferrous metals; and separation of various non-ferrous metals.

The shredder process is capital intensive and uses a considerable amount of energy. Car wrecks are a major input into shredders but other feedstock is used as well, such as white-goods, rails, ships, trains, and so on. An average ELV constitutes 70 to 80 per cent by weight of shredder input. When feeding ELVs into a shredder, some pre-treatment of the feedstock may be required, depending on quality levels of desired output, and also to increase safety. The next step is recovery of iron and steel by means of magnetic separation. Relatively high recovery levels are reached; it is reported that currently over 95 per cent of ferrous metal contents are recovered. The final step is separation of non-ferrous metal from heavy fraction. Several techniques are used, often in combination. With such technologies, over 90 per cent of aluminium fraction can be recovered. Other non-ferrous metals are recovered less efficiently. The residues of these processes cannot be further separated with state-of-art technology; they have to be landfilled or incinerated.

As shredder residue is defined as hazardous waste in many countries, shredder residue becomes a serious cost problem to shredders, who are responsible for treating shredder residue. Another problem relates to increasing non-metal contents, including plastics in ELVs, which negatively affects the economics of metal recovery processes.

3.1.2 Environmental Problems and Difficulties of End-of-Life Vehicles

Abandoned vehicles

Problems start with last car owners, who are in the start line of ELV chain. Sometimes, they are paid for the remaining value of ELVs, or they are relieved from the charges for treating and recycling their ELVs. But in some instances, last owners feel too much effort to take ELVs to dismantlers, especially in remote areas. In such cases, although it is forbidden, the simplest way is to just leave a vehicle in nature. If the owner decides not to scrap his car and just abandons it in the environment, this gives rise to significant pollution problems.

Poor performance by car dismantlers

The environmental impact of car dismantling is mainly related to poor treatment activities, especially in smaller or uncontrolled car dismantlers. Such car dismantlers try to reduce costs to minimum level. In the worst case, they stack ELVs in high piles, waiting for scrap metal prices to be high enough to make profit by selling them to shredders or scrap metal traders. In such cases, occasionally, oils and other fluids leak out from wrecks into the ground, partially because tanks and pipes that contain such fluids are broken due to stacking in piles. In addition, some dismantlers just remove oils and other fluids by just letting them drain into ground, which is the cheapest way. The number of such dismantlers is considerable.

In addition, there is weak working relationship between dismantlers and recycling industries, which limits the amount of components to be recycled, leaving the residues for shredding. Recently some regulations in specific countries push for more strict operational and technical conditions that dismantlers have to accomplish, in order to prevent such flow of recyclable materials to shredders.

Problems may arise from export of deregistered vehicles. As environmental standards for dismantling process becomes more stringent in some countries, some ELVs are exported to places with less strict dismantling requirements or with cheaper process. These export flows for scrapping purposes have been witnessed in few countries, even though it is prohibited to export waste.

Shredding and Automobile Shredder Residue (ASR)

In the present practice of shredding industries, often shredders accept untreated ELVs for shredding process. This causes problems in recovering shredded materials for further recycling and also adds toxicity to ASR.

ASR, the residue that cannot be recovered by shredding and metal recovery activities, is considered an environmental hazard waste. Due to its composition, which contains organic, inorganic and hazardous residuals and together with its increasing amount, ASR is often prohibited to dispose in landfills. Special treatment for ASR or alternative way to use ASR such as energy recovery is the major issue for shredders.

Material composition of ELVs

As well as by design and conceptual elements such as assembling, the environmental and economic impact of ELV treatment is influenced by material regime prevailing in car production, which has consequences on share and amount of recoverable/reusable/recyclable materials.

Over the last few decades, car design changed significantly and a change in car materials occurred. This makes rise to material contents that can have problems in mechanical recycling. In 1965, the European car contained on average 82% of ferrous and non-ferrous metals (2% aluminium) and 2% of plastics in terms of total weight. In mid-1980s, the content of ferrous and non-ferrous metals in the car averaged 74-75% (with aluminium at 4.5%) and plastics were estimated at 8-10% of total weight[38]. Not only the weight, plastics materials consisting of various types of plastics give rise to severe constraints to extensive recycling.

In terms of increasing amount of the aluminium share in vehicles, it increases the recyclability of ELVs because aluminium is fully recyclable without loss of properties. It gives also benefit for ELV recycling since a well-developed secondary markets for aluminium exists. However, most of recycling rates are specified based on total weight and aluminium is lighter than steel, the increase of aluminium instead of steel results in a relatively low contribution to the recycling rate of vehicles.

Recycling market

Recyclability is both a technological and an economic issue. On technological side, recyclability depends on the existence of methods that can be used to extract the constituent materials from ELVs. On the economic side, recyclability depends on the market existence for extracted materials. Furthermore, there must be a balance between the cost of employing the extraction technology and the quality of extracted materials so that recyclers have an economic incentive to undertake the recycling[39]. Except for steel and aluminium, other components and materials from ELVs, such as glass, and plastics are connected to limited available recycling technologies and markets.

3.2 End-of-Life Vehicle Policy Initiatives

Concern of environmental problems from ELVs and relative issues have emerged in the 1970s. At European level, the European Council Resolution of 1990 included the ELV issue in its priority list of waste streams. In 1991, with the EU Commission's Community Strategy for Waste Management of 1989, the 'ELV Project Group' was launched, in order to explore possible technical and policy options for ELVs. Under the direction of the French 'state agency for the environment and energy (Agence de l'Environment et de la Maitrise de l'Energie: ADEME)', 40 organizations including European car

[38] Zoboli et al. (2000). *Regulation and innovation in the area of end-of-life vehicles*. Luxembourg: Institute for Prospective technological studies. [Online]. Available: ftp://ftp.jrc.es/pub/EURdoc/eur19598en.pdf [2002, June 13].

[39] Field III, F.R.. (1993). *The recycling of automobiles: Conflicting environmental objectives in a competitive marketplace*. A paper is presented at the KIET International Seminar on Korea's Auto Industry, held November 25-26, Seoul, Korea.

producers, plastics producers, steel and glass producers, car dismantlers and shredders, and representatives of member states participated in this project[40]. Based on the outcome of the ELV project group, several policy proposals for ELVs were presented at the EU commission. After a long political discussion and debate on the ELV proposals, the EU End-of-Life Vehicles (ELVs) Directive (2000/53/EC) came into force in July 2000. All member states are required to transpose it into national laws by April 2002. So far, however, only Germany recently transposed the directive into their national law and in the other member states, the process is still under preparation.

The EU ELV Directive sets up a legislative framework for the European ELV management. It requires certain measures and technical standards concerning ELV collection and treatment. It also demands more material recovery requirements and asks for limiting the use of hazardous substances in vehicles. Additionally, it sets recycling and recovery targets within certain time frames so as to force improvement of ELV treatment.

In light of increasing environmental concern on ELVs and the pressure from upcoming EU legislation, several European countries had already started to set up systems for better ELV management even before the introduction of the ELV Directive. At present, 11 EU member states, Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom, have regulations and/or voluntary agreements for ELVs systems. At the industry level, several European car industries took initiatives, together with dismantlers, shredders, and recycling industries, to develop technical solutions for different aspects. Such efforts are still on going.

The End-of-Life Vehicles Directive

The Directive 2000/53/EC on End-of-Life Vehicles came into force on the 21st of October 2000. It requires all member states to transpose the Directive into their national laws by the 21st of April 2002.

The objectives of the ELV Directive are in line with the over-arching principle of the *Waste Management Hierarchy*:

- To prevent waste from vehicles as a first priority;
- To reuse, recycle and recover end-of-life vehicles and their components so as to reduce the disposal of waste;
- To improve the environmental performance of all of the economic operators involved in the life cycle of vehicles, especially the operators directly involved in the treatment of end-of-life vehicles.

In order to reach the objectives, the Directive requires the followings:

- Member states shall encourage vehicle manufacturers in liaison with material and equipment manufactures to limit the use of hazardous substances in vehicles; to improve design and production of new vehicles to facilitate their dismantling, reuse, recycling, and recovery; and to integrate an increasing quantity of recycled materials in vehicles and other products, in order to develop the markets for recycled materials (Article 4.1);

- Member states shall ensure that materials and components of vehicles out on the market after 1st of July 2003 not to contain lead, mercury, cadmium or hexavalent chromium (Article 4.2);

- Member states shall take the necessary measures to ensure that economic operators set up systems for the collection of all end-of-life vehicles and waste used parts (Article 5.1);

[40] Zoboli et al. (2000). *Regulation and innovation in the area of end-of-life vehicles*. p. I-45.

- Member states shall ensure that all vehicles are transferred to authorised treatment facilities by setting up a system of deregistration that requires presentation of a certificate of destruction (Article 5.2 and 5.3);

- Member states shall ensure that producers meet all, or a significant part of, the costs of the implementation of a system so that it allows the last holder of an ELV with no or a negative market value to dispose it without any cost. This requirement shall apply as from 1st of July 2002 for vehicles out on the market as from this date and as from 1st of January 2007 for all vehicles (Article 5.4);

- Member states shall ensure that any establishment of and presently running ELV treatment operators to be authorised in order to ensure the proper depollution and treatment of ELVs (Article 6);

- Member states shall ensure that the following targets are met; for re-use and recovery - 85 per cent by average weight per vehicle and year by 2006, and to 95 per cent by 2015, and to increase the rate of re-use and recycling over the same period to at least 80 and 85 per cent respectively by average weight per vehicle (Article 7).

3.3 Developing Evaluation Criteria for an End-of-Life Vehicle System

As it is seen in the background information above, several countries took policy initiatives to organise ELV systems to tackle the environmental problems from ELVs. In order to approach the purpose of the thesis, the author examines several existing ELV systems. The author has chosen specific criteria for this examination. Taking into consideration the limitations specified earlier and the special characteristics of ELVs, the author selects these criteria below.

Different actors are involved in the web of an ELV treatment chain, which makes it a more complex issue. Therefore, to induce changes in ELV systems will surely result in different impacts on competition, trade, attitude change of industries and others. However, it is impossible to discuss all different aspects from the changes in organising ELV systems. Thus, the evaluation will focus on core elements in a system and its following effects. Taking into consideration the scope of the thesis, the author chose the following criteria, which were considered as the most important ones to look, in order to fulfil the aim of the thesis. These are: environmental effectiveness; economic efficiency; monitoring; and stimulation of innovation.

Environmental effectiveness was chosen because it is directly connected to the purpose and objective of a system. In the context of an ELV system, the main purpose is to reduce environmental impacts from ELVs. Therefore, in order to examine to what extent an ELV system reaches the goal, environmental effectiveness is the most appropriate criterion.

As for EU ELV Directive, three main objectives can be identified. These are: waste prevention as first priority; increase of reuse, recycling and recovery while reducing final disposal; and improvement of the environmental performance of treatment facilities.

Waste Prevention can be measured by the following questions. For instance, has the amount of hazardous materials been reduced in new vehicles? Are materials that are easier to recycle being used in the manufacturing of new vehicles? What is the input of raw materials per unit of product? What is the percentage of reduction in the use of raw materials in a new vehicle? What is the percentage of recycled materials used in a new vehicle? How have products changed to be environmentally compatible such as the ease to be dismantled, the increase of recycled materials and the reduction of toxic materials used in new products? What has been changed in new vehicles to make them easier to be reused, be recycled, and be recovered? However, the data and information to answer these questions are not available. Data may not exist at a company level, since it may be too expensive for them to collect such information, and they do not have clear, objective, and standardised indicators to measure the level of waste prevention. Therefore, waste prevention in terms of environmental effectiveness is extremely difficult to examine. Thus, waste prevention will be discussed on the "stimulation of the innovation" criterion. By looking at the design of a system, the question on how it stimulates or hinders innovation can be more realistic to discuss.

Increase of reuse, recycling and recovery rates can be examined by looking at, for example, what is the percentage of ELVs that are delivered to environmentally sound dismantlers? What is the percentage of ELVs that follows the chain of good environmentally sound treatment? What are reuse, recycling and recovery rates of ELVs? Is there a reasonable calculation methodology existing? How accurate is it? Has there been an improvement in the quality of sorted materials from ELVs for recycling and recovery? Has there been improvement in collection and treatment infrastructures?

Performance improvement of treatment facilities can be measured by looking at, for example, whether there is any system to encourage improvement of the performance of treatment facilities and, if yes, how reliable the authorisation or certification is, and/or what the percentage of authorised treatment facilities is.

Economic Efficiency is very difficult to measure, especially for full economic efficiency evaluation, since it demands a wide range of data all different aspects of a system. However, the importance of economic efficiency cannot be disregarded. For example, if a system achieves a high recycling rate with high costs to maintain that system, then low efficiency may cause a negative social acceptability. In sum, low efficiency may lead to the failure of a system.

Owing to the difficulty of data collection on financial figures or even the data absence, only limited economic aspects are considered, for example, recycling costs of ELVs. Even with this limitation of economic efficiency, different economic efficiency of case studies can still be considered.

In terms of *Waste Prevention,* economic efficiency can be measured by answering, for example, what is the investment cost for producers to produce more environmentally compatible vehicles? What are the costs to produce more environmentally compatible vehicles? However, such questions should be based on information on environmental effectiveness. As for feasibility issue, such measures cannot be answered.

In terms of the *increase of reuse, recycling and recovery rates,* the following questions will help to reveal the economic efficiency. For examples, what are the costs to set up an infrastructure for collection? What are the costs to establish a good environmental treatment network? What are the additional costs to increase the reuse, recycling and recovery rates? What are the operational costs for organising a whole system? Has there been improvement in terms of cost reduction? Related to the *performance improvement of treatment facilities*, the economic efficiency can be measured by looking at, for example, the costs to set up authorisation for treatment facilities and the costs to improve treatment facilities. As long as data is available, such questions can be answered.

Monitoring is a very important criterion in an ELV system in order to see the progress of environmental effectiveness. Monitoring demands a set of data such as those related to deregistration, general number of scrapped vehicles, and number of scrapped vehicles in environmentally sound facilities.

However, self-monitoring is also important in the context of ELVs. For instance, monitoring the progress of the recycling rate requires accurate documentation from each actor of an ELV recycling chain. General monitoring may be extremely difficult if there is no self-monitoring and coordination among all actors.

In terms of W*aste Prevention,* monitoring system can be examined by looking at, for example, is there a monitoring system for product changes? Has there been improvement in the monitoring system for product changes? Often car producers distribute information on design change related to waste prevention in their annual reports. However, due to the limited scope of the thesis, it is excluded from the evaluation.

Monitoring system in terms of the *increase of the reuse, recycling and recovery rates* is important. It can be examined by looking at, for example, whether there is a monitoring system to measure the collection system, whether there is a good set of indicators to monitor the system such as deregistration number, total number of scrapped vehicles, total number of scrapped vehicles in environmentally-sound treatment chain, total number of abandoned vehicles, and whether there is a monitoring system to measure reuse, recycling and recovery. In addition, it can be examined how effective and accurate the reporting system is throughout each relevant actor in an ELV chain and/or whether there has been improvement of such monitoring system. For the *performance improvement of treatment facilities,* the level of monitoring can be seen by looking at, for example, whether there is any monitoring system to measure the improvement of performance. The reliability of monitoring should be concerned.

Stimulation of innovation is also a relevant criterion in an ELV policy. It is very difficult to measure its environmental effectiveness, especially related to waste prevention. An example could be, how a system stimulates producers, to work closely with suppliers to change the materials or components for waste prevention.

Does a system stimulate innovation for waste prevention? What are these innovations? How much and at what level the system stimulates innovation, are very essential criteria to look into from a *waste prevention* perspective. For the *increase of the reuse, recycling and recovery rate*, does a system stimulate innovation for increased reuse, recycling and recovery rates? What are innovations that stimulate the increase of reuse, recycling and recovery rates? The system can be examined by looking at these example questions. In terms of the *performance improvement of treatment facilities*, the system can be examined by looking at; does the system stimulate innovation to improve the performance of treatment facilities? What are the innovations that stimulate performance improvement of treatment facilities? These can be some examples of measuring a system level in terms of stimulation of innovation.

Other criteria such as administration and compliance costs; concordance with institutional framework; social and political acceptability; transparency; wider economic effects; and soft effects are excluded due to the absence of information, difficulty to measure, and also due to the scope of the thesis. Concordance with institutional framework was excluded since the EU ELV directive does not consider it as a benchmark for the system evaluation.

4. Sweden

The ELV issue emerged in Sweden in the early 1970s. Following the Car Scrapping Law and the Car Scrapping Ordinance, which were enforced in 1975, Sweden set up a system to deal with the ELV issue. However, the Swedish system faced a radical change, when the Ordinance on Producer Responsibility of 1997 was introduced.

Presently, two different ELV treatment systems run in parallel. For the vehicles registered before the 1st of April 1998, the car scrapping premiums are paid and for the vehicles registered after the 1st of April 1998, the producer responsibility principle is applied in physical and financial aspects of the ELV recycling.

4.1 Legal Framework

4.1.1 Car Scrapping Law of 1975

Upon the request of a Government Commission, the Swedish Agency for Administrative Development made a study on ELVs in 1971. The main purpose of the study was to formulate a system that could handle the environmental problems caused by poor performance of car-scrappers. This study also pointed out the importance of the issue of abandoned vehicles in nature and its potential consequence of governmental actions on car-scrappers. The Swedish Agency for Administrative Development considered to co-ordinate a solution for both problems. The Car Scrapping Law (SFS 1975:343) and the Car Scrapping Ordinance (SFS 1975:348) finally were enacted. These regulations provide the legal framework for car scrapping authorisation, certificates of destruction and car scrapping fees and premiums, in order to regulate abandonment of ELVs in nature and the environmental performance of dismantling facilities.

The Swedish car scrapping authorisation contains details of stated requirements for dismantlers to be authorised. By giving the right to the authorised scrappers to issue certificates of destruction, it is regulating the forms of deregistration. It is also stated in the Car Registration Ordinance (SFS 1972:599), which requires submission of certificates of destruction for vehicle deregistration.

The Car scrapping law supports the use of an economic instrument in the form of car scrapping fees and premiums. The car scrapping fees are levied when cars initially come out on the Swedish market, and are collected in a non-interest fund known as the Car Scrapping Fund, which is managed by the Government[41]. The Fund is used for paying scrapping premiums to last vehicle owners, who receive certificates of destruction from authorised car scrappers.

Government Bill 2000/01:47

The Government Bill 2000/01:47 dated the 7th of December 2000 and the parliamentary decision dated the 14th of March 2001 contain amendments to the Car Scrapping Law. To a certain extent, Bill 2000/01:47 implements parts of the EC directive (2000/53/EC)[42]. In addition, in terms of car scrapping fees and premiums, a notice is made to increase in the scrapping fees and premiums[43]. The scrapping fees and premiums will be more discussed in section 4.2.1.

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41 Lindhqvist, T. (2001). *Extended Producer Responsibility for end-of-Life Vehicles in Sweden*. p. 9.

42 Lindhqvist, T. (2001). p. 14.

43 Lindhqvist, T. (2001). p. 14.

4.1.2 The Ordinance on Producer Responsibility for Cars of 1997

In 1993, the Ecocycle Bill entrusted the Ecocycle Commission to define the terms of a producer responsibility system for ELVs, including quantitative targets on recycling and recovery, specific technical regulations, and a free take-back system. In 1994, the car producers, though their association, BIL Sweden (Bilindustriföreningen), presented a proposal to the Swedish Ecocycle Commission in 1995[44]. The proposal was based on a voluntary scheme for producer responsibility with an active participation from other industries concerned.

The Ecocycle Commission responded with another proposal containing legislated producer responsibility with extensive detailed regulations on ELV management. As a reaction, the strong opposition by the car industry brought a joint agreement among eight organizations and companies in the car-recycling field in order to support a voluntary scheme of producer responsibility[45].

A Government Bill containing a proposal for producer responsibility as a complement to the Car Scrapping Law was finally accepted by the Parliament in June 1996. The Ordinance on Producer Responsibility for Vehicles (SFS: 1997:788) was issued and entered into force on the 1st of January 1998. The main contents of the Ordinance are:

- *Scope:* the Ordinance covers vehicles, which have the gross vehicle weight less than 3 500 kg;

- *Collection:* Car manufacturers and importers (from now on called car producers) shall accept ELVs free of charge, which are registered for the first time in Sweden after the 31st of December 1997. This free take-back obligation does not cover vehicles, which have been stripped of economically valuable parts, or have been equipped with parts to a significant extent by others than the producers, which make difficult to re-use or recover;

- *Treatment:* Producers shall facilitate and designate suitable places for ELV collection and also ensure ELVs to be treated in accordance with the Car Scrapping Law (SFS 1975:343);

- *Information:* Producers shall provide information about the materials, components and chemical products in vehicles so that dismantlers have access to the dismantling instructions for dismantling and drainage;

- *Recycling target:* Producers shall ensure that the following targets for re-use, recycling, and recovery are achieved: at least 85 per cent by 2002 and 95 per cent by 2015. The percentage shall be calculated on the basis of the 'tjänstevikt (kerb weight)' and shall represent an average per producer annually;

- *Monitoring:* Producers are responsible for supplying the recycling information to the Swedish Environmental Protection Agency;

- *Role of the Environmental Protection Agency (EPA):* Swedish EPA may issue any further regulations necessary for the implementation of this ordinance.

The Environmental Protection Agency regulations on scrap vehicle operations (NFS 2002:2)

The Swedish EPA Regulations and General Advice on Scrap Vehicle Operations (NFS 2002:2) came into force on the 21st of April 2002. The Swedish EPA specifies regulations and advice for all scrap

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[44] Kvist, K., Hernborg, N., and Jansson-Liljenroth, U. (1997). *Environmentally compatible car recycling with producer responsibility in practice.* Society of Automobile Engineers, Inc.

[45] Kvist, K., Hernborg, N., and Jansson-Liljenroth, U. (1997). *Environmentally compatible car recycling with producer responsibility in practice.*

vehicle operations, in order to pursue the Environmentally Harmful Operations and Health Protection Ordinance (1998:899), and the Motor Vehicle Scrapping Ordinance (1975:348). These regulations are applicable to the storage, emptying, dismantling and other commercial handling for scrapping vehicles. In addition, it regulates certain substances and components to be recovered. Vehicle glasses, for instance, should be dismantled and recovered from 2002 and vehicle plastics will be included from 2006. Main contents of these regulations and advices are summarised in Appendix 1.

4.2 End-of-Life Vehicle Systems in Sweden

Since the Ordinance on Producer Responsibility (SFS 1997:788) was introduced, two different system mechanisms run in parallel, especially in terms of financing. For the vehicles registered before the 1st of January 1998, the last owners can receive car scrapping premiums from an authority by submitting certificates of destruction. Then, the last owners negotiate treatment costs with dismantlers. For the vehicles registered after the 1st of January 1998, the last owners can deliver and hand in their vehicles to certain collection stations designated by car producers. Figure 2 describes the Swedish system in practice, which combines two different financial mechanisms.

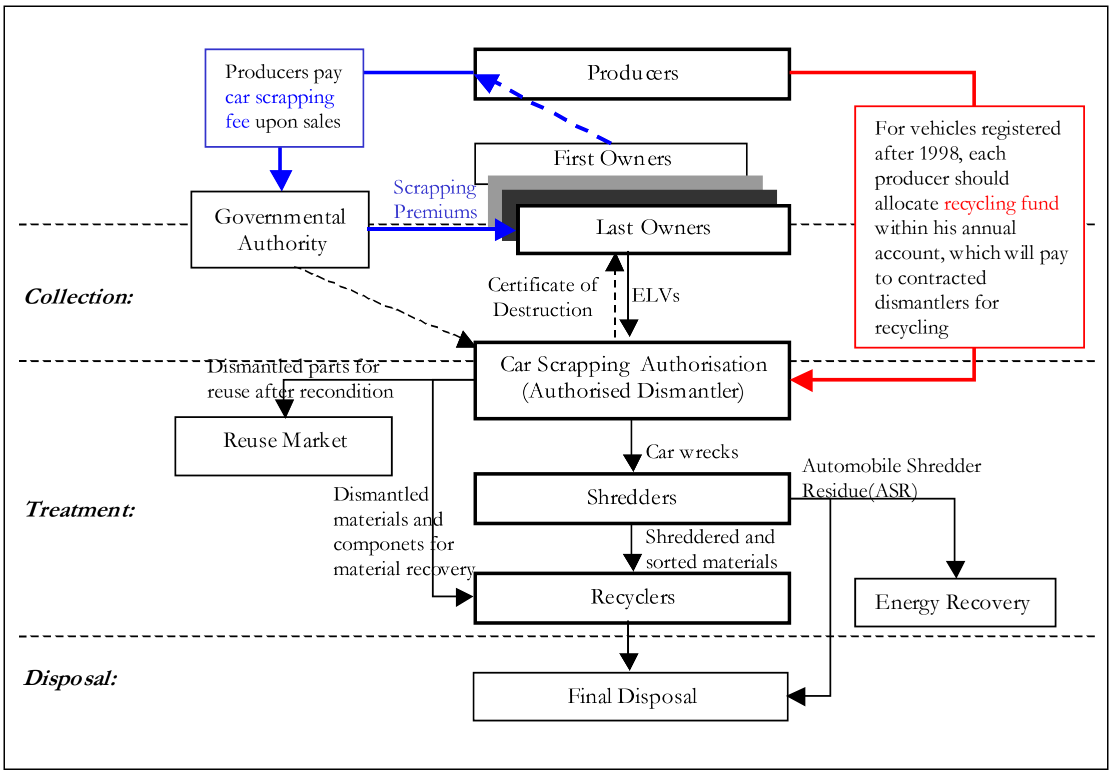

Figure 2. The Swedish end-of-life vehicle system with physical and financial flows.

4.2.1 System Design

This section provides descriptive information on the Swedish ELV system. The description focuses on the use of different policy instruments for collection, dismantling, shredding, and material recycling. In addition, a monitoring system is presented. A specific intention to choose the description style was made. Considering the purpose of the thesis, the author believes that this description style will help readers to understand the use of different policy instruments.

4.2.1.1 Collection

Car Scrapping Authorisation & a Certificate of Destruction

Car scrappers may apply for car-scrapping authorisation at the County Administrative Board. Car authorisation allows issuing certificates of destruction to last owners upon receiving their ELVs. Only authorised car scrappers have the right to issue the car-scrapping certificates of destruction, which are required by law to de-register vehicles for scrapping purpose. As long as a car is registered, the car owner is obliged to pay taxes and charges for traffic insurance. The combination of the car-scrapping authorisation and the certificate of destruction are intended to secure ELVs to enter to proper treatment facilities.

Temporary deregistration and Administrative deregistration

According to the Car Registration Ordinance (SFS 1972:599) on car deregistration, a last holder of vehicle has three ways to deregister his vehicle depending on purpose: (1) deregistration for end of use, (2) deregistration for export, and (3) temporary deregistration for temporary end of vehicle use. Deregistration allows a vehicle owner to be exempt from taxes and charges for traffic insurance.

For (1) deregistration for scrapping, a last owner is required to submit a certificate of destruction to an authority. Upon deregistration, the last owner receives a car scrapping premium. The premium is used for a scrapping cost, which the last owner has to negotiate with a dismantler. The premium, in most cases, covers the scrapping cost and can leave some money to the last owner.

If a last holder wants to (2) deregister his vehicle for export purpose, he should prove its purpose to an authority. In this case, the car scrapping premium is not paid.

A vehicle holder can (3) temporarily deregister his vehicle during the time that a vehicle is not in use. The maximum period for temporary deregistration is continuous three years. If a vehicle holder does not re-register his car after successive three years, an authority deregisters the car permanently if the owner is not reachable. It is called, 'administrative deregistration'. The authority has not been able to trace the final destination of the administratively deregistered vehicle. It can be scrapped somewhere or stored, or abandoned.

The Swedish system does not have a system to measure abandoned cars in nature.

Car Scrapping Fee/Premium

To support ELV collection, the car scrapping premium system has been designed, in order to give an economic incentive for the last owners. In order to support premiums, fees are charged from first owners through the hands of producers. The car scrapping fees are collected as a car scrapping fund, which is managed by the Government. Car scrapping fees and premiums have been adjusted several times. Table 1 shows the change of car scrapping fees and premiums over time.

The Swedish scrapping fees are a type of flat fee, so are premiums, which do not reflect the level of recyclability or ELV value at recycling market. The premium differentiation during 1992 and 1997 was only based on whether vehicles were approved to be safe to drive by an annual inspection before scrapping. By encouraging an annual inspection through the higher premium, the Government intended to scrap more vehicles, which are not supposed to run for safety reasons. Therefore, this differentiation does not reflect the recycling value or recyclability of ELVs.

According to the Government Bill 2000/01:47, an amendment to the Car Scrapping law, the scrapping premiums are radically increased. The main purposes of these changes are to reduce the abandoned vehicles in nature and to compensate the actual recycling costs for the dismantlers[46]. According to the

[46] Email communication with Erik Westin at the Swedish EPA.

recent report from the Government, a considerable number of certificates of destruction from extremely old vehicles and ELVs that were stored have arisen[47].

Table 1. Several adjustments of the Swedish car scrapping fees and premiums

Time	Car Scrapping Fee	Car Scrapping Premium
January 1st, 1975	250 SEK	
January 1st, 1976	250 SEK	300 SEK
April 1st, 1988	250 SEK	500 SEK
July 1st, 1988	300 SEK	500 SEK
January 1st, 1992	850 SEK	500 SEK / 1 500 SEK*
November 1st, 1993	850 SEK	500 SEK / 1500 SEK*
January 1st, 1994	1 300 SEK	500 SEK / 1500 SEK*
January 1st, 1998	700 SEK	500 SEK
Since July 1st 2001	700 SEK	700 SEK for up to 7 years old cars
		1 200 SEK for 7 to 16 years old cars
		1 700 SEK for more than 16 years old cars

**The higher premium level is for cars approved by the annual vehicle inspection within 14 months before scrapping.*
Source: BIL Sweden. (2002).

Free take-back for the last owners of vehicles registered after the 1st January 1998

According to the Ordinance on Producer Responsibility, car producers shall provide free take-back systems for the vehicles, which are firstly registered after the 1st of January 1998. Producers shall designate sufficient collection points. Producers are obliged to provide this information to the Swedish EPA and to the public.

4.2.1.2 Dismantling

Car Scrapping Authorisation

To be authorised, dismantlers must have been granted a licence for the business. Their buildings, warehouses, and/or other facilities should fulfil all requirements. In addition, they should have access to a machinery plant for further transformation of ELVs. Or they should guarantee proper recycling of ELVs, for example, by signing an agreement with another party[48].

Requirements for Dismantling

The Swedish EPA passed the regulation on scrap vehicle operations (NFS 2002:2) (detailed information presented in Appendix 1). NFS 2002:2 regulates more detailed requirements for dismantlers, such as technical standards, including the list of materials and components to be drained and dismantled. Additionally, it regulates reporting obligation to all authorised dismantlers on their performance to the Swedish EPA.

Producer network

Since the Ordinance on Producer Responsibility was introduced, the role of car producers in Sweden becomes critical for ELV recycling. The ordinance requires producers to take physical and financial responsibilities on ELV recycling but allows freedom for designing how to fulfil this obligation.

Most of Swedish car producers take a mixture of individual and collective actions. As a collective action, 24 BIL members agreed to establish the BIL Automobile Producer Responsibility Sweden (BIL

[47] Naturvårdsverket. (2002).*Samla in, återvinn! Uppföljning av producentansvaret för 2001, Men också mycket mer*. Rapport 5237. p. 20.

[48] Rydén, E. (1995). *Car Scrap: Throw it away? Or Make it pay?*. Lund, Sweden: IIIEE, Lund University. p. 33.

Producentansvar Sverige AB: BPS in short), in 1999. One of the main objectives of BPS is to develop a network by selecting good performing dismantlers among the authorised so as to ensure the quality and environmental management of the vehicle recycling system[49]. The BPS network, at this moment, consists of 80 selected authorised dismantlers[50]. BPS, together with car producers, is today designing a new type of network in order to improve the efficiency[51].

Each producer individually selects the number of dismantlers within the BPS network, considering his market sales. This means that within the BPS network, each car producer establishes its own network. For instance, Volvo Personvagnar Sverige AB has a network with 70 dismantlers, Saab (cooperates with all GM brands, Fiat, and few Japanese brands) with 50, K.W. Bruun Autoimport AB (Peugeot) with 65, BMW with 5[52]. Recycling costs that car producers have to pay are negotiated individually with contracted dismantlers.

4.2.1.3 Shredding and Recycling

Voluntary Action to Regulate a Delivery Condition of Scrapped Metals

By law, dismantlers should have access to further treatment facilities. There are two companies running shredders in Sweden. Stena Fragmentering AB, the biggest shredder in Sweden encourages dismantlers, including all scrappers, to follow the delivery regulation for scrap materials (see Appendix 2). It regulates certain conditions of car wrecks before processing into shredding.

Concerning the automotive shredder residue (ASR), Stena has been closely working with car producers for improvement of shredding technology, to reduce the amount of ASR, and to find alternatives to use ASR.

Requirement for Material Recycling

By law, materials, which are required to be dismantled, are also required to be recycled. Together with this requirement, recyclers have a reporting obligation on their performances. Considering the lack of recycling market, the Swedish legislation allows vehicle plastic parts to be dismantled and recycled from 2006. Since there has been a development of technology and market for vehicle glasses, these are required to be dismantled and recycled from 2002.

4.2.1.4 Monitoring

Monitoring by Swedish EPA

The Swedish EPA is a monitoring body for the overall Swedish ELV system. Monitoring contains several aspects, such as an overview of the Swedish ELV system, a collection infrastructure including producer networks, recycling facilities and their performances, recycling and recovery rates and so on. Monitoring system demands a proper allocation of responsibilities and coordination of different actors.

By law, all authorised dismantlers are obliged to report their dismantling performances to the Swedish EPA. Apart from the dismantlers within the producers' networks, only around five authorised

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[49] Other objectives are to find suitable recycling process and market for recycled materials from ELVs both in Sweden and abroad; to develop tools and methods for rational handling in order to contribute a high international standard in Swedish ELV recycling system.

[50] Personal communication with Nils Hernborg at BPS.

[51] This is under negotiation at this moment. The details of the new network will be announced around the end of August 2002.

[52] Personal communication with each car producer

dismantlers annually reported their performances. Thus, the Swedish EPA recognises it as a problem and seeks for alternatives how to improve the monitoring system[53].

Self-Monitoring by car producers

The Swedish producers show strong commitments to the reporting obligation. Through the car producers association, BIL Sweden, a reporting model was designed and approved by the Swedish EPA. The BIL self-monitoring system requires all network dismantlers to report their performances with accuracy. Every year quarter, BIL Sweden collects reports from actors within the entire recycling chain and prepares the general report of the entire producer network. The report from BIL Sweden is used for the Swedish average recycling and recovery rates.

4.2.2 Role of main actors

To maintain a good system, the roles of respective actors are essential elements. The **last owners** should perform a hand-in duty. **Dismantlers** are important economic actors. Their role in proper depollution and dismantling process is of major importance to reduce the environmental impact of the ELVs. In Sweden, around 150 to 200 scrappers are dealing with ELVs. The authorised dismantlers are around 150[54]. Due to the car scrapping authorisation and the certificate of destruction, serious environmental impact from dismantling operators has not been reported. **Shredders** in Sweden do not accept untreated ELVs for shredding process.

The **car producers** play an important role in the Swedish ELV system. The active participation from the car producers has been started from the mid 90s. Due to the threat of the producer responsibility on ELV recycling, Volvo and Saab took initiatives to conduct pilot projects in 1994. The Environmental Car Recycling in Scandinavia (ECRIS) project by Volvo and the plastic recycling project by Saab were aiming to develop certain ELV recycling technologies. In addition, Saab has built a dismantling facility, in order to learn and develop dismantling skills. After introduction of the producer responsibility on ELV recycling, Saab, together with Volvo, is working for the improvement of dismantling activities. The lessons from participating in the dismantling process facilitate the design improvement of new vehicles[55].

BIL Sweden, the car producers association, together with **BPS,** also plays an important role in ELV recycling. As a collective action, BIL Sweden and BPS is developing and improving the efficiency of the producer network, continuously organising different developing projects. In addition, BPS, together with the Competence Centre, is also developing the market for recycled materials, including co-ordination of material sources and logistics to enlarge material volumes, and is searching for purchasers of dismantled materials among raw material suppliers, car component suppliers, and car industries and others[56].

Authorities are important. The Government manages the scrapping fee and premium system, controls recycling facilities through regulatory instruments such as NFS 2002:2 and standards, establishes better communication channels to the producers to support, and so on. The **local authority** is responsible to monitor dismantling sites in their areas.

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[53] Personal communication with Erik Westin at the Swedish EPA.

[54] European Ferrous Recovery & Recycling Federation (EFR). *European shredder group-economic operators*. [Online]. Available: http://www.efr2.org/EFR-ESG3.htm [2002, June 10]

[55] Personal Communication with Joakim Halvarsson at Saab Automobile AB.

[56] BIL Producentansvar Sverige AB (BPS). (2002). *BIL automobile producer responsibility Sweden.*

4.2.3 Findings and Discussion

4.2.3.1 Effects of Car Scrapping Fee and Premium System

The number of new registration and of certificates of destruction

As Table 1 shows, the scrapping fees and premiums have been changed several times. According to the number of new registrations and of certificates of destruction over time (Figure 3), the scrapping fees and premiums may have some influence in different aspects.

In 1992, the **scrapping fee** radically increased from 300 SEK to 850 SEK. New registered vehicles decreased in that year. However, new vehicle numbers had continuously declined after 1988 so that it is difficult to say that radical increase of scrapping fee results the decrease of 1992 and 1993 new registrations. In 1994 when the scrapping fee radically increased from 850 SEK to 1300 SEK, the number of new registrations increased and the following years show the same phenomena. It can be concluded that scrapping fees do not influence the vehicle purchasing. Vehicle purchasing is more influenced by the growth of the Swedish economy.

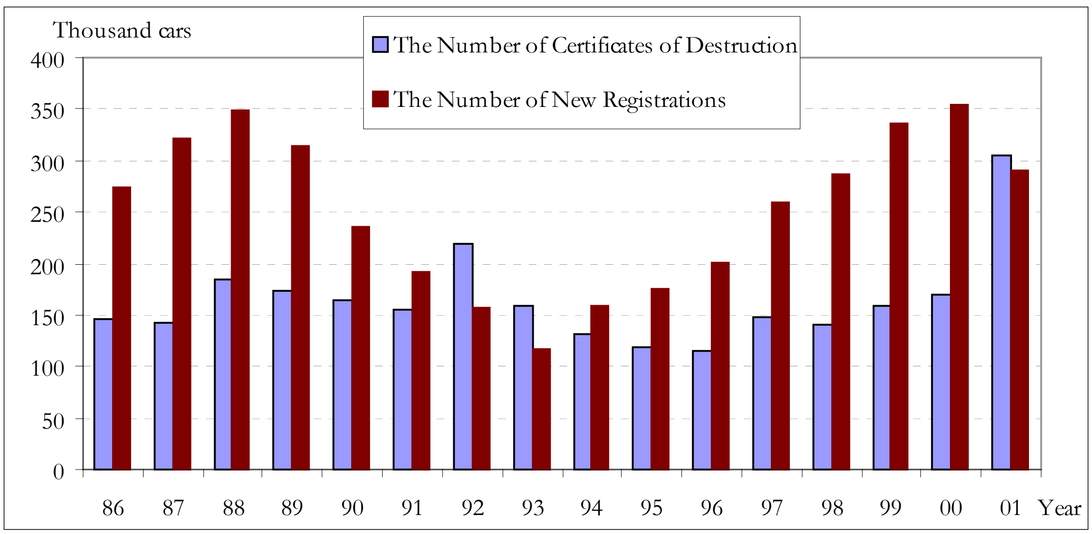

Figure 3. The number of new registrations and the number of certificates of destruction during 1991and 2001 in Sweden.

In 1992, the differentiated **premiums** were introduced. The outcome of scrapping premiums seems to bring the increased number of certificates of destruction in 1992 and 1993. However, certificates of destruction decreased again in 1994. During 1994 and 2000, certificates of destruction do not seem to be influenced by differentiated premiums. Especially if looking at the situation in 1998 when the premium went down to 500 SEK without differentiation, the total number of certificates of destruction maintained a similar level as the one in 1997.

In 2001, when a radical change in the scrapping premiums was introduced, the number of certificates of destruction dramatically increased: 284 313 certificates of destruction were issued, compared to 158 803 in 2000. This radical increase of premium seems to strongly influence the car scrapping. Not knowing the future, it is still a question whether the number of certificates of destruction will be maintained in the following years. It seems that this radical increase in 2001 is a temporary one similar to what we have seen in 1992. This radical change might come from a misuse of the premium system from certain groups of people. Those who know about this governmental announcement purchased ELVs and waited for the increase of premiums. After the premiums increased, they deregistered these purchased ELVs and got profits.

Collection Rate

'Collection' is defined as collection of ELVs, which are delivered to the authorised dismantlers. **The collection rate, here, is defined by the author, as how many ELVs were collected and delivered to the proper treatment facilities among the total number of ELVs generated, including abandoned vehicles and scrapped vehicles by uncontrolled dismantlers.** Since it is aimed that ELVs should be treated in environmentally sound performing treatment facilities, the author believes that how many ELVs are collected and delivered to authorised (or approved) dismantlers should be considered as true collection for an ELV system. The number of exported vehicles should be excluded in the calculation of collection rate. As long as vehicles left the territory of the system, the recycling duty is not in control of the system.

Due to the car scrapping authorisation system in Sweden, the certificate of destruction is considered as a proof that an ELV enters the environmentally sound treatment chain. Thus, the author calculates the collection rate as such.

$$\frac{\text{Total number of ELVs scrapped by authorised dismantlers}}{\text{Total number of ELVs generated}} \times 100$$

During the data collection of the total number of deregistration, the number of administrative deregistration, the number of deregistration for export, the author found out there is inconsistency in data in the sources. For instance, for the number of administrative deregistration, the Statens Institut för Kommunikationsanalys (SIKA) shows higher numbers than the National Road Administration (Vägverket). The author chose data from Vägverket, who primarily provides the deregistration information[57]. However, data that is not available at Vägverket, was used from SIKA (See Appendix 3).

In order to calculate the Swedish collection rate, the author searched data on **abandoned vehicles in nature**[58]. There was no actual data on how many abandoned vehicles are generated annually. However, according to Lars Alm, a campaign project leader at 'Keep Sweden Tidy (Håll Sverige Rent)', the total number of ELVs including abandoned vehicles collected from this first national campaign will be 80 000. He mentioned that total number of abandoned vehicles would be half of these number. To date, there are 58 137 collected by this campaign (statistic data on September, 2002), which is still ongoing till 2004[59].

Based on this information, the author estimated the number of abandoned vehicles generated per year. Since this campaign is the first one since 1975, the author calculated that 40 000 (50% of 80 000) divide by 30 (from 1975 to 2004 when the campaign will end) so that an approximate abandoned vehicles generated in Sweden per year is **1 333**. This estimation is far from what have been reported in press

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57 Personal communication with Karim Barsoum at Vägverket

58 There is no data existing in Vägverket, nor in the Swedish EPA. The author approached Malmö municipality. No data was found in the environmental department. Only possible finding was from interview with the street department (Gatukontoret), which mentioned that they do not collect such data over years. The author contacted the County Administration (Länsstyrelsen) in Malmö. There no data was found. Recommended by Länsstyrelsen, the author contacted with Hans Zetterling (an expertise in vehicle issues) at the Swedish EPA branch office in Halmstad. No data were found. Recommended by Hans Zetterling, the author contacted Lars Alm at 'Keep Sweden Tidy (Håll Sverige Rent)', a non-profit organization that has been conducting campaigns on abandoned vehicles, together with collecting ELVs from private owners upon request.

59 Further detailed number of ELVs including abandoned vehicles in each province, please see their website and section 'Statistik på anmälda skrotbilar'. http:// http://www.hsr.se/sa/node.asp?node=1145

over last years[60]. However, none of published information seemed to be based on actual data, but from unexplained assumption.

Together with information from Lars Alm, the high premium does not prevent the generation of abandoned vehicles. Even more abandoned vehicles can be generated due to the financial burden that last owners may face from requested recycling costs from dismantlers. Thus, the author assumed that the average estimated number of abandoned vehicles is equally distributed over years without a significant fluctuation.

The author also looked at the number of administrative deregistration from Vägverket. From 1991 to 2001, total 14 268 of vehicles have been deregistered by the authority. 14 268 should be divided by 11 years[61] so that **1 297** vehicles are administratively deregistered per year. Owing to uncertainty on the administrative deregistration processes, the author considered the average administrative number as the annual generation of administrative deregistration.

Comparing the two estimated numbers, the author found out that there is no big difference between the average number of abandoned vehicles and the average number of administrative deregistered vehicles.

In conclusion, there was no possibility to find out the collection rate for each year so that there is no possibility to find out the effect of different premiums on the generation of abandoned vehicles in Sweden. Therefore, it is wrong to say that higher premium would prevent or reduce the generation of abandoned vehicles.

Based on the findings above, the annual average number of abandoned vehicles with assumption, the general collection rate in the Swedish system can be roughly estimated. Comparing the number of certificates of destruction and average number of administrative deregistration, the collection rates in the Swedish system seems very high, for example one in 2000 is 99 per cent. The generation of abandoned vehicles seems rather to be influenced by the delivery inconvenience that the last owners face when considering the large number of abandoned vehicles in the Northern part of Sweden[62]. High collection rates have been already stabilised in the Swedish system due to the combination of the premium system, the certificate of destruction, proper deregistration system and car scrapping authorisation.

Recycling and Recovery rates

As one of the indicators to measure the outcome of recycling performance, recycling and recovery rates are used. The Swedish ELV system, in 2001, reached 81 per cent of reuse and recovery rates[63]. Since vehicle glass from ELVs are regulated to be dismantled and recycled from 2002, along with the development of vehicle glass recycling in Sweden, it will be interesting to see how the new requirement of vehicle glass recycling would influence recycling and recovery rates of the ELV system in a near future.

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[60] For instance, two press releases from 'Keep Sweden Tidy' had reported the estimation data on abandoned vehicles existing in Sweden. One in 2000 mentioned that there are 1 million abandoned vehicles existing in Sweden and the later one in 2001 mentioned 300 000 abandoned vehicles existing. From the interview with Lars Alm, information on both figures came from Vägverket. In conclusion, it seems that there was no clear and reliable information how many abandoned vehicles are generated in Sweden.

[61] Due to the unknown situation on how administrative deregistration has been done, whether it have been regularly or on irregular basis. Therefore, in order to get an approximate number of the average number of administrative deregistration per year, such a calculation was made.

[62] www.hsr.se.

[63] Naturvårdsverket. (2002).*Samla in, återvinn! Uppföljning av producentansvaret för 2001, Men också mycket mer.* Rapport 5237.

Calculation Methodology for Recycling and Recovery Rate

The Swedish system sets up a calculation methodology based on actual measuring methods.

The Ordinance on Producer Responsibility provides a legal basis for the recycling calculation. It is regulated to use 'tjänstevikt' (kerb weight) as base. The kerb weight can be defined as a weight of an empty vehicle without a passenger or payload, but including oil, gas, coolant, and other standard equipment[64]. In Sweden, the average weight of vehicle is defined as 1 200 kg, at present. 1 200 kg is calculated from the total kerb weight of registered vehicles (based on model number and its kerb weight) divided by the total number of registered vehicles. The information of the total number of registered vehicles and their models are available at Vägverket. For the calculation of the average ELV weight, the average weight of drivers, 70 kg is excluded. In sum, the average ELV weight is that 1 130 kg is used in the Swedish system. 1 130 kg includes a full tank, 46.5 litres on average, and other liquids, 14 litres on average[65].

Parts for reuse, dismantled materials for recycling, and body shells, are actually measured at the dismantler level. The information on how much each material weighs is followed by its physical flow to its final destination. After receiving materials, recyclers measure and report the amount of materials recycled, recovered, and/or landfilled. However, a metal recycled percentage is measured on an annual base. Stena provides information on the average percentage of ASR, when it conducts an annual cleaning process of the shredding facility. Stena measures the total weight of ASR and calculates what percentage of metals is recycled. In 2001, the average percentage of the metal recycled was 75 percent of the body shell weight. At present (in 2002), around one percentage increased (thus, 76%) owing to technical improvement[66].

4.3 Economics of End-of-Life Vehicle System

Since two different systems are running in parallel, the financing Swedish ELV system shows two different financial mechanisms. For the vehicles registered before 1998, the car scrapping fee and premium system runs. First owners, through hands of car producers, pay scrapping fees and last owners receive scrapping premiums, partly or all of which compensate to dismantlers for recycling costs.

For the vehicles registered after 1998, no scrapping premium is paid to last owners. However, scrapping fees for new vehicles are still collected to support the scrapping fund. The free take-back duty of car producers is regulated to allocate the future recycling costs for their new vehicles upon sales. The amount and method to allocate recycling costs are under freedom of each producer. (Table 2)

4.3.1 The Car Scrapping Fund

System design for car scrapping fund

The car scrapping fund is collected by scrapping fees from the new vehicles, when producers put vehicles on the Swedish market. The car scrapping fees are still collected for all new cars.

The scrapping fund can be used for car recycling related purpose[67]. For instances, during 1990 to 1993, around 9 million SEK has been used for local authorities to finance local scrapping and clean-up

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64 Audi. (2002). Autdi Lexicon. [Online]. Available: http://www.audiusa.com/lexicon/0,4824,categoryId-2_,00.html [2002, July 18].

65 Naturvårdsverket. (2002).*Samla in, återvinn! Uppföljning av producentansvaret för 2001, Men också mycket mer*. p. 58.

66 Telephone conversation with Joakim Halvarsson at Saab Automobile AB on the 16th of July 2002.

67 SFS 1975:343 Bilskrotningslagen, §7.

campaigns for reducing the presence of car wrecks in nature. The tyre recovery sector received 2.5 million SEK during 1991 to 1993 and shredding activities received 2 million SEK during 1993[68]. The car scrapping fund also subsidised the collection of old batteries from vehicles by the company, Returbatt, which was established in 1988 with common interests of the battery industry, the recovery industry and the Swedish scrap merchants. From 1989 to 1991, around 20 million SEK from the scrapping fund financed the collection system before the new legislation for batteries was in force in 1991[69].

However, the main purpose of the scrapping fund is to pay the scrapping premiums to the last owners in order to give economic incentives for hand-in duty. On the other hand, the premium is not paid to vehicles, which are deregistered for export. Therefore, the deregistered vehicles for the purpose of export supports the scrapping fund. Since the Swedish used car export market is relatively small, less than 10 per cent at maximum (Figure 4), there has been no critical voice heard. However, in case of an expansion of the export market for used cars, the design of the funding system may be reconsidered.

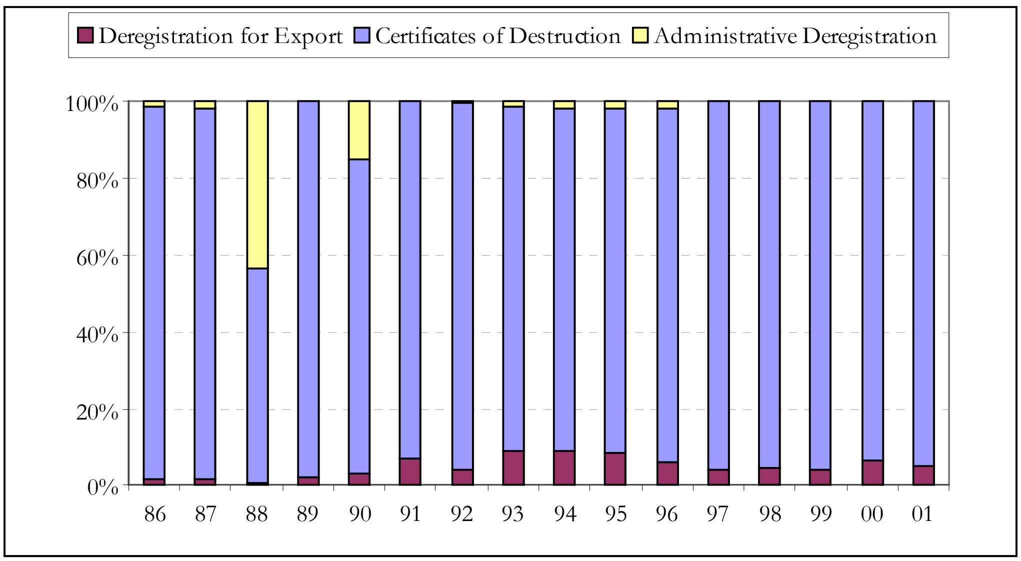

Figure 4. Overview of certificates of destruction, deregistration for export, administrative deregistration during 1986 to 2001.

Discussion on the Scrapping Fund

The scrapping fees and premiums have been raised several times (Table 1). The fund management has received a lot of criticism especially after the radical change of high premiums in 2001. Even though the Government recognises the potential risk relating to unsustainable financing of the car scrapping fund, the Swedish EPA announced that it is too early to judge the reasonability of the radical change of 2001 at this time[70]. Additionally, the Government is discussing about the fund management, whether a public sector or private sector should manage it for the more sustainable management. However, no clear plan is announced[71].

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68 Rydén, E. (1995). *Car Scrap: Throw it away? Or Make it pay?* p. 37.

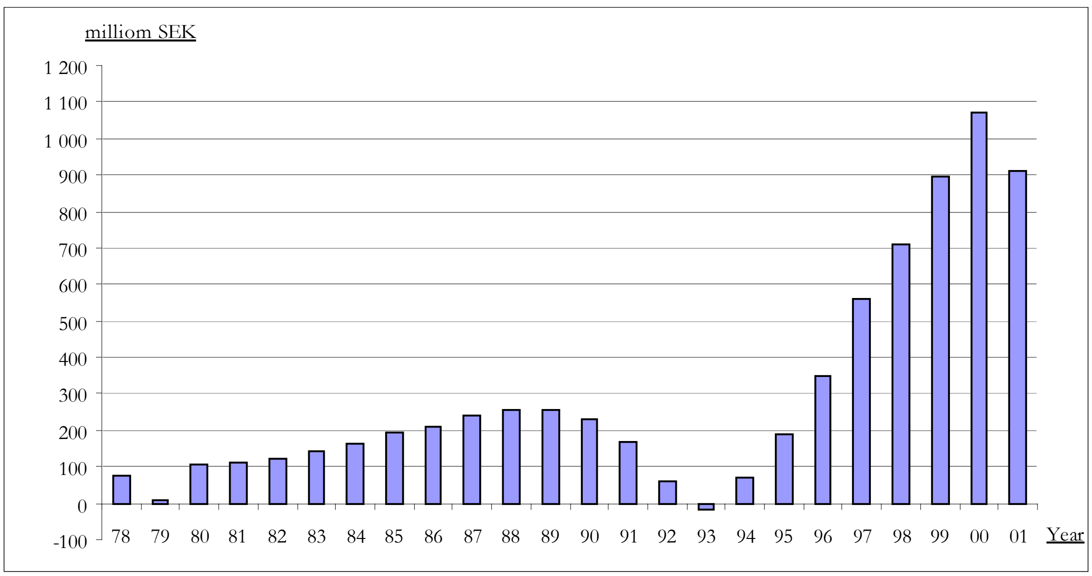
69 Rydén, E. (1995). *Car Scrap: Throw it away? Or Make it pay?* p. 37.

70 Naturvårdsverket. (2002). *Samla in, återvinn! Uppföljning av producentansvaret för 2001, Men också mycket mer.* p.20.

71 Naturvårdsverket. (2002). *Samla in, återvinn! Uppföljning av producentansvaret för 2001, Men också mycket mer.* p. 20.

The balance of the car scrapping fund in Figure 5 shows that the fund declined from 1989 and dramatically decreased in 1991 and 1992, and finally reached a negative balance in 1993. Among other reasons, this was the outcome of the increasing premium in 1992, which resulted in substantially increased numbers of scrapped cars. At the same time, the sale of new cars was fading owing to the overall financial state in Sweden[72].

In 1994, the Government raised the scrapping fee from 850 SEK to 1 300 SEK, in order to cover the negative balance of the scrapping fund and finance the high differentiated scrapping premiums. As it is seen earlier, the number of new vehicles registered sine 1994 has increased. On the other hand, the differentiated premium did not contribute to the increase of the total number of certificates of destruction (Figure 3). Consequently the scrapping fund has been rapidly accumulating. In 1998, another adjustment was made for the scrapping fee and premium. The sufficient amount of the fund balance helped to reduce the scrapping fee to 700 SEK, which is lower than the 1992 premium. However, owing to continuous increase of the number of new registered cars, the fund balance has increased slowly. The rapid drop of the fund balance in 2001 is the outcome of the designated high premiums of 2001.



Source: Vägverket. (2002). (See Appendix 4. for figures of the actual amounts)

Figure 5. The Car Scrapping Fund Balance in Sweden during 1978-2001.

It is difficult to conclude that the Swedish scrapping fund system is sustainable. There are several points identified to support this argument. First, the significant increase of the scrapping fee in 1992, and again in 1994, gave a heavy economic burden to new vehicle purchasers during 1992 to 1997. Considering a continuous increasing amount of the fund balance and the increase of new vehicles, 1 350 SEK during 1994 to 1998 seems to be determined too high. Second, the Government seems to introduce the high and differentiated premiums in 2001 in order to lower the fund balance, when taking into consideration the stabilisation of a high collection rate in Sweden.

4.3.2 Recycling cost for vehicles in free take-back system

Without demanding a high environmental performance in ELV scrapping, to scrap ELVs would generate profits for dismantlers. However, such environmental demand adds around 100 per cent

[72] Rydén, E. (1995). *Car Scrap: Throw it away? Or Make it pay?* p. 38.

increase of expenses for dismantlers[73]. These expenses are mostly due to the additional working time for de-pollution and dismantling, which shows in labour costs.

According to the ordinance on producer responsibility, car producers are regulated to pay these additional costs to dismantlers. Car producers are obliged to allocate certain funds for the future recycling costs for vehicles registered after 1998. By law, it is required to show the fund allocation in the annual accounting report.

In Sweden, two ways of the recycling fund allocation by car producers are identified. The most common way is that each producer allocates and saves certain funds for future recycling cost per vehicle within an annual company's financial account. The other way is that a car producer buys a recycling insurance from an insurance company. There is one insurance company that offers recycling insurance in Sweden. Table 2 shows the different recycling costs per vehicle, which an individual car producer allocates or manages.

Table 2. Recycling costs allocated for the vehicles registered after 1998 by each car producer in Sweden.

Car Producers (Coverage of Car Brand Names)	**Recycling cost**	
	3% interest applied	**5% interest applied**
Volvo Personvagnar Sverige AB and Volvo Personbilar Sverige AB (Volvo, Renault, Jaguar, Land Rover)*	840 SEK	823 SEK
Saab Automobile AB and Saab Opel Sverige AB (SAAB, Opel, Chevrolet)*	704 SEK	690 SEK
BMW Sverige AB (BMW, Mini)*	813 SEK	812 SEK
Svenska Volkswagen AB (Volkswagen, Audi, SEAT, Skoda, Porche)*	1344 SEK	1316 SEK
Toyota Sweden AB (Toyota)**	1 300 SEK	
Svenska Honda Bilimport AB (Honda)**	1 367 SEK	
Italienska Bil AB (Fiat, Alfa Romeo)**	1 300 SEK	
K.W. Bruun Autoimport AB (Peugeot)**	1 300 SEK	
Olle Olsson Bolagen AB (Mazda, Suzuki)	Through LF Miljö AB, insurance company: different recycling insurance costs based on car models, however in general, around 1 300 SEK***	

*Annual report 2001 of each car producer
** Personal communications undertaken by the author
***Personal communication with Bengt Appelqvist, VD, Mazda Motors AB.

It is seen in Table 2 that there are some differences in the fund allocation among car producers. Owing to the high uncertainty in calculating future recycling costs, most of car producers are following the suggestion of BIL Sweden, which is 1 300 SEK per vehicle. The suggestion is based on the outcome of the economic subproject within the ECRIS project.

Among car producers, Volvo, Saab, and BMW show lower fund allocation. Saab, together with Volvo, has conducted several studies on dismantling skill and technology in order to improve dismantling efficiency, consequently to reduce the cost. Their lower allocation seems to reflect such efforts.

73 Naturvårdsverket. (2002). *Samla in, återvinn! Uppföljning av producentansvaret för 2001, Men också mycket mer.* Rapport 5237. p. 19.

Calculation on recycling costs by BIL Sweden

The recycling costs estimated by the BIL Sweden, 1 300 SEK, is based on the outcome of the ECRIS project. The Economic subproject within ECRIS used a Volvo 700 model for the calculation, with consideration of 85% of total recycling with low (78 %) and high (81%) material recovery.

The following estimation for recycling cost by BIL Sweden reflects **81 per cent material recovery, considering 95 per cent total recovery target**.

Income for selling metal and catalytic converters	+ 100 SEK
Fixed cost for handling ELV(administration cost, insurance cost etc.)	- 700 SEK
Costs for draining, handling of risk and hazardous waste etc.	- 270 SEK
Costs for additional dismantling 6% more materials (labour etc.)	- 350 SEK
Total	**- 1220 SEK**

Source: BIL Sweden. (1998).

The total of 1 220 SEK was estimated in 1996. Subsequently, BIL Sweden considered 3 per cent of annual cost increase rate. In this calculation, around **510 SEK as the labour cost per hour** and **73 min of dismantling time** are applied.

Calculation on recycling costs by Saab Automobile AB

1) 2001 study

In the summer 2001, Saab Automobile AB conducted an economic study of ELV recycling costs. The main objective of this study was to examine the actual dismantling costs and also to foresee the future recycling costs regarding the increasing recycling targets required by the law.

From Saab's own dismantling testing and workshop experiences, Saab calculates the recycling cost, which is considering 84 per cent of total recycling and recovery rates. Table 3 shows the summary of the cost calculation conducted by Saab in 2001.

Table 3. The recycling cost conducted by Saab Automobile AB in 2001.

Category	Average time (min.)	Labour Cost (420 SEK/h)	Development/Investment cost (140 SEK/h)	Material Value (SEK)	Total (SEK)
Pre-treatment	72	504	168	-80	
Glass dismantling	15	105	35	-30	
Personal time 10%	9	61	20		
Distribution time 15%	14	100	33		
Total (SEK)	110	770	256	-110	1026

Source: Saab Automobile AB. (2001).

For the recycling cost calculation, Saab constructed two main processes, which are pre-treatment and increased dismantling process for vehicle glass. Pre-treatment is divided into three areas: administration; internal transports; and a practical part. Administration includes identification checking, de-registration, recycling reports and other administration process. Internal transports include internal transportation of car wrecks and dismantled materials. The practical part is mostly to dismantle materials based on legal requirements.

For estimation of time consumption of each step, Saab measured the average time consumption and applied **20 min. for administration, 11 min. for internal transports,** and **41 min. for the practical part**. For the **increased dismantling of glass, 15 min** was applied for calculation. Considering the reality working environment, 10% of personal time consumption and 15% of distribution time consumption were included in the calculation[74]. It is important to mention that high levels of labour and investment costs were applied for this calculation, which was based on costs for a workshop that Saab conducted.

For pre-treatment measuring time and weight of materials, different car models were used: Volvo 2,3,4, 700, Saab 900, 9000, Opel Kadett D, E, Ford Escort, and Volkswagen Golf I, II[75].

2) 2002 study

Saab conducted another new calculation study, co-communicated with Volvo and BIL Sweden. This study has not been verified yet by the Swedish dismantlers association. However, Saab perceives this cost calculation to be more valid than the previous study in 2001. In addition, it is calculated based on additional dismantling not only for glass but other plastic parts. Table 4 shows the summary of 2002 recycling cost calculation for ELV.

For the recycling cost calculation, total pre-treatment hour was **30 min for total pre-treatment time and 10.8 min for additional dismantling of glass and 10.2 min for dismantling bumper**, **25.2 min. for additional administration and transport time** were applied.

The land and building cost was based on the Swedish property price, which is fairly high among Scandinavian countries. **240 SEK of labour cost** per hour was applied, which is the average of wage per hour for a normal worker.

Table 4. 2002 Saab Study on Recycling Costs. (Unit: SEK per ELV).

No. of ELVs treated per facility per year	**2 500**	**3 500**	**5 000**	**7 000**	**10 000**	**13 000**
Pre-Treatment Costs per ELV						
Total building cost	119	85	59	48	38	32
Total investment cost	30	22	15	12	9	8
Labour cost	120	120	120	120	120	120
Transport cost	146	146	146	138	138	138
Financial expenses	165	118	82	60	43	33
Total pre-treatment cost (A)	*580*	*490*	*420*	*370*	*340*	*330*
Additional Costs per ELV						
Internal transport cost	40	40	40	40	40	40
Administration cost	60	60	60	60	60	60
Additional dismantling for glass	40	40	40	40	40	40
Additional dismantling for bumpers	40	40	40	40	40	40
Total additional cost (B)	*180*	*180*	*180*	*180*	*180*	*180*
Total treatment cost (A+B)	**760**	**670**	**600**	**550**	**520**	**500**

Source: Saab Automobile AB. (2002).

Looking at the time measured in three different studies, it shows that there is a room to improve the work efficiency (Table 5).

74 Saab. (2001). *Guideline for pre-treatment and increased dismantling.*

75 Saab. (2001). *Guideline for pre-treatment and increased dismantling.*

Table 5. Summary of three studies from time perspective (Unit: min.)

<table>
<tr><th></th><th>BIL study</th><th>Saab 2001 study</th><th>Saab 2002 study</th></tr>
<tr><td>Administration time</td><td></td><td>20</td><td rowspan="3">30</td></tr>
<tr><td>Internal transportation time</td><td></td><td>11</td></tr>
<tr><td>Pre-treatment time</td><td>73</td><td>41</td></tr>
<tr><td>Additional Administration time</td><td></td><td></td><td rowspan="2">25.2</td></tr>
<tr><td>Additional transportation time</td><td></td><td></td></tr>
<tr><td>Additional dismantling time for glass</td><td></td><td>15</td><td>10.2</td></tr>
<tr><td>Additional dismantling time for bumpers</td><td></td><td></td><td>10.8</td></tr>
<tr><td>Personal time 10 %</td><td></td><td>9</td><td></td></tr>
<tr><td>Distribution time 15 %</td><td></td><td>14</td><td></td></tr>
<tr><td>Total</td><td></td><td>110</td><td>76.2</td></tr>
</table>

4.4 Conclusion

Based on collected information and findings, this section will conclude the Swedish case study by examining the system based on the selected criteria in Section 3.3.

Environmental effectiveness

Several elements identified in the Swedish system are designed to improve the environmental effectiveness. A certificate of destruction by authorised car dismantlers, stimulated by the scrapping premium to a last owner of vehicles, the Swedish system reaches high collection rates.

The introduction of the producer responsibility both in physical and financial aspects provides an essential base to improve the recycling performances of relevant recycling actors. Since the producer pays the future recycling costs to contracted dismantlers, dismantlers have a strong incentive to improve their performances with continuous efforts in order to make or keep contracts with producers. From the producer side, in order to increase the efficiency of the network so as to reduce future recycling costs, the selection of dismantlers will be tight with strict environmental requirements. From the Swedish experience, these phenomena are identified to a certain extent.

The Swedish regulations on ELVs in general state more detailed requirements to relevant actors. More specific duty and obligation to each actor helps to upgrade the general levels of performance by each actor to a certain standardised levels. For instance, the ordinance on producer responsibility regulates detailed obligations such as reporting the designated number of reception stations to the Swedish EPA, documenting details of recycling performance within their recycling networks, and so on. NFS 2002:2, in addition, regulates detailed requirements for dismantling and recycling of each material, together with reporting obligation followed by the physical flow of materials.

Economic efficiency

The Swedish ELV system seems to reach and stabilise the high collection rate. However, from the analysis by the author, it is difficult to conclude that the scrapping premium system, by itself, leads this outcome. Since the premium does not function to prevent the generation of abandoned vehicles in nature, the use of the scrapping fees and premiums seems to lower the economic efficiency. The reason is that besides the premium system, the proper deregistration system, together with the certificate of destruction, could lead to the same outcome.

The high premium can bring sudden increase of total scrapped cars only in the first year of application, for example, in 1992 and in 2001. In addition, it gives an opportunity to certain groups to misuse the system. Those who are sensitive and aware of the premium changes can have a chance to get profit out of it. Without the general improvement of the number of total scrapped cars and the collection rate, the Swedish premium system can be misused. As the high collection rates have been stabilised in the Swedish ELV system, the premium system seems only to lower its economic efficiency. Additionally, it causes room to create criticism of the public fund management.

On the other hand, the physical and financial responsibilities on ELV recycling by car producers stimulates producers to put efforts on dismantling skill and technology, in order to reduce future recycling costs. Since car producers already show cost improvement from their economic studies, the pressure on dismantlers to reduce the actual recycling costs to a similar level as the producer studies will be expected in near future. Thus, producer responsibility will stimulate the improvement of economic efficiency for treating ELVs in the Swedish system.

Monitoring

Owing to the centralised deregistration system, the Swedish system established data collection on different deregistration numbers such as the traffic fleet, the number of new registrations, the number of administrative deregistration, the number of deregistration for export, and the number of certificates of destruction. Even though there is inconsistency identified within the existing data, it is considered that the Swedish system has a comparatively good base for monitoring the flow of ELVs. However, the weakest part of the Swedish monitoring is that there is no clear measuring of the number of abandoned vehicles.

Regarding reuse, recycling, and recovery rates of the Swedish ELV system, the introduction of producer responsibility brought a positive outcome in the monitoring system. Together with a strong commitment, car producers designed a good reporting model to calculate recycling and recovery rates. In addition, based on their strong implementation power by requiring recycling operators to report their performances, the self-monitoring led by car producers provides accurate and reliable recycling and recovery rates of the producer network.

Besides the self-monitoring by producers, the general monitoring on recycling and recovery rate of other dismantlers seems to be weak. Often the violation of reporting obligations is found. Thus, the monitoring system in general still has room to improve.

Stimulation of innovation

It is observed that the producer responsibility definitely stimulates producers to invest their R&D (Research and Development) relating to ELV recycling. For example, Saab's participates in dismantling by building their own dismantling facility, is innovative. It also stimulates dismantling sectors to improve their performance.

In addition, the producer responsibility for ELV recycling stimulates the improvement of vehicle design. This also leads to opening up of the working relationships among car producers and their upstream and downstream partners.

Additionally, the producer responsibility encourages car producers, through BPS, to move forward to the recycling market development for recyclable and recycled materials from ELVs.

5. The Netherlands

5.1 Legal Framework

A direct legal frame for the ELV management, the Management of End-of-life Vehicles Decree (Besluit Beheer Autowrakken) came into force very recently (on July 2002). Before the ELV decree, the Dutch ELV treatment system has been legally bound under the Environmental Management Act and several relevant decrees on certain materials.

The Dutch ELV system was organised mostly based on the voluntary agreement among industrial sectors related to the ELV recycling and the Government. Initiated in 1993, the system has been running since 1995. Under the Environmental Management Act, the advance disposal fees, which are charged to the first vehicle owners, finance the Dutch ELV system.

This section focuses on the existence of the Dutch legal framework before the introduction of the ELV decree, which allows or regulates certain activities of the Dutch ELV recycling system since 1995. For further information, the ELV decree is presented in Appendix 5.

In a line of integrated approaches within the environmental legislation in the Netherlands, the **Environmental Management Act** was introduced in 1994. Concerning the waste issue, the Chemical Waste Act (1976) and the Waste Substances Act (1977) were incorporated into the waste chapter within the Environmental Management Act[76]. The main features of the waste chapter are summarised in Appendix 6.

Importantly, the waste disposal fee applied to all new vehicles is enshrined in the Environmental Management Act. The Ministry of Housing, Spatial Planning and the Environment (VROM) is an empowered body by the Environmental Management Act and sets waste disposal fee . (The waste disposal fee calculation method is presented in Appendix 7).

To pay the waste disposal fees for new vehicles, which are first registered in the Netherlands, is also regulated within the Road Traffic Act. Thus, under the Road Traffic Act, the governmental department of road transport (RoadRijksdienst voor het Wegverkeer: RDW) may not issue a vehicle registration certificate until the waste disposal fee is paid[77].

Besides the general legal framework provided by the Environmental Management Act, several decrees that regulate certain materials from ELVs are identified in the Dutch legal system. These are summarised below.

- **The Designation of Hazardous Waste Decree of 1994:** Among ELV components, LPG tanks and fuel from ELVs are defined as dangerous waste. Thus, these are regulated to be dismantled or drained, and to be treated in a separate manner.

- **The Car Tyres Disposal Decree of 1995:** The tyres disposal decree regulates a take-back system under producer responsibility. However, it does not clearly define the financial responsibility relating to this take-back system. While producers are defined as producers and importers of car tyres, for the tyres from ELVs, car producers are defined as responsible

76 Ministry of Housing, Spatial Planning and the Environment (VROM). (2001). *Legislation: Waste in the Netherlands. Fact sheet.*

77 ARN (2002). *Bird's eye view of ARN: Legislation.* [Online]. Available: http://www.autorecycling.nl/engels/1vogelvlucht/14.php. [2002, May 28]

producers. The most important statement of this decree is the prohibition of landfilling all used tyres

- **The Waste Oils Collection Decree and the Decree on fuels containing organic halogens of 1999 (Besluit Organish Halogeengehalte Brandstoffen):** Since the legislation known as the Waste Oils Collection Decree under the Meerjarenplan Gevaarlijk Afval II (Second long-term plan for dangerous waste products) came into force in 1998, spent oils from ELVs have been collected nation wide. However, a year later, the Decree on fuels containing organic halogens came into force in 1999 so that the processing of used oil to make fuel oil with a high halogen content is banned in the Netherlands.

- **The Waste Substances (Prohibition of Landfill) Decree:** the Waste Substances Decree prohibits landfilling ASR from ELVs.

5.2 End-of-Life Vehicles System in the Netherlands

The Dutch policy on ELVs started with the governmental action programme of 1992. The response from the Dutch industry formulated a voluntary agreement among five industrial organisations[78] relevant to the ELV recycling issue. The Dutch Government strongly supports this agreement.

Encouraged by VROM, the foundation Auto & Milieu (Car & Environment) was set up in 1993. In 1994, the name was changed to the foundation Auto & Recycling (Car & Recycling)[79]. In order to implement the management system for ELVs, the Auto Recycling Nederland BV (ARN), a private company was established by the foundation.

The legal structure is given to the executive board of the Foundation, which determines the policy for ELVs with advice from the Government and other interested parties such as environmental and consumer groups. ARN is implementing the determined ELV policy. In summary, a private company is empowered by the Government to run the Dutch ELV system. Figure 6 describes the Dutch ELV system managed by ARN, including its financial flows.

5.2.1 System Design

From collection to final disposal, the Dutch ELV system is strictly managed by ARN. ARN approaches to use strong economic incentives for steering high quality in ELV recycling and improvement of recycling facilities. More specifically, the recycling premiums to recycling industries controls the environmental performances throughout the ARN recycling chain. The waste disposal fees finance the whole ARN scheme.

5.2.1.1 Collection

Car authorisation and certificates of disposal

Since the character of the motor-car tax changed from being a road tax to an ownership tax in 1995, last vehicle holders must present certificates of disposal to RDW for deregistration in order to be exempted from paying taxes.

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78 These are RAI (car manufacturers and importers), BOVAG (garage), FOCWA (damage repair companies), STIBA (car dismantlers), and SVN (shredder companies)

79 The foundation determines the main thrust of company policy, with each of five organisations involved in the recycling initiative represented on the foundation's Executive Board. The foundation's Advisory Board was installed, whose role is to advise on policy within a broader social context.

By regulating that the dismantlers approved by RDW can only issue certificates of disposal, the collection system is designed to ensure the input of ELVs entering to authorised dismantlers. An inspection for the certification to be approved by RDW is carried out by SGS (Société Générale de Surveillance)[80]. Consequently, dismantlers or car scrappers, who are not approved by authorities, are not allowed to handle Dutch-registered cars[81]. For the certificate of disposal and deregistration, no fee is charged to a last owner.

Nation Wide Network by the ARN

The ARN has built a nation-wide network with authorised dismantlers in order to provide convenient collection points for last owners. At the end of 1996, 266 dismantlers contracted with ARN. The information on the ARN network is arranged to be easily distributed to the public through the Dutch yellow pages, car dealers, and car producers[82].

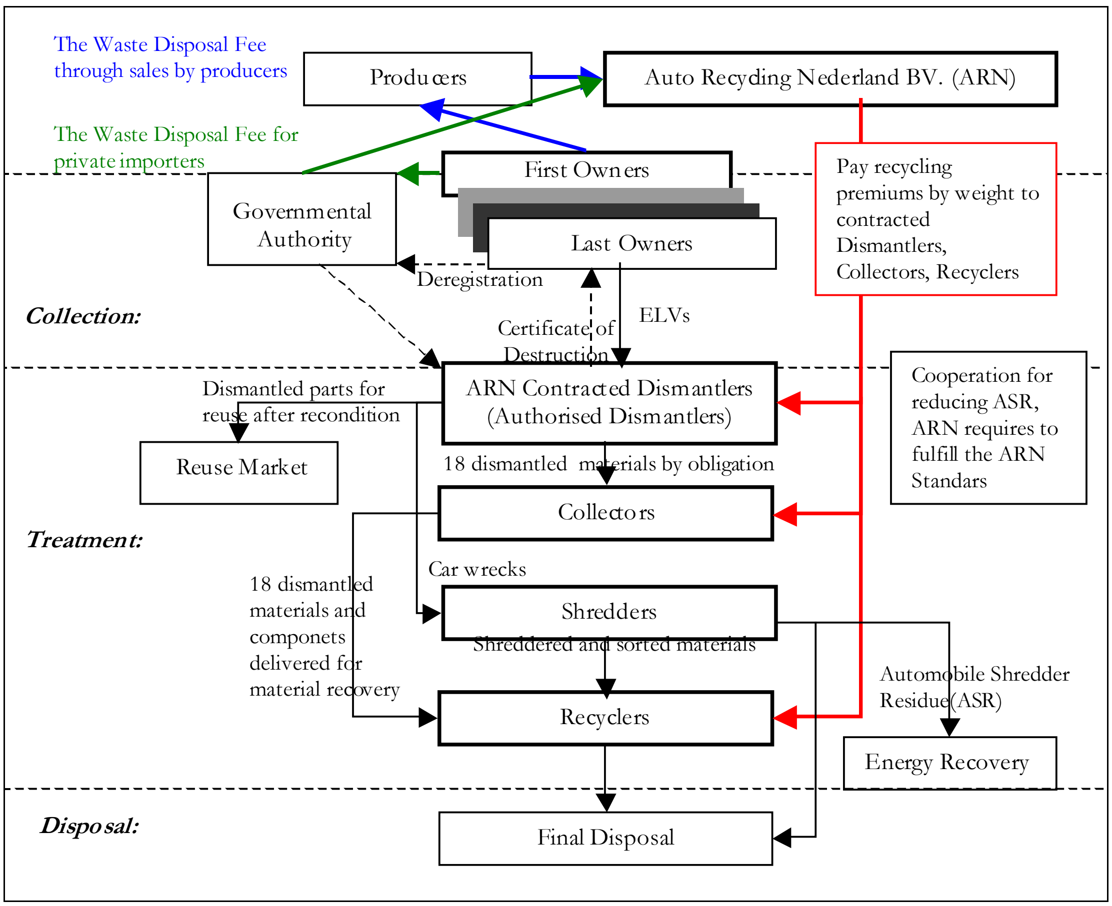

Figure 6. The Dutch End-of-Life Vehicles System Managed by the Auto Recycling Nederland BV

80 ARN. (1997). *Environmental report 1997*. p. 19.

81 ARN. (1996). *Environmental report 1996*. p. 20.

82 ARN. (1996). *Environmental report 1996*. p. 24.

5.2.1.2 Recycling

ARN standard for dismantlers

ARN sets up a stringent standard for dismantlers, in order to select environmentally conscious dismantling. Only an organisation that meets the ARN standard can succeed signing a contract. The ARN standard consists of the number of criteria including equipment requirements and requirements for the dismantling process. In 1997, the standard became more stringent particularly with regard to keeping of records and the status of the equipments[83].

ARN requirement on material dismantling

All contracted dismantlers must dismantle certain designated materials from all ELVs as the contract obligation. Concerning the recycling possibility, ARN selects certain materials to be dismantled. In 1995 when starting the system operation, 9 materials were required to be dismantled; batteries, tyres, inner tubes, glass, coolants, oil, PU form, brake fluid, and rubber strips. In 1996, bumpers, coconut fibre, washer fluid and safety belts were added. In 1997, rear lights and indicators, grilles, and hubcaps were added. Since 1999, fuel and LPG tanks were added and total 18 materials are binding and have different premium prices. From January 2002, oil filter caps are added in the list[84].

ARN recycling premium scheme

ARN uses a strong economic incentive to ensure the proper dismantling. ARN sets up certain premium prices for different materials in the list of the dismantling requirement. According to ARN reports, ARN revises premiums for each material annually. However, there is no recent information accessible, except the information during 1995 and 1996. The information how ARN determines each premium price for each material is also unavailable.

All premiums are paid for different materials based on weight. ARN premiums provide supplement income for contracted dismantlers. Since such a strong economic incentive is given by ARN, dismantlers are encouraged to increase the quantity of dismantled materials by improving dismantling skills and performances.

ARN standard for collectors

The ARN system is also concerned with increasing the efficiency in material collection and securing the quality of dismantled materials. By hiring the collection companies, ARN designates the responsibility to them for transporting materials from the dismantlers to the recyclers. In order to be contracted, a collection company also has to meet the ARN standard for material collection, including requirements for storage and transportation. ARN monitors their compliance through periodic and spot checks.

ARN standard for recyclers

Each year ARN approaches recycling companies both inside and outside of the Netherlands, requesting to submit a tender for the processing of one or several types of material. A recycler should meet the ARN standard for recyclers for the contract. In addition, an extensive processing test is carried out at their sites, in order to ensure high-grade recycling, before a contract is actually signed.

One of contract obligation is to submit accurate reports on the quantity and quality of the materials they have received and recycled.

Shredder licensing scheme

Since 1998 when ARN and the Metal Recycling Federation (MRF) decided to work together to reduce ASR, the working relationship with shredders has been built. There is no contract relationship between

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[83] ARN. (1997). *Environmental report 1997*. p. 19.

[84] ARN. (2001). *Environmental report 2001*. p. 45.

ARN and shredders, nor any economic compensation is made to shredders. However, in order to work with ARN, shredders should meet the shredder-licensing standard, which was made by ARN in 2000[85]. The shredder licensing requires having a manual during shredding procedures[86].

5.2.2 Role of main actors

The Dutch system requires **first vehicle owners** to pay the advance waste disposal fees. And **last owners** are obliged to hand in their vehicles to authorised dismantlers without any additional payment for recycling.

VROM is responsible for determining the amount of the waste disposal fee. In addition, this ministry is responsible to monitor the ELV system in general. However, the authority seems to ignore the issue of abandoned vehicles in nature. A responsibility for monitoring abandoned vehicles is not identified. The authority also regulates the dismantling operators.

The most important actor in the Dutch ELV system is **ARN**. ARN plays a significant role in keeping the proper treatment chain tight and ensuring the high ELV recycling. Funded by the waste disposal fees, ARN uses economic instruments for contracted dismantlers, material collection companies, and recyclers. ARN holds a strict monitoring system throughout the entire chain of ELV recycling.

Dismantlers contracted with ARN were 265 out of 278 in 2001, counting for 95 per cent of dismantling market share. Their performances are strictly bound by ARN contract requirements: proper depollution; dismantling designated materials; and reporting correctly on their performances and so on. The role of contracted **collection companies** with ARN is to ensure the quality of dismantled materials until they are delivered to recyclers. **Recyclers** are also committed to conduct high quality recycling processes for each material.

Car producers in the Dutch system do not play a significant role. Car producers in the Netherlands fully represent car importers. As the member of the foundation, the car producer association is participating in ARN. Thus, car producers are sharing the responsibility for ELV recycling with other members of the Foundation. Because of the first owner pays principle is applied, benefits of the producer responsibility for ELV recycling do not appear in the Dutch system. For instance, the first owner pays system does not encourage car producers to improve new vehicle design, nor to actively participate in dismantling of ELVs.

5.2.3 Findings

Collection rate

'Collection rate' refers to the defined 'collection rate' by the author (see Section 4.2.3.1 collection rate part).

In order to find out the accurate collection rate in the Dutch system, the author have tried to collect the data on abandoned vehicles in nature. However, no data was found[87]. Considering the fact that there is no data existing on the number of abandoned vehicles and the number of ELVs scrapped by

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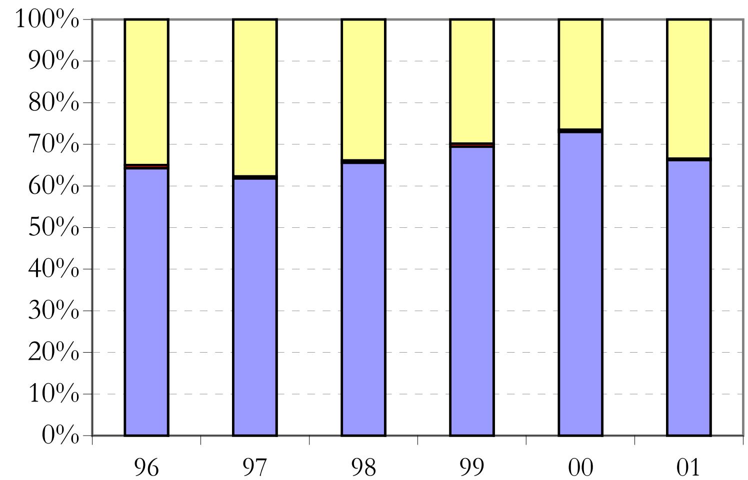
85 ARN. (2001). *Environmental report 2001*. p. 26.

86 ARN. (2002). *ARN in Practice: shredders* (starting on the 1st of July)

87 When tracking information on abandoned vehicles, the author contacted RDW. RDW did not collect any data on abandoned vehicles. Recommended by RDW, the author contacted the central statistic office in the Netherlands (Centraal Bureau voor de Statistiek: CBS). The answer from CBS was that data on abandoned vehicles does not exist. *"In addition, due to the fining system, there is no abandoned vehicles in the Netherlands"(Jaap de Ruijter,Sales information specialist at Centraal Bureau voor de Statistiek).* However, the author suspected his comment. The further approach was not continued due to the time limitation.

unauthorised dismantlers[88], it is difficult to find out the accurate collection rate. Taking into consideration the Swedish experience (which is that the approximate number of abandoned vehicles is similar as the number of administrative deregistration), the author considers the number of administrative deregistration as abandoned vehicles. Figure 7 shows the figures and percentages of scrapped vehicles, deregistered vehicles for export, and administrative deregistration in the Dutch system. Based on the assumption made by the author and data presented in Figure 7, collection rates in the Dutch ELV system are calculated. In total, the general collection rates are 99 per cent during 1996 and 2001. If only looking at the ARN collection, its collection rate is found to be 87 per cent in 2001[89].



	96	97	98	99	00	01
Total deregistration for export	144 134	161 039	133 277	121 888	118 447	161 113
Total administrative deregistration	3 275	2 164	2 010	2 975	2 522	1 834
Total certificates of destruction	264 685	263 629	257 619	283 939	326 144	318 811

Figure 7. Figures and percentages of scrapped vehicles, deregistered vehicles for export, and administrative deregistration in the Dutch system during 1996 and 2001

Recycling and recovery rates

As seen in collection rates of the Dutch system, ARN covers around 87 per cent of collection. Even without knowing much about other parts of recycling chain, the ARN recovery rate most likely can represent the entire Dutch ELV recovery rate.

It is reported that the ARN system has reached 86 per cent of total recovery rate since 1999. ARN collects comprehensive data from all contracted dismantlers and recyclers. The ARN system monitors the average ELV weight from the data collected from contracted dismantlers. Since all contracted dismantlers are obliged to report the models of receiving ELVs, ARN calculated the average ELV weight on the calculation base for total recovery rate. From measuring dismantled materials, all of

88 The data on scrapped vehicles from unauthorised dismantlers does not disappear in deregistration data. By law, all dismantlers should be authorised in order to deal with ELVs.

89 The ARN collection rate is 78.4% in 1996, 89.3% in 1997, 89.6% in 1998, 87.8% in 1999, and 87.2% in 2000. The calculation is based on the same assumption that the author made for general collection rates in the Dutch system. Data on scrapped vehicles by ARN were collected from ARN annual reports. See Appendix 8 for actual figures in the Dutch system.

which are ensured to be recycled[90], ARN calculates recovery rate. According to ARN environmental reports 1995-2001, Table 6 presents ARN recycling and recovery rates.

Table 6. The amount of reuse, recycling and recovery weight per ELV and consequent rates within the ARN system during 1995 and 2001 (Unit: kg)

	1995	1996	1997	1998	1999	2000	2001
Average ELV weight (A)	955.0		875.0	946.0	896.0	906.0	912.5
Metal recycled* (B)	699		656	710	672.0	679.0	684.4
Total material recovered (C)	89.9		96	97	99.0	100.0	100.0
Material reuse and recycling	-	-	-	-	-	-	84.7
Thermic recycling	-	-	-	-	-	-	15.5
Total recovery (B+C)			752	807	771.0	779.0	784.6
Final disposal (A-(B+C))			123	139	125.0	127.0	127.9
Metal recycled (%)	73		75	75	75	75	75
Total material recovered (%)			10.9	10.3	11.0	11.0	10.9
Total recovery (%)	**75**		**85.9**	**85.3**	**86.0**	**86.0**	**85.9**
Final disposal (%)			14.1	14.7	14.0	14.0	14.1

**Metal recycled is estimated, based on the literature study on metal contents of vehicles.*
***Total material recovered was presented in environmental reports.*
Source: ARN environmental reports. (1995-2001).

The ARN environmental reports present detailed data on how much total weight of each material is dismantled/recycled and the norm of each material. The sum of all norms of each materials is identified as the same as the total material recovered. However, the author recalculates the norm of each material from the total weight dismantled/recycled of each material divided by the total number of ELVs treated in the ARN system (Appendix 9). Table 7 shows the outcome of recalculation by the author.

In addition, ARN metal recycling calculation is based on literature study on different car models, which show 75 per cent of average metal contents. However, total recycled metals are not 100 per cent recovered in reality. Thus, the Dutch system also slightly puts the higher amount of metal recycled, which leads to a higher total recovery rate than the actual one.

Table 7. The norms of total materials recovered and consequent rates within the ARN system during 1995 and 2001, which are recalculated by the author

	1995	1996	1997	1998	1999	2000	2001
Average ELV weight (A)	955.0		875.0	946.0	896.0	906.0	912.5
Average Metal recycled (B)	699		656	710	672.0	679.0	684.4
Norm of material recovered (C)*	89.9	87.4	89.2	93.0	90.0	91.0	91.0
Average recovery (B+C)			745.2	803	762.0	770.0	775.4
Average disposal (A-(B+C))			129.8	143	134	136	137.1
Metal recycled per ELV (%)**	73		75	75	75	75	75
Material recovered per ELV (%)*			10.1	9.8	10.0	10.0	10.0
Total recovery per ELV (%)	**75**		**85.1**	**84.8**	**85.0**	**85.0**	**85.0**
Final disposal per ELV (%)			14.9	15.2	15.0	15.0	15.0

** It is calculated from total material recovered divided by total number of ELVs treated by ARN (Appendix 9).*

ARN recycling calculation methodology

The ARN system uses a kerb weight as base for the average weight of the vehicles. Through a licence registration system, such information is available. Each car model has a different kerb weight, which is

[90] ARN environmental report shows detailed information on how each material are recycled.

provided by its manufacturer. An average weight of ELV is an average kerb weight of ELV models minus the average driver weight.

Owing to the strict reporting obligation for all contracted dismantlers, ARN possibly collects exact information on ELV model names for their kerb weights, weight of each dismantled material from dismantlers. Because ARN pays recycling premiums for each material based on its weight, dismantlers accurately measure and report to ARN. A double-checking process by ARN is often undertaken. Since all dismantled/removed components and materials are ensured to be reused/recycled or recovered by ARN, the total materials dismantled are considered as total materials recovered for the calculation.

For metals recycled, however, it is estimated from the literature study of vehicle contents. As seen earlier, ARN uses 75 per cent of metal recycled rate.

The weight of material residue ending up to final disposal is not measured either. The remaining fraction, which is the difference between the average ELV weight and the sum of ARN materials and metals recycled, represents the weight of material to final disposal.

Conclusion

The data absence on abandoned vehicles leads to the difficulty to examine the accurate collection rate of the Dutch ELV system. However, base on the author's assumption, the general collection rate in the entire Dutch system is around 99 per cent. ARN collection rate is also high, which is around 87 per cent.

The ARN recycling and recovery rates presented in the ARN environmental reports seem to be written slightly higher than in reality. Together with high estimated recycled metals, the recalculation done by the author shows that the total materials recovered rate is also calculated slightly higher than the actual one.

5.3 Economic of End-of-life vehicle system

The Dutch ARN system is fully funded by the waste disposal fees. This visible, not refundable, waste disposal fee is collected from first owners, who register their cars in the Dutch registration system. Cars with four or more wheels and with the gross vehicle weight no more than 3 500 kg are bound to the obligation to pay waste disposal fees. However, there is an exception for classic cars. Since 1998, no fee is levied on classic cars, which is defined as cars 25 years old or more based on a date of first registration[91]. The rationality behind this exception is that such vehicles are valuable as antique goods.

The Dutch system applies the 'pay-as-you-go' principle in its financial mechanism. Waste disposal fees collected from new vehicles are used to pay recycling costs for existing ELVs. ARN manages this fund: to pay recycling premiums to dismantlers, collectors, and recyclers; to set up an ARN infrastructure for collection and treatment; and to invest for different developing projects relating to ELV recycling; and so on.

Waste disposal fees and ARN fund management

The amount of waste disposal fees have been determined and declared every three years by VROM (the calculation methodology for determining the amount of the waste disposal fee is presented in Appendix 7). In 1995, the waste disposal fee was **levied with 250 NLG (113 EUR).** The **second period during 1998 and 2000, the fee was 150 NLG (68 EUR)**, which is 100 NLG lower than the fee during the first period. **In 2001, the fee dropped down to 45 EUR**, which will be binding until the 31st of December 2003. All collected waste disposal fees are transferred to ARN, in order to

[91] ARN. (2001). *Environmental report 2001*. p. 9.

finance the ARN system. Among total collected disposal fees, 19 per cent of VAT (value added tax) is paid to the Government. Table 8 shows the ARN financial status during 1995 to 2001.

Table 8. The summary of ARN financial status during 1995 and 2001 (unit: thousand EUR)

	1995	1996	1997	1998	1999	2000	2001
Total Fund from WDF (1)	52 610	59 142	57 751	40 305	44 385	41 515	24 797
Financial income (2)	842	2 072	3 274	4 270	4 207	7 533	9 358
Other income (3)	0	0	0	0	0	172	165
Total income	**53 452**	**61 228**	**61 026**	**44 576**	**48 593**	**49 220**	**34 320**
Recycling costs	10 073	23 227*	25 596**	21 607	19 424	24 419	26 643
Recycling premiums	*9 964*	*22 838*	*25 073*	*20 091*	*18 364*	*23 900*	*25 400*
Pilot recycling and research	*109*	*278*	*725*	*636*	*1 045*	*500*	*1 200*
Cost price of earnings	827	110	4				
General costs (5)	3 591***	1 707	1 934	1 929	2 206	2 405	2 743
Monitoring and information costs (6)	938	2 487	1 048	568	695	1 457	1 736
Financial expenditures (7)	150	108	175	155	82	128	134
Total costs	**15 579**	**27 639***	**28 758**	**24 263**	**22 412**	**28 409**	**31 256**
Contribution to the fund	39 074	33 589*	32 268	20 313	26 181	20 811	3 064

(1) Total fund from the waste disposal fee (WDF) is excluding 19 per cent of VAT to the Government
(2) Financial income is an income from a bank investment in bonds and non-risk deposits
(3) Other income is identified as the 'wrongfully paid waste disposal fee'. For example, a waste disposal fee already paid is not claimed back if the vehicle is finally not licensed or is licensed later. If ARN cannot trace whoever originally paid the waste disposal fee, this wrongfully paid waste disposal fee devolves to the waste disposal fee after a period of five years
(5) General cost is for practical implementation and operation cost of ARN
(6) Monitoring and information costs is to ensure that the premiums are paid out in as correct a way as possible, and to guarantee that materials actually are recycled
(7) Financial expenditure is the cost for paying external accountants
** In 1996 report, the pipeline cost (the cost for materials that are already dismantled but stored in containers due to different delivery timing) is included in the recycling cost. Thus, the figure is recalculated by excluding this pipeline cost in order to make consistent with annual reports in other years. Consequently, the author recalculates the total costs and the contribution to recycling fund*
*** Data provided in their environmental report 1997 does not show consistency. Recycling costs are less than the sum of recycling premium costs and pilot research cost. However, recycling cost presented in the expenditure table was chosen*
**** 1995 general costs are accumulated since 1993 in order to prepare the ARN setting*

Source: ARN environmental reports. (1995-2001).

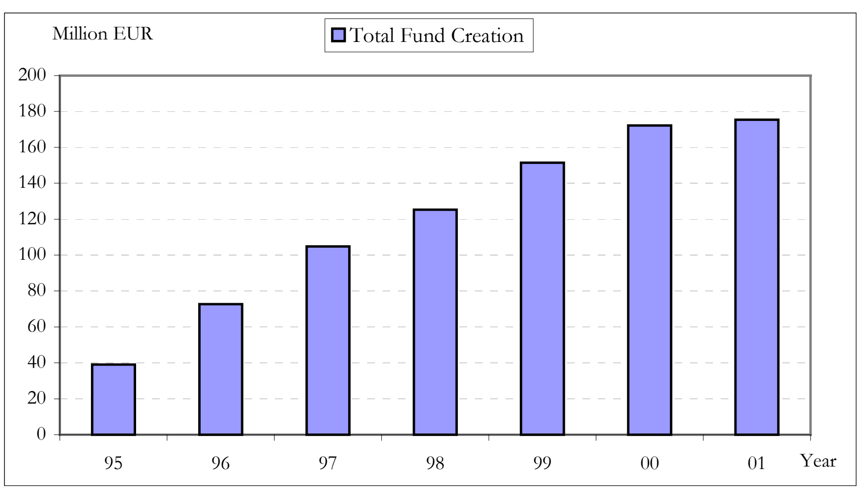


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Figure 8. The ARN fund creation during 1995 and 2001

Since 1995, the ARN fund balance has increased dramatically (Figure 8). Since the fund mechanism applies the 'pay-as-you-go' principle, the amount of fee should be determined carefully, not too much and not too low. It should be considered how much ELVs are generated among the total deregistration number. The number of used cars exported should also be considered. The fee calculation method presented by ARN (Appendix 7) shows that those facts also seem to be addressed. However, still the Dutch waste disposal fees has been criticised to be too high.

As seen in Table 8, the total fund collected from waste disposal fees has significantly exceeded the total annual expenses during 1995 and 2000. Around 20 to 40 million EUR were added to the ARN fund annually, which leads the large amount of the total ARN fund today. ARN, a private body, manages more than 160 million EUR fund (Figure 8).

High waste disposal fees did not influence new vehicle purchasing (Figure 9). If looking at new registration numbers during the first period (1995-1997) compared to the second period (1998-2000), it may be assumed that higher disposal fees somehow influence on the decrease of car sales. However, the continuous decreasing numbers of newly registered vehicles since 2000 after the radical drop of the waste disposal fee proves that the waste disposal fee does not significantly influence the behaviour change in vehicle purchasing (Appendix 8 presents the relevant data in the Dutch system). The car purchase seems to be influenced by the economic situation or the customers' need, not by high disposal fees charged to new vehicles. Taking into account this fact that the number of new registrations seems to be stable, the annual number of ELVs processed by ARN are around two fifths of the annual number of new registrations (Figure 9).

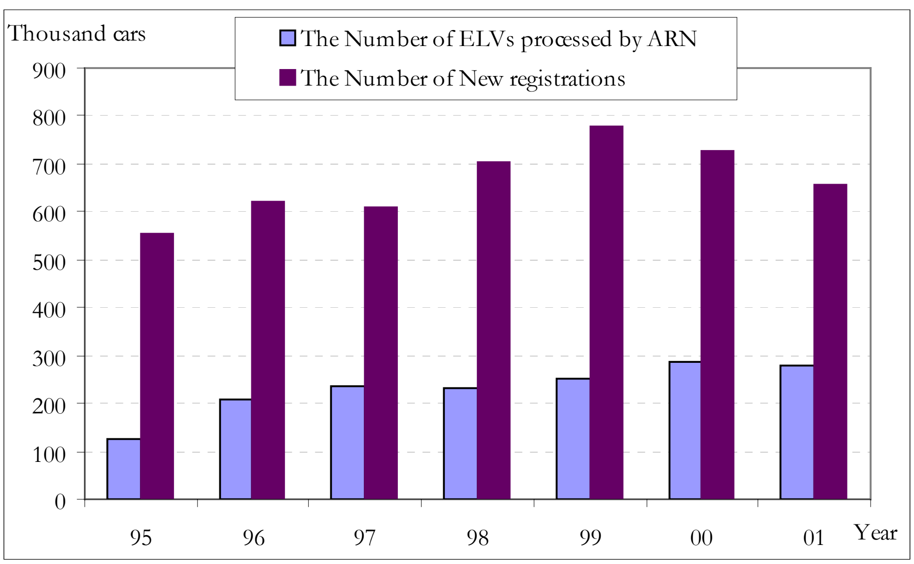

Figure 9. The number of new registration and the number of end-of-life vehicles processed by ARN during 1995 and 2001

Additionally, the export market for used cars in the Netherlands seems to be active. Around 25 to 35 per cent of the total deregistered vehicles are leaving the country (Figure 10). In short around 35-40 per cent of the total new registrations, which is around 60 per cent of total number of deregistered vehicles, are processed by ARN. In summary, actual ELVs recycled in the ARN system is much lower than the amount of ELVs that waste disposal fees are able to cover for recycling costs. Therefore, the waste disposal fee could have been lower if the flow of exported used cars and estimated ELVs that can be processed by ARN are seriously considered before the fee determination. The effort seems to be weak, which resulted in giving high financial burden to the first owners during the first and second periods.

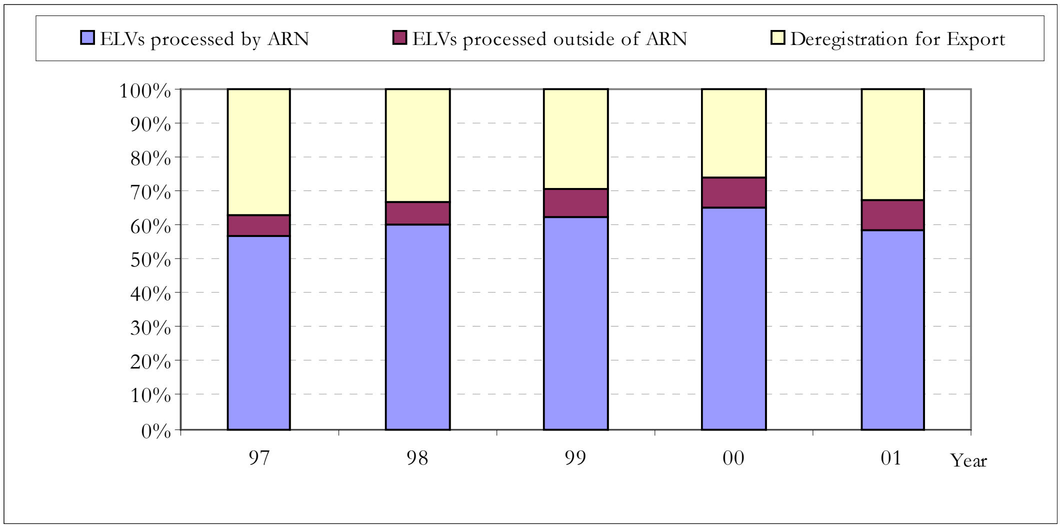

Figure 10. Percentages of end-of-life vehicles processed by ARN, ones processed outside of ARN, and deregistered vehicles for export during 1997and 2001

Recycling Cost

Based on financial information from ARN environmental reports (Table 8), the recycling costs per ELV in different aspects are calculated in (Table 9).

Table 9. Recycling relating costs per end-of-life vehicle of the ARN system during 1995 and 2001 (Cost unit: EUR, the cost calculation is based on Table 8)

	1995	1996	1997	1998	1999	2000	2001
The number of ELVs processed by ARN	*126 000*	*210 092*	*237 266*	*232 685*	*251 943*	*286 595*	*278 972*
Recycling cost per ELV	**80**	**110.6**	**108**	**93**	**77**	**85**	**96**
Recycling premium per ELV	**79.1**	**108.7**	**105.7**	**86.3**	**72.9**	**83.4**	**91**
General cost per ELV	28.5	8.1	8.2	8.3	8.8	8.4	9.8
Monitoring and information cost per ELV	7.4	11.9	4.4	2.4	2.8	5.1	6.2
Financial expenditure per ELV	1.2	0.5	0.7	0.7	0.3	0.4	0.5
Total ARN cost per ELV	**124**	**159.9**	**121.2**	**104.3**	**89.0**	**99.1**	**112**

The recycling cost per ELV includes recycling premiums and pilot project costs. Recycling premiums per ELV are considered as payment made to contracted dismantlers, collection companies, and recyclers. Total ARN costs per ELV include all expense items that ARN uses for ELV recycling related. These main three cost categories show different recycling costs per ELV. Taking into consideration how the system is designed for cost reduction while maintaining total recovery rates, it is very difficult to conclude that the ARN system improves in its cost reduction. According to Table 8, the recycling costs per ELV do not show any consistent or significant improvement in recycling cost efficiency.

Conclusion

The high waste disposal fees collected for ELV recycling in the Netherlands lead to high fund accumulation. Even though the fee significantly dropped in 2001, it is clear that the financial burden was higher for the first car owners during the first and second periods of waste disposal fees. It may cause a discussion whether it is reasonable in a financial sustainability perspective that a private body, ARN manages the huge recycling fund, which is collected from the public.

Often the fund management by a public body is criticised to be less efficient than a private body. However, the fund management by ARN does not clearly show the improvement of the cost efficiency in terms of recycling costs for ELVs.

5.4 Conclusion

Based on criteria chosen in Section 3.3, the concluding remarks on the Dutch system follows.

Environmental effectiveness

The Dutch ELV system is organised in a tight manner for improving the environmental effectiveness. The use of certificates of disposal as requirement for deregistration, together with scrapping authorisation, the Dutch system reaches high collection rates, around 99 per cent. However, regarding the issue of abandoned vehicles, the absence of data leaves a loophole in their monitoring system. The ARN system provides the dense and nation-wide collection network, which leads around 87 per cent collection rates.

ARN uses economic instruments of recycling premiums to contracted dismantlers, material collectors, and recyclers. Such economic instruments hold a strict management of recycling operators throughout the entire recycling chain. As ELVs enter to the ARN system, all recyclable materials (possible at that time) are secured to be dismantled and recycled with high quality. As the part of the contracted obligations, all recycling facilities fulfil the reporting requirement, which drives a secure information flow. Benefits from participating in ARN networks, mainly high recycling premiums, encourage all recycling facilities to improve their environmental performance. Thus, ARN ensures the high quality recycling of dismantled materials by economic incentives. Not only contributing to the increase of recycling and recovery rates, but also economic incentives for being contracted, steer a continuous performance improvement.

Such tight arrangements of the ARN system contributes to the environmental effectiveness of the ELV recycling. However, regarding the issue on abandoned vehicles, ARN does not provide any relevant information. In addition, throughout the research, the data relating to abandoned vehicles in nature seems to have never been collected. The Dutch system does not seem to consider it as a major issue to solve.

Economic efficiency

In terms of recycling costs paid by ARN, which is closely linked to the environmental effectiveness, it is difficult to judge the economic efficiency of the system. Taking into consideration the cost calculation in Table 9, the economic efficiency seems to be moderate. However, the point is that it is difficult to say that there is an improvement in economic efficiency over the last 6 years. It may lead to the discussion whether flat fees of waste disposal fees charged to first owners do not create motivation to reduce recycling costs not only for ARN but also for any relevant industrial sectors including car producers, dismantlers, and recycling facilities. ARN is a private body to manage the recycling fund, which is collected from the public. Thus, their main interest does not seem to reduce the recycling cost, rather to ensure good environmental performance.

Car producers, for instance, do not bear the direct financial responsibility of ELV recycling within the ARN system. As waste disposal fees do not significantly influence car sales (as it is seen above), there is no motivation for car producers to reduce the general recycling costs. Contracted dismantlers receive the recycling premium determined by ARN. Dismantlers may have slight interest to reduce the dismantling costs through improving work efficiency. However, since recycling premiums are fixed and are provided based on the weight of materials dismantled, their main interest is to dismantle more materials.

A more important issue is that waste disposal fees have been determined too high, considering the volume of ELVs recycled and also moderate recycling costs. Thus, the calculation method to determine the amount of waste disposal fees needs to be reconsidered. Considering the volume of ELVs, which can be recycled within the ARN network, financial burdens to the first owners were given during the first and second period of the waste disposal fees.

In summary, the economic efficiency is moderate but there is no improvement during last 6 years. The first owner pays principle applied in ARN system does not create motivation for any economic operators throughout the ARN ELV system to reduce recycling costs.

Monitoring

The general monitoring in all areas of the ELV recycling in the Netherlands does not seem to be a complete. For example, the collection rate cannot be examined due to the lack of data on how many abandoned vehicles are generated and how many vehicles are still flowing into the existing scrappers in an uncontrolled manner. Therefore, it is difficult to judge the representation of the ARN system and its performance.

On the other hand, the ARN system itself established a tight self-monitoring system. By the economic benefits given to contracted dismantlers, material collectors, and recyclers, the ARN system has a clear overview on the actual recycling and recovery performance, the quality or environmental performance of all contracted recyclers, development of recycling technology and so on. Additionally, the self-monitoring system by ARN shows good transparency.

Stimulation of innovation

The first owner pays system in ARN does not create or stimulate innovative actions among recycling operators including car producers. Car producers do not seem to directly involve in ELV recycling. Funded by public, ARN manages to conduct pilot projects related to ELV recycling; to develop new recycling technology; and to develop market for recycled materials.

6. Germany

6.1 Developing Legal Framework and Voluntary Agreements

In Germany, the End-of-Life Vehicle Ordinance was formulated, taking into account the Voluntary Agreements, called Voluntary Pledge (Freiwillige Selbstverpflichtung: FSV). Throughout the process of developing the legal framework for ELV treatment, the German Government did not take the traditional command-and-control approach, which has dominated policies in the early 1970s until the middle or late 1980s in waste management legislation[92]. It was rather a combination of top-down regulation and self-commitment by the German automobile industry.

Recently, Germany transposed the EU ELV Directive into the national law, the End of Life Vehicle Act of 2001. However, this section mostly focuses on the legal framework, which influences the German ELV system presently running. Thus, the End-of-Life Vehicles Act of 2001 will be excluded (more detail on ELV act of 2001, see Appendix 10).

The Waste Avoidance and Waste Management Act of 1986 (WMA)

The importance of the environmentally sound waste disposal was already implied to the Waste Disposal Act (was enforced in 1972). The further development of legislative framework on waste issues is seen in the Waste Avoidance and Management Act (WMA), which stresses waste minimisation and recycling[93].

The foundation of the regulation on ELV and car recycling was set up within WMA of 1986. WMA prepared the legal possibility for the Government to issue statutory (Verordnung) and technical regulations (TA: Technische Anleitung) regulations on specific waste streams, announcing a specific measure on ELVs. The producer responsibility principle was applied for ELV processing though Verordnung and more stringent technical regulations on the disposal of ASR through TA.

Negotiation and Voluntary Pledge (Freiwillige Selbstverpflichtung- FSV) Regarding the Environmentally Sound Management of End-of-Life Vehicles Within the Framework of the Closed Substance Cycle and Waste Management Act

The consideration of the ELV issue has been strengthened since 1990. The Minister of Environment, Töpfer, presented a draft ordinance proposing national objectives for ELV management in June 1990. Several issues were discussed: recycling targets; the introduction of a general take-back obligation for automobile producers; a general return obligation for the car owners; labelling obligations for plastics; and extraction and separate disposal for components such as operating fluids, tyres, batteries and large plastic components. Car producers reacted on the draft ordinance by presenting an alternative: the establishment of a network of certified dismantlers led by car producers; the last owner pays principle; and introduction of a proof of disposal.

After the first draft of the ELV ordinance, there was a long negotiation process between the Government and the car industry. As reaction on the draft presented in 1994, the 'Voluntary Pledge Regarding the Environmentally Sound Management of End-of-Life Vehicles within the Framework of the Closed Substance Cycle and Waste Management Act' was supported by 16 branch organisations of automotive, recycling, and automobile component supplying sectors. Adoption of the draft ordinance of 1994 was postponed when the automobile industry announced this voluntary self-commitment. (A summary of the voluntary pledge is presented in Appendix 11).

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92 Busch, P.O. and Jörgens, H. (2001). *Breaking the deadlock-voluntary agreements and regulatory measures in German waste management.* p. 6.

93 Busch, P.O. and Jörgens, H. (2001). p. 6.

The End-of-Life Vehicle Ordinance (Altautoverordnung- AltautoV)

As reaction to the voluntary pledge, the German Government refrained from the comprehensive regulation, but presented the 'lean ordinance' to supplement the voluntary solution, which was adopted by the Parliament in June 1997. This supplementing ordinance had been asked for by the signatories of the voluntary agreement as a central precondition for its enactment. The voluntary agreement and the parallel ordinance came into force in April 1998.

The main objectives of the ordinance are: to stimulate ELVs to arrive in facilities operating in an environmental manner; to establish an independent expert system for certification of recyclers; to define standards for collection centres, dismantling, and shredding plants, for which it implies a whole series of new rules and obligations[94].

In particular, the ordinance:

- Regulates the obligation for last owners to return their ELVs to certified return stations or dismantlers;
- Requires proofs of disposal issued by certified dismantlers for vehicle deregistration;
- Requires comprehensive documentation of ELV flows by all parties involved;
- Requires establishment of detailed organisational, technical and operative requirements for return stations, dismantlers and shredders or similar installations, which are preconditions for certification of these installations.

The ordinance has a set of detailed obligations including organisational, technical, operative requirements for return stations, dismantlers, recyclers, collectors and shredders as preconditions for certification of these installations[95][96]. In detail,

- Collection centres, dismantling/recycling plants, and shredders have to be authorised;
- Car dealers of car producers can operate as authorised collection centres;
- The stringent technical provision for collectors and dismantlers in particular on removal of used oils and liquids and on dismantling of different parts and components;
- Dismantlers have to remove large plastic parts, wheels, from, rear and side windows, seats, all parts containing copper;
- Dismantlers have to assure that by 2002 the proportion of parts, materials and operating fluids are at least 15% of the weight of used car;
- The rest of ELVs after dismantling process have to be delivered to authorised shredders;
- Shredders have to comply with general regulations and must reduce the disposal of waste accumulated to 15% of the net weight of vehicle before pre-treatment and disassembling by 2002 and 5% by 2015, including the possibility of energy recovery[97].

The End-of-Life Vehicle Act of 2001

In respect of the EU End-of-Life Vehicle Directive, the draft End-of-Life Vehicle Act resolved by the Federal Government in December 2001. After debate by the Bundesrat and Bundestag (Upper and Lower Houses of Parliament), the draft was passed by the Parliament in 2002, came into force in April 2002. Thus, Germany became one of the first Member States to implement the EU End-of-Life Vehicle Directive. (for detailed information of the ELV Act of 2001, see Appendix 10)

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[94] Zoboli et al. (2000). *Regulation and innovation in the area of end-of-life vehicles*. p. II-20.

[95] Busch, P.O. and Jörgens, H. (2001). *Breaking the deadlock-voluntary agreements and regulatory measures in German waste management*. p. 31.

[96] European Commission Directorate General - Environment. (2000). WRc Ref: EC 4739/A.1/11452-0. p. 217.

[97] Zoboli et al. (2000). *Regulation and innovation in the area of end-of-life vehicles*. p. II-22.

6.2 ELV system

The German ELV system presented here focuses on a system created based on the ELV Ordinance of 1997 and the Voluntary pledge, in order to identify important elements in the presently running system. Figure 11 shows the ELV system in Germany.

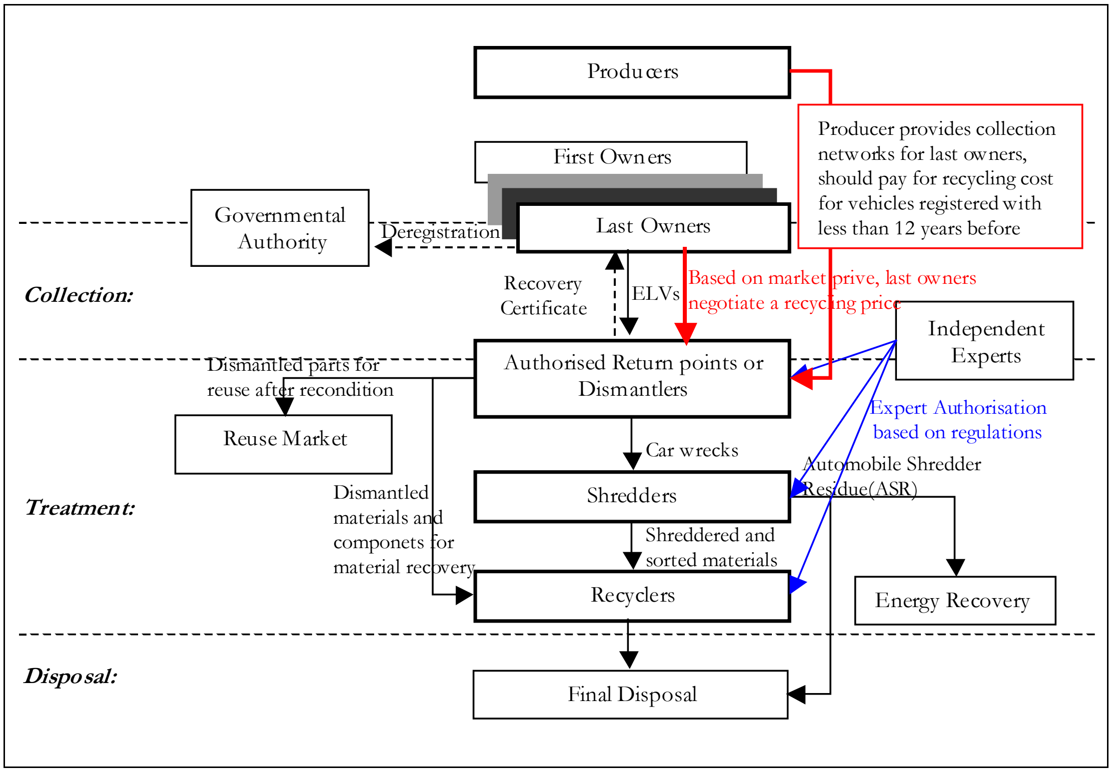

Figure 11. The ELV system in Germany

6.2.1 System Design

6.2.1.1 Collection

Deregistration system

The German deregistration system sets up three types: deregistration for scrapping; temporary deregistration; deregistration for export. In the case of deregistration for scrapping, proofs of disposal should be handed in to the licensing authority. The German deregistration system requires the documentation as a proof of final destination of deregistered vehicles.

Proof of disposal and authorisation of returning points

Proof of disposal is required to hand in to the authority in order to deregister vehicles for scrapping purpose. Only authorised dismantlers and /or authorised return points can issue such certificates. An independent expert issues authorisation for dismantlers and returning points.

Cooperation between returning stations and dismantlers

The German legislation requires cooperation between certified return stations and certified dismantlers, in order to secure the flow of ELVs entering to proper recycling facilities. After the voluntary agreement and the ELV ordinance came into force, the numerous certified return stations contracted the co-operation with certified dismantlers. For example, in 1998 when 130 certified return stations were examined; it was found that almost 74 per cent had already developed contracts of with dismantlers[98].

6.2.1.2 Treatment

Expert authorisation system

For authorising return stations, dismantlers, and other recycling facilities, the German system applies an expert authorisation system. Independent experts certify ELV treatment facilities and control their follow-ups of environmental standards on an annual base. An independent expert, a private individual, should be certified to be an expert to examine recycling facilities based on regulative requirements. The Chambers of Industry and Commerce and other expert organisations shall conduct certifications of the independent experts[99].

Restrictions on hazardous substances

In Germany, although in the regulatory provision of the Technical Guideline on Hazardous Waste (TA Abfall) of 1991, ASR has been classified as hazardous waste so that is subject to special treatment.

However, in practice, state agencies have granted broad exceptions to these rules, taking into consideration comparatively high costs of hazardous waste disposal and consequent economic impact on shredding business.

6.2.1.3 Monitoring

Documentation Requirement

The German legislation requires documentation throughout the entire chain of ELV recycling. Starting with last vehicle owners, documentation should be followed and filled by all actors along with physical ELV flows. Documentation requirement is designed in order to control and monitor the ELV recycling, together with having an overview of the status of the German ELV system. However, the documentation requirement has not been implemented properly.

Self-monitoring system

According to FSV, self-monitoring systems by the Association of the German Car dismantlers (Interessengemeinschaft der deutschen Atutoverwerter-IGA) and the Federal Association of the German Steel Recyclers (Bundesvereinigung Deutscher Stahlrecycling-und Entsorgungsunternehmen-BDSV) are running. Their reports should be submitted to Bundesministerium fur Umwelt, Naturschutz end Reaktorsicherheit (the federal ministry for the Environment, Nature Conservation, and Nuclear Safety: BMU)[100]. However, there is no further information on these reporting systems found by the author during the research.

6.2.2 Role of main actors

The role of **last vehicle owners** is an essential part for determining the final destination of ELVs, since there is no strict implementation of documentation and the proof of disposal system. Last owners have the hand-in obligation regulated by law. In addition, the free take-back system in Germany allows

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[98] Busch and Jörgens. (2000). P. 38.

[99] Busch, P.O. and Jörgens, H. (2001). *Breaking the deadlock-voluntary agreements and regulatory measures in German waste management.* p. 31 and 32.

[100] Busch and Jörgens. (2000). p. 45.

favourable conditions for car producers[101]. In most cases, the last owners have to bear recycling costs through negotiation with dismantlers. Due to the financial burden and the lack of sanction on last owners for the hand-in duty, only strong environmental concern from last owners can be a major successful element of ELV collection.

There are around 15 000 **return stations** in Germany[102]. Two different types of return stations are found, one of which is connected to car producers and the other is without connection with producers[103]. All return stations are supposed to be authorised by law. In addition, regulations demand cooperation between certified return stations and certified dismantlers, in order to secure a proper treatment recycling flow within the system. Since the voluntary agreement and the ELV ordinance were enforced, numerous certified return stations signed contracts of co-operation with certified dismantlers.

There is a variety of dismantling facilities existing in Germany such as scrappers, **dismantlers**, car dealers and repair stations that also occasionally perform a part of dismantling process. Clear distinction is very difficult. The total number of dismantling operators is estimated 3 500 to 6 000 or around 4 500 to 5 000[104]. After the voluntary agreement and the ELV ordinance wre enforced, the dismantlers are required to be authorised. Around 1 000 dismantlers were certified and still maintain their valid certifications. However, there are still a great number of unauthorised dismantlers in Germany after the ELV ordinance.

Several **shredding companies** in Germany are owned and operated by large steel companies, which can afford high investment costs for shredder plants. Only a few independent shredders operate in Germany[105]. Shredders are ultimately responsible for reducing ASR and also responsible for the environmental damage resulting from dumping of contaminated ASR. However, shredders still dump hazardous ASR in landfills, owing to the lack of sanction and further, official exemptions by local authorities.

In terms of controlling environmental performances of recycling facilities, the role of **independent experts**, who issue certifications of relevant recycling facilities, is important. These independent experts are supposed to examine facilities based on regulatory requirements for each case. However, their tasks and qualities are in question in the present German system[106]. Quality improvement of this existing expert system will be closely connected with improvement of recycling facilities and their performances.

Often major problems are found in the role of **authorities.** For instance, local governments are responsible for deregistration, implementation of documentation obligation for ELVs, and monitoring expert system. However, their implementation powers are weak. In addition, the gap of communication between local governments and central government is found, which makes it difficult for the central government to have a clear view on ELV flows and ELV recycling in general[107] [108].

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101 Car producers only pay recycling costs for less than 12 years old vehicles. However, most of less than 12 years old ELV dos not create negative benefits to dismantlers.

102 Busch and Jörgens. (2000). p. 38.

103 Personal communication with Kunt Sander , Researcher, Institut fur Ökologie und Politik GmbH

104 Busch, P.O. and Jörgens, H. (2001). p. 26.

105 Busch and Jörgens. (2001). p. 27.

106 Lohse, J. & Sander, K. (1999). *General requirements for monitoring the recycling of long-lived, technically complex products with an in-depth-analysis of end-of-life vehicles: summary.* Institut fur Ökologie und Politik GmbH. [Online]. Available: http://www.oekopol.de/de/Archiv/Archiv/Stoffstrom/Autoeng.htm [2002, July 12].

107 Lohse, J. & Sander, K. (1999). *General requirements for monitoring the recycling of long-lived, technically complex products with an in-depth-analysis of end-of-life vehicles: summary.*

108 Busch, P.O. and Jörgens, H. (2001).

There are seven main **car producers** in Germany: BMW; DaimlerChrysler; Ford; Opel; Porsche; Volkswagen; and Audi. They are responsible for more than two thirds of the total turnover in the automobile sector. German car manufacturers sell the most vehicles, totalling 70 per cent of the German market[109]. According to FSV and the ELV ordinance of 1997, German car producers committed to ensure the establishment of a nation-wide infrastructure for the free take-back system of ELVs. Such a task was fairly easy for them because there was a wide web of different recycling operators already existed[110]. Besides the national infrastructure, major car producers in Germany set up separate individual networks with dismantlers by contract. According to the Ministry for the Environment, about 300 dismantlers have relations with automobile producers[111]. Related to the design for new vehicles, car producers claimed that the progress in improvement of car recyclability. However, it is difficult to distinguish whether such car producers' efforts in design improvement is due to the existing German ELV system or due to the threat of upcoming stringent legislations that expands the condition of the producer responsibility for ELV recycling.

As collective action of the German car producers, Verband der Automobilindustrie (**VDA),** the German car producers association, has undertaken several projects for recycling oriented design for cars, for examples, Projektgruppe Altfahrzeug-Verwertung der deutschen Automobilindustrie (PRAVDA), Initiativkreis Autoteilerecycling (IATR), and Teilerecycling im Handel (TRH). In addition, the Arbeitsgemeinschaft Altauto (**ARGE-Altauto),** the producer responsibility organisation established within VDA, facilitates co-ordination and implementation of the voluntary agreement. ARGE-Altauto fosters information exchange between different actors in the German ELV chain by initiating workshops, conferences, meetings and other internal events. Furthermore, ARGE-Altauto provides comprehensive information about the progress in the implementation of the voluntary agreement such as regularly updated numbers of certified dismantlers and shredders, third-party evaluations of the voluntary agreement, official documents, and information on further policy development[112].

6.2.3 Findings and Discussion

Infrastructure

According to the first evaluation and data provided by ARGE-Altauto after FSV and the ELV ordinance of 1997, it is reported that a nation-wide infrastructure for collection, recycling, and disposal of ELVs has been successful. In 2000, ARGE-Altauto estimated a total of 15 000 return stations. 91 independent experts were appointed. 1092 certified dismantler (based on the figure of February 2001) were registered with ARGE-Altauto. 41 shredders were certified in Germany. And another 16 certified shredders operate in other European countries[113]. Especially, a number of dismantlers underwent dramatic decrease of, at least, 67 per cent. This is a part of outcome of increasing professionalism in dismantling business due to the significant rise of overall environmental standards in this sector[114].

Apart from the figure above, a serious issue arises in terms of dismantling authorisation. It has been found out that a large number of certified operators have not been always kept valid certifications[115]. In addition, the level of certification practices still considerably varies in different provinces, which closely relates to the general lack of controlling independent experts. In addition, qualities and reliabilities of some of organisations, which certify independent experts, are also questioned. Even though the Ministry for the Environment is concerned about the insufficient qualities of certifications and supervisions from appointed independent experts, it is reported that authorities at the local or state

109 Busch, P.O. and Jörgens, H. (2001). p. 23.

110 Busch, P.O. and Jörgens, H. (2001).

111 Busch, P.O. and Jörgens, H. (2001). p. 43.

112 Busch, P.O. and Jörgens, H. (2001). p. 42.

113 Busch, P.O. and Jörgens, H. (2001). p. 27 and 32.

114 Busch, P.O. and Jörgens, H. (2001). p. 38.

115 Busch, P.O. and Jörgens, H. (2001). p. 38.

levels continue to tolerate dismantlers, which do not completely fulfil required environmental standards[116].

Collection rate

It is extremely difficult to examine the actual collection rate in the German ELV system. Several reasons are identified. First, proof of disposal, which are required by last owners for deregistration for scrapping, are not implemented in a controlled manner[117]. Owing to the lack of information flow from local authorities for vehicle registration, the total number of proof of disposals is not collected in the central government. Second, the German deregistration system creates serious difficulty. In Germany, most of vehicles are finally deregistered through temporary deregistration. In the German system, temporary deregistration automatically turns into final deregistration after one year or one and half year at the latest when the vehicle owner does not re-register his car[118]. In such a case, the proof of disposal system cannot be properly applied to meet its original purpose. Third, the documentation obligation to last vehicle owners does not show any enforcement power. Often, authorities ignore to check the reliability of documentation from the last owners.

Consequently, the total number of deregistrations, the actual number of ELVs scrapped, and the actual number of vehicles exported or abandoned is not precisely known. In addition, differences among deregistration figures are also found during the research. According to the annual report 2002 of BMU around 3.7 million cars are annually taken off the road[119]. The figure from Kraftfahrt-Bundesamt (Federal Motor Transport Authority: KBA) seems to show more reliable data. During 1997 and 1998, the total deregistered vehicles (passenger cars) reaches around 3.4 million. However, since 1999, the number of deregistered cars has reduced to around 3 million and in 2000, 2.5 million and 3 million in 2001. Appendix 12 shows the number of cars deregistered in Germany last 10 years from KBA.

Among total deregistration, a large number of vehicles are considered to be exported, even though there are no clear data on the exact number of exported cars. The used car export market in Germany seems to be active since the opening of Eastern European market[120].

For the ELV generation in Germany, only approximate figures exist. Around **30 to 60 per cent[121] of total deregistered cars, which are about 1.1 to 1.7 millions of ELVs, are recycled** in Germany[122][123]. In addition, there is no data found on how many proof of disposals are issued and/or how many abandoned vehicles are generated. The serious problem of abandoned vehicles in nature has been recognised. Around **100 000 abandoned vehicles** are roughly estimated.[124] For example, in

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116 Busch, P.O. and Jörgens, H. (2001). p. 38.

117 Busch, P.O. and Jörgens, H. (2001). p. 38.

118 Lohse, J. And Sander, K. (1999). *General requirements for monitoring the recycling of long-lived, techinically complex products with an in-depth-analysis of end-of-life vehicles*. Institut fur Ökologie und Politik GmbH.

119 The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. (2002). *German environmental report 2002: Report on environmental policy in the 14th legislative period*. p. 113.

120 Lohse, J. and Sander, K. (1999). *General requirements for monitoring the recycling of long-lived, technically complex products with an in-depth-analysis of end-of-life vehicles*.

121 The Federal Environmental Agency. (2000). *Data on the Environment: the State on the Environment in Germany 2000*. [Online]. Available: http://www.umweltbundesamt.org/cgi-bin/byteserver.pl/dzu-e/kap-a.pdf [2002, July 15]. p. 51 and ARGE monitoring report.

122 Rainer, Lucas. (2001). *End of life vehicle regulation in Germany and Europe: Problems and perspectives*. Wuppertal, Germany: Wuppertal Institute for Climate, Environment and Energy.

123 ARGE-Altauto. (2000). Arbeitsgemeinschaft Altauto 1st monitoring report. [Online]. Available: http://www.arge-altauto.de [2002, June 20]

124 Jörgens, Helge and Busch, Per-Olof. (2000). *Agreement on the environmentally sound management of end-of-life vehicles*. Environmental Policy Research Unit, FUB. NEAPOL closing conference (Nov. 30 - Dec. 1, 2000).

Berlin, it is reported that considerable illegal ELV dumping exists. In half of illegal dumping cases, people temped to claim that they sold their vehicles to Eastern Europe, in order not to be penalised[125]. Since there is no clear control of documentation obligation for all deregistered vehicles, it is difficult for authorities to prove against such claims.

In sum, the absence of accurate data, together with weak implementation power at the level of authorities, the exact collection rate cannot be examined. However, considering a great number of ELVs flowing into unauthorised dismantlers and a large number of abandoned vehicles in nature reported, the actual collection rate seems to be low.

Recycling and recovery rates

As a consequence of the absence of correct figures in ELVs generation, an actual picture of recycling and recovery rates in Germany is very difficult to be identified. The available data on recycling and recovery rates presented by ARGE-Altauto is only a small part of the present German ELV system due to the low collection. Therefore, the actual rates of recycling and recovery should be considered much lower than the following information presented by ARGE-Altauto.

Based on the **average ELV weight, 903 kg**, ARGE-Altauto reported the **average body shell weight, 647 kg (71.7 per cent**) and the **average material recovery weight, 296 kg**, which seem to be measured total dismantled materials including parts for reuse. The ARGE-Altauto report does not measure the actual metal recycled. ARGE-Altauto estimated and stated that the present shredder residue goes to **landfills is around 18 to 22 per cent** of total ELV weight. However, **BMU still uses 25 per cent of total ELV weight going to landfill**[126]**.** Thus, the present recovery rate within the controlled recycling networks ranges between 75 and 82 per cent.

Recycling calculation methodology

According to the first report of ARGE-Altauto, ARGE-Altauto applies the following calculation methodology for recycling and recovery rates.

The average ELV weight is actually measured at dismantling sites. When ELVs come into the dismantling facilities, dismantlers measure actual weights of ELVs and then divide by their total number of ELV input. Based on this measurement, the average ELV weight is 903 kg. Compared to the average ELV weight, 907 kg, based on literature, which is the difference between a kerb weight minus an average driver weight[127], two figures do not show much difference.

The average body shell weight is also measured after dismantling certain materials. Materials that are regulated to be dismantled or be removed are: batteries; dangerous substances; components containing asbestos; catalytic converters; tyres; large plastic components such as bumpers; glass; metal components containing copper, aluminium or magnesium unless the metals are segregated during the shredding process; balance weights; and aluminium wheel rims[128].

The average material recycling rate is calculated as the difference between the average ELV weight and the average body shell weight. And all dismantled and removed materials at dismantlers are considered to be reused, recycled and/or recovered.

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125 Jörgens, Helge and Busch, Per-Olof. (2000). *Agreement on the environmentally sound management of end-of-life vehicles.*

126 The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. (2002). *German Environmental Report 2002: Report on environmental Policy in the 14th legislative period.* p. 113.

127 VDA. (2002). [Online] Available: http://www.vda.de/en/service/jahresbericht/auto2000/auto+umwelt/u_24.html [2002, May 30]

128 Liquefied gas tanks are added according to the new obligation by the ELV Act of 2001.

The average weight of material goes to landfills is observed and roughly measured by shredders. In addition, the average weight of energy recovery is measured by recovery facilities. The metal recycling rate is calculated as the remaining fraction from the average ELV weight minus the average body shell weight and then, minus the average weight of energy recovery minus the average weight of material to landfill.

However, the calculation methodology by ARGE-Altauto is not represented once in the entire German ELV system. In Germany, there was no fixed calculation methodology existing until recently. The ELV Act of 2001 regulates a new guideline of the German ELV calculation methodology, in order to set up a nation-wide model (for more detail, see Appendix 13).

Conclusion

After the ELV ordinance and FSV were introduced, the German ELV system started to be formulated. As a consequence, deregistration requires a proof of disposal issued by authorised returning points or dismantlers and the expert authorisation system authorises recycling operators in Germany. The nation-wide infrastructure for collection and recycling network was created. Close cooperation between authorised return stations and dismantlers was built due to the regulatory requirement.

Apart from the good design of the German ELV system, it shows a lot of drawbacks mainly due to the weak implementation. The implementation faults not only leads to the failure of the system but also creates the lack of data and information collection, which are necessary for having the clear view on German ELV collection, recycling and recovery rates. This eventually leads the difficulty to measure the progress of the German ELV system.

6.3 Financial Mechanism

Throughout the research, it was difficult to collect economic information, which relates to the change of relevant economic figures after the ELV ordinance and voluntary pledge were introduced. For example, several documents mentioned the difficulty of cost assessment data for recycling costs. In addition, no official data related to cost issues are found. Thus, this section presents some available information during the research, which can be fragmented but worth mentioning.

Recycling Cost

Since the ELV ordinance and FSV were introduced, it was expected that higher administrative expenses and investment costs at dismantlers would influence the increase of recycling costs that last owners will pay. One year after the ELV ordinance, **disposal costs to dismantlers were around 61 - 76 EUR** (120 and 150 DM) in Berlin, which excludes transportation costs for delivery[129]. In some cases, ELVs have been taken back even free of charge irrespective of their age[130]. BMU estimated **average recycling costs at 51 - 76 EUR (DM 100 to 150), ranging between cost free and 102 EUR (DM 200)** per ELV[131].

In terms of costs for improving recycling facilities, investment costs to be authorised to return stations, for example, were estimated an average about 969 EUR (DM 1 900) per return station[132]. From the study on 249 dismantlers, IGA estimated the average investment costs of 183 673 EUR (DM 360 000), in order to meet environmental standards based on the ELV ordinance. The largest part of these investment costs (which was an average of 133 878 EUR (DM 262 401) per dismantler) was for the

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129 Busch, P. & Jörgens, H. (2001). p. 42

130 Busch, P. & Jörgens, H. (2001). p. 42.

131 Busch, P. & Jörgens, H. (2001). p. 42.

132 Busch, P. & Jörgens, H. (2001). p. 42.

construction of storage halls for materials and dismantled cars, followed by 49 814 EUR (DM 97 636) for ground packing[133]. IGA's estimation was made under the assumption that material flows would considerably increase as a consequence of the ELV ordinance and FSV. However, Germany faces the decreasing number of ELVs due to a large exportation of used cars to the Central and Eastern European countries[134]. Thus, investment costs estimated by IGA would be slightly lower than actual ones. General costs for setting up the adequate disposal infrastructure for existing cars are estimated to be high, especially in the light of increasing recycling quotas, but concrete numbers are not available[135].

With regard to monitoring and control in the area of ELV management, BMU estimated administrative costs at public authorities, which would decrease as a result of increasing self-regulation due to the producer responsibility for ELV recycling. In addition, the government expected for state and municipal authorities to save some costs for treatment of illegally disposed cars. However, no concrete data or information was available.

Throughout the research, the author faced the difficulty to get information from producers. Only possible information was from VDA, who estimated the recycling cost, **around 100 EUR per ELV**, for car producers to bear, due to the fulfilment of legislation[136]. Mr. Sander (from personal communication), a researcher at Institut fur Ökologie und Politik GmbH, mentioned that it is very difficult to get information of estimated recycling costs by individual car producers but total recycling costs per vehicle, including investment costs for improvement of facilities, fulfilling regulations on depollution and dismantling, would be **100 EUR at a very maximum level**.

6.4 Conclusion

It is very difficult to measure the **environmental effectiveness** of the German ELV system. Due to the data absence to measure collection rates, and consequently recycling and recovery rates, and various reasons identified as difficulties in the system, the accurate and reliable information to measure the environmental effectiveness of the system and its progress is not possible. However, considering a large number of ELVs scrapped in uncontrolled sites and abandoned vehicles in nature, the environmental effectiveness seems to be quite low.

Due to the lack of implementation force for the proper deregistration by authorities, limited responsibility allocated to car producers, the last owner pays system is running in practice. Thus, neither control, nor benefit from the producer responsibility for ELV recycling appears in the present German ELV system.

At present, German car producers, for example, show some movements to improve the design of new vehicles. Some car producers are also participating in dismantling sectors in order to improve dismantling skills for ultimate reduction of recycling costs. However, such movements are considered mainly due to the threat of upcoming expansion of the producer responsibility for ELV recycling.

Owing to difficulty of data collection regarding the financial mechanism of the German system, it is very difficult to find out **the economic efficiency** of the system. And also existing information on recycling costs does not provide any reflection of recycling and recovery rates in the system, which makes it more difficult. Considering the design of financing the system, German free take-back gives a favourable condition for car producers, which does not create motivation for car producers to reduce

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133 Busch, P. & Jörgens, H. (2001). p. 42

134 Busch, P. & Jörgens, H. (2001). p. 42

135 Busch, P. & Jörgens, H. (2001). p. 42

136 VDA. (2001). *Stellungnahme zum Gesetz über die Entsorgung von Altfahrzeugen – Altfahrzeug-Gesetz (Statement to Law over the disposal of old vehicles)*

recycling costs. Mainly due to the threat of the ELV act of 2001, not due to the presently running producer responsibility, the German car producers are conducting economic studies in order to find out the actual recycling costs and further to reduce these recycling costs.

In terms of **monitoring**, the German system has a serious drawback. As it is seen in the discussion on the environmental effectiveness, the monitoring on different flows of deregistered vehicles is very weak due to the weak implementation of the system. Consequently, it drives negative impacts on recycling and recovery of ELVs in the German system.

The system based on the ELV ordinance and FSV does not give a **strong stimulating power** for producers and other relevant actors to act in an innovative manner. The reason is similar as above. For instance, the limited responsibility allocated to car producers does not create motivation to improve vehicles design, to reduce recycling costs, to enhance the monitoring of recycling and recovery, and to move further for innovation.

Considering the sensitivity that German car producers receive from the threat of the EU ELV directive and the ELV Act of 2001, some innovative actions from car producers are found. However, it cannot be considered as effect of the design of the present ELV system based on the ELV ordinance and FSV.

7. France

7.1 Legal Framework and Voluntary Agreement

The French legislation does not have a specific regulation to directly cover end-of-life vehicle waste as whole. Only regulations related to ELVs are found in the law N° 286 of July 19, 1976, to the Classified Installations and the law N°75-633 of July 15, 1975, and its modification of July 13, 1992, relating to the elimination and the recovery of materials. At present, the French Government prepared the draft decree relating to the transposition of EU ELV directive. Such French transposition is planned to be the end of this year, 2002[137].

The law N° 286 of July 19, 1976 to the Classified Installations regulates the sites where the scrap metal recovery activities and storage take place. All relating operators should follow the specific technical regulations mentioned in this law. Therefore, any storage of ELVs, with more than 50 square metres, is subject to be authorised according to this law. **The law N°75-633 of July 15, 1975 and its modification, the law of July 13, 1992 relating to the elimination and the recovery of materials** came into force in order to correctly manage recyclable waste. All recyclable materials from ELVs are regulated by these laws.

The ELV system, which is presently running in France, is organised according to the Accord Cadre on ELV of 1993 (the Master Agreement on ELV), which is the voluntary agreement among the governmental authorities and relevant industrial sectors.

The Accord Cadre on ELV is the first national voluntary agreement in Europe pursing the self-regulation of ELV management[138].

The Background of signing the Accord Cadre on ELV dates up to the early 90s. Agence de l'Environnement et de la Maîtrise de l'Energie (the French State Agency for Environment and Energy Conservation: ADEME) was leading and coordinating the European ELV Project Group established by the European Commission. From the learning process during this project, the French Ministries of Environment and Industry and the automobile industry and eight professional associations[139] involved in ELVs committed to work on the national ELV issue by signing the Accord Cadre on ELV in 1993. In 1995, car importers of foreign brands[140] joined.

The Accord Cadre includes several objectives: (1) to channel all scrap vehicles into the reprocessing chain by 2002[141]; (2) to reach specific targets to reduce ELV disposal such as maximum 15% of car

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[137] Email communication with Nicolas Le Bigot at Comité des Constructeurs Français d'Automobiles (CCFA) on the 11th of July 2002.

[138] Zoboli et al. (2000). *Regulation and innovation in the area of end-of-life vehicles*. p. II-2.

[139] These are The Ministry of the Environment (le Ministère de l'Environnement), The Ministry of Industry and Foreign Trade (le Ministère de l'Industrie et du Commerce Extérieur), The National Control of the Renault Factories (la Régie Nationale des Usines RENAULT), PSA-Peugeot-Citroen, The Branch Demolition contractors of Cars of the National Council of the Professional of Cars (La Branche Démolisseurs d'Automobiles du Conseil National des Professions de l'Automobile :CNPA), The French Federation of Recovery for the Industrial Management of Environment (La Fédération Française de la Récupération pour la Gestion Industrielle de l'Environnement :FEDEREC), The Commission of the Crushers of FEDEREC (La Commission des Broyeurs de FEDEREC), The French Federation of Steel (La Fédération Française de l'Acier), The Federation of the Ores, Industrial Mineral and non-ferrous Metals (La Fédération des Minerais, Minéraux Industriels et Métaux non-ferreux), The Trade union of the Plastic Producers (Le Syndicat des Producteurs de Matières Plastiques), The Federation of Industries of the Equipment for Vehicles (La Fédération des Industries des Equipements pour Véhicules), The Federation of Plasturgie (La Fédération de la Plasturgie).

[140] BMW, Fiat, Romeo Esparto, Lancia, Ford, Opel, Mecedes-Benz, Rover, Volkswagen, Audi, Seat, Skoda, Volvo, Honda, Nissan, Porsche, Toyota.

[141] Zoboli et al. (2000). p. II-2.

weight by 2002, maximum 10% for new models produced from 2002, and maximum 5% in the long term. In addition, another important commitment is to build coordination and responsibility sharing among the participants, based on free market principles and free choice among different technologies and technical approaches, including energy recovery[142]. To reach the objectives, the Accord Cadre includes series of commitment by the different industrial categories involved, which are summarised in Appendix 14.

At present, the French government prepared the draft to transpose the EU ELV Directive. More detailed information is presented in Appendix 15.

7.2 French End-of-Life Vehicle System in Practice

In France, a lot of diverse scrappers, dismantlers and shredders have been dealing with ELV recycling. Last owners of vehicles have three major choices to hand in their ELVs: car dealers; dismantlers including scrappers; and shredders. The **major problem** is that a large number of ELVs are entering uncontrolled scrappers and dismantlers and are also directly entering shredders, who accept untreated ELVs in the shredding process. Last owners tend to bring their ELVs to anyone who offers a better price for their ELVs and/or who gives the least financial burden. There is **no specific regulation on a deregistration system**. Neither a certificate of destruction, nor a hand-in duty for the last owners supports collection of ELVs for proper treatment facilities.

After the Accord Cadre on ELV of 1993 was signed, and initiated by dismantlers, shredders, and recyclers, the Manager-Distributors (MD) system was set up in order to establish a proper treatment chain for ELV recycling. The MD system, however, is only an initiative by relevant recycling industries not a nation-wide system supported by the Government or legislations.

7.2.1 Manager-Distributors (MD) System

As a consequence of the Accord Cadre, French shredders, dismantlers, and recyclers took an initiative to set up 'Manager-Distributors (MD)' in order to develop a secure channel for proper ELV recycling and a treatment chain. In the circumstance where no relevant legislation exists and guides ELV treatment setting, MDs play a pivotal role in the French ELV system. Subsidised mostly by shredders, MDs work out a complex system of contractual agreement with the actors of the ELV chain[143]. There are four MD companies existing in France. These are ECO-V.H.U. (subsidiary of shredder CFF), Valorauto (subsidiary of the Gallo shredder group), ORA (subsidiary of CFF and shredder Guy Dolphin), and INDRA (independent)[144].

System design

MDs buy ELVs only from car dealers of contracted producers and sell them to contracted dismantlers, who were chosen among authorised (certified) dismantlers (Appendix 16 informs about the scrapping certification system in France). Contracted shredders, who are committed to perform environmentally sound shredding, are ensured to receive properly treated car wrecks from these dismantlers.

As well as being facilitators of the physical flow of ELVs into the proper recycling chain, MDs are **monitoring** the environmental performances of contracted dismantlers, recyclers, and shredders. This monitoring system provides clear recycling and recovery rates throughout the entire chain in their

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142 Zoboli, Roberto. (1998). *Implications of Environmental Regulation on Industrial Regulation on Industrial Innovation: the Case of End-of-Life Vehicles*. European Commission. EUR18688EN. Luxembourg. Belgium. p. 16.

143 Zoboli et al. (2000). p. II-4.

144 ADEME. (2001a). *La gestion des véhicules hors d'usage.*

networks. The outcome of their monitoring is reported to car producers. Figure 12 describes the physical and financial flows of the MD system in France.

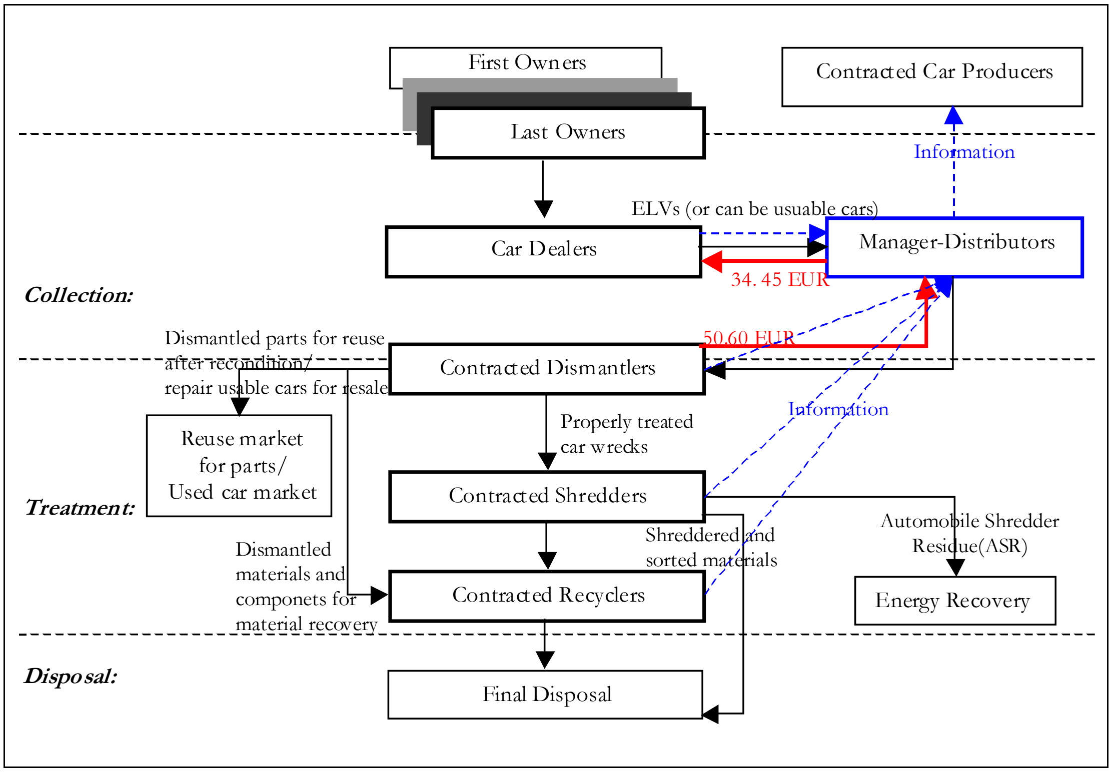

Figure 12. The physical and financial flows of MD system in France (Figures on financial costs are in ECO-V.H.U. case)

Financial flows of MD system[145]

According to information provided by ECO-V.H.U., which manages 60 per cent of the physical flows of the entire MD system, the current price of a vehicle that ECO-V.H.U. buys from car dealers is 34.45 EUR per vehicle and the sale price to dismantlers is 50.60 EUR per vehicle. Transportation costs from car dealers to dismantlers are born by dismantlers.

The financial mechanism of the MD system had been set up based on the situation of 1993 and 1994. When the Government undertook the withdraw policy for old vehicles by providing financial support for new car purchasing, through the MD system, contracted dismantlers were receiving a lot of ELVs with positive value and also used cars. Therefore, dismantlers are buying ELVs and used vehicles from MDs with a little premium and also paying for transportation costs.

Relevant actors

At present, all **car producers** signed contracts with MDs. Based on this contract, car producers allow MDs to collect ELVs from their **car dealers**. The role of car producers in the MD system is very

145 Personal communication with Arnald Humbert-Droz at ECO-V.H.U.

passive. They do not hold any responsibility for ELV recycling. At present, car producers are just observers of the performance of the MD system.

There are 227 **certified dismantlers** in MD networks. Dismantlers are paying for transportation and flat prices for ELVs (including old cars). Contracted dismantlers are committed to perform depollution and dismantling process in an environmentally sound manner. Dismantlers provide information on their performances to MDs.

Dismantlers are not only carrying out dismantling of ELVs, but are also repairing vehicles coming through MD networks and reselling them. Thus, their major income comes from reselling old cars and selling used parts for reuse. In financial terms, dismantlers play a significant role, in bearing the transportation and recycling costs. However, based on the information collected by the author, dismantlers are facing difficulties due to several reasons. One is the change in characters of old vehicles and ELVs coming through MD system. Since there is no governmental support for old vehicles, vehicles ending up at car dealers consist of less re-sellable cars and more ELVs and especially ELVs with negative value. Another reason is that the market for used parts for reuse has been slowing down. In addition, the upcoming restriction on dismantling business, which is to prohibit repairing and reselling activities, threatens the French dismantlers.

Shredders have also an important role since the set-up of the MD system. Especially the biggest shredder in France, CFF, subsidises most MD companies. The rationale behind their subsidies is that shredders experienced serious environmental impacts and faced serious operational problems in the shredding process due to untreated ELVs. Therefore, by establishing the MD system, shredders can be ensured to receive clean and treated ELVs, which can prevent such difficulties in shredding process and eventually give major benefits for shredders. There are 30 shredders contracted in the MD system, who are committed not to receive untreated ELVs.

7.3 Findings and discussion

The French MD system does not deal with all generated ELVs in France. MDs are only collecting ELVs from car dealers. ELVs from the general public, insurance companies, and public authorities are not dealt within the MD system.

Taking into consideration that fact, this section presents some findings during the research and brings up a discussion.

Collection rate

No accurate data on total deregistration, deregistration for export, nor ELV generation are available. Only estimated data were found, which is based on the sales of new cars on the last 20 years and their probability to become ELVs[146][147]. Using various assumptions, one estimates roughly that between 1.2 and 1.6 million ELVs are generated annually. Certain sources continue to present quite high figures - around 1.8 and 2 million of ELVs[148]. According to the 'national status report for ACEA', CCFA states that 1.8 millions of vehicles are deregistered annually in France. 1.3 million of ELVs are scrapped and the rest are exported to outside of France[149].

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146 ADEME. (2001b). *Traitement des vehicules hors d'usage: Bilan de l'accord-cadre de mars 1993.*

147 ADEME (2001a). *La Gestion des vehicules hors d'usage.* Direction de l'Industrie, ADEME.

148 ADEME (2001a). *La Gestion des vehicules hors d'usage.*

149 CCFA. (2001). *The national status report of France for implementation of the EU ELV directive.*

By law, all dismantling facilities have to be authorised. However, there are a lot of unauthorised dismantlers operating in France, who are dealing with a great number of ELVs. According to the information from ADEME, around 400 000 ELVs go to authorised dismantlers in 2000[150]. The rest go to unauthorised dismantlers or directly to shredders.

Therefore, the collection rate in the present French system **accounts 31 per cent, which goes to proper treatment facilities.**

As for **abandoned vehicles** in nature, it is announced that the French system does not have any abandoned vehicles. During the research, Dorothée Giffard at the Conseil National des Professions de l'Automobile (CNPA) (the car dismantlers association) responded to a question about abandoned vehicles as follows, "*In France, the ELV treatment system is already efficient. For instance, we do not face any problems like having ELVs in the street or in the countryside. This is a problem solved for 20 years.*"

However, Den Hond (1996), in his PhD thesis, mentioned, "*in France, it is estimated that 20 per cent of vehicles are abandoned*[151]*.*" Taking into consideration this inconsistency in these information sources observed during the research, the author is sceptical of the fact that the French ELV system does not create abandoned vehicles in nature. Since no one except for the last owner pays recycling costs for their ELVs, it is difficult to believe that there is not one abandoned vehicle generated in France. In order to claim that the French system does not generate abandoned vehicles, there should be a proof of data collected. However, no data on abandoned vehicles in the French system was found.

Without a proper deregistration system for **export of used cars**, no clear data exists in the French system. According to CCFA, around 500 000 vehicles are leaving the territory[152]. ADEME observes from the trans-boundary movement of used vehicles, which is that several ten thousands of old vehicles are exported, especially to Spain, for scrapping purpose or for reselling as used cars[153].

In conclusion, the absence of a proper deregistration system and the lack of data collection relating to ELVs makes it difficult to have a clear overview on the physical flow of ELVs generated, abandoned, or exported.

Recovery rate

It is difficult to generalise recycling and recovery rates of the present French system. Still a significant amount of ELVs are treated by uncontrolled scrappers and directly by shredders. There is no information how they perform, which reflects recycling and recovery rates. Taking into consideration this fact, ADEME more realistically estimates 70 to 75 per cent of recycling and recovery rates in these types of recycling chains. Only around one third of total ELVs are properly treated and recycled[154]. Therefore, ADEME presents **75 to 80 per cent** as representative rate of the present French system[155].

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150 According to the development of the internet tool, minitel (3615 VHU), around 400 certified dismantlers declared 400 000 ELVs treated. This tool is operating since March 2000 in order to trace better flows of ELVs within the French system based on the Accord Cadre on ELVs.

151 Den Hond, F. (1996). *In search for a useful theory of environmental strategy: a case study on the recycling of ELV from capabilities perspective.* [Online]. Available: http://home.scw.vu.nl/~den_hond/onderzoek/proefschrift/inhoud.html [2002, June 30]. p. 80.

152 CCFA. (2002). *Implementation of the EU ELV Directive: country status report.*

153 ADEME. (2001b). *Traitement des vehicules hors d'usage: Bilan de l'Accord-cadre de mars 1993.*

154 ADEME. (2001b).

155 ADEME. (2001b).

Recovery rate in MD system

Particularly in 1998 and 1999, a lot of studies were conducted on recovery performance within the MD network. There are two important studies, which are considered to closely reflect recycling rates of the MD system. These are the 'Renault study' on over 250 000 ELVs treated in MD network (including 250 certified dismantlers) and, with assistance of ADEME, the 'Sofival study' on nearly 300 ELVs treated by a group of certified dismantlers, shredders and INDRA[156].

A summary of these studies follows:

- The average ELV weight entering within dismantlers increased slowly to reach approximately 900 kg in 1999, compared to 870 kg in 1995;
- The average weight of body shell sold to shredders ranges between 650 and 730 kg;
- The material recovery at certified dismantler is around 20 to 25 percent of the whole ELV by weight;
- The recycled metals account for around 60 to 65 per cent of the whole ELV by weight;
- The average of material that goes to landfill is around 147 kg, which is around 16 to 17 per cent of the whole ELV by weight;
- The average rate of recovery reaches 83 – 84 % within certified actors[157].

Besides these studies, recycling and recovery rates of MD networks in 2000[158] were collected. Through three MD companies, which are ECO-V.H.U., ORA, and Valorauto, 42 587 ELVs were collected and treated by 232 contracted dismantlers. Compared to 45 504 ELVs collected in 1999, the volume of ELVs collected by MDs decreased 6 per cent. In addition, a number of incomplete ELVs (which is missing some parts from ELVs) coming into MD network increased up to 817 in 2000, compared to 542 in 1999.

The outcomes of 2000 result on recovery rate in MD networks is summarised in Table 10.

Table 10. The 2000 result on recovery rate of MD networks

	Recovery weight (kg)	**Recovery rate (%)**
Average weight of ELVs	899	100
Average car wreck weight sent to shredders	694	78.5
Average weight of materials extracted by **dismantlers (A)**	205	**21.5***
Average weight of oil & brake fluid	*5.8*	*0.6*
Average weight of coolant & windscreen washer	*3.8*	*0.3*
Average weight of batteries	*11.1*	*1.2*
Average weight of parts for reuse	*184*	*20.5*
Average recovery at **shredders (B)**	420	**60.5**
Total recovery (A)+(B)		**82.0**

* *Total average of materials extracted by dismantlers, which is 21.5 % is less than the sum of average weights of different materials by 1.1%. Data gap is found*

Source: ECO-V.H.U. (2001).

From the information collected, it seems that the general quality of ELVs entering the MD system has decreased. This fact reflected by the outcome of recovery rate reported by ECO-V.H.U in 2000 is lower than those reported by studies on 1998 and 1999. In addition, 2000 study still shows high 'reuse

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156 ADEME. (2001b).

157 ADEME. (2001b).

158 ECO-V.H.U. (2001). *ECO-V.H.U. 2000 result.*

rate' within total recovery rate, which can lead to the conclusion that even though the average year of ELVs is similar as other systems, the MD system still receives a large volume of ELVs with good qualities.

Future financial flow

In France, often dismantlers conduct different types of business: as dismantlers to dismantle parts and metals from ELVs to sell them in the reuse and recycling markets and to shredders; as used car dealers and as repair shops to sell old vehicles after reconditioning or as they are. It means that existing French dismantlers with multi-function have a good chance to get more profits from different activities. Since vehicles coming from MDs consist of a number of old vehicles and also ELVs with positive value, contracted dismantlers have benefit to deal with MDs, which often cover recycling costs for ELVs with negative value.

However, the present situation has changed. Contracted dismantlers receive less and less positive valued ELVs and used cars, and more and more negative valued ELVs. Thus, it is observed by MDs that contracted dismantlers face the difficulty in financing the MD ELV recycling system so that it is expected that the present financial mechanism in the MD system will radically change in the near future.

7.4 Conclusion

After the Accord Cadre was signed among relevant recycling industries, including car producers, the MD system was established in order to create the proper recycling chain. However, the MD system only deals with ELVs entering from car dealers. There are still large numbers of ELVs entering uncontrolled dismantlers. Only around one third of ELVs from total deregistered vehicles are properly treated in France.

There are many unknown facts in the French ELV system. Without a proper deregistration policy, it is impossible to have a clear overview on end-of-life phase of vehicles. Roughly, 500 000 old vehicles are leaving the territory for scrapping and/or reselling purposes. Even though some organisations involved in ELV recycling claimed that the French system does not generate abandoned vehicles in nature, it is still suspected that a significant number of abandoned vehicles are generated.

In order to arrange a nation-wide ELV system in France, proper legislation that can give clear guidelines for ELV policy making are needed. In addition, a new type of financing method is needed in order to secure a proper treatment system.

8. The UK

8.1 Legal Framework and Voluntary Agreement

There is no specific and comprehensive regulation dealing with ELVs in the UK. The UK government and relevant industries discussed how to set up legislative guidelines. Finally, on the 21st of June 2002, the UK government announced that final owners, not car producers, would have to pay for recycling costs until 2007. This governmental confirmation means that the UK is still in the way off transposing the EU directive[159].

Regarding ELVs, there are **the Scrap Metal Dealers Act of 1964, the Environmental Protection Act of 1990, and the Waste Management Licensing Regulations of 1994** to regulate car dismantling and scrap metal recycling industries. However, these laws still allow small companies to have official exemptions[160].

In terms of policy development for ELVs, the **ACORD agreement** (Automobile Consortium on Recycling and Disposal) is considered as a start-up. On July 1997, SMMT (car producers association), material & component suppliers, dismantlers, shredders, the recycling industry, and the Departments of Industry and of Environment (DTI) signed the agreement. The main principle of the ACORD agreement is the shared responsibility, which leads coordinated actions by various industries.[161] The main objectives of the ACORD agreement are: to reduce ASR to be landfilled; to organise an ELV treatment system; to develop appropriate recycling and disposal options; and, on policy-making ground, to avoid the European directive[162].

ACORD, formulated within SMMT, is monitoring the performances of participants as outcomes of the ACORD agreement. ACORD is supported by the industry consortium, CARE (Consortium for Automotive Recycling). CARE works on a number of pilot projects concerning both mechanical recycling and energy recovery. CARE functions as a research group and provides results of technological feasibility and economic viability of disposal options. The ACORD approach seems to focus on energy recovery options such as fuel for electricity generation, blast furnaces, and cement kilns as the ACORD agreement does not divide recycling and recovery targets. Their recovery targets committed within the ACORD agreement are 85 per cent by 2002 and 95 per cent by 2015[163].

8.2 UK ELV System in Practice

One of commitments of the ACORD agreement is to organise an ELV treatment system. However, no special arrangement to organise ELV recycling chain is found. The ACORD agreement mainly focuses on strengthening responsibilities and improvement of performances of relevant actors. However, there is no coordination or cooperation among ACORD participants in terms of organising the recycling chain.

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159 ENDS Environmental Daily. (2002). *Last owners to be liable for UK's scrap cars*. Issue 1241-Friday 21 June 2002.

160 House of Commons-Trade and Industry. (2001). End of life vehicles directive, First report. [Online]. Available: http://www.parliament.the-stationery-office.co.uk/pa/cm200102/cmselect/cmtrdind/299/29906.htm. [2002, June 4]

161 Zoboli, Roberto. (1998). *Implications of Environmental Regulation on Industrial Regulation on Industrial Innovation: the Case of End-of-Life Vehicles*. p. 16.

162 Zoboli et al. (2000). p. II-64.

163 Zoboli et al. (2000). p. II-65.

Therefore, ELVs generated in the UK are treated in different routes, which have been established by market mechanisms. There are several routes for last owners to handle their ELVs. Last owners of vehicles may pay or get compensated to hand over their ELVs to scrap yards, dismantlers, authorised dismantlers, or directly to shredders.

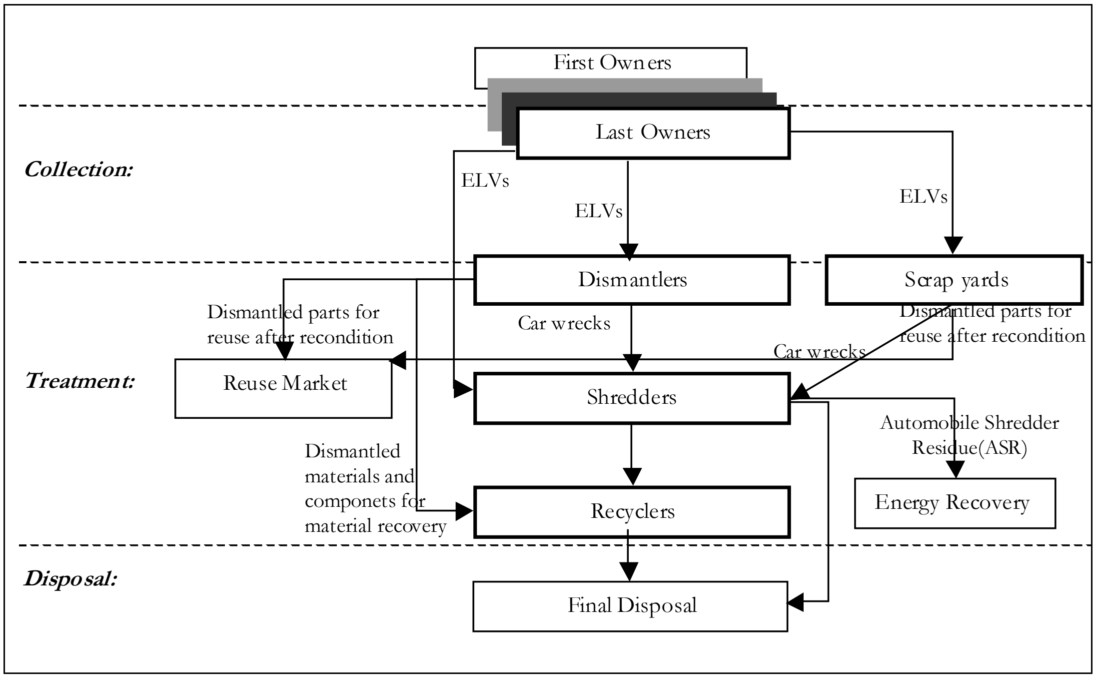

Figure 13. The end-of-life vehicle system in UK

System design

The Deregistration system in the UK does not require a certificate of destruction neither documentation to show how last owners handle their ELVs. The need of a certificate of destruction was discussed among ACORD participants. However, the governmental response is slow. Initiatives by some dismantlers are done to open up channels with the Driver and Vehicle Licensing Agency (DVLA), where they report on how many ELVs they treated in an environmentally sound manner.

Financial mechanism

Since there is nothing arranged for the ELV treatment system, financial flows follow the market situation. Last owners are responsible to finance recycling costs. However, the actual amount of costs is unknown.

8.3 Actors

Dismantlers

No exact data are found on how many dismantlers deal with ELVs in the UK. Several documents mentioned around 3 500 dismantlers with around 500 more or less[164][165]. Among existing dismantlers in the UK, around 2000 are licensed and the rest are uncontrolled dismantlers, including scrap yards[166].

[164] Committee on Trade and Industry. (2001). *End of Life Vehicles Directive.* First Report to House of Commons. [Online]. Available: http://parliament.the-stationery-office.co.uk/pa/cm2001102/cmtrdind/299/29902.htm [2002, June 14]

In terms of the volume of ELVs, a small number of authorised dismantlers are dealing with 70 per cent of all ELVs generated in the UK. On the other hand, a large number of garages and scrap yards are handling the rest[167][168]. Among authorised dismantlers, 334 are members of the Motor Vehicle Dismantlers Association of Great Britain (MVDA), who handle nearly 50 per cent of ELVs[169].

However, even though authorised dismantlers should remove certain components such as batteries, fluids, and tyres outlined in the Environmental Protection Act, it is observed that a large number of authorised dismantlers do not follow such regulative requirements[170]. Also, to what extent, it is unknown that local governments monitor and sanction such poor performing authorised dismantlers.

Therefore, it can be estimated that around 50 per cent of ELVs generated in the UK are treated in a proper way. But it is not known for certain that the other half is properly treated.

Shredders

There are 14 shredder companies[171] running 37 shredders sites[172] in the UK. Around 60 to 80 per cent of the existing shredding capacity is in the hands of two shredders[173]. Shredders in the UK often process untreated ELVs from scrappers and directly from last owners. There is no regulation to control such shredders at present. Even though all shredding companies are members of the British Metal Recycling Association (BMRA), BMRA does not have power to self-regulate such poorly performing shredders. BMRA can only encourage their members. BMRA assumes that governmental regulations may stop such shredding practices[174].

Car producers

As there is no arrangement to organise the ELV recycling chain in the UK, car producers do not play a significant role in participating in an ELV collection and recycling infrastructure. Only few car producers take initiatives to perform the free take-back system, together with a few authorised dismantlers[175].

Car producers in the UK mostly focus on design improvement in order to prepare the upcoming transposing law of the EU ELV directive, which is expected in 2007. This results in that most of car producers participate in CARE in a collective manner.

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165 MVDA & CAIR. (2000). *Impact of the end of life vehicle directive on the motor vehicle dismantling industry in the UK.* Cardiff, UK: Lichfield & Cardiff.

166 According to Committee on Trade and Industry (2001) report, DEFRA revised the data on dismantlers that 3000 dismantling operators with 700-800 operating illegally. However, according to the UK EPA, a number of dismantlers are 1 500 and scrap yards are 1 000. Different information shows data inconsistency.

167 MVDA & CAIR. (2000). *Impact of the end of life vehicle directive on the motor vehicle dismantling industry in the UK.* Cardiff, UK: Lichfield & Cardiff.

168 Committee on Trade and Industry. (2001). *End of life vehicles directive.* First Report to House of Commons. [Online]. Available: http://parliament.the-stationery-office.co.uk/pa/cm2001102/cmtrdind/299/29902.htm [2002, June 14]

169 ACORD. (2001). *Annual report 2001*.

170 MVDA & CAIR. (2000). *Impact of the end of life vehicle directive on the motor vehicle dismantling industry in the UK.*

171 Personal communication with David Hulse, Director General at British Metal Recycling Association (BMRA) on the 27th of August 2002.

172 ACEA. (2002). *Country status reporting system: Status May 2002*.

173 Committee on Trade and Industry. (2001). *End of life vehicles directive.*

174 Personal communication with David Hulse, Director General at British Metal Recycling Association (BMRA) on the 27th of August 2002.

175 As an example, Volkswagen Group UK undertakes the free take-back system, with contracted dismantlers, Charles Trent LTD (the second biggest dismantlers in UK). The information is available in the website of Charles Trent LTD.

Governmental authorities

The role of governmental authorities is weak in the UK ELV system. No comprehensive regulation is established to handle the ELV issue. Even though there are certain regulations to control the recycling facilities, governmental authorities allow a lot of exemptions on these regulations and also weakly monitor these facilities.

Recently, by announcing the last owner pays principle for the ELV system, the UK government shows a passive attitude, even though it seems to be aware of the seriousness of abandoned vehicles problems.

8.4 Findings and Discussion

Collection rate

In the UK, it is estimated that around 2 to 2.25 million ELVs are generated yearly [176]. General sources of ELVs are identified: as 70 per cent from private owners; 10 per cent from insurance companies; the rest from garages and local authorities, which collect abandoned cars in nature[177].

Clear information on the total number of vehicles deregistered, the number of vehicles deregistered for export purpose, the number of ELVs scrapped, and the number of ELVs scrapped in authorised dismantlers, are not found. Only several estimated figures are found, which show the data inconsistency. Taking into consideration the situation of the UK ELV system, the collection rate can be estimated around 50 per cent (As it is estimated in section 8.3, Dismantlers parts).

In addition, the UK system faces a serious problem of **abandoned vehicles in nature.** Even though there are no national statistics on abandoned vehicles, local authorities estimate **around 350 000** cars were dumped in 2000[178]. Taking into account the total estimated number of ELVs generated, **around 15 to 17.5 per cent are abandoned vehicles**. Even from this rough estimation, the generation of abandoned vehicles is high.

It can be concluded that the UK collection rate is low, which is estimated around 50 per cent. And due to the absence of a recycling chain network in an organised manner, the last owner pays system results in a large number of abandoned vehicles in nature.

Recovery rate

As there is no clear information on ELV treatment performance in the UK system, it is not possible to examine the general recovery rate.

However, ACORD collects information from different recycling associations, such as MDVA, BMRA, and other recyclers associations. Based on the collected information, ACORD presents information on recovery rate for the UK ELV system. Table 11 shows these rates, presented in annual reports during 1997 and 2000.

However, the author had questioned the credibility of data presented in ACORD reports. Taking into consideration the UK ELV situation (which is described above), total recovery rates seem to be too high, especially in the 2000 performance. According to information collected from a personal communication (as for personal request from the interviewee, the author will not present the source of

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[176] Environment Agency (EA). (2002). End of life vehicles. [Online]. Available: http://www.environment-agency.gov.uk/subjects/waste/306772/244174/?version=1&lang=_e [2002, July 23]

[177] MVDA & CAIR. (2000). *Impact of the end of life vehicle directive on the motor vehicle dismantling industry in the UK.*

[178] Committee on Trade and Industry. (2001). *End of life vehicles directive.*

information), the author's assumption seems to be more correct. The following information was collected during the interview.

In the present UK system, there is no clear guidance to calculate recycling and recovery rates. Each organisation, which provides information on recycling and recovery, has its own calculation formula. Some of them estimate the rate from calculating the input and output of the facility, with making a formula to apply for recycling and/or recovery. Based on such a calculation formula from each organisation, one presents their performance to ACORD. However, not only the calculation based on such a formula, but also a rough estimation of their yearly performance can be added. For example, in 2000 recovery rate, it is informed that several organisations added one per cent more on their outcomes of calculations, taking into consideration that accumulated materials during past years were processed during 2000. Thus, this results in the increase of the recovery rate in 2000. According to the interviewee, the more representative recovery rate for the UK system in 2000 is around 77 or 78 per cent, which is similar as 1999.

Table 11. Recovery rate of the UK ELV system during 1997 and 2000

	1997	1998	1999	2000
Total number of ELVs recycled	1 900 000	1 800 000	1 800 000	2 017 000
Average weight of ELVs	1 024 kg	1 030 kg	1 030 kg	1 030 kg
Measurement (tonnes)				
Total weight of ELVs recycled	1 947 500	1 854 000	1 854 000	2 078 000
Total weight of waste part units from ELVs	60 000	30 000	30 000	30 500
Total weight of material for disposal	2 007 500	1 884 000	1 884 000	2 108 000
Total weight of metal recycled	1 200 000	1 094 000	1 195 000	1 402 000
Non-ferrous metal recycling (shredders)	*34 000*	*33 000*		
Non-ferrous recycling (dismantlers)	*22 000*	*20 000*		
Total weight of parts for reuse	207 000	193 000	193 000	240 000
Total weight of materials recycled	64 500	49 500	58 500	58 000
Total weight of recycled	1 527 500	1 398 500	1 446 500	1 700 000
Total weight of materials to landfill	480 000	485 500	437 500	408 000
Landfill percentage	24 %	26 %	23 %	19 %
Recovery percentage	76 %	74 %	77 %	81 %

Source: ACORD annual reports. (1997-2000).

8.5 Conclusion

In 1997, the ACORD agreement was signed by different industries related to the ELV issue. According to the ACORD agreement, certain recovery targets were set. And also each participant made self-commitments to perform his recycling activities in an environmentally sound way.

However, there was no arrangement among participants to organise an ELV treatment network, in order to secure the proper recycling performance. In addition, there is no proper legislation to control or regulate ELVs in the UK. No requirement of hand-in duty, nor sanctions on poorly performing recycling facilities, nor allocation of physical and financial responsibility is made. Therefore, last owners bear recycling costs, which is negotiated with any of ELV treating operators.

As a result, the UK system faces a serious problem of abandoned vehicles in nature, the low collection rate, the existence of a large number of uncontrolled dismantlers, and serious environmental impacts from dismantling and shredding facilities. In conclusion, there is no significant improvement in the UK ELV system resulting from the ACORD agreement.

9. Determinant Factors for Effective End-of-Life Vehicle Policy

From the experiences of selected European countries, several important factors are identified, which influence the success or failure of the ELV system. This section provides an in-depth discussion of these factors.

9.1 Target setting

Evaluating waste policy of four different products, including ELVs, Tojo et al (2001) concluded that the establishment of mandatory targets often has been effective in achieving high reuse, recycling, and recovery rates[179]. The setting up of targets for collection, recycling and recovery of ELVs demands collection of certain necessary data. This setting, based on collection and recycling and recovery rates, can be used to make good indicators to measure progress of the system.

Collection target

- A collection target has a different purpose and effect than reuse, recycling and recovery (3R) targets[180]. What does 'collection' mean for a collection target in the context of ELV systems? The author defined the collection as the number of ELVs delivered to proper dismantlers. A collection rate, thus, is defined as the total number of ELVs delivered to proper dismantlers over the total number of ELVs generated in the territory. The rationale of defining collection and collection rate is that ELVs treated by uncontrolled dismantlers may cause larger environmental impact than authorised ones. Thus, they should be excluded.

- Vehicles, which are deregistered for export, are not considered as ELVs generated in the territory.

- Abandoned vehicles in nature may not appear as any type of deregistered vehicles. But they should be included in ELVs generated.

The author, by analysing the case studies, recognised the need of a collection rate in ELV systems for two main reasons. These are:

- It will lead to collection of data on abandoned vehicles in nature. In most cases, an ELV system is designed to prevent abandoned vehicles in nature as the Swedish car-scrapping premium, the first owner pays system in the Netherlands, and the obligation to prove destination of ELVs by last owners in Germany. However, none of the systems examined actually collects such data. That makes it difficult to evaluate the system. A clear overview on abandoned vehicles based on reliable data collection will facilitate policy design. Governments of Germany and the UK seem aware of the problem of abandoned vehicles in nature. However, they apply the last owner pays principle in their systems, which, in theory, leads to more abandoned vehicles. If they have accurate data on abandoned vehicles that shows the seriousness of the issue, they may try to avoid the last owner pays principle and give preference to other financing mechanisms. Or at least, they would get a signal if they need to change.

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179 Tojo, N., Lindhqvist, T., and Davis, G. (2001). *EPR programme implementation: Institutional and structural Factors*. OECD Seminar on Extended Producer Responsibility, EPR: Programme Implementation and Assessment. 13-14 December 2001. p. 32.

180 Tojo, N., Lindhqvist, T., and Davis, G. (2001). *EPR programme implementation: Institutional and structural Factors*. p. 32.

- If collection rate is low, governments will seek different solutions to reduce the flow of ELVs to uncontrolled dismantlers. For instance, they can make or tighten up regulations on dismantlers or they may strengthen supervision or apply a strong sanction. Another solution can be to introduce 'Extended Producer Responsibility' in such a way that car producers gradually control poor dismantlers. (This issue will be discussed more in detail in section 8.3)

To conclude, defining the 'collection' in a way, which reflects the flow of abandoned vehicles in nature and the flow to uncontrolled dismantling operators, will encourage the collection of relevant data. Also a target setting for collection will help to examine the present situation of ELVs flow in a system. Such evaluation will help for revising policy or even for seeking a new type of policy.

Reuse and recycling (hereafter those are referred to as recycling[181]) and recovery targets

Recycling and recovery targets are used as good indicators to measure the progress of ELV recycling. In addition, they can stimulate: improvement in the environmental performance of recycling facilities; new car design for recyclability; development in recycling technologies; and development of markets for recycled materials.

A decision on target levels can affect behaviours of actors and the degree of improvement. Lower targets may promote actors to improve performance at recycling facilities to only a moderate extent. On the other hand, higher targets may affect actors to go beyond the improvement of their own performances, but also facilitate design changes, making cars more recyclable and easier to be dismantled. For example, change of material use in vehicles will stimulate communication channels and build cooperation between material and component suppliers and producers. In addition, car producers will communicate with shredders and recyclers in order to increase recycling rates. Such communication will help producers to know what are the difficulties that shredders and recyclers face for the improvement of ELV recycling. Thus, producers will account for these difficulties in car design. Thus, higher targets may stimulate innovative relations among actors and speed up improvement of ELV recycling.

Recycling and recovery targets can be combined or used separately or together. If recycling and recovery targets are combined, actors may take the easier way, which may be to burn recyclable materials for energy recovery. Energy recovery may be more attractive in economic terms. On the other hand, a separation of recycling and recovery targets leads to encourage optimal levels of material recycling. For example, the EU ELV directive sets the total recovery target 85 per cent with limited recovery rate, which should not exceed more than 5 per cent. To limit certain levels of recovery targets will stimulate more material recycling. This is considered as a more sustainable way of moving up the waste management hierarchy.

Two practical issues should be concerned in recycling and recovery targets. First is to set up a calculation methodology that reflects the actual recycling and recovery rates. It should be a good methodology that makes actual measurement at optimal levels. In the case studies, the author identified that each analysed ELV system uses different calculation methodologies. Some of them do not show the actual recycling and recovery. For example, in the calculation methodology of the UK ACORD system, no actual measurement appears at any level of the recycling chain. The Dutch ARN metal recycling is calculated from literature on metal contents of ELV models, which may affect recycling and recovery rates, even to a very slight extent.

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181 A reuse rate mostly depends on the quality and the age of ELVs. For example, engines can be used depending on the age of vehicles, not depending on dismantling skills to extract. In addition, most of reusable parts and components are major income sources of any types of dismantling. Therefore, dismantlers always try to maximise a reuse rate. Of course, in the condition, those prices of reusable parts exceed the costs to dismantle them.

Due to the difficulty to examine clearly and of comparison reason, standardisation of calculation methodology for ELVs emerges as an issue. According to the information the author collected, ACEA is planning to open a discussion with its members in September 2002, in order to set up a standardised calculation method[182]. The author expects that standardisation of calculation methodology will provide a good baseline to examine the actual recycling and recovery rates of each system. Further, it will facilitate comparative study among different countries.

Second is to ensure follow-up reporting on recycling and recovery. The major difficulty to measure nation-wide recycling and recovery rates is the lack of information from all recycling routes in the system. This is common in all the cases examined. In Sweden, clear information on recycling and recovery rates is only available in producer networks. Information from authorised dismantlers outside these networks is mostly non-existent. Similar to the Swedish case, no information on recycling and recovery is available from dismantlers outside of the Dutch ARN network and the French MD networks. In Germany, the reporting obligation from deregistration of vehicles to final disposal is regulated by law. However, the implementation of the reporting system is extremely weak. Thus, to measure recycling and recovery rates nation-wide is impossible.

In summary, the outcome of recycling and recovery of ELVs is not only affected by how and what level of recycling and recovery targets is being set, but also by a credible calculation methodology and the follow-up reporting system.

9.2 Deregistration Policy

A proper deregistration system is an important factor. How the deregistration system is designed can influence the rate of ELV flows into the proper recycling treatment chain.

Several categories of deregistration can be used: (1) deregistration for scrapping purpose; (2) deregistration for export purpose; (3) temporary deregistration; and (4) administrative deregistration. The latter is used when authorities can no longer find the owners of temporary deregistered cars. The Swedish deregistration system, for example, is designed for all the four categories. Classifying different types of deregistration may encourage setting up data collection that provides general overview of vehicle flows after deregistration.

Besides establishing a good deregistration system, its implementation is of more importance. This is the case of the German deregistration system. The administration for deregistration is held at local governments. They often show loose administration in deregistration procedure and do not pass related information to the central government. These characters impair in monitoring the quantities and routes of deregistered vehicles.

Based on the case studies, the following sections discuss issues relevant to the deregistration policy, together with the design of such a policy and its consequent outcome.

Use of certificates of destruction

A certificate of destruction is a type of proof that a last owner receives after handing in his vehicle to a treatment facility for scrapping. First, by designating authorised returning stations or authorised dismantlers as issuing bodies and, second, by making a certificate of destruction as deregistration requirement, the use of certificates of destruction can lead to an effective control of the ELV flow to enter the proper recycling chain. The Swedish, Dutch, and German deregistration systems use such a system. The UK has a voluntary initiative to use a certificate of destruction by some authorised

182 Personal communication with Joakim Halvalsson at Saab Automobile AB.

dismantlers, but it is not a requirement for deregistration. The French system does not have it. Thus, the two latter countries do not experience the advantage of the use of certificates of destruction.

Accurate information on collection rates is not known for each system due to non-existence of data on abandoned vehicles and/or ELVs treated by uncontrolled scrappers. However, systems using certificates of destruction seem to have higher rates of ELVs going to authorised dismantlers than those, which do not use it.

Temporary deregistration

A temporary deregistration system can lead to negative impacts on the collection rate of ELVs. Temporary deregistration is designed, in first place, to make vehicle owners to be exempted from taxation during the period of off-use. However, the German system shows a misuse of the temporary deregistration system. Most of last owners in Germany deregister their vehicles through temporary deregistration[183]. After one year of temporary deregistration, the authority automatically deregisters these vehicles if owners do not renew the temporary deregistration or re-register the vehicle. Therefore, the German system does not have a clear overview of how many deregistered vehicles actually physically exist. Only estimation can be made.

Therefore, when designing the deregistration system, the potential misuse of temporary deregistration should be considered. Convenience and cost structure of temporary deregistration should also be taken into consideration in order to prevent such negative impact on an ELV system.

Deregistration for export

A vehicle deregistration system for export purposes will provide data on how many vehicles are exported. The size of the used car flow to export markets and its fluctuation can be monitored, which is needed for calculating the collection rate. In addition, this data is also useful in designing the financial mechanism of the ELV system.

When the 'first owner pays principle' is applied for financing the system, the determination of a suitable fee should take into account the actual number of ELVs generated within the territory. By knowing the actual flow of used car exported and its fluctuation will help to count the actual numbers of ELVs in the system. The following scenario makes it clear. In a system with the first owner pays principle, the export flow of deregistered vehicles is constantly 30 per cent of total deregistered cars. However, the advanced recycling fee is determined to cover 100 per cent of deregistered vehicles. It means that fees charged to first owners in this system are burdensome.

In sum, improper deregistration system design can cause negative impact on an overall ELV system.

9.3 Producer responsibility

The author identifies the producer responsibility as the most important factor that can promote an effective and efficient ELV system. From the progress and outcomes of examined case studies, it is found that the producer responsibility on ELV recycling has actually accelerated progress in waste prevention, increase of recycling and recovery, and improvement of recycling facilities.

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183 Lohse, J. & Sander, K. (1999). *General requirements for monitoring the recycling of long-lived, techinically complex products with an in-depth-analysis of end-of-life vehicles: summary.* Institut fur Ökologie und Politik GmbH. [Online]. Available: http://www.oekopol.de/de/Archiv/Archiv/Stoffstrom/Autoeng.htm [2002, July 12].

Physical and financial responsibility for collection and recycling

Producers play the most pivotal role in **waste prevention**. How, then, to stimulate producers to promote waste prevention in the car design phase? From the case studies examined, the introduction of 'responsibility for recycling' to car producers affects the level of waste prevention.

Producers commonly take responsibilities on products that is limited to the stages from the design to production. Due to the liability issue during the user phase of products, producers also take responsibility on product user phase. However, for last few years, the new concept of **Extended Producer Responsibility** (EPR) has been introduced in waste management. Their conventional producer responsibility has been extended also to the end-of-life phase of products. Producers are responsible not only for production and user phases, but also should take responsibility for its end-of-life phase. The application of EPR has been found in an ELV management system.

In the Swedish ELV system, for instance, car producers started improving the design of vehicles to be more recyclable and easier to be dismantled when they felt the threat of the producer responsibility for recycling in the ELV system. After EPR was introduced, concepts of design for recycling, design for dismantling, and overall design for environment clearly became essential elements in car design. Elimination or reduction of hazardous substances, change in material use, introduction of labelling and coding system for materials and components are examples of waste prevention actions. In order to meet such requirements, producers develop communication and strengthen cooperation with suppliers, shredders, and recyclers. On the other hand, the Dutch system does not have the strong producer responsibility that stimulates producers to adopt waste prevention.

Besides waste prevention, EPR also affect the **increase of recycling and recovery** through improvement of collection and recycling infrastructure. 'Free take-back' commonly represents the physical and financial producer responsibility under EPR scheme. The free take-back means that producers are responsible for a physical collection of ELVs without giving additional financial burden to last owners. The allocation of physical and financial responsibilities to car producers brings advantages in terms of increased recycling and recovery. These are:

(1) It will increase collection rate by preventing abandoned vehicles in nature. When car producers bear recycling costs, last owners do not have financial burden to hand in their vehicles. Therefore, it will help to reduce abandoned vehicles in nature.

(2) Producers will only deal with authorised dismantlers for their collection networks. Taking into account cost reduction, car producers tend to limit their collection networks in the most sufficient and efficient manner. Thus, their choice will be among authorised dismantlers. Also, the collection rate, as the author defined earlier, will increase because last owners will bring their vehicles to producer networks.

(3) Consequently, good performing dismantlers, who ensure proper depollution and dismantling of all recyclable materials, will treat more ELVs. This will lead to improvement in recycling and recovery rates.

In practice, it is difficult to witness all of these advantages mentioned above due to the short implementation period of EPR. However, in most cases where car producers are involved in collection and recycling network, the recycling and recovery rates are higher. So that improvement of recycling and recovery, after implementation of EPR takes place, can be foreseen.

From the perspective of **improvement of recycling facilities**, the producer responsibility controls performance of network dismantlers and may help to gradually eliminate uncontrolled or poorly performing dismantlers. Producers will closely monitor those dismantlers whom they pay recycling costs in order to ensure their good performance. Thus, contracted dismantlers will be encouraged to maintain good performance. The reason is that, as it is mentioned earlier, producers will select only sufficient amount of dismantlers, who perform the best. Thus, producers will closely monitor the performances of contracted dismantlers and also contracted dismantlers will put effort to keep contracts. Similar efforts are found in dismantlers in the Dutch system.

Last vehicle owners do not want to bear recycling costs, so they will only bring their ELVs to producer networks. This makes less ELVs ending up with dismantlers outside of producer networks so it will be more difficult for these dismantlers to stay in business and compete. Especially it is very difficult for uncontrolled dismantlers to compete and they will gradually be phased out.

In addition, EPR steers **innovation**. Such innovative actions would be that producers set up their own dismantling facilities or they can conduct various pilot projects or develop markets for recycled materials such as ECRIS project by Volvo, plastic recycling project by Saab in Sweden, PRAVDA project by German car producers in Germany, and so on.

Individual or collective action

Actions taken by producers to execute their responsibilities could be by two approaches: the individual approach and the collective one. Collective action is mainly established due to the limitation in capacity and resources individual producers have, the difficulty and inefficiency of establishing multiple recycling infrastructures, and the inefficiency of individual producers negotiating with different actors for ELVs management[184]. Most car producers already have associations in each country; therefore, collection actions can be easily formulated through their associations. The Swedish BPS, the German ARGE-Altauto and the UK ACORD are examples of special organisations set forward by car producer associations.

Collective actions can be responsible for whole or part of EPR system. If car producers are working collectively in setting up collection and recycling networks, and its management, a major issue of concern is how to determine the fee for collective actions. A flat fee is often applied based on the market share of each producer. Due to difficulty in determining the level of recyclability and degree of easiness of dismantling, it is extremely hard to make consensus on differentiated fees. However, the flat fee, in theory, does not stimulate producers to make their vehicles more recyclable and easier to be dismantled. Such outcome is identified in the Dutch collective action on ELV recycling. ARN collects flat fees and conducts all relative recycling and recovery projects. Therefore, producers do not seem to be motivated to improve vehicle design of more recyclable.

An individual action, on the other hand, stimulates improvement of car design. It also encourages producers to work on cost reduction for recycling, especially dismantling cost. Cost reduction efforts are found with the Swedish car producers as it is seen in Saab recycling cost studies, which were conducted with Volvo in 2000 and 2001.

Considering different aspects of collective and individual actions, it is more beneficial to combine two approaches in ELV recycling rather than selecting one approach. Investment on developing further ELV recycling technologies, market development for recycled materials, and/or providing and recommending the best dismantlers for producer network(s) can bring better outcomes through collective actions. However, individual actions related to recycling costs can stimulate improvement of car design for dismantling and for recyclability. A good example of combined actions is found in the Swedish system.

In Sweden, the car producers' association, BIL Sweden, established BPS, which is a producer responsibility organisation that focuses on ELV recycling issue. BPS is funded by member fees, which are based on market shares. BPS conducts different collective actions on ELV recycling. BPS introduces selected dismantlers and recommends them to car producers who then can make further

184 Tojo, N., Lindhqvist, T., and Davis, G. (2001). p. 28.

selection to set up an individual network. Each car producer has to negotiate recycling costs with contracted dismantlers within his network. In terms of recycling project development, few car producers had conducted individual pilot projects. At present, BPS plays a role in organising and leading recycling and recovery projects for different materials. BPS also works for market development for recycled materials. Individual actions in the Swedish system focused mainly on car design and dismantling phases. Some producers are deeply involved in cost reduction by taking part in the dismantling sector.

9.4 Sustainable Financial Mechanisms

Additional recycling costs due to the demand for proper depollution and treatment of ELVs gives negative benefit to dismantlers. These costs are defined as 'recycling costs' in an ELV system. Recycling costs, which reflect the level of recycling and recovery of ELVs, should be financed in the system. Different types of financial mechanisms have been designed and implemented.

How to finance ELV recycling costs in a sustainable manner is one major concern in an ELV system. Two critical questions are 'who will finance' and 'how much'. Even if these costs are ultimately transferred to consumers, the design of financial mechanisms definitely will affect behaviours of actors, may alter structures of existing recycling industries, and will eventually influence the failure or success of the ELV system.

Visible or Invisible fee

Recycling costs can be covered through different types of payment. It can be included in the car price, paid by vehicle tax, by insurance, by advance disposal fee upon registration, or paid after price negotiation between last owners and dismantlers. These costs can be visible or invisible.

The advantage of charging a visible fee is providing an opportunity for consumers to be aware that specific fee is paid for proper ELV recycling. This gives an educational effect. Visible fees can encourage consumers to demand green products. Consumers would recognise the charge they pay is at recycling level where costs are determined. Thus, they will purchase cars with lower level of recycling costs. Such purchasing decisions will stimulate car producers to produce cars, which can reflect lower recycling costs.

If a fee (or cost) is invisible, the consumers do not observe how much they are paying for recycling. Invisible fees will not provide an educational effect. However, it may help to finance recycling costs in a more smooth way. For instance, producers often are concerned about the decline of car sales, especially when a high and visible fee is charged. If that concern appears in reality, an invisible fee will slow down this phenomenon. Therefore, financing recycling costs with invisible fees may be useful to avoid rapid market distortion. In addition, it may be easier to get social and political acceptance.

Flat or differentiated fee

A flat fee (or cost) is an even fee charged equally for recycling costs for all types of ELVs. The advantage of charging flat fees is to make administration easy. The convenience and easiness in administration may help to decrease administrative costs. However, disadvantages are:

- Flat fee does not stimulate or encourage behavioural change of relevant actors. From a consumer perspective, consumers will not be motivated to change their consumption pattern seeking green or more recyclable cars. On the other hand, producers will not be motivated to improve vehicle design.

- Flat fee may cause a fairness issue. For example, if the last owners have to pay flat recycling costs upon handing in, some of them, whose vehicles give even positive value for dismantlers, have to bear the recycling costs. This is not fair for vehicle owners, who have ELVs with positive value for dismantlers. Thus, on individual base, a flat fee does not meet the fairness in cost payment.

On contrary, differentiated fee, which reflects the level of recyclability and easiness of dismantling, encourages consumers and producers to change their behaviours. As an example, an insurance company in Sweden applies differentiated recycling insurance based on different models of vehicles. Differentiated insurance costs can stimulate producers to improve vehicle design for easier dismantling and recycling. Also it will solve unfairness implications of flat fee.

The difficulty of fee differentiation is in how to reach consensus in determining the different level of fees. In a system where car producers or last owners have to pay for present recycling costs, the difficulty to determine differentiated fess comes from how to measure the level of recyclability and ease of dismantling in consensus way. Fluctuation of market prices for steel and for other recycled materials will add difficulty to the issue. In a system where recycling costs should be allocated in advance for future recycling costs, major difficulties in calculating costs arise. Difficulties are not only in measurement and price fluctuation for materials, but also in the uncertainty of efficient improvement of dismantling and the future recycling technology.

Public or Private Management

Whether public or private body manages the fund of collected recycling costs is an issue of concern. Public fund management ensures that the fund is for public purposes. Also, it is expected that the fund be equally distributed. However, some risks exist in public fund management. The Swedish scrapping premium system shows an example of risk. When the Government announces an increase of scrapping premium, some private individuals take advantage of it, by deregistering their vehicles that have been kept with them during the period of low premium payment. The rapid increase of premium accelerates the occurrence of such risk by privates, who are aware of such premium change.

Another risk observed is the case following. Increased premiums are intended to give bigger incentives for last owners to scrap their vehicles and also to prevent them from abandoning vehicles. However, when premiums increase, dismantlers may also increase recycling costs to last owners. Since last owners are not knowledgeable about dismantling and recycling costs, they do not have much negotiation power. So that instead of paying high recycling costs, more people tend to abandon their vehicles. Due to such distortion by dismantlers, the opposite outcome from increase of premium can appear.

An advantage of fund management by a private body is that it may eliminate risk to misuse the system by certain groups. The private management body should be credible and trusted by the person paying the recycling fee. In order to build this trust, the private body is encouraged to manage the fund in the most effective way. For example, ARN in the Dutch system has shown the improvement of recycling rate of the system, part of which, is done through trust building for public and authorities. Moreover, ARN created an innovative fund management. For instance, it increases the fund through safe investment of part of it outside of the system. Such fund management can only be found in private management. The disadvantage of private management is related to possible problems like bankruptcy.

First owner pays

First owner pays systems are one type to finance recycling costs in ELV systems. Advance disposal (or recycling) fee can be charged to first vehicle owners upon purchasing or registering. If fees are charged upon registration of vehicles, there are advantages to solve the problem of financing orphan ELVs or privately imported ones. The first owner pays system is often combined with ‘pay-as-you-go’ principle. The fund managing body collects advance disposal fees and pays for recycling costs for ELVs, which are presently generated. In doing so, it solves the problem of paying recycling costs for existing products. Another advantage is that such financial mechanism will reduce abandoned vehicles in nature. Last owners do not have additional financial burden to hand over their ELVs, since first owners already pay recycling costs.

The level of charged fees is an important element for sustainable fund management. A high-level fee may lead to negative impact on social and political acceptability of the system. In order to decide a suitable level of fee, the number of ELVs generated and the number of used cars exported should be considered. In addition, the scope of fund use should be determined in advance, in order to know whether recycling fund is strictly used for paying actual recycling costs or it will be used for other purposes related to ELV recycling, such as funding campaigns, sponsoring recycling pilot projects, supporting recycling facilities, etc. All these elements above will influence the level of fee. The Dutch system, for example, applies the first owner pays principle. The collected fund from advanced disposal fee is used for different purposes, such as setting up infrastructure for collection; paying recycling premiums to dismantlers, material collectors and recyclers; investing in the development of recycling technologies and market for recycled materials; and others. However, the information obtained tells that the levels of fees collected during the first and second periods were too high. As proof, after paying all the costs related to ELV recycling, as it is mentioned above, still a large amount of money was contributed to the fund during the first and second periods: over 30 million EUR per year was added to the fund during the first period of disposal fee; and 20 million EUR per year during the second period. This means that their fee calculation might need adjustment based on the situation. In any event, this enormous amount of contribution translates to a financial burden for the first owners during these periods.

Another issue of concern is whether the advance fee, which was charged upon registration, will be reimbursed for exported vehicles. If vehicles, which already paid for recycling costs, are exported, they will not end up as ELV in the territory of the system. The Dutch scrapping fee and the Swedish premium systems are not paying back for exported vehicles. If the system does not pay back the recycling fees for vehicles leaving the system and if these export numbers are large, the system may be criticised for not returning the advances disposed fees of their recycling costs. The decision on whether to pay or not for export cars should take into account the sensitive social and political aspects of this issue. However, if the fee will be get reimbursed, one negative potential risk also that one can think of. In case of France, near the border of Spain, the French government recognised a large flow of trans-boundary movement of old vehicles. It is highly expected that many of them be exported for dumping or being scrapped due to different costs and regulations. In such case, if the advance fee is reimbursed, export for dumping may increase.

In some cases, successive vehicle owners throughout user phase of the vehicle can share the advanced disposal fee. They can share it, for example, through annual tax or insurance. This is a **shared costs** system as found in Denmark. The advantage is that it reduces the financial burden for one specific owner and applies equal sharing of recycling costs to all successive vehicle owners. As a disadvantage, the shared cost system may increase administration costs.

Last owner pays

If there is no specific arrangement to finance recycling costs, it is common that last owners bear the costs. There are advantages of the last owner pays system. First, in theory, it makes recycling costs close to actual ones. Second, it solves the problematic issue on who will pay recycling costs for existing, orphan, and privately imported vehicles. Third, it also eliminates extra administration costs and time, which are allocated for managing the recycling fund.

On the other hand, a considerable problem is that last owners are not motivated to hand in their vehicles to proper treatment facilities, especially when they have to bear high recycling costs to bring ELVs to proper treatment facilities. Therefore, this can generate more serious level of abandoned vehicles in nature. Or sometimes, last owners may seek scrappers or uncontrolled dismantlers, who offers better prices. In such case, the system cannot prevent ELV flows, which goes to improper treatment facilities.

Another disadvantage of last owner pays system is that dismantlers can choose arbitrary amount of recycling costs to charge last owners. In the last owner pays system, dismantlers are the only ones, who really know the actual recycling costs of proper treatment so they can have better bargaining power. For instance, such price manipulation was observed when high premium was paid in the Swedish scrapping premium system.

Producer pays

As was discussed in section 8.3, the 'free take-back' demands producers to bear ELV recycling costs. The major benefit from the producer pays system is that it stimulates producers to reduce future recycling cost. Producers start learning about dismantling activities, in order to improve their negotiation power with dismantlers. Consequently, this can prohibit dismantlers from dominating the determination of recycling costs. Moreover, in order to make contracts with producers, dismantlers are motivated to improve or sustain their good environmental performances, while improving work efficiency to reduce recycling costs. In sum, mutual efforts from both producers and dismantlers will appear in developing dismantling skill and improving work efficiency to reduce the costs.

On the other hand, the producer pays system faces difficulties such as the issue on who pays recycling costs for existing, orphan, and privately imported vehicles. If producers were responsible to pay for recycling costs for their vehicles after the date of implementation, they would not accept to pay the costs for existing ELVs. In such cases, various measures have been taken such as differentiated enforcing timing for existing and new cars, and differentiated recycling rates[185], which may reduce financial burden of producers.

If car producers shut down their business, orphan products will appear. Then, who will pay recycling costs for these orphan ELVs. In the Swedish system, the law regulates producers to allocate future recycling costs upon their sales. Such in-advance allocation of recycling costs in the producer pays system may provide an opportunity to find alternatives. By allocating such advanced recycling costs from producers to a third party such as an insurance company, the issue of orphan products can be solved. An insurance company provides recycling insurance so that producers allocate recycling costs through this insurance. By allocating such recycling costs outside of the company through recycling insurance, for example, producers may get certain benefit from lowered tax, which they have to pay if they allocate recycling costs inside the company finance. However, there is also risk to hire the third party to manage recycling fund, which may lead to similar effects that can be expected from the first owner pays system with hands of producers. If an insurance company dominate a determination price for recycling insurance, it would be difficult to gain benefits from the producer pay system described above.

On the other hand, privately imported vehicles are more problematic. However, this can be solved through vehicles registration system. If registration systems can recognise the privately imported cars, a kind of charging procedures can be applied in order to charge recycling costs upon registration. Otherwise, producers may bear recycling costs for privately imported vehicles.

9.5 Monitoring

Monitoring is an essential and important factor in order to examine progress of a system. Monitoring for an ELV system demands several elements. The most important are good indicators to measure progress or outcome of policy and proper allocation of responsibility to gather information that affects the success of the system.

Developing indicators

The type of information needed for a monitoring system is the main key concern. Indicators should be developed taking into consideration the three main objectives of the ELV system: waste prevention;

185 Tojo, N., Lindhqvist, T., and Davis, G. (2001).

increased recycling and recovery; and improvement of recycling facilities. As for waste prevention and improvement of recycling facilities, it is difficult to set good indicators to measure progress. Therefore, it is a challenge to establish objective indicators, which can gain consensus. In the meantime, monitoring can be focused on qualitative observation on how policy instruments or certain systems stimulate relevant actors to change their behaviours.

On the other hand, it is easier to develop objective indicators for measuring recycling and recovery. Several important indicators are identified from the case studies. These are collection rate, reuse & recycling rate, and recovery rate. For collection rate, the author stressed the importance of monitoring of **abandoned vehicles** in nature. (See section 8.1)

Responsibility allocation for monitoring

As an ELV system involves various actors, it is difficult or inefficient for one authority to run the entire monitoring system. Therefore, to allocate the responsibility for monitoring to vital actors in different areas is an issue that is crucial to consider. Proper allocation will enhance more accuracy of information, which is critical for system revision and evaluation.

Areas related to waste prevention could be monitored through producers a **self-monitoring** system, which becomes popular and useful in environmental policies. Producers have better capacity to examine their own products. Since they are central key actors in all related environmental impact of their production and products, producers themselves can monitor their performance in a more accurate way.

Monitoring improvement of recycling and recovery definitely requires accurate and reliable information. In order to get such information, it requires good reporting from all economic operators in the entire recycling chain. Self-commitment, cooperation, and transparency are essential elements for a good reporting system. In practice, it is difficult to maintain a good reporting system only depending on commitment. Thus, some kinds of incentives or enforcement are useful. Often, good reporting and monitoring can be found in producer networks under the producer responsibility.

9.6 Cooperation

Cooperation among relevant actors in the complicated web of an ELV recycling system is essential for the success of the system. However, the key issue is how to encourage the optimal level of cooperation. Future uncertainty of ELV recycling can be a motivation to gather relevant actors.

Being aware of the importance of each stage of ELV recycling, all actors build a strong cooperation in order to achieve the goal. Governments are not experts in recycling issues and they often invite relevant actors, who actually have good knowledge, to work on policy design for ELV. Therefore, voluntary agreements and cooperation actions among industries and governments are very often found in ELV systems. Besides this cooperation between government and industries, cooperation among last owners, dismantlers, recyclers, shredders, and producers can better shape the outcome.

Going back to the question above of how to give incentives for relevant actors to participate and maintain cooperation and coordination it is answered by first, reasonable allocation of responsibility that takes into account the social and economical backgrounds of actors. Second, market distortion or strong intervention by one specific sector should be avoided. Third, information distribution and data should be transparent. These are the criteria that the author identified.

Economic incentives or any types of compensation or benefit can be useful. However, the use of only economic incentives can be dangerous. In the Dutch case, the tight cooperation was built on high economic incentives provided for dismantlers, material collectors, and recyclers and to certain extent to shredders. If economic incentives suddenly disappear, such cooperation may collapse. Thus, together with the proper use of incentives, awareness building should be promoted.

9.7 Regulatory requirements

Legislation provides a framework or guideline for policy making. Clear and detailed legislation does not always guarantee the successful outcome of a policy. However, they give certain advantages. From experiences of the case studies, the existence of detailed regulations gives opportunity to organise ELV system in easier way than cases without regulations.

This section presents discussion on certain benefits from the use of specific and detailed legislative requirements related to ELV recycling activities.

Use of technical standards

The use of technical standards on ELV treatment facilities affects the upgrading of the general level of environmental performance among facilities and stimulates their professionalism. The introduction of technical standards on facilities' building, storage, and equipment can regulate the quality of dismantlers when they want to open businesses. In addition, it can control the existing poorly performing dismantlers or scrappers. Another aspect of using technical standards is that it provides objectivity for monitoring body when they regulate or sanction poorly performing dismantlers.

Use of dismantling and recycling requirements

Specific requirements to dismantle or remove certain materials and components from ELVs can standardise the dismantling process. In doing so, the depollution process, which some of dismantlers and scrappers skip for cost reduction, can be ensured. The Swedish NFS 2002:2 and ARN requirements for dismantlers provide examples of these requirements.

Considering the existing recycling market and the available technologies to recycle dismantled materials, the dismantling and recycling requirements should be established in feasible and flexible manners. Moreover, these requirements should take into consideration future market and technologies development. Different time frames for implementation of these standards will easier stimulate relevant actors to develop recycling technology and markets than immediate implementation. For instance, the Swedish dismantling and recycling requirements regulate vehicle glass to be dismantled and recycled from 2002 and plastics from 2006. Vehicle glass was difficult materials to recycle in Sweden due to the lack of technology and market demand. However, plastic recycling is still difficult, even though this promotes relevant actors to develop technology and to expand markets for such materials.

Use of ban on hazardous substances and landfill restrictions

While the use of technical standards and dismantling and recycling requirements focus on performance of the end-of-life treatment phase, the use of substances and landfill restrictions focus on design and final disposal phases. Even though bans have been criticised for ignoring other potential impacts of alternative substitutes while reducing problems in waste management perspective, bans have been playing a significant role in triggering new vehicle design and material substitution[186].

As ASR is defined as hazardous waste in many countries, a landfill restriction on hazardous substances can also encourage shredders to develop technologies that reduce ASR and to find alternative ways of its treatment such as energy recovery. In addition, it stimulates shredders to cooperate with producers in order to find better material use to reduce ASR and to change material composition for better energy recovery.

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186 Tojo, N., Lindhqvist, T., and Davis, G. (2001). *EPR programme implementation: institutional and structural factors*. p. 33.

9.8 Role of Government

Not only policy design, but also governments per se play important roles. Governments should strongly consider institutional structures and capacities at different levels of authorities. Understanding the institutional capacity of governments may help in the selection of mandatory, voluntary approaches or a mixture of policy approaches for an ELV system.

Institutional capacity

Policy enforcement is another critical factor besides formulation of legislation. Governments and its authorised bodies perform enforcement. To assign enforcement power to a certain level of government, or governmental institutions, affects the outcome of policy. Sometimes for instance, local governmental authorities are lacking their capacities to execute such a task. For example, in Germany, deregistration approval procedures, which require excessive documentation from individuals, are the task of local authorities. In order to control ELV generation and its physical flows, the documentation requirement is regulated. However, since the lack of enforcement by local authorities led to issuing deregistration without documentation or without ensuring the reliability of documentation, this will not bring the outcome expected from the function of documentation requirement.

Since political structures of countries and their legislative power are distributed among different levels of governments, the way to allocate responsibilities, enforcement powers, and coordination task among different governments, affect the success of system.

Mandatory or voluntary approaches

For the use of different policy instruments, governments can choose the mandatory approach or allow voluntary actions. The types of approach affect reactions from relevant actors, which eventually leads to the success or failure of a policy. Mandatory approaches give clear guidelines for actors and can induce behavioural change in an effective way. Voluntary approaches may easily provide social and political acceptability. Through a voluntary agreement, each participant is encouraged to demonstrate commitment.

In the context of ELVs, the author observed that to use voluntary agreements merely does not seem to create an effective outcome. For example, in French and UK systems, voluntary agreements were made among relevant recycling industries, car producers and governments. However, the major agreements were mostly focusing on commitment for their own tasks. Especially in the UK case, there is no interactive cooperation to organise collection or recycling infrastructure in order to improve the direction of ELV flows to proper recycling chains. In the case of France, the only initiative shown is to organise the recycling chain, such as the MD network. However, without a proper deregistration system, where no mandatory requirement such as hand-in duty and clear allocation of financial responsibility within the MD network, such initiatives face difficulty to expand as nation-wide network.

The Swedish system exhibits detailed mandatory regulations with room for certain voluntary actions. As an example, a mandatory free take back system demands producers to set up collection network. However, determination on recycling costs that producers have to allocate is under their freedom. Thus, further proactive actions by producers are observed.

In conclusion, mixed approaches or allowing voluntary actions within mandatory schemes can have positive and effective outcomes of an ELV system.

10. Important lessons and final remarks

A recycling market for ELVs has been established, owing to the high metal content and reusable parts from them. However, major environmental impacts occur from improper treatment of non-recycled parts, which contain or are contaminated by spent oils, solvents, heavy metals, organic toxics, and ozone depleting substances. Additionally, abandoned vehicles in nature cause serious problems to environment and human health due to potential accidents.

The size and environmental performance of businesses vary among different economic operators throughout the recycling chain. From an environmental perspective, the most important treatment activity in ELV recycling is proper dismantling. Various types of dismantlers exist. Their major concern is to sell reusable parts and car wrecks for metal recycling. Proper treatment, for example depollution and dismantling different materials and components, requires time and labour costs, which gives negative benefits to dismantlers. In addition, the fluctuation in market demand for reusable parts and metal prices, adds more difficulty for dismantlers to bear the costs for proper dismantling. Improper dismantling process conveys environmental problems and difficulties to the shredding process. Shredders, in some cases, are accepting untreated ELVs, which lowers the quality of shredded materials, makes it difficult and costly to recycle them, and also adds toxicity to ASR.

Considering such environmental problems from ELVs, the thesis has focused on finding policy solutions to tackle this issue. In line with sustainable waste policy, a question on how an ELV policy can be designed in the most effective and efficient way arises. Thus, this thesis strives for identifying **determinant factors that facilitate developing an effective and efficient ELV policy,** aiming for three main goals: (1) waste prevention; (2) increase of reuse, recycling and recovery of ELVs; (3) improvement of environmental performance of recycling facilities. The case study approach, not in a comparative way, was used in the thesis. Five European countries, Sweden, the Netherlands, Germany, France and UK were selected.

Throughout the thesis, the author identified **the most important actors**, who influence the success of an ELV policy. These are car producers and governments. Conventionally, producers do not take responsibility for end-of-life phase of their products. The responsibility is mainly focused on design and production phases of products. Further, the producer's liability had been added to the producer responsibility. In sum, traditional producers' responsibilities for products are limited to production and user phases. Recently, as a new strategy for waste management, the 'Extended Producer Responsibility (EPR)' has been introduced. The scope of producer responsibility has been expanded to the end-of-life phase of products. Thus, producers should be responsible for end-of-life management. The EPR concept also has been adopted in ELV waste policy area. Sweden and Germany show the application of EPR in their ELV systems while the Netherlands applies the shared responsibility among car producers and other relevant recycling industries. In France and the UK, the EPR concept seems to be a baseline of their voluntary agreements. However, there was no actual involvement of car producers in organising a proper ELV recycling chain. They mainly committed themselves to consider the end-of-life phase of their products so that they are focusing on design improvement for reduction of environmental impact from new vehicles. After examining different levels of car producers' participation in ELV recycling, the author recognised that car producers have the best position to facilitate and stimulate other actors to make an ELV system more effective. Producers can play pivotal roles in organising and shaping a proper treatment and recycling chain. Through their involvement in the arrangement of ELV recycling system, producers can also achieve better design improvement for recyclability and for dismantling. For design improvement, producers establish communication channels with upstream and downstream sectors involved in the life cycle of vehicles. In sum, the role of producers under the extended producer responsibility becomes the most determinant factor for an effective ELV policy.

Another important actor to promote an effective ELV policy is government. Governments can have specific power and can play a significant role that no other actor can play. The role of governments includes: use of legislative power to establish clear guidelines for ELV systems; establishing different rules and requirements such as technical standards or restrictions or bans on the use of hazardous substances; integrating the ELV policy with other types of policy such as vehicle deregistration policy, and cooperating with different governmental levels and departments.

Associated with the role of governments, several specific **policy instruments** are identified as useful and effective tools for developing an effective ELV policy. First, the mandatory requirement of a certificate of destruction for car deregistration, together with a car scrapping authorisation can facilitate and effectively control ELV flows into a proper treatment and recycling chain. The examples of such instruments are found in Sweden, the Netherlands, and Germany. Comparing to France and the UK, which do not use such tools, it is clear that the design and use of these tools contributes to the increase of ELV collection.

Second, the 'free tack back' by car producers is also an effective policy tool. The free tack-back tool can be used as voluntary or mandatory action. Comparing the effect of the overall ELV system, the mandatory free take-back is more effective approach than a voluntary one. The voluntary free tack-back, if adopted by few car producers, does not create strong influential power over dismantling industry as a whole, due to the lower volume of ELVs that they are dealing with. For fast and effective outcomes, the mandatory free take-back can perform better. In addition, as the German case under the ELV ordinance experienced, the free take-back to a limited extent lowers the outcome of the system.

Third, certain types of specific and detailed regulations, for examples, regulations on installation of recycling facilities; technical standards; dismantling and recycling requirements on certain materials; and bans and restrictions on hazardous substances, can give incentives for treatment and recycling facilities to improve their performances. In addition, these regulations can facilitate monitoring and enforcement actions by authorities.

Concerning economic instruments, such as the Swedish car scrapping premiums for last owners and the Dutch recycling premiums for recyclers, it is important to mention that unexpected risks and possible negative effects may appear. As was noted in the Swedish case, certain groups can misuse economic instruments.

The thesis has examined different types of **financial mechanisms** of ELV systems, in order to find out the most efficient and sustainable one. The author identified 'producer pays' system as the most efficient and sustainable for financing ELV recycling costs. The reason is that producers will invest a lot of effort to reduce recycling costs through different approaches, for example keeping their networks sufficient and more efficient with limited contracted dismantlers. Also, they might participate in developing technical skills of dismantling processes, which would contribute to recycling cost reduction. In addition, through the selecting power of producers, dismantlers will also be motivated to improve their performance to get involved in producer networks. Combining the efforts from both directions will lower recycling costs for ELVs and will consequently improve environmental performance in dismantling.

A last owner pays system is the least favourable option for financing recycling costs. Since there is no intervention from any other actors on ELV recycling costs, dismantlers are dominating the determination of these costs. This gives unfavourable conditions for last owners, which may lead to a problem of abandoned vehicles in nature.

Regarding the economic and financial issues, the author tried to examine how the actual recycling costs are made and how much it will change if higher recovery and recycling rates are imposed. 'Recycling cost' is an additional cost, which gives negative benefits for dismantlers. It often hinders proper depollution and further dismantling processes of ELVs. This cost issue has always been one of the most sensitive issues. There have been some studies on how to calculate the recycling costs in different systems. However, the author concludes that it is not possible to conduct a comparative analysis on what type of ELV system can influence and which elements of the system can make the difference in recycling costs. Based on the data collected by the author, the high uncertainty of recycling and variables in a system for recycling cost calculation: such as different labour costs; difference in dismantling time; different investment costs; various and fluctuated market prices for recycled materials; different volumes of ELVs in treatment facilities; and others, are factors that hinder the comparison and the analysis on recycling costs of various ELV systems.

There are other important factors for developing an effective ELV policy. These are: the use of collection and recycling targets; monitoring; and cooperation among relevant actors. Collection and recycling targets are stimulating factors to encourage relevant actors to improve collection and recycling performances. In case of collection target, the author defined 'collection' as the collection of ELVs that are delivered to proper treatment facilities. The author also pointed out the need to set a collection target and its consequent benefits. Collection targets will demand data collection on abandoned vehicles, total ELVs generation, the flow of old vehicles exported, and the ELV flow to improper treatment chain. Using results of data collection can give a clear view and the system can be revised and changed accordingly. For recycling and recovery targets, they should be separated in order to maximise recycling over recovery. High recycling and recovery targets not only can stimulate relevant recycling actors, but also can promote innovative actions to seek ways to increase recycling and recovery by looking at all aspects of vehicle life cycle.

Together with collection and recycling issues, monitoring is an essential element for an effective ELV policy. Regarding monitoring issues, the development of indicators to measure the progress and the outcome of an ELV system in many different aspects should be done. Based on reliable measurements, a clear and objective monitoring can stimulate improvement of an ELV system.

Cooperation is considered as an important element. Besides cooperation between government and industries involved in ELV recycling, cooperation among relevant industries themselves can influence the level and the speed of progress. To build strong commitment, cooperation can be stimulated by reasonable allocation of responsibility, by avoiding strong market distortion or intervention, and by keeping transparency of information. However, cooperation should not over exceed the incentive for competition.

Final remarks and further research

The thesis attempts to explore different factors that influence the effectiveness of ELV policy. However, due to the various limitations the author faced, there is still a place for improving the research more in-depth. Especially, the author was not able to check the information on abandoned vehicles in nature at municipal levels in all selected systems except for the Swedish case.

In addition, it will be interesting to follow up with the progresses of selected systems as they evolve. As some changes are expected from the introduction of the ELV directive, it will be very interesting to see how countries will transpose it into national laws, how it will shape the ELV system, and how and to what level it will affect the environmental impact from ELVs.

In addition, the purpose of the thesis could be better reached, if certain other aspects and factors that the author could not cover can be explored, such as wider effects of ELV systems, market changes and development for recyclable and recycled materials, trade effects related to ELVs, impact on cross-border movements and so on. These factors may affect the success or failure of the ELV policy.

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Abbreviations

ACEA	Association des Constucteurs Européens d'Automobiles (European Automobile Manufacturers Association)
ACORD	Automobile Consortium on Recycling and Disposal, UK
ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie (State agency for the environment and energy), France
ARGE-Altauto	Arbeitsgemeinschaft Altauto (a producer responsible organisation), Germany
ARN	Automobile Recycling Nederland BV, the Netherlands
ASR	Automobile Shredder Residue
BDSV	Bundesvereinigung Deutscher Stahlrecycling-und Entsorgungsunternehmen, Germany
BIL	Bilindustriföreningen (Car producer association), Sweden
BMRA	British Metal Recycling Association, UK
BMU	Bundesministerium fur Umwelt, Naturschutz end Reaktorsicherheit (the federal ministry for the Environment, Nature Conservation, and Nuclear Safety), Germany
BPS	BIL Producentansvar Sverige AB, Sweden
CARE	Consortium for Automotive Recycling, UK
CCFA	Comité des Constructeurs Fraçais d'Automobiles, France
CNPA	Conseil National des Professions de l'Automobile, France
DTI	Department of Trade and Industry, UK
DVLA	Driver and Vehicle Licensing Agency, UK
EC	European Comission
ECRIS	Environmental Car Recycling in Scandinavia, Sweden
ELV	End-of-life vehicle
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
EU	European Union
FEDEREC	La Fédération Française de la Récupération pour la Gestion Industrielle de l'Environnement, France
FNDA	La Fédération Nationale de Déconstruction Automobile, France
FSV	Freiwillige Selbstverpflichung (Voluntary Pledge on End-of-life vehicles), Germany
IATR	Initiativkreis Autoteilerecycling, Germany
IGA	Interessengemeinschaft der deutschen Autoverwerter (Association of the German Car dismantlers)
KBA	Kraftfahrt-Bundesamt (Federal Motor Transport Authority), Germany
MD	Manager-Distributors, France
MRF	Metal Recycling Federation, the Netherlands
MVDA	Motor Vehicle Dismantlers Association of Great Britain
OECD	Organisation for Economic Co-operation and Development
PRAVDA	Projektgruppe Altfahrzeug-Verwertung der deutschen Automobilindustrie
PELV	Premature end-of-life vehicle

RDW	RoadRijksdienst voor het Wegverkeer, the Netherlands
SGS	Société Générale de Surveillance, the Netherlands
SIKA	Statens Institut för Kommunikationsanalys, Sweden
SMMT	The Society of Motor Manufacturers and Traders Ltd., UK
TA	Technische Anleitung (Technical regulation), Germany
TRH	Teilerecycling im Handel, Germany
VAT	Value Added Tax
VDA	Verband der Automobilindustrie (German car producers association)
VROM	The Ministry of Housing, Spatial Planning and the Environmental, the Netherlands
WMA	Waste Management Act, the Netherlands

Appendix 1. The Swedish environmental protection agency regulations on scrap vehicle operations (NFS 2002:2)

Main contents of these regulations and advices of NFS 2002:2 are summarised below.

- *Place for storage before processing*: Before processing, a scrap vehicle shall be stored at a place with impermeable surfacing, with proper devices for de-pollution[187];

- *Place for processing:* Emptying, dismantling and other processing of scrap vehicles shall be carried out at a place with impermeable surfacing, with proper devices for de-pollution, with proper and separate storages or tanks for dismantled spare parts, dismantled batteries, filters, capacitors containing PCB/PCT, components containing mercury, scrap tyres;

- *Processing for decontamination, safety and promotion of material utilization:* Substances, liquids, components listed (see below) should be emptied, dismantled or neutralised and should be collected and stored separately in an appropriate manner and also as soon as possible;

- *Obligation to prepare documentation:* Written maintenance and operating instructions for all handling operations shall be prepared and be available. And a dismantler shall keep notes of their operations;

- *Requirement on harmful substances:* The environmentally harmful substances, liquids and components for decontamination and safety should be emptied and dismantled. Those are all spent oils, oil filters, fuels, other fluids, capacitors containing PCB/PCT, refrigerants, batteries, all components containing mercury, lead weights, tanks for liquefied gas, airbags and seat belt pretensioners.

- *Recovery requirement:* Certain materials and components should be recovered. These are catalysts, tyres, metal components, glass windows, and as from the 1st of January 2006, large continuous plastic parts, including bumpers, fascias, liquid containers etc.

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[187] Proper devices for de-pollution are devices for collecting spillage, equipment for treating waste water and day water by sludge and oil separation, and any additional cleaning devices decided by the municipality

Appendix 2. Voluntary delivery regulations for scrap material concerning scarp vehicles by Stena Fragmentering AB

The delivery regulations for scrap vehicles require all scrap vehicles (Scrap Vehicles Class 44) to be approved for delivery for fragmenting. Chemical products and chemicals that are hazardous to health and the environment, such as paints, oils, petrol, diesel, gas, and solvents should be removed. All containers for these substances must be opened and empty. The more detail information on each material is below.

- Fuels such as petrol, diesel and gas and fuel tanks should be opened, and the hold should be at least 100 x 100 mm. Non-visible fuel tanks should be dismantled. Gas containers should be dismantled;
- Anti-freeze should be drained away;
- All oils should be drained away and engine, gearbox, rear axle, steering and brake and other servo systems should be dismantled;
- Oil filters should be dismantled;
- Batteries should be dismantled;
- Air conditioning should be dismantled and CFCs should be drained away;
- Airbags and inertia reel seatbelts should be dismantled;
- Catalytic converters should be dismantled;
- Wheel balancing leads should be removed from wheel rims;
- Tyres should be removed;
- Mercury switches should be dismantled;
- Radioactive materials must not be present in the vehicles.
- Other materials, such as stone, cement, gravel, wood, paper, plastic, and tyres should be removed.

Appendix 3. The Swedish statistic data

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
SIKA (Statens Institut för Kommunikationsanalys)																
New registration	**274393**	**322136**	**349635**	**314126**	**235195**	191755	157295	127738	159578	175060	200154	258944	286671	335632	354649	290262
Total Deregistration	151361	148787	333569	184208	215886	166873	244743	216546	164358	142067	135174	160097	155477	172124	169517	299758
Certificates of destruction	**145489**	**142556**	**185089**	**172795**	**163579**	149014	226949	168650	125224	115613	121830	149013	143576	161518	158803	284313
Deregistration for export	**2936**	**2807**	**2844**	**3618**	**6314**	**12078**	**9 907**	**15907**	**13593**	**11023**	**7388**	**6311**	**6747**	**6914**	**6929**	**10723**
Administrative deregistration	2936	3424	145636	7795	45993	5781	7887	31989	25541	15431	5956	4773	5154	3665	3788	4722
Vägverket																
New registration	-	-	-	-	-	**191755**	**157295**	**117738**	**159587**	**175060**	**200154**	**258644**	**286672**	**335862**	**354650**	**290350**
Certificates of destruction	-	-	-	-	-	**154348**	**218990**	**158930**	**131157**	**118975**	**114393**	**147628**	**139844**	**159562**	**169401**	**304214**
Administrative deregistration	-	-	-	-	-	**0**	**2141**	**3099**	**3128**	**2880**	**2488**	**209**	**38**	**0**	**123**	**162**

Bold letter *are the figure that the author used for analyses.*

Appendix 4. The scrapping fund balance during 1978 and 2001 in Sweden

Year	Car Scrapping fund balance (Thousand SEK)
1978*	74 317
1979*	9 185
1980*	105 420
1981*	112 999
1982*	123 083
1983*	144 352
1984*	165 617
1985*	195 394
1986*	210 627
1987*	242 793
1988*	258 514
1989*	255 246
1990*	228 253
1991**	168 208
1992**	58 329
1993**	- 20 032
1994**	68 714
1995**	186 852
1996**	346 478
1997**	558 946
1998**	711 252
1999**	893 903
2000**	1 070 62
2001**	912 347

*During 1978 and 1990, the car scrapping fund balance is based on the 1st of July. (Source: Rydén, E. (1995). But this figure was provided by Vägverket)

**During 1991 and 2001, the fund balance is based on the 31st of December. (Source: Vägverket. (2002).)

Appendix 5. The management of end-of-life vehicles decree (Besluit Beheer Autowrakken) in the Netherlands

Ministry of Housing, Spatial Planning and the Environment (VROM) prepared the 'Management of End-of-Life Vehicles Decree' in order to reflect the EU directive in the Netherlands. The decree came into force from July 2002, together with the 'Slate Wire', the decision on information for communication and submitting reports to VROM.

The main contexts of the Management of ELV Decree are summarised below.

- *Scope:* Passenger cars and light commercial vehicles less than 3 500 kg;

- *Waste prevention:* Car producers (manufacturers and importers) are obliged to take preventive measures considering waste generation of vehicles;

- *Collection and treatment:* Car producers are obliged to set a collection and processing system with ensuring that a last owner of a vehicle can deliver his car without paying additional cost;

- *Technical regulations on storing, treating, processing, dismantling and shredding car wrecks* are stated in order to improve environmental performances of relevant sectors, including garages, repair shops, scrap yards, dismantlers, shredders and recyclers;

- *Role of Local government:* Local governments are exempt from taking responsibility for ELV collection. However, they should incorporate their waste product regulations that ELVs must be transferred to the ELV system. In addition, local governments must incorporate technical regulations on the licensing scheme for all relevant facilities to deal with ELV and its components;

- *Encoding:* Producers should apply an encoding system for certain materials and components;

- *Monitoring:* Producers must report to VROM on their performances related to their legislative obligations on annual base. The more details on reporting and communication on relevant information are stated in the 'Slate Wire'.

Appendix 6. A summary of the environmental management act in the Netherlands

The main features of the waste chapter are summarised as:

- The act defines a waste management hierarchy, from the most to least preferred option: prevention, reuse/recycling, incineration and only then landfill/dumping;

- Landfill/dumping or incineration of waste can be prohibited;

- Manufacturing or importing particular products can be prohibited;

- Producers and importers can be obliged to take products back, and to dispose of it in a specified manner;

- Companies and waste collectors can be obliged to separate, to transfer them separately or to process them in situ in some other manners;

- It includes rules on the shipment of waste within, into and from the European Community;

- The Ministry of Housing, Spatial Planning and the Environmental (VROM) is empowered to require certain rules to be included in provincial and municipal ordinances[188].

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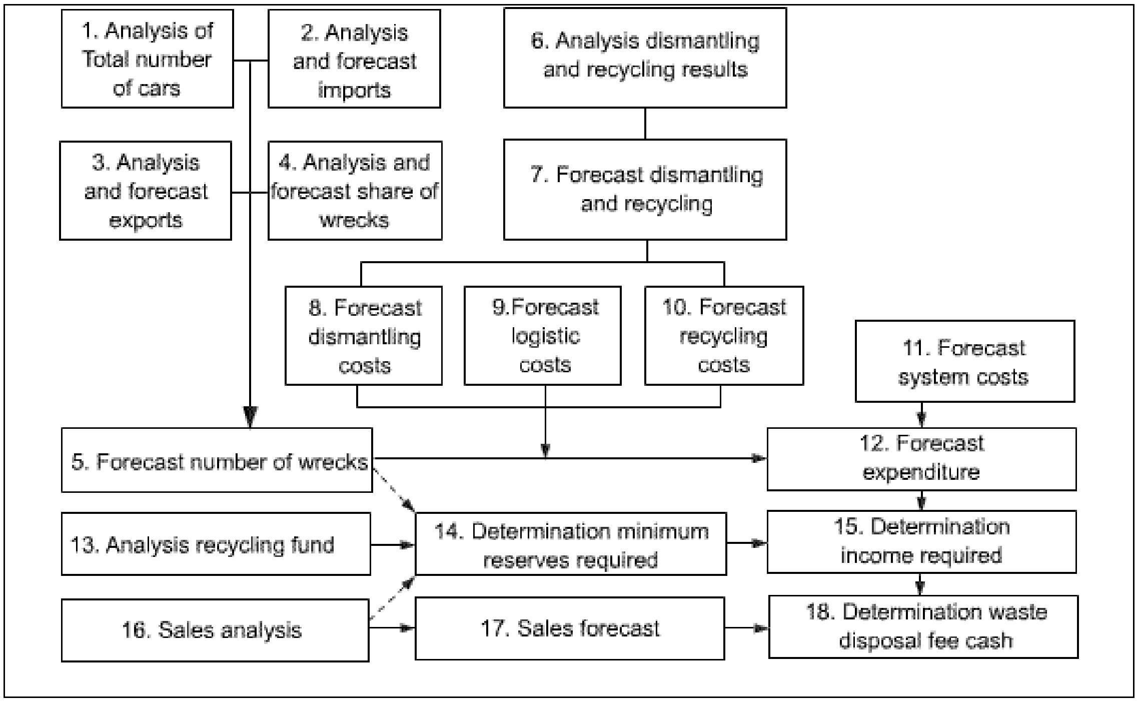
[188] Ministry of Housing, Spatial Planning and the Environment (VROM). (2001). Legislation: Waste in the Netherlands. Factsheet

Appendix 7. A method for determining the waste disposal fee in the Netherlands



Source: ARN environmental report. (1997).

Appendix 8. The Netherlands statistic data

	1996	1997	1998	1999	2000	2001
New registration*	622822	608174	705337	776737	726512	655742
Total deregistration***	411627	433620	393693	408690	446599	482885
Certificates of Destruction	264248	270414	258456	283827	325630	319938
ELVs processed by ARN**	210092	237266	232685	251943	286595	278972
Deregistration for export***	144134	161039	133277	121888	118447	161113
Administrative deregistration***	3275	2164	2010	2975	2522	1834

**Calculated by the author, base on the amount of collected waste disposal fees*
*** Source: ARN environmental reports. (1996-2001).*
**** Source: Centraal Bureau voor de Statistiek. (2002).*

Appendix 9. Materials recycled in the Dutch ARN system during 1995 and 2001

Year	1995	1996			1997			1998			1999			2000			2001		
Total ELVs	126 000	210 092			237 266			232 685			251 943			286 595			278 972		
Materials	Total weight	ARN norm	Total weight	Actual norm	ARN norm	Total weight	Actual norm	ARN norm	Total weight	Actual norm	ARN norm	Total weight	Actual norm	ARN norm	Total weight	Actual norm	ARN norm	Total weight	Actual norm
Batteries (kg)	1233175	13.4	2799495	13.3	13.6	2799414	11.8	13.6	2908629	12.5	13.6	2947431	11.6	13.6	3619296	12.6	13.3	3534660	12.6
Rear lights and indicators (kg)					1.4	53530	0.2	1.4	237245	1.0	1.4	263400	1.0	1.4	303280	1.0	1.4	319837	1.1
Tyres (kg)	2411240	25.4	5319902	25.3	27.3	6621157	27.9	27.3	6745545	29.0	27.3	6740940	26.8	27.3	7962820	27.8	27.9	7831005	28.0
Inner tubes (kg)	30535	0.7	144976	0.7	0.5	76220	0.3	0.5	102650	0.4	0.4	94 250	0.4	0.2	22660	0.2	0.2	51260	0.2
Fuel (kg)*											1.0	23281		5.0	67132		5.0	123573	
Bumpers (PP and PC) (kg)		2.1	435804	2.0	3.1	755052	3.2	4.4	877760	3.8	5.0	1027026	4.0	5.2	1318607	4.6	5.5	1387800	4.9
Glass (headlamp glass) (kg)	1620210	24.3	5077806	24.2	25.4	5539250	23.3	25.4	5260080	22.6	25.4	5834730	23.2	25.4	6313560	22.0	25.4	6050120	21.7
Grilles (kg)					0.8	29600	0.1	0.8	123002	0.5	0.8	114060	0.5	0.8	119260	0.4	0.8	113900	0.4
Coolant (kg)	174879	2.6	541246	2.6	2.6	605114	2.6	2.6	631400	2.7	3.4	645500	2.6	3.6	874240	3.1	3.6	799240	2.8
Coconut fibre (kg)		0.7	144354	0.7	0.7	146256	0.6	2.7	124208	0.5	0.9	94962	0.4	0.9	82775	0.3	0.7	87969	0.3
LPG tanks (stuks)*											0.06	7782		0.06	1118		0.06	6783	
Oil (ltr)	380900	3.8	797636	3.8	4.2	1043311	4.4	4.2	1063533	4.6	4.9	1104012	4.4	4.9	1267000	4.4	4.9	1107723	4.0
PU Foam (kg)	287162	6.3	1313611	6.3	6.3	1361330	5.7	6.3	1593520	6.8	6.5	1548100	6.1	6.5	1736130	6.0	6.5	1745120	6.2
Brake fluid (kg)	15799	0.3	66240	0.3	0.3	38187	0.2	0.3	41744	0.2	0.3	130920	0.5	0.3	43992	0.2	0.3	75479	0.3
Rubber strips (kg)	493208	7.2	1505579	7.2	7.7	1880026	7.9	7.7	1655450	7.1	7.7	1752990	7.0	7.7	1980180	6.9	7.7	1931020	6.9
Washer fluid (kg)		0.7	144142	0.7	0.7	158637	0.7	0.7	169240	0.7	0.7	148040	0.6	0.9	166420	0.6	1.0	196780	0.7
Safety belts (kg)		0.3	61933	0.3	0.4	47610	0.2	0.4	67362	0.3	0.4	63236	0.3	0.4	85008	0.3	0.35	86320	0.2
Hubcaps (kg)					1.0	18780	0.1	1.0	60100	0.3	0.6	139900	0.6	0.7	161420	0.6	0.7	185300	0.7
Total (kg)		87.8		87.4	96.0		89.2	97.3		93.0	99.3		90.0	99.8		91.0	100.4		91.0

**Fuel and LPG tanks are excluded in the ARN calculation, thus also are excluded in actual norm calculation by the author.* (Source: adapted from ARN environmental reports. (1995-2001).)

Appendix 10. The end-of-life vehicle act of 2001' in Germany (German transposed law of the EU ELV Directive)

According to the new ELV Act of 2001, several related acts were amended, including the ELV Ordinance of 1997. Compared to the ELV Ordinance of 1997, the ELV Act of 2001 extended the scope of ELVs bound to the legislation and also added the regulation of waste prevention. The main contents are summarised below.

- Producers are required to collect their makes of ELVs from last registered owners with condition that ELVs should be registered in German vehicle legislation. ELVs, containing fundamental components and that foreign waste, should not been added. The scope of ELVs is passenger cars (M1) and light weight commercial vehicles (N1), which are registered after July 2002.

- The Following targets must be reached - by January 2006, at least 85 per cent by weight to be reused and recovered and at least 80 per cent by weight to be reused and recycled; and by January 2015, at least 95 per cent by weight to be reused and recovered and at least 85 per cent by weight to be reused and recycled.

- Materials and components of vehicles marketed after 1 July 2003 shall not contain lead, mercury, cadmium or hexavalent chrome.

The ELV act of 2001 envisages that from 2002, the last owners of end-of-life vehicles will be able to return all vehicles licensed from that date onwards to the manufacturer; from 2007 onwards, this option of free return will also be extended to include all end-of-life vehicles licensed prior to entry into force of the new provision. The cost of disposal will be borne by the automotive manufacturers[189].

[189] The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. (2002). German Environmental Report 2002: Report on environmental Policy in the 14th legislative period. p. 113.

Appendix 11. The voluntary pledge of 1996 in Germany

The main contents of the Voluntary agreements are,

- To set up a nation-wide infrastructure for taking back and recycling of ELVs no later than two years after the creation of necessary regulatory framework, which is April 2000;

- To set up a nation-wide infrastructure for taking back and recycling used parts from car repairs;

- To reduce the amount of ELV residue for disposal from 25 per cent by weight to an average 15 per cent at maximum by the year 2002, and 5 per cent at maximum by 2015;

- To take back any ELV according to its market condition and to take back free of charge for ELVs, which have been registered after the ordinance, and which are not older than 12 years. In addition, conditionally, ELVs for free take-back should be registered in Germany for at least 6 months prior to return in the name of the last owner, be complete and movable, free of waste, and without serious damage. Parts and accessories of these cars have to comply with relevant statutory requirements.

Implementation of the voluntary agreement shall be monitored through

- A committee appointed at the VDA named consortium End-of-Life Vehicles (Arbeitsgemeinschaft- ARGE-Altauto) in order to or-ordinate the fulfilment of the voluntary agreement and to verify the level of progress achieved;

- A monitoring report delivered every second year to the Ministry for Environment and the Ministry for Economy, initially two years after the establishment of the supporting regulatory framework (April 2000);

- The establishment of an advisory board including consumer organisations.

Finally, the official text states that the voluntary agreement will take effect with the creation of a regulatory framework introducing a mandatory certificate of disposal for owners of ELVs as well as legal requirements for return stations and dismantlers.

Appendix 12. Numbers of vehicles deregistered in Germany from Kraftfahrt-Bundesamt (KBA) during 1991 and 2001

Year	No. of Cars De-registered
1991	2 359 678
1992	1 873 006
1993	2 252 601
1994	2 695 384
1995	2 949 704
1996	3 145 259
1997	3 392 358
1998	3 468 798
1999	3 045 903
2000	2 554 137
2001	3 023 777

Appendix 13. A new guideline for an ELV calculation methodology on reuse, recycling and recovery in Germany[190]

Followed by the new ELV act, recently the German recycling and recovery calculation methodology was newly adopted by law. In order to monitor the German system based on the German transposition law of EU ELV Directive, this new calculation methodology will be applied in all ELV recycling process in Germany.

This recent adaptation of calculation methodology is a quite different than the way VDA and ARGE-Altauto use for their monitoring, which was part of the voluntary agreement and the ELV Ordinance of 1997.

The base of ELV recycling and recovery calculation is a kerb weight. Thus, the average weight of ELVs is calculated as the average kerb weight with 90 per cent of fuel minus 75 kg as the average driver weight. The better deregistration system in future will help to calculate the average kerb weight from ELVs generated in Germany.

At dismantlers, the body shell after draining all fluids and dismantling materials should be measured before sending to shredders.

Material recovery rates of dismantled materials should be calculated along with a proof of delivery of materials to further recyclers. However, there is no demand to trace after delivery to recyclers. Therefore, waste or residue left from recyclers are not counted and included in total recycling and recovery rates.

Metal recycling rate would not be actually measured. The metal recycled rate of total ELVs by weight will be calculated based on the various literatures, which is now considered as around 70 per cent of total ELVs by weight.

Energy recovery and ASR should be closely observed and measured by shredders. At present, there is a study further to propose further detail of application of measuring recycling and recovery rates.

190 Personal communication with Knut Sander, a researcher at Institut fur Ökologie und Politik GmbH.

Appendix 14. A summary of the commitment based on the Accord Cadre on end-of-life vehicles in France

Actors	Commitments
Car and Equipment Manufacturers	• Intensify R&D efforts in connection with suppliers and public authorities to produce and use parts with higher degree of reprocessing possibilities; • Use increasing amounts of recycled materials within the scope of existing technologies; • Adapt design consequently with the constraints imposed by other functional requirements; • Ensure that by the year 2002, new models may be reprocessed to generate a final waste not exceeding 10% of the total weight under the condition of economic feasibility and sufficient degree of innovation taking place; • Provide information and introduce marking of parts to enable dismantling and recycling, to supply technical assistance and develop cooperation also at the European level
Dismantlers / Recyclers	• Comply with the responsibility of reprocessing vehicles also in agreements with other downstream operators; • Take responsibility for vehicles from last owners, with full information on the transfer of ownership and at prevailing market conditions within competition rules; • Take into account technical information form manufacturers and intensify their effort for technical and economic efficiency of their operations; • Supply information on the state of reprocessing activities
Material Manufacturers	• Develop their relations with manufacturers and dismantlers/recyclers for allowing optimisation of material choice for environmental protection; • Intensify R&D on material revalorisation, and develop recycling channels to increase reprocessing of metals; • Participate in industrial initiatives aiming at developing revalorisation of synthetic materials
Public Authorities	• Conduct campaigns against illegal dumping of ELVs; • Control compliance of reprocessing operators for existing regulation; • Take statutory measures if required and in accordance with the framework agreement

Appendix 15. The draft decree relating to setting up the market for retake, recovery and elimination of ELVs in France (Projet de decret relatif a la mise sur le marche des vehicules ainsi qu'à la reprise, la valorisation et l'élimination des vehicules hors d'usage)

The last version of the draft decree of ELV treatment was presented on May 27th, 2002. The transposition of EU directive is planned to be end of year 2002. According to the personal communication with CCFA, the ELV treatment system in France will be connected exactly with that described in the directive. Therefore, car producers will align themselves on system set-up by the French Government, also with supporting additional costs of the ELV recycling. Thus, there will be no financial burden to last vehicle owners.

The draft decree describes the outline of the upcoming ELV decree. The main contents of the draft decree are summarised below.

- *Scope:* End-of-life of passenger cars and light weight commercial vehicles less than 3.5 tonnes, three-wheel automobiles, and the components and materials from these vehicles are included;

- *Hazardous waste:* Vehicles must be designed in order to limit the use of dangerous substances for prevention of these substances released to the environment, and for facilitating recycling and for avoiding dangerous waste;

- *Design for recyclability:* Vehicles must be designed and be built in order to facilitate disassembling, reuse, recycling and recovery. A coding system for components and materials should be followed;

- *Collection:* Last ELV owners should hand in their vehicles to authorised dismantlers or shredders with free of charge, except if vehicles do not contain their essential components such as engine and body, or if they contain additional waste. This provision is applicable from July 1, 2002 for the vehicles registered after this date and from January 1, 2007 for vehicles;

- *Treatment:* Treatment of all ELVs, their components, and materials, must be carried out in authorised operators. Return stations, depollutioning, regrouping, dismantling, and shredding facilities must be authorised. Car producers should set up recycling networks with approved dismantlers and shredders in order to secure a proper treatment of ELVs;

- *Recycling and recovery target:* At the latest of January 2nd, 2006, the recovery rate of all ELVs should be more than 85 per cent by weight, with 80 per cent at minimum level of reuse and recycling rates. At the latest of January 1st, 2015, 95 per cent recovery with at least 85 per cent of reuse and recycling rates;

- *Information:* Former vehicle owners must address the destination of their vehicles within 15 days to an authority, by declaring sales or transferring for destruction. A certificate of destruction will be established. Documentation along with the physical flow of ELVs should be followed throughout all economic operators.

Appendix 16. Initiatives on authorisation for dismantlers in France

There is no clear number of companies for storing and dismantling ELVs. Some estimates 2 000 to 3 000 dismantlers existing in France. In 1998, more than 1 000 dismantlers are considered uncontrolled sites, while only about 900 had valid operating permits.

In order to reduce the environmental impact from uncontrolled dismantling sites, there were several action and initiatives.

- The National Federation of Automobile Deconstruction (La Fédération Nationale de Déconstruction Automobile: FNDA), affiliated with FEDEREC, took various actions towards uncontrolled dismantlers particularly located in Brittany and the Rhone-Alps;

- The branch demolition contractors of the CNPA (La branche démolisseurs du CNPA) launched a 'Green pact (Pacte Vert j'adhère)' for dismantlers in Lorraine region, in order to encourage them to follow the legislative framework for dismantling and to good performance of dismantling work;

- Followed by the CNPA initiatives, the Ministry of the Environment recently recalls the DRIRE and the necessary to respect the ICPE regulation within the dismantling business[191].

In nation-wide, the branch of the National Automotive Council (Conseil National des Profession de l'Automobile-CNPA) took an initiative in certification process. Since 1994, CNPA developed a certification of services on ELV treatment (la Certification de services 'Traitement des V.H.U.'). The SGS-Qualicert, the certifying organisation is in charge of certifying dismantlers by testing their facilities and revising their certifications by unexpected annual visits.

This certification address five main frames related to ELVs treatment; ensuring environmentally sound depollution and dismantling processes; physical and administrative traceability of ELVs during the treatment period; commitment to take back ELVs at market prices; and other requirements on information of customers and training personnel[192]. Since 2000, around 420 to 440 dismantlers are certified by Qualicert[193].

In 1997, the CNPA, with the assistance of ANFA, also set up a Certificate of Occupational Qualification of Automobile dismantler (un Certificat de Qualification Professionnelle de démonteur automobile). In addition, the National federation of Automobile Deconstruction (FNDA) pushes its members to achieve ISO certification after the certification of service[194].

191 ADEME. (2001b).

192 Zoboli et al. (2000). p. II-2.

193 ADEME. (2001b).

194 ADEME. (2001b).