

End-of-life vehicles management in Europe:

Driving the change

Cases of Sweden and Germany



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Abstract

End-of-life management of cars in Europe is regulated by a common legislative framework since 2000, when the Directive 2000/53/EC on end-of-life vehicles (ELVs) was adopted. The objectives of this legislation are: prevention of waste from ELVs through design improvements, and facilitating better recycling and treatment of ELVs by improving environmental performance of treatment facilities and attaining quantitative material recycling and recovery targets. The analysis of the car recycling sector shows that in a number of areas ELV treatment is falling behind legislative requirements and presumably behind its actual technically and economically feasible potential. The purpose of this thesis is to explore these areas where improvements are possible by looking at the current state of legislation implementation and enforcement, available technologies of ELV treatment and recycling of its components, and by exploring in a more detailed way the situation in two European countries with well established and currently compliant ELV management systems: Sweden and Germany. Special attention is paid to the analysis of current and prospective ELV related legislation; the implementation of extended producer responsibility principle; and currently applied practices and technologies in the dismantling and recycling sectors. A number of areas of concern are identified, and suggestions for the possible improvement strategies are made. Potential positive changes in car recycling sector are linked, but not limited to the technological possibility of attainment of ambitious recycling targets, while there is a significant potential in acquiring the long term strategic vision by the automotive sector, and applying sustainable resource utilisation philosophy.

Executive Summary

Automobiles play a crucial role in shaping lifestyles and infrastructure in Western societies, where the value of personal mobility is hard to overestimate. Modern cars are complex products that consist of thousands of components and a wide variety of materials. During their lifecycle cars have a significant environmental impact such as raw materials use, fossil fuels use, and air emissions among others. The subject of this thesis is end-of-life management of cars. Scrap cars, otherwise called end-of-life vehicles (ELVs), constitute a significant waste stream, which is estimated to have generated over 10 million tonnes of waste in 2005 within the EU. The number of cars on European roads is constantly growing, which means that ELV derived waste will also increase in the future. The car recycling sector historically developed around scrap metals, which were and to a large extent still are the main valuable component recovered from an ELV. Metal components of a car constitute around 75% of its total weight. When compared to other complex products, cars already have been recycled to a relatively high rate. But given the massive amounts of waste, and particularly the composition of this waste which includes valuable plastics and rubber components as well as contaminants that make it qualify as hazardous waste in many countries, non-metallic components of ELVs (i.e., the remaining 25% of a car's total weight) is a significant problem.

The problems associated with treating car wrecks started attracting attention of legislators in countries like Sweden from the 1970s, and a common European legislative framework was adopted in the year 2000. Legislators' concerns started with trying to solve the problem of abandoned cars in nature. At the present stage, two main objectives of ELV legislation are waste prevention from ELVs, which is to be achieved through design improvements and extending producers responsibility over end-of-life management; and facilitating better treatment and recycling of ELV components through improving environmental performance of treatment facilities, and achieving quantitative targets for material recycling and recovery. The challenge of these targets concerns non-metallic components recovery and recycling, because with current shredder - based recycling technology the emphasis is made on metals recovery, and the shredder residue is either separated for energy recovery, or simply landfilled.

Looking at the car recycling sector, it appears that not all requirements and provisions of legislation are well implemented or enforced, and there seems to be a gap between actual practices and economical and technological potential of the car recycling sector. The aim of this thesis is therefore to explore the current situation with end-of-life vehicles management in European context with regard to the shortcomings in legislation enforcement, and identify the potential ways of catalysing improvements. Research questions addressed in the study include the effectiveness of the legislation as a driver to bring about the necessary changes to car recycling practices; identification of areas where the sector falls behind its legislative, technological and economically feasible potential; and suggestions on possible improvement in these areas. Among these areas are prospective legislation changes, implementation of extended producer responsibility principle, recycling of non-metallic components, monitoring and compliance reporting.

This thesis is based on legislation analysis, technology overview, but to a larger extent on two case studies exploring in a more detailed way the situation in two European countries: Sweden and Germany. Both these countries have well established and currently compliant ELV management systems, and therefore it is assumed that difficulties that may be encountered by these systems are of a rather generic nature, and will enable one to draw wider conclusions. From the start of this study a practical approach was taken by conducting field research to learn about practices of dismantling and recycling sectors. Findings of this research underline a lot of statements presented in the study.

Legislation gives a good enough framework for improving and advancing material recycling of non-metallic components, but cannot be a single driver. Technologically it seems possible to achieve significant improvements in non-metallic material recycling, but at the moment there is not enough motivation among the actors to initiate wider improvements. What is lacking is the agent of change. According to the EPR principle this agent should be car manufacturers, while currently recovery of plastics and other potentially valuable materials are left to the decision of the recycling company that operates a shredder. Therefore practically responsibility is transferred away from producers; moreover producers are trying to keep ELV management a zero-cost for them and on average keep low involvement in dismantling and recycling of ELVs. Producers seem to have chosen a short term benefit of having no cost ELV management today, over the potential long term benefit of taking a proactive position and taking the full consequences and benefits of the producer responsibility implementation. Therefore extended producer responsibility is seen as a crucial aspect in triggering changes in the ELV management sector.

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1 Introduction

1.1 Background

Cars are one of the most important artifacts for modern society where infrastructure is largely shaped by automobiles, and the value of personal mobility is immense. Conceptually the car with an internal combustion engine is more than a hundred years old, and throughout this time cars became more comfortable, faster and safer, and as a result they became too complex. The subject of interest for this thesis is end-of-life management of cars. Scrap cars, in trade called end-of-life vehicles (ELVs), constitute a significant waste stream, which is estimated to generate over 10 million tonnes of waste in 2005 within the EU, projected to increase to 14 million tonnes by 2015¹.

The car recycling sector appeared decades ago. Historically the main interesting component from the recycling perspective of an ELV were metals, while other materials were not treated properly. High metal content which is easily recycled into secondary material through shredder operation leads to the fact that a recycling rate of about 70 -75% may be reached only by recovering metals. European countries started regulating car recycling sector in 1960s – 70s, when the problem of end-of-life vehicles abandoned in nature became notable. Scrap cars contain various environmentally hazardous substances and components such as oils, solvents, heavy metals, organic toxins and ozone depleting substances². If these substances and components are not treated properly and leak into nature, significant negative environmental and health damages can occur. Potential to improve conservation of material and energy resources along the lifecycle of a car, particularly in its end-of-life management was realised, and by 1990s, the need for harmonised Europe-wide legislation was acknowledged. The legislation has been adopted in the year 2000 and enforced since 2002. The main focus of the legislation is prevention of waste generation from ELVs and improvement of recycling and treatment practices. The latter includes material recycling and recovery targets, where the main challenge is put upon the remaining 25% of an ELV, which is non-metallic fractions: plastics, rubber, glass, liquids, and textiles. This challenge concerned reverting this waste stream from landfilling and better resource utilisation, while almost all these components have very good potential to be recycled as secondary materials or substitute fossil fuels in energy recovery.

Although the legislation has been in place for several years, in many ways ELV treatment is falling behind its requirements and presumably behind its actual technically and economically feasible potential. Voices are raised, particularly from the car manufacturers' side³ that targets set by the legislators are impossible to attain, in other words, that material recycling ambitions will not be implemented. The reasons for it as well as possibilities for improvement are worth exploring and understanding.

¹ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, p. 1

² Thomas Lindhqvist (2001) *Extended Producer Responsibility for End-of-Life Vehicles in Sweden - analysis of effectiveness and socio-economic consequences*, IIIIE Reports, Lund University, Sweden, p.9

³ M. A. Reuter et. al (2006) Fundamental limits for the recycling of end-of-life vehicles, *Minerals Engineering* 19 (2006), p. 433

1.2 Research questions

The aim of this thesis is to explore the current situation with end-of-life vehicles management in the European context with regard to the shortcomings in legislation enforcement, and identify the potential ways of catalysing improvements. Three main research questions are addressed:

- How effective is the legislation as a driver to bring about the necessary change to car recycling practices?
- What are the areas where car recycling sector falls behind its legislative, technological and economically feasible potential?
- How is it possible to improve these areas in ELV management?

In order to answer the main questions, a number of more specific issues were addressed:

- Who are the main actors in the car recycling sector and what are their interests?
- What constitutes a successful ELV management system?
- Does legislation contain necessary provisions for establishing a successful ELV management system?
- Which are the shortcomings that may be contained in the legislation itself?
- Which are the technological and market possibilities and limitations of car and its components recycling?

Understanding these issues should create a more comprehensive framework for analysing the situation in car recycling sector.

1.3 Methodology

The methodology followed in this research had two main components: stakeholder analysis and bottom-up approach. Stakeholder analysis implies that as a first step in the research, all stakeholders and actors are identified, and their respective roles are understood. When it comes to policy evaluation, stakeholder analysis is important, because policies and legislation are results of negotiation processes between the interested parties (stakeholders) and decision-makers/legislators who pursue certain objectives of the legislation. A bottom-up approach was chosen over pure policy evaluation tools and expert assessments to see and understand the on-ground practices in order to be able to draw conclusions about the effectiveness of policy measures and arrangements.

When it comes to the policy implementation and its prospects it is important to base the assessments and extrapolations not only on economic feasibility and technological development potential, but to take into account the actors who are going to be involved in the implementation; and, in this case, the companies in the ELV recycling chain, which includes collection, dismantling, reuse and preparation for recycling, shredding and further material recycling, monitoring and reporting of legislation compliance, and producers with regard to implementing the extended producer responsibility. Each of these areas are explored to an extent found relevant to the current and prospective developments in the sector. Current

practices are described based on field research, interviews and a literature review in order to identify the potentials that are not utilised, or the ways to optimise these practices. ELV management is viewed through the legislative framework: on both European and national levels.

The issues taken into consideration while conducting case studies in Sweden and Germany are: how the ELV Directive was transposed in the national legislation of respective countries; how the ELV management system is designed, particularly in which way the Individual Producer Responsibility (IPR) principle is implemented; how the recycling industry is organised; which are the practices in the whole car recycling chain; and how reporting and compliance monitoring procedures look like. Among the non-country specific questions addressed in this research are opportunities for improvement of the ELV management practices with regard to material recycling, among others: what are the constraints and opportunities in non-metal components recycling; what role is played by the producers; which opportunities are there in reuse; which implications are created by the current legislation, and which may arise from the upcoming revision of European framework waste legislation. Significant attention is also paid to reporting and monitoring, because when it comes to statistics the result always depends on how you count.

The choice of the case countries was influenced by physical accessibility (Sweden) and knowledge of the language (Germany). The practical part of the research required mobility and time, and therefore field work in Sweden turned out to be more elaborate and substantial, because more possibilities to arrange site visits were available. In case of Sweden, several dismantlers, spare parts resellers, shredder facilities, as well as specialised facilities (e.g. battery recycling facility) were visited. In Germany three companies representing dismantling and metal recycling businesses were visited. The questions and issues discussed with respective interviewees in both Sweden and Germany were consistent, making the comparison credible.

The main purpose of the interviews with companies along the ELV recycling chain was to follow step by step their everyday activities and practices regarding ELV treatment and reporting, as well as their opinions about legislation changes, cooperation (or lack of it) with car manufacturers, and situation in the ELV sector in general. The questions were following these lines, although interviews were not formally structured. From the combination of personal observations, analysis of literature and expert opinions, the attempt of evaluation and conclusions are made. The analysis of field work results are focused on common trends in the industry rather than country specific facts.

What makes this work different from more theoretical academic works on this subject is that it is based on primary data collected during the field work rather than on secondary sources, therefore helping to discard some myths and misconceptions about the ELV sector.

1.4 Scope

The broad scope of the thesis is on the current implementation of the European end-of-life vehicles (ELV) legislation, namely the Directive 2000/53/EC (ELV Directive), and prospects and challenges of its implementation in the near future. Following the lines of other academic works devoted to this sector⁴, areas of potential improvements in the ELV management are linked (but not limited) to the material recycling targets set by the ELV Directive. While optimisation and improvement of treatment practices will lead to most probable attainment of

⁴ For example P. Ferrao et. al. (2006), J. Gerrard et. al. (2005), R. Zoboli (2005) M.A. Reuter et. al. (2005)

current and prospective recycling targets. Within this wider scope, the practical side of car recycling is addressed as well as current and prospective legislation and its implications on the ELV management. While the challenges and difficulties of establishing an ELV management system as such is a significant issue particularly for the new Member States, the feasibility and appropriateness of design and organisational structure will be addressed only when relevant.

In order to limit the practical scope of the thesis, two case countries have been selected: Sweden and Germany. These countries are proved to be both the front-runners in compliance. Both countries have a long history of car recycling practices and legislative regulations, particularly in case of Sweden. Both countries possess well-established ELV management systems, have transposed the European legislation timely, and report full compliance with 2006 targets⁵. At the same time, both countries retained their own historically developed peculiarities in the system, which makes the two cases worth looking at. The rationale behind choosing two countries with well functioning and established ELV management systems is that they have presumably less organisational constraints in implementing the legislation compared to other EU Member States, particularly, new members. This eliminates concerns related to the start up of the ELV management system, and it is assumed that in these countries implementation and enforcement of the legislation have more generic rather than country specific constraints.

The feasibility of attaining the targets set by the Directive is not questioned in this thesis, and the legislation is taken for granted as something that was once adopted and shall be implemented and fulfilled. There is an opinion propagated particularly by car manufacturers that the environmental impact of car recycling is relatively insignificant if viewed from the lifecycle perspective, arguing that the use phase has the most environmental impact, and therefore the most reduction potential. This discussion remains out of scope of this study, which is focused on the actual potential to implement the existing legislation.

The automotive sector including the ELV management is recognised to be a highly politicised area⁶ where strong automotive and steel scrapping industries created influential lobby groups on different levels of decision-making process, but such issues will not be given much attention in this study due to limited reliable information available. It is worth mentioning that for this reason producers' point of view is presented through secondary sources and other actors involved in car recycling, and is well represented in sections concerning target attainment debate. ELV management is addressed from the points of view of organisational structure including interests and motivations of main actors, technological development and economic feasibility.

1.5 Limitations

An important limitation of the study is the choice of case countries, because practices observed may not be representative for other European countries. Also both Sweden and Germany are countries where automotive industry is an important player in the national economy, so further differences with countries where cars are not produced may arise. Both countries also employ the principle of individual producer responsibility, while in some

⁵ According to German Europäischer Wirtschaftsdienst GmbH Recycling and Waste Management Journal, in September 2008 the German Ministry of Environment reported 87% reuse and recycling rate achievement for the year 2006. [Online] www.euwid-recycling.com

⁶ Renato J. Orsato (2001), *The ecological modernisation of industry: Developing Multi-disciplinary Research on Organisation & Environment*, PhD Thesis, University of Technology, Sydney, p. 283

Member States without strong car industry a collective responsibility principle is applied (for example Portugal, Greece, the Netherlands)⁷. This may influence the course of analysis particularly when it comes to the discussion about extended producer responsibility. Nevertheless, as explained in scope definition, the author believes that trends rather than facts alone are more important in this study and trends are assumed to be similar due to European market integration and common legislative base.

Technology is widely addressed in this study, though the author lacks enough technical expertise to give a reliable assessment of technologies and their implications. One of the core issues in car recycling is non-metallic fraction recovery and recycling, and in this domain there is no consensus among experts about the technical feasibility of different recycling processes⁸. Therefore this issue is presented in a form of discussion, where points of view of different sides are presented, providing a competent reader with opportunity to build up own opinion. The conclusions drawn from the technology analysis may also be influenced by the fact that not all possible technologies were addressed; therefore some technology trends may be missed out.

Another limitation commonly mentioned when writing about the ELV sector is the lack of reliable information, particularly statistics and data from the recycling businesses. As observed during the study, the companies in the sector are on very different stages of information technology usage and reporting accuracy, as well as the statistics compilation may not precisely correspond with actual practices, rather with extrapolations and modeling. Therefore some information inconsistencies may also influence the discussion statements.

The course of field research which was focused on the recycling sector may create an impression of a biased approach in assessing interests and motivations of key actors, while information from dismantling and recycling sectors (except post-shredder) technologies is received through primary sources, while authorities and car manufacturers were addressed mainly through secondary sources.

1.6 Structure of the thesis

After this introductory chapter an overview of the main actors and key components of an ELV management system is given to assist understanding of the context. Existing legislative framework is analysed in relation to those key actors. Then the account of possible shortcomings or dubious issues of the current and prospective legislation is given with regard to possible impacts on the ELV sector. Particular attention is paid to the concepts of reuse, recycling, recovery and disposal. Framework Directive on Waste and its upcoming revision is analysed together with the ELV Directive. Finally the areas of concern for the current thesis are identified.

In the next chapter current technologies of treating ELVs and their components are described through compiling observations made during the field research and literature review. Special attention is paid to reuse as one of potential sources for reporting and compliance improvements. Aspects of non-metallic components treatment and recycling are also emphasised, where a number of unexploited possibilities seem to exist.

⁷ Paulo Ferrao et al., (2006), *Strategies for meeting EU end-of-life vehicle reuse/recovery targets*, Journal of Industrial Ecology, Vol. 10 Number 4, p. 79

⁸ See discussion in Section 3.5

In the following chapter the outcomes of field work conducted in Sweden and Germany are described, in accordance to the key components of the systems as identified in Chapter 2. The two countries are described separately, and differences between them are emphasised and explained where possible.

Chapter 5 combines the field work observations with different standpoints on the areas of concern identified, and the analysis of the shortcomings in legislation implementation and enforcement is made. Potentials available in car recycling sector which may open improvement opportunities are discussed.

Conclusions and recommendations related to this research are shared in Chapter 6.

2 On ELVs and their management

Annual generation of waste derived from ELVs in Europe is estimated to reach 10 million tonnes. Around 25 % of this waste is considered to be hazardous, which amounts to around 10% of the total hazardous waste generated each year in the EU. This waste stream is primarily landfilled⁹. Therefore ELVs constitute a significant waste stream, whereby treatment improvements will contribute to reducing a number of environmental concerns. Environmental problems related to ELV include not only the hazardous waste landfilling. Abandoned or improperly treated cars have significant negative impact on the natural environment due to land and groundwater contamination. Also poorly managed treatment and dismantling sites create risks of oil spillage and soil contamination.

The number of personal cars in Europe is still growing consistently at a rate of about 1.9 % annually for passenger cars¹⁰, and particular increase in numbers is expected in new Member States, which means that an effective ELV management system should be established in order to meet the waste generation that will grow in time. Due to the fact that cars consist of a lot of valuable materials such as metals, quality plastics and rubber there is a significant potential for those to be recycled and returned into the industrial cycle, therefore saving on raw materials and energy consumption. Some markets for recyclates are better developed than others, for example for steel scrap and other metals, but potential for material recycling or energy recovery exists for nearly all components. In the current chapter the overview of the main actors and key components of the ELV management system is presented.

2.1 Main Actors

ELV management system involves a number of actors who may be identified in the following way: *governmental authorities, car manufacturers, recycling businesses* and *consumers*. Governmental authorities are setting goals and regulate operations of other actors by the means of licencing, imposing legal compliance and reporting obligations and subsequent monitoring. Governmental authorities are represented by:

- authority responsible for overall implementation of legislation and reporting to the European Commission, usually this role is assigned to the equivalent of national Environmental Protection Agency;
- licencing and inspecting authorities that authorise and monitor dismantling and recycling companies, usually represented by regional or local environmental authorities;
- authority responsible for vehicles registration and deregistration, often road police or road administration.

Car manufacturers also include related component and material producers that constitute a production chain. This actor may be considered the most important, because ultimately the materials used in car manufacturing and eventually undergo dismantling and recycling are put there by the producers. Therefore producers have the most influence on ELV recycling in the

⁹ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p. 9

¹⁰ European Environment Agency, [Online] <http://www.eea.europa.eu/themes/transport/about-transport>

long run. Extended producer responsibility is meant to give producers an incentive to choose materials and construction methods with regard to dismantling and recyclability.

Recycling businesses include scrap dealers, dismantlers, shredders, waste management companies, metal and other recyclers. Generally the interest of these actors lies in recovery of valuable parts and materials from ELVs, which bring profit exceeding the treatment costs. At the moment those value adding components are used spare parts and metal contents of an ELV.

Consumers also play an important role because it is up to the owner of a car to decide if the car is delivered to an authorised dismantler for proper treatment. As discussed in Section 2.2.1, a number of incentives and/or requirements are used to ensure that consumers deliver ELVs.

In one of the early publications about ELV management system E. Rhydèn draws a matrix of actors in the car recycling sector dividing them into primary and secondary actors, and suggesting dynamic or static steering instruments that may be applicable to them, depending on whether the actors have static or dynamic interests. The matrix is presented in Table 2-1 below.

Table 2-1 Main actors in car scrapping and applicable steering instruments

	Primary actors	Secondary actors
Dynamic steering instruments	Car manufacturers	The suppliers of car manufacturers
Static steering instruments	Consumers	Dismantling and recovery industry

Source: Erik Rhydèn, 1995 “*Car scrap – throw it away? Or make it pay?*”, HIEE Research Report

Car manufacturers and their suppliers therefore are regarded as dynamic actors who are capable of bringing about a significant change in the system. Consumers and the treatment sector are regarded as static actors whose interest remains constant and determined by external factors. Primary actors are those who may influence the activities of other actors, while secondary actors have less initiative and potential for influencing the system. This analysis leads to a conclusion that conceptually car manufacturers are the most powerful actor in the sector, while the authorities have to find effective steering mechanisms to regulate them.

This is a sound conclusion, but a few modifications may be made to the analysis with regard to the experience of development of the system in the last years. Dismantling and recycling industry may be considered as a secondary, though dynamic actor. As mentioned above, the interest of this actor depends on the market situation, which is dynamic in itself and determines the value of different materials and cost of treatment and waste disposal. Changes in these parameters drive the actions of those businesses more notably than environmental standards regulations, which are an example of a static steering instrument. At the same time consumers are questionably considered as primary actors, because the consumer demand is only partially significant for car manufacturers when it comes to material composition of a vehicle. For the car recycling system presently consumers still may influence the system by their willingness to deliver ELVs to designated treatment facilities.

2.2 Key components of an ELV recycling system

A successful ELV management system is based on a number of pillars that are linked to its very objectives, namely (1) avoiding waste generation by design adaptation to facilitate recycling, and (2) improvement of ELVs treatment. Those components are effective collection of ELVs, authorisation of treatment facilities, functioning recycling industry that will allow processing the required number of ELV arisings, and extended producer responsibility. First three serve the objective of treatment improvement, and the fourth serves the primary objective of waste prevention. These components are discussed in the current section.

2.2.1 Collection

To a big extent the development of car recycling went in line with overall awareness and environmental knowledge establishment in the society. Historically in the 1970s the concern about waste end-of-life vehicles arose from the problem of cars abandoned in the nature¹¹. Therefore collection of end-of-life vehicles became a task for the legislators.

Effective collection is a cornerstone of successful waste management. Capturing the maximum number of ELVs into the system resolves the problem of cars abandoned in nature, avoiding uncontrolled negative environmental impacts. In order to ensure that ELVs are being collected, two main conditions should be fulfilled: the infrastructure of reception facilities should be in place, and the last owner or holder of a car should have the incentives for delivering it. The first requirement is dependent more on the market situation, i.e. business rationale of establishing stationary reception sites, or a pick-up based collection. Here, the number of ELVs and their market value are the key factors. The more value ELVs present and the bigger are collection rates, the more likely it is that a good infrastructure will be developed.

The second condition can be addressed in a number of ways, both of which are used by the public authorities and policy makers to stimulate collection. One component is the public awareness about the waste-related problems and wide availability of the information about what should be done with ELVs, where they should be delivered or collected, and what is to be done with them further. For this purpose information and promotion campaigns are organised, and information about collection points is made accessible through various sources. Other ways of stimulating last owners are administrative obligation to hand in the car supported by deregistration procedure that requires certification that the car has been handed over to an appropriate treatment facility. Financial incentives for handing in an ELV play a significant role in stimulating collection. In current ELV management practice last owners hand in their cars at least for no cost, in most cases they are also paid remuneration.

2.2.2 Authorisation of treatment facilities

Scrap metals from cars have been recovered and recycled for decades, but the treatment was far from being environmentally considerate¹². With growing number of ELVs and improved knowledge about environmental impacts the need to regulate the treatment sites and their operations in order to reduce negative impacts has gained importance. Hence the state authorities established systems to license and control and monitor the operations of treatment

¹¹ Erik Rhydèn (1995) *Car scrap – throw it away? Or make it pay?*, IIIIEE Research Report, Appendix 2, p. A-13

¹² Hans Zetterling (2006), *Car Dismantling 2006– Legislation and Environmental Law Handbook*, Sweden Safety Academy, p. 17

facilities to ensure they are conducted according to set environmental regulations through licencing.

Ability of authorities to enforce the regulations and make treatment facilities into a more transparent business is a decisive factor. The level of supervisory authority (municipal or regional), its expertise in environmental issues and frequency and thoroughness of inspections play a significant role. In some countries, for example Germany, independent certification companies are entitled to authorise treatment facilities.

2.2.3 Recycling sector

Developing markets for spare parts and metal scrap formed a car recycling sector as a chain where companies are interdependent, and have to maintain coherence in practices to ensure successful operations. Large scale recycling activities require an established and technologically developed industry sector. Car recycling today is an example of such established business, where such a chain of companies is formed. The structure of this sector is slightly different across Europe, but at the core the chain consists of dismantlers/scrap yards, waste management companies, shredders and recycling companies. Strictly speaking, only dismantlers (i.e. companies with core business in end-of-life vehicles) are working specifically with ELVs, while other companies in the chain have ELVs as one of the business areas. Still recycling companies, who collect and treat e.g. lead batteries or waste oils, play a significant role in completeness of the recycling process.

The major profit making centre in this chain remains with steel scrap, and therefore the sector is highly dependent on market price fluctuations. Relatedly, recycling of other car components (glass or recycled plastics) and recovery of spare parts for reuse also are closely related to the respective market situations, which has to be taken into account on a local and international levels. Once the market demands certain products, businesses respond to it more readily rather than to governmental regulations alone.

2.2.4 Extended producer responsibility

The most recent component in car recycling is introduction of the extended producer responsibility (EPR) principle. The logic of waste prevention and reduction at source together with allocation of physical, economical and legal responsibility for complex products at the end of their useful life to producers led to employment of the EPR principle as a socially fair measure to manage the ELV waste.

The idea of allocating physical, legal and economic responsibility for complex products throughout their life cycle to producers intended to provide constant and dynamic incentives to producers for incorporation of environmental concerns into the design of products. If producers are made responsible for end-of-life management of their products, it is assumed that related costs will be incorporated into the price of new products, and the more successful the producers are in reducing these costs by improving the design, the better they can compete on price. The EPR principle implementation sought to mobilise businesses to find the most clever and cost-efficient solutions, without much government interference¹³.

¹³ Reid Lifset, Thomas Lindqvist (2008), *Producer responsibility at a turning point?* Journal of Industrial Ecology, Vol.12, Issue 2, p. 144

Two models of extended producer responsibility for cars are applied in Europe: collective, where the system is designed to include all vehicles on the market and producers share the costs according to market share; and individual, where each producer is responsible for its own brands. Bearing responsibility should give producers enough incentive to adapt the design of vehicles in order to reduce waste generation and facilitate recycling. This is meant to be supported by the obligation to ensure environmentally sound (compliant with legislation) treatment and disposal of cars together with bearing costs related to their treatment.

Producers therefore should find a common ground with recycling businesses to fulfill these obligations. This is usually done by the scheme of contracting either individual scrapping companies, which is a more time consuming process; or by contracting a group of dismantling and recycling companies that form a readily available network that covers certain regions or countries. These networks are coordinated by industry associations (both car manufacturing and recycling) or individual recycling companies, for example one of such networks is coordinated under Stena Recycling AB in Sweden. These contracts are value neutral, when transferring obligations and responsibilities is assumed to be of mutual benefit. In practice it means that the dismantlers/network take the responsibility of accepting the ELVs of a certain brand for no cost to the last owner without generating any financial flows between the contractors.

It is observed though that existing car recycling activities with current levels of treatment are financed out of the positive resale value of parts and scrap metal¹⁴, and does not require any additional financing from producers' side. Moreover producers are trying to keep the ELV management at zero cost for them. Consequently, it is questionable whether extended producer responsibility functions at its full potential.

In the following section the current European legislation will be reviewed and analysed as applied to the main actors.

2.3 Legislative requirements: Directive 2000/53/EC on end-of-life vehicles

The concern about ELV derived waste arised in early 1970s after a rapid growth in number of personal cars, and related growth in ELVs generation. Many European countries started regulating ELV sector and developed their own legislation (for example Sweden in 1975/1997, the Netherlands in 1995, Germany in 1998). On the European level, ELVs have been included in the list of priority waste streams in 1990. Under the requirement of the EC Community Strategy for Waste Management adopted in 1989, the ELV Project Group was established in 1991, in order to explore technical and policy options. The group included a wide range of stakeholders and industry representatives¹⁵. Present legislation is a result of four years of negotiations on the European level. The initial Proposal for a Directive was presented by the European Commission in 1997 using results of the ELV Project Group's work as contribution, but the final version was adopted by the European Parliament and Council in September 2000, requiring all member states to transpose it into national legislation by 2002.

¹⁴ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p.108

¹⁵ Nawon Kim (2002), *Exploring Determinant Factors for Effective End-of-Life Vehicle Policy*, IIIIEE Thesis, Lund, p. 18

Current European legislation is represented by the Directive 2000/53/EC¹⁶ as amended by Directive 2008/33/EC¹⁷.

The Directive, which is the first adopted under the priority waste streams programme, has set the main principles and requirements for a more environmentally sound end-of-life vehicles management. The requirements laid out in the Directive are mandatory for each member state and may only be strengthened or elaborated within national legislation. The main objectives of this legislation are: (1) prevention of waste from ELVs, which mainly concerns improvements in design with regard to recycling and eliminating hazardous components; (2) reuse, recycling and other forms of recovery of end-of life vehicles and their components to: reduce the disposal of waste, as well as improvement in the environmental performance of all of for collection and treatment facilities, which includes attainment of quantitative targets for materials reuse, recycling and recovery. The purpose of this section is to give an overview of what the legislation actually requires from the main actors and stakeholders.

These quantitative targets for materials reuse, recycling and recovery were set in two steps: 80% reuse and recycling and 85% reuse and recovery to be achieved by the year 2006, followed by their increase up to 85% reuse and recycling and 95% reuse and recovery in the year 2015. The targets are significant in a way that they are set by far at higher levels than similar targets in Directives devoted to other waste streams (e.g. packaging, WEEE). There are a few reasons for this: first of all, the automotive market is considered to be well regulated, with each car being registered, and the number of producers limited and known, therefore monitoring and control are supposed to be easier than on more diverse markets. Secondly, recovery of metals from waste vehicles has been an already established business in virtually all the countries, and since the metal content of ELVs to-date is estimated at around 75 - 76%¹⁸, this level of material recycling was assumed accomplished under business as usual scenario; thirdly, the composition of cars is well known and relatively similar among different producers, so it is potentially easy to apply recycling technologies and methods once they are in place.

Therefore, the challenge of the quantitative targets concerns only non-metallic components and represents 5% (reuse and recycling target for 2006), and 10% (reuse and recycling targets for 2015) of the total car weight. These figures correspond to respectively 25% and 50% of the rest non-metallic components of a car¹⁹, mainly polymers and rubber. This figure is based on the rough estimation that an ELV consists of 75% metals, 5% of waste will be allowed for landfill, and 20% is the rest non-metallic waste, half of which should be recycled by 2015. Put in this context, recycling targets are seemingly comparable to the ones set by other directives. Still by 2006 not all European countries reported target compliance, and a stakeholder consultation report commissioned prior to revision of the 2015 targets, which according to the clause 7.2(b) of the Directive was required to happen by the end of 2005, revealed the opinion that 2015 targets are hardly achievable. Despite the stakeholder pressure was put on the legislators, targets were left intact.

¹⁶ OJ L 269, 21.10.2000, p. 34 - 43

¹⁷ OJ L 81, 20.3.2008, p. 62 - 64

¹⁸ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p. 10

¹⁹ DG Environment, ASSURE (November 2005), *Stakeholder consultation on the review of the 2015 targets on reuse, recovery and recycling of end-of-life vehicles*, Final Report, p. 13

It is acknowledged that a lot of difficulties were faced by the Member states on the way of implementing the legislation²⁰, which extended beyond recycling targets attainment and includes stipulating all the key components of the ELV management system described above. The technical and organisational constraints and shortfalls of building up a well-functioning management system will be addressed in Chapter 3, while here the legislative implications will be explored.

The key requirements of the ELV Directive will be analysed in relation to the actors they are addressed to. The key issues of the Directive will be presented in their order of appearance. The language of the Directive mentions three main actors: *Member States*, *producers* and *economic operators* (which include producers), but are in some cases specified otherwise as for example “authorised treatment facilities” or “shredder”. This doesn’t exactly fit with the main actors description given above which is based on the real sector situation. Inclusion of producers together with recycling businesses into the same category as opposed to governmental authorities makes sense on the legislative level, but may cause ambiguities when the responsibility within *economic operators* needs to be separated between producers (due to Extended Producer Responsibility implementation) and recyclers. Still these definitions are used in this section not to mislead the interpretation of the Directive.

In the Preamble the Directive states the necessity to harmonise the national measures in order to minimise the impact of end-of life vehicles on the environment; and to ensure the smooth operation of the internal market and avoid distortions to competition by creating a common EU framework. The Preamble mentions that the overall responsibility for implementation of the measures lies with the Member States that have to ensure other operators fulfilling the legislation requirements. The Preamble also states the need for plastics recycling improvement; preservation of competition and access for small and medium size enterprises in collection, dismantling, treatment and recycling markets. It also underlines that producers should ensure that vehicles are designed and manufactured in a way that allows the quantified targets for reuse, recycling and recovery be achieved. To this end the European Commission is required to establish European standards and take other necessary measures in order to amend the pertinent European vehicle type-approval legislation.

Article 1 lays down the objectives of the Directive, which are: (1) prevention of waste from ELVs; (2) reuse, recycling and other forms of recovery of end-of life vehicles and their components to: reduce the disposal of waste, as well as improvement in the environmental performance of all of the economic operators. So, the objectives indicate the main actors who are required to improve their performance: *producers* and other *economic operators*, and Member States who have to ensure this improvement.

Article 2 sets the definitions. *Producer* is defined as “vehicle manufacturer or the professional importer of a vehicle into a Member State”; *economic operators* are defined as “producers, distributor, collectors, motor vehicles insurance companies, dismantlers, shredders, recoverers, recyclers and other treatment operators of end-of-life vehicles, including their components and materials”. This latter definition is very broad, and encompasses virtually all types of businesses that may be related to ELV treatment, and the use of this term in the Directive where unspecified indicates that the governmental authorities can choose to implement the requirements of the Directive by influencing different players in the business sector. Definitions of reuse, recycling and recovery are addressed separately in Section 2.5.

²⁰ European Parliament Committee on the Environment, Public Health and Food Safety, March 2007, *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, Summary

Article 4 lays down the measures aimed at prevention of waste from ELVs. The overall responsibility is assigned to Member States using the language of “shall encourage” when it refers to the producers who should limit and reduce the use of hazardous substances in vehicles from the design stage, employ the principles of Design for Dismantling and Recycling. “Shall ensure” is used when referring to elimination of the use of lead, mercury, cadmium and hexavalent chromium in vehicle components other than listed in the exemption list in Annex II, therefore indicating a stricter requirement for eliminating certain components.

Collection measures are listed in Article 5 where the responsibility is assigned also to the Member States, in a way that they have to “take necessary measures to ensure” that:

- economic operators set up systems for the collection of all end-of life vehicles and, as far as technically feasible, of waste used parts, and the adequate availability of collection facilities within their territory;
- that all ELVs are transferred to the authorised treatment facilities; that the system of Certificates of destruction issuance is established; that there is no cost for the last owner of ELV when it is delivered to the authorised facility;
- and that producers meet all or a significant part of the costs related to free take back. Hence the collection system should be set up and operated according to these requirements by the economic operators who should also bear the cost of it.

Article 6 uses the same language for Member States “shall take necessary measures to ensure”:

- that treatment facilities are compliant with the relevant technical and environmental requirements laid down in this Directive and in the Waste Framework Directive (Directive 75/442/EEC) by establishing authorisation bodies and conducting annual inspections;
- treatment facilities are required to fulfill a number of obligations in their operations: ELVs should be stripped before treatment; components that contain hazardous substances and heavy metals referred in the Article 4(2) must be removed and collected separately;
- stripping operations and storage shall be carried out in such a way as to ensure the suitability of vehicle components for reuse and recovery, and in particular for recycling.

In Article 7 paragraph 1 mentions the hierarchy of treatment that is to be encouraged by the Member States: reuse of components that are suitable for reuse, recovery of components that can not be reused and giving preference to recycling when environmentally feasible. Paragraphs 2(a) and 2(b) set reuse and recovery and reuse and recycling targets to be achieved by economic operators by 1 January 2006 and 1 January 2015 respectively. Member States have the responsibility to ensure their implementation. Paragraph 7.2(b) also states that the European Commission shall establish the detailed rules necessary to control compliance of Member States with the targets set out in this paragraph, and it should be done in the year 2002. A detailed study has been undertaken in this area²¹, and in 2005 Commission Decision

²¹ Ökopol - Institut für Ökologie und Politik GmbH, September 2002 *Rules on compliance with Article 7.2 of Directive 2000/53/EC*

2005/293/EC²² laying down rules on the monitoring of the reuse/recovery and reuse/recycling targets was adopted. First year for which the reporting form was applied is 2006.

Article 8 requires producers together with material and equipment manufacturers use component and material coding standards to facilitate identification of components suitable for reuse and recovery; and provide dismantling information to the treatment facilities for each type of new vehicle put on the market. Producers are also obliged to make the information concerning dismantling, storage and testing of components that can be reused to the authorised treatment facilities upon request.

Article 9 sets reporting requirements for Member States that should report on implementation of the Directive to the European Commission in three-year intervals. Based on these reports from Member States the Commission should publish a common report. Such report was commissioned by the European Parliament in 2007²³. “Relevant economic operators” are also obliged to publish information on:

- the design of vehicles and their components with a view to their recoverability and recyclability;
- the environmentally sound treatment of end-of life vehicles, in particular the removal of all fluids and dismantling;
- the development and optimisation of ways to reuse, recycle and recover end-of life vehicles and their components;
- the progress achieved with regard to recovery and recycling to reduce the waste to be disposed of and to increase the recovery and recycling rates.

In the Annex I the minimum technical requirements for storage and treatment sites (treatment facilities), the necessary treatment operations for depollution of end-of-life vehicles are listed as following:

- removal of batteries and liquefied gas tanks,
- removal or neutralisation of potentially explosive components (e.g. air bags),
- removal and separate collection and storage of fuel, oils, cooling and other liquids,
- removal of all components containing mercury.

Paragraph 4 lists treatment operations that have to be undertaken in order to promote recycling:

- removal or catalytic converters,

²² OJ, L 094 , 13/04/2005 P. 30 - 33

²³European Parliament's Committee on the Environment, Public Health and Food Safety, (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*

- removal of metal components containing copper, aluminium and magnesium if these metals are not segregated in the shredding process,
- removal of tyres and large plastic components (bumpers, dashboard, fluid containers, etc), if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials,
- removal of glass.

The Directive therefore is addressed first of all towards the Member States who should “encourage” and “ensure” the implementation of its provisions and requirements by “taking the necessary measures” that have to be harmonised across the EU. Member States should be assisted in this task by various standards and procedures adopted on the European level. In practice the overall responsibility of national authorities for implementing the requirements of European legislation means that a national legal framework have to be established and enforced.

Economic operators also have a number of requirements addressed directly to them. More descriptive and definite requirements are set towards the treatment operators, setting the minimum environmental standards and prescribing treatment methods. More indicative requirements are directed towards the producers, who are only given directions: to limit, to eliminate, to take the costs for free take back, without pointing at actual measures. This leaves the Member States a degree of flexibility on how to enforce these requirements, but also may create loopholes in enforcement.

In the coming two sections issues that may have negative or limiting impact on the legislation enforcement and implementation will be addressed and analysed, starting from the implications of present and upcoming European legislation, and followed by wider view on the issues where legislation is lacking enforcement.

2.4 Legislation related implications

There are a number of issues within the current and upcoming European legislative framework that regulate the ELV management that may have negative implications on its actual enforcement and implementation. One is related to a certain degree of in clarity with how the reuse, recovery and recycling are identified across the legislation, others may come from the soon to be updated Waste Framework Directive. These issues are analysed below.

2.4.1 Definitions of reuse, recovery and recycling

Before starting a technological discussion about the recycling practices and targets, it is important to understand what exactly is meant when we speak about *reuse*, *recovery*, *recycling* and *disposal*. The aim of this section is therefore to give an overview of a legal understanding of the terms. Since the scope of this study lies within Europe, European legislation is taken as a reference starting from a more general to specific level. The primary legislative source here is the Directive 2006/12/EC on waste (which is the amended version of Directive 75/442/EEC), so called Waste Framework Directive (WFD). This Directive sets definitions of *waste*, *recovery* and *disposal* operations. All three definitions are presented in form of listing the categories of materials/operations. Definition of waste moreover sets the condition that a substance or a product is considered waste in case the “holder discards or intends or is required to

*discard*²⁴. Hence the condition of intention is implied. Both *recovery* and *disposal* operations are listed in form of possible practical operations with different degree of precision, and when mentioned in other pieces of legislation, these terms are referenced in the WFD, Annex II A and II B respectively. *Recycling* and *reuse* are mentioned in the WFD, but not given a specific definition. These terms are defined in each specific Directive. Different forms of recycling are listed as forms of recovery along with energy recovery, oil re-refining and other operations.

WFD also contains a defined waste treatment hierarchy²⁵, where prevention or reduction of waste is given the highest priority, being followed by material recovery and energy recovery. Member states are required to promote these waste treatment options over disposal. Prevention includes cleaner technologies, more efficient resources use, together with reducing environmental impact of products along their life cycle: design for environment, reduction of hazardous substances use, design for recycling. Recovery in this context includes material recycling, reuse or reclamation²⁶. Energy recovery from waste is listed separately. This in my opinion creates certain confusion, because e.g. reuse²⁷ is not defined in the current WFD at all, and it is unclear what kind of reuse is given priority in the waste treatment hierarchy, whether it is prioritised over material recycling. At the same time, by definition recovery includes energy recovery, and the directive does not give a direct indication of prioritising material recycling over it. In other words, the term *recovery* used in the WFD is broad and leaves room for uncertainties and different interpretations.

As mentioned above, *reuse* and *recycling* are defined in the individual Directives, and applied to this study, in the Directive 2000/53/EC on the end-of-life vehicles (ELV Directive). These definitions are clearer. Reuse implies that “*components of an end-of-life vehicle are used for the same purpose for which they were conceived*”²⁸. Recycling means “*reprocessing...the waste materials for the original purpose or for other purposes but excluding energy recovery*”²⁹. Taking these definitions into account, we can clearly understand which operations are considered in the ELV legislation. Consequently, what we are speaking about here is that the target for “*reuse and recycling*” includes reuse of ELV components together with material recycling, i.e. extracting secondary raw materials; while target for “*reuse and recovery*” includes the above plus energy recovery. Incineration without energy/heat recovery may not be included in any of the two categories, while it is defined as a disposal operation under the WFD.

2.4.2 Revision of the WFD

For the last three years the WFD is undergoing a revision. As a result of which the language of Directive will be significantly changed. Currently the discussions in the European Parliament are finalised and the compromise document adopted in the Parliament is awaiting its adoption by the Council. The official text therefore does not exist yet, since it is expected to be published by the end of 2008. Information in this section is obtained through position papers of different stakeholders, documents published on the official site of the European Parliament and a presentation held by an expert who was involved in negotiations. The text referenced

²⁴ OJ L 114, 27.4.2006, p.10

²⁵ Two steps hierarchy in the 2006 version, which is usually presented as three-steps: prevention, recovery, disposal. But the Directive itself doesn't mention disposal while listing the hierarchy.

²⁶ OJ L 114, 27.4.2006, p. 11

²⁷ Reuse in the ELV sector is addressed in more detail in Section 3.2

²⁸ OJ L 269, 21.10.2000, p. 36

²⁹ OJ L 269, 21.10.2000, p. 36

here as it is presented in Position of the European Parliament adopted at 2nd reading on 17 June 2008³⁰.

If the compromise document is adopted by the Council in its present state, the WFD will be changed completely. The objectives for revising the Directive were, among others, to simplify and clarify the existing legislation, to promote the “recycling society” with improved resource efficiency, to give more detailed definitions, and to set the minimum waste treatment targets to be implemented by 2020³¹. Revision will also have a major impact on the ELV legislation in the near future, because the revised WFD is to be transposed by the Member States into national legislation after 2 years from adoption, which most likely means the end of 2010. So, here I will give an overview of the amendments and additions that are going to affect the ELV Directive, leaving out other issues with no less importance but less relevance to the topic of this study.

The definitions part is going to be much more elaborate and precise. Definitions of *recycling*, *reuse* and *preparation for reuse* are included, therefore compiling all relevant terms in one piece of legislation. *Recycling* (Article 3.17) still excludes energy recovery, but includes mentioning of the reprocessing of organic materials. The term *reuse* (Article 3.13) is defined exactly the same as in the ELV Directive, although the new term *preparation for reuse* (Article 3.16) is introduced, and implies: “*checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they will be re-used without any other pre-processing*”. This term describes exactly the activities of a dismantler/scrap dealer who dismantles reusable spare parts from an ELV. Therefore this formerly undefined activity is now mentioned in the legislation. Further implications of introducing this term come from the newly formulated waste treatment hierarchy, which now contains five distinct steps described in Article 4.1: a) prevention; b) preparing for re-use; c) recycling; d) other recovery, e.g. energy recovery; and e) disposal. Article 11 also contains requirements to Member States to “*promote the reuse of products and preparing for reuse activities, notably through encouraging the establishment and support of reuse and repair networks, the use of economic instruments...*”, which may be interpreted as providing support to used spare parts dealers and encouraging secondary spare parts market. Therefore, unless stated otherwise, spare parts dismantling and reuse will be prioritised over material recycling according to the revised Directive.

Another important issue is introduction of so called “*end of waste criteria*” for a number of materials in Article 6.1, such as aggregates (e.g. polymers), paper, glass, metal, tyres and textiles, i.e. virtually all of ELV’s components. According to this concept, materials should not be called waste any more if they have undergone through recovery/recycling operations and meet the following criteria:

- have a common use for specific purposes;
- there is existing market or demand for these materials;
- materials fulfill purpose specific technical requirements and meet the existing legislation and standards applicable to products; and

³⁰ European Parliament, The Legislative Observatory. [Online] <http://www.europarl.europa.eu>

³¹ Caroline Jackson, “New waste targets to be attained by 2020 as deal set to be approved,” http://www.europarl.europa.eu/news/expert/briefing_page/30708-168-06-25-20080603BRI30699-16-06-2008-2008/default_p001c005_en.htm

- the use of the materials does not have adverse environmental or human health impacts.

It is quite straightforward that the majority of recyclable components of an ELV, particularly metals, fully match these criteria, and along these lines Article 6.3 and paragraph 23 of the Preamble state that once waste reaches these end-of-waste criteria, it should not be considered as waste for the purpose of the recovery and recycling targets set out in *inter alia* in the ELV Directive. Materials that ceased to be waste should be accounted for as recycled and recovered components. In the context of the ELV directive it still sounds confusing, because targets for recycling and recovery are separated, so potentially this (and the whole end-of-waste concept) leaves a lot of room for flexibility in compliance reporting. It would be beneficial to distinguish in the legislation whether materials that meet end-of-waste criteria will be accounted for as recycled or recovered. The assumption would be that they should be considered as recovered, because the end use of some components may be energy recovery.

Coming back to the definition of recycling (Article 3.17), that now mentions reprocessing of organic materials, it also lists operations that it does not include in the original proposal from the European Parliament³² such as “*energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations*”. This list originally included also “*processes involving combustion or use as a source of energy, including chemical energy*”, leaving no chance to any type of incineration without energy recovery be accounted for as a recycling activity. This was proposed mainly because in some technological processes, plastic components are being incinerated in blast furnaces and are claimed to add their carbon content to the final product (steel alloy), which is called chemical energy recycling or thermal recovery³³.

Recycling sector, particularly in Germany, where this process is accounted for as recycling, raised concerns and called for a lobbying influence, claiming that this “narrow” definition will make recycling industries “never be compliant” with 2015 targets³⁴. But since in the compromise document adopted later lacks this part of the definition, it may allow this operation be reported and accounted for as a recycling operation, hence artificially increasing the recycling target reporting.

As shown above, the current revision of the WFD may have significant impact on the ELV legislation and practices particularly in the part of calculating targets and reporting compliance opening up opportunities for accounting for more material recycling than is fulfilled in reality, and by diverting major streams of recycled materials off reporting by applying the end-of-waste. On the other hand, all these effects are likely to occur in case the current Directive 2000/53/EC (as amended by Directive 2008/33/EC) will not be revised to incorporate all the changes and mitigate all the uncertainties such as for example identifying the role and position of “preparation for reuse” in the treatment procedures and hierarchy; and employ the end-of-waste criteria in a way that will reflect the actual recycling practices, and will not mislead the compliance reporting.

³² European Parliament, The Legislative Observatory, [Online] <http://www.europarl.europa.eu>

³³ Paulo Ferrao et al., (2006), *Strategies for meeting EU end-of-life vehicle reuse/recovery targets*, Journal of Industrial Ecology, Vol. 10, Number 4, p. 84

³⁴ Europäischer Wirtschaftsdienst GmbH Recycling and Waste Management Journal, (April 2007), *Uncertain future for ELV recycling with new WFD definitions*, [Online] <http://www.euwid-recycling.com>

2.5 Areas of concern for this thesis

There seem to be a number of deficiencies in how the legislation is enforced and implemented. Some of them are related to the broad or uncertain definitions and to possible flexibilities in the reporting procedures as discussed in the previous section. Other issues related to technological and organisational sides are discussed below. The statements made here will be further tested in the following chapters where the practical side of ELV recycling sector is described based on the field study observations.

The primary objective of the legislation is the prevention of waste deriving from ELVs, and according to the principle of early source reduction, the measures for waste prevention should be taken at the stages of car design and manufacturing by reducing the use of hazardous materials, the diversity of materials and heterogeneity, ensure that components are easier to dismantle and recycle – all these requirements are mentioned in the Directive. This should be taken care of by the producers and is included in the concept of extended producer responsibility. Still prevention measures do not seem to be enforced enough to make a significant difference.

Car manufacturers provide information and conduct trials and recycling related projects for their new models. However, due to low affiliation between producers and the dismantling sector on the one hand, and on average 15 years delay from the time a new models enters the market to the time it is scrapped, this information flow is not well channeled. Another possible reason of a lack of motivation from car producers' side is due to the fact that in practice ELV management, although formally included into the area of producer's responsibility, remains no cost for them. It is determined by the current market situation, but may change in the near future.

The Directive clearly states the treatment hierarchy, which implies that reuse and recycling are to be preferred, where reuse (with regard to environmental and health standards) is on top of the hierarchy. Nevertheless reuse has not been paid enough attention as a preferential treatment method, the reason for which may be a certain degree of reluctance from the car manufacturers to stimulate the second hand market of spare parts, while this is a significant profit making activity for them. On the contrary, car manufacturers create barriers for this market in a way of warranty rules, where the warranty remains valid only when the car is treated in the authorised service centre.

Low non-metallic components recycling rates, which in many countries do not reach even the 2006 recycling targets is another area of concern. Since from the beginning the challenge of the targets was directed towards non-metallic components, the legislation contains everything that allows the development in this area. Articles 6.3(c) and 7.1 clearly indicate the priority of recycling and the requirement to conduct the dismantling operations in such a way to ensure that components are suitable for further recycling. The requirements for coding and standardisation are also supposed to contribute to improvements in dismantling. In turn Annex II gives a clear indication of what has to be removed from the ELV prior to shredding, and it includes glass and plastic components, but the language in the Annex leaves the flexibility which is widely used: it says that these components (except for glass) do not necessarily have to be dismantled if post shredder recovery is used. The modern shredder facilities are usually equipped with different types of post shredder separation, and a common practice for dismantlers is not to strip off plastic or non-ferrous metals components. Another implication here is that it seems to be a widely acknowledged opinion in the literature that dismantling is less economically feasible than developing post shredder technologies, and

therefore the focus of the studies is on the latter³⁵. Nevertheless it seems to be slightly more complicated when it comes to practices and market structure, and this statement is not taken for granted in this research.

A common complaint among the experts and scholars who write about ELV management and recycling is lack of credible primary data and information, because despite the set reporting obligations, the procedures and reporting lines differ among the Member States. Statistical calculations are based on formulas with a few figures taken from practice (e.g. CODs issued) and other figures are assigned as averages. Also a common complaint is about different interpretations of treatment methods in Member States, although according to the legislation they have to be harmonised.

All these issues seem to be significant distortions to adequate implementation of the legislation and ensuring the establishment of an ELV management system with improved recycling performance. In the next chapters these distortions will be further explored by addressing ELV treatment practices; and the areas for improvement and possible mitigation opportunities will be suggested.

³⁵ Paulo Ferrao et al., (2006), *Strategies for meeting EU end-of-life vehicle reuse/recovery targets*, Journal of Industrial Ecology, Vol. 10, Number 4, p. 79

3 Technical aspects of ELV treatment

3.1 Material composition of an ELV

The main components of a car are: ferrous metals – around 68%, non-ferrous metals particularly aluminium – 8%, plastics and polymers – 10%, tyres and glass – around 3% each³⁶. During last decades two clear tendencies in car manufacturing were observed: cars became heavier (from an average weight of 887kg in 1980 to 1,000kg in 2000 in Germany) and larger, but at the same time producers tend to use lighted materials to improve fuel efficiency and driving performance, therefore steel component is constantly decreasing (from 78% in 1980 to 57.5% in 2000)³⁷. This trend is expected to continue, with estimations that the average weight of an ELV in the EU will increase from 951kg in 2004 to 1,025kg by 2015³⁸.

The main change in composition of the future ELVs is an increased share of plastics by weight, rising from approximately 95kg (10%) per ELV to 120kg (12%), and by 2015 an average ELV will consist of 9% non-ferrous metals, 12% plastics and 65% ferrous metals³⁹. It is worth mentioning that rest 14% will be constituted from rubber, glass, textiles and other materials that currently are not recycled at the full scale.

3.2 Reuse in ELV sector

Applied to ELVs reuse means dismantling and reselling used parts of the vehicle, be it large components such as engines and chassis, or hulk parts, or smaller parts up to light bulbs and power cables. Although the targets set in the ELV Directive are called “reuse and recycling” and “reuse and recovery”, in practice reuse is not accounted for based on actual practices. It seems almost impossible to keep track of what is actually being sold on the secondary market and reused when it comes to reporting outside one company, and reuse quotas are excluded from the reporting lines towards national authorities. Therefore reuse of the ELVs may deserve more attention than it is given at the moment.

Spare parts for cars are traditionally the value adding business for car manufacturers, and they are very concerned about this “unauthorised” second-hand market. Although the system of new spare parts distribution is very well established and functioning in Europe through the network of dealerships and authorised service centres, and almost any part can be delivered very quickly (e.g. within 48 hours within Mercedes Benz network⁴⁰), the price of the services and parts is so high, that car owners often prefer to revert to the second-hand market. It applies in particular to the owners of older cars (and it is known that the lifetime of a car in Sweden, for example, is 17 years⁴¹).

³⁶ J. Gerrard, M. Kandlikar, (2007), *Is European end-of-life vehicle legislation living up to expectations? Assessing the impact of the ELV Directive on 'green' innovation and vehicle recovery*, Journal of Cleaner Production Vol. 15, p.18

³⁷ T. Reinhardt, U. Richers, (2004), *Entsorgung von Schredderrückständen – Ein aktueller Überblick*, Wissenschaftliche Berichte, Forschungszentrum Karlsruhe, p. 19

³⁸ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p. 9

³⁹ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex III, p. 1

⁴⁰ Interview with Henrik Lykke, Senior Manager of Parts division in Daimler Chrysler Sverige and Danmark November 2007.

⁴¹ Hans Zetterling (May 2008), *Skrotbilar - ett miljöproblem*, Presentation

Due to this market situation, a separate type of business has arisen in the ELV sector: companies focused on reselling spare parts and components dismantled from ELVs. It is important to note that all primary receivers of ELVs from last owners, municipal authorities or insurance companies dismantle and resell spare parts, but to a very different scale, as all of them eventually sell certain amount of hulks for shredding, still there is a significant difference in the operations of these *first tier*⁴² companies. Some generalisations from the field work findings are discussed below, while some particular characteristic features observed in case countries will be mentioned in respective sections.

The first tier in ELV management is commonly addressed in the literature, and is not differentiated. Nevertheless, there are two main types of businesses differentiated by the main focus of activities and accordingly, main source of profit. There are variations across this sector, but I believe it is a useful generalisation to describe those two types. The first type is usually called a *scrap yard*: its main business is delivering ELVs from the last owners to the recycling plant (shredder facility), and consequently, the main source of profit is the price of a hulk as paid by the purchaser. The second type is often called *car dismantler* or *car recycler*, with the main business activity of reselling spare parts, which is also the main source of profit. To make the description comparative, main characteristics of the two types are summarised in the table below.

Table 3-1 Two types of dismantling businesses: generalisation

Criteria	Type 1: Scrap yards	Type 2: Spare parts resellers
Scale	Small or medium sized: 200 – 400 ELVs per year; but may vary from a few dozens to thousands ELVs per year, present the majority of companies in number ⁴³	Medium to large scale: 500 – 3000 ELVs per year. Comprise smaller percentage of companies on the market.
Equipment	Basic equipment requiring mainly manual work: one dismantling/depollution station, forklift truck; may not have an indoor workshop.	Several dismantling stations, more complex equipment with automation; indoor workshop with various tools; computer based accounting and registration systems.
Personnel required	Some companies are run by one person, usually the owner; but usually two to five people are employed, depending on the scale.	More than four people, up to fifteen, depending on scale. Usually at least one staff member is doing administrative work.
Dismantling	Spare parts are not dismantled until required by the customers; smaller, dismantlers allow customers to come on site and take the parts off themselves, as in the supermarket; other mandatory depollution and dismantling is done according to the requirements from a recycling company ⁴⁴ .	Some spare parts that are in constant demand or suffer from being kept outdoors are dismantled, registered, marked and kept in the warehouse; other bigger parts are identified and marked while kept inside the hulk. Once demanded, these parts are dismantled by the personnel, the customers are usually not allowed to use the workshops or their own tools. Mandatory depollution and dismantling is also done according

⁴² This term is used further on to identify the primary receivers of ELVs: car dismantlers and scrap yards.

⁴³ Number of ELVs processed is counted based on the CODs issued by the company. Eg. In Sweden (2006) 77% of authorised dismantlers issued less than 150 CODs per year. (Hans Zetterling (2006), *Car Dismantling 2006– Legislation and Environmental Law Handbook*, Sweden Safety Academy, p. 15)

⁴⁴ Here legislation compliance is assumed by the recycling company.

Criteria	Type 1: Scrap yards	Type 2: Spare parts resellers
		to the recycling company requirements.
Time spent on ELV	Time to perform the mandatory depollution and dismantling varies from 20 minutes to 2 hours, depending on the car model ⁴⁵	Time needed for performing mandatory depollution and spare parts checking/dismantling and registration is estimated up to one man-day, depending on car model.
Receiving ELVs from	Cars are received mainly from private last owners: individuals or companies. Cars are old, and therefore the potential of reselling spare parts is limited.	Due to the main profile of the companies they are interested in newer cars rather than ELVs, and apart from private last owners they often have contracts with insurance companies that deliver cars after accidents and municipal parking authorities. Remuneration ⁴⁶ paid to private owners is often higher, which helps attracting more customers.
Personnel training	No specific training required apart from manual mechanical skills acquired and developed through practice.	Work requires better knowledge of spare parts and models, computer skills (including digital cameras) for keeping databases, in addition to mechanical skills.
ICT usage	May have no computers in the office, telephone/fax communication with authorities and customers.	All or most of the operations are digitalised, computer based record is kept for transactions and spare parts; electronic communication with customers and authorities; access to national registration databases; commonly a regularly updated website.
Transparency	Less possibilities of transparent accounting and tracking because no (or limited) record is kept for the spare parts reselling and other transactions. The most reliable sources of information are CODs and material/financial flows registered according to the contracts with recycling and waste management companies.	More possibilities for transparent accounting due to full or nearly full computer registration of all transactions, formal contracts not only with recycling/waste management companies but also with logistics operators, insurance companies; payments are registered, and often credit cards are accepted; official contracts are often made with other companies for replacement of used parts, e.g. engines, that are being exchanged via shipping.
Profit distribution	A rule of thumb is profit distribution of 30% to 70% with high steel scrap prices (10% to 90% with low steel scrap prices) for spare parts/scrap for Type 1, and reverse scrap/spare parts for Type 2.	
Reporting accuracy	Reporting accuracy is limited to CODs issuance, and tonnes of scrap and wastes delivered to contractors.	Potentially reporting may be extended to accounting for number of spare parts sold, in addition to amounts of scrap and wastes delivered to contractors.
Networking	Can be members of respective industry associations, but do not see good reasons for wider cooperation and active participation.	Usually members of respective industry associations, have a more proactive position in networking and cooperation with other companies; create common spare parts online databases to increase convenience to customers and therefore

⁴⁵ According to dismantlers, the newer the car is, the more time it takes to dismantle.

⁴⁶ The remuneration sum depends mainly on steel scrap market price and the condition of the car, decided for each car individually. Although the amount paid is varies significantly according to local conditions such as competition.

Criteria	Type 1: Scrap yards	Type 2: Spare parts resellers
		create stable demand.
Relation to producers	Depending on the national arrangements, these companies may have mediate or no relation or affiliation with car manufacturers.	These companies are more notable by car industry, and often there is a direct contact and in some cases these companies act as contractors for fulfilling the obligation of free take back.
Advertising	Advertisements are placed in conventional and online Yellow pages; no resources are available for further advertising; customers have to contact via phone to find out spare parts availability or purchasing conditions.	In addition to Yellow pages advertising, these companies are often visible in industry journals and associations websites; dismantlers who have contracts with producers bear their logos also for advertising purposes. Information about spare parts in stock (often with digital pictures), shipping rates and conditions is available online on their own websites or wider (national or regional) databases.

According to the data presented in the table, Type 1 is a conventional understanding of how dismantling sector operates, and a lot of criticism has been put upon it in literature⁴⁷ which reiterates some myths about this sector as “junk business”, operating at low environmental profile, poorly organised and often illegal. According to what was observed during the field study, these are indeed myths. All dismantlers are equally subject to environmental requirements and monitoring procedures due to authorisation process, so Type 1 companies should ideally be complying with them, in order to retain the license. What they lack – is proactive environmental and business approach, which is unlikely to appear mainly because of absence of any additional financial and human capital resources.

Type 2 companies succeeded to move towards more service-based business and are better adjusted to modern customer service conditions. Many of those companies present proactive environmental attitude, some are ISO 14001 certified or ready to be certified if their contractors require it. These companies have better potential to be transparent and cooperative with authorities, and are easier to control because of their visibility, relatively small number and large scale of operations. But at large, there is almost no difference in how the ELV is being treated in dismantlers of both types.

Still, development of second hand spare parts business and stable demand on this market creates opportunities for leakages in the system. It is worth mentioning, that companies of both types may have extensive cooperation with spare parts exporters (often to African countries) who are almost impossible to control. The range of exported parts is wide – from engines and body parts to used tyres. These leakages appear on an early stage of dismantling, and although do not have a major impact on overall market situation, harms the image of the sector.

⁴⁷ Nawon Kim (2002), *Exploring Determinant Factors for Effective End-of-Life Vehicle Policy*, IIIIEE Thesis, Lund University, Sweden p.15

3.3 Treatment process

So, what happens with a car when its owner decides it is not worth keeping in the garage any more? The standard fate of a Western European end-of-life vehicle will be described here. The owner brings it to the dismantler or straight to the scrap yard. If the owner would like to deregister the car himself, he needs to make sure that the dismantler or a scrap yard gives him a certificate of destruction (COD) which will be presented as an evidence for the registration authority. CODs may be issued only by the dismantling companies authorised under the national rules that include environmental criteria. In many cases though, the car is being sold to the dismantler or scrap yard, with ordinary transfer of ownership. This happens mainly when the car is not too old and has a potential of being repaired and resold. In this case once the car is destined to be scrapped, the dismantling company has to deregister the car before it gets out of its gate.

Figure 3-1 Car dismantler's yard



At the dismantlers workshop or in the scrap yard the car is being assessed whether it is possible to recover worthy spare parts from it, and if it is considered valuable, the parts are either dismantled on the spot, or most commonly, the car is put in the yard, where it will wait for customers to come and ask for the parts it contains. Cars stay in the yards until parts are considered to be in demand, and also depending on the profile of the

dismantling company. The difference between the two types of car scrapping businesses is described in the previous section.

But before the car turns into the “donor” role, it undergoes some necessary procedures. All the liquids – fuel, oils, antifreeze, windscreen cleaner, etc. - are being drained off, and normally collected in separate tanks. The wheels and tyres are being dismantled, and the battery is taken off. According to the requirements of the ELV Directive oil filters, parts containing lead, mercury and other heavy metals should be dismantled too. This process is called depollution. Also the catalytic converters are cut off on this first stage because they have a significant value due to rare metals and have an established recycling market.

All the substances and components removed during the depollution process are taken care of by waste management companies that have to ensure that the components are treated according to the standards.

Figure 3-2 Depollution station



Once the car is no more useful as a “donor”, it is being sold to the metal scrapper, and eventually ends up in the shredder facility. Some cars are being pressed or bailed prior to being transported to the shredder others are collected as almost untouched shells. This depends solely on logistical arrangements and the cost of transportation, which is done by trucks. Car bodies are shredded together with different kinds of other wastes,

mainly ferrous metal scrap. From the field experience ELVs constitute between 10 and 20% of the shredded load.

Shredder facilities are trying to buy ELVs only from the authorised and well operating dismantlers, because proper depollution of the vehicle is essential for the safety of the shredder operation. In cases when gasoline or other igniting substances are left inside the car body, major fires and explosions are possible that may terminate shredder’s operation for days and cause significant economic losses. So, more trust is put on the authorised dismantlers, because on site of the shredder facility the means to control what is inside the ELV are limited to visual observation by the feed-in truck operator. Capacity of shredder facilities may differ significantly, but most commonly shredders take around 150,000 to 200,000 t of scrap per year, which corresponds to about 2,500 horsepower (HP) engine power (e.g. in Germany the largest shredder has 6,000 Hp engine).

Figure 3-3 Shredder facility



When an ELV is shredded, the residue is usually separated into four fractions: ferrous metals (using magnetic separation), non-ferrous metals (using mechanical separation), heavy shredder residue and light fraction, which is separated by air suction. Ferrous metals are not being processed further, and are considered ready to be shipped away as they

come out of the shredder. This type of scrap is either sent directly for export or used in steel smelters.

Non-ferrous metals may also be sold straight away, or alternatively pure aluminium and copper components (mainly from induction coils) are further recovered from reprocessing the residues. Light and heavy shredder residues are a mixture of all the materials that remain after metals are recovered and consist of different kinds of plastics, rubber, composite materials, textiles, wood. The distinction into light and heavy fractions is made by the means of separation.

Light fraction is separated by air suction and contains smaller particles. Its end application depends on the technology used in the shredder facility – it may be just lighter fractions of mixed materials that become waste, and may be grinded into small pieces and used further in e.g. landfill construction. Heavy shredder residue consists of bigger pieces of materials, and may still contain some non-ferrous metals. Different sorts of heavy and light shredder residues are shown in Figures 3-4, 3-5 and 3-6, 3-7 respectively. There are a number of alternatives for treating mixed shredder residues, which will be addressed later in this chapter, but the purpose of treatment can be: to recover leftover metal components; to separate plastic or rubber components for further recycling or energy recovery.

Figure 3-4 Heavy fraction of shredder residue (1)



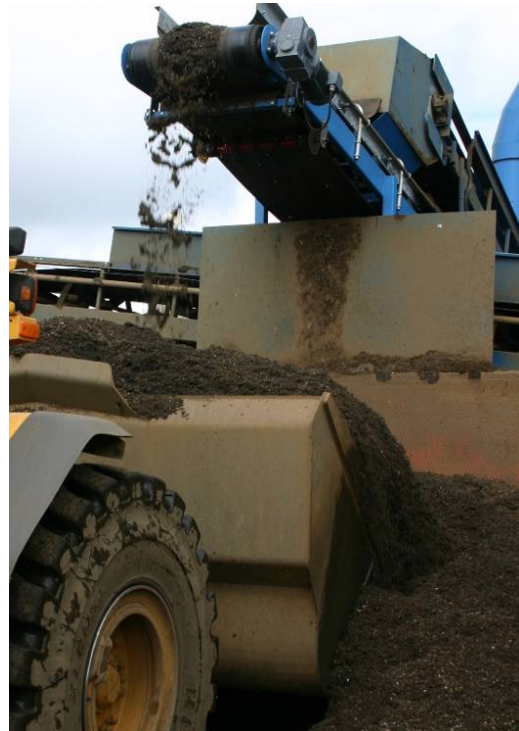
Figure 3-5 Heavy fraction of shredder residue (2)



Figure 3-6 Light fraction of shredder residue (1)



Figure 3-7 Light fraction of shredder residue (2)



The constraint towards improvement of mixed fractions recycling is that since ELVs are shredded together with other scrap, the composition of the non-metallic residue is very diverse and at the same time contaminated with metals, chlorine and other chemicals. Heavy shredder residue has a very high calorific value, because it mainly consists of organic matter (plastics, rubber, textiles, wood), but contamination makes it less suitable even for use as fuel for the industries that would otherwise be interested in uncontaminated organic materials. The readily possible option is Municipal Solid Waste incineration plants, but their capacities and availability are limited.

More detailed accounts of current and developing technologies of mixed fractions of shredder residue (light and heavy) is given in Section 3.5. Treatment of other separate ELV components is discussed in the following section.

3.4 Recovery and recycling of ELV components

Batteries

Treatment of waste batteries is regulated by the Directive 2006/66/EC, and their producers and importers are obliged by the EPR principle to take care of their end-of-life. In every country there is a battery collection system set up, and car batteries usually are easier to collect than smaller types. Car batteries are collected by service stations, auto repair shops and dismantlers and transported to a recycling plant by a waste management company. For example in Sweden, collection is administered by Returbatt, a fund, whose mission is to coordinate collection of lead-acid batteries in Sweden and the recycling of lead, and which

collects fees from the producers for each battery put on the market⁴⁸. There are a few lead acid batteries recyclers in Europe, and one of them is located in the South of Sweden.

Recycling process of lead acid batteries is technologically not complicated. The batteries are crushed in a sealed area whereby the acid is drained away, which is then collected and treated in the onsite wastewater treatment plant. After batteries are drained they are fed into a furnace where lead is remelted and plastic adds its carbon content to the combustion process. Energy from this technological process is valuable enough to be recovered for example for district heating, but it is not always done.

Batteries are reported as recycled as a whole by weight, excluding only the weight of sulphuric acid (H₂SO₄) content. This means that plastics are included in the reporting as also recycled, but according to the definition, plastics are being disposed of (incinerated) if energy recovery is not taking place. It may be described in the future as chemical energy recovery with regard to amended WFD.

Tyres

Tyres are another type of waste that is regulated on the European level by a number of waste related Directives and is subject to extended producer responsibility. Since the middle of 1990s (for example in 1994 in Sweden, in 1995 in Finland) tyre manufacturers started establishing extended producer responsibility schemes where a non-interest fund is collected and managed by the clearing company. Recycling is financed from these funds, which collect a charge for every tyre put on the market, both manufactured and imported.

It took several years to develop a well functioning system of tyre recycling, although they consist of valuable components and are almost fully recyclable. Landfilling used to be a common disposal method in many countries. From 1992 to 2005 the rate of tyres being landfilled decreased from 62% to 22%⁴⁹. Legislative requirements encourage reuse and recycling of tyres also by banning landfilling of tyres from the year 2006 through the Directive 1999/31/EC on the landfill of waste.

There are a number of treatment options. Retreading which is an environmentally preferable option⁵⁰, reuse as a whole, for example in landfill construction, as noise barriers or dock fenders. Granulating/shredding is a basis for almost all reuse applications, shredded tyres are used in road construction, sports grounds surfaces, carpet underlay. Granulate has also the widest market compared to other material recycling options. Tyres are also very suitable for energy recovery because of their high calorific value. They may either be incinerated directly e.g. in cement kilns, or undergo pyrolysis, whereby oil, solid carbon and steel are recovered. Other technologies include gasification, cryogenic fragmentation, de-vulcanisation⁵¹ among other developing but not yet fully commercialised methods.

A significant part of waste tyres is exported from Europe to less developed countries for example in Africa. There is no exact statistics on how many tyres are exported.

⁴⁸ Returbatt, *Battery Collection in Sweden*, [Online] <http://www.batteriinsamlingen.se/>

⁴⁹ European Tyre Recycling Association: *Trends in tyre recycling*, [Online] <http://www.etra-eu.org/>

⁵⁰ *Warmer Bulletin* Issue 95, May 2004, p.16

⁵¹ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p.16

Metals

Metals are the least problematic when it comes to recycling. Both ferrous and non-ferrous metals are being recovered through shredder operation. Metals recycling business is well functioning, there is a growing world market for metal scrap and although prices are constantly fluctuating, they remain relatively high throughout last years. Despite this dependency on market fluctuations, metals are the main value adding components of the ELV recycling for scrap yards and shredders.

Glass

Glass is one of the components that is required to be dismantled prior to shredding, but in practice it is hardly done. Glass is being broken by forklifts when transporting an ELV or when the hulk is crashed prior to shredding, so some of it gets lost on the way, some ends up in heavy shredder residue. Still some dismantlers perform separate collection of glass. Manual dismantling of glass takes a lot of time, and the most effective method of dismantling is to cut it out⁵².

There are a few constraints towards developing automotive glass recycling. One is the mentioned economic inefficiency because of low market value of recovered material, relatively small quantities of glass in individual dismantlers to be handled, the cost of working time required for dismantling. Other constraints are technical: automotive glass is impure and contains toughening additives and laminate, so can't be taken to remelting with other types of clear glass, and requires separation according to type, and further treatment. But although glass recycling is not seen as an economical activity, is stipulated by the ELV Directive, and formally not recovering glass is a breach of legislation.

Liquids

In case when depollution process is conducting according to the standard fuels, various oils, brake liquid, coolants, air conditioning system fluids and other liquids contained in an ELV are supposed to be collected separately at the first stage of an ELV depollution. Gasoline is usually directly reused as fuel, oils and other hazardous liquids are being handled by the waste management companies. Waste oils are usually reused as fuel in power generation, heavy industries, but the most environmentally preferable option is re-refining waste oils for reuse as lubricants⁵³. Oil from dismantled filters can also be recovered, and some companies use technologies that allow oil filters recycling rate to be up to 90%⁵⁴ including both metal components and oil, for example *RagnSells AB* in Sweden.

3.5 Non-metallic components recycling

It is widely recognised that targets set by the ELV Directive are ambitious, and if 2006 targets are possible to attain without changing the existing shredder technologies and practices, 2015 targets will require significant changes. Target of 85% reuse and recycling is achievable primarily through recycling of metals (76%), tyres (3%) recovery and recycling of fluids (2%)

⁵² Hans Zetterling (2006), *Car Dismantling 2006– Legislation and Environmental Law Handbook*, Sweden Safety Academy, p. 110

⁵³ DG Environment, GHK in association with Bio Intelligence Service, (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p. 18

⁵⁴ RagnSells AB, *ReUseOil: Recovery of used oil filters generating recyclable metal and oil fractions*, EC co-financed project. [Online] http://www.ragnsells.se/upload/3695/ReUseOil_eng.pdf

and batteries (1%). Together this makes 82%, where the remaining 3% may be reached through energy recovery of combustible components of shredder residue or material recycling. Higher rates e.g. in the Netherlands are achieved primarily through intensive dismantling of ELVs⁵⁵.

3.5.1 Target attainment discussion

It is clear that under business-as-usual scenario, with landfilling a significant part of materials, higher targets are not attainable. Shredder technology has definite limits, as was shown, for example, by the full-scale shredder experiment conducted in Portugal, where even by applying extensive mechanical (manual) separation the recycling rate of 80,3% was achieved. Authors of the experiment concluded that 2015 targets represent a real challenge to all the actors involved in car recycling sector⁵⁶.

Since the issue in question is recovery and recycling of the non-metallic components⁵⁷, there are two options recognised: either larger plastic components will be dismantled prior to shredding and then subject to separate recycling process; or more advanced post-shredder technologies are required⁵⁸. The second option is given priority in the literature, while it is believed that dismantling is a too expensive option due to high labour costs. This may be true, but it is difficult to have a well-grounded comparison of costs that will include externalities. And the first option is more preferable from the point of view of waste hierarchy, where prior dismantling will equal prevention by reducing the mixed non-recoverable waste generation. There are controversial opinions about preferability of the two approaches. Referenced above EC consulting report states that dismantling will not contribute much towards achieving higher recycling targets, because according to Automobile Recycling Netherlands (ARN) 85 – 86% recycling rate is a ceiling for dismantling based practices. It suggests that increase in recycling rate is expected only from recovery of energy and materials in post-shredder processes, prioritising energy recovery⁵⁹. European Environmental Bureau (EEB) suggests a combination of post-shredder treatment and dismantling as a more successful strategy⁶⁰.

Among the post-shredder treatment technologies both increase in energy recovery and co-combustion, as well as mechanical separation are advocated. For example, the stakeholder consultation report harshly promoted dismissing the 85% material recovery target for 2015 as unachievable, suggesting instead to restrict landfilling of shredder residue and leave the recovery target of 95%, which implies that 15% would go through energy recovery⁶¹. European Environmental Bureau criticised this statement claiming that this point of view is

⁵⁵ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p.22

⁵⁶ Paulo Ferrao et al., (2006), *Strategies for meeting EU end-of-life vehicle reuse/recovery targets*, Journal of Industrial Ecology, Vol. 10, Number 4, p. 91

⁵⁷ The term *non-metallic components* is used to refer to both material recycling of plastics and other means of treating mixed shredder residue fractions, e.g. energy recovery of all combustible components.

⁵⁸ Paulo Ferrao et al., (2006), *Strategies for meeting EU end-of-life vehicle reuse/recovery targets*, Journal of Industrial Ecology, Vol. 10, Number 4, p. 83

⁵⁹ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p.24

⁶⁰ European Environmental Bureau (20th July 2006), *EEB comments on report produced by GHK and BIOIS (June 2006) to investigate the costs and benefits of the potential 2015 targets for re-use, recycling and recovery of End-of-life vehicles*, [Online] <http://www.eeb.org>

⁶¹ DG Environment, ASSURE (November 2005), *Stakeholder consultation on the review of the 2015 targets on reuse, recovery and recycling of end-of-life vehicles*, Final Report p. 35

advocated by car producers, and the proposed scheme will not go beyond current technological possibilities, which means that there is no incentive for implementing Design for recycling principles. EEB also draws a number of counterproofs such as growing market for plastic recyclates, limited energy recovery capacities and strengthening requirements for flue gases that will affect incinerators⁶².

Producers are subject to the requirement⁶³ that all cars put on the market after 15 December 2008 should be compliant with the recycling and recovery targets. For example, new Volvo S80 is presented as 85% recyclable, where 75,6% is accounted for metals and the rest for thermoplastics, liquids and glass⁶⁴. This notably requires changes in today's practices, but the producer just says that material recycling requires specific infrastructure and market, without suggesting any ways for improvement. Other producers, e.g. BMW, conduct experiments to prove the recyclability of their cars, but the methods they are using are not the same as would be used in reality. Recyclers comment it by expressing a concern that "if producers will deliver their own numbers and results, they will always achieve their targets"⁶⁵.

As a matter of practice, plastics, rubber, textiles and composite materials end up in shredder residue, which is left after metals are recovered. A common term is used to define it, when it comes to issues of non-metallic components recycling and post-shredder technologies - the Automotive Shredder Residue (ASR). In practice the ASR does not exist as a separate stream due to the mix of wastes and scrap that is shredded together with ELVs. Theoretically or on the experimental level, to create ASR the cars should be shredded separately, but in practice it is not feasible for shredders, while the percentage of ELVs in the mix range from 10 to 30%. Hence is it also questionable whether experimental developments of post-shredder technologies for ASR will be exactly matching the currently employed practices.

At the moment mechanical separation (e.g. flotation) of lighter combustible materials (plastics and rubber) for further energy recovery is most commonly used in shredder facilities. This technology is not sufficient for separating these fractions for material recycling. In some cases mixed waste fraction is entirely landfilled, although some degree of further treatment, e.g. plastics separation may be an economically feasible activity. But keeping in mind the actual composition of mixed fraction and the scale of activities, it is questionable whether post-shredder plastics separation will be technically and economically feasible in current conditions. An issue outside the actual cost and technology is the scale of shredder plants – the majority of them are not big enough for establishing another separate installation for mixed fraction reprocessing.

3.5.2 Overview of post-shredder recycling technologies

A number of technologies for recovery of mixed shredder residue exist and are developed at the pilot stage. Two main directions of those treatment technologies are: aimed at recovery of combustible components for energy recovery, and aimed at further material recovery and reprocessing, mainly of plastics. Eight of these technologies are described in the report to the

⁶² European Environmental Bureau (15th November 2005), *EEB brief comment on the stakeholder consultation process on the review of the 2015 targets on reuse, recovery and recycling of end-of-life vehicles in Directive 2000/53/EC and the final report of 4 November 2005*, [Online] <http://www.eeb.org>

⁶³ Directive 2005/64/EC on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability, OJ L 310/14, 25.11.2005, p. 10 - 27

⁶⁴ The Vehicle Component (1/2008) *Recycling needs infrastructure*, p. 12

⁶⁵ Nordisk Bilättervinning (2/2008) *Report from International Automotive Recyclers Congress 2008 in Munich*, p. 9

European Commission on exploring costs and benefits of the implementing higher recycling targets set by the ELV Directive performed by GHK in association with BioIS⁶⁶. These technologies have been developed by recycling companies alone or in cooperation with car manufacturers. Some technologies were already at industrial operation stage by the time the report was compiled, such as Galloo, Sult, R-Plus and Twin-Rec, others (VW-Sicon, Reshment, Citron and SVZ Schwarze Pumpe) were at development stage. A summary of these technologies is given in Table 3.2 below. The information given in the report is updated with today's data where possible.

Reshment technology was developed by CTC Umwelttechnik of Switzerland. An agreement had been made with The Swiss Auto Recycling Foundation to build the first plant for treatment of shredder residue in Switzerland. However this agreement was not implemented, and presently there are no plants applying this technology. Therefore this technology was excluded from the list presented here.

The **SVZ Schwarze Pumpe** (Sekundaerrohstoff-Verwertungszentrum Schwarze Pumpe GmbH) pilot plant used the slagging-bed-gasifier process to carry out "feedstock recycling". This process uses high-temperature gasification of waste materials, including shredder residue, to produce a synthetic gas and a vitrified slag. The gas is used for the large scale production of base chemicals such as methanol, ammonia and formic acid. The slag produced by the process can be used as road undercover, dyke barriers and cavity filling in mines⁶⁷. But as explained on the company's website, in 2007 due to changed market conditions, the company displaced the majority of its production. At the moment the plant is operating as a waste-to-energy facility, but the company claims to be working on other development projects⁶⁸.

R-Plus recycling GmbH was based in Eppingen, Germany. The company had one shredder and post-shredder plant. R-Plus process treats shredder residue mechanically by sifting and density separation. Three fractions are produced: metals (ferrous, non-ferrous, copper), which are sold on the secondary materials market, mineral fraction (sand, glass etc), which is used in the construction industry, and an organic fraction which is used as feedstock for energy recovery or chemical processes⁶⁹. Presently the plant in Eppingen belongs to a giant recycling concern ALBA GmbH, and has turned to processing mainly electronic waste⁷⁰.

Sult is a technology employed in recycling plants in Japan. The process treats shredder residue and other wastes mechanically. The waste is separated by sifting and density separation, similarly to the R-Plus technology. The organic fraction is separated into plastics such as polyurethane and polypropylene and recycled. The remainder of the organic fraction is used as feedstock in an electric furnace. The metal fraction can be sold for recycling, the sand fraction is used as sanitary landfill cover, slope filling or in road construction⁷¹.

⁶⁶ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex III

⁶⁷ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex III p.23

⁶⁸ Sustec Schwarze Pumpe GmbH, [Online] <http://www.svz-gmbh.de>

⁶⁹ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex III p.13

⁷⁰ ALBA Wertstoffmanagement GmbH & Co. KG, [Online] <http://www.alba.info>

⁷¹ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex III p.11

Galloo is an old shredding company that has now diversified into metal and plastic recycling in addition to ELV dismantling operations. Presently it has six centres for ELV treatment, four shredders and one plastics recycling plant, and more sites with different specialization located in France, Belgium and the Netherlands⁷². The technology used is a multi-step process for the treatment of ELV and other metallic wastes from shredding to post-shredding with sorting of heavy fraction. In the current process, cars are de-polluted and dismantled before being shredded. Plastics recovery produces granulate, which is sold to producers of plastic components. 60% of the plastics produced are sold to car manufacturers for production of new spare parts⁷³.

CITRON was started by a Swiss company in 1997 as a project to build recycling facilities for a wide variety of heavy metal containing wastes. The first industrial plant was put into operation in August 1999. The plant is located in the port of Le Havre, the largest container port in France. The principal technology is the Oxyreducer process undertaken by a rotary hearth furnace. It includes the following steps: heating and pyrolysis of the organic compounds; reduction of the metallic oxides to pure metals; high temperature separation of Zn, Cd, Hg from the Iron-, Cu- and Mg fraction; oxidation of the process gases as well as the re-oxidation of Zn⁷⁴.

TwinRec is a thermal technology developed by the Japanese company EBARA. It is based on fluidised bed gasification in combination with ash melting and combines material recycling with energy recovery. The technology is successfully used in more than 15 installations in Japan, but so far in Europe there are no TwinRec plants in operation. The TwinRec gasifier, besides detoxification of the organic material, separates the remaining metals and large inert particles from the combustibles and fine ash, maximising total metal recovery from ELVs. The combustible gas and fine char are used to vitrify the ashes and fine particles turning these into a recyclable, inert construction material. The excess energy is recovered with a steam for heat and power generation in a steam turbine. It is suggested that recycling percentage can be further increased by recovering Zn, Pb and Cu from the secondary fly ash, which will result in reducing the amount of landfilled shredder residue to less than 5%, pumping the total recycling and recovery of the ELV up to 99%⁷⁵. The combined thermal capacity of TwinRec installations in Japan is over 370MW⁷⁶.

VW-SiCon is maybe the most successful technology developed so far. It has the widest application in already built and currently constructed plants in Europe, and has been awarded with the “European Business Award for the Environment” by the European Commission in 2006⁷⁷. VW-SiCon process was developed by the Volkswagen AG in cooperation with SiCon GmbH in 1999. It includes the mechanical treatment of shredder residue from end-of-life vehicle recycling while at the same time considering the specific requirements of the customers buying the products generated by the process. By means of process steps including crushing, screening and separation, based on physical parameters such as density, grain size,

⁷² Group Galloo, [Online] <http://www.galloo.com>

⁷³ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex III p.9

⁷⁴ Citron SA, [Online] <http://www.citron.ch>

⁷⁵ Adrian Selinger et. al., (2003), *TwinRec - Bridging the Gap of Car Recycling in Europe*, International Automobile Recycling Congress March 12 - 14, 2003, Geneva, p. 9

⁷⁶ EBARA Environmental Engineering Corporation, (2007) *TwinRec Reference List* [Online] <http://www.ebara.ch>

⁷⁷ Volkswagen Group [Online] <http://www.volkswagen-umwelt.de>

magnetic saturation, electrical conductivity and optical characteristics, more than 95% of the shredder residue can be recycled into usable products. During mechanical treatment, the following main fractions are produced: shredder granules (hard plastics, rubber); shredder fibres (foams, textile fibres); shredder sand (glass, rust, iron particles, heavy metals)⁷⁸. The innovation process is ongoing, with current developments of recovering some pure plastics out of shredder granules. It is done by the means of a special solvent named CreaSolv® that removes a particular type of plastic from the granulate: the polyolefins used to make air filter housings, shock absorbers and side panels. CreaSolv® process can also separate any toxins with which the polymer may have come into contact during shredding. This technology is believed to allow reaching the overall recycling rate for ELVs to over 90%⁷⁹.

It is important to note the economically feasible scale for these technologies. The analysis presented in the report and actual capacities of plants in operation suggest that there are significant economies of scale associated with these technologies. The estimation in the report is that economic feasibility starts from 100,000 tonnes of wastes treated and is optimised at about 200,000 tonnes per year⁸⁰. It means that with a very rough figure of 200 kg shredder residue output from one ELV, one full-scale plant operation will require collecting shredder residue from 500,000 to 1,000,000 ELVs.

⁷⁸ SiCon GmbH [Online] <http://en.sicontechnology.com>

⁷⁹ Fraunhofer Institute for Process Engineering and Packaging IVV (November 2007) [Online] <http://www.ivv.fraunhofer.de>

⁸⁰ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex III p. 4

Table 3-2 Summary of post-shredder technologies

Name of Technology /Developer	Type of Technology	Level of Technology Development	What is being processed	Approximate Outputs from Process	Overall Rate of RRR (%)	Recycling Rate (%)	Indicative Gate Fee (EUR per tonne of ASR)
VW - SiCon	Mechanical separation	Several operating installations and a number of plants under construction.	Shredder residue and mixed scrap	Shredder granulates 36%, shredder fibers 31%, metals 8%, wastes 26%	74	74	20 - 50
Galoo	Mechanical separation	Operating plants in Belgium, France and the Netherlands	Light and heavy shredder residue fractions	Recycled plastics 9%, metals 30%, refuse derived fuel 13%, wastes 48%	52	39	Not available
Sult	Mechanical separation	Operating plant in Japan	Shredder residue and other wastes	Organic (plastic) 50%, minerals 20%, metals 10%, water 20%	100	80	100
R-Plus	Mechanical separation	Operating plant in Germany	Shredder residue	Organic fraction 60%, metals 5%, minerals 35%	100	100	90
Citron	Thermal treatment - oxyreducer	Operating plant in France	17 different types of waste including shredder residue	Ca Fe concentrate 45%, Zn concentrate 4,3%, Hg 0,7%, wastes 50%	50	50	100 – 200 (excluding energy recovery)
				Plans to recover wastes	100	100	
TwinRec	Thermal treatment – gasifier	Operating plants in Japan	Metal scrap, shredder residue	Metals 8%, glass granulate 25%, recovery 52%, wastes up to 15%	85	33	120 - 200
SVZ Schwarze Pumpe	Thermal treatment – gasifier	Industrial trial plant (?)	Mixed wastes including shredder residue	Synthetic gas 75%, metals 8%, wastes 17%	87	8	Not available

Source: adapted from DG Environment, GHK in association with Bio Intelligence Service, May 2006, “A Study to examine the costs and benefits of the ELV Directive”, Final Report, Annex III p.5

4 ELV management practices: cases of Sweden and Germany

4.1 Sweden

The car industry is Sweden's most important export sector, accounting for more than 15 % of total Swedish exports in 2004 with 290,400 cars manufactured in Sweden itself. Of all cars on the road Volvo is the most common brand with 1,200,000 cars produced, followed by Volkswagen with 500,000 cars and Saab with 440,000⁸¹. The total number of passenger cars in use is growing steadily at the rate of about 1% annually. In the year 2006 number of personal cars on Swedish roads was 4,207,000⁸². The number of cars deregistered and scrapped peaked in the year 2001 at 304,214 cars, and fluctuates since then around the figure of 250,000. In 2007 the number of scrapped cars under 3,500 kg was 248,683⁸³.

4.1.1 Main actors

The responsible governmental authority is the Swedish EPA - Naturvårdsverket, which is entitled to report to the European Commission about the implementation of legislation on the national level. The registration and deregistration of vehicles is under the authority of the National Road Administration - Vägverket, which is a point of contact to dismantlers and car scrappers when they report deregistration of an ELV and issuance of a COD. The licencing authority is County Administrative Board – Länsstyrelsen, which operates on the regional level. A direct supervisory authority over dismantlers and recycling companies are Municipal Environmental Inspections - Kommuns Miljöförvaltningen. The inspections are conducted once a year.

The car industry is strong in Sweden and is represented by two main personal cars brands: Volvo and Saab. Other producers present on the market are importers. All producers are organised in an industry association - BIL Sweden which plays a very important role in cooperation between producers, recycling businesses and government authorities, in particular by taking a major role in implementing extended producer responsibility principle and negotiating with recycling sector.

The recycling sector in Sweden is particular: there are three companies operating in the metal recycling sector which are Stena Gotthard/Stena Recycling AB, Skrotfrag AB and Kuusakoski AB. Out of 8 metal shredding facilities 4 are operated by Stena which illustrates the market domination. A number of waste management companies along with other divisions of Stena offer all services related to collection and treatment of tyres, waste oils and wastes. There is also a lead batteries recycling plant operated by Boliden Bergsjö AB, which recycles all car batteries from Swedish and a significant part from neighbouring markets. The industry association of recycling businesses - Recycling Sweden, is not an active player in the car recycling sector.

⁸¹ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p. 49

⁸² Vagverket registration statistics (2007), [Online] <http://www.vv.se>

⁸³ Vagverket deregistration and scrapping statistics (2007), [Online] <http://www.vv.se>

The car dismantling sector is clearly divided into the two types of businesses described in Section 3.1. There are in total around 400 car dismantling companies registered, but around 100 firms perform almost no activity, while on average companies treat between 400 and 2,000 ELVs per year⁸⁴. A few larger firms receive up to 3,000 ELVs annually. More than 130 dismantlers and scrap dealers are now united in a *Refero* network coordinated by Stena. This network was created in cooperation with Bil Sweden as a response to changes in the legislation introduced in 2007 with a purpose of helping producers fulfill their legal obligations to establish a nation-wide collection network. Consequently, producers find it more convenient to sign one contract covering the whole country, but simultaneously one company gets a significant preference on the market. For dismantling companies the practical value of participating in this network is limited to wider information dissemination through *Refero* website, and the majority of firms in the network belong to Type 1 dismantling companies.

Another industry association in dismantling sector is Sveriges Bilskrötares Riksförbund (SBR – Swedish Car Scrappers National Association), which unites around 150 companies. All these firms are active and majority of them may be classified as Type 2 dismantling businesses. SBR has its own certification system, which is based on ISO 9001 and 14001 requirements, and around 30% of its members are internally certified. Under the SBR 70 bigger companies created a cooperation called *LAGA* (which currently includes 86 companies), with the primary purpose to present the interests of those companies during negotiations with contractors, such as waste management and recycling companies. For example, *LAGA* members have a common fixed rate they are paid by Stena for metal scrap, which is higher than for individual contractors. In turn the *LAGA* members guarantee professional treatment and full compliance. Another dimension of *LAGA* activities is a common online spare parts database that gathers information about spare parts available in the largest dismantling companies across Sweden.

Semi-formal/semi-legal sector exists, but doesn't play a major role in material and economic flows, although public raises concerns about illegal dismantlers who break not only fiscal, but also environmental laws⁸⁵.

Overall, the sector is characterised by domination of recycling companies, particularly Stena, over dismantling companies, who compete against each other especially in densely populated areas. Still the majority of dismantlers prefer contracts with Stena rather than other two companies, who while offering better price for steel scrap, can not offer complete services for all types of wastes handling and convenient customer support, which are the main advantages on Stena.

4.1.2 Legislation

Sweden has a long history of legislative elements regulating the problem of abandoned cars prior to the implementation of the ELV Directive. The Car Scrapping Law (SFS 1975:343) and the Car Scrapping Ordinance (SFS 1975:348) were enacted in order to regulate the problems that had been observed of end-of life vehicles being abandoned in the countryside. The Ordinance on Producer Responsibility for Cars (SFS 1997:788), which came into force 1 January 1998, is the main piece of legislation that covers the requirements of the ELV

⁸⁴ SBR Sveriges Bilskrötares Riksförbund (2008), <http://www.sbrservice.se>

⁸⁵ Dagens Nyheter (8 July 2008) *Miljöfarlig bilskrötning ökar sedan premien slopats*

Directive. The Government Bill 2000/01:47 dated 7 December 2000 and the parliamentary decision dated 14 March 2001 contain amendments to the Car Scrapping Law, implementing remaining parts of the ELV Directive⁸⁶.

Sweden in many ways was running in front of the Directive with national requirements:

- The year when the total level of reuse, recovery and recycling is to reach 85 % was set at 2002, compared to 2006 in the ELV Directive. However, the year for achieving the 95 % target is set as in the ELV Directive for 2015.
- Free of charge handing-in is specified for all cars that were released on the market after 1 January 1998 compared to 1 July 2002 in the ELV Directive. This free of charge handing-in will be extended to apply to all cars from 1 July 2001, whereas the EC directive specifies that this shall apply no later than 1 January 2007.

From 1 June 2007, the Ordinance was amended by removing the Scrapping Fund and introducing additional requirements under individual producer responsibility, e.g. obligation to create a country-wide network of collection points with maximum accessibility distance of 50 km.

4.1.3 Collection

Collection is stimulated in two ways – administrative, where the last owner has to present a COD in order to deregister a car, and financial. Although the government managed Car Scrapping Fund has been eliminated, dismantlers and scrap yards usually pay the last owner for the vehicle. Moreover, if there are several dismantlers in the range of one municipality, they compete on price. The variations in remuneration for an ELV met during the field work are from nothing (for a car with missing components and not driveable), to 400 to 1,200 SEK depending on the company.

Information about what to do when one wants to scrap a car and the location of authorised dismantlers is widely available both on the websites of government authorities (Vägverket, Naturvårdsverket), from car manufacturers and Bil Sweden and specialised websites on Refero and SBR networks.

In past years the problem of abandoned vehicles was raising significant concerns of authorities, especially in the remote areas, but as a result of public information campaigns and abandoned vehicles removal campaigns, e.g. under the “Keep Sweden Tidy” foundation, the collection rate now is estimated at a high level, when comparing the number of deregistered cars to the number of scrapped cars⁸⁷. Leakages in collection come from a small percentage of ELVs that are exported (semi-legally or illegally) or treated by an illegal scrap yard.

⁸⁶ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p. 49

⁸⁷ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p. 6

4.1.4 Extended producer responsibility

Ordinances adopted in 1975 introduced the system for free take back by establishing a non-interest fund where charges for new cars entering Swedish market were collected from the producers. The Car Scrapping Fund that was under State control. The Fund was then used for paying scrapping premiums in conjunction with the end of-life car being handed over to an authorised car dismantler who has the right to issue a scrapping certificate. In practice, the scrapping regulations of 1975 were an economic producer responsibility for the car industry⁸⁸. The amount paid as a scrapping premium gradually increased, and in the year 2001 came up to 1,500 SEK (around €174).

With the transposition of the ELV Directive and recent amendments from 2007, producers bear full responsibility for establishing a nation-wide collection system and ensuring the proper treatment of ELVs. As mentioned in the Section 4.1.1 it is done through contracting a network of dismantling companies – Refero, managed by Stena, or Skrotfrag's own network (in three regions of Sweden).

4.1.5 Recycling practices

A high standard of ELVs treatment at dismantler level was observed in different types of companies, determined mainly by licencing requirements and a well organised work of waste management companies, who provide dismantlers with the opportunity to get rid of separated wastes and tyres. Also there is an overall high level of environmental awareness. People working in the sector are often enthusiasts and a lot of companies are kept as family businesses established decades ago.

After depollution and removal of valuable spare parts, a recycling company collects car bodies by a specially equipped truck. The truck is equipped with a crane that crushes the roof of cars to reduce their volume for transportation. In this case a recycling company has more control of how well the cars are prepared before they are put into shredding. When transportation is required for longer distances, recyclers require car bodies to be flattened or bailed. This leads to less possibility to see whether the car was treated properly prior to shredding. In general shredders do not accept ELVs from non-certified scrap yards. But in some cases contracted dismantlers may serve as transit points for non-authorised scrap yards.

Glass is a problematic issue, because it is hardly dismantled and rather broken in the transportation and handling process by forklifts. Some companies collect glass to some extent and have a separate storage for it, others don't, although recycling companies require glass to be removed before an ELV is shredded.

In the shredding stage ELVs are mixed with other steel scrap to balance the final composition of products and waste. The percentage of ELVs fed to the shredder is around 30% (Skrotfrag AB) to 20% (Stena Recycling AB). ELVs are specific because they contain many types of materials and generate more waste than more pure types of scrap. In Stena's internal reporting practice it is estimated that an ELV gives 68% ferrous metals recovered, about 6% of non-ferrous metals and approximately 26% remains non-recoverable waste.

⁸⁸ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p. 50

Post shredder separation into light and heavy shredder residue is used in all facilities, although there is a significant diversity in post shredder treatment used within Sweden. As mentioned before, landfilling of shredder residue with high calorific values is banned, which should serve as a clear incentive to recover and recycle more components from it. Some companies do this, for example at Skrotfrag's facilities, mixed shredder residue is separated into two fractions – landfill construction material which contains mainly sand, pieces of gravel, glass and insulates from cars and constitutes approximately 60% by weight; and combustible component which contains mainly plastics, rubber and wood, which constitutes remaining 40%. The first fraction is used in landfill construction and maintenance, and the latter is used as a supplement fuel in Municipal Solid Waste incineration plant. This fraction is considered waste, although it in fact undergoes energy recovery, but as a matter of fact, no wastes are landfilled. On the contrary, in Stena Recycling shredder facility, the respective combustible component is entirely landfilled, receiving an exemption from the landfill ban. Stena does not find market application for combustible component (due to contamination and unavailable Municipal Solid Waste incinerators capacity), and economic incentives for performing material recovery of plastics and rubber, although a technical possibility exists to do so.

4.1.6 Monitoring and reporting

The proportion of reused, recovered and recycled ELVs was in 2000 at 83%. The target of 85%, set by the Swedish legislation, was almost achieved for 2002, with the proportion being just over 84%. For 2005 the proportion reached 85 %. The calculations are based on information from a 2 % proportion of all cars scrapped in Sweden. This figure comes from the SBR that collected information from its members who are mainly Type 2 businesses with better practices and reporting accuracy. This information on overall number of scrapped cars is provided by Bil Sweden's network. The formula for calculating the reuse, recovery and recycling rates in Sweden differ slightly from that set by the ELV Directive. The main difference is the way the weight of petrol is calculated and hence the Swedish formula overestimates the proportion by 0.5%⁸⁹. Therefore a degree of overestimation or discrepancy may be found in the reporting system.

The calculation formula is based on average curb weight of 1,130 kg. (average weight of a car on the road minus the weight of driver, but includes an imaginary full tank and all necessary liquids)⁹⁰. No evidence of credible accounting for reuse component is found.

The Ordinance on the End-of-life vehicles was amended in the year 2007 and among others the reporting procedure has changed. A new reporting system was introduced since 1st June 2007, and first reports are made this year. Hence it is yet impossible to judge how well they work at the moment. The changes concerned both dismantling companies and shredders. According to the new rules reporting is gathered by car manufacturers represented by Bil Sweden to be compiled and reported to the Swedish EPA.

The main features of this system are that producers are supposed to receive a possibly full picture of the sector activities, and that it is digitalised. Dismantlers who take part in Refero

⁸⁹ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p.53

⁹⁰ Nawon Kim (2002), *Exploring Determinant Factors for Effective End-of-Life Vehicle Policy*, IIIIEE Thesis, Lund University, Sweden, p. 33

network, should report through its website; members of SBR should still use the old reporting system of SBR; and the independent dismantlers are invited to join a free online reporting system created by Bil Sweden⁹¹. The reporting includes the number of cars scrapped and the amount of scrap sold and wastes disposed of (by weight). Shredder facilities are now also entitled to report the amount of shredded ELV scrap to producers.

4.2 Germany

Due to the same European legislative framework, a lot of conditions in Germany are similar to the ones described in the previous section in Swedish context, so in this chapter they will not be repeated, but the emphasis will be made on the differences in the German ELV management system.

Germany has the largest vehicle fleet in Europe, which comprise around 20% of all European cars⁹². A high proportion of cars on the roads belong to the national brands. Consequently, many of the cars sold and used in Germany have also been manufactured in the country. The German Association of the Automotive Industry's (VDA) statistics show that 5,350,187 cars were produced in 2005. Automotive fleet in Germany in 2005 went up to 44 millions cars⁹³. Germany is also the largest export market of used vehicles in Europe. Of the 3.2 million cars, which were de-registered from German system in 2005, about 2.4 million cars are assumed to be exported. There is no certainty as to whether they were kept in circulation as used cars or scrapped abroad. A significant proportion is exported to the new Member States and other countries further east. Statistics about ELV recovery indicates that 540,000 ELVs were treated in 2004, which amounts to less than 20 % of the cars that were de-registered from the German market⁹⁴. Although another report⁹⁵ gives a figure twice as much – about 1,200,000 cars scrapped in 2004 referencing Austrian Institute for Economic Research. Statistics on deregistration is a more reliable source.

4.2.1 Main actors

The responsible government authority is Federal Ministry of Environment-Bundesumweltministerium. The supervision and authorisation functions are delegated to the Federal States (Bundesland) and municipal levels. Statistical authority (Statistische Bundesamt) and Environmental authority (Landes Umweltsamt) on the Federal States level receive reports and produce statistical information.

Strong national car manufacturers such as Mercedes Benz, BMW, Audi, Volkswagen, Porsche are members of a well established industry lobby association whose history goes back to more than 100 years – Verband der Automobilindustrie (Association of Car Industry

⁹¹ Bil Sweden (2008), *Återvinningsrapportering* [Online] <http://www.bilsweden.se>

⁹² DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p. 3

⁹³ Verband der Automobilindustrie (2007) *Annual Figures: vehicles on the road* [Online] <http://www.vda.de>

⁹⁴ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p.22

⁹⁵ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report, Annex II, p. 6

– VDA), which apart from car producers include companies along the whole car manufacturing supply chain and related businesses.

1,116 treatment facilities for ELV were registered at the Joint Point ELV (*Gemeinsame Stelle Altfahrzeuge*) – a nation - wide database of end-of-life vehicles treatment facilities. Majority of them are small and medium sized dismantling businesses, and the distinction between the two types is also notable. A number of bigger companies specialising on selling used spare parts set up an online database (similar to LAGA database in Sweden) of available parts with possibility to order and ship parts within the Germany and to neighbouring countries.

There are 46 shredding facilities across Germany. They are of different scale, some are significantly larger than the ones that are met in Sweden. What is different from Swedish situation, car dismantlers and recyclers are not as well integrated into associations. There is a network of car recyclers and related businesses - EUCAR Recycling GmbH, which includes bigger car dismantlers and spare parts resellers. It has members all over the country, but far from all companies are its members. A well-established industry associations represent the steel industry Bundesvereinigung Deutscher Stahlrecycling und Entsorgungsunternehmen (BDSV – German National Association of Steel Recyclers and Waste Treatment Facilities), which includes most of the metal scrapping companies and some bigger car recyclers, paying tribute to traditionally strong German steel industry. There are a number of big metal recycling companies operating in Germany, some of them acquiring plants all over the country, for example ALBA AG. Unlike Sweden, the sector is characterised by competition among metal recycling companies who compete on price for receiving more metal scrap.

Licensing and certification in Germany on all levels is delegated to independent auditors/certifying companies who conduct annual auditing inspections and grant licences and permits to dismantlers, shredder sites and recyclers according to every set of legislative requirements, e.g. compliance monitoring with ELV Ordinance is conducted separately by an individual auditor. Those auditors then submit their reports to environmental authorities.

4.2.2 Legislation

The first ELV Ordinance was adopted in 1998 and laid down requirements for the treatment/recovery of end-of life vehicles including recovery and recycling targets. The ordinance amendment (version adapted to the Directive) came into force on 1 July 2002 technically with two months delay as to what was required by the Directive. This amendment did not satisfy the European Commission that required aligning it closer to the requirements of the ELV Directive by removing the exemptions in Scope and Free take-back implementation. This process was finalised in 2006.

A number of steps have been taken in order to improve the target compliance: an amendment that bans landfilling wastes with high calorific value has been enacted to the German Waste Disposal and Landfill Ordinances⁹⁶.

⁹⁶ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p.25

4.2.3 Collection

There are administrative incentives for deregistration of cars when not in use, as well as a remuneration paid to the last owner for delivering a car for scrapping. The amount of remuneration is linked to market price of steel scrap, and presently an ELV brings 70 - 100 EUR. A peculiar trait of collection system in Germany is a well spread practice of picking up an ELV from the last owner “at the door”, including a country-wide network. The owner makes arrangements over a phonecall with a customer service centre, and the car is picked up at no cost, and the owner is not getting remuneration. This service is provided by larger companies and is one of the ways to ensure national coverage of treatment facilities, without having physical infrastructure all over the country. Information about dismantling operations and location of companies is available from various sources: from the Joint Point ELV, authorities and car producers.

The ELV legislation implementation report gives figures from a Bavarian NGO that from 50,000 to 100,000 ELVs are abandoned in Germany⁹⁷ but those who work in the sector say that this problem, once acute, now ceased to be important because last owners have a financial interest.

4.2.4 Extended producer responsibility

With adopting the first Ordinance on ELVs in 1998, the voluntary agreement was signed between 16 sectors representing car manufacturers, automotive industries and recycling operators. The provisions of this voluntary agreement preceded the requirements of the EPR from the ELV Directive. Individual producer responsibility is applied in Germany, where each producer contracts authorised dismantlers and must ensure the free of charge take back, and provision of country wide coverage of reception facilities. Existing network of companies is used, as well as network of EUCAR in relation to this requirement. Also, as mentioned above, a system of free pick-up of ELVs exists that allows coverage of the whole country without multiple stationary facilities. Contracts with producers are also value neutral, presenting a formal agreement with dismantlers.

4.2.5 Recycling practices

Dismantlers' operations are conducted according to good environmental standard, similarly to Sweden. Shredder residue recovery and recycling is organised in a way that allows recovery of combustible components and in some cases material recycling. As shown in the Section 3.5, several post-shredder recovery and recycling technologies were developed and are implemented in Germany. There is a cooperation scheme between recycling companies when light and heavy shredder residues are collected from several shredding facilities for further reprocessing by other recyclers. Contract agreements imply balancing the cost of transportation and treatment and benefits from selling recovered materials, so in the end either shredder company receives a bill, or gets paid. This also means that depending on market prices, treatment and recycling of non-metallic fraction may still remain a negative cost for shredder operators. As mentioned before, shredder residue is prohibited for landfilling, and this requirement is enforced. Therefore, instead it is being widely used for energy recovery, either in co-combustion with municipal solid waste recovery plants, or in blast furnaces.

⁹⁷ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p.22

Apart from successful developments in post-shredder treatment, a number of projects were undertaken to explore the opportunities of dismantling more plastic components from ELVs by both producers and dismantlers. For example, BMW Group established a Recycling and Dismantling Centre, where dismantling techniques are tried and developed under practical conditions. The Centre also serves as an experimental base for BMW Research and Development department⁹⁸. EUCAR initiated the project on prior dismantling bigger plastic parts in 2003, where 85 of its members and recycling companies participated. In the Progress report published on their website, the results of the project were assessed as not successful, and a number of difficulties were indicated, such as lack of capacities in dismantling companies to perform time consuming dismantling and practical difficulties with sorting the components according to materials, while there wasn't enough information available⁹⁹.

4.2.6 Monitoring and reporting

Based on data from the Federal Statistical Office Germany, the German Federal Environmental Agency has calculated the reuse and recycling rate for 2004 at 77.2 % and the reuse and recovery rate at 79.7 %. Therefore, the recycling and recovery targets (at least 80 % reuse and recycling, 85 % reuse and recovery as from 1 January 2006) might not be achieved. ARGE Altauto working group estimates the real recycling rate to be lower (around 70 % as an optimistic number). In particular, the reuse/recycling of glass and synthetic materials has been criticised¹⁰⁰. For 2006 German Ministry of Environment recently reported that the recycling and reuse rate achieved nationally in 2006 was 87%. The total recovery rate achieved through all material and energy recovery processes achieved 90%¹⁰¹.

The system of collecting data in Germany is significantly different from Sweden. Due to the fact that all companies are certified by the independent auditors, who present reports to respective government authorities, there is more practical information collected. Dismantlers also report to the environmental authority about the number of ELVs treated and types and amounts of wastes generated. The system of CODs in Germany is also slightly different: a copy of a COD issued by the dismantler should be kept at the recycling company (i.e. shredder facility) as an evidence for destruction. And although this is not included in auditing and doesn't always work, this is an additional source of credible information. Therefore it is assumed that monitoring and statistical figures should be more reliable, since there is a more standardised reporting from fewer sources (independent auditors). Still as indicated above in this Section, there is a lack of reliable data about the number of ELVs treated, and this information is being distorted by high export figures. It implies also that CODs are not used as a source of more credible data.

⁹⁸ BMW Group (March 2002) *BMW Group Recycling* [Online] <http://www.bmwgroup.com>

⁹⁹ EUCAR Recycling GmbH (2003), *Zwischenbericht der EUCAR Recycling GmbH zum Projekt „Recycling von großen Kunststoffbauteilen aus der Altfahrzeugverwertung“* [Online], <http://www.eucar.de>

¹⁰⁰ European Parliament's Committee on the Environment, Public Health and Food Safety (March 2007), *End of Life Vehicles (ELV) Directive An assessment of the current state of implementation by Member States*, p.24

¹⁰¹ Europäischer Wirtschaftsdienst GmbH Recycling and Waste Management Journal, (September 2008), *ELV targets exceeded in Germany* [Online] <http://www.euwid-recycling.com>

5 Analysis

In the previous chapters we tried to understand the trends in European car recycling through looking into its organisational aspects, legislation, technologies and practical case studies. This section is structured according to the issues identified as areas of concern for this thesis.

Legislative implications

In the given situation legislation is ambitious enough to give an incentive to improve the currently employed practices. It gives a good framework for implementing these changes based on the principles of EPR and governmental control over economic operators, but it is apparently weak in enforcement and compliance reporting. National interpretations of treatment methods and reporting procedures are poorly harmonised, although formally Member States implemented all the requirements of the Directive by transposing its provisions into national legislation.

New developments related to the WFD revision may have significant impacts on ELV legislation, and they still are to be explored further once the updated WFD is adopted. Particularly the introduction of two concepts: “preparation for reuse” (with subsequent removal of “reuse” itself from the waste treatment hierarchy) and “end-of-waste criteria” is potentially the most significant. The first may imply restructuring of targets definitions, and necessarily needs to be defined in ELV treatment context, because, as was mentioned above, all the activities of dismantlers regarding spare parts fall under this category. The latter may affect the whole system of currently employed practices, e.g. if some materials recovered from ELVs in a shredder process will cease being waste, they will not be subject to other waste regulations, such as transportation of waste for example. Also this concept needs to be defined in ELV context to identify the material streams which meet end-of-waste criteria, and the way these materials will be accounted for (as recycled or recovered).

The proposed “wider” definition of *recycling* may have an impact on a wider use and acceptance of burning plastics in blast furnaces, and account it for as thermal recycling. This change may open an opportunity for unfair target compliance reporting and reporting flexibilities, moreover compromising the very objectives of the legislation.

Among the minor things it is worth mentioning that the language of the Directive is not always clear and often leaves room for interpretation. For example in Article 9 which requires the *relevant economic operators* to *publish* specific information, it is not very clear in a sense that “publish”, i.e. make available to public, may mean putting the required information in the annual corporate report, in specific journal publication or in compliance reports to authorities, and there is no more direct indication on which companies should publish it, the source of publication and its completeness.

Extended producer responsibility

The current situation in the ELV recycling sector shows very low degree of connection and affiliation between car manufacturers and dismantlers. The extended producer responsibility principle is implemented rather formally; contracts between producers and dismantlers do not seem to play any role in dismantlers’ operations. Regardless of whether one has a contract with producer or not, all car makes are accepted by every dismantler. Dismantling

information exchange and provision is rather weak – International Dismantling Information System (IDIS)¹⁰² database exists but is not used to its full potential, and often not seen as adding value by dismantlers. IDIS accumulates information from 58 producers around the world and contains data about composition and stripping methods for over 1200 models and 88,000 parts. It is a potentially valuable resource, but it is hardly used by the dismantlers, because only a limited range of parts that are re-sellable are dismantled, which barely includes plastic components.

Design improvements to facilitate dismantling and recycling is a requirement in line with the primary objective of the ELV legislation, which is waste prevention. Although it may be too early to look for any results of producers' effort now, since cars scrapped today were designed before these requirements came into play, there are some constraints. In particular the unification and common classification of materials is not giving good results due to high competition among producers and strive to acquire competitive advantage by developing unique materials.

Therefore, while producers' obligations are formally fulfilled, actual responsibility, and control is shifted to the recycling sector, which not only becomes a value centre in high metal scrap prices situation, but also impedes producers towards becoming agents of change, simply because it is outside their core business. Producers have chosen a short term benefit of having no cost ELV management today, making themselves dependent on recycling businesses and a fluctuating market situation, over the potential long term benefit of taking a proactive position in implementing the producer responsibility principle in practice. Now with approaching increases in recovery and recycling targets, producers are put in the situation where recycling companies have much more negotiation power.

Non-metallic fraction recycling

It is important to clearly understand that legislation gives a good enough framework for improving and advancing material recycling of non-metallic components. What is lacking is the agent of change. According to the EPR principle this agent should be producers, while currently recovery of plastics and other potentially valuable materials are left to the decision of the recycling company that operates a shredder. And since the business of the shredder is metal scrap, there is a reluctance to take extra costs and invest in a side activity. To date the costs associated with non-metallic components treatment (especially further treatment and landfilling) are borne by shredder operators. The possibilities offered by the market and available technologies may not be adopted by the actors also because of conflicting interests, lack of strategic vision or reluctance to shift from the convenient current practices altogether. As seen from the overview of a few post-shredder technologies, the companies who can afford taking these investments and operate these technologies are big, as ALBA, Volkswagen Group, Galloo or EBARA. Smaller players have more risks involved, and in some cases may win, as the Citron AG/SA or loose, as owners of Reshment technology.

A highly debatable issue is energy recovery of shredder residue. On the one hand it is an economical option, when capacities of municipal solid waste incineration plants are available, but on the other hand, wider application of residues, for example in cement kilns and other production processes still requires decontamination and pre-treatment of shredder residues. As pointed out by the EEB, energy recovery capacity is already limited, and there is a

¹⁰² Accessible online at <http://www.idis2.com/>

possibility that the requirements of the energy recovery clients of the residues could also change (especially concerning hazardous substances control), which post-shredder technologies may not be able to meet¹⁰³.

The constraints to non-metallic fraction recycling as drawn in e.g. the Stakeholder consultation report¹⁰⁴, is the lack of market for non-metallic recyclates. This statement has two dimensions: market for plastic recyclates exists, for example for plastics recovered from WEEE, and it is developing due to increasing raw materials prices. Also commonly used shredder based recycling practices lead to lower quality of recovered plastics than acceptable by industries. In the latter case prior dismantling of plastic components could help solving the problem. Here it is important to understand the limitations and opportunities of plastics recycling market. Although the GHK and BioIS consulting report¹⁰⁵ states that market demand for plastic recyclates will be sufficient stimulated by high oil prices, and the demand will be growing. Among the limitations is the “critical mass” of supplies, which will make the market function. Creating this “critical mass” to trigger market development is one of the reasons for setting the recycling targets so high. This is affected by both the capacities and incentives for stripping plastic components on the dismantlers’ level, and also by the capacity of the collection system particularly in smaller countries. It is clear that on the level of an individual middle range shredder facility it is unfeasible to establish a separate plastics recycling plant, if the assessment of economies of scale for post-shredder technologies (100,000 to 200,000 tonne per year) presented by GHK and BioIS is correct at least to within one order of magnitude. For example in Sweden, where there are 8 shredders in total, establishing one or two of such installations will imply long distance transportation. Therefore some sort of cooperation could be beneficial in order to facilitate collection of economically feasible amounts.

As shown in Section 3.5, dismantling-based strategy is not believed to achieve higher recycling rates, moreover it is considered to be too costly especially in countries with higher wages. But as per field observations, more complete dismantling could be possible for the majority of dismantlers. Plastic components dismantling may be incorporated into the routine. It will take extra working time, but will not significantly change take longer to get the car from “entrance to exit”, because many cars stay in the yards for long time, kept as spare parts donors. Dismantlers have personnel trained well enough to be able to perform these operations. If plastic or rubber components will be dismantled and delivered to a recycling company separately this will bring more benefits to both plastics recyclers (plastic will be cleaner) and to shredders (less waste in the heavy fraction). It will probably have lower energy consumption factor (if comparing manual dismantling work with energy intensive shredding and post shredder treatment), will require less transportation, and overall less complicated technologies. This strategy has a number of limitations: smaller dismantlers and scrap yards will not be able to perform these activities; cost of additional dismantling should not be negative, i.e. selling clean plastic components should cover the extra labour costs, which means finding a demand for them. And as a rule of a prevention principle (or in other words

¹⁰³ European Environmental Bureau (15th November 2005), *EEB brief comment on the stakeholder consultation process on the review of the 2015 targets on reuse, recovery and recycling of end-of-life vehicles in Directive 2000/53/EC and the final report of 4 November 2005*, [Online] <http://www.eeb.org>

¹⁰⁴ DG Environment, ASSURE, (November 2005), *Stakeholder consultation on the review of the 2015 targets on reuse, recovery and recycling of end-of-life vehicles*, Final Report p. 12

¹⁰⁵ DG Environment, GHK in association with Bio Intelligence Service (May 2006), *A Study to examine the costs and benefits of the ELV Directive*, Final Report p. 83

“rubbish in – rubbish out”) it is always better to separate waste streams as high up as possible rather than treat mixed waste. So, the overall benefit for the society will be bigger if dismantling is used. Currently pre-shredder separation of plastic and other non-metallic components is an economically unfeasible activity, and potentially producers are responsible and legally obliged to bare the cost of recycling, at least partially. But as long as producers will be aiming at keeping the ELV obligations a zero-cost solution for themselves, this scenario is unlikely.

Already developed post-shredder recycling technologies based on mechanical material separation and its combination with energy recovery show good material recycling rates and in this view heightened recycling targets set by the legislation do not appear as “unattainable” any more. Although from the time the data was presented in the report some positive developments took place with most of the technologies, they are not yet widely spread. It is assumed that the reason for it is not in technology deficiencies, but rather, as mentioned above: lack of motivation to invest and rigid market. Purely regulative measures to facilitate recycling are insufficient. For example, one of the ways to make shredder residue fractions worth recovering and recycling is to make landfilling a very expensive and complicated practice by several means: ban landfilling of organic materials with high calorific value, increase landfill tax and make opening of new landfill sites difficult. All these measures are already taken formally, but recycling companies e.g. in Sweden constantly receive derogations from these rules. Although the description of post-shredder technologies leads to a conclusion that in countries where the landfill ban is enforced, such as Japan and Germany, post shredder technologies have better ground for development.

Depending on the national context including marketability of non-metallic recyclates, labour costs, availability of energy recovery capacity, number of ELV arisings, among others differentiated strategies may be applied successfully enough if a combination of most preferred methods will be used.

Reuse

As presented in Section 3.2, a significant share of companies in the dismantling business is focused on the secondary market of spare parts. These companies have little in common with a traditional image of “junk business” – some of them are ISO 9001 and 140001 certified, many maintain high environmental standards. These companies are well connected with each other through industry associations and online spare parts shops and databases. They have a potential to be a better cooperation partner for authorities due to relatively high transparency of operations, and are more likely to have awareness and resources to take a proactive position with regard to possible changes in treatment technologies. This situation is made possible because spare parts reselling is a more profitable business than car scrapping alone, but it requires also more man hours and investments. This underlines the industry trend – more successful companies in the dismantling sector grow in size, in number of cars treated, and offer more customer oriented services on secondary spare parts market. This seems to be an important observation because there is still a significant opposition from car manufacturers to this market, which attracts customers who would otherwise turn to authorised dealerships for new spare parts. This conflict of interest may be growing, if more dismantlers will enter this business sector.

Monitoring and compliance reporting

The actual reuse, recovery and recycling rates are not exactly reflecting the practices, because there is no common system for collecting data. In different countries recycling rates are calculated based on different sources of information and by different authorities. The common European compliance monitoring rules that were put in place in 2005 provides with guidelines, which allow using estimations, models and backcasting in calculating the recycling/recovery rates. And when it comes to modeling and estimations, one has to have reliable data to create a model in order to receive proper data. In this respect, it seems important to review the way rates are calculated and probably move towards putting more practical data as a basis, and rely less on estimations and average figures.

At the moment it is impossible to draw a certain figure for the percentage of ELVs by weight that is being reused as spare parts, because no accurate statistics exists on that account, and practically it is difficult to imagine how this statistics is to be gathered unless more attention will be given to this sector. Consequently, there is a risk that the whole part of targets definitions “reuse” is being practically improperly accounted for. Calculation methods presented in the report devoted to developing common compliance rules in accordance with Article 7.2 two methods of calculating the reuse of spare parts are the following¹⁰⁶:

1. Counting of sold spare parts combined with using key factors for the determination of the weight

2. Calculation of spare parts reuse, where

$$ms.p. = mi.w. - [mo.w. + mh.z. + md.m. + mo.m.]$$

ms.p. = mass of spare parts

mi.w. = input weight of ELV

mo.w. = output weight of body shell

mh.s. = mass of hazardous substances from depollution

md.m. = mass of dismantled materials for recycling

mo.m. = mass of other materials for disposal

If the input weight or the output weights can not be determined in a reliable way only the first approach or even individual weighing of all spare parts would lead to sensible results. In case that the second approach is chosen, effective controls of the activities of the dismantling companies and a stringent monitoring will be necessary. Both these requirements seem questionable: input weight is not physically measured and not reported, although theoretically it is possible to calculate; and stringent monitoring is out of capacity of local environmental authorities who usually are the controlling body.

Despite obvious difficulties with statistics gathering, the reasonable way to start accounting for reuse in ELVs is to collect information from spare parts specialised (Type 2) companies, where it is technically possible due to high levels of computer-based registration. Assuming that the majority of ELVs are treated by those companies, and absolute majority of used

¹⁰⁶ DG Environment, September (2002), Ökopol - Institut für Ökologie und Politik GmbH, *Rules on compliance with Article 7.2 of Directive 2000/53/EC*, p.2

spare parts are being sold by them, it will create a basis for collecting and accounting for reasonably reliable data.

The Commission Decision 2005/293/EC establishing detailed rules to monitor compliance with the ELV targets¹⁰⁷ says that Member States using the metal content assumption shall determine reuse on the basis of declarations from the authorised treatment facilities. In practice dismantlers do not have this precision in their reporting, which makes the initial weight (input weight) of a vehicle unknown. If the reporting rules will be adjusted, and reporting becomes fully integrated with online registration database, the input weight will be better estimated based on the model/year of vehicles. This will require computerisation of all authorised dismantling facilities.

Another important aspect of monitoring and reporting is that definitions and interpretations of existing legislation still differ across Member States. This creates difficulties not only for reporting, but also for spreading new technologies.

¹⁰⁷ OJ, L 094 , 13/04/2005 P. 30 - 33

6 Conclusions

By looking more precisely at the European ELV management sector it was attempted to find answers to the following questions:

1. How effective is the legislation as a driver to bring about the necessary change to car recycling practices?
2. What are the areas where car recycling sector falls behind its legislative, technological and economically feasible potential?
3. How is it possible to improve these areas in ELV management?

First of all, legislation possesses all the provisions that seem necessary to make the ELV management system function and improve, but do not have enough power to shift the practices towards an increase in material recycling. This is due to a number of reasons discussed in the previous chapter, for example, a lack of enforcement. A few weaknesses are to be found in the legislation itself, such as possibilities for wide interpretations of some concepts and requirements, and a lack of precision in definitions. In the near future the new definition of *recycling* introduced in the revised Waste Framework Directive may open the window for increasing reported material recycling percentages without changing current practices, through allowing the incineration of plastics in blast furnaces to be considered as recycling.

The car recycling business is well established, and the new legislation requirements did not manage to change the core of it. The core business of car recyclers is either scrap metal or spare parts, in different combinations. Recycling non-metallic components, which is one of the main challenges of ELV management, is outside the traditional view on car scrapping. Technological and market potential for e.g. plastics recycling is not utilised in many countries. Currently, plastic components and even glass are hardly dismantled, and as a result plastics and rubber are not recycled or incinerated with energy recovery, but in some cases are landfilled.

Extended producer responsibility for cars has not been enforced and implemented effectively enough to make a difference in the ELV management. The actual responsibility for car recycling lies outside producers, mainly with shredder operators. This also results in shifting the value and control centres of the system towards recyclers and makes producers dependent on them in the long run. Also the evidence for effective implementation of design for recycling principle by the producers is not obvious, and is criticised by recycling sector.

There are inaccuracies and approximations in the way recycling statistics is being collected and reported, which makes the actual target achievement uncertain even in the countries with well-established ELV management systems. Better monitoring and reporting will be a good enforcement incentive.

In all these areas there are potentials for improvement. With regard to the legislation it is necessary to avoid dubious definitions to prevent the variety of interpretations across countries, and enforce the policy harmonisation requirement in the Member States. After a final adoption of an updated WFD it is seen necessary to review the ELV Directive accordingly, and give precise definitions in the ELV context to the new entries in the WFD such as end-of-waste criteria and “wider” definition of *recycling*.

There is a room for another type of business in the non-metallic fractions recycling, which may be more effective and efficient in dealing with shredder residues, because companies focused on steel scrap do not have enough motivation and scale of operations to invest in new facilities. An interesting and successful example of such a company is a cooperation between car manufacturer Volkswagen Group and an environmental consulting company SiCon GmbH. It is also worth noting that another successful technology in Japan is operated by the environmental engineering division of EBARA. Combining environmental engineering perspective and knowledge of car manufacturers seems to be a good strategy for this innovative sector.

Related to the above, there should be more significant interest provoked in car manufacturers to implement EPR principle in its full sense. Producer responsibility is likely to start working when ELV management will no longer be a zero-cost solution to car manufacturers. Research and development in design for environment together with investments in non-metallic components recycling are the two ways that seem to be most appropriate. This is seen as hardly enforceable, because it is in producers' authority.

It is also considered promising to assess the feasibility of performing the large plastic and composite components stripping at the level of dismantlers in different countries, and see if there will be profit associated with it for dismantlers and any improvements in material recycling of plastics.

It seems beneficial to create a reporting system that is more linked to practice by employing computer technologies. It will help in controlling the companies in the sector, and will allow for a clearer picture of the situation on this market. Also more attention could be paid to reuse, because a more realistic account of this component may add to the reporting of target compliance, and will increase reporting accuracy in general. In order to shift the monitoring responsibility burden from governmental authorities, the German practice of independent certifying companies may be looked at. This strategy may be more effective due to a more standardised reporting from fewer sources.

The overall conclusion of the study is that there is a potential to implement the legislation with its current and prospective requirements, and the key elements there are strategic vision and commitment from the manufacturers side.

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