

General requirements for monitoring the recycling of long-lived, technically complex products with an in-depth-analysis of end-of-life vehicles

Summary

by

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General requirements for the monitoring of long-lived products

The present way of production and consumption is characterised by a more or less linear change from products into wastes, leading to constantly increasing amounts of waste. In order to change this general behaviour, more and more take-back obligations are being developed in Germany and other European Member States either on a legally binding basis or on the basis of voluntary agreements.

The first take back obligations in Germany and Europe, which are already in force today concerned the sector of short-lived packages. The instrument was subsequently extended to cover also wastes from long-lived goods which are considered as priority wastes either because of their quantitative arising or due to their hazard potential. The most advanced draft regulations in this field are concerning end of live vehicles and wastes from electrical and electronic equipment.

It is the principal objective of all these regulations to manage the environmentally sound recycling and disposal of the wastes. According to the hierarchy of waste management options, recyclable materials shall be recycled into the economic circle at the highest possible level. At the same time, hazardous substances shall be prevented from being released to the environment in an uncontrolled way. Rather, they shall be recycled as well, or disposed of in an environmentally sound way.

One central concept of most take back obligations is the new idea that the producers still bear responsibility for their products even after the end of their usage time. With this concept, producers are taken up on their promise to contribute to the implementation of the waste hierarchy by taking measures towards a quantitative and qualitative prevention of wastes, and by generating the prerequisites for high level recycling (e.g. by construction along „design for environment“ rules). Additionally, the producers' responsibilities embrace the obligation to supply certain information to consumers and recyclers, as well as the obligation to report to the government about the actual realisation of the above-mentioned obligations.

To summarize, the monitoring of take-back activities for long-lived goods must fulfill three main requirements:

- 1. It must prove the steering function of the take-back instrument for the controlled recycling and disposal of the addressed waste streams.**
- 2. It must give evidence for the actual usage of recyclable materials and for the environmentally sound disposal of hazardous substances.**
- 3. It must show the fulfilment of the producers' responsibilities concerning prevention of wastes and improved design for recycling.**

The European discussion on the monitoring of long-lived technical products

The European Commission has worked out two draft directives which are dealing with the management of end of life vehicles (ELV) and wastes from electrical and electronic equipment (WEEE). Both draft directives impose on the producers the duty to take back their products after the end of their usage time. For the same two product groups, the discussion is fairly advanced in several Member States, the quantitative targets and the monitoring concepts being further developed for ELV than for WEEE.

The draft ELV directive contains several provisions that will inevitably require a specific monitoring for verification. Certain information and reporting obligations for economic actors and Member States are generally addressed but not specifically explained in the Commission proposal. The specific formats for reporting shall be worked out until mid 1999.

Take-back regulations which are under development in several Member States differ from each other considerably both in their choice of instruments as well as their degree of concretion. As far as these Member States already report statistics on the number of recycled cars in relation to the total number of deregistered and exported cars, their figures are mostly based on rough estimates or extrapolations from a fairly small data base and are therefore affected with a high error margin.

One notable exception here are the Netherlands where a direct link between on-line deregistration and the road tax allows a precise counting of all cars accepted for final disposal as well as all exported cars. Sweden is expected to possess a similar data base for monitoring in the near future, as on-line deregistration of ELV by the recycler immediately on acceptance has already been introduced several years ago. Sweden also intends to use the road tax as the main steering instrument, and the authorities are presently working on the closing of certain loop-holes (such as the automatic deregistration after a certain period of temporary deregistration, and some local exceptions from the last owner's duty to prove the proper disposal of his old car).

Whether such a detailed monitoring of numbers of end of life vehicles is necessary or not is seen differently by the various actors. E.g. the Austrian Chamber of Economy (Wirtschaftskammer Österreich) considers it to be sufficient to optimise the steering instruments by establishing a link between the road tax and the certificate of disposal, without spending too much effort on a monitoring of numbers.

With respect to the material quantities that are generated during the extraction of fluids and hazardous materials and during dismantling of car wrecks, the Netherlands are again the only European country at present that is able to provide precise monitoring data: From each dismantling enterprise, the material quantities extracted from the car wrecks are reported to a central organisation, where they are checked for plausibility not only against the number of cars accepted for dismantling, but also against the quantities of materials that finally arrive at the recycling companies.

Additionally, regular control visits at the dismantling enterprises and the shredder operators and the quality control of incoming materials at the recycling companies ensure that the reported data do actually reflect the real situation, and that fraud and misuse are rendered as difficult as possible.

With these features, the Dutch monitoring system has some similarity with the monitoring under the German Dual System for packaging wastes (DSD) which also consists of the three elements: the accounting of materials at each of the actors, plausibility checking in a central data bank, and random control visits at the various actors. In the DSD system each transaction is registered according to the principle: „Input and its origin, output and its destination“.

DSD experience has shown that either a certain pressure or an economic incentive are necessary to motivate the actors to participate in the monitoring system by properly reporting their data. After only a few years, even small actors begin to accept computer-based reporting systems rather than filling out the reporting forms by hand.

DSD experiences have also shown that plausibility checking is needed in order to distinguish between unavoidable weighing inaccuracies and deliberate manipulations of figures. This observation is expected to be generally transferable also to the monitoring of long-lived products.

In Sweden, the actors are presently establishing a reporting system for materials generated from the recycling of end of life vehicles on a voluntary basis. It is to be expected, however, that in the long run the Environmental Protection Agency (EPA) will oblige all authorised scrap recyclers to participate in the reporting scheme.

Concerning the quantitative recycling targets, the Member States' concepts are largely similar to the targets of the European Commission. However, it has to be stated that until now, the problem of system boundaries, which are of crucial importance for the percentages of recycled materials, has hardly been addressed at all. Where this question has been addressed, different answers have been given so far: In the Netherlands, some materials are considered to be fully recycled once they are delivered to a recycling company (e.g. large plastic parts or coolant), while on the other hand only the metal content of the heavy fraction from shredding is considered as recycled. Still another concept is used in the German DSD where the recycling quota is defined as the mathematical product of collection quota and sorting quota (with subsequent delivery to a recycling company), while no proof of the actual quantity of recycled material is required.

To summarise this last point, none of the EU Member States have yet finalised their concept on how the achievement of the quantitative recycling targets shall be monitored in the future. Some reporting duties for the economic actors are broadly described, but the precise reporting formats and the methods for plausibility checking still are to be developed.

Status Quo of take back and monitoring activities for end of live vehicles in Germany

In April 1998, the voluntary agreement (Freiwillige Selbstverpflichtung - FSV) of the car producing industry and other involved industrial sectors as well as the take-back ordinance for end of live vehicles (Altautoverordnung - AltautoV) entered into force in Germany.

In the FSV, the industry associations committed themselves to reduce the amount and the harmfulness of the wastes arising from the disposal of end of live vehicles. For this task, the following duties are laid down in the voluntary agreement:

- optimisation in the field of design for recycling;
- environmentally sound treatment of end of live vehicles;
- developing, establishment and optimisation of material cycles and recycling possibilities, as well as improving the recycling characteristics of cars;
- reduction of the wastes from the recycling of end of live vehicles destined for disposal to 15% (until the year 2002) respectively 5% (until the year 2015) on an average per car manufacturer;
- assurance of the free take-back of end of live vehicles under certain conditions (e.g. the car should not be older than 12 years, not seriously damaged and must be complete and must be able to roll), leading to the effect that the majority of the end of live vehicles is excluded from free take-back.

The "AltautoV" describes the technical and specialized demands on some of the actors more concretely. Most of these demands are concerning the dismantling companies, such as

- the actual practice of the removal of hazardous substances and parts and the removal of fluids;
- the dismantling of certain parts for recycling („shall“ provision);
- delivery of the extracted liquids and dismantled parts to reuse or recycling;
- the supply of 15 weight percent of the weight of each car wreck to recycling („shall“ provision).

Concerning the general monitoring requirements discussed above, the status quo is characterized as follows:

ad 1 Steering function

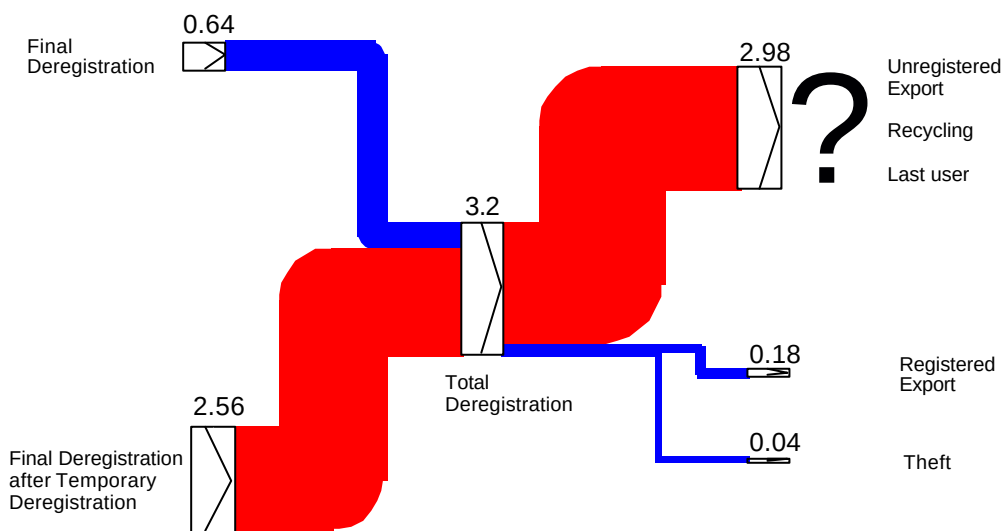
At present, the necessary prerequisites to prove the steering function of the "FSV" and "AltautoV" do not exist in Germany, because the number of end of live vehicles accepted for recycling is not registered centrally on any level. The reasons are:

- The local car registration authorities do not pass on any information to a central institution (e.g. the "Kraftfahrtbundesamt") on whether a deregistered car is recycled or left elsewhere.
- Neither the „points of acceptance“ (Annahmestellen) as defined in the AltautoV, nor the car dismantlers are obliged to forward any information about the number of accepted car wrecks and make it accessible for a central evaluation.
- At first, most end of life cars in Germany are deregistered only temporarily, which automatically turns into a final deregistration after one year (or one and a half year for the latest).
- No meaningful data exist about the number of exported cars, because most exportations of cars are either not registered at all, or the data for a clear identification of these export cars are not passed on and evaluated by a central institution.

In most cases, the proper delivery of an old car to a certified dismantler is more expensive or connected with more effort for the last owner than other possible ways to get rid of the car. Therefore, it can be assumed that within the given framework, the intended steering function of the FSV and AltautoV will not become effective.

Under the existing *status quo*, this area is not accessible to any monitoring.

Whereabouts of Finally Deregistered Cars 1996 (Millions)



ad 2. Recycling and environmentally sound disposal

With respect to recycling quotas, the monitoring must be able to verify whether the quantitative targets are achieved¹. Additionally, it is desirable to monitor the actual dismantling for recycling of large plastic parts, wheels, screens, seats and copper containing parts, as they are explicitly mentioned in the AltautoV (even if these requirements are not mandatory for the dismantlers).

Due to its widely varying degrees of concretion, it is a structural weakness of the AltautoV that the most specific obligations are imposed on the dismantlers although this group of actors have the least influence on the necessary boundary conditions. E.g. the amount of materials or spare parts dismantled for reuse or recycling and thus the achievement of the 15% recycling target by the dismantlers is essentially determined by the necessary effort, and by the question whether or not there is a market for these parts and materials. Here, the producers would have much more influence than the dismantlers, but for them these goals have not been operationalised yet.

The legal basis for a monitoring of the recycling ratio, and the dismantling of parts for reuse and materials for recycling, has not yet been created: Neither the dismantlers nor the shredder companies are obliged to forward any data about the mass flows in their companies.

As a positive prerequisite, it can be said that the necessary data for such monitoring are already available in the companies because of existing legal obligations. Therefore, no new data must be generated. Rather, it is just a question of transferring and using those data for monitoring.

In order to actually calculate the recycling ratio on the basis of these data, some additional technical prerequisites must be created:

- The weight of an incoming end of live vehicle must be determined with sufficient accuracy.
- A method must be found, how the material flows from the removal of fluids and hazard substances as well as the materials for recycling can be kept separate from similar materials arising from other activities of the company (like garage activities).
- It must be defined how the spare parts removed for reuse by the dismantling company shall be registered for the mass balance.
- As the pre-treated car wrecks are normally shredded in a mixture with other types of scrap, a method must be found how to distinguish between shredder residues from car scrap and shredder residues from other sources.
- System boundaries must be defined within which the percentages of recycled and disposed materials are used for calculation of recycling quotas.
- Methods must be developed for verifying the producer-specific quota as granted in the FSV.

For none of the technical questions mentioned above, a clear and binding concept exists at the moment. Above all, the methodology for determining the weight of the incoming ELV and the question of system boundaries have a crucial influence on the results of the calculation of recycling quotas.

Also, the question whether a certain way of dealing with shredder light fraction is considered as recycling or as disposal process, is subject to a legal debate that is far from being finalised. Depending on the outcome of this debate, the answer to the question whether the recycling targets of the FSV or AltautoV are reached without any more efforts, or whether they are missed by far, can change from one

¹ I.e. a minimum of 15% direct recycling by the dismantler, a maximum of 15% (resp. later 5%) per car producer waste for disposal after shredding.

day to the next.

In other words, at present the legal definitions of recycling do not provide sufficient orientation how to improve the waste management of ELV towards the goals of a sustainable cycle economy.

As a consequence, monitoring the fulfilment of producer responsibility obligations as granted in the FSV will gain particular importance.

ad 3. Producers' obligations concerning prevention of waste and design for recycling

In the FSV, the following aspects of producer responsibility which are already a part of the German law on cycle economy and waste management (KrW/AbfG) have been granted by the car manufacturers

- optimisation in the area of design for recycling;
- developing, establishment and optimisation of material cycles and recycling possibilities;
- improving the recycling characteristics of cars.

However, in the FSV these promises have not yet been operationalised in the form of a time schedule, by definition of indicators, and by defining verifiable interim goals which can serve as benchmarks for measuring the overall progress.

While for the actors of the disposal sector, the legal requirements are described very accurately down to technical details, a similar concrete catalogue with respect to prevention of wastes on the producers' side is missing in the AltautoV.

On the existing basis, a monitoring of the question whether the targets of the producer's responsibility are achieved or not, is not possible.

Setting priorities between the various monitoring areas

In the following table, the various objectives for monitoring as they result from the FSV and AltautoV are assessed concerning their priority:

Table: Priority matrix for monitoring objectives					
Target area / monitoring objective	Relevance for recycling quota		supported by market forces ?	subject to legal control	Priority of the law on cycle economy
	>15% recycling at dismantler	<15% disposal after shredding			
disposal route for end of life vehicles	irrelevant	irrelevant	no	only partially	very high
removal of fluids and hazardous constituents	low	very low	no	yes (but only partially)*	high
removal of spare parts for reuse	very high	low	partially	only partially	medium
removal of materials for recycling	very high	low	scarcely	only partially	medium
disposal routes for materials after dismantling and shredding	low	very high	scarcely	scarcely	very high
design for recycling	high	low**	scarcely	no	high
closed-loop recycling of materials in new car production	high	low	no	no	high

* Existence of technical installations but not their actual performance is checked

** Very low for metals, medium for plastics

The analysis shows that except for the removal of fluids - for which the existence of technical installations but not their actual performance are supervised - none of the target areas of the FSV and AltautoV are strongly supported by market forces, nor are they sufficiently backed by the existing legal framework.

This lack of an effective framework is most obvious with respect to the steering of ELVs into the collection system, but also for the disposal pathways of materials generated at the dismantling or shredder companies, i.e. for the two target areas which have the highest priority in the context of the KrW/AbfG.

A similar situation must be stated for the design for recycling and the usage of secondary raw materials in new cars (closed-loop recycling), as these two areas also have a high priority in the context of the KrW/AbfG.

As long as market related as well as regulatory steering is missing, obviously the monitoring in these five areas must be particularly intense. Otherwise there will be no way how to prove that the targets of the KrW/AbfG will be achieved.

Furthermore, the analysis of priorities clearly demonstrates that monitoring exclusively the recycling ratios will not provide a reasonable picture about the achievement of important goals of an environmentally sound disposal of ELVs.

Proposal for action

Proposed concept for monitoring the take-back of ELVs

Monitoring of steering function

In order to improve the steering function of FSV and AltautoV on the one hand, and to make it accessible for an adequate monitoring on the other hand, some legal framework conditions should be adjusted.

More specifically, it is proposed

- that the local registration authorities pass on the „certificate of disposal“ (Verwertungsnachweis) or the last owner's „declaration of the car's fate“ (Verbleibserklärung) to the national registration authority (Kraftfahrtbundesamt - KBA) for a central evaluation;
- to change the rules for temporary deregistration of vehicles in such a way that, after one year (or one and a half year), instead of being deregistered automatically, the car will fall back into the road tax system;
- to modify the export laws by implementing a duty to register every exported car by its vehicle identification number (VIN)²;
- to submit information (VIN) of every illegally deposited car to the KBA;
- to oblige every dismantling company to submit their data about the number of recycled cars to the KBA as the neutral clearing institution (for identification of cars, the vehicle identification number (VIN) should be submitted as well).

If, as proposed, the VIN shall be used for the monitoring of numbers of recycled cars, the data flow can be organised in several ways. In every case, the data collection and evaluation will have to be done by an institution where it is ensured that the possible concerns with respect to confidentiality are respected.

For these reasons, it would seem problematic to establish a new data base with owner-specific data that can be traced back to individual persons. The problem can be avoided when the data are evaluated by the KBA, because principally the complete data which are necessary are already there. If necessary, the KBA can make the data available in anonymised form to other actors for further evaluation.

Using the VIN for the monitoring of numbers brings significant advantages, including

- minimising of faults (e.g. prevention of double counting);
- a considerable potential for extended monitoring, e.g. other whereabouts of deregistered cars;
- the foundation for building up a database for additional monitoring tasks, such as
 - producer specific recycling rates,
 - the actual weight of the incoming ELV,

² This rather expensive way of collecting information will become unnecessary when it is ensured that for each deregistered car there will be either a „certificate of disposal“ (Verwertungsnachweis) or the last owner's „declaration of the car's fate“ (Verbleibserklärung), and that these documents will be forwarded to a central institution.

- expected amounts of fluids and hazardous substances from the dismantling of the ELV.

The proposed concept can be realised step by step.

By including the existing KBA data base in a monitoring on the basis of the VIN, the system will be able to discover faults by itself, and it will be possible to make highly reliable statements about the real whereabouts of deregistered cars.

Monitoring the recycling rates and the disposal of hazardous substances

With respect to recycling rates and the proper disposal of hazardous substances, the obligation for dismantling and shredder companies to forward data about their mass flows to a neutral clearing institution is a fundamental prerequisite for reliable monitoring. This includes a description of their input (in terms of number and type of ELVs accepted for recycling) as well as their output (parts for reuse and recycling, and mass flows after dismantling and shredding).

For **determination of the weight** of the incoming ELV, the theoretical weight as described in the car registration document can serve as a basis. However, as this weight is almost always too high, it must be adjusted by a correction factor which is yet to be determined. Although the weighing of each individual ELV would give more precise results, it is not suggested as a general procedure because of the high related costs and efforts; but weighing of individual cars should be continued to be done by those companies who are already running a scale anyhow, as their data are useful for determination of the general correction factor. The additional effort for weighing (in relation to other dismantling companies) as a contribution to the building up of a statistical data base should be compensated (also financially).

The technical prerequisites for an environmentally sound removal of fluids and hazardous substances according to the rules of the AltautoV will be routinely checked in detail as part of the certification. In order to control the actual performance, spot checks are recommended both in the form of visits at the companies, and by examination of the dismantled and dried car wrecks by a neutral and independent organisation. To be effective, these controls must be accompanied by possible sanctions such as e.g. the withdrawal of certification. Although more precise mass data would be generated if the materials from dismantling were kept strictly separate from materials from other activities, a simplified registration of material quantities is justified because these materials have a low mass and thus little influence on the overall recycling rates.

Instead, for inclusion of the quantities of removed fluids and hazardous substances in the calculation of recycling rates, the experts propose the usage of expectation values, which should be generated *via* dismantling campaigns, and / or by evaluating the data of dismantling companies who do not work in other areas (such as garage activities).

Mass data of materials for recycling should be registered *via* weight notes issued by the recyclers. Although some recyclers do not really weigh the materials but estimate the weights, the imprecision of data will be kept in limits because weight determination is the basis for the fixing of the costs (or profit resp.) for the materials between dismantler and recycler. Potential mixing of mass data from ELV with materials from garage activities should be controlled by plausibility checks against the expected values described above.

The registration of spare parts for the mass balance is a major monitoring problem: These parts have a

high relevance for the determination of recycling rates on the level of dismantling companies, but in the usual working practice their weight will never be determined. In order to avoid the high efforts necessary for weighing of each individual part, a two-step procedure is recommended:

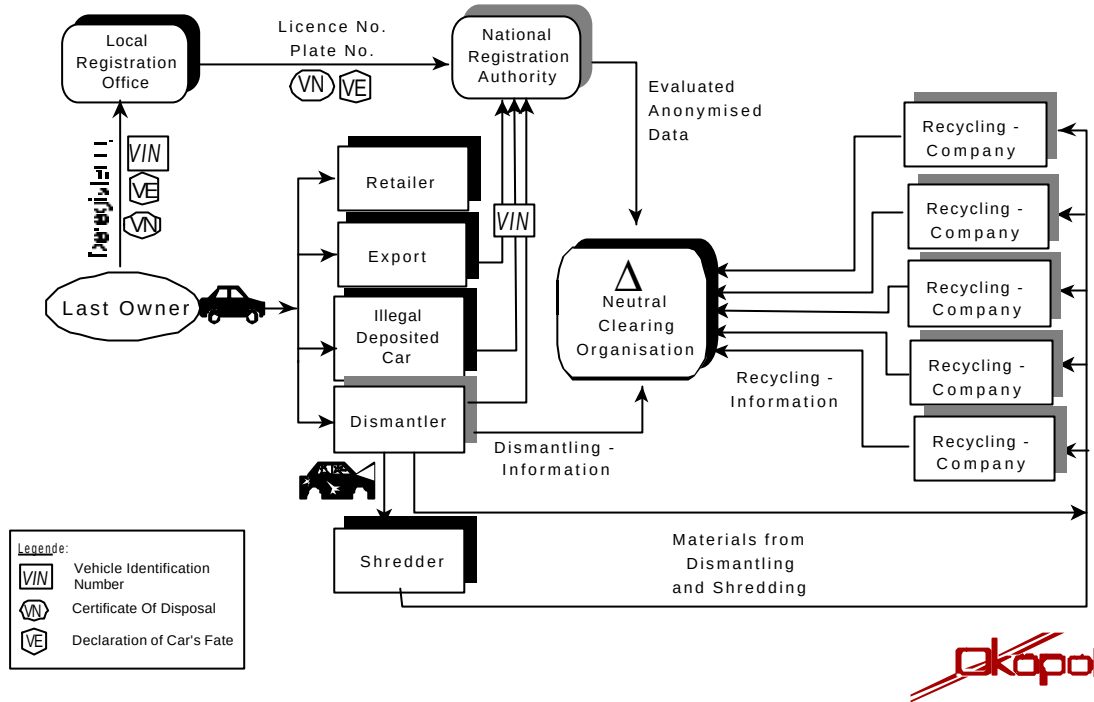
- The weight of materials for recycling is determined by a mathematical subtraction of the weight of outgoing car wrecks and the expected values for removed fluids and hazardous substances from the weight of the incoming ELV.
- As a supporting measure, the weight of spare parts for recycling should be determined by multiplying their number with the single weights of the parts. The database for the weights of spare parts (differentiated by the car types) should be provided by the car manufacturers (for example on the basis of the IDIS system established by the European car producers).

The exact determination of the weight of the incoming ELV is a fundamental prerequisite for this procedure. Otherwise, weighing each spare part individually will be the only alternative that could provide the data which are needed for the monitoring of recycling rates with sufficient accuracy.

The **output mass flows from shredding of ELV** should be determined by shredder campaigns in regular intervals (e.g. annually). The various types of installations, their different configurations and their individual way of working will lead to a certain inaccuracy of data which can only be reduced by broadening the statistical database.

For the determination of the overall recycling rates, the **definition of the system boundaries** is even more important than e.g. the registration of precise mass data at the dismantling companies. When, for example, the recycling percentages are determined on the basis of the mass input at the first step of treatment or recycling, the result will be completely different, as if the outputs of the recycling process are examined and classified into materials for recycling or energy recovery, and on the other hand materials for final disposal. In spite of the intense discussions held over these questions during several years, a broad consensus for an applicable method has not yet been found.

ELV - Recycling: Suggested Information Flow



In order to give reasonable results, the whole disposal chain should be taken into consideration, until the materials themselves or their energy content are eventually used. It should be kept in mind, however, that the recycling rates should stand as symbols for a cycle economy rather than be taken literally. In the sense of such a cycle economy, the aspects of high grade recycling are much more relevant than the mathematical or even rhetorical definition of achievable recycling rates.

In the long term, it might be worthwhile to replace the solely quantitative recycling targets by specific, authorized processes for the individual materials. Only those processes should be approved which can achieve a high quantitative recycling rate, and at the same time fulfill the demands of a high grade recycling and an environmentally sound process. The adjustment of such a selection of approved processes to the progressing state of technology should be done in appropriate intervals.

The achievement of producer specific recycling rates (FSV 3.4) can only be monitored with a sufficient data quality when the VIN will be integrated as a basis in the data flow. A differentiated evaluation of the yearly dismantling and shredder campaigns should be integrated as an additional orientation.

Monitoring of the fulfilling of the obligations resulting from the producers responsibility

In order to monitor the fulfilment of the duties resulting from the producers' responsibility, a fundamental prerequisite will be the development of an applicable method on the level of indicators. It should be possible to describe improvements in the field of „design for recycling“ by indicators such as:

- time and efforts which are necessary for the dismantling of mono-materials or spare parts
- usability of spare parts in other car models than the original ELV.

The experience and know-how of the dismantling companies should be taken into consideration in the development of suitable indicators.

Numeric indicators for the amount of recycled material used in the construction of new cars appear to be well-suited to monitor the fulfilment of the producers' obligation to develop, establish and optimise of material cycles and recycling possibilities (as granted in the FSV [item 2.3] and also according to § 22 KrW/AbfG).

Future progress with respect to qualitative prevention of hazardous substances should be demonstrated by the monitoring of residual contents of hazardous substances in the shredder residues. More specifically, the contents of halogens and heavy metals in the light fraction appear to be suitable indicators which should be monitored during the regular annual shredder campaigns. Producer specific information can be derived from the dismantling of individual ELV.

Central monitoring body

As some of the data required for this monitoring concept can be traced back to individual persons, it is recommended to collect and evaluate these data at the national motor vehicle authority (Kraftfahrtbundesamt - KBA), because the KBA does already possess all the data, and the rules to respect the confidentiality of data are well established.

For evaluation of company specific data, a neutral clearing organisation should be established. At present, the ARGE Altauto as an organisation of several industry associations does not seem to be sufficiently neutral as it does not represent the whole spectrum of economic actors. Thus it is questionable whether all companies (and in particular every dismantler) can be expected to submit their detailed data to the ARGE Altauto. Also, the ARGE Altauto in its present form does not have the neutrality that is necessary for plausibility checks and on-site visits at the companies.

As a result of these considerations, the requirements of data confidentiality will be best guaranteed if a public authority (such as the KBA) will function as the central monitoring body. If the KBA will not extend its activities in this field, a new, neutral monitoring body will have to be created.

Costs for monitoring

The monitoring concept as described in this study will require an initial investment of *circa* two to 2.5 million DM for the central computer system, plus an investment between 2,000 and 10,000 DM for each company who will participate.

The annual costs for the monitoring of ELV numbers will lie around one million DM. Monitoring of materials from dismantling and shredding will cost a minimum of 300,000 DM annually, when based mostly on online submission of data without on-site visits for plausibility checking, and with only few shredder campaigns. Regular on-site visits at the dismantlers' and shredders' and more frequent shredder campaigns will raise the annual costs to approximately three million DM.

Depending on calculative assumptions, monitoring of the individual vehicle and its further fate in waste management will cost between one and four DM at a maximum.

The complete study is available at the Federal Environmental Agency, Berlin.