THE CARE FOR ENVIRONMENT BY RATIONAL VEHICLES RECYCLING MANAGEMENT

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Abstract: Recycling of vehicles may be one of the possibilities significantly diminishing the destructive human activities. In Poland, a growing number of end-of-life vehicles forces us to look closer on that problem. The study presented in the paper concerns the different aspects of car recycling in Poland. Age structure of used cars registered in Poland, import statistics and other data concerning Polish car market are analyzed on the background of forecasted number of end-of-life vehicles. The main problems of development of the recycling network are identified. Different scenarios, which are characterized in detail to define changes in the number of cars recycled in Poland in the future, and environmental consequences of these scenarios, are analyzed. The specific method - LCA and Ecoindicator 99 - are used for calculations. The main environmental impacts are classified and ecological consequences of the average car recycling in Polish conditions are defined. Results illustrate the scale of environmental consequences of car recycling problem. They can support activities oriented towards finding the most rational environmental solutions. The study confirms also that the LCA tools may be helpful in evaluation of environmental consequences of end-of-life processes and potential suggested improvements in recycling processes.

Keywords: *environment, care, end-of-life vehicles, recycling*

SKRB ZA OKOLJE V OBLIKI SKRBNEGA OBVLADOVANJA RECIKLAŽE VOZIL

Povzetek: Reciklaža vozil je lahko ena od možnosti, da bi pomembno zmanjšali rušilne človeške dejavnosti. Na Poljskem sili rastoče število izrabljenih vozil, da se s tem problemom ukvarjajo natančneje. Študija, o kateri poroča ta prispevek, zajema razne vidike reciklaže avtov na Poljskem. Analiziramo starostno sestavo tam registriranih avtov, uvozno statistiko in druge podatke o poljskem trgu avtov na osnovi predvidevanj o izrabljenih avtih. Spoznamo glavne probleme reciklažnega omrežja. Analiziramo razne scenarije, ki jih proučimo podrobno, da bi spoznali, kako se bo spreminjalo število avtov, recikliranih na Poljskem v bodoče, in kakšne bodo posledice za naravno okolje. Uporabljamo za izračune svojstveno metodo – LCA in Ecoindikator 99. Klasificiramo glavne vplive na okolje in opredelimo ekološke posledice povprečnega recikliranja avtov v poljskih razmerah. Izidi ponazorijo, kako velike so okoljske posledice problema reciklaže avtov. Študija potrjuje, da je LCA lahko metoda, ki pomaga ovrednotiti okolje posledice procesov z izrabljenimi avti, in nudi možnosti, da bi izboljšali reciklažni proces.

Ključne besede: izrabljena vozila, okolje, reciklaža, skrb

1 Introduction

The general problem of car recycling is perceived also in Poland. The actual conditions of recycling, in connection with the age structure of cars registered in Poland and constantly rising number of imported used cars, have made the problem of recycling extremely important.

In 2003 more than eleven million passenger cars were registered in Poland and it is worthy to notice that 56% of these vehicles were older than 10 years [1].

In recent years about 30.000 new cars were sold per annum in Poland, while more than 800.000 used cars were imported [2]. Taking into consideration the age structure and number of vehicles entering Poland at the same time, it is obvious that there are more older cars nowadays than five years ago. Within last 4 years more than three million used cars were imported. It is necessary to emphasize that 61.57% of these cars were older than 10 years.

A growing number of the old cars contributes to the fact that the number of end-of-life vehicles will rise as well. Exact number of all end-of-life vehicles is unknown but with accordance to an estimation some 250.000 end-of-life vehicles were withdrawn per annum from exploitation in nineties [3], and the forecast for the nearest future is presented in Fig. 1.

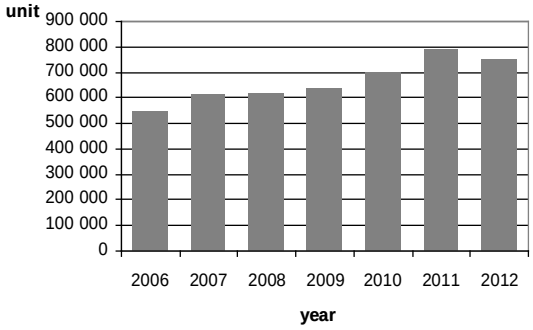

Figure 1: Estimated number of end-of-life vehicles for the period 2006-2012 [4]

Presently the car recycling system in Poland consists of 605 legal disassembly stations and 108 legal points of collecting the end-of-life vehicles [5].

The great problem of Polish recycling system is a number of illegal „recycling" enterprises that intercept most of cars withdrawn from exploitation. Number of all recycling stations is unknown because most of them are probably registered as e.g. service garages or scrap yards. „Grey area" of the branch is developing as quickly as the legal recycling network. As a result, much more end-of-life cars are dismantled by enterprises that are not entitled to run a business connected with waste management. For this reason it is assumed that only every fourth end-of-life vehicle is delivered to the authorized recycling network [6] and remaining three thirds of all vehicles find their "last way" somewhere in the environment. Some sources indicate the fact that in reality about one million cars are withdrawn from exploitation per annum and even 9/10 from them are not delivered to legal disassembly stations [7]. The main aim of analysis presented in this paper is the evaluation of environmental consequences of the final stage of a vehicle's life cycle. The tool used for this evaluation is LCA (Life Cycle Assessment).

2 LCA

Ecological analysis of recycling processes was based of the Life Cycle Assessment method (Fig. 2).

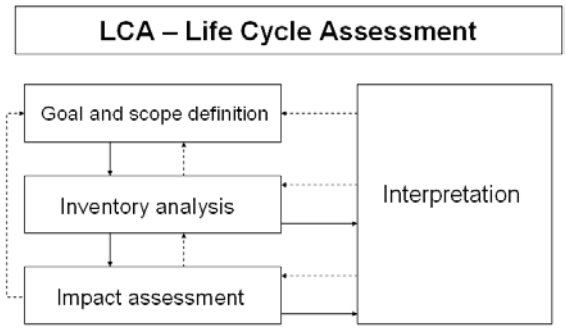

Figure 2: Stages of the LCA method [8]

The environmental consequences were studied using Ecoindicator 99. That procedure made it possible to classify main environmental impacts in three general categories: human health, ecosystem quality, and resources. For the calculation of environmental consequences the SimaPro 5.1 programme was used.

3 Goal and Scope of Research

Environmental analysis is based on the data that concerns the end-of-life vehicles market in Poland (Tab.1). As a functional unit a one end-of-life (EoL) vehicle is considered.

For the analysis it is assumed that wastes credited to the cars that are not delivered to official recycling network are treated as wastes stored on a landfill site.

In spite of the fact that regulations of Directive 2000/53/EC have been implemented into Polish legal system, lack of unified system of car recycling, loopholes at „grey area", effectively restrict the development of the recycling system and limit possibilities of significant improvements of this situation. But there are some ideas about significant improvements of the recycling situation in Poland that create a base to build possible scenarios. Different scenarios are characterized in detail to define changes in the number of cars recycled in Poland in the future.

Table 1: Average mass of materials possible to gain from 1 EoL vehicle in Polish conditions

Metals	**559,83 kg**
Plastics, glass, rubber	**26,59 kg**
Exploitation materials	**23,48 kg**
Wastes	**51,72 kg**
Total	**661,62 kg**

The first scenario of policy concerning recycling issues in Poland is the reflection of actual situation when only 25% of the total number of out-of-use vehicles will be recycled. This scenario assumes:

- Lack of unified approach to the problem of car recycling,
- Lack of an outside source of financing of the recycling network,
- No change with reference to authorized recycling network - insufficient number of cars for recycling, poor condition of authorized stations, lack of possibilities of development,
- Lack of the last owner motivation – end-of-life vehicles might be left out or delivered to illegal „grey area",
- Quick development and increase of number of illegal „recycling stations".

The second scenario assumes implementation of Directive 2000/53/EC into Polish law system, but in case of imprecise regulations on national level, the number of recycled cars should increase, but probably not too much. Therefore, the second scenario assumes some alterations in law system, but with lack of executive regulations, causing:

- Lack of sanctions for organizations omitting the environmental regulations, what might lead to development of „grey area",
- Lack of an outside financing of recycling network with the adaptation of disassembly stations to directive requirements at the same time (limited possibilities of development for official recycling stations because of the need of bigger and bigger investments),
- In extreme cases decreasing number of authorized disassembly stations and increasing average distance among stations.

In the second scenario, an insignificant increase of number of car recycled by the legal network is assumed, up to some 33% of all the end-of-life vehicles.

The third scenario assumes the implementation of Directive 2000/53/EC into Polish law system as well as introduction of returnable deposit payment in order to motivate the last car owners to deliver their end-of-life vehicles to the recycling stations. Last owners would win back the deposit payment only after showing the car destruction certificate. Such a source of financing gives some possibilities and so the financial standing of the recycling network should be improved. Therefore, the third scenario assumes an increased number of recycled cars, up to 50% percent of total amount end-of-life vehicles, thanks to the motivation of the last owners to recover money, leading to limitation of „grey area" activity.

The highest number of recycled cars, 75% of total amount, is assumed in the fourth scenario. Introduction of product payment and recycling payment should involve producers and importers to organize the recycling network. They could be supported by recycling stations and the cooperation among all entities could bring the best effects. This scenario assumes, that:

- Non-returnable product-payment concerns the producers of cars, who do not achieve required recycling index,
- Non-returnable recycling-payment concerns the importers of cars,
- Better possibilities of financing of legal recycling stations result in a quicker development of authorized recycling network,
- This causes the greatest possibilities to limit the range of „grey area" activity.

It is assumed that the significant increase of number of recycled cars will occur in the authorized network (75% of all the out-of-use vehicles as mentioned before).

All these individual scenarios were elaborated in detail to count the precise quantity of cars recycled in the future (Fig. 3).

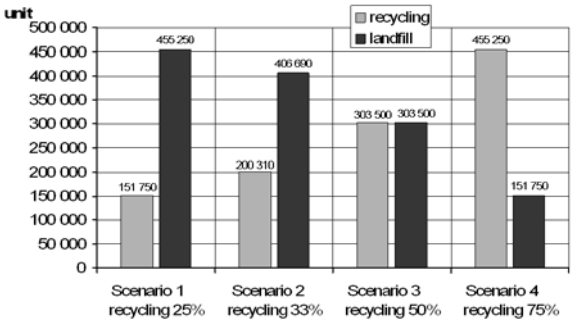

Figure 3: Estimated number of recycled cars for different scenarios

4 Results and Discussion of Results

The results of detailed calculation expressed as environmental consequences are presented in the next figures. Fig. 4 shows the comparison of total environmental indicators.

As it can be seen from Fig. 4, of the analyzed scenarios only realization of the first scenario causes negative environmental impact. Realization of other scenarios is characterized by positive effects on the environment. It is worthy to notice that environmental benefits from realization of the fourth scenario are nearly thirty times more positive than in the case of the second scenario. Results expressed in the three main impact categories are presented in Fig. 5.

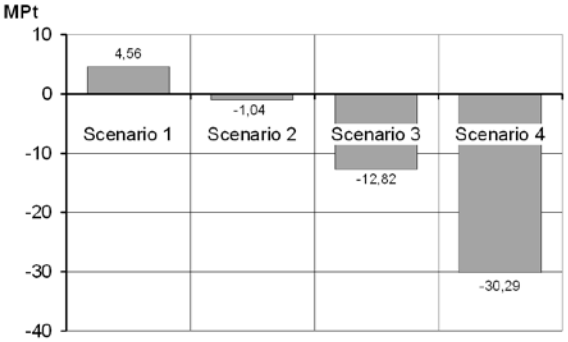

Figure 4: Environmental indicators compared as the results of realized processes of recycling

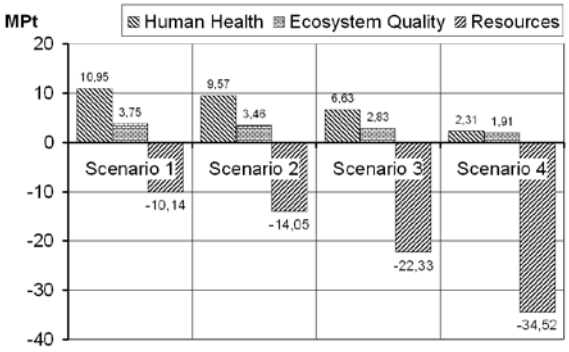

Figure 5: Environmental impacts of analyzed recycling scenarios

Results presented in Fig. 5 show that the impacts on human health and ecosystem quality cause the negative influence on environment, while impacts related to category of resources are characterized by positive effects in every scenario.

A substantial influence on human health is caused by carcinogens. Irrespectively of any scenario, carcinogens' impacts are characterized by negative factors. In case of categories: respiratory organics and climate change, there are impacts identified as environmental benefits in all analyzed scenarios. Unfortunately, the size of these impacts is significantly smaller and it cannot balance the negative influence of carcinogens on human health.

The obtained results show that the categories of impacts connected with ecotoxicity and land use are the dominating categories in terms of influence on ecosystem. The size of ecotoxicity impacts decreases along with growing number of recycled cars whereas in case of land use the negative influence is rising.

The results of analysis show that the main environmental benefits of recycling are connected with the "fossil fuels" impact category.

5 Conclusions

Environmental benefits from recycling can be significant and recycling of vehicles may be an effective way to limit the destructive human activity credited to transportation. As a result of application of the LCA method for evaluation of consequences of car recycling in Poland it has been possible to show the scale of environmental problems of improper proceedings with end-of-life vehicles.

Taking into consideration the economic, technical, legal, and logistic aspects of recycling in Poland, the following conclusions can be made:

- There is a lack of the unified recycling network,
- Most of recycling stations have bigger re-manufacturing capacities than they can gain waste materials,
- Implementation of directive 2000/53/ec could be helpful to achieve ecological aims because of treating the problems of car recycling in a comprehensive way,
- Creation of local and national system of the recycling network should be the imperative aim of ecological policy in Poland.

The analysis of the above gathered data shows the potential improvements of recycling network in Polish conditions. So, organizing an efficient system of waste collection and recycling network should contribute to reducing the scale of negative environmental impacts.

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