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MODEL RECYCLING SYSTEM OF END-OF-LIFE TRANSPORT MEANS

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Abstract. This paper presents a reuse, recovery and recycling system of end-of-life vehicles. A selected module of this system is described. The waste management process is discussed.

Keywords: end-of-life vehicle (ELV), reuse, recycling, recovery

INTRODUCTION

Table 1 presents data concerning the quantities of end-of-life vehicles in the European Union in the years 2006 and 2007, as well the weight of waste generated by end-of-life vehicles, which must be managed correctly [20]. The management of such a huge mass of waste requires a systemic approach. Directive No. 2000/53/EC must be observed in relation to the waste management process [19, 22].

Table 1. Number of ELVs in the European Union, 2006 and 2007 [20]

Years	End-of life vehicles (ELVs) [number]	Wastes (end-of life vehicles) [tonnes]
2006	6086906	5740377
2007	6581968	6119842

It is difficult to fulfil this Directive without the synchronizing of all the activities of the end-of life vehicles disposal management process. This is evidenced by the differentiation of the end values for the reuse, recycling and recovery of end-of-life vehicles as achieved by the individual EU Member States (Fig.1 and Fig. 2). The directive sets out the following targets for reuse, recycling and recovery of end-of life vehicles [19, 22]:

- 85% of reuse and recovery and 80% of reuse and recycling by January1st, 2006,
- 95% of reuse and recovery and 85% of reuse and recycling by 1 January1st, 2015.

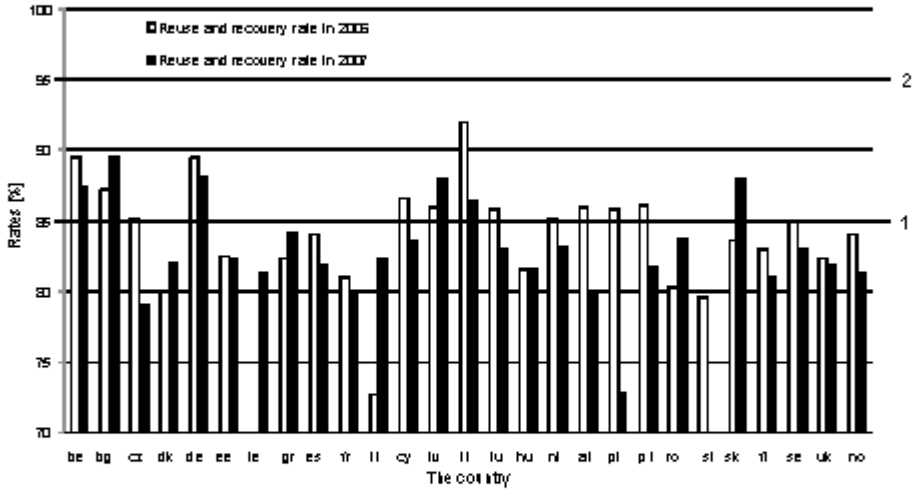

Fig. 1. Reuse and recovery rates for end-of life vehicles in 2006 and 2007 [20]: 1 – reuse and recovery rate by 2006 (85%), 2 – reuse and recovery rate by 2015 (95%)

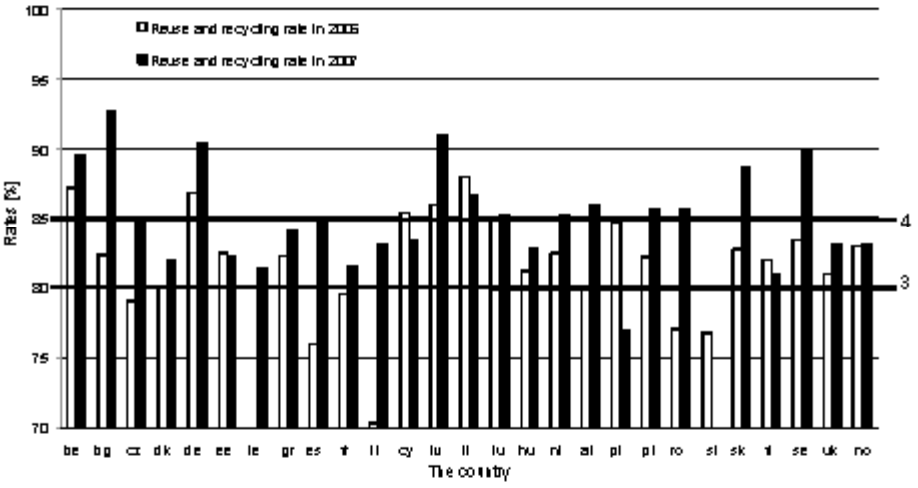

Fig. 2. Reuse and recycling rates for end-of life vehicles, in 2006, 2007 [20]: 3 – reuse and recycling rate by 2006 (80%), 4 – reuse and recycling rate by 2015 (85%)

Also, the differences regarding the average mass of the processed end-of-life vehicles in the individual EU states give rise to concern. They might prove that incomplete end-of-life vehicles are processed (Fig. 3). A synchronization of the management process of end-of-life vehicles with the guidelines of the said Directive involves a combination of the individual stages of this process to form a unified system through the reuse, recovery and recycling of end-of life vehicles.

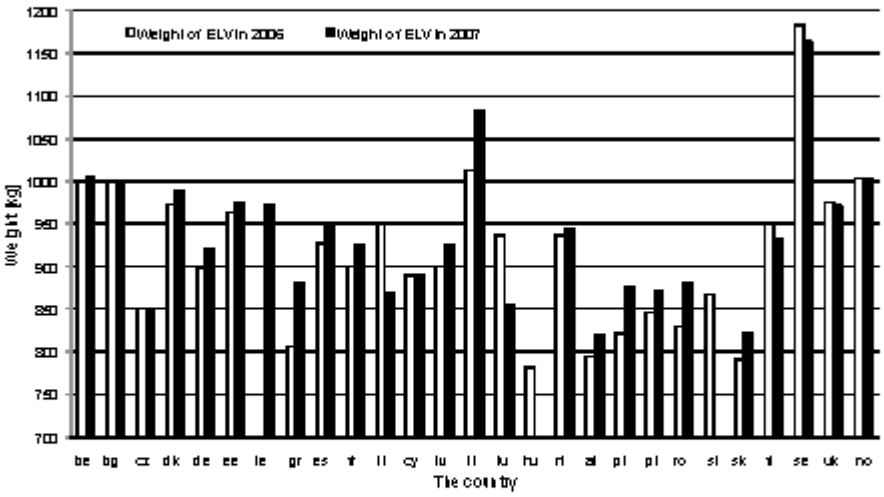

Fig. 3. The average weight of ELV in the individual EU Member States in 2006 and 2007 [20]

REUSE, RECOVERY AND RECYCLING SYSTEMS FOR END-OF LIFE VEHICLES

The proposed reuse, recovery and recycling systems for end-of life vehicles (Fig. 4) was constructed on the basis of the existing and suggested systems. On the modeling stage of the system, those guidelines were taken into account which relate to the systems described in the literature [1, 6, 7, 8, 9, 10, 15, 18]. At the same time, the assumption was taken into account in the system modeling process that the disassembly process constitutes the basic process of this system, its purpose being the recovery of elements and materials. This is confirmed by research into an optimization of the disassembly process focused on the reuse, recovery and recycling of components and materials from end-of life vehicles [2, 3, 4, 5, 12, 13, 14, 16, 17]. The functioning of reuse, recovery and recycling systems of end-of life vehicles is based on five modules (Fig. 4). Owing to the specification of these modules, optimization research of the reuse, recovery, recycling components and materials from end-of life vehicles is made possible. One of these is the module of the collection procedure of end-of life vehicle, which includes the module of end-of life vehicle collection and the module of important components (Fig. 4).

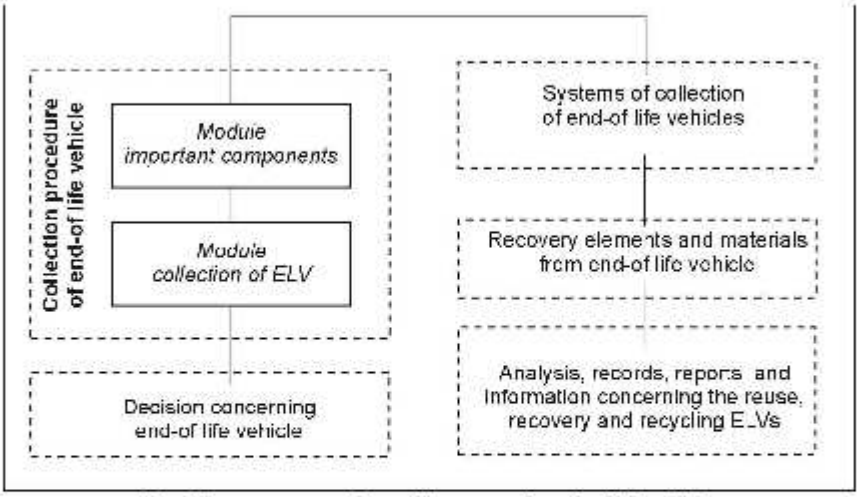

Fig. 4. Ruse, recovery and recycling system for end-of life vehicles

THE END-OF LIFE VEHICLE COLLECTION MODULE

The following parameters are specified in the module of the collection of end-of-life vehicle:

an identification feature: each end-of-life vehicle must possess one of the identification features as defined in set C:

$$C = \{c_1, c_2, c_3, c_4\}, \tag{1}$$

where: C- set of identification features [21], c_1 – number of VIN, c_2 number of vehicle body c_3 – number of vehicle chassis, c_4 – number of vehicle frame.

The weight of the end-of life vehicle: when a vehicle is being accepted, no fee is charged if Equation 2 has been fulfilled; otherwise, a fee in compliance with Equation 3 is charged.

$$\mathbf{W_r \geq W_{ELV} \geq W_q} \quad \textbf{where} \quad \mathbf{W_q = 0{,}9 \cdot W_r} \quad \textbf{where} \quad \mathbf{W_r = w_r - w_f}, \tag{2}$$

$$F_{ELV} = (W_V - W_{ELV}) \cdot R_{1g}, \tag{3}$$

where: W_r – weight of vehicle, W_{ELV} – weight of end-of-life vehicle, W_q – calculation weight of vehicle, w_r – certification weight of vehicle, w_f – weight of fuel, F_{ELV} – recycling fee, R_{1g} – rate for kilogramme.

IMPORTANT COMPONENTS MODULE

On the basis of the ELV Directive, a set of those elements has been defined in the module of important components which must be possessed by any vehicle accepted for processing (Eq. 4).

$$E_i = \{e_1, e_2, \ldots e_{15}\}, \tag{4}$$

where: E – set of important components [19, 22], i – number of components.

The collection algorithm of the end-of-life vehicle is presented in Fig. 6.

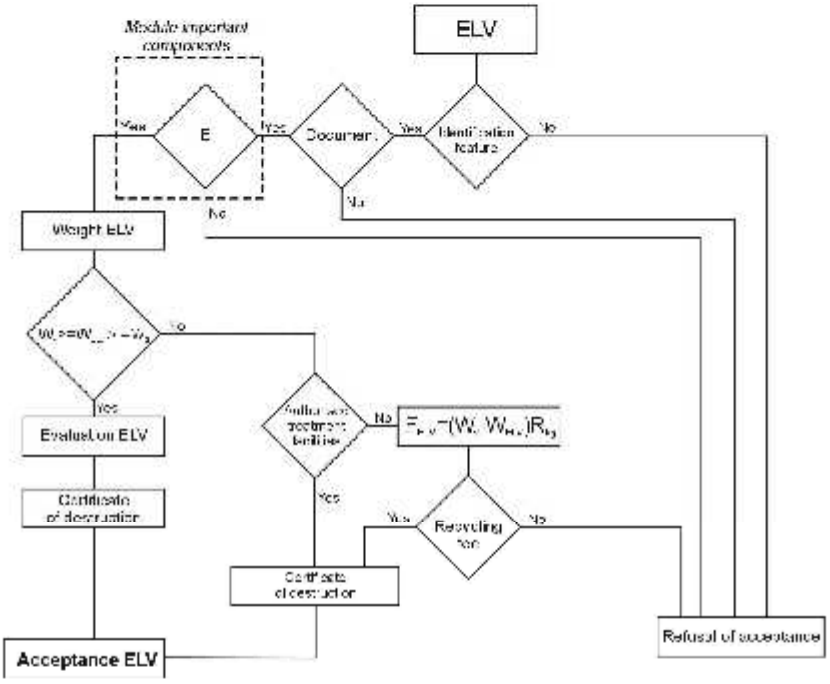

Fig. 6 Algorithm of end-of life vehicle collection

CONCLUSIONS

The purpose of the reuse, recovery and recycling system for end-of- life vehicles as proposed in the present paper is the organization of the end-of-life vehicle processing including the following:

- limitation of the end-of life vehicles environmental impact,
- an increase of the number of complete vehicles which undergo recycling,
- an increase of the reuse, recycling and recovery rates of end-of life vehicles.

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MODELOWY SYSTEM RECYKLINGU WYCOFANYCH Z EKSPLOATACJI ŚRODKÓW TRANSPORTU

Streszczenie. W pracy zaprezentowano system recyklingu samochodów wycofanych z eksploatacji oraz scharakteryzowano jeden z modułów tego systemu. Wyszczególniony z systemu moduł przyjęcia samochodu wycofanego z eksploatacji został podzielony na dwa mniejsze moduły a ich wzajemna korelacja została uwzględniona w algorytmie przyjmowania samochodu wycofanego z eksploatacji do punktów zbierania pojazdów lub stacji demontażu.

Słowa kluczowe: samochód wycofany z eksploatacji (SWE), ponowne użycie, odzysk, recykling