

Nikola Komatina¹
Aleksandar Aleksić
Danijela Tadić

THE SIGNIFICANCE OF ELV RECYCLING EQUIPMENT FROM THE ASPECT OF PRESERVING NATURAL RESOURCES IN THE REPUBLIC OF SERBIA

Abstract: *This paper explains the importance of ELV recycling in the Republic of Serbia as well as the influence of the circular economy on the automotive industry. The advantages and significance of recycling of motor vehicles at the end of the life cycle, as well as the justification for the reuse of resources and the preservation of the environment, have been presented. Also, the paper presents the development of ELV recycling equipment and its importance for the entire state industry and economy.*

Keywords: *Circular economy, End of Life Vehicle, automotive industry, recycling equipment*

1. Introduction

Motor vehicle recycling at the End of Life (ELV) is a strategically important segment of environmental protection. Resources, ie. materials that come from recycling and return to reuse are very expensive and require great resources to be re-produced. For this reason, the aim is to reduce the consumption of natural resources that are necessary for the production of these materials, so that these materials will be re-used after their primary use.

Worldwide, there is a need for reuse of materials, and so the term circular economy, which refers to the use of materials after the end of the life cycle, has now received a large number of spokesmen.

The subject of this paper is the circular economy and recycling of ELVs in terms of their significance in the Republic of Serbia. The aim of the paper is to demonstrate the benefits of using ELV recycling equipment and its importance for preserving natural resources and the environment.

The paper has been organized in the following way: After the introductory chapter, Chapter 2 explains the influence of the circular economy on the automotive industry. The third chapter explains the importance of ELV recycling on the example of the Republic of Serbia. The fourth chapter refers to the justifiability of ELV recycling and resource analysis that can be preserved by its application. Chapter 5 presents some of the basic characteristics of recycling equipment as well as devices most commonly used for this purpose. Conclusions are given in Chapter 6.

2. The influence of the circular economy on the automotive industry

Raising public awareness and awareness of industrial enterprise managements, with aim to the conservation of strategically important resources, is one of the main goals of each country. Over the last decades, and especially at the beginning of the 21st

¹ Corresponding author: Nikola Komatina
Email: nkomatina@kg.ac.rs

century, the idea of reuse of resources in the industry has been expanding.

This way of doing business, where some product is exploited again after the end of its life, has significantly changed business models of industrial companies.

Many authors see the circular economy as a new business model that needs to come to fruition more sustainable development and a harmonious society (Zhijun & Nailing, 2007;

Naustdalslid, 2014). Unlike traditional, linear economics, which is based on three basic business principles: take–make–dispose, circular economy aims to extend the life expectancy of products after dispose process. The circular economy is based on three key principles: manufacturing–consumption&use–recycling (Official site EU SCIENCE HUB). The principles of circular economy are shown in Figure 1.



Figure 1. The principles of circular economy (Official site EU SCIENCE HUB)

The circular economy aims to support the re-exploitation of resources, which actually becomes a waste after exploiting a product. The purpose of the circular economy is that these resources and after their use maintain or re-gain their economic value (Webster, 2017).

Also, the circular economy gained its significance in the automotive industry as the need for re-utilization of resources and after the end of the lifetime of motor vehicles became apparent. The expensive and very necessary materials from which motor vehicles are made can be reused in various ways. Such materials include steels, light metals, precious metals, rubber, plastics, and others.

Despeisse et al. (2015) analyzed the recycling of motor vehicles from the aspect of circular economy by case studies in the United Kingdom and Japan, and came to the

conclusion that the waste generated at the end of a life cycle of motor vehicles can be treated in three ways: the reuse and processing of parts, recycling of materials and reintroduction and renewal of energy through chemical and thermoemy conversion.

It should be noted that recycled materials do not have to be strictly used for the same purpose (automotive industry), and so certain treatments can be adapted to some other industry.

3. Importance of recycling of motor vehicles at the end of life in the Republic of Serbia

The needs of modern society have led to a great increase in the production of cars around the world. Day-to-day automotive companies produce from hundreds to several

thousand cars, and it's inevitable that these cars will be on the roads shortly after production. In fact, the problem occurs when new cars come on the market, and old cars are still in use. Apart from the energy resources used to drive the car, the problem is also the impact of old cars on the environment. For this reason, in September 2000, the European Union (EU) adopted Directive 2000/53 / EC on the treatment of motor vehicles at the End of the Life Vehicle (ELV). The purpose of the directive is to raise awareness among citizens about the importance of recycling old motor vehicles in order to protect the environment, but also to re-use the materials used in the construction of the car.

According to the data of the Statistical Office of the Republic of Serbia (serb. *Republički zavod za statistiku – RZS*), in 2017 were registered 1.968.787 passenger cars, while in 2018 this figure was 1.999.771. This actually means that within a year the number of registered vehicles of this purpose in the Republic of Serbia increased by 30.984, or by about 1.6%. It should also be noted that the number of passenger vehicles produced in the year under review, registered in the Republic of Serbia, increased from 18,838 (2017) to 21,541 (2018) (Statistical Office of the Republic of Serbia – 062 statistical report).

From the above mentioned report, it can be concluded that the number of new cars in use in the Republic of Serbia compared to the previous years was significantly low, ie only 1% of cars produced in 2018 were represented on the streets of Serbia. According to a survey carried out by the website Used cars (serb. *Polovni automobili*) on a sample of 31.988 users of this website, which offer their used cars for sale in this platform, it was found that the average age of cars in use in Serbia for about 15 years, that is to say, the cars that are most frequently used are produced between 2001 and 2005. Such cars on the roads of the Republic of Serbia have represent about 40%

of total number of cars (Official site: *Polovni automobili*).

Such data is worrisome because older cars are emitting more harmful substances, above all CO₂, and given their age, it is expected that their lifetime will not be much longer. All this implies that in the near future there will be a need to dispose of a large number of useless vehicles, and in aim of the use of resources will be necessary to recycle these vehicles.

4. The justification of ELVs recycling

The need for recycling of motor vehicles at the end of the life cycle has been recognized by companies as an opportunity for their business. As car owners have the need to discard unusable cars and cars that can not be registered, they need to find a way to do this. ELV recycling companies buy cars at relatively affordable prices and then recycle them and get profit.

At the end of the life cycle of motor vehicles, there are different types of waste. Each of these wastes occurs in a different and disproportionate amount and has a different impact on the environment. In addition, each type of waste is recycled in a different way and has a different application after recycling.

The most common waste that occurs at the end of the life cycle of motor vehicles may be classified as metal and non-metal waste. The enterprise ELV Metal Recycling which operates in the territory of Australia, waste that occurs at the end of the life cycle of ELV-a, divides into the following groups (Official site ELV Metal Recycling):

- **steel waste:** can be recycled on several occasions without loss of basic properties, making it one of the best materials in the world
- **aluminum waste:** as well as steel, it can be recycled on several

occasions without any major changes of quality. The tendency is that aluminum is increasingly used in car production, above all because of the low mass of this material;

- **precious materials** (such as platinum, rhodium, palladium and other): catalytic converters contains these materials;
- **lead waste:** occurs in batteries (accumulators) and due to the lack of this metal in recent times, it is very important to recycle;
- **tire/rubber:** the mass of rubber materials in the car makes about 3.5% of their total mass, and can be recycled again for fuel production and for some other purposes.
- **vehicle operating fluids:** the importance of recycling these fluids, such as engine oil, brake

fluid, transmission oil, refrigerant fluid, etc., is due to the fact that these fluids have a highly negative environmental impact;

- **glass:** the importance of recycling glass comes from the fact that this is a dangerous waste and there is a large quantities of this material; and
- **plastic waste:** harmful environmental impacts is the main reason for recycling of plastic waste from the car. Also, plastic waste can be successfully recycled and used for various purposes.

Figure 2 shows the parts of cars that can be reused and after exploitation with the type of material that is most significant in the recycling of the considered part (Official site ELV Metal Recycling).

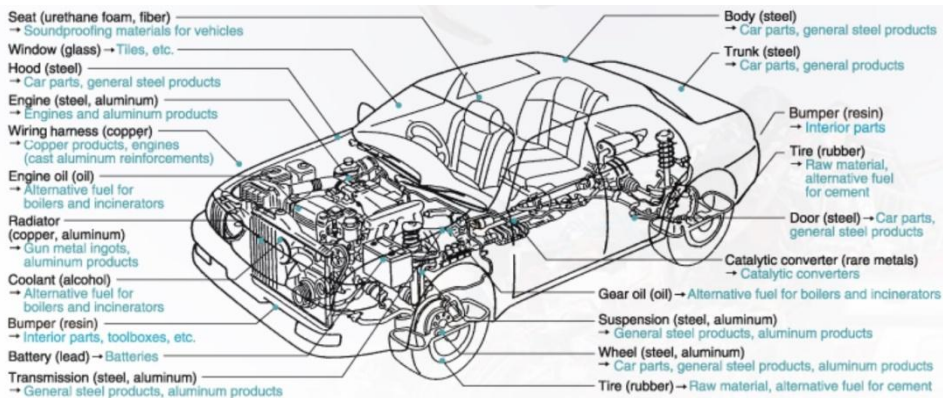


Figure 2. Parts of cars that are most often recycled (Official site ELV Metal Recycling)

These types of waste can be subdivided under basic, but depending on an ELV company's business model, they can have different significance. For this reason, there was a need to develop various types of ELV recycling equipment. The next chapter will show some of the basic types of this equipment.

5. ELV Recycling Equipment

Depending on the purpose, various types of ELV recycling equipment have been developed. This primarily depends on the type of recycled material, the recycle that needs to be obtained, but also about some other features. Although the production process of recycling equipment requires resource consumption (metal, plastics, rubber, etc.) and has an impact on the

environment (Komatina et al., 2015), this equipment is of great importance for resource reconstruction and environmental conservation.

Recycling equipment is largely different in the scope of the purpose or the need it needs to satisfy. Thus, the equipment can be used for various purposes (Despeisse, et al., 2015):

- processing of materials that can be reused for the same purpose and
- prerada materijala koji se moraju processing materials that need to be dismantled before further processing or depositing (cutting, melting, burning, crushing, etc.).

As a contribution of project TR 35033 which is funded by Ministry of Education, Science and Technological Development of the Republic of Serbia, are created three motor vehicle recycling machines at the end of the life cycle (ELV). One of them is Mobile Car Press, which is used to pressing waste sheet metal from the car. The second device, which is the result of this project, is the cable cutting device. In addition to the two devices mentioned above, a car oil waste treatment device was also created.

In addition to these devices, different types of devices of this type can be found on the market. On the official site of Environmental Expert company, a sales representative of a large number of companies producing ELV recycling devices, devices of various uses can be found, such as (Official site Environmental Expert):

- Scrap Car Shredder,
- Baling Press Car Baler,
- Mobile Car Baler,
- Waste Car Body Compactor,
- Twin-Ram Car Logger Baler,
- Stationary Systems for ELV Drainage,
- Car Flattener etc.

The price of these devices differs depending

on the different factors. First of all, from the purpose of the device itself, to the complexity of the production of the device, but also to the extent to which the material is being treated.

It can be said that there is no universal ELV recycling equipment, and that depends on the manufacturer's technological solution. Thus devices of the same purpose can be distinguished by mode of operation, construction, performance, etc. In paper Zhou et al. (2015) was developed model for selection of corresponding ELV Recycling Service Provider by using hybrid MCDM model based on TrFN Type-1, Shannon entropy method and VIKOR method. On the other side, in paper Aleksić et al. (2018) is proposed model for selection of recycling equipment based on COPRAS method and TFN Type-1.

6. Conclusion

The importance of ELV recycling equipment is reflected in the reuse of materials for which it would be necessary to invest both natural and financial resources to re-produce. The need for reuse of materials is due to the fact that more and more cars are produced, and a small number of obsolete ones are disposed of and recycled, but are still being used and have a negative impact on the environment due to excessive CO₂ emissions.

It is extremely important to raise the awareness of the citizens of the Republic of Serbia on this issue, because of the fact that far older cars are driven in Serbia than is the case in the EU, where this issue is of greater importance.

Also, it is very important that ELV's recycling opens new companies for this purpose, produces devices, generates profits, and hence employs people in these jobs. So, in addition to re-utilizing resources and preserving the environment, ELV recycling also has its own social aspect.

Acknowledgment: Research presented in this paper was supported by Ministry of Science and Technological Development of Republic of Serbia, Grant TR-35033, Title: Sustainable development of motor vehicles recycling technology and equipment.

References:

- Aleksić, A., Komatina, N., Tadić, D. (2018). *The selection of equipment for recycling by using fuzzy COPRAS method*. 7th International Symposium on Industrial Engineering, pp 164-167, Faculty of Mechanical Engineering University of Belgrade, Serbia.
- Despeisse, M., Kishita, Y., Nakano, M., & Barwood, M. (2015). Towards a circular economy for end-of-life vehicles: A comparative study UK–Japan. *Procedia CIRP*, 29, 668-673.
- ELV Metal Recycling – Official site, link: <http://www.elvmetalrecycling.com>, accessed date: 20.03.2019.
- Environmental Expert – Official site, link <https://www.environmental-expert.com>, accessed date: 23.03.2019.
- EU SCIENCE HUB – Official site: link: <https://ec.europa.eu/jrc/en/news/research>, accessed date: 24.03.2019.
- Komatina, N., Tadić, D., Arsovski S. (2015). *Evaluation of influence recycling device on environment in production process phase by TOPSIS method*, 9th International quality conference, pp 239-244, Faculty of Engineering University of Kragujevac, Serbia
- Naustdalslid, J. (2014). Circular economy in China—the environmental dimension of the harmonious society. *International Journal of Sustainable Development & World Ecology*, 21(4), 303-313.
- Polovni automobili - Official site, link: <https://www.polovniautomobili.com>, accessed date: 18.03.2019.
- Statistics of Traffic and Telecommunications, *Statistical Office of the Republic of Serbia*, no. 062 – year LXIX, 08. 03. 2019., ISSN 0353-9555
- Webster, K. (2017). *The circular economy: A wealth of flows*. Ellen MacArthur Foundation Publishing.
- Zhijun, F., & Nailing, Y. (2007). Putting a circular economy into practice in China. *Sustainability Science*, 2(1), 95-101.
- Zhou, F., Lin, Y., Wang, X., Zhou, L., & He, Y. (2016). ELV recycling service provider selection using the hybrid MCDM method: a case application in China. *Sustainability*, 8(5), 482.

Nikola Komatina
University of Kragujevac,
Faculty of Engineering,
Kragujevac,
Republic of Serbia
nkomatina@kg.ac.rs

Aleksandar Aleksić
University of Kragujevac,
Faculty of Engineering,
Kragujevac,
Republic of Serbia
aaleksic@kg.ac.rs

Danijela Tadić
University of Kragujevac,
Faculty of Engineering,
Kragujevac,
Republic of Serbia
galovic@kg.ac.rs
