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MARKET ANALYSIS IN THE REPUBLICS OF SERBIA FROM THE ASPECT OF THE CIRCULAR ECONOMY IN THE ELV DOMAIN

Abstract: *This paper presents the literature review of circular economy (CE) and ELV recycling in Republic of Serbia. While circular Economy involves the circulation of materials, resources, energy and their reuse, in the automotive industry the circular economy is implemented by re-manufacturing a wide variety of components and parts. Leading vehicle producers souch as Renault, Fiat have implemented elements of circular economy in order to transform end-of-life parts and vehicles into a vehicle production and maintenance resource in order to reduce the consumption of raw materials. According to literature presented, circular economy is not quite implemented in overall ELV recycling process in Republic of Serbia.*

Keywords: *Circular economy, End-of-life vehicle, Automotive industry, Energy management*

1. Introduction

One of the burning issues of modern civilization is energy. Limitation of fossil fuels could be partly overcomed by sources of renewable energy. When we refer to renewable energy we often refer to „classical“ renewable energy sources such as: solar energy, wind power, water power etc. However in everyday life the number of goods has been used which have potential to be used as renewable energy sources or energy recovery. In each form (paper, plastic, rubber, communal waste….) there are component with high energy potential and through recycling process they could be used as a source of „renewable energy“.

In all countries for many years a linear model is applied. Maxim of this model is: take - make - use–dispose. The movement of resources in this model takes place in one direction. The transition from linear to circular economy model involves changes in the entire value chain of the product. European Commission introduced the EU action plan for the circular economy, which addressed the whole product life cycle from design and production through consumption to waste management. This action plan forms is part of the circular economy package, which includes proposals to revise key elements of the EU waste acquis (legal acts and court decisions as they relate to EU law) including directives on end-of-life vehicles and batteries, hence Serbia has accepted the EU's recommendations on circular economy.

Recently waste (non-desired output of each process) as well as waste management has been considered as a valuable source of renewable energy. Automotive industry is very propulsive sector around the world. Besides its positive impact, this sector has many negative impacts. One of it is connected with high rate of energy spending for producing a vehicle (Che, Yu and Kevin

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2011; Gass, Schmidt and Schmid 2014; Wang and Chen 2013). Besides that, each input part or material for vehicle is also produced with appropriate amount of energy (Manomaivibool 2008; Chen, Huang and Lian 2010). It depends on kind of parts, level of technologies, local and global business environment (Santini et al. 2011; Go et al. 2011), etc. The ELV (*End of Life Vehicles*) is problem which can be resolved through simple disposal, but with a lot of ecological and spatial problems.

2. ELV recycling

The ELV (*End of Life Vehicles*) is problem which can be resolved through simple disposal, but with a lot of ecological and spatial problems. The least favored option of ELV is disposal and land-filling the ELV. The more favored options are energy recovery, recycling and reuse parts from ELV. End-of-Life Vehicles has been in first phase recognized as environmental problem, which have to be solved through many approaches, directives and standards. The ELV has been treated as an important issue by European Union (EU), so EU developed The Directive on End-of Life Vehicle 2000/53/EC as the first directive in the concept of extended producer responsibility. European Union (EU) recognized this problem and in last twenty years made directives and supported EN and ISO standards (Ericson et al., 2014; Paterson et al. 2018). In strategy for year 2020 it is proposed recycling rate and other indicators connected to higher sustainability (Partlitzianas et al., 2008; Kim et al., 2013). It leads to higher ELV recycling business connected with higher spending of energy, employment rate, development and implementation of new recycling technologies. Besides that, outcome of this process is lower environmental impact, lower price of recycling parts and materials, which generate expansion of this business.

ELV recycling is well investigated related to different aspects, as dismantling technologies (Lam and Chase 2012; Antoniou and Zabaniotou 2013), recycling technologies (Dodic et al. 2010; Lopes, Antunes and Martinsl 2012; Liu, Farnsworth and Tiwari 2017), socio – economical benefits (Lam and Chase 2013; Benkovic, Makojevic and Jednak 2013), energy recovery (Tarantini and Laforgia 2017) impact on quality and environment (National assembly of the Republic of Serbia, Energy Law, 2016), infrastructure (National assembly of the Republic of Serbia, Act for incentive measures for privileged producers of electricity, 2016), this Regulation sets forth more incentive measures for the production of electricity from renewable sources and of the highly efficient combined production of electricity and heat.

3. Circular economy

In Cvetić et al. (2018) is stated that customer demand dictates production, therefore in the literature can be found wide range of statistical reports and survey analysis of leading car manufacturers with their engagements and quality assurances. While researching car demand and customers behaviour, leading car manufacturers also try to implement circular economy addressing both ecological and economic issues. Increasing exploitation of resources in the automotive industry increases the amount of waste. Large quantities of waste which are generated in the automotive industry represent a major problem in all countries of the world as well as in Serbia. Hence, recycling and circular economy is gaining importance.

The automotive industry has a responsibility to its customers to support the longevity of their current vehicles by ensuring that products can be serviced, repaired and maintained in such a manner as to not be detrimental to their function, safety and reliability. Key materials used in EV batteries are cobalt, nickel, aluminium

oxides and lithium. The advantage of electric cars is reflected in the use of renewable energy sources, so they are called green cars or vehicles with zero emissions. European Commission encourages the lengthening of the life of batteries before being recycled (Hawkins et al. 2013; "Electric vehicles from life cycle and circular economy perspectives - TERM 2018, Report").

In all countries for many years a linear model is applied. Maxim of this model is: take - make - use–dispose. The movement of resources in this model takes place in one direction. In linear economy model, products are often recycled or discarded when a part fails. The linear model is based on the belief that resources are inexhaustible and there is unlimited space for waste disposal and as such is unsustainable (Despeisse et al. 2015).

Figure 1. Linear economy

Unlike linear economy, circular economy promotes the circular movement of resources and energy and their reuse through recycling already used materials, parts and products. The circular economy concept include the use of renewable energy and sustainable consumption.

The main maxim circular economy is: take - device - fix - reuse – recycle ("What is a Circular Economy? Ellen MacArthur Foundation" 2013). In a circular economy, the product and its components are remanufactured when they breakdown.

In a perfect circular economy, a vehicle would typically go through four stages (Repair, Reuse, Remanufacturing and Recycle- 4 Rs). Remanufacturing returns the part to "as new" condition, enabling the remanufacturer to offer at least the same guarantee as a new product. Ideally reuse is planned in the design process so that the product can be disassembled easily and its components repurposed for other uses with the minimum amount of work.

Figure 2. Circular economy

During recycling every part of the vehicle is recovered and reused to make new materials. In a circular economy the value of materials and products is kept as high as possible for as long as possible (Mitrović, Radosavljević & Veselinov, 2017). This helps reduce requirements for new materials and energy needs, ameliorating environmental pressures. Circular Economy involves designing and manufacturing the components and parts that can be easy separate at the end of life, replace, repair and re-useand which contain organic materials that are not harmful and have a longer lifetime. All stages of production of products according to a circular economy are interrelated ("What is a Circular Economy? Ellen MacArthur Foundation" 2013). The waste from one manufacturing process comes as a resource to another. Benefits of CE include:

- products designed to reduce waste and pollution
- keeping products and materials in use for as long as possible/feasible
- re-manufacturing and recycling of products.

The transition from linear to circular economy model involves changes in the entire value chain of the product (design, development of new technologies, innovation, new business and market models, reorganization and change of management style, changes of organizational structure, changes in consumer behavior, etc.) (Electric vehicles from life cycle and circular economy perspectives - TERM 2018, Report).

4. Energy management as important issue in circular economy

Circular Economy is applied in the automotive industry in a large number of EU countries (Germany, Scotland, Sweden, Switzerland etc.). 2014 The European Commission has adopted Communication "Towards a circular economy: a zero waste programme for Europe", aimed at establishing a common EU framework for the promotion of circular economy.In December 2015, the European Commission introduced the EU action plan for the circular economy, which addressed the whole product life cycle from design and production through consumption to waste management. This action plan forms is part of the circular economy package, which includes proposals to revise key elements of the EU waste acquis (legal acts and court decisions as they relate to EU law) including directives on end-of-life vehicles and batteries. In January 2018, the EU Commission updated the circular economy package with a new set of measures including a Europe-wide strategy for plastics, a monitoring framework on progress towards a circular economy, and a report on critical raw materials and the circular economy.

Figure 3. Circular movement of energy and matter

The transition to a circular economy is of great importance for the completion of the program of efficient use of resources in the context of the Europe 2020 strategy - the smart, sustainable and inclusive growth. Application of circular economy in Renault has contributed to optimizing the use of resources, extending the life of batteries for electric vehicles and increasing recycling raw materials (steel, copper, plastic, etc.). 36% of the total output of Renault's products in Europe is made from recycled materials. Also, Renault plans to increase the recycling of plastics in the future (figure 4).

Figure 4. Circular economy in Renault

Renault implements the circular economy through different product life cycle phases in order to transform end-of-life parts and vehicles into a vehicle production and maintenance resource in order to reduce the consumption of raw materials.

5. Market analysis in the republics of Serbia from the aspect of the circular economy in the ELV domain

The amount of produced waste from motor vehicles is constantly increasing with the dynamics of purchasing new vehicles and regular production and maintenance activities. Serbia and other less developed countries in the region also face the problem of a large number of old vehicles that were supposed to be recycled. In order to acquire an environmentally friendly ELV waste, it is necessary to carry out a proper process of de-pollution, which is compounded by the complexity of hazardous materials contained in a motor vehicle. Therefore, the most appropriate way to achieve this is by using specially designed equipment for removing liquids, batteries and other hazardous materials from the ELV components (Pavlović et al. 2019).

Serbia has accepted the EU's recommendations on circular economy. EV batteries provide useful life in vehicles until they degrade to around 80% of their original capacity. Tesla and Nissan warrant their batteries against malfunction for eight years. FCA promotes biomethan as an alternative and renewable fuel that reduces environmental pollution (Biomethane: A Natural Choice | FCA Group, 2019). Biomethane is obtained by upgrading biogas, which is produced from various types of organic waste. All of FCA's natural gas models can run on biomethane. Previously a niche segment, in recent years the natural gas vehicle market has grown significantly.

Ilić & Nikolić (2016) point out that the largest percentage of waste was landfilled, which is not in compliance with circular economy. Recycling is presented as small percentage (figure 5). Authors also categorized circular economy drivers into four major categories which are

- basic drivers,
- public health,
- resource management, and
- economic-financial capacity,

and used these drivers as a tool to compare different municipalities' goals achievement in Serbia. In 12 selected municipalities in Serbia, most waste ends up in landfills as mixed waste. In order to progress to the circular economy, Zero Waste Europe recommends moving towards resource efficiency.

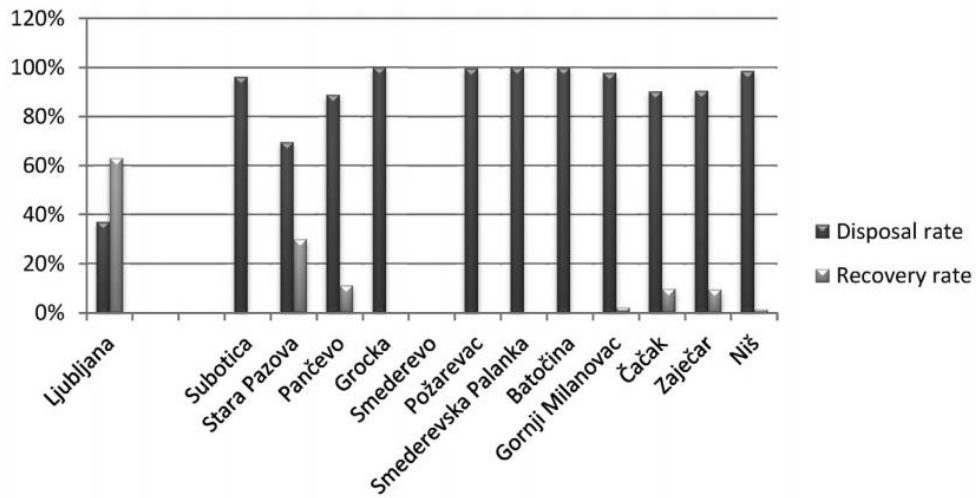

Figure 5. Waste treatment options in Republic of serbia

In order to apply the circular economy, reduction, reuse and recycling activities should be encouraged, resulting in a reduction in the amount of waste. Authors Aćimović & Mijušković (2017), analyzing the current state of compliance and the practical use of green initiatives in the Republic of Serbia claim that there is no generally high level of progress. Namely, the last serious step towards the introduction and implementation of green laws in the Republic of Serbia was made in 2009, when the so-called Green Laws (a package of 16 environmental laws) were introduced. Until 2009, unfortunately, there have been no serious developments in this area.

6. Conclusion

The amount of produced waste from motor vehicles is constantly increasing. Serbia and other less developed countries in the region also face the problem of a large number of old vehicles that were supposed to be recycled. End-of-Life Vehicles has been in first phase recognized as environmental problem, which have to be solved through many approaches, directives and standards. The ELV has been treated as an important issue by European Union. According to directives and moving trends transition to a circular economy is of great importance for the completion of the program of efficient use of resources in the context of the Europe 2020 strategy - the smart, sustainable and inclusive growth. Leading vehicle producers souch as Renault, Fiat have implemented elements of circular economy in order to transform end-of-life parts and vehicles into a vehicle production and maintenance resource in order to reduce the consumption of raw materials. According to literature presented, circular economy is not quite implemented in overall ELV recycling process in Republic of Serbia.

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