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GLOBAL CIRCULAR E-CHAIN IN OVERCOMING THE GLOBAL WASTE*

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Abstract

This article presents the circular economy in the context of circular e-chain formation as a solution in overcoming the global waste. The global waste composition and global waste generation by region is to analyzed. The regression and correlation analysis of waste generation, global regions scale is evaluated. Their practical implementation in case of the circular e-chain id developed. The problem's spaces and company policy of circular e-chain is identified. It allows doing one main conclusion – countries should trade of their waste – this is one real solution for government and source of wealthy for inhabitants. The circular e-value chain of the lithium-ion battery divided into six key segments ranging from mining and processing of raw materials, to the disposal of the finished product, the production of storage batteries and the production of electric vehicles. Extraction of minerals and raw materials for the lithium-ion batteries, and the processing of these materials, usually takes place outside the EU. The process of circular e-chain formation on each stage has a risk: too centralized supply link in one country; new areas for extraction; future of a lithium-ion battery is anxious. The main goal in developing their new electric models is increasing their energy efficiency in increasing their range.

Keywords: circularity, e-chain, emissions, recycling, waste

1. Introduction

“2019 must be the year where we translate the positive momentum and commitments to shape a circular plastic economy into tangible investment and actions globally. In Davos, public and private

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leaders debated how to make this happen, and the Global Plastic Action Partnership is now poised to move into action in collaboration with Indonesia, Vietnam and other partners as 2019 kicks off.”

Antonia Gawel

Head of Circular Economy Initiative, World Economic Forum

Based on an inclusive approach, the green economy operates with the concepts of “justice”, “equality”, “participation”, “freedom”, “democracy”, the central place among which belongs to the social and environmental problems. But focus on the green economy is not so much meet the needs of people and ways to realize their benefits or the satisfaction of the requirements of powerful private corporations (Odum, 1994). The slogans of the linear economy, on which the foundations of the organization of ensuring the vital functions of society – “take, make, dispose” - ignore the environmental and social aspects, which inevitably leads to the destruction (Ghisellini et al., 2016). This means that the current economy is not sustainable. In the majority, it does not pay enough attention to the environmental and social aspects that symbolize the value of the Porter's value chain. In contrast to the linear economy, the green economy, which is based on a closed loop (Gregson et al., 2015), is founded on the sustainable value chain 9Rs principles (refuse, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recover energy, which greatly expanded the existing 4R principles (reduction, reuse, recycle, replace) of waste prevention.

In scientific literature, this type of economy is called circular. It is associated with the ability to “build” a strong chain of “economic growth-consumption of natural resources”. However, this is only part of the sustainable development concept, and this part, if not ignored, does not emphasize the need to improve the quality of life. In addition, the circular economy, let us to save energy, increase energy efficiency in general and minimize carbon emissions by focusing on the resource component of the socio-economic transformation (Ayres, 2008).

Geissdoerfer et al. (2017) developed the idea about the interconnection between the circular economy and sustainable development and the result of which was the conception of its positioning. The concept of the circular economy can be interpreted also as a combination of the existing socio-ecological paradigm of the transition from nature to nature management, because it focuses not only on resource use, but mainly on resource formation, which can be considered as a methodological basis for managing resources in accordance with the objective of the “green” economy and sustainable development. The circular economy is transmitted along with such concepts: cradle-to-cradle (C2C), performance economy, life-cycle assessment, planetary boundaries (Kalmykova et al., 2018).

The aim of the article is to analyze global circular e-chain as a solution in overcoming the global waste. According to the aim we proposed some tasks:

- to analyze the global waste composition and global waste generation by region;
- to evaluate the regression and correlation analysis of waste generation, global regions scale;
- to develop their practical implementation in case of the circular e-chain;
- to identify the problem's spaces and company policy of circular e-chain.

2. Method for data processing and interpretation

The world generates 2.01 billion tons of municipal solid waste annually, with at least 33 percent of that – extremely conservatively – not managed in an environmentally safe manner. Worldwide, waste generated per person per day averages 0.74 kilogram but ranges widely, from 0.11 to 4.54 kilograms. Though they only account for 16 percent of the world's population, high-income countries generate about 34 percent, or 683 million tons, of the

world’s waste. Across regions, Sub-Saharan Africa collects about 44 percent of waste while Europe and Central Asia and North America collect at least 90 percent of waste (Fig. 1).

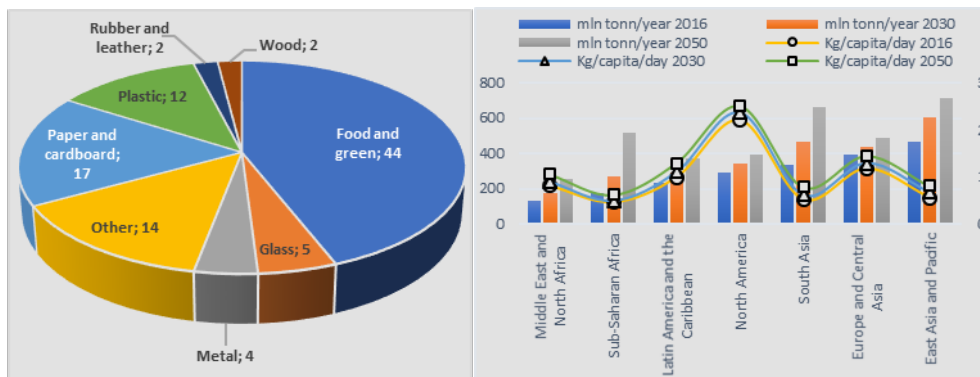


Fig. 1. Global waste composition %, 2017; global waste generation by region

So, Global waste composition (%) in 2017 represented the max meanings in Food sector – 44%, Paper industry – 17%, Plastic – 12%, Glass – 5% - basic target sectors for formation of global circular supply e-chain. According to the forecast calculation Global waste generation by region: in 2050 – Sub-Saharan Africa, South Africa, East Asia and Pacific. Biggest gap between waste consumption mln.t. per year and kg. cap. per day is in North America (fig.1).

We used data of World Bank Group and IMF Data. With help of program Statistica 12, which includes analytic and exploratory graphs in addition to standard 2- and 3-dimensional graphs that allow outline data analysis. According to the regression and correlation analysis of waste generation, global regions scale, 2016-2030 $R=0.99701603$ $R^2=0.99404096$ Adjusted $R^2=0.98212289$ (Table 1).

Table 1. Regression and correlation analysis of waste generation, global regions scale, 2016-2030

<i>Correlations of Regression Coefficients b; DV: GDP per capita ths 2030 R=0.99701603 R2=0.99404096 Adjusted R2=0.98212289 F(4.2)=83.406 p<0.01188 Std.Error of estimate: 2.7633</i>						
N=7	b*	Std.Err. of b*	b	Std.Err. of b	t(2)	p-value
Intercept			-12.981	5.18852	-2.5018	0.129458
Waste Generation 2016	0.92031	0.335302	0.158	0.05759	2.74473	0.111060
Waste Generation 2030	-0.52481	0.330291	-0.076	0.04776	-1.5889	0.253019
Waste per capita 2016	7.87283	2.164085	266.420	73.23368	3.63795	0.067948
Waste per capita 2030	-7.02475	2.168930	-227.064	70.10718	-3.2388	0.083556

Based on the volume of waste generated, its composition, and how it is managed, it is estimated that 1.6 billion tons of carbon dioxide (CO₂) equivalent greenhouse gas emissions were generated from solid waste treatment and disposal in 2016, driven primarily by open

dumping and disposal in landfills without landfill gas capture systems. This is about 5 percent of global emissions. Solid waste-related emissions are anticipated to increase to 2.6 billion tons of CO₂-equivalent per year by 2050 if no improvements are made in the sector.

In most countries, solid waste management operations are typically a local responsibility, and nearly 70 percent of countries have established institutions with responsibility for policy development and regulatory oversight in the waste sector. About two-thirds of countries have created targeted legislation and regulations for solid waste management, though enforcement varies drastically. Direct central government involvement in waste service provision, other than regulatory oversight or fiscal transfers, is uncommon, with about 70 percent of waste services being overseen directly by local public entities. At least half of services, from primary waste collection through treatment and disposal, are operated by public entities and about one-third involve a public private partnership. However, successful partnerships with the private sector for financing and operations tend to succeed only under certain conditions with appropriate incentive structures and enforcement mechanisms, and therefore they are not always the ideal solution.

According to the factor analysis plots of waste generation, global regions scale, 2016-2030: 2030 Maximum point of GDP would provide by maximum waste generation and waste per capita. It means even the most developed countries couldn't avoid accumulation of waste (deep red point). It allows to do one main conclusion – countries should trade of their waste – this is one real solution for government and source of wealthy for inhabitants (Fig. 2).

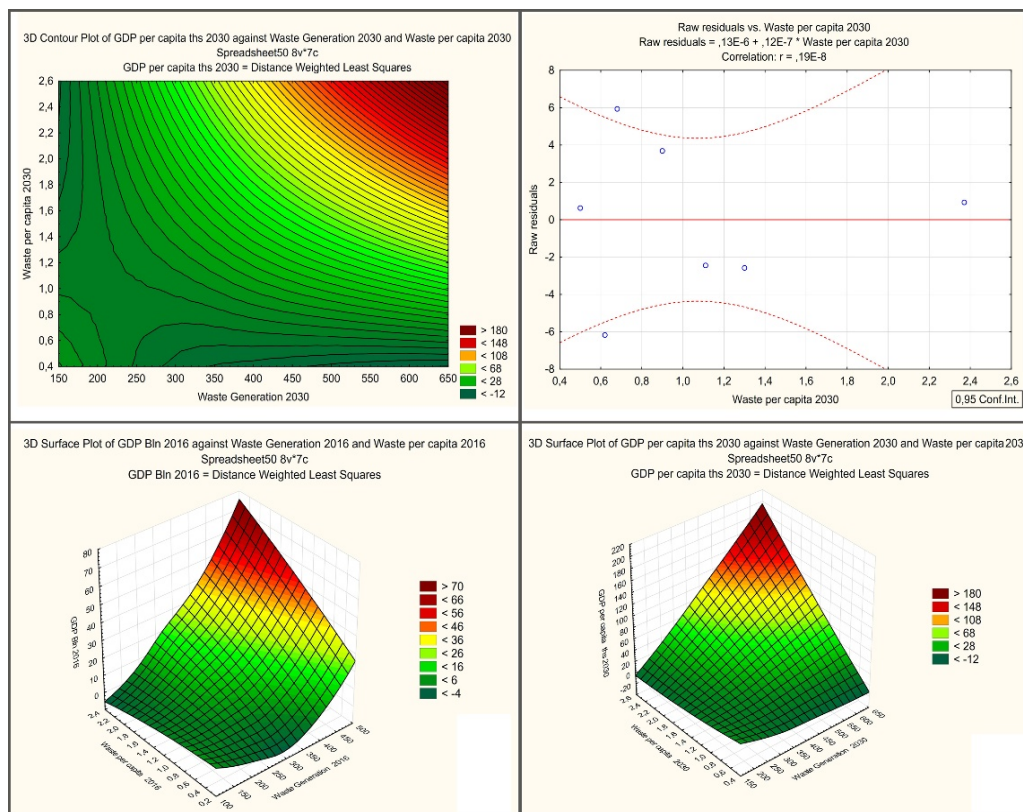


Fig. 2. Factor analysis plots of waste generation, global regions scale, 2016-2030

3. Case Study: Circular e-chain

According to the chief executive officer of the Swedish company, which works with Porsche and Volvo Cars Johann Sternberg, car manufacturers have a big problem now - a large amount of used battery. On the other hand, it is the so-called circular market for e-batteries with inclusive vector, which is according to our research – the first link (or section) in circular chain.

Bloomberg NEF has proven that by 2040 more than half of the sales of new cars and thirds of the world fleet - will be electric (559 million cars). By 2050, companies will invest about 550 billion dollars in industrial and network batteries. This is a circular economy that accumulates the battery, which makes it possible to assemble an electric car, becoming a part of the new energy world or one of the link of circular e-chain.

Efforts to reuse can slow down if it is more profitable to extract materials like cobalt and simply make new batteries. The components will usually be replaced in family cars (10 years) and four years in bus and taxi. Despite the fact that replaced batteries cannot handle a passenger car, but they are ideal for less demanding tasks such as solar power storage and wind turbines, as well as to save energy from regular network connections at low prices.

According to the founder of the London-based company Hans Eric Melina, Circular Energy Storage Research & Consulting, the lithium ion battery virtually never dies. It's the same as taking a alkaline battery from the lantern and putting it on the remote control - and that will be enough. By 2025 about three-fourths of used batteries will be reused and then utilized for collecting raw materials in new circular e-chain. For example, in western Sweden, the so-called Box of Energy is fitted as a big fridge, which uses 20 battery modules obtained from hybrid Volvo cars. They save energy from solar panels on the roof of the residential complex. Another example is The Nissan Leaf. Their batteries will soon be able to light the streets in the Japanese coastal town of Naomie, which is recovering from the 2011 Fukushima Daiichi nuclear power plant.

So, Toyota, the manufacturer of the hybrid Prius, will install its used batteries outside the 7-Eleven stores in Japan. Hybrid batteries will save energy from the solar panels, and then use it to cool the beverages, heat the fried chicken and sausage grills inside the stores. Typical EV battery holds about 50% - 70% of its power after its use in electric vehicles.

The circular e-value chain of the lithium-ion battery can be divided into six key segments ranging from mining and processing of raw materials, to the disposal of the finished product, the production of storage batteries and the production of electric vehicles (Fig. 3). Extraction of minerals and raw materials for the lithium-ion batteries, and the processing of these materials, usually takes place outside the EU. China is a leader in the production of fuel cells. In 2014, China had 41% of the world's automotive cell production capacity, while in the EU it was only 5%.

The next step in the process is the production of a battery pack (40% of the EV battery). EU has 22% of the worldwide market, while China is the leader with 33% of the market. The lithium-ion batteries contain materials that are among the candidates classified as critical raw materials (CRMs) defined by the European Commission. The process of circular e-chain formation on each stage has a problematic place.

The problem (risk) is *too centralized supply link in chain in one country*. Currently, graphite is rather centralized because it produces fewer countries, but reserves are more diversified. Since nearly half of world cobalt ore reserves are concentrated in the Democratic Republic of the Congo in the foreseeable future, and with a large share of processing capacity in China, the supply chain may be more vulnerable. China has been shown as a unreliable supplier of this material in e-chain.

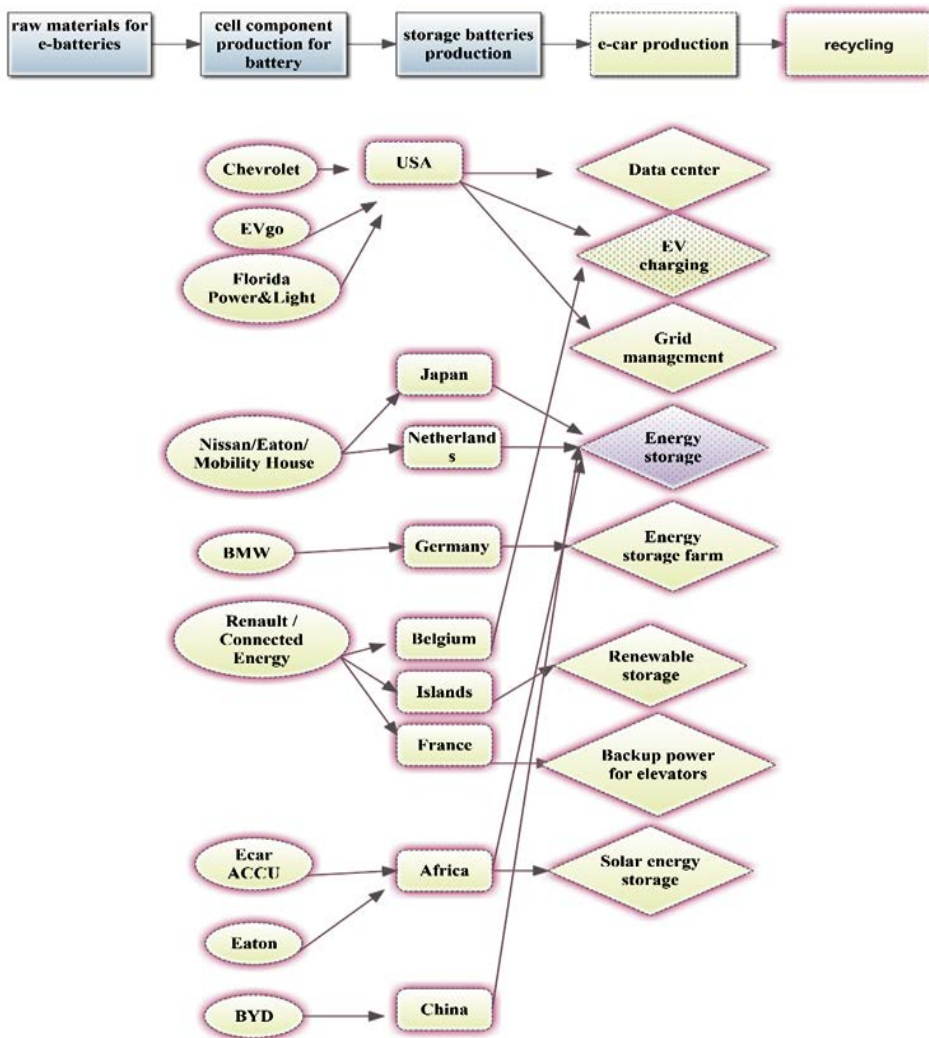


Fig. 3. Circular e-chain

Ecologically, the future of a lithium-ion battery is also anxious. Ultimately, recycling of lithium should play a role in mitigating the political, environmental and economic risks. But lithium battery recycling has not yet begun. In particular, it is possible to distinguish companies that are leaders in using recycled material and are members of circular e-chain (Table 2).

Electric car makers have one main goal in developing their new models - increasing their energy efficiency in increasing their range. One of the key factors is the weight of the car. The problem of recycling parts of cars, especially metals is a metal pollution. Due to the contamination of other materials, the metals are not considered sufficiently clean for recycling and make new structural parts of the car. However, during the production process, there is an opportunity for structural materials of the car to be submitted and recycled in supply chain – circular e-chain. In a controlled production environment, the quality of the secondary material can be saved, and pollution can be a much smaller problem.

Table 2. E-cars – company’s policy

<i>Company</i>	<i>Policy</i>
• <i>Nissan Leaf</i>	<ul style="list-style-type: none"> • <i>The Nissan Green Program aims to eliminate all waste throughout the life of the vehicle, from design to utilization.</i> • <i>Almost 25% of Nissan Leaf is made from recycled materials.</i> • <i>Old PET bottles are redone to make seats, recycled fabrics are used in sound insulators under the hood, and parts from old electric appliances are used in the central part.</i>
• <i>BMW i3</i>	<ul style="list-style-type: none"> • <i>Some of the eco-friendliest features of the BMW i3 do not use secondary materials, but instead take into account the impact of production on the environment.</i> • <i>Instead of using formaldehyde or other chemicals to ignite leather seats, BMW uses olive leaves.</i> • <i>Door panels are made of renewable natural fibers, such as open-air eucalyptus, which has been certified by FSC.</i>
• <i>Toyota Prius</i>	<ul style="list-style-type: none"> • <i>Prius uses bio-plastic in their seat cushion design, and in a few other parts.</i>

For example, only about half of the sheet metal in the car door production can be used in the circular e-chain, and the rest is utilized. In such way, the circular value-added chain or circular e-chain - between Jaguar Land Rover (JLR) and Novelis aluminum producer ceased was organized. In such form of partnership 30,000 tons of aluminum bar of the press were restored in JLR factories and modified by Novelis to be used in the production of new car panels.

4. Conclusions

According to our research the biggest gap between waste consumption mln.t. per year and kg. cap. per day is in North America. According to the factor analysis plots of waste generation, global regions scale in 2030 maximum point of GDP would provide by maximum waste generation and waste per capita. It means even the most developed countries couldn’t avoid accumulation of waste.

Countries should trade of their waste. So, we can talk about formation in the near future circular multinational corporations with headquarters in the developed countries and their daughter companies in centers of waste generation – Sub-Saharan Africa, South Africa, East Asia and Pacific.

References

- Ayres R.U., (2008), Sustainability economics: Where do we stand? *Ecological Economics*, **67**, 281-310.
- Geissdoerfer M., Savaget P., Bocken N.M.P., Hultink E.J., (2017), The circular economy - a new sustainability paradigm?, *Journal of Cleaner Production*, **143**, 757-768.
- Ghisellini P., Cialani C., Ulgiati S., (2016), A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems, *Journal of Cleaner Production*, **114**, 11–32.
- Gregson N., Crang M., Fuller S., Holmes H., (2015), Interrogating the circular economy: the moral economy of resource recovery in the EU, *Economy and Society*, **44**, 218-243.
- Kalmykova Y., Sadagopan M., Rosado L., (2018), Circular economy – from review of theories and practices to development of implementation tools, *Resources, Conservation and Recycling*, **135**, 190-201.
- Odum H., (1994), *Ecological and General Systems: An Introduction to Systems Ecology*, Colorado University Press, Colorado, USA.