# CHALLENGES OF CIRCULAR ECONOMY IN CROATIA[1]

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## ABSTRACT

"Take-make-consume-dispose" approach or a linear model of economy is nowadays replaced with circular economy or "take-make-consume-take-make…" approach. Instead of throwing away circular economy recycles and reuses. The main idea is, as the nature returns everything back to the cycle, the economy also needs to have a closed loop in order to be sustainable. Two reasons lie behind this claim. First, the world population is increasing at growing rates and the scarce resources are to be exhausted. Second, linear economy leads towards environmental degradation that contributes to the climate change. Circular economy systematically changes the way the economy functions. The governments support use of renewable energy resources and waste management as well as discovery of new technologies. The goal of this paper is to assess the Croatian economy in the light of circular economy. Unlike the rest of the European Union which is considered the greenest region of the world, Croatia is lagging behind. The shift towards circular economy is yet to begin and this paper is considering the most important steps Croatia will have to make to accelerate the transition process.

**KEY WORDS:** circular economy, Croatia, waste management, renewable energy.

## 1. INTRODUCTION

As the standard of living rises, more and more different products are used. To produce these products, we need different materials from nature. However, planet Earth cannot keep pace with extensive utilization of scarce natural resources as the world population continues to grow along with their insatiability. Besides, in order to make these products fossil fuels are used. Also, large amounts of waste are thrown away after the consummation of a product. This means we have at least two big issues: the reduction in available resources due to population growth and climate change due to environmental deterioration.

The above described functioning mode is usually known as linear model of economy which relies on "take-make-consume-dispose" approach. Today it is becoming increasingly replaced with circular economy (CE) model focused on "take-make-consume-take-make…" approach. The goal is to achieve the economy with no waste i.e. an economic system where economics and environment are interlinked. So, instead of throwing away CE constantly recycles and reuses materials. In order not to exhaust resources, the renewable energy is used. In opposition to open system, CE is closed, regenerative system in which everything is designed to be repaired, reused, reproduced, recycled etc. This makes CE a sustainable development[2] strategy.

CE systematically changes the way economy functions. And the change is mostly amended and implemented by the government who support the use of renewable energy resources and waste management as well as discovery of new "green" technologies. Since the concept of CE is new, many governments are yet to start their support and movement towards it. Some authors even call for a new economic model (see e.g. Persson, 2015) that will lead to resource saving and environment friendly society (Zhou, 2006). Due to high importance of this concept which is supported by many European Union (EU) documents[3], this paper aims to give a practical contribution and policy recommendations and implications for Croatia which seemingly lags behind western EU economies.

The paper analyses how the concept of CE evolved and why it is an imperative for the sustainable development. The

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[2] The approach of sustainable development takes the Earth scarce resources into consideration. The point is to make a system that can work indefinitely without collapsing. This makes economics and environment inseparable entities.

[3] Most of these documents can be found on European Commission site, available at: http://ec.europa.eu/environment/circular-economy/index_en.htm (accessed 13.07.2017.)

main contribution of this paper is threefold. First, we gave an assessment of CE concept development so far. Second, it contains the institutional framework for European Union and its member states showing where the countries that have aspirations of implementing the CE have to start and what adaptations are necessary to continue that path. Lastly, this is the first study which points to analysing challenges of CE concept implementation in Croatia. The most urgent challenge for the Croatia lies in waste management, which requires on radical changes – namely leaving behind old practises and focusing on separate waste collection. Much more needs to be done in the area of information provision and education on the local level.

The paper is structured as follows. Section 2 defines the concepts of CE and gives its theoretical specificity and highlights its practical importance. Regulatory framework presented in section 3 focuses on the European Union legislation and the key elements of a CE Package as it presents the legal framework for Croatia. In section 4 we analyse opportunities and challenges of CE in Croatia. Finally, section 5 concludes and presents some limitations and recommendations for future research as well as policy implications and recommendations for future improvement of CE.

## 2. THE ASSESSMENT OF CIRCULAR ECONOMY

The idea of CE comes from the nature where everything returns back to the cycle (take for example a tree and its blossoms that either create another tree or serve as a food through biodegradation). Accordingly, the economic system should also close a loop of used materials in order to be sustainable. The importance of closing the system was visionary emphasized by Boulding in 1966, who claimed that the closed system (earth) of the future will require different economic principles from those of the open system (earth) of the past (Boulding, 1966:7). The difference between these systems is that in a closed system, the outputs of all parts of the system are linked to the inputs of other parts (ibid:2). This is very exact description of CE. Su et al. (2013) note that CE concept itself has been first raised by Pearce & Turner (1990) who pointed that traditional economy treated environment as a waste reservoir. In line with Boulding (1966) their proposal focused on creation of a closed-loop of materials in the economy i.e. CE. Persson (2015) sees CE as "a way to face resource limitations through continuous circulation of materials, which could also foster economic growth decoupled from extraction of finite resource". He states that CE is an industrial model where waste is designed out, the way things are produced is improved and products are designed to be easily recovered and recycled (ibid:5). It is generally believed that circular model no longer represents "business as usual".

The key methods in CE are "reduce, reuse and recycle" or the 3Rs. Reducing refers to minimizing inputs of materials and energy in production process (supply) and minimizing consumers' consumption (demand). Reusing means that someone's waste is someone else's raw material. This opportunity has to be encouraged along with the production of convenient materials that can be reused. Recycling encourages transformation of used materials for a production of new products. In that sense the eco-design directives should be promoted as to improve recyclability. According to Heshmati (2015:3) the CE in practice resonates with the concept of industrial ecology which aims at benefits exploration of reusing and recycling residual waste materials including energy, water, different byproducts as well as knowledge.

McDonough & Braungart (2002) argue that the above mentioned concept of reducing, reusing and recycling is still a 'cradle-to-grave' principle that only minimizes damage and therefore is not good enough to accomplish circular and sustainable economy. The authors suggest that 'cradle-to-cradle' strategy needs more radical change. Authors analyze two alternative concepts: downcycling and upcycling. The first corresponds with recycling materials in order to make new lower-value products than the original ones. The latter is in correspondence with the notion that the recycling process should add new value to the recycled materials or items. The idea goes further and assumes that the use of such inputs can be converted either to biological (non-toxic materials good for nature e.g. food products that can decompose) or technical (materials that can be recycled e.g. metals or minerals) nutrients at the end of their lifecycle (for a detailed explanation see e.g. Ellen MacArthur Foundation (EMF), 2012 or EMF, 2013). Therefore, the upcycling concept is preferable to the downcycling concept.[4] But to make this concept a reality, for the purpose of retaining the materials in a closed loop, the manufacturing process needs to be changed radically. Thus 'cradle-to-cradle' concept expanded the CE concept. Another important concept that supported the development of CE concept is 'biomimicry' – an approach focused on innovation which seeks for sustainable solutions "by emulating nature's time-tested patterns and strategies. The goal is to create products, processes, and policies - new ways of living - that are well-adapted to life on earth over the long haul." (Biomimicry institute, 2017). European Commission (EC) took the similar approach to this expanded concept of CE. As it can be seen from EU documents, European Union promotes the idea that CE has to go beyond the pursuit of waste prevention and waste reduction and inspire "technological, organizational, and social innovation throughout the value chain in order to 'design-out' waste from the beginning, rather than relying solely on waste recycling at the end of the chain" (EC, 2014b:3). In addition, the cooperation between all phases of industrial production to recycling in the form of industrial symbiosis is desirable (Bastein et al., 2013).

As many concepts of CE exist so do their own visualizations. On Figure 1 we represent a European Environment Agency's (EEA, 2016) simplified model. The 3R principles ("reduce, reuse and recycle") are at the core of the model. The basic idea is to reduce waste generation and material inputs through

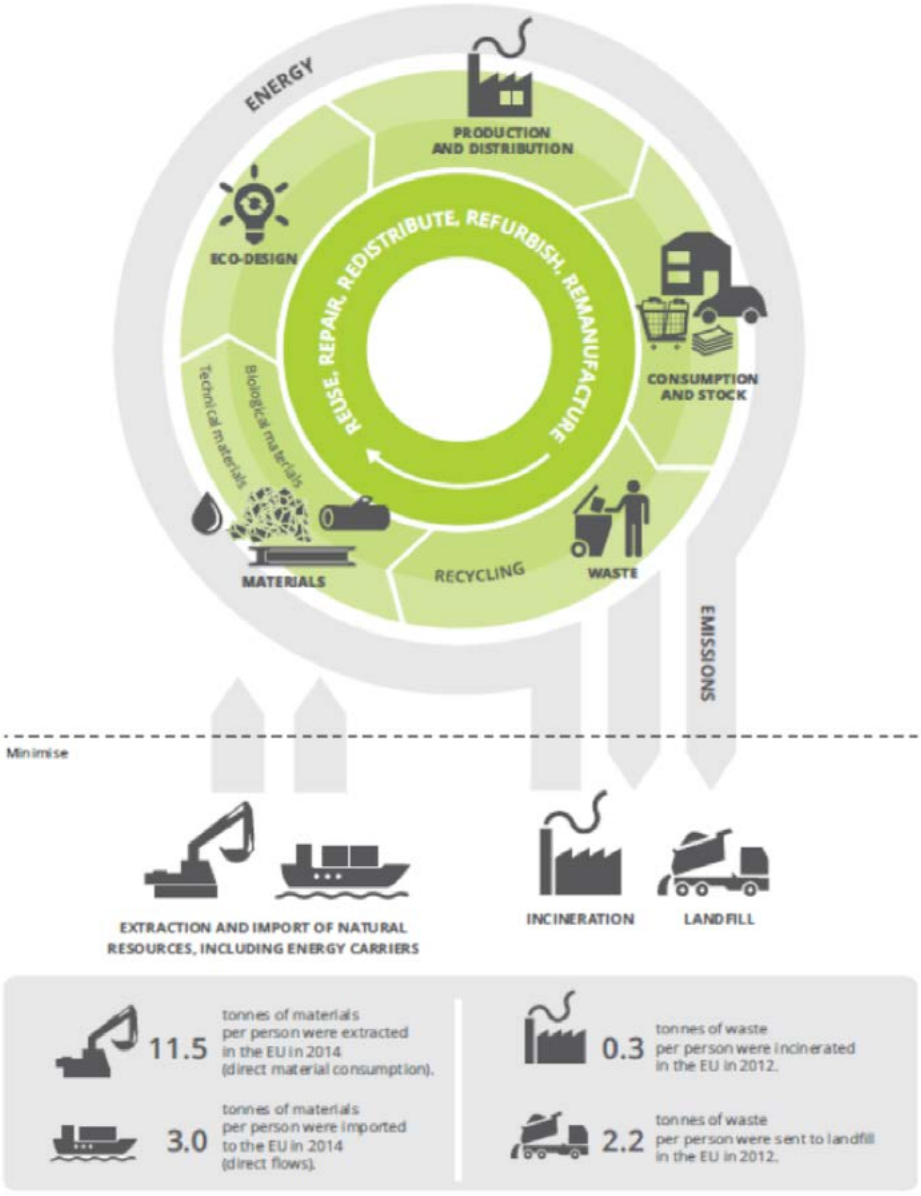
[4] There is also the concept of precycling that refers to avoiding the use of materials that cannot be recycled.

eco-design, recycling and reusing of products. The outer circle represents the overall energy flows. First, total energy efficiency and the share of renewables should both increase. The implications for incineration are not straightforward as energy recovered through it can partly compensate for (fossil) fuel use; but again, the energy from incineration can be used only once and thus removes materials from the loop. The landfills should be exterminated. In parallel with reduced dependency on extraction of materials and imports the reduction in the emissions to the environment declines.

The middle circle represents the material flows in the recycling loop starting with eco-design and finishing with abiotic technical or biological nutrients. As the biological materials are truly renewable it is beneficial if their share would increase whereas technical materials are not so their share should fall. In practice, both materials are often mixed, which has implications for biodegradability and recyclability (ibid:9).

Finally, the inner circle requires minimal resource input as reusing, repairing, redistribution, refurbishment and remanufacturing bypass waste generation and recycling. This 5R's retain the value of products, components and materials at the highest possible level (ibid:9-10).

**Figure 1.** A simplified model of the CE for materials and energy




Source: EEA, 2016:10

Over the past six decades, ever since the Boulding writings, the concept of CE is evolving. Along with its development containing somewhat different and sometimes even contrasting view of economy and world (with even some caring only about nature and not at all about the economy, e.g. many ecologists) the definition of CE was missed. Accordingly, at the beginning stage of development of new CE paradigm (solid-) waste management was the first step in solving environmental and resources problems. Later it became a whole new model for sustainable economy including whole product lifecycle from production (starting with eco-design) to consumption. Therefore,

in order to make a transition to CE, all economic agents have to collaborate: public (including policy makers) and private sector (especially researchers) along with civil society. This is possible if all of them have a common goal – the introduction of CE – that will make the economy and society better and sustainable. The final positive effects of CE should be sought in four different areas: (1) *resources* as CE conserves materials and recycles them making a country less dependent on imports. Current estimates show that 6–12 % of all material consumption, including fossil fuels, is currently being avoided as a result of recycling (Dodick & Kauffman, 2017:4); (2) *economics* as the competitiveness and innovation should rise through the resource efficiency/cost savings. Also, sources of economic growth would change in the CE. Physical goods will no longer be the main driver of growth but the amount of services consumed; (3) *environment* as the nature is preserved. Ellen MacArthur Foundation & McKinsey Center for Business and Environment (2015) estimate a CO2 emissions drop of 48 % by 2030 and 83 % by 2050, compared with 2012 levels; (4) *society* as it should improve people's overall well-being. It is expected that sharing, eco-design, reusing and recycling result in more sustainable consumer behavior, while contributing to human health (Dodick & Kauffman, 2017). Also, CE is expected to create job opportunities. According to the European Commission's impact assessment policies towards CE, it could result in the creation of up to 178 thousand new jobs by 2030 (EEA, 2016). Nevertheless it is important to note that in the transition processes towards CE benefits will not be evenly distributed and there will be some losers (e.g. jobs in low-quality consumer goods industries could be lost).

In moving towards CE, governments considered not only waste management policies but also policies oriented towards energy efficiency, energy conservation, water management, land management etc. The first country which introduced CE law was Germany in 1996[5], the second was Japan in 2000[6] and the third was China in 2003[7]. Today many economies strive to introduce the concept of CE. Along with these trends many studies are carried in order to assess the improvements brought by CE concept implementation. Persson (2015) analyses how the Swedish public sector employees perceive introduced CE projects and concludes that the general notion is highly positive. Jackson et al. (2014) proposes practical tools and methods which should be used in the transition of the Australian metals sector towards a CE model. Similar analysis is performed for the Netherlands (Bastein et al., 2013) with the conclusion that clear and consistent communication across governmental departments is crucial for CE concepts' success. Authors also stressed out that then the transition to a CE will be beneficial for all. Guldmann (2016) presents best practial examples of circular business models in Denmark. She finds that many of the examined companies apply a step-by-step or experimental strategy, where they test the resilience of a circular business model within a limited number of product lines or in one business unit at a time.

European Union enacted common environmental and energy policy that includes environmental policies and covers all aspects from production to consumption and waste management. Those policies often do not refer to CE concept – but the purposed patterns are very similar or even the same. Additionally, lately European Commission calls for a support and movement towards a CE in many documents (EC, 2012, 2014a, 2014b). One example is European Commission's adoption of legislative package in 2015 dealing with CE which is, along with few other documents, described in the next section (EC, 2017).

In countries like China and Japan problems of high air pollution as well as environmental degradation and resource scarcity have led efforts towards establishment of a CE. Geng & Doberstein (2008a & 2008b) describe measures being implemented in China for the long-term promotion of a CE (including objectives, legislation and policies) and also analyse current barriers and problems in promoting green procurement in the Chinese governmental sector. They emphasize that policies concerning CE have to be simultaneous at micro, mezzo and macro levels. According to Heshmati (2015) China is the only country that practices CE as a development strategy on a large scale. He concludes there is more to do, but the progress is apparent. On the contrary, Japan is a country where CE legislative experience is mixed. Davis & Hall (2006) state that many Japanese laws concerning CE are not matching Japan's cultural norms and therefore the results are not promising.

To conclude, achieving CE concept goals will not be easy. Ellen MacArthur Foundation provides evidence that circularity has started to make inroads into the linear economy and has moved beyond proof of concept. China is an example of positive effects circularity brings. Europe is driving fast towards it. But not only governments strive to establish CE but many companies (e.g. Ricoh, Philips, H&M, Trina Solar, and Vodafone) also use different forms of circular arbitrage and capture more value over time (EMF, 2014). Hopefully, the good examples will continue to appear.

## 3. REGULATORY FRAMEWORK FOR CIRCULAR ECONOMY IN THE EUROPEAN UNION

The concept of CE is closely linked to the United Nations (UN) sustainable development goals (SDGs) adopted in 2015, especially those that stimulate action to "protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate

[5] Available at: https://germanlawarchive.iuscomp.org/?p=303 (accessed 12.07.2017.)

[6] Available at: http://www.env.go.jp/recycle/low-e.html (accessed 12.07.2017.)

[7] Available at: https://www.ecolex.org/details/legislation/cleaner-production-promotion-law-lex-faoc046926/ (accessed 12.07.2017.)

change, so that it can support the needs of the present and future generations" (UN, 2015). The EU contributed to shaping SDGs that balance economic, social and environmental dimensions of sustainable development, and it strives to be a frontrunner in implementing the UN 2030 Agenda and its goals. The principles of sustainable development are included into EU policies and legislation through the EU Sustainable Development Strategy 2001, the EU 2020 Strategy 2010, and the EU's Better Regulation Agenda 2015. The sustainable growth is put forward as one of three priorities in Europe 2020 strategy emphasizing the need to "promote a more resource efficient, greener and more competitive economy" (EC, 2010).

The rapid environmental deterioration around the world has led to the development of policies for reducing the negative impacts of production and consumption on the environment (Heshmati, 2015:2) leading to transition to a different economic model. As it is already mentioned, Germany acted as a pioneer and implemented CE in 1996 when the "Closed Substance Cycle Waste Management Act"[8] came into force. This Act is considered the most significant element of German CE legislation and its principal innovation was creating a framework for the imposition of "Extended Producer Responsibility" to avoid generation of waste by building a life-cycle economy (Davis & Hall, 2006). In 2012, the "Circular Economy Act"[9] implementing the EU Waste Framework Directive came into force and clearly stated Germany's dedication to promote ecologically sound waste management and a CE protecting natural resources (Bourguignon, 2014:6). France developed a strategy and a roadmap for the CE transition in 2013, and the UK also initiated transition process by developing an initiative on CE (WRAP), supporting waste reduction and improving resource efficiency (Bourguignon, 2014:7). Reducing waste to a minimum is the first step in CE, but policies must go beyond waste management to achieve sustainable production and consumption (EEA, 2015:152).

In order to overcome the limitations of a linear economy and heavy dependence on imported raw materials, the European Commission launched Circular Economy Package in December 2015. The Package includes an EU action plan for the CE with its annex and four legislative proposals on waste policy[10]. Besides Circular Economy Action plan, several other EU policies are also directed at the CE, including the environment policies, energy and climate policies, the Digital Single Market and the Collaborative Economy (Taranic et al., 2016:11). According to European Commission, although waste management is only one part of CE, it plays a leading role and determines how the EU waste hierarchy is put into practice (EC, 2015a:8). The legislative proposals revised six EU Directives on waste management to facilitate implementation and address differences across EU member states. The average recycling rate of waste produced by EU households is only 40 % with strong variations between member states (MS) and regions. The recycling rates are as high as 80 % in some areas, and even lower than 5 % in others (EC, 2015a:8) indicating that the member states have different starting positions regarding the adopted waste targets. The member states with the biggest implementation challenge are allowed to use time extensions of maximum 5 years to meet the proposed targets (EC, 2015b:3).

The revised waste proposals contain new targets and additional means to ensure their proper implementation (Table 1.) providing stable framework for waste management in the EU based on a long-term vision (EC, 2015b:3).

**Table 1.** Key elements of the revised proposals on waste management in the EU

| **Recycling and reuse** | **Landfilling** |
|---|---|
| A common EU target for recycling 65 % of municipal waste and recycling 75 % of packaging waste by 2030. | A binding landfill target to reduce landfill to maximum of 10 % of municipal waste by 2030. |
| Simplified and improved definitions and harmonised calculation methods for recycling rates throughout the EU. | A ban on landfilling of separately collected waste (except for certain hazardous waste and residual waste). |
| Concrete measures to promote re-use and stimulate industrial symbiosis (turning one industry's by-product into another industry's raw material). | Promotion of economic instruments to discourage landfilling (charges on landfilling). |
| Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (e.g. for packaging, batteries, electric and electronic equipment, vehicles). | |

Source: http://ec.europa.eu/environment/waste/target_review.htm, EC (2015b:3)

[8] In 1991, the German Cabinet approved the "Ordinance on the Avoidance of Packaging Waste" (VERPACKVO), which was supplemented and expanded three years later by the "Closed Substance Cycle Waste Management Act" (KrW-/AbfG) (Davis & Hall, 2006) now considered the most significant element of German circular economy legislation.

[9] Available at: http://www.gesetze-im-internet.de/bundesrecht/krwg/gesamt.pdf (accessed 15.08.2017.)

[10] The four proposals to amend 1) Directive 2008/98/EC on waste, 2) Directive 94/62/EC on packaging and packaging waste, 3) Directive 1999/31/EC on the landfill of waste, 4) Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators and 2012/19/EU on waste electrical and electronic equipment form part of a Circular Economy Package which also includes a Commission Communication "Closing the loop – An EU action plan for the Circular Economy".

Besides these key elements described in Table 1, the waste policy proposals also set minimum requirements for extended producer responsibility (EPR) schemes, aligned definitions, calculation methods for targets, reporting obligations and provisions on delegated and implementing acts (Bourguignon, 2016:5). In order to monitor progress towards a CE the Commission and the European Environment Agency provided a modelling tool for the management of municipal waste to be used within the early warning system. A reference modelling tool has been developed to regularly assess the distance to target in all MS, analyse ex-ante expected progress in terms of waste management and identify member states at risk of not meeting the target (EC 2015b:6).

Apart from waste management and a monitory framework, the EU action plan covers several other major aspects for transition to CE including production, consumption, markets for secondary raw materials and innovation. Regarding production, the Commission puts emphasis on improving product design by promoting the reparability, durability and possibilities for upgrading and recycling of products through the Ecodesign Directive[11] and extended producer responsibility schemes (Bourguignon, 2016:5). The ecodesign[12] refers to the integration of environmental aspects into product design with the aim of improving the environmental performance of the product along its life-cycle from raw material use to final disposal (EC, 2009). In the future, the Ecodesign directive should achieve even more significant contribution to the CE, by extending its focus from energy efficiency improvements to material efficiency issues such as durability and recyclability (EC, 2016a:3). Extended producer responsibility implies that producers take financial or organisational responsibility for collecting or taking back used goods and for sorting and treating them for eventual recycling (EEA, 2017:23). Differentiating the financial contribution paid by producers under EPR schemes on the basis of the end-of-life costs of their products should stimulate design of products that are easier to recycle or reuse (EC, 2015a). The policy attention in the EU has mostly been directed towards improving material and energy efficiency as well as recycling of different types of waste, with less attention given to reuse, repair, redistribution, remanufacture and refurbishment, resulting in recent development of the strategies introducing these concepts (EEA, 2017:10). The Commission also intends to facilitate industrial symbiosis (e.g. one company's raw materials are waste from another company) in order to reduce environmental impacts and to create business opportunities, especially for SMEs (Bourguignon, 2016:5).

Raising the consumers' awareness on sustainability of consumption and ensuring trustworthy information about the properties of available products (e.g. improved labelling system) especially their environmental impact can support the CE via choices consumers make. The consumers choices are also influenced by the range and prices of existing products and the regulatory framework aimed at preventing and reducing the generation of household waste (EC, 2015a:7). Since price is the key factor influencing consumer behaviour, the Commission proposes the use of incentives and economic instruments like higher taxation for products that incur higher environmental costs and the use of "pay-as-you-throw schemes" for municipalities where households pay according to the amount of non-recyclable waste that they throw away. The Commission also promotes innovative forms of consumption that can foster the development of the CE, such as sharing products or infrastructure, consuming services rather than products, or using IT or digital platforms. Collaborative consumption[13] or sharing economy is an important aspect of consumer behaviour contributing to a CE under the assumption that shared use of assets leads to an increasing utilisation of existing products and a lower demand for new products (EEA, 2017:22). The European public consumption is also directed towards CE through Green Public Procurement (GPP) by emphasising CE aspects in new or revised criteria, such as durability and reparability, and supporting higher use of GPP especially through Commission's own procurement and EU funding (EC, 2015a:8).

The development of market for secondary raw materials is crucial for the transition to CE because recyclable materials are fed back into the economy as new raw materials that can be traded just like primary raw materials (EC, 2015a:11). Injecting materials back into the economy and avoiding waste being sent to landfill or incinerated enables capturing the value of the materials as far as possible, reducing losses (EEA, 2016:29), increasing the supply of materials, and consequently decreasing the dependence on imported raw materials. However, a considerable amount of raw materials originating from waste leaves Europe[14] and does not contribute to increasing circularity of the European economy (EC, 2016b:76). In order to prevent illegal transport of waste and raw materials leakage, a revised regulation on waste shipment was adopted in 2014[15] specifically targeting high-value waste streams, such as end-of-life vehicles (EC, 2015a:10). According to Raw Materials Scoreboard[16] (EIP, 2016:66) 16 % of raw materials used in the EU in 2005 were imported, only 13 % came from recycling and more

[11] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, OJ L 285, 31.10.2009, pp. 10 35.

[12] The EU Ecodesign Directive and the Waste Electrical and Electronic Equipment (WEEE) Directive are the most important EU legislative documents on eco-design in products, promoting increased energy efficiency during the use phase (O'Brien et al., 2014:17).

[13] In order to facilitate the application of national legislation on taxation and social protection to collaborative consumption activities, the Commission has published good practices and guidance on applying existing EU rules to the collaborative economy especially through a European agenda for the collaborative economy (EEA, 2017:22).

[14] The export of iron and steel waste and copper, aluminium and nickel increased substantially between 1999 and 2011 (EEA, 2012).

[15] Regulation (EU) No 660/2014 of the European Parliament and of the Council of 15 May 2014 amending Regulation (EC) No 1013/2006 on shipments of waste.

[16] The Raw Materials Scoreboard is an initiative of European Innovation Partnerships (EIP) on Raw Materials. EIP is a stakeholder platform with a mission to provide guidance to the European Commission, Members States and private actors on innovative approaches to the challenges related to raw materials (https://ec.europa.eu/growth/tools-databases/eip-raw-materials/).

than 70 % originated from domestic extraction. Moreover, only 41 % (1 billion tonnes) out of 2.4 billion tonnes of end-of-life waste was recycled indicating that the circular use of raw materials in the EU economy is still relatively low but slightly higher than the global average. In the EU action plan the Commission is committed to promote development of market for secondary raw materials through several actions, especially by developing EU-wide quality standards to increase trust in secondary raw materials and in recycled materials. Furthermore, it will facilitate the safe reuse of treated wastewater (including legislation on minimum requirements for reused water), encourage nutrient recycling in fertilisers (by proposing a revised EU regulation on fertilisers) and promote non-toxic recycling cycles (Bourguignon, 2016:6; EC, 2015a:13).

Redesigning materials and products for circular use could trigger a large innovation drive across sectors (Bourguignon, 2016:4) that could boost competitiveness of the EU economy. The impact of innovation in linear system mechanism differs substantially from its role in the circular system mechanism. As EEA (2017:14) describes, in the linear economy technological innovation makes old products obsolete and urges consumers to buy new products which are hard to repair due to protective design measures. In the CE, the creation of value shifts from product to the performance or functionality by applying technological innovation to provide product longevity, reuse, reparability and remanufacturing. Innovation is at the very heart of transition to the CE because new technologies, processes, services and business models are needed to rethink our ways of producing and consuming, and to transform waste into high value-added products (EC, 2015a:18). Social innovation, eco-innovation and ecodesign are especially important in terms of achieving sustainability. Collaborative consumption and prosumerism both serve as examples of social innovation, while eco-innovation goes beyond technical innovation (EEA, 2015:163) and presents "any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle" (EIO, 2010:10). Considering that Small and Medium-sized Enterprises (SMEs) are particularly active in fields such as recycling, repairing and innovation, the Commission supports these companies by analysing the barriers to a more efficient use of resources and waste management, encouraging innovation and cooperation across sectors and regions, and providing sources of funding (EC, 2015a:19). As announced in the EU action plan, the Commission introduced a non-legislative approach of "Innovation Deals" to help innovators overcome perceived regulatory obstacles by setting up agreements with stakeholders and public authorities[17]. A policy portfolio that provides a protected innovation space for innovators, especially via dedicated funding opportunities, is necessary to share risks of entrepreneurial discovery processes and to support the CE transition (O'Brien et al., 2014:6). Horizon 2020[18] is EU's Framework Programme for Research and Innovation that fosters innovative projects relevant to the CE in fields such as waste prevention and management, food waste, remanufacturing, sustainable process industry, industrial symbiosis, and the bioeconomy (EC, 2015a:18)[19]. Financial support is also foreseen from other EU funding programmes such as LIFE[20], COSME[21], EaSI[22], Cohesion Policy Funds, the European Structural and Investment Funds (ESIF) and the European Fund for Strategic Investments (EFSI).

The transition towards a CE is a challenging process requiring actions at many levels (e.g. European, national, local, business, individual) and in many policy areas (e.g. waste management, professional training for developing specific skills, packages and product design, research and development, and finance) including taxation (e.g. shifting from labour towards pollution and resources) (Bourguignon, 2014). Monitoring progress towards CE includes building on existing indicators, ensuring reliability of data, and developing new indicators for better assessment of member states performance (EC, 2015a:21). Several scoreboards, containing indicators at EU-28 and country level, have already been developed like Resource Efficiency Scoreboard[23], Raw Materials Scoreboard[24] and Eco-innovation Scoreboard[25] to asses and illustrate performance across EU countries. Member states should ensure sufficient resources at all government levels for the monitoring and reporting on waste management policies, develop electronic waste registries, and set up training for local/regional authorities and relevant stakeholders (EC 2015b:8). Five years after launching action plan to promote the CE, the Commission will report on its implementation (EC, 2015a:21).

[17] The first Innovation Deal was signed in April 2017 with a focus on an existing regulatory framework affecting water reuse for agricultural purposes (http://ec.europa.eu/research/index.cfm?pg=newsalert&year=2017&na=na-070417).

[18] The Horizon 2020 Work Programme for 2016-2017 provides funding of over €650 million for initiative 'Industry 2020 in the circular economy' (EC, 2015a:19).

[19] The SME Instrument under Horizon 2020 supports exploring the feasibility and the commercial potential of highly eco-innovative ideas in order to develop new businesses for SMEs (EC, 2014c:6).

[20] EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU (http://ec.europa.eu/environment/life/).

[21] EU programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises running from 2014 - 2020 with a planned budget of EUR 2.3 billion (https://ec.europa.eu/growth/smes/cosme_en).

[22] EU programme for Employment and Social Innovation (http://ec.europa.eu/social/main.jsp?catId=1081).

[23] http://ec.europa.eu/eurostat/web/europe-2020-indicators/resource-efficient-europe

[24] http://ec.europa.eu/growth/content/raw-materials-scoreboard_en

[25] https://ec.europa.eu/environment/ecoap/scoreboard

## 4. CIRCULAR ECONOMY IN CROATIA – CHALLENGES AND OPPORTUNITIES

It is generally believed that first step towards CE should be to adopt new rhetoric including CE benefits (i.e. CE is positive for every agent), the notion that waste is a resource and that systematic change is needed in order to have a sustainable economy and society. The next stage is to adopt laws promoting CE. Most of the promotional activities in these stages should be done within governments. Final stages include all economic agents as it is described earlier. It is known that most of EU laws refer to its member states including Croatia. But to further build a CE in Croatia, there has to be a political will within a country to overcome many challenges. First obstacle is poor leadership and management and poor enforceability of legislation along with weak economic incentives. Many new policies including economic incentives will be necessary to overcome these challenges. Next is lack of public awareness about relationship between mankind and nature. Population of Croatia has to realize this relationship is crucial in order to ensure sustainable development. Other challenges include: lack of reliable information and shortage of advanced technology (Su et al., 2013:18).

So far, the most relevant policies for the development of CE in Croatia include (1) Sustainable Development Strategy of 2009; (2) Strategical plan of Ministry of Environment and Nature Protection 2015-2017 ; (3) National renewable energy action plan until 2020; (4) Strategy for innovation encouragement of the Republic of Croatia 2014-2020; (5) Third national plan for energy efficiency 2014-2016; (6) Waste management plan of the Republic of Croatia for the period 2017-2022 (2017); (7) Smart specialisation strategy of the Republic of Croatia for the period from 2016 to 2020 and; (8) Action plan for the implementation of the Smart specialisation strategy of the Republic of Croatia in the period from 2016 to 2017 (2016). The European directives on the CE are currently in the phase of implementation in Croatian legislation. The adoption of action plans is also in progress.

The indicators measuring progress towards CE are very important. Despite numerous laws, the problem of performance assessment is general illness of the CE. There is a lack of common metric indicators that would assess the effectiveness of various policy instruments. Also, the heterogeneity of firms, industries and regions have implied that different sets of assessment indicators need to be simultaneously developed (Heshmati, 2015). However there are some indicators. Heretofore the EU developed a set of different indicators under the Resource efficiency scoreboard[26]. European Academies' Science Advisory Council (EASAC) finds that many indicators relevant for the CE are available (EASAC, 2016). These indicators will help EU and member states for monitoring the achievement of CE. Selected indicators in Table 2 are the most important for progress measurement towards CE based on EASAC report and Resource efficiency scoreboard[27].

**Table 2.** Selected indicators measuring progress towards CE

| Indicator | Explanation |
|---|---|
| Resource productivity[28] | Gross domestic product (GDP) divided by domestic material consumption (DMC – total amount of materials directly used by an economy) |
| Eco-innovation index | Index based on 16 indicators from eight contributors in five areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, environmental outcomes and socio-economic outcomes[29]. The overall score of an EU member state is calculated by the unweighted mean of the 16 sub-indicators. It shows how well individual MS perform in eco-innovation compared to the EU average, which is equated with 100. |
| Recycling rate[30] | The recycling rate is the tonnage recycled from municipal waste divided by the total municipal waste arising. |
| Municipal waste per capita | The amount of municipal waste generated (consists of household and similar waste collected by or on behalf of municipal authorities) divided by annual average population. |

Source: based on EASAC (2016) and Resource Efficiency Scoreboard[31]

[26] The Resource Efficiency Scoreboard presents indicators covering themes and subthemes of the Roadmap to a Resource Efficient Europe. The EU Resource Efficiency Scoreboard indicators illustrate the progress towards increased resource efficiency of individual member states and the European Union as a whole. (http://ec.europa.eu/eurostat/web/europe-2020-indicators/resource-efficient-europe)

[27] http://ec.europa.eu/environment/resource_efficiency/targets_indicators/scoreboard/index_en.htm

[28] Resource productivity may be expressed in euro per kilogram using current price data for GDP, which could be used when analysing a single economy for one particular year or in PPS (purchasing power standards) per kilogram using current price data for GDP expressed in purchasing power standards (PPS) (Eurostat).

[29] Eco-innovation inputs comprising investments (financial or human resources), which aim at triggering eco-innovation activities; Eco-innovation activities, illustrating to what extent companies in a specific country are active in eco-innovation; Eco-innovation outputs, quantifying the outputs of eco-innovation activities in terms of patents, academic literature and media contributions; Resource efficiency outcomes, putting eco-innovation performance in the context of a country's resource (material, energy, water) efficiency and GHG emission intensity; Socio-economic outcomes, illustrating to what extent eco-innovation performance generates positive outcomes for social aspects (employment) and economic aspects (turnover, exports) (EU Eco-Innovation Index 2016).

[30] Recycling includes material recycling, composting and anaerobic digestion. Municipal waste consists to a large extent of waste generated by households, but may also include similar wastes (Eurostat).

[31] http://ec.europa.eu/environment/resource_efficiency/targets_indicators/scoreboard/index_en.htm

The first indicator is Resource productivity (Table 3). Resource productivity in the EU-28 increased by 41 % between 2000 and 2016. The maximum increase was achieved in Ireland, 131 %, and maximum decrease was in Romania, -35 %.

**Table 3.** Resource productivity (GDP divided by domestic material consumption)

| Country | 2000 | 2005 | 2010 | 2015 | 2016 |
|---|---|---|---|---|---|
| EU 28 | 1.4702(s) | 1.5441(s) | 1.7676(s) | 2.0189 (ps) | 2.0728(ps) |
| Croatia | 1.0509(s) | 0.7983 | 1.0088 | 1.0783 | 1.0768(ps) |

s=Eurostat estimate (phased out); p=provisional

Source: Eurostat[32]

After the economic crisis in 2008 the significant increase in resource productivity (30.6 %) was caused mostly by a 19.7 % fall of domestic material consumption (DMC) in the same period. Between 2000 and 2016 resource productivity in Croatia increased only by 2.5%. Expressed in GDP in PPS over DMC, the resource productivity amounts to 2.23 PPS/kg for the EU-28 and 1.7 PPS/kg for Croatia in 2016. Croatian index is about 25 % lower than EU index. The ratio varies considerably across EU member states from 0.68 €/kg in Bulgaria to 3.98 €/kg in Italy[33].

The second indicator is Eco-innovation index (Table 4). The eco-innovation index shows how well individual member state performs in eco-innovation compared with the EU average (EU=100). Croatia has achieved an index 19 % (81) lower than the EU average[34] (2015 index was 33 % lower and 2013 44 % below the EU average)[35]. Croatia has significantly improved its eco-index last few years but is still among nine least eco-innovative countries in EU (countries catching up in eco-innovation)[36]. In 2016 Germany is top ranked of all EU countries, with an aggregated score of 140. Luxembourg (score of 139) and Finland (137) follow Germany very closely. According to the eco-innovation index Bulgaria (41) and Hungary (60) have the worst results.

**Table 4.** Eco-innovation index

| Index (EU 28=100) | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| Croatia | 56 | 93 | 61 | 81 |

Source: Eurostat[37]

Waste generated in kilograms per capita is next indicator (Table 5). The EU generated 476 kg of waste per person in 2015[38] of which 45% was either recycled or composted, according to Eurostat data. EU waste generation was 10% lower than at its peak of 527 kg per person in 2002. Croatia generated 393 kg of waste per person in 2015 (18 % below EU average) and recycled 18% of its waste. It is 2 % more waste per person compared to 2006. When observing the quantities of produced municipal waste with regards to the origin (county), a disproportion between "continental" and "coastal" counties can be noted, mostly due to the effect of tourism. The quantity of municipal waste from tourism in 2015 was 98,960 tonnes, constituting 6% of the total quantities of municipal waste. The largest quantities of municipal waste from tourism are produced in the county of Istria, the county of Primorje-Gorski Kotar and the county of Split-Dalmatia[39].

**Table 5.** Waste generated in kilograms per capita

| Country | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| EU 28 | 522 | 524 | 521 | 511 | 504 |
| Croatia | 384 | 399 | 415 | 405 | 379 |
| **Country** | **2011** | **2012** | **2013** | **2014** | **2015** |
| EU 28 | 498 | 485 | 478 | 477 | 476 |
| Croatia | 384 | 391 | 404 | 387 | 393 |

Source: Eurostat

The last analysed indicator is Recycling rate of municipal waste (Table 6). Recycling rate of municipal waste in the EU has increased over time, from 35% in 2007 to 45% in 2015. The most successful EU member state is Germany with the recycling rate of 55 %, while the lowest recycling rate have Malta (6.7 %) and Romania (13.1 %). Recycling rate of municipal waste in Croatia was about 6 times higher in 2016 compared to 2007 (3.1 %).[40] It is very low municipal recycling rate and much progress will be required to meet the 65 % recycled municipal waste target by 2030 according to European Commission's revised legislative proposals on waste. The best waste management (CE) results at the municipal level are realized by the island Krk on the Adriatic Sea (54.2 % was recycled in 2016 compared to 18.2 % in 2006[41]) and the town Prelog in the continental part of

[32] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=0&language=en&pcode=tsdpc100

[33] http://ec.europa.eu/eurostat/statistics-explained/index.php/Resource_productivity_statistics

[34] Scores in the five components of the Eco-Innovation Index: Eco-innovation inputs=15, eco-innovation activities=89, eco-innovation outputs=100, environmental outcomes=104 and socio-economic outcomes=100 (https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/eio_brief_eco-innovation_index_2016_final.pdf)

[35] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_rt200&plugin=1

[36] Countries catching up in eco-innovation (EI), with around 85 % or less performance compared to the EU average (EU Eco-Innovation Index 2016, EIO Brief, April 2017), https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/eio_brief_eco-innovation_index_2016_final.pdf

[37] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=0&language=en&pcode=t2020_rt200

[38] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tsdpc240&plugin=1

[39] http://www.mzoip.hr/doc/management_plan_of_the_republic_of_croatia_for_the_period_2017-2022.pdf

[40] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&pcode=t2020_rt120&language=en

[41] http://www.grad-krk.hr/www.grad-krk.hr/files/0f/0fe995e9-1756-4f1c-8d63-9b3883b5308f.pdf

Croatia (53.12 % was recycled 2016 compared to 16.9 % in 2011[42]). Municipal waste recovery rate in the capital city of Croatia – Zagreb was as low as 22.2 % in 2015. The highest rate has county Međimurje (38 %) and the lowest rate has county Karlovac (11.5).[43]

**Table 6.** Recycling rate of municipal waste (%)

| Country | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| EU 28 | 35(s) | 36.5(s) | 37.5(s) | 38.3 | 39.6(s) |
| Croatia | 3.1 | 2.8 | 2.3 | 4 | 8.3 |
| **Country** | **2012** | **2013** | **2014** | **2015** | |
| EU 28 | 41.5(s) | 42.2(s) | 43.7(s) | 45(s) | |
| Croatia | 14.7 | 14.9 | 16.5 | 18 | |

s=Eurostat estimate (phased out)

Source: Eurostat[44]

The indicators measuring progress towards CE show that much progress would be required to meet set EU goals. But, the bright side can be seen in examples of several companies that show the concept of CE can become the path to development in Croatia which will create new jobs, raise competitiveness and generate profits. One of the rare examples of the company taking the CE approach is Stražaplastika which annually produces about 4000 tons of plastic of which 1000 tons are recycled. Unfortunately, these are imported because required quantities cannot be purchased in the Republic of Croatia. Croatia unclassified plastic waste export to Austria where Austrian companies then manually or mechanically sort and sell it to Stražaplastika Company at a higher price.[45] The question is why sorting is not done in Croatia? Also a good example of CE is the company Holcim which has been using the byproduct from Plomin Thermal Power Plant in the cement plant in Koromacno[46]. There are also other companies with examples of the CE like Tehnix, Regeneration, Agrokor's farms or Solin's recycling centre for hotel soap.

According to Eco-Innovation Observatory (EIO Country Profile 2014-2015) the following circumstances are identified as a key barrier towards a CE in Croatia: (1) Current Croatian regulatory framework is not yet fully compliant with the EU regulation; (2) Most of the national strategies which serve as the legal framework for the creation of laws and regulations have not been updated and are not in compliance with the goals of circular economy and; (3) The process of development of some strategic documents has been relatively slow which has had a negative impact on the state of the overall regulatory framework. Another important issue lies in the failed implementation of laws and regulations, particularly in the field of waste management. The cause of the problem is the absence of political action to guarantee the enforcement of fines for breaking the law.

Based on EIO Croatian Country Profile the biggest and the most urgent challenge for Croatia lies in the waste management. It requires a radical change – namely leaving behind old practices and focusing on separate waste collection. Much more needs to be done in the area of information provision and education on the local level. One step towards more efficient innovation system was the Strategy for Innovation encouragement of Croatia 2014-2020 which defines the mechanisms for stimulating innovation and application of new technologies.[47]

Introducing rightly chosen and designed policy measures is essential for moving Croatia from linear to a CE model. The GreenXpo paper on Circular Economy Policy Guidance[48] presents five categories of policy measures (or supportive framework conditions) with examples for each policy measure to build CE:

(1) *Regulatory instruments* with regarding policies: a) Regulations e.g. on waste recycling, extended producers responsibility, ecodesign, take-back, transparency in material chain and responsibilities. etc.; b) Quality and other mandatory targets e.g. waste recycling. re-use; c) Codes, standards, certification for products, recycled material content, packaging, emissions, as well as the ones triggering innovation prior to setting new minimum performance limits;

(2) *Economic instruments* with regarding policies: a) Fiscal/ financial instruments and incentives including charges and taxes for waste, incineration, landfill, subsidies and tax reliefs, pay as you throw; b) Direct investment/ funding e.g. infrastructure, programme etc.; c) Demand pull instruments including public procurement; d) Market based instruments.

(3) *Research, development and deployment* with regarding policies: a) Funding for R&D in CE related themes e.g. direct or competitive grants; b) Pre-commercial /R&D procurement for products and services with sustainable design; c) Providing R&D infrastructure; d) Innovation vouchers schemes for SME on CE related innovations; e) Support to innovation incubators focusing on CE related areas; f) Support programmes and incentives for R&D personnel.

(4) *Information, capacity building and networking support* with regarding policies: a) Advisory services & information provision to companies, start-ups, customers, technology

[42] http://www.pre-kom.hr/zero-waste-2020.html
[43] http://www.mzoip.hr/doc/management_plan_of_the_republic_of_croatia_for_the_period_2017-2022.pdf
[44] http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=0&language=en&pcode=t2020_rt120
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[46] http://sajamideja.fkit.hr/sajam%202016/prezentacije/Vu%C4%8Di%C4%87_predavanje.pdf
[47] http://www.eco-innovation.eu/index.php?option=com_content&view=article&id=649&Itemid=296
[48] GreenXpo, Circular Economy Policy Guidance, 2014

adopters etc.; b) Professional training and qualification and skills enhancement courses i.e. in material chain management; c) Support networking via matchmaking technology platforms.

(5) *Voluntary measures* with regarding policies: a) Performance label for products and services; b) Guarantee for product durability repair; c) Negotiated agreements (public-private sector); d) Public or unilateral voluntary commitments (by private sector).

## 5. CONCLUSION

One of the intentions of this paper was to bring the debates about the circular economy concept to a wider audience primarily in Croatia and increase its impact in the literature but also in the practice. The conclusion is that CE must go beyond concept to make a change in the economic system that will be oriented towards sustainable development.

In order to promote the transition to circular economy, the European Union launched regulatory package setting waste management targets and encouraging member states to create more value from products throughout their lifecycle. Finally, the challenges of introducing CE in Croatia are described in the context of the achieved progress based on available indicators.

Although there are several examples of good practice at the company level regarding the introduction of CE principles in production process, Croatia is facing significant barriers especially regarding the waste management. Developing regulatory framework in full compliance with EU regulations, introducing economic instruments, providing professional training, improving product design and encouraging innovations require portfolio of carefully chosen policy measures to initiate the CE transition process in Croatia.

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