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CRADLE TO CRADLE APPROACH IN DEVELOPMENT OF RESOURCE-EFFICIENT ECONOMY

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ABSTRACT: In the article, cradle to cradle approach, as the desired direction of changes in the management of resources in production processes, is discussed. The study based on the analysis of literature, action programs, and case studies. Attention has been focused on the development of cradle to cradle approach around the world. The research aimed to raise awareness of the importance of resource management so that waste generation would be eliminated from the manufacturing processes. Residues of consumption and production should be re-integrated into biological or technological circulation. Cradle to cradle approach means a revolutionary change in the approach to the organization of following processes: products and services design, production and distribution. It also extends the scope of responsibility of manufacturers and users, but at the same time gives a chance to reduce the negative impact on the environment and to create new job opportunities.

KEY WORDS: resource management, resource-efficient economy, cradle to cradle approach

Introduction

Maintaining the access to scarce resources was the subject of effort since the dawn of human civilization. Initially, it had only a practical dimension. The industrial revolution seemed as a way to solve the problem of resource scarcity. It appeared that the man has gained a new, almost unlimited possibilities to reach resources previously unavailable or even unknown. Today with greater humility we look at these possibilities. This happened not because of the actual lack of access to resources, but rather because of the environmental and social (including health) consequences of wasteful exploitation and the growing cost of acquiring them. Growing demand on natural resources is caused by increasing human population and aspiration of billions of people in less developed countries to reach a higher level of consumption, recently typical for rich part of western societies. Now it has become the subject of scientific inquiry how to ensure sustainable and fair access to resources for all. In the paper, the cradle to cradle approach is discussed as a solution proper for the development of a modern circular economy, which enabled sustainable access to scarce resources and meeting the needs of next generations. However, this is connected with the necessity to change the organization of production and even the way of thinking about the purpose of the business operation. It is discussed as a potential field for innovation needed for the circular economy.

An overview of literature

For quite some time more resource-efficient economy focuses researchers' and politicians' interest. The idea of circular material flows as a model for the economy was already presented in 1966 by Kenneth E. Boulding in his paper Economics of the Coming Spaceship Earth (Boulding, 1966). In 1976 the first report for Commission of the European Communities (today the European Commission) titled The Potential for Substituting Manpower for Energy was written by Hannah Reekman. Walter Stahel and Geneviève Reday-Mulvey sketched the vision of a circular economy as an economy in loops in 1987 in a book Jobs for Tomorrow: The Potential for Substituting Manpower for Energy (Stahel, Reday-Mulvey, 1981). For them, the most important were the impact on job creation, economic competitiveness, resource savings, and waste prevention. In 1982 W. Stahel, with O. Giarini, founded in Geneva the Product-Life Institute to develop practical strategies

for economic growth with lower resource consumption. The pragmatic orientation of the Institute means focusing attention on the following issues: product-life extension, long-life goods, reconditioning activities, and waste prevention. It also insists on the importance of selling services rather than products, an idea referred to as the "functional service economy" and sometimes put under a wider notion of "performance economy" which also advocates "more localisation of economic activity". The vision is a sustainable economy and society resting on the following five pillars: nature conservation, limited toxicity, resource productivity, social ecology, cultural ecology. All these elements are integrated into a holistic view of a sustainable society. For further considerations of resource, productivity is of particular importance, which "is based on the need of industrialized countries to dematerialize their lifestyle, in order to allow the material development of industrially less developed countries" (www.product-life-org). An interesting contribution to the discussion on needs of new development trends is also in books published by Janine Benyus (2003), Reid Lifset and Thomas Graede (2001), Paul Hawken and Amory and Hunter Lovins (2008).

Research methods

The conducted research based on literature studies and analysis of documents and programs of EU and other organizations interested in development and introduction into practice cradle to cradle approach.

Results of the research

A resource–efficient Europe is a flagship Europe 2020 Initiative adopted by European Commission in 2011 (COM(2011)21final). It supports the shift towards a resource-efficient, low-carbon economy as a means for achieving sustainable growth. A strategy to make the EU a "circular economy", bases on a recycling society with the aim of reducing waste generation and using waste as a resource (p. 7).

In 2008, the EU revised the legal framework for waste based on the entire product life cycle from generation to disposal, with emphasis on "waste hierarchy" as follows: waste prevention, reuse, recycling, and recovery. The Member States must prepare waste management plans covering the type, quantity, sources of waste and collection systems. Waste prevention plans must also be drawn up with a view to breaking the link between economic growth and waste generation.

It was estimated that each year in the EU recyclables such as paper, glass, plastics, aluminum and steel worth 5.25 billion euro are landfilled. If this was recycled, the equivalent of 148 million tons of CO_2 emissions could be avoided annually. Improved management of municipal waste could result in 92 million tons of greenhouse gas emissions avoided in 2020 compared with 1995. At least 500 000 new jobs would be created in Europe if countries recycled 70% of their waste. In EU undertaken measures should lead to:

- reduction EU greenhouse gas emissions by 80 to 95% by 2050;
- protection valuable ecological assets, services they provide and the quality of life for present and future generations;
- ensuring that the agricultural sector and fisheries are strong, sustainable and reduce food insecurity in developing countries;
- reduction of reliance on increasingly scarce fuels and materials;
- improvement the security of Europe's supply of raw materials;
- making the EU's economy more resilient to future increases in global energy and commodity prices.

Example are "critical raw materials" listed in 2011 by European Commission. On the list of them are: antimony, fluorspar, gallium, germanium, graphite, indium, magnesium, rare earths, tungsten (from China), platinum group metals (Russia), cobalt, tantalum (the Democratic Republic of Congo), niobium and tantalum (Brazil). The listed 14 raw materials are critical because the risks of supply shortage and their impacts on the economy are higher compared with most of the other raw materials. Their high supply risk is mainly due to the fact that a high share of the worldwide production mainly comes from a few countries.

Measures to tackle the challenges in commodity markets and on raw materials will, amongst others, periodically assess critical raw materials (COM(2008)699; COM(2011) 25) and define a trade policy to ensure sustainable supplies of raw materials from global markets. These measures will help to ensure coherence between the EU's raw materials and external policies, including the promotion of good governance, transparency of activities and creation of local value added in developing countries. It will promote extraction, recycling, research, innovation and substitution inside the EU.

Because of growing international awareness of the strategic importance of avoiding risks to supply of resources such as rare earths, fishing grounds, land, energy, and water European Commission decided to make efforts towards the development of circular economy A strategy to make the EU a "circular economy", based on a recycling society with the aim of reducing waste generation and using waste as a resource (p. 8.) It is worth to add that promoting a circular economy was identified as national policy in other countries as well. China's 11th five-year plan starting in 2006 emphasis on

more efficient use of resources. In the same time, a report about Japan's Experience in Promotion of the 3Rs For the Establishment of a Sound Material-Cycle Society, where 3Rs mean reduce, reuse, recycle was published (www.env.go.jp/recycle/3r/en/approach/02.pdf).

In broader terms, the circular approach is a framework that takes insights from living systems. Its practical applications to modern economic systems and industrial processes have gained momentum since the late 1970s. In accordance with the publication of EllenMacArthur Foundation (www.ellenmacarthurfoundation.org), which mission is to accelerate the transition to a circular economy, this kind of economy rests on three principles:

1. "Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows.
2. Optimize resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles.
3. Foster system effectiveness by revealing and designing out negative externalities."(Towards a circular…)

"A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times (www.ellenmacarthurfoundation.org/circular-economy/overview/concept)." The concept distinguishes between technical and biological cycles, shown in Figures 1. and 2.

The circular economy is a generic term for an industrial economy that is producing no waste and pollution, by design or intention, based on two types of material flows:

- biological nutrients, designed to reenter the biosphere safely. It can be consumed by microorganisms and return to the material/energy streams as an element useful for the next production cycles (Braungard, McDonough, 2009),
- technical nutrients, designed to circulate at high quality in the production system without entering the biosphere as well as being restorative and regenerative by design. Technical nutrients are materials or products that are designed to go back into the technical cycle, into the industrial metabolism from which it came.

A number of products are already being designed as biological or technical nutrients. But unfortunately, some materials do not fit any of these metabolism systems because they contain materials that are hazardous and toxic. They need special technologies of detoxification (which in some cases still do not exist) or the development of production without them. The key to understanding the concept of circular economy is the assumption that waste does not exist. Usually, waste is defined as any substance or object which the

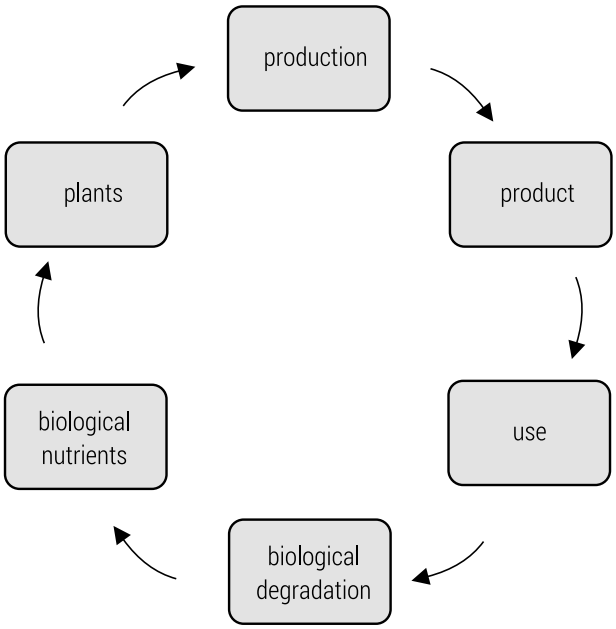

Figure 1. Biological cycle for products for consumption

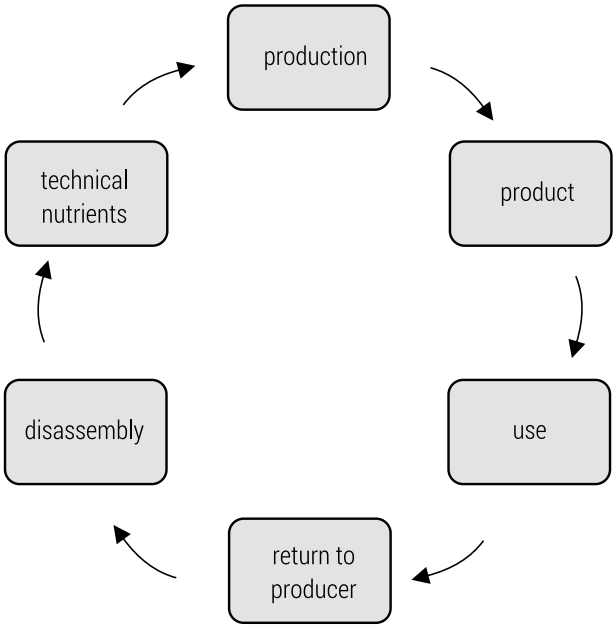

Figure 2. Technical cycle for products for services

holder discards or intends or is required to discard. Waste comes in many different forms and may be categorized in a variety of ways (Jędrczak, 2007; Rosik-Dulewska 2007).

About 60% of waste generated in EU are the mineral waste, soil, mostly originating from construction and demolition and mining. The share of metal, paper and cardboard, wood, chemical waste, medical waste and animal and plant products in the total mass of waste generated ranged between 2 and 45%. About 10% of all waste generated in Europe are municipal waste, generated mainly by households, but also by small businesses, and public institutions such as schools and hospitals.

Over 90% of raw materials and energy mobilized for the production of consumer goods is consumed long before the stage of the finished product. These are among others waste in the mining industry, heat loss in power plants, barren soil in mechanized agriculture, waste wood and metals processing, grain in animal husbandry, water used in the finishing of metals and, fuel for transportation. Nowadays over 67 million different substances are known, each of which has its eco-toxicological potential. For example, the average television is made up of 4,360 chemicals. Some of them are toxic, but others are valuable materials for industry (Braungart, McDonough, 2009, p. 110). Development of a circular economy seems as a way to reduce consumption of primary resource and extending the share of recycled materials. It is not only a technical issue but rather a process of rethinking of production patterns, developing a new approach to goods and services design and functioning of the whole economic system. The typical process of new product development includes following six stages: arising of any idea, researching, development of prototypes, testing, analysis of the feedback, introduction the product to the market.

Successful manufacturing bases not only on understanding product life cycle shown in Figure 3., but also proactively managing products throughout their lifetime, which in the case of the circular economy required the accordance with cradle to cradle approach (instead cradle to grave approach, which until today was a standard in an industrialized economy). Products in a circular economy should be restorative and regenerative by design. That is why already at the idea-development stage should be taken into account proper for disassembly selection of materials and technologies. Preferred are pure materials, easier to sort at end of life. Besides material selection, other areas important for economically successful circular design are standardized components, designed-to-last products, separation or reuse of products and materials, and design-for-manufacturing criteria that take into account possible useful applications of by-products and wastes (Towards a circular…). Important is also a feedback between design and end-of-use activities,

because the final user in circular economy should be/is involved in a reverse logistic system organized by a producer to receive back used products or parts thereof to put them into the process of repairing or recycling. Transformation of business model, where access to the product is prioritizing over ownership is also worth consideration. Consumers instead being owners of things became users of theirs functions and utility. It requires the development of new design patterns, new materials, and new distribution/reverse logistic.

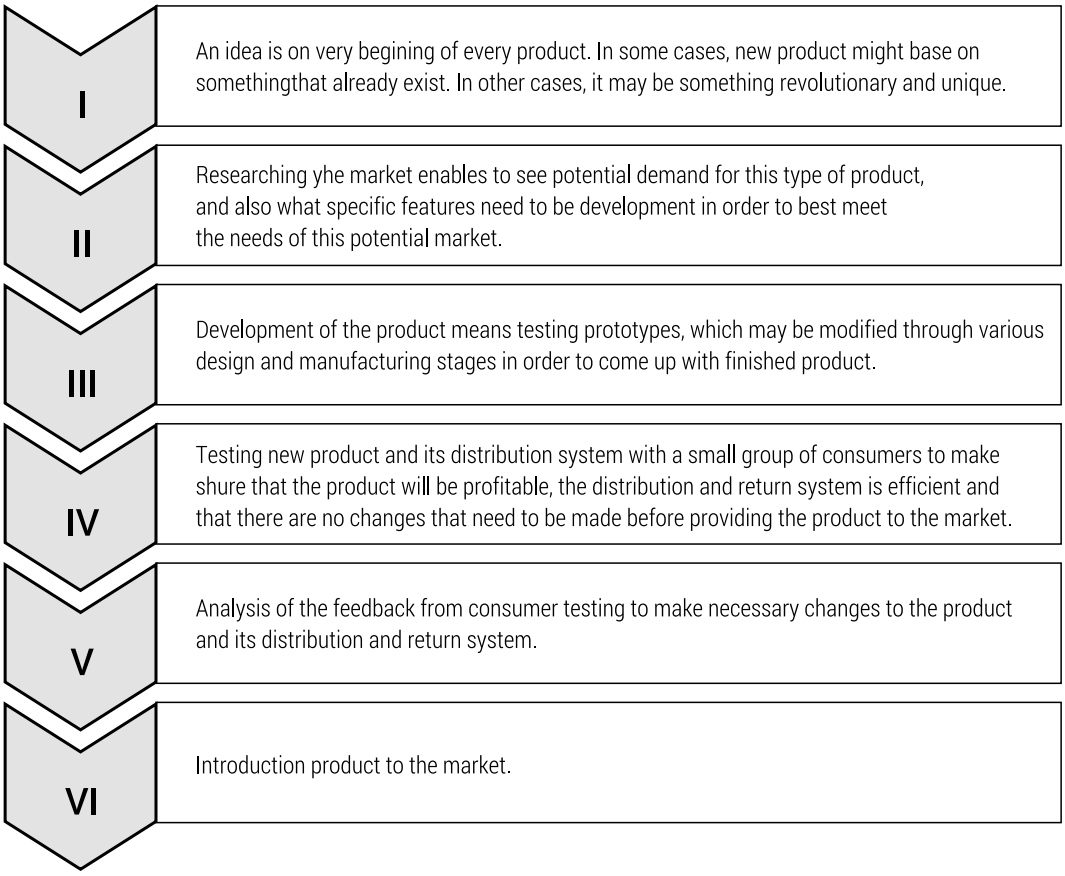

Figure 3. Stages of product development

A circular economy development path could result in a reduction of primary material consumption (measured by car and construction materials, real estate land, synthetic fertilizer, pesticides, agricultural water use, fuels, and non-renewable electricity) by 32% by 2030 and 53% by 2050, compared

with today (Growth within, 2015). However, development of cradle to cradle approach is nowadays at the very beginning of its way, The Cradle to Cradle Certified™ Products Program has been registered as a trademark (http://s3.amazonaws.com/c2c-website/resources/certification/policy/POL_TM_Surveillance_v1.0_012216_.pdf).

Development of circular economy is seemed by its advocates not only as an opportunity but as an obligation to future generations and good solution for economically efficient business. This opens a space for innovation and creativity, dominated by business strategies that lead to a higher resource productivity over long periods of time.

Conclusions

From practical point of view the development of a circular economy needs new patterns of design, production, distribution and management based on the approach that each element used in production should be seen as a part of the matter-energy life cycle in the world, where the concept "waste" would be replaced by the concept of "nutrient". In this case, a nutrient is a substance that provides nourishment essential for growth and the maintenance of the life of our economy. Products start their life cycle in a "cradle" and end in the same place as a nutrient for next product generations. To be successful in development this cradle to cradle approach it is important to remove toxic substances from production cycles and further from the waste stream. The poisoning of the environment by toxic materials, and finally by toxic waste, is an irresponsible and short-sighted action. The trend in material reuse should be extended across the entire material stock, recycling if it leads to higher environmental and economic benefits. The aspiration to replace one-way products with goods that are circular by design and create reverse logistics networks and other systems to support the circular economy is not nowadays widespread. For some of us may be it is like utopia. For others, it became a challenge, a business opportunity. The benefits of a more innovative economy include higher rates of technological development, improved materials, labour, and energy efficiency, and more profit opportunities for companies. The latter are mainly due to the development of collection and reverse logistics companies that support end of life products being reintroduced into the system, creation of product remarketers and sales platforms that facilitate longer lives or higher utilization of products and finally return to favor of parts and component remanufacturing and product refurbishment offering specialized knowledge. Unfortunately, our present production and consumption systems insufficiently encourage pre-

vention and waste reduction. The entire value chain, from the design phase of the product and packaging to material selection must be planned anew, this time in order to reduce waste. It requires a joint effort of many stakeholders, for which the attractiveness of new solutions should result from new business and job opportunities and a perspective for life in a better environment.

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