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Challenges for the packaging industry in the Circular Economy

Abstract: The concept of a Circular Economy assumes that the value of products, materials and resources is to be maintained in the economy for as long as possible to ultimately reduce waste generation to a minimum. In this concept, raw materials are repeatedly put into circulation many times, often passing from one branch of industry to another. So energy, water, metal ores, oil, gas, coal and others, and wherever possible, their replacement with renewable resources (wind and solar energy, natural resources). It is important, and this is the essence of the Circular Economy, the maximum re-use of scarce materials and raw materials from already produced and used products. This concept has found the support of the European Commission and activities in this area will successively be implemented through appropriate legal acts of the European Union. The need to implement solutions in the field of minimizing the consumption of raw materials, materials and energy or reducing waste production is also felt by consumers and industry. The packaging industry is particularly interested in implementing the concept of a Circular Economy. Due to the dynamic growth of the packaging market, which in 2017 reached around EUR 9.6 billion in Poland (data from the Polish Chamber of Packaging) and the increasing amount of post-consumer waste, it is necessary to introduce solutions limiting the consumption of raw materials and energy throughout the product life cycle.

The aim of the article is to present current practices regarding the reduction of the negative impact of packaging on the environment and the indication of directions for the implementation of the Circular Economy concept in the packaging industry.

Keywords: packaging industry, Circular Economy, sustainable packaging

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Wyzwania dla branży opakowaniowej w gospodarce o obiegu zamkniętym

Streszczenie: Koncepcja gospodarki cyrkularnej zakłada, że wartość produktów, materiałów i zasobów ma być utrzymana w gospodarce tak długo, jak to możliwe, aby ostatecznie ograniczyć wytwarzanie odpadów do minimum. W tej koncepcji surowce są wielokrotnie wprowadzane do obiegu, często przechodząc z jednej gałęzi przemysłu do drugiej. Zatem energia, woda, rudy metali, ropa, gaz, węgiel i inne, w miarę możliwości, są zastępowane odnawialnymi zasobami (energią wiatrową i słoneczna, zasobami naturalnymi). Jest to niezwykle ważna kwestia, która stanowi istotę gospodarki cyrkulacyjnej poprzez maksymalne ponowne wykorzystanie rzadkich materiałów i surowców z już wyprodukowanych i zużytych produktów. Koncepcja ta znalazła poparcie Komisji Europejskiej, a działania w tym obszarze będą sukcesywnie wdrażane poprzez odpowiednie akty prawne Unii Europejskiej. Potrzebę wdrożenia rozwiązań w zakresie minimalizacji zużycia surowców, materiałów i energii lub ograniczenia produkcji odpadów odczuwają również konsumenci i przemysł. Branża opakowaniowa jest szczególnie zainteresowana wdrożeniem koncepcji gospodarki obiegowej. Ze względu na dynamiczny rozwój rynku opakowań, który w 2017 roku osiągnął w Polsce około 9,6 mld euro (dane Polskiej Izby Opakowań) oraz rosnącą ilość odpadów poprodukcyjnych, konieczne jest wprowadzenie rozwiązań ograniczających zużycie surowców i energii w całym cyklu życia produktu.
Celem artykułu jest przedstawienie aktualnych praktyk dotyczących ograniczania negatywnego wpływu opakowań na środowisko oraz wskazanie kierunków realizacji koncepcji *Circular Economy* w przemyśle opakowaniowym.

Słowa kluczowe: przemysł opakowaniowy, gospodarka cyrkularna, zrównoważone opakowania

Introduction

The general assumption of the Circular Economy concept assumes closing the product life cycle, which requires the transition from the linear economy model to the model called "cradle to cradle", which includes activities related to: production – use – waste utilization in the next production cycle. This idea aims to increase investment and support eco-innovation, without unnecessary losses to the environment. The new economic model changes the approach to product life cycle analysis, which goes beyond focusing on its final stage. New environmental technologies are to be an impulse for the development of the European economy. By announcing the concept of a Circular Economy on December 2, 2015, the European Commission has given the economic operators a clear signal that one of the European Union's priorities for the coming years will be to use all the tools available to fully implement the principle of sustainable development (Attitudes of European…2017). One of the areas important for the concept of sustainable development are solutions aimed at reducing the negative impact of the packaging industry on the environment. As part of the implementation of the concept of sustainable development, the packaging industry has developed and perfected the idea of "sustainable packaging". According to it, the criteria for sustainable packaging are complex objectives of sustainable development, namely economic, social and environmental. These criteria define the areas in which companies should be encouraged to transform, innovate and optimize. By solving problems in areas defined by criteria, the flow of material streams can be transformed into a system that is economically efficient and provides benefits across the entire sustainable packaging system.

The aim of the article is to present current practices regarding the reduction of the negative impact of packaging on the environment and the indication of directions for the implementation of the Circular Economy concept in the packaging industry.

1. Characteristics of the Polish packaging market

Poland is one of the largest packaging markets in Europe. The packaging industry is equipped with modern means of production and the latest technologies, and the offer of packaging producers is fully competitive on foreign markets. The last twenty years have been a period of dynamic growth of the packaging market in Poland. The constant increase in demand for modern packaging has been noted since the systemic transformation. The 1990s brought both the assignment of packaging to the marketing function and the influx of technologies used for years in Western European countries, enabling the production of previously unused forms of packaging (aluminum cans, PET bottles, etc.). This was possible due to the entry of foreign investors into the Polish market and resulted in a dynamically growing supply and sale of packaging. The first decade of the 21st century brought continuity and stabilization of these trends.

According to Equity Advisors, in 2017, the value of the packaging industry market in Poland was PLN 38.2 billion. However, forecasts for 2020 indicate an increase in value of up to PLN 46 billion, with an annual growth rate of approx. 6.8%. The forecasted increase in the value of the packaging market in Poland was presented in Figure 1.

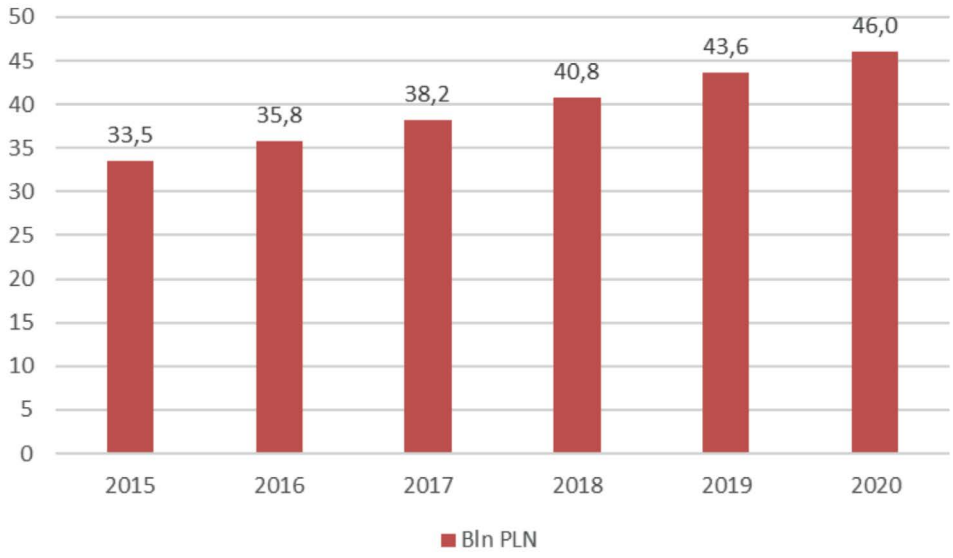

Fig. 1. Forecasted increase in the value of the packaging market in Poland
Source: Branża opakowań w Polsce. Podsumowanie 2010–2016 i prognozy 2017–2020, Equity Advisors, Kraków 2017

Rys. 1. Prognozowany wzrost wartości rynku opakowań w Polsce

The increase in the value of the packaging market is determined by macroeconomic indicators, such as GDP and trends in the Polish society and the economy. Firstly, the growth rate of the packaging market is positively correlated with spending on consumption. The

latest CSO data shows that in all of 2016, consumption dynamics amounted to as much as 3.6 percent, y/y, which is the best result since 2008. Secondly, the forecast of almost double the dynamics of the Polish packaging market in comparison to the international market is a consequence of the growing demand for packaging per person. According to the calculations of the Polish Chamber of Packaging (PIO), the average consumer coming from highly developed countries, such as the US, Japan or Western European countries uses packaging worth EUR 300–340 per year, on average. For comparison, the average for Poland is about EUR 100 lower (Wasiak 2018).

Global corporations operate on the Polish market, however, a larger part of the sector's revenues is generated by smaller companies competing with each other in various segments. Almost 500 companies with annual revenues below PLN 50 million in total account for of the 77% industry revenues. There are definitely fewer entities with higher revenues. Only 59 companies achieve revenues in the range of PLN 50–100 million (9% of revenues), and 90 – higher (14% of revenues). Sales revenues generated by the 20 largest enterprises constitute 32 percent. When analyzing the structure of the packaging market based on the type of materials used to produce packaging, the dominant role of plastics (50%) and paper products (25%) should be emphasized. The structure of materials in 2015 and the forecast share and value in 2020 are presented in Table 1, the predictions were made by Equity Advisors.

TABLE 1. The structure of the packaging market in Poland

TABELA 1. Struktura rynku opakowań w Polsce

Packaging materials	Share and value in 2015	Share and value in 2020 (forecast)
Plastic	50% (PLN 16.5 bn)	38% (PLN 17.5 bn)
Paper and cardboard	25% (PLN 8.2 bn)	37% (PLN 17.0 bn)
Metal	13% (PLN 4.3 bn)	11% (PLN 5.0 bn)
Glass	10% (PLN 3.3 bn	9% (PLN 4.1 bn)
Other materials	2% (PLN 0.7 bn)	5% (PLN 2.3 bn)

Source: Author's elaboration on the basis of (Branża opakowań w Polsce 2017).

Packaging is a product used in various sectors of the economy. Packaging for food and beverages accounts for as much as 63% of all packaging produced in Poland. Subsequently, the packaging is intended for industrial products such as: household chemicals, paint and varnish industry (24%). Cosmetics packaging accounts for 7%, and drugs for 6% of total production. The packaging industry is closely related to industrial production in the country, because its value depends on the general trends of the economy, and the share in the GDP of the industry is relatively constant and amounts to 2% of Poland's GDP.

2. The role of packaging in the supply chain

The dynamic development of the packaging market influences the growth of interest in packaging, which is the basic element of the supply chain defined as the activity related to

the flow of products and services from its original source through all intermediate stages, to the form in which products and services are consumed by the final customer. In the structural (organizational) approach, the supply chain is defined as a group of enterprises that jointly implements the activities necessary to satisfy the demand for specific products throughout the entire flow of goods – from obtaining raw materials to deliveries to the final recipient, which is the implementation of the linear supply chain model presented on Figure 2 (Definition of Sustainable Packaging, Sustainable Green Blue 2015).

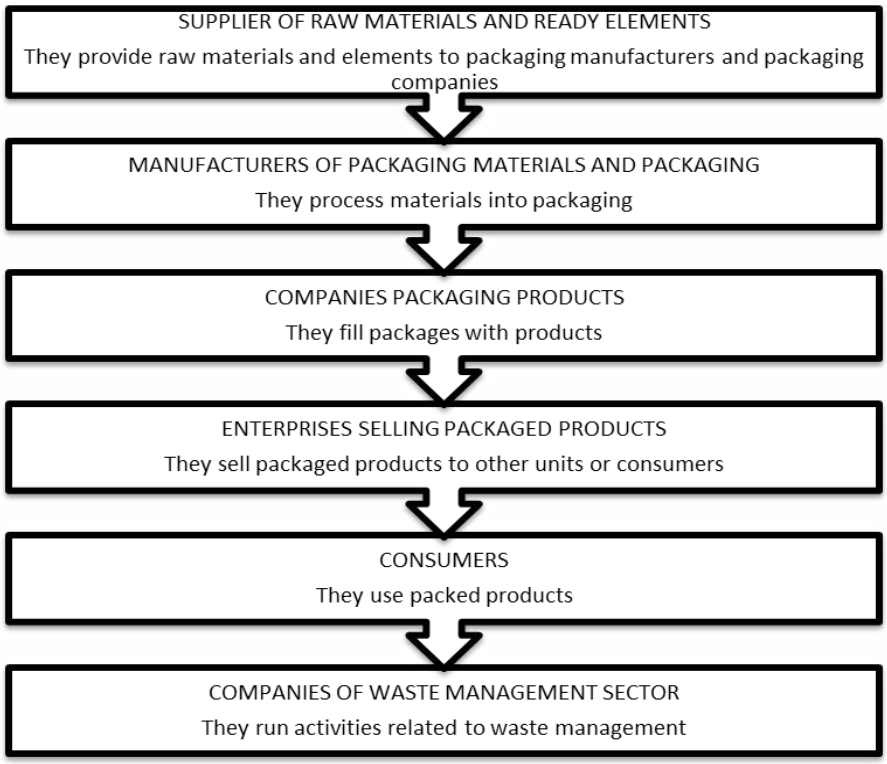

Fig. 2. Linear model of packaging supply chain
Source: Cholewa-Wójcik 2016; Fechner 2016

Rys. 2. Liniowy model łańcucha dostaw opakowań

The leading task of suppliers of raw materials necessary for the production of packaging and ready elements is to provide raw materials with appropriate characteristics and properties of the right quality of packaging. The role of the next entity in the packaging supply chain, i.e. the producer of packaging materials and packaging is to conduct the production process. In turn, the task of enterprises packaging products is the selection of packaging materials taking the characteristics of the packaged products and possible interactions between

the product and the packaging into account. The next link in the chain are sellers whose job is to sell packaged products to other individuals or consumers. After consuming the product, taking the selective collection of post-consumer packaging into account, consumers get rid of waste by handing it over to companies in the waste management sector.

This model requires a transition to a Circular Economy, in which waste will be transformed into new consumer goods. In the circular model of packaging turnover, a definitely larger share of reusable packaging should also be predicted, which will be returned to companies filling them with new products. Such a model is shown in Figure 3.

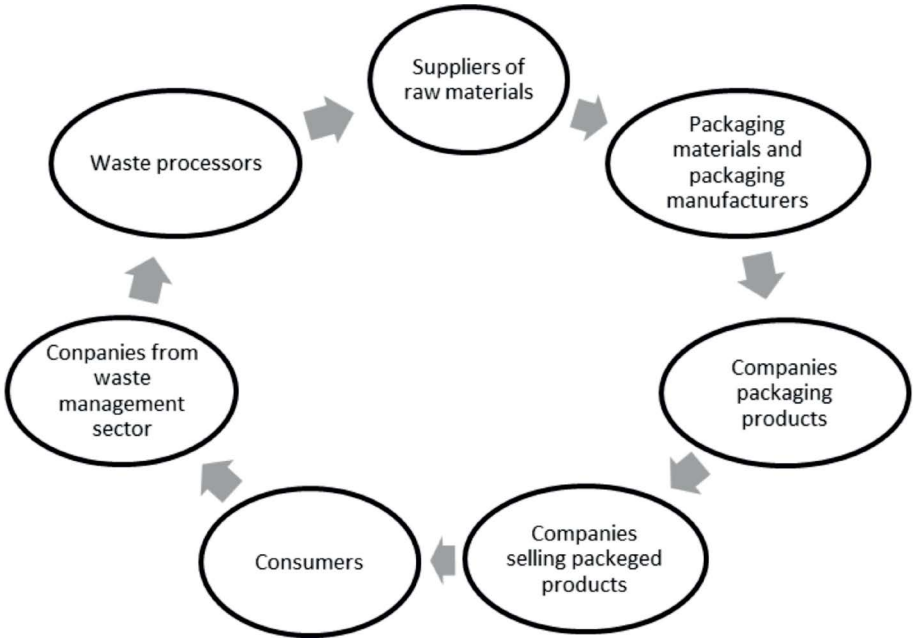

Fig. 3. Circular model of packaging supply
Source: Authors'

Rys. 3. Cyrkularny model dostaw opakowań

In order for the circular model to function correctly, verifying the existing practices of handling packaging and packaging waste is necessary.

3. Practices regarding the reduction of the negative impact of packaging on the environment

Practices regarding the reduction of the negative impact of packaging on the environment for many years have been implemented, the assumptions of which deal with packaging and packaging waste are presented in Directive 94/62/ EC of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste (L.365, 31/12/1994). The

requirements of the directive indicate that the most important action is to reduce the mass, volume and impact of packaging materials and packaging on the environment. Another action to be considered is the use of reusable packaging where possible. Another in the hierarchy of solutions is to provide the possibility of recycling post-consumer packaging waste. Other recovery processes exist at the lower levels of the hierarchy, including composting and incineration with energy recovery (Paszun and Spychaj 1997). The storage of waste is not recommended and this process is considered only when there are no other solutions for waste management. All methods of waste management are included in the Circular Economy concept, in addition to storage. The key action in the case of the packaging industry should be to reduce unnecessary packaging levels, for example in the case of a toothpaste packaged in a tube together with the protection of resigning from a cardboard box. In addition, the trend of reducing the weight of PET bottles for water or beverages is clearly visible. In 2015, the average weight of a 500 ml PET bottle ranged from 15 to 20 g, in 2017 the new bottle was 12 g, the producers currently market 8g bottles (www.packagingpolska.pl.). Therefore, the trend of reducing the weight of the packaging while maintaining its protective function, as well as the unchanged way of production and packaging is clear. It can therefore be said that the search for the optimal weight of the packaging with the chosen design using the chosen material is underway. The search for the optimum is to find a packaging weight below which the packaging can no longer be offered due to its failure to meet the requirements. Therefore, an optimal package is sought, which is ideologically shown on Figure 4. Below this optimum there is talk of underpacking, above of overpacking. Attempts to reduce packaging impacts should only be pursued if they maintain or reduce the impacts of the packed product (Żakowska 2017; Wojnarowska 2018).

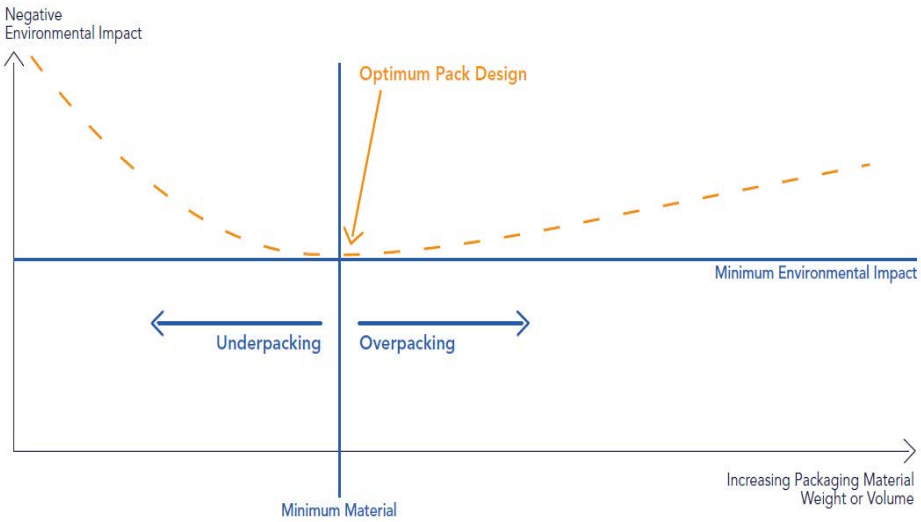

Fig. 4. Optimal packaging
Source: Packaging in the Sustainability Agenda... 2009

Rys. 4. Optymalne opakowanie

Multiple use creates a very simple connection between the units responsible for packaging the product, distribution, consumption and operator ensuring the return of the packaging to the product manufacturer, and preparing the packaging for re-use and the packaging of products. It should be remembered, however, that reusable packaging may be damaged, destroyed and does not circulate an infinite number of times in the economy. It should be possible to manage the waste generated after reusable packaging, mainly through the possibility of their processing (recycling) (Ucherek 2005). Unfortunately, there are not many reusable packagings available on the market, mainly glass bottles, and their value is estimated at PLN 150 million. The big market of reusable packaging is market of transport packaging such as: boxes for bottles, boxes for fruit, vegetable, meat use in transport. Transportation packaging are very often in a reusable circle, where they come back to producers from sellers, are prepared for use (they are cleaned) and reused again. For economic reasons some of them are constructed in the way that it is possible to fold them. This is an example where capacity needed in transport is reduced (cabka-ips.com).

Another activity that is implemented by the packaging industry is material recycling. In this case, in the economy, the return road from post-consumer waste to packaging the product in a new packaging is no longer as simple as in the case of reusable packaging (Fortelný et al. 2004). The material must be processed by the appropriate units. A new packaging or other product is produced from the recirculation tank and the return to the economy is implemented (Yam 2009). Recycling is easier to connect with on the industrial scale – where different types of technologies of mass recovery and the reuse of materials are used. This is clearly visible, for example, in metallurgical, chemical, paper or electronic factories. There are well-known examples of obtaining rubber from shredded tires, re-melting precious metals contained in used electronics or reusing waste paper or glass.

In the case of this end-of-life management method, many requirements should be taken into account in both design and production, use and the collection and management requirements. This form of end-of-life management is possible and that the new product obtained in this way it is not losing value. Scientists and the processing industry are constantly trying to improve existing technologies so that the loss of properties would be as small as possible, or even improve the properties of new products (Packaging in Sustainability Agenda… 2009). In the case of such processing of raw materials, which is associated with a decrease in the quality of the material, it is referred to as downcycling. The opposite of downcycling is upcycling, that is, a solution that gives new objects life, makes them even more attractive than during their original use – for example, increasing their functionality or giving aesthetic value.

There is a lot of examples of recycled packaging on the market. On the significant scale, plastic waste becomes a raw material in the production of transport boxes, plastic pallets, shopping bags, packaging used in household chemicals. Recycled materials are not used in food packaging due to problems in hazard analysis and unpopular chemical recycling methods.

Other activities bearing the hallmarks of development processes include composting. Composting is a way to recover organic matter, which returns it to the environment and can be used to grow plants, nourishing them. This method of closing the cycle is shown

in Figure 5. Bioplastics are becoming more popular in the food industry as packaging materials, there are companies that uses this kind of material – the Coca-Cola company uses the Plant Bottle where about 30% of the plastic is bio-PET (https://www.cocacola.com.pl/historie/plantbottle-bo-30-ma-znaczenie). Material such as PLA or other fully biodegradable materials are commonly used on the packaging market (www.european-bioplastics.org).

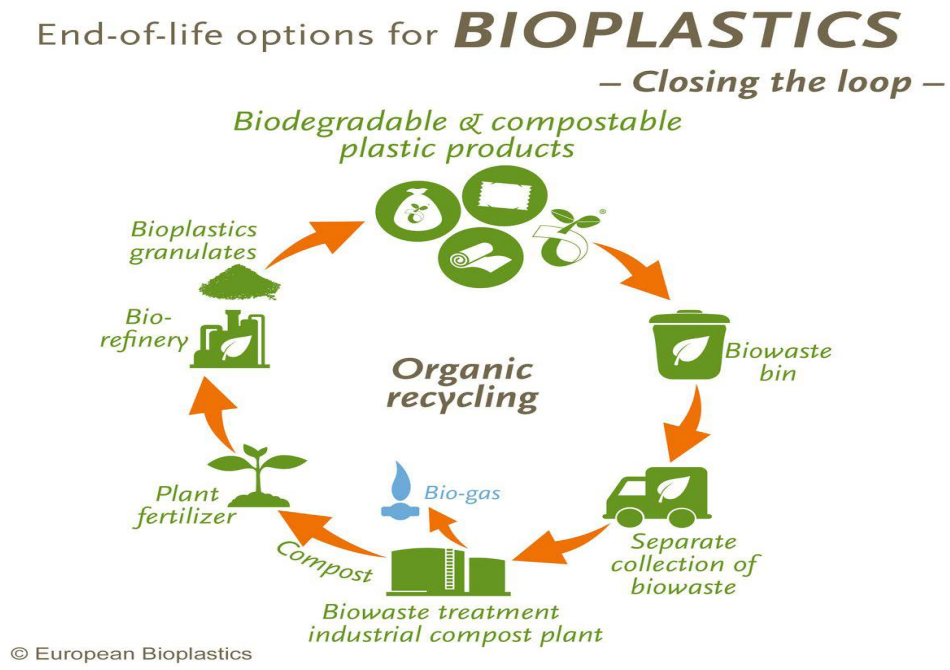

Fig. 5. Organic recycling
Source: www.european-bioplastics.org

Rys. 5. Recykling organiczny

4. Challenges for the packaging industry

Despite the current legislation in the field of packaging and packaging waste management, the aim of which is to reduce the negative impact on the environment, entrepreneurs are introducing, to a small extent, the necessary changes aimed at the transition or closer approximation to the assumptions of the Circular Economy concept. The challenges still facing the packaging industry include (Kawecka 2018):

- further reducing the weight and volume of packaging, maintaining the functional characteristics,
- use of reusable packaging along with an effective system of packaging collection from consumers and return to users,
- building an effective collection system for segregated waste,

- development of modern processing processes, so that there is no downcycling in practice but for recycling or upcycling,
- designing packaging useful for recycling,
- wider distribution of bioplastics as an alternative to plastics,
- change of legal regulations,
- applying incentives to enterprises and consumers, while penalizing non-compliance,
- education of consumers and entrepreneurs.

The implementation of the trend related to the desire to further reduce the weight and volume of packaging forces the necessity to develop new materials with improved barrier and strength properties, which in turn may lead to the protection of the packed product at a very low weight of packaging material. It is also necessary to build effective collection systems for both reusable packaging and segregated post-consumer waste. The organization of such systems forces the involvement of more entities or the introduction of solutions in the form of recyclers. Packaging designers should take better account of the requirements of recycling systems, implementing the ecodesign of packaging (Lewis 2008).

At the same time, the recycling industry and research units are working on new ways to recycle materials, including the chemical recycling of polymers allowing for depolymerization, obtaining monomers and re-conducting the polymerization process (Paszun and Spychaj 1997). The challenges of the packaging industry also include: striving to improve the properties of biodegradable plastics from renewable sources and spreading their use to packaging various types of products. Plastics of this type fit perfectly into the Circular Economy concept, causing the return of packaging waste in the form of biomass to the environment and the supply of new raw material resources. The above proposed actions will have a chance of implementation if legal regulations are introduced that will encourage or forcefully change existing packaging to more environmentally friendly packaging. These activities should be supported by appropriate educational campaigns among consumers and entrepreneurs.

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References

Attitudes of European citizens towards the environment. 2017. Special Eurobarometer Raport 468, Wave EB88.1 – TNS opinion & social, European Commission, Brussells.

Branża opakowań w Polsce. Podsumowanie 2010–2016 i prognozy 2017–2020. 2017. Equity Advisors, Kraków.

Cholewa-Wójcik, A. 2016. Rola i udział opakowań w łańcuchu dostaw [In:] Wasiak W. ed. *Opakowania w łańcuchu dostaw. Wybrane problemy*, Warszawa: Polska Izba Opakowań (*in Polish*).

Definition of Sustainable Packaging. 2005. Sustainable Packaging Coalition, Green Blue.

Directive 94/62/EC of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste, L 365, 31/12/1994.

Fechner, I. 2016. Łańcuch logistyczny. Struktura. Podstawowe ogniwa i funkcje [In:] Wasiak W. ed. *Opakowania w łańcuchu dostaw. Wybrane problemy*, Warszawa: Polska Izba Opakowań (*in Polish*).

Fortelný et al. 2004 – Fortelný, I., Michálková, D. and Kruliš, Z. 2004. An efficient method of material recycling of municipal plastic waste. *Polymer Degradation and Stability* 85(3), pp. 975–979.

[Online] http://www.european-bioplastics.org [Accessed: 2018-09-10].

Kawecka, A. 2018. Rola użytkowników opakowań we wdrażaniu rozwiązań z zakresu gospodarki w obiegu zamkniętym [In:] Wasiak W. ed. *Transformacja przemysłu opakowań w kierunku gospodarki w obiegu zamkniętym. Wybrane zagadnienia*, Warszawa: Polska Izba Opakowań (*in Polish*).

Lewis, H. 2008. Eco-design of food packaging materials [In:] Chellini E. ed. *Environmentally Compatible Food Packaging*, Woodhead Publishing.

Packaging in the Sustainability Agenda. 2009. A Guide for Corporate Desision Makers, ECR Europe, EUROPEN, Brussels.

[Online] http://cabka-ips.com [Accessed: 2019-02-25].

[Online] https://www.cocacola.com.pl/historie/plantbottle-bo-30-ma-znaczenie) [Accessed: 2019-02-25].

[Online] http://www.packagingpolska.pl/pg/pl/rozne/opakowania_spozywcze/odpowiednia_waga_innowacyjna_8gramowa.html [Accessed: 2018-09-16].

Paszun, D. and Spychaj, T. 1997. Chemical Recycling of Poly(ethylene terephthalate). *Eng. Chem. Res*. 36(4), pp. 1373–1383.

Ucherek, M. 2005. *Opakowania a ochrona środowiska*. Kraków: Wydawnictwo Akademii Ekonomicznej w Krakowie (*in Polish*).

Ustawa z dnia 13 czerwca 2013 r. o gospodarce opakowaniami i odpadami opakowaniowymi Dz.U. z 2016 r. poz. 1863.

Wasiak, W. 2018. Rynek i przemysł opakowań w Polsce w 2017 roku. Ocena Polskiej Izby Opakowań, *Biuletyn Opakowaniowy* 2(134), pp. 18–19 (*in Polish*).

Wojnarowska, M. 2018. Importance of Recycling in a Circular Economy. *Towaroznawcze Problemy Jakości* 2(55), pp. 13–24.

Yam, K. 2009. Sustainable Packaging: Conceptual Framework [In:] Yam K. ed. *The Wiley Encyclopedia of Packaging Technology*, 3rd ed., J. Danvers, Wiley and Sons.

Żakowska, H. 2017. *Opakowania a środowisko – wymagania, standardy, projektowanie, znakowanie*. Warszawa: PWN (*in Polish*).