

Review

The Concept of Extended Producer Responsibility in the Field of Packaging Industry and the Energy Sector in the Light of the Circular Economy—The Example of Poland

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Abstract: The aim of this article is to analyze the effectiveness of the Extended Producer Responsibility (EPR) concept for packaging in the context of the transition to a Circular Economy (CE) and the corresponding transformation of the energy sector. The functioning of today's packaging industry is becoming more and more linked to the assumptions of the CE due to the use and recycling of raw materials. The basic research method used in this work is an analysis of the literature on the links between the concept of the EPR and the CE. The authors limited their research to the selected legal, economic and social aspects of packaging production and management in the European Union (EU). The situation in Poland is discussed in particular and the legal, economic and social specificity of the implementation of the EPR in this country is presented. This paper emphasizes the dependance between the implementation of the EPR concept and the effectiveness of the transformation toward a CE, which is achieved by increasing the circularity in the energy sector.

Keywords: extended producer responsibility; energy sector; circular economy; packaging; sustainable development



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1. Introduction

In each of the technological eras to date, a linear model of resource and goods management was dominant, which was expressed in the formula “produce–use–dispose” [1]. The consequence of such an approach were the excessive exploitation of non-renewable resources, a rapid increase in the amount of post-production and post-consumer waste and the progressive degradation of the natural environment. It is now recognized that, since about 1970, humanity has been living “on ecological credit”. Today, we consume 1.6 times more resources annually than the Earth's regenerative capacity allows [2]. Therefore, the need to find solutions on a global level that will reconcile the economic priorities with ecological reasons is becoming more and more relevant [3,4]. In response to this need, a Declaration of the United Nations Conference on the Human Environment (the Stockholm Declaration) was adopted in 1972 [5]. This document indicated that the natural environment must also be protected for the benefit of future generations, and declared the following goals: The consistent implementation of responsible and forward-looking planning, more conscious management and the in-depth monitoring of the surrounding environment [6].

There has been increasing recognition, at local and global levels, of the importance of the sustainable development concept. A crucial assumption of this civilizational development strategy is the need for the mutual integration of political, economic and social activities, maintaining a balance between fundamental natural and technological processes [7]. This necessity results not only from concern for the condition of ecosystems

and the preservation of biodiversity, which directly affect the quality and durability of human life [8], but the concept of sustainable development has also become a response to the constantly growing costs of acquiring non-renewable resources and the costs of waste management [9]. By relying primarily on renewable resources, the Circular Economy (CE) will become an effective response to the shortcomings of the linear economy. The new economic strategy also offers an alternative to the traditional dependence of economic growth on the possibility of the extensive use of natural resources. According to the CE doctrine, materials and raw materials should be used as efficiently as possible for the longest possible period of time and the waste generation should be minimized by the use of effective material recycling [10].

One of the economic tools used to implement a CE is the concept of Extended Producer Responsibility (EPR) formulated in 1994 [11,12]. The EPR is an expression of an environmental policy in which the producer's responsibility for the product is extended also to the post-consumer stage of its life [13]. It is based on the adoption of the "polluter pays" principle, one of the guiding principles of environmental law and a pillar of the European Union (EU) environmental policy [14]. This principle was established in 1972 in order to raise funds for the fight against environmental pollution [5,15]. A broader understanding of the EPR principle concerns the financing of ecodesign, environmental education, and the monitoring and the repair of possible environmental damage [16]. At the same time, the EPR is not just a derivative of the "polluter pays" principle but also a practical tool for its implementation, considering all costs related to placing products on the market [12]. The following types of the EPR should be distinguished, particularly the legal and economic ones [17,18]. The scientific research in this field is presented in the example of Poland's economy as the case study. The choice of Poland's economy is a consequence of the observed difficulties in implementing the EPR and CE concepts in practice, which in the context of the ongoing convergence processes in the EU is an important and significant area of scientific research.

A key factor for the successful implementation of the CE in Poland is the reform of the country's energy sector, which has been the main source of pollution of the local natural environment for many years. This situation results from the specific structure of the Polish energy sector, which is based primarily on fossil fuels with a minimum share of renewable sources [7,12,18]. In this regard, the issue of managing renewable raw materials, including packaging waste, is becoming more and more important. Today, packaging issues include not only technological, economic and ecological aspects but also ergonomic, sociological and sanitary factors. Packaging as such has become an integral component of the socio-economic system and can be considered as the link between the producer, trader, distributor and consumer of goods [13,15,18]. As will be shown later, the implementation of the EPR principle will become an important factor stimulating the search for packaging materials more suitable for the CE. Moreover, in the longer term, the EPR principle will have not only ecological and economic but also social and cultural significance.

2. Methodology

In the presented study, the publications were reviewed in terms of two main issues—the concept of EPR and the CE. This choice is related to the rapidly growing number of publications on these two issues. This raises the need to systematize and properly link the EPR concept and the CE at the theoretical level.

Literature reviews are a valuable research method, helpful in the development of a given scientific discipline [19,20]. Recognizing the value of a similar research strategy, the professional literature was reviewed in terms of current trends and research perspectives regarding the relationship between the EPR and the CE.

The process of reviewing the literature on the subject, as a research method, included the following stages:

- (1) The preliminary division of the collection of materials prepared for study into individual categories.

- (2) The study of individual publications in particular categories.
- (3) Making a synthesis at the level of individual categories and then at the level of the entire set of studied publications.

During the implementation of the research strategy presented above, the authors encountered the problem of delimitation and excess of the data set. Therefore, an appropriate selection was made, and the number of publications subjected to further research was reduced. For the purposes of this study, scientific works in the form of papers, articles, scientific works and dissertations, as well as specialized reports of selected institutions and research units were used.

The theoretical objectives of a given article can be summarized in three main research questions:

- (1) What kind of legal conditions are considered for EU countries in regarding EPR implementation?
- (2) What is the essence of the economic aspect of EPR in the field of packaging industry?
- (3) What is the significance of the EPR concept for the effectiveness of the implementation of the CE?

The undertaken literature review aims to obtain answers to the above research questions in a deductive [21] and integrative way [22]. Research limitations include favoring primarily scientific articles and databases, as well as depending on the reliability of the articles' authors referred to in the selection of keywords [23]. Despite these methodological limitations, the value of the qualitative synthesis of the collected scientific papers should be emphasized. The element of novelty presented in this publication is an original approach, including conclusions about the effectiveness of EPR for packaging in the context of the transition to CE and the corresponding transformation of the energy sector. Therefore, taking into account two different ways of introducing changes in the energy sector, together with an indication of the higher efficiency of one of them, is an important aspect of this scientific work from the economic, environmental and social points of view.

The main research reference point for the authors is the Polish economy. This choice is related to the need to include in the study such an economy, which can be described as different from the more developed economies in terms of EPR and the CE implementation [24]. Focusing on an abnormal example also involves the need to understand the convergence processes taking place in the EU. In addition, showing the specificity of Poland may be an inspiration for further research in the field of EPR and CE considering the situation of other Central and Eastern European countries admitted to the EU in 2004 and later.

3. Legal Aspects of EPR Implementation

EU legislation defines the EPR as a set of instruments obliging producers to bear the financial (or financial and organizational) responsibility for the management of their products at the stage when they become waste [25]. However, this definition is incomplete as it only refers to the last stage of a product's life. It omits such important activities as ecodesign or shaping the right consumer attitudes. The minimum requirements for EPR systems are included in Article 8a of the directive amending the framework directive on waste [25] and include the following legal and organizational conditions for individual EU countries:

- Defining the roles, rights and obligations of all the actors involved in the EPR;
- Defining the quantitative and qualitative waste management targets relevant to the EPR;
- The provision of a reporting system to collect data on the products placed on the market and the waste generated from these products;
- Ensuring the equal treatment of all the producers, considering the specificity and capabilities of small and medium-sized enterprises;
- Informing companies covered by the EPR on methods of the proper handling of the waste generated from the products placed on the market;

- Determining the requirements for the producers and organizations implementing the obligations under the EPR on their behalf, concerning, inter alia, the geographic coverage, use of financial resources, self-control mechanisms and public disclosure of information;
- Ensuring the correct amount of financial contributions made by the product manufacturers to implement the EPR;
- Conducting the monitoring, control and enforcement in the field of the correct implementation of the EPR and the proper use of the funds collected for this;
- The appointment of an independent body to oversee the implementation of the EPR;
- The creation of a mechanism for the appointment by the manufacturer of a foreign representative who will carry out the EPR on its behalf in a given country;
- Ensuring regular dialogue between all the actors involved in the EPR system [25].

The above requirements are a significant legislative and administrative challenge for those countries where economic growth remains the overriding goal of all economic activities [26,27]. Poland belongs to this group, in the case of which it is difficult to talk about the sustainable development of the economy. An illustration may be the dysfunctional system of packaging and packaging waste management in force in the country. The changes planned in Poland, aimed at transposing the EU requirements regarding the EPR into Polish law [28], will have a revolutionary significance for the law and economy of this state.

4. The Economic Aspect of EPR in the Field of Packaging Industry

From the point of view of economic theory, the EPR concept fits into classical economics as well as the emerging post-capitalist economy [18]. It is an attempt to transfer the paradigm emphasizing the key importance of the rational use of natural resources to the practical sphere [13]. The key EU requirement in the field of EPR is that individual countries provide the appropriate amount of financial burdens collected from businesses placing packaged products on the market [25]. The most important of these burdens is the cost of separate packaging waste collection, transport and processing. This burden will be reduced by the amount of income from the reuse of packaging, the sale of recyclable materials and unclaimed deposits [29].

Determining the actual level of this cost for a given country is problematic because it is necessary to determine it for each type of packaging and also to consider their properties, durability, serviceability, reusability and recycling, and the presence of hazardous substances [25]. Another complication is the requirement to include in the amount of burdens incurred by an entrepreneurs' income from the sale of secondary raw materials. The value of these resources depends on many factors: on the quality of the raw materials determined by their purity, homogeneity and degree of sorting [30]. The research has shown that only in the case of aluminum fractions (beverage cans) and PET plastic (beverage bottles), the revenues from the sale of the raw material exceed the previously incurred costs of waste management [31]. Other assortments, especially some polymers (due to their material composition, significant contamination or the inability to sell them), are not always recycled and are used in production plants as alternative fuel or as ballast in landfills [32].

In view of the above, it is important to modulate the rates of fees that will be charged to businesses placing packaged products on the market and they should consider all the costs related to the collection and recycling of packaging waste [33]. Therefore, it is necessary to calculate by how much cheaper a PET bottle placed on the market is compared to a multi-material cardboard package for liquid food and how much more expensive a polystyrene container is compared to the analogous shape made of cellulose pulp. The obtained data will have an impact on the purchasing decisions of conscious consumers [30]. Each EU country is responsible for choosing the right tools to modulate (eco-modulate) the rates of charges. An example of such a mechanism is the Life Cycle Assessment (LCA), which refers to the environmental impact of each stage of production and operation of a specific types of packaging [29]. Such an assessment can indicate which among several similar packaging types is the most beneficial from the ecological point of view [34].

The effective collection of used packaging requires the provision of a network of easily accessible points for the collection and collection of this waste as well as the technical facilities for their segregation [27]. An appropriate level of awareness among waste producers, especially among final consumers, is also important [30]. The material recycling of packaging waste, in turn, depends on the efficiency of the treatment plant. Another important issue is the degree of cleanliness of the supplied secondary raw materials, which directly determines the suitability of the waste for further processing [29].

An investment gap has been identified in Poland regarding the preparation of waste for further recycling. This gap is the cause of a reduction in the capacity of domestic waste treatment installations. However, similar waste can be used as a raw material for energy production. The scope of the selected Polish investment needs in the field of waste management is presented in Table 1.

Table 1. List of investment outlays for selected types of waste in the example of Poland.

Type of Waste	Type of Investment	Required Outlays (PLN Billion)	
		2020–2028	2029–2034
Glass waste	New installations for the treatment of glass cullet prior to its recycling	0.225	0.075
Paper and cardboard	New installations for material recycling	1.700	2.600
Plastic	New installations for material recycling	3.440	0.860
Non-ferrous metal	Retrofitting existing installations with non-ferrous metal separators	0.110	0.010

Source: Institute of Environmental Protection—National Research Institute 2020.

5. The Importance of the Concept of EPR for the CE

The CE is a development strategy that maximizes resource efficiency and minimizes waste generation [9]. Currently, the professional literature uses over 200 definitions of the CE. Among the most pictorial is the concept of a “spacecraft Earth” as a resource-constrained object. Only the continuous re-processing (reusing) of materials would allow humanity to survive [35,36]. One of the most important features of the CE concept is the attention to each stage of the life cycle of a selected product: from the design stage, through production and distribution, to the stage of consumption and waste recycling. According to Wróbel and Sołtysiak [37], today, over 80% of all energy produced globally comes from conventional sources. However, the draft Energy Policy in the EU until 2040 is to change this: it assumes a reduction in the share of solid fossil fuels to 55% in 2030 compared to 1990 [38]. As many researchers believe [18], an appropriate tool to achieve this goal is, *inter alia*, the EPR concept.

The Netherlands, Italy, Austria, Spain and France have already taken steps to initiate the transformation toward a CE, and internships that fit into the EPR concept have also been planned [39]. In the Netherlands, the transformation toward a CE will result in a reduction in the consumption of natural resources and independence from their import. Similar goals are to be achieved, among others, by extending the life of products and by encouraging consumers to share certain goods (e.g., cars). In Italy, the introduction of appropriate economic incentives is being considered. An example is the shift of the tax burden from income to “unsustainable” consumption [39].

The experience of the above-mentioned EU countries shows that the EPR is an economic mechanism that promotes the transformation toward this economic model. The EPR is particularly effective in the case of packaging and electronic equipment (including batteries and accumulators).

6. Implementation of EPR Principles in Packaging Production and Its Expected Impact on the Energy Sector in Poland

In economic practice, there is a clear dependence between the EPR and the energy sector. The impact of the EPR on the real reduction in the mass of waste intended for incineration is noted. The implementation of a CE in Poland is to begin in the energy, construction, mining, metallurgy, bio-economy and plastics sectors [7]. First of all, new economic rules should be implemented in the energy sector, which, as mentioned above, remains the main source of environmental pollution in Poland today. The important role of renewable energy sources in the efficiency of a CE has been the subject of many studies that are far ahead of the contemporary activities undertaken by the European Commission [18,40,41].

Today, as part of the so-called green economy, ways to reduce the demand for resources and energy and the development of “green industries” are being sought. They include renewable energy sources, energy-efficient construction and ecological transport [42]. These practices are part of the European Green Deal, which is the EU’s development strategy [43]. Because of this, the EU has the potential to become one of the neutral areas of the climate by 2050. One of the pillars of this philosophy is the improvement in energy efficiency, which will be manifested by a more effective use of the existing energy sources in production processes [44]. The CE assumes the production and use of sustainable products, the use of closed production circuits and a reduction in the material and energy consumption of manufacturing and service processes [45].

The planned net emissions of zero, a 55% reduction in CO₂ emissions by 2030 and the systemic preference for zero-emission energy and transport are challenges for the packaging industry. This will be especially felt in the glass packaging industry, where traditionally energy-intensive processes mean that the ratio of energy costs to revenues exceeds 9%, compared to the industry average of approximately 1.7%. The situation is similar in the case of plastic packaging, for which this ratio is 3.4% [44,46]. Therefore, businesses in the packaging industry are looking for opportunities to produce more sustainable packaging materials that meet the following criteria:

- Sourcing, producing, transporting and recycling using renewable energy and clean technologies. The use of renewable or recycled source materials;
- To manufacture in such a way as to optimize the use of materials and energy;
- Ensuring a safe impact on individuals and the general public throughout the entire life cycle of the packaging;
- Meeting the market criteria for efficiency and cost;
- Capable of being effectively recovered and used in closed circuits [47].

By motivating the production and use of more environmentally friendly packaging [18], the EPR will contribute to increasing the circularity of the energy industry by ensuring a greater share of renewable energy sources in the entire life cycle of packaging. The production of packaging from secondary raw materials will provide measurable energy savings compared to production from primary resources. As indicated by the results of the empirical research and mathematical modeling, recycling aluminum packaging waste requires only 5% of the energy necessary to process a primary raw material, and the processing of similar steel waste saves as much as 70% of the energy compared to primary production [48]. The use of reusable packaging guarantees a reduction in the energy consumption of the packaging industry.

A mention should also be made of the impact of the EPR on the reduction in the weight of waste to be incinerated. Today, in Poland, approximately 50% of non-salable packaging waste from paper and cardboard is utilized solely by energy recovery. For plastics, this ratio is 90% [49,50]. Therefore, the combustible fraction of waste is a significant resource support for waste incineration plants in Poland [26]. Experts believe that the implementation of the EPR concept in this country will significantly increase the mass of waste destined for material recycling or composting. In this way, Poland will achieve the level of recycling of packaging waste required by the EU [21,44,46]. In the event of an energy crisis, a significant

reduction in the amount of packaging waste intended for incineration may lead to an increase in energy prices for entrepreneurs and individual recipients. Nevertheless, in a broader perspective, the reuse of packaging and recycling of packaging waste are activities more beneficial for the natural environment and society than energy recovery [50]. Table 2 presents the recycling level applicable in Poland in 2021 and the levels necessary to be achieved by the end of 2025 and 2030 as required by the EU.

Table 2. Recycling levels of packaging waste in the example of Poland.

A Kind of Package	Required Levels of Packaging Waste Recycling (%)		
	Until 31 December 2021	Until 31 December 2025	Until 31 December 2030
Plastic	23.5	50	55
Aluminum	51	50	60
Steel	51	70	80
Paper and cardboard	61	75	85
Glass	61	70	75
Wooden	16	25	30

Source: own study based on Journal of Laws 2013 item 888 with amendments and OJ L 150/141.

Experts emphasize that packaging has long ceased to be only products intended for the protection, storage and movement of goods. Currently, the packaging materials must not only be fully functional, safe and aesthetically attractive, but are also supposed to have a positive impact on the buyer's experience, which is determined not only by the quality of the product itself but also its packaging, the social perception of a given brand, the purchasing process and the quality of further customer service [10]. It is worth emphasizing that the EPR does not contradict these values but adds to them a balance between economic and environmental priorities, thus perfectly fitting into the CE.

In the specialist literature there is a belief that the packaging waste management system operating in Poland is extremely underfunded, which prevents its effective operation [51–53]. In the case of six of the seven types of packaging analyzed by the authors, the financial burdens applicable in Poland resulting from the EPR are below the European average, and in the case of plastic (EUR 27.00/ton) and steel (EUR 12.00/ton) packaging, they are the lowest fees among all the compared European countries. In the case of the two other types of packaging examined, paper (EUR 22.00/ton) and glass (EUR 15.00/ton), Poland ranks third lowest in Europe. Only in relation to wooden transport packaging does the amount of financial burdens applicable in Poland (EUR 41.00/ton) exceed the European average [53]. In the opinion of most Polish experts, this is due to divergent interpretations regarding the recognition of certain types of wood waste treatment as recycling. It also results from the common treatment of used wooden pallets as reusable packaging (no waste status), the repair of which does not count toward the overall recycling level [51,53].

As shown above, the amount of the EPR fees in Poland is significantly lower than the EU average. However, it should be clearly noted that the efficiency of recycling systems does not mean that they have to be associated with high costs. The strategies undertaken in different EU countries to encourage producers have taken various forms, both imposing restrictions and penalties, as well as positive motivation [16,52]. These strategies should be adapted to the specificity of the economy, to the possibility of taking specific obligations by specific businesses [1,3,7,11]. The factor that will bind the various systems within one EU market is the constant monitoring and control of activities adjusted to given market systems [13,18,24,52].

7. Conclusions and Discussion

The energy transformation of the coming decades will significantly affect the way energy resources are used in production processes. Deepening ecological awareness in societies and governments, and appropriate pro-ecological restrictions, will open the way for zero-emission energy produced in the CE. The energy sector should increasingly rely

on advanced technological and ecological solutions. It should be better and better adapted to the local needs of a specific recipients and should be stable and safe for ecosystems. The energy sector of the future must fit into a long-term development strategy, creating and using appropriate economic and social patterns.

One such effective economic and organizational instrument is the EPR concept, which is currently evolving to include more and more new product types and ranges. Technological development makes it possible to predict the effects of pollutant emissions, which in turn allows for the implementation of appropriate economic and social strategies for the preservation of natural ecosystems. Today's modeling capabilities allow, already at the stage of designing the production methods, to accurately recreate the actual course of production cycles, providing information about their impact on the environment.

In its theoretical assumptions, the CE is based on the strategies of making available, repairing, reusing, refurbishing and recycling products. However, recycling of plastic packaging is a major challenge for the EU economy today. A significant increase in the recycling rate is not possible without adequate financial resources allocated to the improvement in the packaging waste collection and recycling processes. This also applies to the improvement in mechanisms to maximize the product life cycles, returning raw materials and waste from products for processing and reuse.

The wide application of the EPR concept will result in the achievement of the levels of recycling of packaging waste required by the EU legislation. However, it must not be forgotten that there are no universal rules for all EU countries and the EPR must be adjusted to the specificity of a given country, its market and a consumer's profile.

In the context of the current intensifying energy crisis, a significant reduction in packaging waste intended for incineration may contribute to lowering energy prices for businesses and individual consumers. As the analysis presented in this article show, the recycling of packaging waste is more beneficial for the environment and society than energy recovery. It limits the anthropogenic impact on the natural environment and leads to a final reduction in production costs.

The implementation of the EPR is aimed at motivating businesses to produce and use more environmentally friendly packaging, which is necessary for the correct transformation toward a CE. In the longer term, the EPR will contribute to increasing the circularity of the energy sector. The mechanism to achieve this goal is to ensure a greater share of renewable energy sources throughout the entire life cycle of packaging, to favor recycled packaging and to promote reusable packaging that can be re-marketed.

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