

NEW REQUIREMENTS FOR PACKAGING WASTE MANAGEMENT IN POLAND AS A WAY TO REALIZING THE GOALS OF A CIRCULAR ECONOMY

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Purpose: The aim of the article is to present the legal changes in the field of packaging and packaging waste in Poland over several years. These changes also concern various institutions adapting to the amendment to the law by, for example, introducing a deposit system or purchasing bottle dispensers. The authors want to show what the deposit system in Poland will look like in principle. It is intended to reduce the waste of secondary raw materials and accelerate the implementation of circular economy (CE) and sustainable development goals.

Design/methodology/approach: The aim of the article will be achieved by analyzing the proposed changes to the Act on packaging and packaging waste management and comparing them to economic realities. A review of scientific articles, the authors' participation in online debates on changes in the deposit system and a review of websites will allow for a comparison of the work/changes made so far by various institutions (cities, shops) in this area. This will also allow you to formulate the benefits and difficulties that may arise when implementing the system.

Findings: Based on the analysis of documents and implemented investments, ecological, economic and social benefits for the country were identified in the implementation of the deposit system (affecting the implementation of CE objectives).

Research limitations/implications: The research conducted by the authors is based on the previous initiatives of the organizations described. The real benefits of implementing the deposit system will be visible at least after a year or two of its operation. Currently, these are guesses based on other countries. In their research, the authors intend to monitor the results and benefits of the deposit system in Poland in the coming years.

Practical implications: The article has a synthetic application for retail chains that can observe the activities of competitors. Moreover, it constitutes source material for future comparisons and research in this area.

Social implications: The implementation of the deposit system from January 1, 2025 in Poland will have a positive impact on increasing the recovery of packaging waste. This has a direct impact on environmental protection, saving raw materials and energy, increasing the responsibility of packaging producers and society for the implementation of packaging waste management and CE.

Originality/value: The article presents current achievements in the implementation of the deposit system in Poland as a result of new legal regulations.

Keywords: deposit system, bottle dispensers, waste packaging management, circular economy, SUP - Single Use Plastics.

Category of the paper: research work, case study.

1. Introduction

The aim of introducing circular economy (CE) is to change the farming system from linear to circular. This goal is to be achieved by introducing high-quality and durable products to the market that can be: borrowed, reused, repaired, refurbished and recycled for as long as possible. In this way, the life cycle of existing products operating on the market will be extended (COM 98/2020; COM (2014) 398; Smol, Kulczycka, Avdiushchenko, 2017, pp. 669-678; Zarębska, 2017, pp. 286-295). Packaging is a perfect example here. Packaging is perfect for recovery and recycling. For example, beer bottles, barrels, wooden and plastic crates are suitable for multiple use; for material recycling - plastic bottles, juice cartons, linen or cotton bags; for thermal recycling - mixed and contaminated plastic packaging. In addition to reusable packaging, there is a large amount of disposable packaging on the market, which quickly becomes waste for example: disposable bags, juice and mineral water bottles, beverage cans, milk cartons, disposable food packaging (Plastics Europe, 2023; Szczepański, Waszczyko-Miłkowska, Kamińska-Borak, 2022; Zarębska et al., 2018; Zarębska, 2019).

According to data from the European Commission (Eurostat, 2024), over 2.2 billion tons of waste are produced annually in the European Union (EU), of which 27% (594 million tons) of all waste is municipal waste. In 2021, 84.3 million tonnes of packaging waste was generated in the EU, which corresponds to almost 189 kg per inhabitant. Of this packaging waste generated, approximately 80% was recovered, but only approximately 64% was recycled. Between 2010 and 2020, the amount of plastic packaging waste generated per capita in the EU alone increased by 23% (Eurostat, 2024). As you can see, packaging waste including plastic is a big problem to solve in terms of its management. This problem is very important because, as the EU forecasts, the amount of packaging waste produced will continue to increase.

By implementing a deposit system, EU countries intend to increase the recovery and recycling of packaging waste and thus minimize the amount of packaging waste deposited in landfills or incinerated (Directive 2019/904; Directive 2018/852; Lewicka et al., 2023; Zarębska, 2019). In the 16 European countries that have already introduced a deposit system, the best results are achieved by: Croatia - the average collection rate for all packaging is approximately 90%; Finland - collection rate for glass - 88%, for PET (Polyethylene Terephthalate) - 92%, for metal - 96% (Deloitte 2019). Such effectiveness of the deposit system convinces other countries, including Poland, to implement it.

Packaging and packaging waste solutions applicable in the European Union must also apply in Poland. The deposit system in Poland is to be introduced from January 1, 2025. However, preparations for its implementation have been ongoing for several years. Therefore, in order to adapt Polish law to EU requirements, the Council of Ministers adopted an amendment to the Act of June 3, 2013 on packaging and packaging waste management (consolidated text: Journal of Laws 2023, item 1658; item 1852). According to the 2023 Act, from January 1, 2025, for a plastic, glass bottle or metal can returned to the store, the consumer will receive a refund of the specified amount that he previously paid for it. In Poland, there are two names used to describe the additional fee for packaging: 1) deposit for reusable packaging and 2) deposit for disposable packaging.

The article will discuss the current work of the Ministry of Climate and Environment (in Polish: Ministerstwo Klimatu i Środowiska) in the field of changes to legal acts and the results of conversations and consultations with entrepreneurs, recovery organizations and representatives of municipalities in the implementation of the deposit system. The above data, characteristics of current legislative work, a review of the literature and work on infrastructure in Poland will allow the authors to compare the barriers and benefits of the deposit system. The main objective of this article is to compare the barriers and benefits of the deposit-refund system. The authors also want to answer the question whether the deadline of January 1, 2025 is realistic in the event of introducing a deposit system in Poland? This deadline has already been postponed many times and currently, among entrepreneurs, there are many supporters of another postponement of the deadline to 2026. This topic is particularly important and current because its results may be useful for stakeholders (enterprises, municipalities, non-governmental organizations) to create and implement appropriate initiatives, strategies within public policies and waste management.

2. Materials and methods

The subject of the article is the implementation of broadly understood packaging waste management and the packaging deposit system in Poland. In their research, the authors analyze EU and national legal acts, website databases (Eurostat, EEA - European Environment Agency; Central Statistical Office - in Polish: GUS; Ministry of Climate and Environment) and reports of non-governmental organizations (Deloitte, 2019, Togetair, 2024; Plastics Europe, 2023). The implementation of the deposit system in Poland is widely discussed on online forums, in the media, and in domestic and foreign publications (Lewicka et al., 2023; Teraz Środowisko, 2023; Malowaniec, 2022; Szczepański, Waszczyko-Miłkowska, Kamińska-Borak, 2022; System kaucyjny..., 2024). This topic raises many doubts and controversies, as it requires not only legal changes, reconstruction of waste management infrastructure, but also expansion of

business responsibility. The authors, at least partially, want to answer the following questions in this publication:

- Is January 1, 2025 for the implementation of the deposit system a realistic deadline?
- What estimated benefits can be expected after implementing the system in Poland?
- Are Polish prepared to implement a deposit system?

In response to the questions, hypotheses were formulated:

- H1. The date of January 1, 2025 is realistic for the implementation of the deposit system in Poland, but only partial.
- H2. Polish residents want to introduce a deposit system, seeing the financial benefits from the recovered deposit and the environmental benefits.

The research carried out consisted of two parts. The first part of the research consisted of: analysis of the literature on the subject, EU directives and Polish legislation in the field packaging waste management and the deposit system. The second part consisted of a comparison of the stores' activities to date and the projected barriers and benefits of the system, divided into three pillars of sustainable development. To sum up, in order to effectively achieve the assumed research goals, several research methods were used in the publication:

- analysis of the subject literature,
- tabular and descriptive charts,
- deductive method,
- analysis of source documents.

The national activities undertaken so far are intended to check society's readiness to implement the deposit system and the effectiveness of its operation. The analysis of documents and national activities allows us to compare the barriers and benefits of the system in which not only enterprises, but also Polish residents themselves must be involved.

3. New legal regulations regarding the management of packaging and packaging waste

The EU rules on packaging and packaging waste cover both packaging design and waste management. Their aim is to harmonize national regulations, prevent waste generation and increase packaging reuse, recovery and recycling. They also define minimum requirements for packaging recycling on the EU market. The regulations are constantly changing and modified depending on the needs of the changing market situation and political pressure (Zarębska et al., 2018; Zarębska, 2019; Zarębska, Lewicka, 2020; Raftowicz, Ochman, 2024).

The implementation of CE and sustainable development goals varies and depends on the country. Not all EU member states are able to achieve the assumed recovery or recycling targets for municipal waste or packaging waste by 2025 and 2030 (Lewicka et al., 2023). Poland also

has problems with achieving such high levels of recycling (in 2021, the average recycling rate of packaging waste for the EU was 64%; Poland – 56.7%) (Eurostat, 2024). It should also be mentioned that failure to meet the deadlines for Poland to achieve the objectives of Directive 94/62/EC on packaging and packaging waste may result in the Commission initiating infringement proceedings. According to the Ministry of Climate and Environment, the introduction of the deposit system will contribute to a reduction in Poland's contributions to the common EU budget for non-recycled plastic packaging waste. In 2023, Poland paid approximately PLN 2.4 billion for not recycling plastic packaging waste (Ministerstwo Klimatu i Środowiska..., 2024b).

The EU regulations have recently amended:

- the waste framework directive (Directive 2008/98/EC),
- the packaging waste directive (Directive (EU) 2018/852),
- the directive on reducing the impact of certain plastic products on the environment - the so-called SUP (Single Use Plastics) (Directive (EU) 2019/904).

These provisions impose specific obligations on Poland:

- in 2020 – 50%, and in 2035 – 65% of waste should be recycled,
- by 2025 we must collect at least 77% of PET plastic bottles, and by 2030 as much as 90%,
- each PET bottle must contain 25% recycled materials by 2025 and 30% by 2030,
- by 2030, all plastic packaging should be recyclable or reusable,
- packaging waste recycling targets by 2025 and 2030 are for: plastic 50%/55%, respectively; aluminum 50%/60%; steel 70%/80%; glass 70%/75%; paper and cardboard 75%/85%.

Targets for recycling municipal waste and packaging waste are presented in Table 1.

Table 1.

Targets for recycling municipal waste and packaging waste

Specification	Waste recycling targets (%)					
	According to Directive 2018/851 amending 2008/98/EC			According to: Dz. U. 2020 poz.1114; Dz.U. 2021 poz. 2375; Dz.U.2023.poz. 2550.		
	years					
	2025	2030	2035	2025	2030	2035
municipal waste	55	60	65	55	60	65
packaging waste (total), including:	65	70		65	70	
plastics,	50	55		50	55	
aluminum	50	60		50	60	
steel	70	80		70	80	
glass	70	75		70	75	
paper and cardboard	75	85		75	85	
wood				25	30	
multi-material				65	70	

Source: own work.

National targets for recycling municipal waste and packaging waste are aligned/consistent with EU targets. Table 1 additionally presents recycling levels for wooden packaging and multi-material packaging (excluding hazardous packaging), which are also listed in national legislation. In the future, it is also planned to apply a deposit system to these packaging.

The national act implementing the SUP (Single Use Plastics) directive is the Act of April 14, 2023 amending the Act on the obligations of entrepreneurs regarding the management of certain waste and on the product fee and certain other acts, including on the management of certain waste and on product fee (Dz.U. 2023, poz. 877). It introduces systemic solutions aimed at reducing the impact of plastic waste on the natural environment, in particular the water environment, as well as on human health. The new obligations include a ban on placing certain types of plastic packaging on the market (from May 2023) and charging entrepreneurs fees for single-use plastic products (from January 1, 2024) and ensuring the availability of alternative packaging (from January 1, July 2024).

Changes in the laws also apply to packaging manufacturers, especially Extended Directive SUP (Single Use Plastics) Producer Responsibility (in Polish: ROP – Rozszerzona Odpowiedzialność Producenta). ROP makes packaging producers responsible for the entire packaging life cycle, from production to disposal. The manufacturer must cover the costs of collection, recycling and disposal of packaging waste. A strategy and regulations requiring the manufacturer to include all environmental costs in the price of the product, covering its entire "life" cycle - from its production, through use, to disposal after use. ROP may be introduced in the form of a simple fee depending on the type of product and material, or the obligation to organize a full system for its collection and management. So far, ROP has been introduced, among others, for packaging waste, waste electrical and electronic equipment, batteries and accumulators, oils, end-of-life vehicles.

According to the Togetair report, in 2018 the recycling rate achieved by Poland was supposed to be 30%, but approximately 300 municipalities failed to achieve this rate. Many experts emphasize, however, that even the 30% figure is overstated, because real recycling (not the one declared on paper) is around a dozen or so percent. Despite mandatory segregation, the vast majority (63-73%) of waste still goes to sorting plants as mixed waste, from which it is impossible to effectively sort out more than a few or a dozen percent of valuable raw materials suitable for processing (Togetair, 2024).

In 2020, packaging recovery organizations identified in the Waste Database (in Polish: BDO - Baza Danych o Odpadach) showed that 3954.44 thousand tons were produced in Poland Mg of packaging, of which: 964 thousand Mg of plastic packaging, 935.6 thousand Mg of glass packaging, 7157.8 Mg of aluminum packaging, 56,788 thousand Mg of steel packaging, 1366.3 thousand Mg of paper and cardboard packaging (P/T), 385 thousand Mg of wood packaging, 239.7 thousand Mg of other packaging, including multi-material packaging. Over 90% of packaging produced in the country is disposable packaging. In 2020, 1200.6 thousand were imported to Poland. Mg of total packaging. In the same period, almost 6 times

more packaging was exported from Poland, i.e. 6496.1 thousand. Mg of total packaging (Szczepański et al., 2022, pp. 33-40; GUS, 2023).

Packaging recovery organisations provide information in their annual reports, packaging recovery organizations provide information on the amounts and types of packaging waste recovered in the country and abroad. The information concerns specific types of packaging waste subjected to material recycling, another recycling method, thermal transformation and another recovery process. The total amount of packaging waste recovered in the country was 2731.6 thousand. Mg, outside the country 1243.2 thousand. Mg. The total amount of packaging waste recovered in the country and outside the country was 3974.8 thousand. Mg. Material recycling in Poland accounted for 90.8% of all packaging waste recovered in the country. An 8.2% share of thermal transformation processes was recorded, of which 4.7% were processes in waste co-incineration plants and 3.5% in waste incineration plants. Other recovery and recycling processes accounted for a total of 1% of the weight of packaging waste recovered in the country (Szczepański et al., 2022, pp. 80-81). In 2020, a total of 83.54 thousand were thermally transformed. Mg, waste code: 15 01 01, 15 01 02, 19 12 04, 20 01 01, 20 01 38. The waste was thermally transformed with energy recovery. Most packaging was thermally transformed from plastic. The largest amounts of packaging waste, 223.95 thousand Mg, were subjected to thermal transformation processes, including 127.7 thousand in co-incineration plants. Mg. and in incineration plants 96.2 thousand Mg (Szczepański et al., 2022, pp. 86-87).

The creation of a deposit system in Poland is intended to help achieve the goal of selective collection of beverage packaging made of plastic, aluminum and glass (and in the future also packaging made of steel and multi-material plastics - juice and milk cartons). In the Act of July 13, 2023 amending the Act on management of packaging and packaging waste and certain other acts (Dz.U. 2023, poz. 1852) defined the deposit system as "a system in which, when selling products in single-use or reusable beverage packaging referred to in Annex No. 1a to the Act (Table 2), which are beverages, a deposit is collected, which is returned to the end user in upon the return of packaging covered by the deposit-refund system or packaging waste generated from packaging covered by the deposit-refund system", respectively. It was also proposed that the system would be universal, non-discriminatory and that there would be no obligation to have a receipt in order to recover the deposit. The proposed regulations oblige every store with a sales area of more than 200 m² to collect empty packaging and packaging waste resulting from packaging covered by the deposit system and to return the deposit.

Table 2.

Minimum levels of separate collection of packaging and packaging waste

Types of packaging	Level of selective collection of packaging and packaging waste in % per year				
	2025	2026	2027	2028	2029 and following years
Single-use plastic beverage bottles of a capacity of up to 3 liters, including their plastic caps and lids, excluding glass or metal beverage bottles with plastic caps and lids.	77	81	84	87	90
Metal cans with a capacity of up to 1 liter.	77	81	84	87	90
Reusable glass bottles with a capacity of up to 1,5 liters.	77	81	84	87	90

Source: Act of July 13, 2023 amending the Act on packaging and packaging waste management and certain other acts (Dz.U. z 2023 r., poz. 1852).

The Act of 13 July 2023 amending the Act on packaging and packaging waste management and certain other acts (Dz.U. z 2023 r., poz. 1852; hereinafter referred to as the Deposit Act) introduces a deposit system into the Polish legal order. This Act amends the Act of June 3, 2013 on packaging and packaging waste management (consolidated text: Dz.U. z 2023 r. poz. 1658; latest amendments: Dz.U. z 2023 r., poz. 1852; hereinafter referred to as the Act on packaging management). However, the new deposit system is to start operating only from January 1, 2025 (Figure 1). Only from this date, for a plastic, glass bottle or metal can returned to the store, the consumer will receive a refund of the specified amount that he previously paid for it.

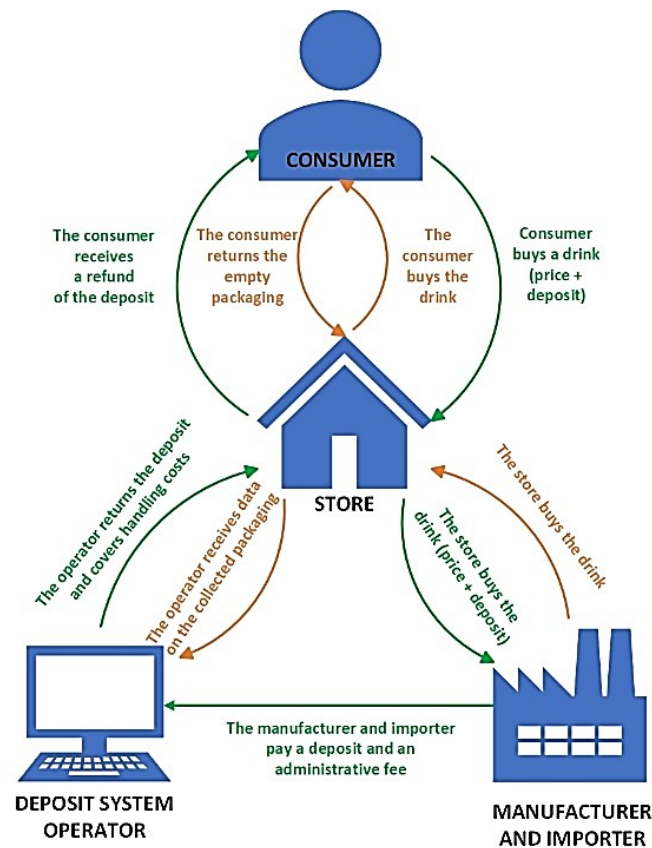


Figure 1. Simplified diagram of the deposit and packaging collection system.

Source: own work.

The proposed regulations will cover all market participants, both beverage producers, as well as modern and traditional trade stores, franchise outlets, wholesalers, bars and restaurants, as well as many other outlets offering drinks in plastic and aluminum packaging.

The main goals of implementing the deposit/refund system are: promoting environmentally friendly packaging, improving recycling, ensuring access to good quality and locally produced secondary raw materials and reducing the amount of waste that ends up in landfills. The idea is to ensure that the streams of returned packaging are homogeneous, without contamination from other fractions (e.g. food remains, sand, metals from caps), which would make them a valuable raw material for which relatively high prices can be achieved (Togetair, 2024).

The Ministry of Climate and Environment announced the introduction of the following changes to the deposit system (System kaucyjny od 2025..., 2024):

- VAT deposit exemption (for disposable and reusable packaging),
- collecting a deposit at every stage of sale,
- increasing the deposit to PLN 1 for reusable glass bottles,
- maintaining a low product fee for failure to meet the required collection levels in the first year of operation of the deposit system (in 2025 it is 77%),
- ability to return reusable glass packaging wherever they are sold,
- postponing the collection of milk and dairy product packaging under the deposit system to 2026,
- keeping disposable glass packaging outside the system (including "monkeys", juices, alcohol),
- inclusion of standard glass packaging (various types of bottles and jars) in the refund system gradually from 2026,
- minimum 1 collection point in each commune.

All the above changes and amendments to acts are intended to lead to the achievement of the goals set by the European Commission. Their implementation will prove useful in the near future. Today, however, some cities and organizations are trying to implement future-proof solutions related to the deposit system and others on their own initiative.

4. Current activities in the implementation of the deposit system in Poland (barriers and benefits of its implementation)

Circular economy (CE) is an economic model that aims to minimize waste and maximize the reuse of resources. In the Polish context, the introduction of new legal regulations regarding packaging waste management (in line with EU requirements) is a key element in achieving CE goals. However, this is only the initial element of the pursuit of CE (Zarębska, 2017, 2019). Poland faces many challenges and obstacles to overcome, building an entire deposit system and

infrastructure to introduce the deposit system into everyday life in every commune, in every city. The proposed regulations oblige every store with a sales area of over 200 m² to collect empty packaging and packaging waste resulting from packaging covered by the deposit system and to return the deposit (Dz.U. 2023, poz. 1852, art. 44.1).

The first mentions of building a deposit system in Poland appeared a long time ago (in 2019, the first machine was installed in Krakow), but the system itself was to be introduced initially from January 1, 2023, then from January 1, 2024, and the current proposal is January 1, 2025 (Lewicka et al., 2023; Plastics Europe, 2023; Ministerstwo Klimatu i Środowiska, 2024a). Legislative work and public debates led to the implementation of own initiatives at the level of cities or some store chains. City initiatives regarding the installation of bottle dispensers were created in cities such as Warsaw, Kraków, Toruń, Wrocław. Bottle dispensers in Warsaw are publicly available. Their operation is similar to that of loyalty programs. Bottle machines are integrated with a phone application that grants the so-called Eco-points. For each item uploaded, we receive points to an account created in the EcoTech system. These points can be exchanged for various types of bonuses: discounts on cinema tickets, coffee or shopping discounts (<https://butelkomaty.pl/lokalistyczny/warszawa/>).

The first packaging machines were installed in 2019 (most often accepting PET bottles and aluminum beverage cans). The machines were installed by store chains such as: Kaufland, Żabka, Lidl, Biedronka, Spar, Carrefour and PSH Lewiatan. Work on installing vending machines took place in large cities such as Warsaw, Kraków, Wrocław, Olsztyn. Table 3 lists the initiatives of stores in the field of installing packaging machines, divided into: name of the store chain, type of collection, form of identification of the return of deposits for empty packaging (vouchers, money) and the type of packaging accepted.

Table 3.

Shop initiatives to install bottle dispensers before the Act enters into force

Name of the store chain	Type of collection	Form of identification of the refund of the deposit for empty packaging	A kind of package
Biedronka	automatic	vouchers	- PET bottles with a capacity of up to 3 liters; - aluminum cans with a capacity of up to 1 liter
Carrefour	manual collection of packaging	payment vouchers	- glass bottles;
	automatic; PETfur machines	e-vouchers (15 pennies for packaging)	- PET bottles; - aluminum cans
Żabka	automatic; EKOMat	Żapps (50 Żapps for one bottle/can that meets the conditions)	- PET bottles; - metal beverage cans
Lidl	automatic	5 pennies	- PET bottles
Kaufland	automatic	a voucher with a value corresponding to the deposit amount	- returnable glass bottles

Cont. Table 3.

PSH Lewiatan	automatic; bottle machine;	payment vouchers	- PET bottles
Chorten (Olsztyn)	automatic; Ekomat	payment vouchers (15 pennies for packaging)	- PET bottles; - aluminum cans
Spar (Wrocław)	automatic	Donating 50 pennies to the Kociarnia Foundation	- PET bottles; - aluminum cans

Source: own research.

The legislative work to date and the actions of local governments (cities) and shops confirm hypothesis 1 (H1) - The date of January 1, 2025 is realistic for the implementation of the deposit system in Poland, but only partial.

It is expected that 36.5 thousand jobs may be created under the deposit system in Poland: collection points for bottles and cans – 22.5 thousand manual and 14 thousand automatic (currently there are approximately 135,000 packaging collection points in Germany). In the case of automatic collection, the packaging machine (bottles, cans) will do the work for the store employee - it will scan the product, compress it and place it in the internal bin. Such a machine can also be a kind of warehouse for packages received as part of a deposit (Togetair, 2024).

The Polish Chamber of Waste Management (in Polish: PIGO - Polska Izba Gospodarki Odpadami) estimates that the introduction of the deposit system in Poland alone will cost the economy between PLN 19 and 23 billion, and the annual cost of operating the deposit system in Poland may amount to approximately PLN 3 billion. According to PIGO, the deposit system will only slightly increase the level of waste recycling (it is estimated that PET bottles will account for 200,000 tons of waste, i.e. only 1.5% of the total waste mass; metal cans - about 80,000 tons). The Chamber believes that the deposit system in Poland should be postponed until at least 2026 (Szczepański et al., 2022; System kaucyjny..., 2024).

Table 4 summarizes the barriers and expected benefits for the planned implementation of the deposit system that can be noticed in media discussions (representatives of the waste industry, recovery organizations and representatives of municipalities).

Table 4.

Selected² barriers and benefits of implementing the deposit system in Poland

Area of influence ¹	Deposit system in Poland	
	barriers	benefits
Environment	<ul style="list-style-type: none"> - Water, energy and chemicals are still used in packaging recycling. - Energy consumption (in Poland in 2023, 73% of electricity production came from non-renewable sources) for cleaning and processing recycle (glass cullet from packaging, aluminium, plastic). 	<ul style="list-style-type: none"> - Saving primary raw materials, especially non-renewable ones. - Reducing water and energy consumption for production. - Less polluted streets and cities. - Less waste means less pollution and more space in landfills (extending their functionality). - Less plastic in the seas, oceans and our bodies (microplastics). - Eliminating the burning of plastic bottles in home stoves.

Cont. Table 4.

Economy	<ul style="list-style-type: none"> - High investment costs of the deposit system. - High transformation costs. - High operating costs in relation to profits (low efficiency). - There is a need for innovative, less energy-intensive technologies for processing and treating packaging for reuse. - Problems with municipalities achieving appropriate levels of recovery and recycling of packaging waste (fines). - Investments in new recycling technologies. - Additional investments in eco-design of packaging. 	<ul style="list-style-type: none"> - Supporting research and innovation for: <ul style="list-style-type: none"> (a) recycling processes and technologies; (b) resource efficiency of industrial processes; (c) innovative and sustainable materials, products, processes, technologies and services, as well as their industrial expansion; (d) bioeconomy; e) monitoring and evaluation of the exploitation of primary raw materials. - Implementing eco-innovations in production means less pollution. - Greater recycling of raw materials means lower production costs. - Better quality of packaging = longer life cycle and possibility of rotation. - Recycling raw materials on-site (in Poland). - Beverage sellers may also receive additional revenues from a handling fee related to the operation of devices (bottle dispensers) or the sale of packaging waste.
Society	<ul style="list-style-type: none"> - Reluctance to change. - Appropriately trained employees. - There is a need for greater cooperation between system stakeholders. - Lack of employee motivation and reward in relation to employers' requirements. 	<ul style="list-style-type: none"> - Creating new jobs. - The right to decide whether to join the deposit system for customers. - Possibility to recover money from the deposit. - Possibility for children and teenagers to earn extra pocket money. - Convenience of recovering your deposit when shopping in the store. - A cleaner environment for rest and recreation. - Protecting biodiversity for future generations. - Less microplastics in the environment and in human bodies.

Note.

¹ the division of areas of influence is conventional because in fact they all interpenetrate and influence each other, in accordance with the pillars of sustainable development.

² The authors of the study, due to the breadth of the issue discussed and its multi-threadedness, made major simplifications for the purpose of compilation.

Source: own research.

There is still some time left until January 1, 2025 to solve the problems and eliminate the barriers that the implementation of the deposit deposit system will cause. Is January 1, 2025 for the implementation of the deposit system a realistic deadline? It seems so, but it will not be a fully functioning system immediately. The authors of the study believe that this system will be improved over the next two to three years. Additional obstacles will probably appear during its operation, but they will also be solved over time. In the case of introducing a deposit-refund system in Poland, the benefits include an increase in packaging recycling and thus savings in primary (non-renewable) raw materials, reduced littering of streets and landfills with packaging waste, clear and transparent rules of the deposit-refund system, which will be uniform throughout the country and a reduction consumption of primary raw materials.

A simulation of the possible increase in recycling levels in Poland was carried out for plastic packaging (PET bottles), household glass and multi-material packaging after the introduction of the deposit system. Simulation results indicate that introducing the system could

bring benefits in the area of improving recycling levels, for plastic packaging by 11.1%, for household glass by 13.8%, and for multi-material packaging by 65%. Thanks to the opening of borders, Poles are traveling more and more, seeing the bottle dispensers and the involvement of the society of other countries, they are also supporters of this system and are waiting for its introduction. From research (Deloitte Polska 2019; Plastics Europe, 2023) shows that over 81% of Poles want to introduce a deposit system and place bottle dispensers in stores.

The current preparation of the deposit system indicates confirmation of hypothesis H2. Both entrepreneurs and consumers in Poland speak positively about the implementation of the deposit system and want it to be introduced, seeing the great benefits.

5. Summary

Annually, Poland consumes a total of 613.4 million tons of materials, of which primary raw materials constitute 517.9 million tons, or 13.8 tons per person per year. Moreover, Poland's national resource extraction of 16.7 tonnes per capita per year is well above the EU average (10.3 tonnes per capita) (The Circularity Gap Report Poland, 2022).

The introduction of new requirements for packaging waste management in Poland is a key step towards achieving CE goals. These changes include legal, technological, educational and systemic aspects. Effective implementation of these requirements will contribute to sustainable development, environmental protection and increased efficiency of primary raw materials management. It may be a small success (according to PIGO), but it is always the first step towards recycling and reducing the consumption of primary raw materials.

Polish companies are constantly investing in new recycling technologies that allow for more effective processing of packaging waste. An example is chemical recycling, which enables the transformation of plastic waste into primary raw materials. Next is the promotion of eco-design, which involves creating products with their subsequent recycling in mind. Conducting educational campaigns aimed at increasing public awareness of the importance of waste segregation and recycling. Cooperation with local governments and non-governmental organizations to promote activities for CE and the deposit system in each commune - these are further initiatives that contribute to the promotion and effective implementation of the system from 2025.

Polish residents want to introduce a deposit system, seeing the financial benefits from the recovered deposit and the environmental benefits. Our neighbours boast of the high effectiveness of the deposit system (even about 80-90%), and this success is also achievable in our country, we just have to wait for its real implementation. Assuming that packaging recovery in Poland is 80% and that approximately 900,000 tons of packaging are introduced to the Polish market, the system will allow for the recovery of approximately 720,000 tons of packaging

waste per year. This amount of recovered waste will reduce the pollution of public spaces and the degree of use of primary raw materials.

The authors of the publication are aware of the imperfections of their research. In the future, they plan to check how the implementation of the system will look like in the coming years. Comparing the current research results and preparation for the implementation of the system in Poland, the authors believe that the system will require continuous expansion and improvement of the infrastructure. As scientists, they want to follow this process, its progress and examine the benefits that it will bring (Zarębski, Zarębska, Marosek, 2024, p. 5489).

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