

ЕКОНОМІКА

UDC 330.34(477):502.17:332.142.6

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ORCID: <https://orcid.org/0009-0001-4150-8754>**EVOLUTION OF THE CIRCULAR ECONOMY:
EUROPE'S SUCCESSES AND LESSONS FOR UKRAINE**

This article explores the concept of transitioning to a circular economy as a means of addressing pressing global environmental and economic challenges posed by the traditional linear economic model. It underscores the importance of rethinking production, consumption, and waste management to promote sustainability and resilience. The article begins by formulating the problem, highlighting the detrimental effects of resource depletion, environmental degradation, and inefficiencies inherent in the "take-make-dispose" paradigm. It then outlines the objectives of a circular economy, emphasizing resource efficiency, waste reduction, and the regeneration of natural systems. The main content delves into the multifaceted benefits of circular practices at both macroeconomic and microeconomic levels. Key advantages include reduced environmental impact, increased operational efficiency for businesses, and the generation of new revenue streams through innovation in repair, refurbishment, and sustainable design. Furthermore, it discusses the role of government policies and incentives in driving the adoption of circular practices, particularly in job creation and resource resilience. However, the article does not shy away from addressing significant barriers to implementation. These include financial and technological challenges, the complexity of transitioning from linear infrastructure to circular systems, and consumer skepticism regarding the quality of recycled or reused products. To overcome these challenges, the article calls for increased awareness, regulatory harmonization, and collaborative efforts across sectors. The analysis is enriched by examples of global best practices and innovations, such as Germany's "Green Dot" system and Japan's efficient use of resources laws, which serve as benchmarks for successful circular economy adoption. It also examines international initiatives like the Ellen MacArthur Foundation's efforts to tackle plastic waste. Despite notable successes, the article recognizes persistent challenges, such as the environmental trade-offs associated with replacing plastics and the need for further innovation. In conclusion, the article emphasizes the transformative potential of the circular economy in fostering a sustainable and equitable future. By leveraging collaboration among governments, businesses, and consumers, it argues that the transition to a circular economy is not only feasible but essential for addressing the interconnected crises of environmental degradation and economic vulnerability.

Keywords: circular economy, sustainability, resource efficiency, waste reduction, environmental innovation, linear economic model, recycling and reuse, global best practices.

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**ЕВОЛЮЦІЯ ЦИРКУЛЯРНОЇ ЕКОНОМІКИ:
УСПІХИ ЄВРОПИ ТА УРОКИ ДЛЯ УКРАЇНИ**

У статті досліджується концепція переходу до циркулярної економіки як засобу вирішення нагальних глобальних екологічних та економічних проблем, спричинених традиційною лінійною економічною моделлю. Наголошується на важливості переосмислення підходів до виробництва, споживання та управління відходами з метою сприяння сталості та стійкості. Стаття починається з формулювання проблеми, висвітлюючи негативні наслідки виснаження ресурсів, деградації довкілля та неефективності, властивих парадигмі «бери-роби-викидай». Далі окреслюються цілі циркулярної економіки, зокрема підвищення ефективності використання ресурсів, зменшення кількості відходів та відновлення при-

родних систем. Основна частина розглядає багатоаспектні переваги циркулярних практик на макро- та мікроекономічних рівнях. Серед ключових вигад виділяються зменшення впливу на довкілля, підвищення операційної ефективності бізнесу та створення нових джерел доходів через інновації у сфері ремонту, відновлення та сталого дизайну. Крім того, обговорюється роль урядових політик та стимулів у впровадженні циркулярних практик, зокрема у створенні робочих місць і зміцненні ресурсної стійкості. Втім, стаття також акцентує увагу на значних бар'єрах для реалізації цієї моделі. Серед них фінансові та технологічні виклики, складність переходу від лінійної інфраструктури до циркулярних систем, а також скептицизм споживачів щодо якості перероблених або повторно використаних продуктів. Для подолання цих перешкод стаття закликає до підвищення обізнаності, гармонізації нормативної бази та колабораційних зусиль між секторами. Аналіз збагачено прикладами світових найкращих практик та інновацій, таких як система «Зелена точка» у Німеччині та закони Японії щодо ефективного використання ресурсів, які є еталонами успішного впровадження циркулярної економіки. Також розглядаються міжнародні ініціативи, зокрема зусилля Фонду Еллен МакАртур щодо боротьби із пластикомі, пов'язані із заміною пластику, та необхідність подальших інновацій. На завершення наголошується на трансформаційному потенціалі циркулярної економіки у сприянні сталому та справедливому майбутньому. Завдяки співпраці між урядами, бізнесом і споживачами, стверджується, що перехід до циркулярної економіки є не лише можливим, а й необхідним для вирішення взаємопов'язаних криз екологічної деградації та економічної вразливості.

Ключові слова: циркулярна економіка, сталий розвиток, ефективність використання ресурсів, зменшення відходів, екологічні інновації.

Introduction. The global economy is at a critical juncture, confronted with escalating environmental degradation, resource depletion, and unsustainable consumption patterns. These challenges, deeply intertwined with the traditional "take-make-dispose" linear economic model, threaten both ecological balance and economic resilience. In response, the concept of a circular economy has emerged as a transformative framework designed to address these pressing issues. By prioritizing resource efficiency, waste minimization, and the continual use of materials, the circular economy offers an innovative pathway to sustainable development that aligns economic growth with environmental stewardship. The urgency for adopting circular practices is underscored by mounting evidence of the linear model's limitations. Global resource extraction has more than tripled since 1970, driven by population growth and industrial expansion. Yet, this resource-intensive approach has left economies vulnerable to supply chain disruptions, commodity price volatility, and the long-term impacts of climate change. Furthermore, the linear model's reliance on disposable products has resulted in unprecedented levels of waste generation, with approximately 2.1 billion tons of municipal solid waste produced annually. Only a fraction of this – estimated at 13.5% – is recycled, while the remainder ends up in landfills or as environmental pollutants. The economic cost of these inefficiencies, combined with the social and ecological consequences, necessitates a paradigm shift.

The circular economy challenges the status quo by redefining the relationship between production, consumption, and waste. At its core, this model emphasizes designing out waste, keeping products and materials in use for as long as possible, and regenerating natural systems. It calls for systemic change across industries and regions, demanding collaboration among governments, businesses, and individuals. Unlike the linear model, which views economic growth and environmental conservation as opposing forces, the circular economy positions sustainability as a driver of innovation and prosperity.

Several regions and industries are already embracing the principles of circularity. In Europe, policies such as the European Green Deal and Circular Economy Action Plans aim to decouple economic growth from resource use. Meanwhile, pioneering companies in sectors like manufacturing, fashion, and technology are adopting circular strategies, including product-as-a-service models, recycling technologies, and sustainable design innovations. These

initiatives illustrate the potential of a circular economy to unlock economic opportunities, create jobs, and reduce environmental footprints. However, achieving widespread adoption requires addressing significant challenges, such as financial barriers, regulatory inconsistencies, and the inertia of entrenched systems. As the global community grapples with the dual crises of environmental degradation and economic inequality, the circular economy represents a beacon of hope. By reimagining the ways in which societies produce, consume, and dispose of resources, it offers a vision of progress that transcends short-term gains, focusing instead on long-term resilience and equity. The transition, though challenging, is both a necessity and an opportunity – one that holds the promise of a world where economic growth and environmental health coexist harmoniously.

Statement of the problem. The global economy predominantly operates on a linear "take-make-dispose" model, which heavily relies on finite natural resources and generates substantial waste. This approach not only depletes the Earth's resources at an unsustainable rate but also exacerbates environmental challenges such as pollution, biodiversity loss, and climate change. The linear model fails to account for the negative externalities of production and consumption, resulting in economic inefficiencies and ecological harm. The urgency of addressing these challenges is heightened by growing global demand for raw materials and increasing concerns over waste management. Transitioning to a circular economy emerges as a viable solution to counter these issues, offering an alternative paradigm that prioritizes resource efficiency, waste minimization, and sustainability. However, implementing such a transformative model poses significant challenges, including the restructuring of industrial systems, changing consumer behavior, and aligning policies across regions. Understanding the benefits, obstacles, and innovations related to the circular economy is crucial to fostering a sustainable and resilient future.

Formation of the objectives of the article (task statement). The primary objective of this article is to analyze the potential of the circular economy as a sustainable alternative to the linear model, focusing on its benefits, challenges, and successful global practices. Specifically, the article aims to:

1. Highlight the economic and environmental advantages of adopting circular economy principles, emphasizing their role in promoting sustainability and innovation.

2. Identify the key challenges and barriers to the implementation of circular practices at both the macro and micro levels.

3. Explore global best practices and successful innovations in circular economy initiatives, providing insights into how they can be adapted and scaled in diverse contexts.

4. Propose strategies to overcome existing challenges and foster collaboration among governments, businesses, and consumers to accelerate the transition.

By achieving these objectives, the article seeks to contribute to the discourse on sustainable development and inform stakeholders about the pathways to a circular economy.

Summary of the main research material. In today's context, society and the economy are focused on improving environmental conditions and reducing negative impacts on humanity. To achieve sustainable economic growth, it is crucial to minimize environmental harm by altering production, recycling, and consumption methods for goods and resources [1; 2].

On the path to European integration, effective management of existing resources and new waste disposal methods is of utmost importance, especially in Ukraine, which is undergoing economic reforms.

In general, EU countries are actively working to reduce emissions and increase the share of renewable energy sources, though some are still far from achieving their goals [3; 5]. Achieving economic growth and sustainable development is impossible without reducing the negative environmental impact through the use of new and innovative production, recycling, and consumption responsibility methods [6]. One of the key tools to achieve these objectives is the transition to a circular economy model.

The concept of "circular economy," "closed-loop economy," or "circular economy" involves a fundamental rethinking of the system as a whole. The circular economy model is primarily associated with strategic management that involves the exchange of resources and by-products between industrial enterprises on a commercial basis through recycling or processing, meaning that the waste from one becomes a resource for another [7; 9]. Moreover, the Circular Business Model (CBM) is increasingly attractive, especially in academic institutions, promoting the reorganization of the current architecture to create value and supply chains that support a sustainable system of production, recycling, and consumption [10]. "A closed-loop economy is a viable alternative, maximizing the value of resources and their life cycle relative to the products they contain. Resources can be used more efficiently, and negative environmental, economic, and social impacts can be minimized" [11]. In the context of Ukraine, there are several obstacles to implementing these principles [12; 13], yet it is crucial for domestic manufacturers to understand the potential benefits they would gain from modernization and transitioning from a linear to a circular economy.

As they enter the EU market, Ukrainian manufacturers must comply with directives, and their implementation is required by the Association Agreement with the EU. Waste prevention can be achieved in two ways: by informing consumers about the risks of certain products and their typical disposal methods, or through motivational incentives that may influence producers, such as prohibiting the use of certain materials.

Regarding the high percentage of waste that is lost for resource recovery, such as biodegradable waste, paper and

cardboard, plastics, or glass, the EU Council decided in May 2018 to introduce new waste management rules and establish legally binding requirements for the reuse and recycling of municipal waste and packaging (Table 1).

Table 1
Plans for the preparation, reuse, and recycling of household waste in the EU

Indicators	By 2025 (%)	By 2030 (%)	By 2035 (%)
Municipal Waste	55	60	65
All Packaging	65	70	-
Plastic	50	55	-
Wood	25	30	-
Ferrous Metals	70	80	-
Aluminum	50	60	-
Glass	70	75	-
Paper and Cardboard	75	85	-

Source: Compiled based on data from [8–11]

The new directives came into effect on July 4, 2018, and must be implemented by July 5, 2020, at the latest. Additionally, by January 1, 2025, member states are required to establish separate collections for textiles and hazardous household waste. Furthermore, member states must take necessary measures to ensure that by 2035, the amount of municipal waste sent to landfills is reduced to 10%. It has also been noted that a member state may postpone the final deadline by 5 years if it landfilled more than 60% of its municipal waste generated in 2013. However, the state must inform the Commission of its intention to delay the deadline and submit an implementation plan. In the case of a postponed deadline, according to the rules, the target value for 2035 can be as high as 25%. This exemption rule can be used by 10 member states that landfilled more than 60% of their municipal waste in 2013: Malta (85%), Greece (84%), Croatia (82%), Cyprus (79%), Latvia (74%), Slovakia (70%), Bulgaria (69%), Romania (69%), Hungary (65%), and Lithuania (62%) [12; 13].

The data from Table 1 is presented in graphical form in Figure 1.

Bulky waste, its quantity, and composition depend on many factors, such as the collection system, payment system, billing structure, available income, and consumer behavior, as well as the availability of repair, reuse, or recycling options for large items. Table 2 presents the composition of bulky waste and household waste collection themes in the UK under the Acron Program.

Table 2
Acron Program for Waste and Resources (WRAP): Composition by Themes for Bulky Waste Collection and Household Waste Recycling Centers in the UK

Components	Share
Furniture	41,9
Textiles	19,4
Lighting	9,0
Garden	4,6
Mixed	4,3
Bulky	1,5

Source: Compiled from data [12; 13]

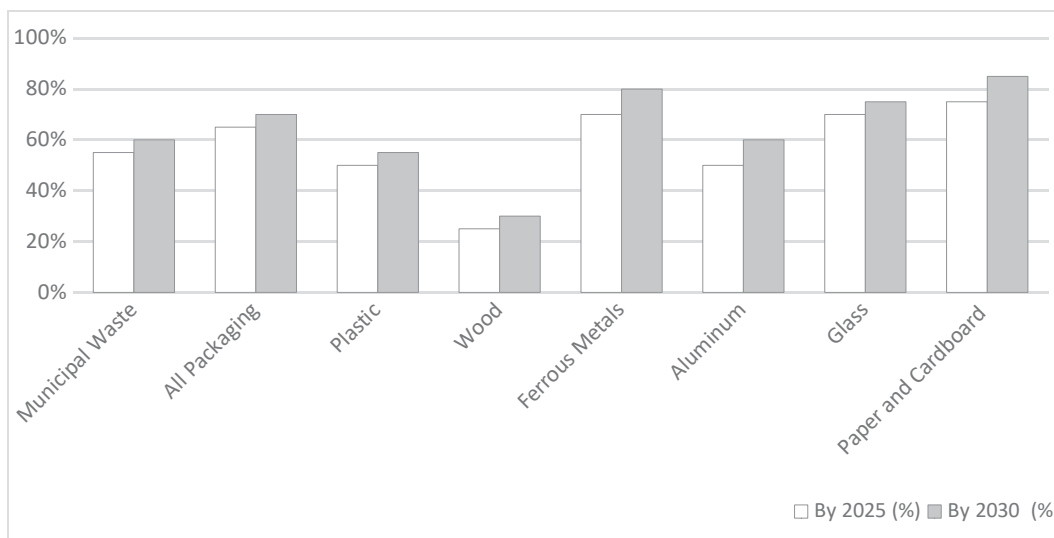


Figure 1. Plans for the preparation, reuse, and recycling of household waste in the EU by 2030

Source: compiled from data [8–11]

WRAP Waste and Resources Action Programme: The range and composition of solid waste categories in the United Kingdom are presented (Table 3).

From the table, it can be observed that approximately 30% of bulky waste (mainly furniture and large household appliances with enamel coatings) is estimated to be repairable and reusable. Another 20% (appliances and other metals) is suitable for recycling. Mineral and solid waste constituted the largest waste stream in the EU-28 in 2016 (71%) and should also be considered a potential source of valuable resources.

Mineral and solid waste is primarily generated (85%) in the construction sector (49%) and the mining industry (35%). The residual portion of mineral and solidified waste (15%) comes from sectors such as manufacturing (6%), electricity, gas, steam, and air conditioning supply (6%), and material collection, treatment, and disposal (3%) [12; 13].

The data visualization from Table 3 is presented in Figure 2.

The Waste Framework Directive (Article 11.2 of Directive 2008/98/EC) stipulates that by 2020, at least 70% of construction and demolition waste, excluding natural materials, must be prepared for reuse or recycling. In line with the project "Innovative Strategies for High-Quality Recovery of Materials from Construction and

Demolition Waste," some EU countries have achieved high recycling rates for stony fractions. However, most recycled products are used for low-grade applications, and the market for recycled aggregates is becoming increasingly saturated. This is due to the significantly higher suitability of clean crushed concrete aggregates compared to mixed crushed masonry-cement aggregates. Producing high-quality aggregates requires the use of well-sorted waste. Additionally, alongside on-site segregation, clear and unequivocal criteria for waste acceptance and quality standards for recycled materials, such as certifications and quality labeling, are essential.

The EU currently imports over 6 million tons of phosphate rock annually but could recover up to 2 million tons of phosphorus from sewage sludge, biological waste, meat and bone meal, or manure [17]. There are various approaches to utilizing these resources more efficiently than merely applying sludge in agriculture.

Ukraine should leverage the experience of leading countries, with one of the key elements being a robust waste management policy, regulated by the "Law on Waste." However, the implementation of this law has been delayed due to a lack of infrastructure and inefficient policies at the local level. Adopting the "National Waste Management Strategy in Ukraine until 2030" could improve the situation [18].

Table 3

**WRAP Waste and Resources Action Programme:
The range and composition of solid waste categories in the United Kingdom**

Material Category	Composition Range, %	On Average, %
Furniture: Reusable in Current Condition	5–10	7,5
Furniture: Potentially Repairable	10–20	15
White Goods: Potentially Repairable	5–10	7,5
White Goods and Other Metals: Recycling	10–30	20
Waste Disposal	30–70	50
Overall Reuse Rate		30
Overall Recycling Rate		20
Residual Waste Katergorія		50

Source: compiled from data [12; 13]

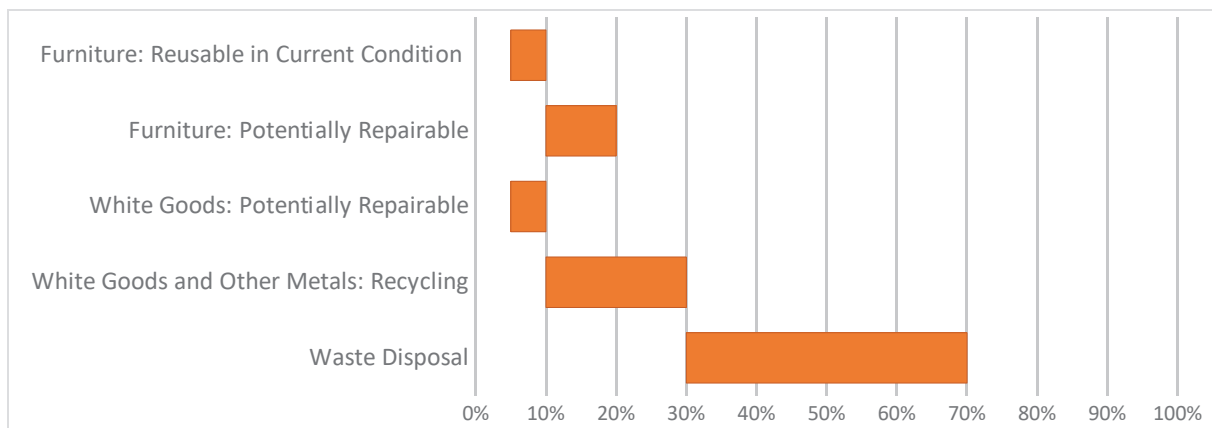


Figure 2. Range and Composition of Solid Waste Categories in the United Kingdom

Source: compiled from data [12; 13]

According to the strategy, the use of primary raw materials is expected to be reduced to 80% by 2023 and to 20% by 2030. Additionally, waste collection centers will be established by 2023 to enable further reuse, with their share expected to increase significantly by 2030. Specifically, 8% of household waste should be directed for reuse by 2023 and 10% from 2024 to 2030. However, currently, only about 5% of waste is recycled in Ukraine.

The main principle of these documents is the prevention of waste generation, followed by preparation for reuse, recycling, disposal, and, as a last resort, landfilling. According to Directive 2008/98/EC, such a procedure should be implemented at all levels of the country, which is currently lacking in the present environment [19].

A new paradigm for Ukraine's development could be the circular economy model, based on sustainable development principles. The primary tools for this model would include eco-innovations and "green" technologies—environmentally friendly technologies that prioritize environmental sustainability [20, p. 43].

Numerous studies by scientists highlight the following priorities: in developed countries—changes in production and consumption structures, competition, and job creation; in developing countries—sustainable development and poverty alleviation. Examining the trends in circular economy development across different countries reveals that even within the EU, despite shared framework approaches, each country has national nuances in implementing this concept [22, p. 3].

Research on the effectiveness of methods applied in EU countries demonstrates a positive impact on reducing emissions, creating jobs, and balancing trade [23]. Companies adopting a circular economy model in Europe gain several advantages at both micro and macro levels.

First, companies reduce their dependence on commodity markets, making them less vulnerable to price fluctuations. This is because they source necessary raw materials themselves, primarily from waste or products that have reached the end of their useful life.

Second, businesses can influence production costs by reducing raw material expenses. This can lead to increased sales volumes and productivity.

Third, transitioning to circular production allows companies to further reduce tax burdens. It is projected that tax rates will increase for enterprises not employing resource- and energy-efficient methods. Reduced tax liabilities enable companies to allocate working capital more effectively, improving operational efficiency.

According to POLITICO's Circular Economy Index in 2018, Germany, the United Kingdom, and France were the most advanced countries in circular economy development, boasting robust recycling systems and high levels of innovation in this field.

The ranking criteria included indicators such as municipal and food waste, municipal waste recycling rates, the share of products recycled as raw materials, material reuse rates, circular economy-related patents (since 2000), and investments in environmental protection industries.

The "Ecopreneur" digest [16] identified the Netherlands, Scotland, Slovenia, France, Belgium, and Finland as leaders on the "circular path." Other countries, such as Italy and Portugal, have recently made significant progress. However, some, like Cyprus, Greece, Malta, and Romania, are still at the early stages of development.

In China, the circular economy began within the framework of the industrial ecology program, exploring how one company's waste could become resources for another.

Turkey is also starting to implement circular economy principles. Supported by developed nations, some developing countries are just beginning to explore its possibilities. For instance, the governments of Rwanda, Nigeria, and South Africa actively collaborate with the World Economic Forum through the African Circular Economy Alliance [22, p. 4].

Many countries with similar levels of economic development are progressing in circular economy development. Individual country initiatives are presented in Table 4.

The relevance of circular economy issues varies by country and depends on the specifics of each nation's natural, human, physical, and institutional capital, its level of development, socio-economic priorities, and societal environmental awareness.

Table 4

National Measures and Initiatives of European Countries for the Development of the Circular Economy

Country	Initiatives
Germany	National Program "Resource Efficiency" (ProgRes), which includes: improving production processes, expanding recycling, and implementing a circular economy at regional and municipal levels.
France	Strategy "Law on Energy Transition for Green Growth" (2015): reducing waste generation by 50% by 2030, banning the destruction of unsold goods by 2023, and investing in infrastructure for waste sorting and recycling.
Sweden	Initiative "Sweden Without Waste": support program for businesses adopting a circular economy, subsidies for households, and development of innovations in renewable energy and waste recycling.
Italy	"National Action Plan for the Circular Economy" (2020): supporting small and medium-sized enterprises, developing infrastructure for food waste collection and recycling, and promoting the production of easily recyclable products.
Netherlands	National Strategy "Circular Economy by 2050": reducing the use of primary resources by 50% by 2030, creating clusters of circular businesses in key economic sectors.

Conclusions.

The conducted study led to the following conclusions:

1. The implementation and further development of the circular economy concept in Ukraine will inevitably face risks and contradictions between economic and environmental goals. These challenges are determined by the country's development level, necessitating the principle of common but differentiated responsibilities. However, addressing the development challenges while adhering to the overarching principles of the circular economy remains critical.

2. Transitioning to a circular economic model in the coming decades will not only be a way to enhance companies' environmental sustainability but will also become a necessary measure to ensure profitability and create value. For Ukraine, this transition is driven by several key factors:

- Resource Scarcity: The simultaneous consumption of the planet's resources could lead to a significant deficit by the end of this decade, causing a severe crisis. Rising resource demand increases their value, driving up production costs and, consequently, product prices. By adopting a circular business model, companies can reduce reliance on primary raw materials, shield themselves from market fluctuations, and secure necessary resources.

- Legislation and Innovative Management Approaches: Legislative reforms are actively being implemented at both

local and global levels, encouraging businesses to adopt circular production methods. Additionally, innovative management approaches are reframing waste not as a problem but as an opportunity.

- Production Optimization: The circular approach demands innovative methods and tools, requiring companies to modernize and adapt their processes. This enables production optimization through automation and downtime reduction.

3. Recycling is not the ultimate goal; waste and refuse are resources. Recycling activities must not endanger people or the environment. Used products containing hazardous substances must be processed in ways that prevent environmental contamination. Integrating recycling into new economic processes can save materials, utilize resources more efficiently, stimulate innovation, attract investment, increase revenues, and strengthen Ukraine's economy.

In summary, the conclusion that "waste is merely raw material in the wrong place at the wrong time" remains valid. For specific waste streams, such as mixed household waste and mineral and solid waste, innovative solutions are essential to maximize the existing recycling potential. By adopting these approaches, Ukraine can address its challenges while aligning with global sustainability trends and fostering economic resilience.

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