CHAPTER
THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF THE CIRCULAR ECONOMY PARADIGM IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Summary

This chapter explores the theoretical and methodological foundations of the circular economy paradigm within the framework of the sustainable development concept. The relevance of the research is determined by the growing environmental challenges, depletion of natural resources, and the need for the transformation of traditional economic models. The circular economy is considered as an alternative development model focused on efficient resource use, waste minimization, and the creation of closed production cycles. Particular attention is given to the relationship between the principles of circular economy and the economic, environmental, and social components of sustainable development. The chapter analyzes key theoretical approaches that form the conceptual basis for circular economy research. Methodological aspects of studying circular processes and resource cycles in modern economic systems are also examined. The role of innovation, technological development, and institutional support in the implementation of circular economy strategies is highlighted. It is concluded that the integration of circular economy principles contributes to improving resource efficiency, reducing environmental impact, and strengthening the sustainability of socio-economic systems.

Introduction

In the context of global environmental challenges, resource depletion, and increasing socio-economic instability, the concept of sustainable development

has become one of the key paradigms guiding the transformation of modern economic systems. Over the past decades, the rapid growth of industrial production, urbanization, and consumption has significantly intensified pressure on natural ecosystems. Traditional linear economic models based on the principle of "take–make–dispose" have demonstrated their inefficiency in ensuring long-term environmental balance and economic sustainability. As a result, the search for alternative models of economic development that harmonize economic growth, environmental protection, and social welfare has become increasingly important in both academic discourse and policy-making.

One of the most promising approaches in this context is the circular economy paradigm, which proposes a systemic transformation of production and consumption patterns aimed at minimizing waste, optimizing resource use, and extending the lifecycle of products and materials. Unlike the traditional linear model, the circular economy is based on the principles of regeneration, reuse, recycling, and resource efficiency. This paradigm promotes the transition from a consumption-oriented economy to a system in which materials circulate within closed loops, thereby reducing environmental impact and increasing the resilience of economic systems.

The circular economy has gradually evolved from a theoretical concept into an important strategic direction of sustainable development policies in many countries and international organizations. The growing interest in circular economic models is explained not only by environmental concerns but also by economic opportunities related to innovation, technological development, and the creation of new business models. In this regard, the circular economy is increasingly viewed as an integral component of the broader sustainable development framework, contributing to the achievement of global sustainability goals, including efficient resource management, climate change mitigation, and the formation of environmentally responsible production systems.

At the same time, despite the growing popularity of the circular economy concept, its theoretical and methodological foundations remain the subject of ongoing scientific discussion. Researchers emphasize the need for a deeper understanding of the conceptual structure of the circular economy, its principles, and mechanisms of implementation within the broader system of sustainable development. In particular, it is important to identify the interconnections between circular economy principles and the economic, environmental, and social dimensions of sustainability. Such an interdisciplinary approach allows for a more comprehensive understanding of how circular models can contribute to the transformation of modern economic systems.

The theoretical basis of circular economy research is formed by a combination of several scientific approaches, including ecological economics,

industrial ecology, systems theory, and sustainable development theory. These conceptual frameworks provide methodological tools for analyzing resource flows, production cycles, and environmental impacts within complex socio-economic systems. At the same time, the circular economy paradigm emphasizes the importance of integrating technological innovation, institutional changes, and behavioral transformations in order to achieve sustainable economic development.

An important methodological aspect of circular economy research is the identification of its key components and structural elements within the sustainable development concept. These components include resource efficiency, waste minimization, eco-design, product lifecycle extension, recycling systems, and the development of circular business models. The effective implementation of these elements requires the development of appropriate regulatory frameworks, economic incentives, and institutional mechanisms that support sustainable production and consumption patterns.

In addition, digital technologies, innovation processes, and knowledge-based management systems play an increasingly significant role in the development of circular economic models. Modern technological solutions, such as data analytics, artificial intelligence, and digital platforms, enable more efficient monitoring of resource flows, optimization of production processes, and improved decision-making in environmental management. Consequently, the integration of technological innovation with circular economy principles can significantly enhance the effectiveness of sustainable development strategies.

Despite significant progress in the theoretical understanding of circular economy principles, many methodological issues remain unresolved. These include the development of unified conceptual approaches to assessing circularity, the formation of indicators for measuring circular economy performance, and the integration of circular strategies into national and regional development policies. Addressing these issues requires comprehensive scientific research aimed at clarifying the theoretical foundations and methodological tools for studying the circular economy within the framework of sustainable development.

1. The circular economy paradigm in the genesis of the concept of sustainable development

The concept of sustainable development has undergone a long evolution and continues to develop in accordance with new global challenges. Sustainable development is connected with the formation of a fundamentally new attitude towards man, on the one hand, as a subject of the ecological and economic system, and on the other hand, as the main goal of its development. The global transition to sustainable development is possible only under the mandatory condition of coordination of all objects and subjects of this process, which has

a systemic nature and connects all levels of the socio-economic system (global, national, regional, local) and various spheres and functioning (economic, social, environmental).

First of all, it is worth noting that the Ukrainian word “steady” most accurately corresponds to the general idea of the concept, but is not an absolutely accurate translation of the first meaning of this term. “Sustainable development” is a translation of the English sustainable development. “Sustainable” can also be translated as “viable”, “ecological” or even “tireless”.

This concept has many interpretations and variations, but the most common is the definition of the UN International Commission on Environment and Development. Sustainable development is defined there as development that «meets the needs of the present without compromising the ability of future generations to meet their own». In other words, sustainable development is a way of organizing society's activities that will allow it to exist in the long term.It aims to achieve social and economic justice, preserve the environment and restore used natural resources.

The essence of sustainable development is to define viable schemes that take into account and balance the economic, social and environmental aspects of human activity. When making decisions, communities, companies and citizens should take into account not only the perspective of 10–20 years, but also the distant future.

Sustainable development is long-term economic prosperity, less dependent on the use of limited resources and exploitation of the natural environment, more socially inclusive, and includes ecological, social, economic and management aspects that are closely interconnected.

Concept (from Latin conceptio – understanding) is a system of views, understanding of phenomena and processes; a single, defining idea. The concept differs significantly from the theory not only in its incompleteness, but also in its lack of verification. Obviously, it can be considered a surrogate form of theory. The main purpose of the concept lies in the integration of a certain body of knowledge, in the desire to use it for explanation, searching for regularities. Passing through the crucible of fact-checking, the concept is clarified both in terms of content and in terms of its cognitive limits. At the same time, it may not stand the test of practice and be neglected. This happens especially often at those stages of the development of science, when the need to explain objects leads to the emergence of many conceptual approaches that integrate knowledge and provide more or less correct explanations [1].

The idea that the concept of sustainable development concerns only the ecological situation is wrong. This concept is much broader than just concern for the environment. It affects all spheres of life: economic, social and ecological, i.e. ecology is given only a third of attention. The central place in

the concept is occupied by the man of today and the man of the future.Whether it is the exploitation of resources, economic development or the direction of investments, as well as education, health care, employment and the fight against hunger – according to this concept, all aspects of the development of society must be consistent with both current and future needs. Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs, and requires joint efforts to build an inclusive and sustainable future for people and the planet.

The history of the idea of sustainable development spans more than three centuries, during which there was a transformation of the understanding of relations in the «man – nature» system, in particular, the dominant role of one or another element in this system [2]. And only at the end of the 20th century. radical changes were actually achieved, which marked a new era of development of the idea of sustainable development, the defining feature of which was the search for specific ways that could ensure its implementation in practice.

The modern "package" of goals and objectives of sustainable development was determined in 2016 [3] and covers the issues of fighting poverty, strengthening institutions and partnerships, effective management of resources, etc.

The balanced development of the economy, the natural environment and the social system is the basis of the problem field of sustainable development and relevant science [4; 5; 2; 6]. Solving this problem requires well-thought-out solutions and targeted measures that must be implemented taking into account the interrelationship of environmental, economic and social aspects [2; 6].

The economy becomes a key area of action for sustainable development. First, because the use of limited resources to meet the needs of current and future generations is the central problem of this science. On the other hand, economics studies the issue of consumption, distribution and production of goods, which is significant from the point of view of economic development and impact on the natural environment [6]. Therefore, achieving the goals of sustainable development involves focusing on economic systems, models of their development and transformation [5].

Green economy, like the idea of sustainable development, is a multifaceted concept [7]. This is a concept based on the goals of improving people's well-being and ensuring social equality with a significant reduction in environmental risks and threats to the quality of the natural environment [8]. The green economy brings to the fore the key interrelationships between the economy, society, and the environment [7].Within this concept, changes in production processes and consumption motives are foreseen, which should ensure the reduction of pollution and waste; more efficient use of material and energy

resources, which leads to the recovery and diversification of economies, creates new opportunities for employment, sustainable trade, energy conservation and fair distribution of income. By its content, the green economy is a plan (program) of actions necessary to ensure the transformation of the economic system in the direction of sustainable development [9; 10; 11].

These measures are concentrated around [9]: reducing the dependence of economic growth and degradation of the natural environment (decoupling) through the implementation of strategies to increase the efficiency of resource use (recycling, reuse, formation of new business models); ensuring a fair distribution of global resources between different countries (developed and developing) by changing, first of all, consumption patterns; ensuring compliance of the amount of resources consumed by the economic system with the capabilities of nature through the reduction of resource consumption (raw materials, water, energy, space resources). Since the achievement of such goals requires the use of new technologies, methods of organizing production and economic activity, regulation of social and economic relations, the green economy appears as one built on eco-innovations, in particular product, technological, management and marketing [11].The green economy is considered as a practice-oriented alternative to sustainable development, and the policy that should contribute to its implementation should be focused on reducing and avoiding environmentally harmful subsidies, spreading market incentives, green public procurement, stimulating green investments [9; 11].

Summarizing the results of research in this area [8; 9; 10; 11], we can conclude that the conceptual green economy focuses on resource conservation, eco-innovations, the 3R-model, thus covering a full range of solutions to ensure compliance of economic processes with the possibilities of nature; this concept is also socially oriented, as it involves the promotion of investments in new green sectors and, therefore, employment; promoting greater social justice through fair distribution of resources.

At the same time, on a practical level, the main focus of the green economy is the issue of energy efficiency and carbon emissions. In particular, these aspects are targeted within the defined EU-20-20-20 Strategy [12]. Because of this, the green economy is often identified as low-carbon, to some extent insensitive to the problems of using other material resources.

The green economy is associated with the categories of “econocentric incrementalism”, “unlimited eco-efficiency”, “transformational function” [7], which is more related to economic growth (as a target function) and technological changes, and therefore corresponds to the model of “weak” sustainability [11], although initially the ideas of the green economy came from “strong” sustainability and the need to take drastic measures in the field of environmental protection and protection [3]. The idea of decoupling is also criticized as being the main factor in the current non-compliance of the

economic system with the principles of sustainable development due to significant side effects [11].

After all, the concept of green economy is criticized because of the too high cost of measures and inconsistency with modern economic conditions; this concept is seen as more romantic than one that can be practically implemented, as it requires significant financial resources that only developed countries can accumulate; green economy is not aimed at transforming the existing linear model of the economy [8]. However, specific indicators and goals within the framework of the green economy still provide operationalization of the idea of sustainable development and its theoretical basis [7]. This concept appears to a greater extent as one that can form the basis for the development of political guidelines.

The blue economy in the modern sense is considered from two positions: as an alternative to the green economy; as an applied form of green economy in the context of water ecosystems and related areas .The basis of the first approach is the logic of the functioning of natural systems, ensuring the imitation of ecosystem principles in the organization of socio-economic processes. This should be facilitated by: the use of physical factors, in particular temperature and pressure, to find possible solutions in production; real estimates of the actual need for resources for production; establishing cascading interactions to ensure fuller use of all possible by-products; compliance with the principle of diversity; the use of natural phenomena as a basis for production innovations; using gravity and solar energy as the main energy sources; using water as the main solvent; use of local resources, including culture and traditions; provision of benefits for everyone, etc. Such ideas of the blue economy, however, were not widely accepted as a scientific concept and a practical program of actions for the transformation of the economic system. Apart from the works of G. Pauli himself, who is the founder of the blue economy in this interpretation, there are only a few studies in this area. The concept of the blue economy as a modern innovation claims to be recognized as one of the mechanisms that makes it possible to achieve the goals of sustainable development. The approach proposed by G. Pauli aims to ensure the consistency of the parameters of the functioning of socio-economic and natural systems through the implementation of ecosystem principles in the economy [13].At the same time, the author of the concept [13] ignores the existing socio-political structures, and therefore the ways to overcome existing bureaucratic, social and economic barriers on the way to the free spread of nature-based innovations within business networks are not sufficiently understood. In view of this, the blue economy in the interpretation of G. Pauli [85] appears as the most romantic among the studied concepts.

In fact, the very principle of imitating natural processes has been criticized by scientists. For example, work [14] emphasizes that the only thing that nature

demonstrates is the need for clear adaptation strategies against the background of limited resources. The implementation of such strategies does not mean the need to imitate natural processes directly, because in conditions of limited resources in nature, the destruction of ecosystems, their integrity and, as a result, the disappearance of certain species also occurs [14]. However, the introduction of innovations based on the imitation of natural processes, where possible, can also be considered appropriate.

Another view of the concept of the blue economy as an applied form of the green economy, considered in the context of water management, is more common. Under such an approach, the blue economy appears as a strategy for the development of industries related to the use of ocean, marine and coastal resources, built on the application of the ecosystem approach in management; as a special type of policy for the development of coastal regions; as a component of the green economy; as a model and new technology for the sustainable development of the marine economy.

Blue economy as a management concept that lays the foundation for sustainable regulation of ocean resource use processes, contributes to reducing the rates of environmental degradation, creates greater opportunities for employment, ensures social justice and well-being. In this context, this concept is considered as a "new economic paradigm", covering environmental and economic development issues and providing effective solutions for achieving sustainable development in countries dependent on ocean resources. The blue economy is also seen as having a greater potential to achieve the goals of sustainable development, compared to the concept of the green economy. In particular, due to the fact that within this concept, the natural environment is considered as the main factor of economic growth, and the complex of natural resources of the ocean is transformed into economic categories, that is, the so-called "commodification" (English "commodification"). This makes it possible to ensure that the value of natural capital is taken into account when making economic and political decisions. Within the concept of the blue economy, ocean resources are considered as a new promising industry with significant development potential. At the same time, against this background, discussions are increasingly arising regarding the compatibility of blue growth with the ecological possibilities of the planet. Since the practical solutions for the implementation of the blue economy concept are not unified and fully understood, the current results of individual countries (especially in African countries) on the implementation of this strategy are quite contradictory. Scientists note that the strategy of industrialization of ocean resources implemented under the auspices of the blue economy has created new risks for aquatic ecosystems and put the issue of "blue anti-development" (blue degrowth) on the agenda as an alternative to the concept of a green economy.

Summarizing the above, we note that the blue economy is still considered as a strategy that complements the green economy, expanding its boundaries relative to oceanic resources. Combined with the principles of green planning, the concept of the blue economy creates new opportunities for developing countries and can be considered as a program of actions to achieve their sustainable development. At the same time, the available results of the implementation of such a model of economic development in practice are ambiguous: unfortunately, the issues of ownership of oceanic resources, access to resources and income distribution were put forward instead of the introduction of green principles in the maritime industry.

The idea of the blue economy regarding the construction of cascading relations in production (interpreted by G. Pauli) is reflected within the limits of industrial ecology and forms the ideological basis of the circular economy. The latter, in fact, originates from the principles of ensuring the closedness of production, the concept of «cradle-to-cradle», the laws of ecology, the provisions of industrial ecology and symbiosis, etc. [1; 7; 9; 14]. A key feature of the circular economy is a shift in emphasis to interactions, relationships between people, and production structures.Within the framework of the circular economy concept, the implementation of cascade relations is associated with the development of new technologies and business models that should ensure environmentally friendly use of resources. The main principles of building a circular economy model are systematicity, complexity, organizational development, emphasis on human resources.

The circular economy does not replace the green economy, rather, it reflects only a component, a tool for implementing the green model of economic development to achieve the goals of sustainable development of society [3]. This concept focuses largely on the material component of “socio-economic metabolism” and is an attempt to overcome the linearity of the economic model by ensuring multiple, as far as possible, the involvement of resources in the cycle of social production.

2. The paradigm of the circular economy and its importance for achieving sustainable development goals

The circular economy focuses mainly on the recovery of resources through the elimination of toxic materials, the proper design of products and production systems, the avoidance of waste, the reuse of resources, the change of consumption and distribution patterns, the use of renewable energy [15].

The circular economy appears as a sphere and form of harmonious development of the natural and social component, where the reproduction of resources, energy and information in the socio-economic system is carried out on an innovative basis, by ensuring their multiple use. The circular economy is the embodiment of a flow-process approach to the production, distribution and

use of goods in the economic system and the circulation of material and energy resources within this system. This approach, i.e. consideration of socio-economic phenomena as a set of resources, energy, and information flows considered at a specific moment in time, acts as a methodological basis for making decisions regarding business interactions, development strategies, operational planning.Therefore, the circular economy ensures the transformation of production relations (economic, organizational and social) and productive forces.

Criticism of the circular economy concept concerns its insufficient attention to social aspects, as well as the possibilities of ensuring systemic shifts. In this context, academics are mostly skeptical about the potential of the circular economy to achieve the goals of sustainable development as socially oriented in nature.

The results of the conducted research and analysis of the main features of the concepts of green, blue and circular economy demonstrate the movement from theoretical debates on sustainable development to specific ways, models, programs and measures to ensure the compliance of economic development with the idea and the goals of sustainability.

The proposed solutions are becoming more targeted and specific, moving from general policy guidelines within the green economy to specific measures to transform business models within the circular economy. As stated in, this is evidence of fundamental changes in economic and management theory, as well as institutional shifts.

Summarizing the above, it can be stated that with the change of “colors” of concepts aimed at ensuring sustainable economic development, there is a transformation of the understanding of the relationship between the economy and nature. There is a movement from anthropocentrism, which to some extent formed the basis of the green economy, built on the implementation of green technological solutions, to the understanding of the unity and interdependence of the movement of resources in the natural and economic system within the framework of the circular economy. A new vision of the socio-economic system, which functions on the basis of congruence with nature, changes the model built on the dominance of man. The proposed solutions are becoming more and more specific – from general political guidelines of the green economy to specific mechanisms for transforming business models and the way resources are used within the circular economy. This illustrates a change in the paradigm of economic knowledge, its adaptation for the purposes of sustainable resource management, the formation of appropriate policies and the support of institutional changes, and in fact gives reason to hope for the realization of the idea of sustainable development, that is, the harmonization of socio-economic processes in accordance with natural limitations.To achieve sustainable development, it is essential to harmonize three main elements: economic

growth, social inclusion and environmental protection. These elements are interrelated, and all are critical to the well-being of individuals and society. Eliminating poverty in all its forms and dimensions is an indispensable requirement of sustainable development. To this end, it is necessary to promote sustainable, inclusive and equitable economic growth, create greater opportunities for all, reduce inequality, raise basic living standards, promote equitable social development and inclusion, and promote integrated and sustainable management of natural resources and ecosystems.

Each business entity defines its general philosophy of development, that is, its general strategy, which depends on its purpose, essence and scope of strategic actions. In our opinion, their development in modern economic conditions should be based on a strategy aimed at preserving the environment.

The development of highly efficient technologies of the new generation creates new requirements for the state of the socio-economic system and the environment. In addition, modern conditions of hypercompetition emphasize the importance of implementing a circular mechanism in the economic system, which is relevant and practically significant. The circular economy contributes to the modernization of production and the introduction of innovative technologies thanks to the improvement of the ecological culture of society, environmental protection, and the reduction of emissions of harmful substances.At the same time, there is a need to differentiate approaches to the implementation of circular economy methods and tools in different socio-economic systems.

The European Investment Bank outlined three main reasons for the transition to a circular economy:

1. Resource limitations. Global demand for resources is growing very rapidly, leading to increasing scarcity of critical resources and water.

2. Technological development. The implementation of new technologies makes it possible to develop and implement new business models of the circular economy. Without the formation of improved technologies and innovative approaches, recycling, replacement and reuse of resources, application of new IT technologies will be impossible.

3. Socio-economic development. Circular models play an important role in the context of increasing urbanization. Cities can develop, implement and maintain systems that will collect and transform various goods, materials and other resources in a cost-effective and environmentally sound manner.

Circular economy is a trend of the 21st century, which provides for:

– increasing awareness of the socio-economic, energy and environmental sectors;

– formation of approaches to solve the problem of safe environment vs economic development;

– the search for a global consensus around the growing importance of environmental factors in the activities of domestic and international companies.

It is worth noting that the transition in the 60s of the XX century. from an industrial society to a post-industrial one, which is based on innovative and technological progress, contributed to the emergence of the concept of circular economy in scientific literature. The concept of circular economy was proposed in 1966.by the American economist Kenneth Ewart Boulding and had a pronounced ecological character: "...man must find his place in the cyclical ecological system..." [16]. Over time, the concept began to transform and acquire an economic character on ecological grounds.

In 1972, Dennis Meadows and co-authors presented the work "Limits to Growth", one of the main ideas of which was the need to develop and manufacture products for effective reuse [17].

Developing the concept of "circular economy", the team of authors D. Raike, V. Vermeulen and S. Vites distinguish three main stages of its formation [18]:

– the first stage (1970–1990) involved work with waste, focused on its reduction, reuse and recycling. The beginning of the birth of the concept of 3R – Reduce, Reuse and Recycling: (Reduce – reducing the use of natural resources, increasing production efficiency; Reuse – reuse of a product for its main purpose; Recycle – processing of materials to obtain products of the same or lower quality);

– the second stage (1990–2010) involves the implementation of the environmental efficiency strategy, which was based on the idea of environmental payments. Environmental problems are given an economic aspect. At the same time, during this period, the problems of the destruction of the ozone layer and warming were assigned the status of global, and the directions of waste-free production concerned only industry;

– the third stage (end of 2010 and up to today) – the "circular economy" takes its final form.The main threats to the survival of humanity in this period, in addition to the recognized global problems of the second stage, were also recognized as:

– increase in the global population (according to UN data, 6.96 billion people in 2010, 8.01 billion people in 2023; forecast for 2050 – 8.92 billion people);

– increase in the amount of waste (according to the World Bank, the amount of waste will increase from 2.24 billion tons in 2020 to almost 3.88 billion tons by 2050;

– depletion or disappearance of most natural resources (world resource extraction will increase to 190 billion tons by 2060, compared to 143 billion tons in 2019). Today, more than 500 global companies implement the concept of circular economy.

Business is conducted based on three principles, namely:

– the principle of green innovation, which consists in reducing the use of input raw materials, recovering materials and minimizing waste, as well as extending product and/or service life cycles;

– the principle of alternative sources, which provides for the use of energy sources that are used to complement or replace traditional energy sources used to produce electricity;

– the principle of changing the industrial paradigm. The term "paradigm shift" refers to a major change in the worldview, concepts, and practices of how something works or is accomplished. A paradigm shift in industry often occurs when a new technology is introduced that radically changes the manufacturing process or production of a good or service.

Investigating the theoretical aspects of the formation of the circular economy, O. V. Shkurenko singles out four stages of its evolution [19] within:

– at the first stage (80s of the 20th century) the concept of "green growth" was formed, which is based on ecological production and consumption, which is the optimal direction of development;

– at the second stage (90s of the 20th century), a new sustainable development strategy was implemented, which involved the implementation of the principles of the 3R (Reduce, Reuse and Recycling) closed cycle economy;

– at the third stage (2000–2008) the transformation of the principles of green growth, which were considered the most relevant to the goals in the field of environment and the Goals specified in the UN Millennium Declaration 2000–2015, took place;

– at the fourth stage (from 2008 to today) the formation of a global green economy is envisaged, the main driver of which was the 26th United Nations Environment Program (UNEP), which launched the Green Economy Initiative, which is aimed at responding to and reducing the global economic downturn, focusing on global economic growth and the creation of "green" jobs [19].

The circular economy ensures harmonization between economic growth and environmental sustainability, creates new opportunities for well-being and is the main engine for achieving the goals of sustainable development of society. Depletion of non-renewable resources, which has become a global problem for humanity, is accompanied by serious environmental and social consequences, and irrational use of resources and manufactured products leads to significant economic losses. Therefore, it is expedient to transition to a more sustainable economic model, namely a circular economy, which is characterized by the closed nature of resource use and their recovery. The transition to a circular economy cannot happen quickly, since its implementation requires a thorough modernization of production and a certain rethinking of environmental problems at the level of society. Based on the principles of resource recovery, prevention and reduction of waste and reuse of used products, it should become

the basis for improving environmental and economic conditions and ensure sustainable development of the country.

A new paradigm of development can become a circular economy model based on the principles of sustainable development, the main tools of which will be ecological innovations (eco-innovations) and "green" technologies, that is, ecologically clean technologies that are friendly to the environment.

Paradigm (from the Greek. paradeigma – an example, a sample) in modern use can be considered an original way of identifying conceptually presented ideas aimed at development.A paradigm is a set of philosophical, general theoretical foundations of science and culture; a system of concepts and ideas that are characteristic of a certain period of development of civilization.

By structurally combining various elements of the concept, the paradigm defines methodological, methodical, instrumental functions, and reflects the essence, the quintessence of a justified and formulated system of scientific views. According to its design, the paradigm is a universal base, a single basis, a typical model for the construction and application of a conceptual apparatus that describes a generally available understanding of the relationship between seemingly completely unrelated phenomena or events. Depending on whether practice will be used in the construction processes and forms of presentation of the system of ideas about the investigated problem, the effectiveness of the construction and application of the toolkit of comparison of theory and practice, which ensures the verification of the correctness of scientific views and concepts, is determined. The paradigm is designed to perform a specific, pragmatic role as a universal tool of reflection, representation, justification and adaptation of innovative ideas and approaches to structuring processes, conditions of their application. In this sense, it is able to significantly unify, adapt and facilitate the introduction of innovations, reasonably revealing and presenting the essence of the proposed approach using clear, generally recognized examples and analogies.We understand the paradigm of the circular economy as an economic and technological model that is aimed at the maximum economic efficiency of the used resources and the achievement of the goals of sustainable development, reducing the harmful impact on the environment, because it contributes to increasing the efficiency of processes in value creation chains, reducing inefficient consumption and nature use.

Circular economy is not traditional recycling in a new way. Ideally, it begins to act long before the product becomes unusable, needs processing or repair. The concept of a circular economy involves direct participation in the stages of planning and development of goods to ensure a long life cycle and a high potential for further reuse, modernization, recovery and recycling.

The circular economy is an economic system of closed cycles in which raw materials, components and products lose their value minimally, renewable energy sources are used, and systemic thinking is the basis.

The circular economy requires not only closed material cycles and renewable energy sources, but also systemic thinking, since business entities interact, creating a common network of activities. Therefore, when choosing a strategy, it is necessary to take into account short-term and long-term consequences, as well as the impact of the entire value chain.

Circularity contributes to a more sustainable world, but not all sustainability initiatives promote circularity. Circularity focuses on the cycle of resources, while sustainability is more about people, the planet and the economy. Circularity and sustainability are linked by visions, models and theories.

Circularity corresponds to the Sustainable Development Goals of the United Nations. The Sustainable Development Goals, also known as the Global Goals, are a universal call to action to end poverty, protect the planet, and ensure peace and prosperity for all people around the world. The SDGs entered into force in January 2016 and underpin UNDP policy and funding for the next 15 years [20].

The 17 Goals are a development of the success of the Millennium Development Goals; moreover, they also cover new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interrelated - the key to success in one of them is solving issues that are generally related to the others. They have a complex and indivisible character and ensure the balance of three dimensions of sustainable development: economic, social and environmental [20]. The circular economy is also a way to implement the Sustainable Development Goals. The results of the review of various literature and studies show that the circular economy can directly contribute to the achievement of a significant number of SDGs.According to research by Patrick Schroeder and Kartika Anggreni, the strongest relationships and synergies between the circular economy model and the Sustainable Development Goals lie in SDG 6 (Clean water and sanitation), SDG 7 (Renewable energy), SDG 8 (Decent work and economic growth), SDG 12 (Responsible consumption) and SDG 15 (Conserving terrestrial ecosystems), which have both direct and indirect effects. SDG 1 (Eliminate poverty), SDG 2 (Eliminate hunger) and SDG 14 (Conserve marine ecosystems) can be achieved through the circular economy indirectly [21].

A circular economy can help achieve the Sustainable Development Goals, the SDGs can also help promote circular economy practices. Progress in the implementation of many other SDGs that are not directly related to the circular economy will be useful for the implementation of the practice of this model. SDG 16 (Peace and Justice), SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure) are of particular importance in this [21].

Ecological economy has a number of principles: ecologically safe business conduct; ensuring sustainable development; the expediency of approving an

ecological lifestyle; circularity, etc. Directions of ecological economy should focus on achieving certain goals of sustainable development. By 2030, the countries of the world aim to achieve 17 Sustainable Development Goals, some of which are closely related to circular practices

Therefore, the achievement of the Sustainable Development Goals is possible thanks to the transition to a circular economy, which is aimed at the recovery and rational consumption of resources. Unlike the traditional model of economic development, the circular model is the most successful way to conserve resources and materials, as it is based not only on efficient waste disposal, but also on global environmental principles, which include recycling of raw materials and reducing the use of resources.

A model (from the Latin modulus – "measure, analogue, sample, sample") is a system, the study of which gives an idea of another system, a representation of some other process, construction or concept of the original. A model is a project, an informational, kind-material or descriptive-layout representation of an object; an object or phenomenon that is an identical or simplified version of a modeled object, project or phenomenon (prototype).

We understand the circular economy model as an algorithm for the transition to a new way of reproduction, which creates new opportunities for creating wealth and well-being, industrial development, and is also the main engine for achieving the Sustainable Development Goals. The implementation of the circular economy will leave a positive impression on companies, consumers and society, since its goal is to improve the quality of life of the population without overtime use of waste and natural resources.

One of the goals of the circular economy is to optimize the use of resources through the circulation of products, components and materials used with the greatest utility at any time in both technical and biological cycles; everything from renewable energy.The energy needed to power this cycle should be renewable in nature in order to reduce resource dependence and increase system sustainability.

Over the past few years, interest in the topic of the circular economy has grown significantly and continues to be consistently high. The non-profit organization "Circle Economy" researched the use of the terms "circular economy" and "circular principles" among more than 20 governmental and non-governmental organizations, universities, consulting companies, etc., and based on the results, identified 7 key elements that underlie the circular economy:

1. Designing for the future – calculating the perspective of systems during design, using appropriate materials, developing a structure for the appropriate service life and developing for further use.

2. Digital convergence – tracking and optimizing the use of resources and strengthening connections between supply chain participants using digital

technologies, online platforms and transparency technologies. Preserving and extending what has already been done – supporting, repairing, upgrading the product while it is in use to maximize its life and give it a second life through return strategies where possible.

3. Giving priority to regenerative resources – ensuring the effective use of renewable, reusable, non-toxic resources as raw materials and fuel.

4. Using waste as a resource – using waste streams as a source of secondary resources and recovering waste for reuse and recycling.

5. Business model review – consideration of opportunities to create greater product value and focus on business models that rely on interaction between goods and services.

6. Collaboration to create shared value – collaboration across the supply chain, within companies and with the public sector to increase transparency and create shared value.

Therefore, the concept of combining linear production lines into a closed cycle, which is called circular economy, has become relevant today. The basis of this model is the implementation of closed production cycles, the use of renewable sources of energy and resources, and systemic thinking. The circular economy is also a way to implement the 17 Sustainable Development Goals of the UN in both direct and indirect ways.

In modern economic conditions, linear consumption is reaching its limits. The circular economy has both operational and strategic advantages at the micro- and macro-economic level. This is an opportunity that is extremely attractive for innovation, job creation and economic growth. The last 150 years of industrial evolution have been dominated by a one-way, or linear, model of production and consumption, in which goods are made from raw materials, sold, used, and then discarded or incinerated as waste. In the conditions of sharp instability, which is growing in the world economy and the spread of signs of depletion of resources, the call for a new economic model is becoming louder [22].

A circular economy is an industrial system that regenerates itself according to certain intentions and design. It replaces the concept of end-of-life with restoration, transitions to the use of renewable energy, excluding the consideration of disposal or consideration of the possibility of using toxic chemicals, and aims to eliminate waste through the special design of materials, products, systems and business models.

The conducted research made it possible to expand the system of principles of a closed-type economy to model 36R, which is presented in Appendix A. In our opinion, taking into account the system of these principles in the practical activities of the modern economy makes it possible to provide additional opportunities for economic growth and job creation, to increase the level of independence from resources, in particular of imported origin, to obtain

specific advantages of the local economy thanks to savings and optimization of resource use, to ensure environmental protection.

The key advantage of the closed-loop economy is the presence of a powerful potential for value creation based on the transformation of waste into new value.The concept of the circular economy is not new to world theory and practice, however, the significant deterioration of the environmental situation and the emergence of new technological possibilities for its correction in recent years have significantly expanded the range of tools for the implementation of the circular economy in practical activities. Today, the circulation economy is a modern and future economy in which a significant (mostly) part of waste is used as an element of the production cycle. Given the content and configuration of these principles, modern practice focuses its efforts on researching six areas of management of transformations related to the preservation of ecosystems:

1) the perspective of complexity (creating micro-principles of management);
2) contextual perspective (management policy, digital trends, financial instruments and financial entities);
3) management perspectives (consciousness, culture, institutions, knowledge);
4) geographical perspective (business location, resources, elements);
5) agency perspective (individual and partnership forms of cooperation);
6) network perspective (using the opportunities of the global network and social capital).

Scientific and practical interest in various aspects of the circular economy is confirmed by the dynamic increase in the number of studies in the domestic and foreign research segments. However, despite a significant number of publications on this issue, the circular economy paradigm has not been fully formed. Scientific literature still lacks a systematic and comprehensive analysis of the conceptual foundations of the circular economy, which leads to various interpretations of this concept.

The variability of scientific and substantiated definitions indicates the complexity of the mentioned concept, as it covers a wide range of issues related to the recovery and regeneration of the economy, increasing the usefulness of materials and product components.

The goal of the circular economy is to ensure the endless use of material resources. In other words, the circular economy is an economic-ecological restructuring of the linear economy not only in accordance with the conditions dictated by the modern market, but also in accordance with innovative conditions and conditions for improving the environmental condition. In a circular economy, it is necessary not to forget about things that were created before, to ensure proper disposal or processing for something else (if possible).

The analysis of scientific publications dedicated to circular economy research shows a deep understanding by scientists of existing problems and the

gradual formation of theoretical and methodological approaches to their solution. Based on the generalization of views on the essence of this category, the following directions of interpretation of the circular economy can be distinguished: model, activity, system, strategy, process, tool, philosophy. Below are the main interpretations of the concept of "circular economy" proposed by representatives of various scientific schools:

– the strategy of sustainable development, which is aimed at increasing the efficiency of the use of materials and energy [2];

– an economic system that is based on business models that replace the concept of end-of-life with reduction, alternative reuse, recycling and recovery of materials in the processes of production / distribution and consumption, functioning in this way at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond) with the aim of achieving sustainable development, which implies the formation of a quality environment, economic prosperity and social justice in the interests of generations [10];

– a complex multi-level system, the principles of which are significantly different from the traditional linear economy [1];

– a global economic model that separates economic growth and development from the consumption of finite resources;

– a political strategy aimed at reducing resource scarcity and reducing the level of pollution [4];

– activity of production, distribution and consumption of goods, which is based on the principles of saving various resources and materials, "zero-waste economy";

– a method of solving the problems of sustainable development of resources;

– implementation of a closed cycle of material flows in the economic system;

– the way to sustainable development;

– a method of continuous economic development without creating significant environmental and resource problems;

– a new trend, the basis of the "Fourth Industrial Revolution";

– a holistic concept covering the actions of "reduction, reuse and recycling" in the process of production, circulation and consumption;

– a model of economic development with maximum use of resources and environmental protection;

– a simple but convincing strategy aimed at reducing both the consumption of primary materials and the volume of waste production by closing the economic and ecological cycles of resource flows;

– a mutually beneficial philosophy, according to which a «prosperous» economy and a "healthy" environment can coexist;

– space for solving ever-increasing problems with resources; a concept that makes it possible to separate the direct use of resources from economic growth;

– a model of production and consumption of goods through closed material flows that absorb external effects associated with the acquisition of primary resources and the generation of waste (including pollution);

– solving a number of problems, such as waste generation, resource scarcity and sustainable economic benefits;

– restorative, or regenerative, production system; comprehensive waste management process;

– an economy that improves people's well-being and ensures social justice, significantly reducing environmental risks;

– a regenerative system in which resource consumption and losses, emissions and energy leaks are minimized due to the slowing down, closing and narrowing of material and energy cycles;

– an economic model in which both the results and actual processes of resource provision andApproaches to the interpretation of the concept of "circular economy" by the period of its formation are grouped as: "global economic model" (2004); "activity" (2007); "new trend 4.0" (2013); "economic model" (2015); "production system" (2016); "economic activity, tool" (2017); "philosophy, economics" (2018).

Based on the generalization of the terminological apparatus from the selected subject in accordance with various scientific concepts and as a result of the conducted research, an author's approach to the formulation of the term "circular economy" is provided.

The circular economy is a technological direction of the implementation of the concept of sustainable development, a modern paradigm of the process of creating added value, which is based on recycling, the use of alternative sources, extending the life cycle of products and is aimed at energy conservation, regenerative environmentally friendly production and consumption.

The symbiosis of the circular economy and sustainable development requires the development of a mechanism for the interaction of the subjects of the circular economy and tools that ensure this interaction.

The formation of a new model of the circular economy involves challenges in the form of economic, ecological and social effects, which are listed in table 1.

In some scientific publications, the circular economy is equated with sustainable development of the country. But not everyone correctly understands the concept of "sustainable development". It is important to note that "sustainable development" is the development of concepts for establishing a balance between the existing problems of society and the development of ways

to protect the interests of the future population in a healthy and safe environment.

Table 1

Challenges of the circular economy

Effect	Manifestation
Economic	– reduction of costs for raw materials and materials; – more rational use of products; – reduction of taxes, payments and fines for environmental pollution; – growth of reputational capital; – reduction of resource intensity of production; – reduction of disposal costs; – obtaining additional profit from the sale of waste and/or by-products
Ecological	– use of renewable raw materials and materials; – reducing the use of natural raw materials and materials; – reduction of emissions polluting the atmosphere, water and soil; – preservation of natural ecosystems
Social	– creation of new jobs in the field of waste processing and recycling logistics; – reduction of social tension due to the development of new consumption models

Source: summarized by the authors

Sustainable development includes meeting the needs of the population, improving the quality of life, taking into account the needs of the future. The main results are the population obtaining physical health, quality resources, products, goods and services, clean and safe air, quality education, proper living conditions, etc.

Let us indicate the main goals of the sustainable development of the circular economy:

1. Improving the environment for clean air.
2. The growth of the economy in general for the improvement of the quality of life of the population, the disappearance of poverty.
3. Effective use of natural resources.
4. Quality provision of education services.
5. Attracting investments in the production and implementation of green technologies.

In general, sustainable development is based on 5 principles depicted in the table 2, and are identified with the application of the circular economy.

In order to more effectively achieve the goals, Ukraine needs full implementation of the developed development strategies, which are based on the circular economy in particular. That is, there is a need to increase the waste recycling rate. Waste processing in Ukraine is just beginning to gain momentum, especially the development of proper and effective disposal.

Table 2

Principles of sustainable development and the impact of the circular economy

№	The principle of sustainable development	The impact of the circular economy
1	The development of sustainable and long-term development with the encouragement of the needs of the population.	Good health depends on reducing emissions and improving public sanitation and water quality.
2	Determination of restrictions on the use of natural resources, taking into account the level of technical support and the ability to restore the biosphere.	Responsible consumption and sorting of processing raw materials. Preservation of terrestrial and marine ecosystems.
3	Providing the opportunity to encourage and realize the needs of the population, taking into account the standard of living of the population. The main cause of occurrence environmental disasters – poverty.	Absence of the poor population, decent work and economic growth.Absence of hungry population.
4	Consideration of ecological possibilities according to the used energy.	Preservation of ecosystems, renewable energy.
5	Reconciling changes in demographic indicators with the potential of the global ecosystem.	Reducing the use of non-recyclable resources in order to increase effective recyclable resources and reduce emissions.

Source: summarized by the authors

Scientists of the Club of Rome point out that the application of the circular economy model will contribute to the country's development, focusing on the emergence of «new market niches», as well as the application of effective ecological and economic business models, based on increasing employment rates and reducing environmental emissions. To improve the economic condition of the country in general, there is a need to use resource-efficient production technologies, change production patterns, reduce non-returnable waste, attract large investments, as well as develop motivational projects by the state. The state should develop at the legislative level normative documents aimed at the application of effective environmental technologies and regulation of emissions into the environment [23].

It is noted that the circular economy is based not only on effective waste disposal, but also on global eco-principles and eco-habits, which include the recycling of raw materials, and accordingly, reducing the use of resources. Under the condition of the planned cost calculation, it is necessary to immediately take into account natural resources, as well as the use of processing raw materials.It is the concept of the circular economy that aims to improve the quality of life of the population without excessive use of waste and natural resources.

The concept of the circular economy with its principles of reduction, reuse and disposal of energy, materials and waste is considered as a viable alternative development strategy in order to ease the tension between the development of the national economy and environmental protection. The circular economy helps to solve the problems of resource scarcity and environmental pollution, and also enables producers to improve their competitiveness by removing green barriers in their international economic relations [11].

Therefore, sustainable development is inevitable, and entrepreneurs have the potential to create a sustainable economy and get to the bottom of the conditions under which entrepreneurship transforms economies into sustainable systems. At the same time, entrepreneurs increase economic growth, achieving social and environmental goals in the context of waste management. Accordingly, the circular economy should be considered at the micro, meso, and macro levels, covering production, consumption, and proper use of waste.

3. Determinants of the Functioning of Linear and Circular Economic Models

At present, one of the most fundamental, complex, and systemic issues concerns the foundations, structure, and principles of the economic system. The natural environment is approaching a critical threshold at which it may lose its capacity to sustain the biosphere in the form known today [15]. Consequently, the existing models of production and consumption, as well as the overall economic system, remain largely unsustainable and pose significant risks to the national security of Ukraine.

According to the Law of Ukraine “On National Security”, national security is defined as the protection of state sovereignty, territorial integrity, democratic constitutional order, and other national interests from real and potential threats. In this context, threats to national security include existing or potential phenomena and factors that endanger the vital interests of the state. From this perspective, the currently dominant linear production model can be considered one of such threats. The traditional linear economic model, which is based on the one-directional use of resources, gradually leads humanity toward a global crisis. The negative consequences of this model of economic development increasingly acquire irreversible characteristics. Even efforts to improve efficiency within the linear model, such as reducing the consumption of resources and fuel, merely decrease the volume of accumulated waste without integrating it back into the economic cycle [23].

Efficient resource management is therefore an essential element of national security and requires a fundamental reconsideration of the role of resources in economic systems. One of the most pressing global challenges is the problem of resource provision. An assessment of the main categories of natural resources indicates that humanity is exhausting the planet’s natural capacity at

an accelerating pace, leaving insufficient time for natural regeneration. Currently, global consumption exceeds the Earth's regenerative capacity by approximately 1.75 times, which means that humanity uses significantly more resources annually than the planet can replenish.

The excessive exploitation of natural resources generates numerous serious problems that threaten the stability of modern civilization. The World Wide Fund for Nature (WWF) has repeatedly warned that the current level of resource consumption creates a significant ecological deficit on a planetary scale. Overexploitation refers to the extraction of resources at a rate that exceeds the natural capacity for regeneration. In other words, humanity is consuming natural resources faster than ecosystems are able to restore them. At present, global consumption already exceeds natural regeneration by about 20 percent. This figure continues to increase as technological development expands production and consumption capacities. If these trends continue, humanity may require the equivalent of 2.5 planets by 2050 to meet its resource needs.

At first glance, Ukraine's vast territory and rich mineral resources might suggest that the problem of resource provision is less critical for the country compared to others. However, Ukraine exports a considerable share of its natural resources to international markets while geological exploration and resource renewal activities proceed at a slower pace than in more technologically advanced economies. As a result, Ukraine must also seek effective solutions to the challenges associated with sustainable resource use.

Currently, the problem of resource provision in the Ukrainian economy is particularly acute. A high level of depreciation of fixed production assets leads to excessive resource intensity in industrial production. Outdated technological infrastructure results in significant volumes of waste and contributes to environmental pollution. As a consequence, several major threats to national security in the sphere of resource use can be identified in Ukraine. These include irrational and excessive exploitation of mineral and natural resources, deterioration of water quality in river basins, degradation of land resources, and reduction of forested areas.

Intensive human activity within the framework of the linear production and consumption model, combined with irrational natural resource management and disregard for ecological laws, has caused severe and often irreversible changes in the environment. These transformations are evident both on a global scale and within specific ecosystems and landscapes. Among the most significant environmental challenges are climate change, depletion of the ozone layer, and the disruption of natural ecological balance [24].

Another global environmental challenge is the growing volume of waste generation. Currently, approximately two billion tons of municipal solid waste are produced annually worldwide, and this amount continues to increase every

year. According to projections by the World Bank, global waste generation could reach 2.58 billion tons by 2030 and nearly 3.77 billion tons by 2050. These trends highlight the urgent need to rethink traditional approaches to waste management and resource utilization.

In Ukraine, waste management has become a crucial issue in recent years due to the need to reduce anthropogenic pressure on the environment and the simultaneous increase in the cost of raw materials caused by the depletion of natural resources. In many cases, existing systems for waste storage and disposal do not meet sanitary and environmental standards. As a result, surface water, groundwater, soil, and atmospheric air are exposed to significant levels of pollution.

Air quality represents another serious environmental challenge. Major pollutants include carbon monoxide, nitrogen oxides, sulfur dioxide, ammonia, phenols, formaldehyde, and benzopyrene. Although emissions have declined in recent years, largely due to the suspension of operations at many industrial enterprises, pollution levels in several industrial regions still exceed permissible limits.

Environmental threats are closely linked with social security challenges. Social security reflects the quality of social relations in which individuals are protected from the risks of social, economic, and physical degradation caused by declining living standards and limited opportunities for personal and professional development. Today, a significant proportion of the population faces barriers that prevent the full realization of their potential in key areas of social and economic activity.

The persistence of an inefficient economic development model is one of the main factors contributing to these problems. The linear production model, given the limited nature of planetary resources, inevitably leads to a slowdown in economic growth, reduction in industrial activity, and increasing risks of unemployment. Consequently, social stability becomes increasingly vulnerable.

Human health is also an essential component of social security. Existing environmental problems pose significant risks to the health of populations and ecosystems. Among the major threats to national security in the social sphere are demographic decline, deterioration of public health, unemployment, decreasing incomes, and uncontrolled migration processes.

Experts warn that the continued growth of resource exploitation may eventually make it impossible for humanity to sustain global food production. Although significant progress has been made in reducing global hunger over the past three decades, the expansion of food production within the framework of the linear economic model has had serious environmental consequences. Nearly half of the world’s forests have already been destroyed, groundwater resources are rapidly declining, and biodiversity loss is accelerating. If these

trends persist, the planet may simply be unable to withstand such pressure [6; 23; 24].

At present, approximately one third of all food produced globally is lost or wasted. This situation not only undermines food security but also intensifies pressure on natural resources. The energy used to produce food that ultimately becomes waste accounts for nearly 10 percent of global energy consumption, while greenhouse gas emissions associated with food loss and waste reach approximately 3.5 gigatons of CO_2 equivalent annually.

Energy security also plays a critical role in ensuring national security. In Ukraine, the energy sector currently faces significant challenges. Aging infrastructure and equipment that have exceeded their operational lifespan create serious risks of technological failures and accidents. Energy production has a substantial environmental impact. The combustion of fossil fuels leads to emissions of carbon dioxide, sulfur dioxide, nitrogen oxides, and other pollutants. In addition, open-pit mining and peat extraction significantly alter natural landscapes and sometimes cause irreversible ecological damage.

Consequently, major threats to national security in the energy sector include the depletion and inefficient use of fossil resources, low efficiency in the utilization of fuel and energy resources, outdated energy infrastructure, and insufficient diversification of energy supply sources.

The linear model of economic development also generates significant threats in the production sector. The physical and technological obsolescence of industrial assets is characteristic of many sectors of the Ukrainian economy. The rapid deterioration of production infrastructure contributes to the continuous growth of operational costs. At the same time, the low competitiveness of domestic products remains one of the main obstacles to structural transformation in the economy. This situation is largely the result of insufficient investment and innovation activity within the industrial sector.

Addressing these challenges requires the implementation of an economic policy aimed at stimulating investment and innovation, modernizing industrial equipment, introducing advanced technologies, and improving production efficiency through a transition to an innovation-driven development model. In this context, increasing attention is being given to the development and implementation of resource-efficient, low-waste, and environmentally sustainable technologies in industrial enterprises.

Among the key threats to national security in the production sphere are the use of outdated technologies and capacities, excessive dependence on natural resources, high energy and material intensity of production processes, the absence of environmental innovations in industrial activities, and the lack of effective environmental protection systems such as modern wastewater treatment facilities and closed water circulation systems.

Conclusions

The conducted research confirms that the paradigm of the circular economy is becoming an important theoretical and practical foundation for achieving sustainable development goals in modern economic systems. Unlike the traditional linear model of economic development, which is based on the principles of extraction, production, consumption, and disposal, the circular economy focuses on the rational use of resources, the extension of product life cycles, and the minimization of waste. Such an approach allows economic activity to be separated from excessive resource consumption and contributes to reducing the negative environmental impact.

The study shows that the circular economy is closely interconnected with the concept of sustainable development and serves as one of the key mechanisms for achieving the Sustainable Development Goals. In particular, circular practices contribute to improving resource efficiency, expanding the use of renewable energy sources, and implementing environmentally responsible production and consumption models. At the same time, circular economic approaches create favorable conditions for economic growth, the development of innovative technologies, and the creation of new jobs.

The analysis of scientific approaches to defining the concept of the circular economy has demonstrated the multidimensional nature of this phenomenon. In modern scientific discourse, the circular economy is interpreted as a model, a system, a strategy, a process, and even a philosophical approach to economic development. Despite the diversity of interpretations, most researchers emphasize its regenerative nature, which is based on closed material cycles, resource recovery, and the integration of environmental, economic, and social priorities.

The results of the study also indicate that the implementation of circular economy principles creates significant economic, environmental, and social effects. Economically, it contributes to reducing production costs, increasing resource efficiency, and creating new market opportunities. From an environmental perspective, the circular model helps reduce emissions, preserve ecosystems, and decrease the level of environmental pollution. Socially, it promotes job creation, improves the quality of life, and supports the development of environmentally responsible behavior in society.

At the same time, the transition to a circular economy requires the transformation of existing production systems, the introduction of innovative technologies, the development of new business models, and the improvement of institutional and regulatory frameworks. A key role in this process belongs to the state, which must create favorable conditions for the implementation of circular practices through appropriate policies, economic incentives, and environmental regulations.

Thus, the circular economy can be considered one of the most promising directions for the transformation of modern economic systems toward sustainability. Its implementation contributes not only to improving environmental conditions but also to strengthening economic resilience and ensuring long-term socio-economic development. Consequently, the further development of theoretical and methodological approaches to the study of the circular economy and the expansion of its practical application remain important tasks for both scientific research and public policy.

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