TECHNOLOGICAL INNOVATION AND ITS ROLE IN STIMULATING THE CIRCULAR ECONOMY TO REDUCE ENVIRONMENTAL DAMAGE

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Abstract

The article defines that at the present stage of human development the economy is acquiring the significance of a factor of direct influence on the natural environment, and that this influence arose as a result of economic development aimed at meeting the needs of humanity in conditions of ignoring the need to ensure environmental neutrality of production and consumption. The article presents the results of a study to substantiate promising areas of development of the circular economy, in which it is considered as a certain stage of economic evolution and an integral component of the real anthropogenic and natural resource cycles. The use of this approach along with the conceptual provisions of the circular economy made it possible to develop: a system of defining features of economy types; a cyclical-resource model of the anthropogenic environment; a set of theoretical and methodological support for substantiating the directions of development of the circular economy.

Keywords: circular economy, sustainable development, anthropogenic impact, resource cycles, environmental neutrality, economic development.

I. Introduction

At the present stage of human development, the economy is acquiring the significance of a factor of direct impact on the natural environment. This is confirmed by the facts of landscape changes, depletion of mineral deposits, environmental pollution, etc. The most significant climate changes on Earth in the current era of geological history are determined by periods of global warming (cooling), but modern global warming is occurring at a somewhat faster pace than in previous periods. "When implementing the policy of sustainable development, it is important for the state to adhere to the principle of synergetic unity - economic, social and environmental" [1]. A significant part of the expert community claims that the cause of this phenomenon is the negative anthropogenic impact on the environment, due to the growth of the population and its needs, and, consequently, the scale of the economy. This situation arose as a result of economic development aimed at meeting the needs of humanity in the context of ignoring the need to ensure environmental neutrality of production and consumption, which, given the inconsistency of the natural and

economic resource cycles and the limited natural resources, determines significant negative qualitative structural changes in the environment. The solution to this problem today is seen in the construction of a system of production relations that, along with satisfying human needs, would ensure the growth of rational use of natural resources and the reduction of anthropogenic load on the environment. The solution to this problem requires supplementing the industrial model of the economy, objectively formed over centuries of economic evolution, with requirements for rational use of natural resources. The results of the search for ways to solve this problem today are seen in the implementation of the concepts of sustainable development, circular economy, and "green" economy.

II. Methods

Many works by domestic and foreign scientists are devoted to the consideration of various elements of the circular economy. Features of the greening of domestic business are considered in their works by T.V. Uskova and E.D. Kopytova [2]. A socio-economic study of green modernization of the economy is investigated by R.N. Botavina [3]. Green investments as a catalyst for the transition to a new course of economic development are studied by I.A. Yakovlev, L.S. Kabir and others [4]. The current state of development of the circular economy in our country is analyzed by S.N. Bobylev, S.V. Solovieva [5]. At the same time, the problems of the circular economy are becoming relevant right now, since it is capable of transforming the production model, promoting economic growth, reducing the volume of waste and providing consumers with innovative products. The purpose of this study is to substantiate the directions of structural and technological transformations in the national economy, aimed at the formation of systemic features in it that meet the conceptual requirements of the circular economy. The following methods were used in the research: comparative analysis (assessment of public policy measures); abstract logical (problem statement, justification of conclusions); monographic (analysis of scientific works).

III. Results

Given the objective of the study, the initial position of this article is to systematize the defining features of various types of economies inherent in past stages of economic evolution and the conceptual requirements of the circular economy [1-6], namely, types of natural resource sources, types of economic resource cycles and degrees of anthropogenic impact on the environment, the characteristics of which are summarized in Table 1. The defining features in combination are inherent in the circular economy, as well as those that are present in the models of other economies, are hereinafter referred to as "circular". In the conditions of the pre-industrial economy, the degree of anthropogenic impact on the environment was insignificant due to the use of renewable resources, despite the openness of the resource cycle and the lack of regular waste disposal and land recreation practices. In the conditions of the industrial economy, anthropogenic impact on the environment has reached a degree capable of causing undesirable significant changes in the natural environment of the planet. The reason for this is the use of an open resource cycle with a significant increase in the share of non-renewable resources compared to the pre-industrial economy and the lack of targeted measures to prevent and neutralize the negative consequences of this phenomenon.

The introduction of a circular economy model is often considered today as a promising path to sustainable development. Ideally, the concept of a circular economy involves the involvement of natural resources in the economic resource cycle in a volume sufficient to ensure the growth of the scale and environmental neutrality of economic activity by increasing the rationality of resource use, creating closed resource cycles in the spheres of production and consumption, and creating a waste disposal industry.

The set of planetary resource cycles in the aspect of the formation of anthropogenic impact can

be represented as a closed hierarchical system, the structural elements of which are resource cycles of specific environments of certain spheres of human activity. Considering the structural identity of the hierarchical system of resource cycles of all types of economies, it can be argued that qualitatively different consequences of anthropogenic impact on the natural environment are determined by the parametric consistency of resource cycles in certain areas of anthropogenic activity. The formation of the global resource cycle under the influence of anthropogenic activity occurs in sequence according to the principle "from the particular to the general", which allows us to methodically correctly consider the results of any type of anthropogenic activity as factors in the formation of parameters of the natural environment.

Thus, the creation of a model of an ecologically neutral economy requires structural changes in certain resource cycles, increasing the rationality and efficiency of resource use, which will lead to a change in the defining features of the economic model.

In terms of the formation of an ecologically neutral economy, it is important that different types of economic activity have different impacts on the environment. In this regard, the problem of determining the types of economic activity arises, ensuring the targeted development of which will determine the most significant results in achieving the signs of ecological neutrality of the economy. On a global scale, the greatest negative impact on the environment is exerted by types of economic activity that have acquired high rates of development in the conditions of an industrial economy, namely energy, metallurgy, transport, etc., which are currently the main sources of anthropogenic emissions of carbon dioxide, that is, greenhouse gas, the increase in the content of which in the atmosphere is one of the significant factors in the acceleration of the rate of global warming. It should be separately determined that the difference in the economic development of world regions, and therefore of certain countries, also determines the differences in the volumes of social production and consumption, rationality and efficiency of resource use, anthropogenic impact, which should be taken into account when determining the directions of development of a circular economy in a certain country.

The rapid growth in the scale of economic efficiency occurred in the industrial era and was determined during the first industrial revolution as a result of the growth in the use of mineral fuels due to the development of industrial methods for converting it into energy. This resulted in the creation of industrial energy as a separate type of economic activity. At the same time, this phenomenon not only does not reduce the importance of the fuel and energy, metallurgy, transport and logistics sectors in the modern economy, but also contributes to the development of these types of economic activity. However, these same industries are also the main sources of anthropogenic greenhouse gas emissions, since most of the primary energy consumed by these sectors is made up of various types of organic fuel, the by-product of the combustion of which is carbon dioxide. The magnitude of anthropogenic impact on the environment is closely related to the level of consumption of primary fuel and energy resources (primary energy), but the relationship of the trends of these characteristics with the scale of the economy does not demonstrate a clearly expressed general pattern of change in trends in certain regions of the world, as evidenced by the results of studies [7]. The data indicate a weakening of the correlation between the trends in the growth rates of the world economy and the use of primary energy and the anthropogenic impact on the environment. The outpacing of the growth rates of world GDP over the growth rates of primary energy use and the anthropogenic impact on the environment determines the trend of increasing the energy efficiency of the economy against the background of an increase in the absolute value of primary energy use.

The energy efficiency of the economy and the degree of its impact on the environment largely depend not only on the total volume of primary energy use, but also on its type structure. The results of studies [7] show significant discrepancies in the structure of primary energy use in the world and determine the need to consider the specifics separately for each region.

The main sources of anthropogenic carbon dioxide emissions are the processes of energy conversion of organic fuels used in almost all types of economic activity. The share of organic fuel in

the global volume of used primary energy in 2020 was 82.2%, of which 26.8% was solid (carbon) fuel, and 55.4% was hydrocarbon. Analysis of the chemical composition of the feedstock and energy conversion products shows that combustible substances are chemical elements - carbon (C), hydrogen (H), as well as hydrogen (H2) and incompletely oxidized compounds - carbon monoxide (CO) in the composition of the products of the primary conversion of solid fuels (artificial gases). The different chemical composition of certain types of organic fuel during their combustion also determines the composition of greenhouse gas emissions. Thus, when burning coal, mainly carbon dioxide is formed, and when burning hydrocarbons, carbon dioxide and less physically stable water vapor are formed, and this determines the possibility of reducing anthropogenic carbon dioxide emissions through the use of organic fuels with a high hydrogen content, that is, hydrocarbons and artificial gases. Considering the wide raw material and technological variability of the modern sphere of energy conversion of organic fuels, it can be argued that the targeted development of a circular economy should ensure structural technological changes in the most energy-intensive types of economic activity.

IV. Discussion

I. Subsection One

In accordance with the conceptual provisions and taking into account the conditions and limitations defined above, the development of a circular economy should occur in the context of meeting the growing needs of society, a relative decrease in the volume of use of economic resources and an absolute decrease in the anthropogenic load on the environment.

Modern national economies of the world can be considered as a set of types of economic activity that were mastered as a certain country developed economically. In this regard, different types of economic activity in terms of composition and degree of manifestation of defining features have different levels of compliance with the conceptual features of a circular economy.

A large number of studies have been devoted to identifying the factors hindering the development of a circular economy [2-4; 8], the systematization of which allows us to identify five main groups of such obstacles:

– socio-cultural - hinder the development of a closed-loop economy in the context of environmental responsibility of society and existing social values. Cultural obstacles, which in some studies are also divided into social and behavioral, include a low corporate culture that is not aimed at developing a circular economy, the backwardness of existing supply chains, and consumer preferences. – legislative obstacles – manifest themselves in the form of restrictions imposed by the current regulatory framework. State regulation of the process of initiating a circular economy involves the development of a system of legislative acts, in particular, we are talking about state strategies; long-term and medium-term programs, industry regulations.

– poor awareness of consumers and producers about the principles and best practices of implementing a circular economy creates information barriers.

– economic obstacles arise as a result of many factors. First of all, we are talking about the price of circular innovations and technological solutions. Large initial capital investments and a fairly long period of recoupment of investments made are negatively perceived by representatives of small and medium-sized businesses, who are more sensitive to additional financial costs, compared to large companies [4]. Economic obstacles also include the low price of raw materials and materials and the underdevelopment of standardization in the field of closed-loop technologies.

– technological obstacles are characterized by the lack of a clear logistics infrastructure for the recycling system; the lack of demonstration projects for working with new technologies and, as a result, concerns about the quality of products made from secondary raw materials. In our country, there are almost no domestic advanced technologies in the field of raw material processing, and the environmental design of products is insufficiently developed.

Taking into account the above, the following should be defined as promising areas for the development of the circular economy:

- maintaining circular characteristics by types of economic activity with a high degree of compliance with the requirements of the circular economy;

- forming circular characteristics by types of economic activity with a high degree of non-compliance with the requirements of the circular economy.

In the field of energy use, the compliance of the value of circular characteristics of types of economic activity with conceptual requirements can be assessed based on the criteria: significance in the total volume of use of mineral organic fuel; efficiency of use of mineral organic fuel; degree of anthropogenic impact on the environment.

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In the field of energy use, the compliance of the value of circular characteristics of types of economic activity with conceptual requirements can be assessed based on the criteria: significance in the total volume of use of mineral organic fuel; efficiency of use of mineral organic fuel; degree of anthropogenic impact on the environment. Thus, it can be stated that the domestic economy has significant potential for circular development, which can be realized through the formation of trends: accelerated growth of production, falling on types of economic activity with a high level of circular characteristics; reduction of the negative anthropogenic impact on the environment by types of economic activity, which are characterized by a high level; sustainable growth of the efficiency of resource use due to the acceleration of their circulation and reduction of standard costs in production.

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