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BOBROV, Ye. A. (https://orcid.org/0000-0002-7397-3132)
KROK University of Economics and Law,
30–32, Laherna St., Kyiv, 03113, Ukraine,
+380 44 455 5707, krok@krok.edu.ua

MODERN INNOVATIONS IN THE CONTEXT OF THE TRANSITION TO CIRCULAR ECONOMY

Introduction. *The major threats to human existence are nuclear war, ecological collapse, and technological breakthrough. They are all closely linked to both security policy and economic development.*

Problem Statement. *The world economic system annually consumes resources that need a year and a half to recover, thus having an irreversible impact on the planet ecosystem.*

Purpose. *The purpose of this research is to explain the main trends associated with the transition to circular economy.*

Materials and Methods. *Analysis and synthesis, comparative analysis and systemic approach have been used in this research. Scholarly research reports of international organizations, private and public corporations, publications on this issue have been used as references.*

Results. *The growth of world GDP has provided a significant progress and allowed, to some extent, freeing billions people from impoverishment. At the same time, economic growth causes a steady increase in demand for natural resources. This, in turn, leads to the loss of biodiversity and to the problems with water scarcity, which are caused by the methods used in the extraction and processing of natural resources. To develop a climate-neutral circular economy, appropriate policy initiatives have been launched and programmatic actions have been developed. Transformation has been already underway, but conceptual decisions need to be developed and adopted as soon as possible.*

Conclusions. *Politics and economics shall aim at the activities that contribute to making more environment friendly society economically viable. The most obvious step should be to ban subsidizing any activities that are harmful to the environment. In Ukraine, there are ample opportunities to transform the dominant model of linear economy into environment friendly and economically efficient circular model. The development of circular economy in Ukraine may give not only a favorable environment effect, but also the economic effect of increasing energy and resource efficiency, as well as the social effect of creating additional jobs and profiting corporations in new industries and activities.*

Keywords: innovations, linear economy, and circular economy.

Short time ago, the world economy has been operating without restrictions on the consumption of available natural resources. The industrial revolution created the preconditions in the economy for the intensive use of natural resources. The benefits were concent-

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rated for certain groups of people in certain parts of the world and only for a certain time. The main disadvantage of this process is that the growing resource extraction and consumer demand has spread all over the globe.

Today, the major threats to human existence are nuclear war, ecological collapse, and technological breakthrough. They are all closely linked to both security policy and economic development. These threats arose long time ago, and now it is time to address the problems that exist because of these threats. Let us focus on one of the problems associated with the current technological structure and state of the economy, which is the need to move from the existing linear economy to circular economy.

The world economic system annually consumes resources that need a year and a half to recover, which has an irreversible impact on the planet ecosystem.

Recently, government and corporate structures are increasingly paying attention to the need to take measures for maximizing waste recycling and creating new resources based on them. Thus, there is a rethinking and gradual understanding of the need to move from the linear economy based on the principle of "take — make — waste," to the so-called circular economy, the basic principle of which is "production — consumption and use — processing."

The main prerequisites for the overall transition to circular economy are as follows:

- growing population;
- growing resource consumption;
- limited resources, their inevitable scarcity in the future.

The circular economy is assumed to address the following problems:

- reduction of waste generation because of the development of recycling;
- reduction of adverse effect on the environment by reducing the consumption of resources in the course of production;
- emergence of new markets, creation of new jobs, rising level of well-being.

The circular economy is renewable by its nature. The idea of its development is as follows: instead of throwing away products before their value is fully realized, use these products repeatedly.

It should be noted that in recent decades there has been reported a relative separation of economic growth from resource consumption. Those achievements that have been made to date are quickly absorbed by economic growth combined with the rebound effect (resources released through efficiency improvement are used very quickly because of increased consumption).

The circular economy uses the enormous economic potential invested in materials and resources already used by society. Understanding of the value of materials and goods, which constitute the infrastructure used by society, is the driving force of circular economic models.

The preconditions for the basic tenets of the circular economy were highlighted in 1962 by American biologist Rachel Carson in his book *Silent Spring*, in which he drew attention to the use of pesticides in agriculture. The publication was severely criticized, and the author was threatened with lawsuits and suggested to want discrediting U.S. agriculture and industry. After all, progress was a characteristic indicator of the industrial development at that time and the price paid for it did not matter [1].

In 1966, Kenneth Boulding was first who in his book *the Economics of the Coming Spaceship Earth* raised the issue of the interaction of economics and ecology, noting that human society was not clearly aware of these problems. K. Boulding's research may be considered fundamental one for the understanding of environmental problems by economists. Here, the author for the first time raises the problem of reuse of goods and introduced the terms "cowboy economy" and "economy spaceship." He considers the economy of the future as an ecological system, similar to a spaceship, which has restrictions on the recovery of resources and waste disposal, while the existing economic system is characterized as "cowboy economy" that operates in unlimited resources in the condi-

tions of increasing production and consumption. The main goal of K. Boulding is to minimize production and consumption rather than to maximize them. The economy of the future shall solve the problem of conserving basic reserves of resources and finding technological innovations that reduce production and consumption. At the same time, he proposes to address the overproduction and overconsumption problems by producing goods with a longer shelf life and recyclability. Emphasizing the need to achieve a "stable circular flow of materials," K. Boulding, in fact, has created a new theory that is now called "circular economy" [2, 3].

In 1970—1971, upon request of the Club of Rome, an international team of researchers from the Massachusetts Institute of Technology (USA) led by Dennis Meadows studied the long-term effects of global population growth, industrial and agricultural production, natural resource consumption, and environment pollution with the help of computer modeling of the process of civilization development, based on the World3 model developed with the use of the system dynamics method of Jay Forrester, in order to find the most optimal (sustainable) scenarios for human development [4].

In 1972, the Club of Rome published *The Limits to Growth*. The main thesis is that the combination of such factors as resource depletion and pollution, unless left unaddressed, may lead to the collapse of the global economy over the next hundred years.

In 2008, Graham Turner of the Commonwealth Scientific and Industrial Research Organization (CSIRO) published the research comparing the forecasts from the Limits to Growth report with the data for the 30 years since the publication and concluded that the current production of industrial goods and food as well as the environment pollution corresponded to the estimates based on the model of 1972 [6].

The strategy for the development of a circular economy involves breaking the link "economic growth — resource consumption." The circular economy is based on and combines such models as "cradle-to-cradle," "blue economy," "performance economy," "industrial ecology," "industrial symbiosis," and "biomimicry" [7—10].

The systematization of existing theoretical concepts has shown that the basic provisions of the circular economy do not use any fundamentally new knowledge. Instead, they provide for accumulating the results of research by scientists in the fields of industrial ecology, environment efficiency, regenerative design, etc. [11].

A review of these research works suggests that the concept of circular economy combines practical approaches widely used by various scholarly research schools. At the same time, having systematized the terms of circular economy, we identified the two main fundamental approaches:

- the resource-oriented approach (Geng, Yuan, Geissdoerfer, and Zink) that proposes to consider a closed flow of materials, energy, and waste, which may be achieved through the reuse at the product level (repair or restoration), at the component level (reuse in production), and at the level of materials (recycling) [12];
- the economy-oriented (Bastein, Hislop and Hill, Ingebrightsen and Jakobsen), according to which the circular economy is an economic system based on the reuse of materials and conservation of natural resources and focused on creating values for people and the economy in each partial system [13—19].

The most commonly used definition combining the above two approaches is the one belonging to Ellen MacArthur Foundation, according to which the circular economy means the economy that has a renewable and closed nature and provides a continuous development cycle that preserves natural capital and increases its value, as well as enhances the return on resources through optimizing their use [20, 21].

The domestic research and development of the functioning of the circular economy mainly focuses on the analysis of foreign experience, some issues of logistics, production and processing technology, and ecology [22—24].

Since 1970, the world gross domestic product has doubled, which has resulted in a significant progress that, to some extent, has allowed billions people to overcome impoverishment. At the same time, the economic growth is fueled by a steady increase in demand for natural resources. All this time, the tendency to increase the demand for natural resources has remained unchanged. This, in turn, leads to the loss of biodiversity and problems with water scarcity, which are caused by the methods used in the extraction and processing of natural resources.

The modern linear models of economic activity depend on a constant inflow of material resources that are extracted and traded, processed, and eventually released into the environment as waste or pollution. Since 1970 till 2017, the annual extraction of material resources tripled from 27 billion tons to 92 billion tons and continues to grow (Table 1) [25].

Since 2000, the growth rate of resource consumption has increased to 3.2% per year, mainly as a result of significant investment in infrastructure and growth of material well-being in countries with developing economies and economies in transition, especially in Asia (Table 2) [26].

The share of production in Africa, Latin America, the Caribbean countries, and Western Asia remained relatively constant in 1970—2010, but grew in total absolute terms. In Europe and North America, there has been a sharp decline in the total world resource production. This also concerns Eastern Europe, the Caucasus, and Central Asia, whose share has declined the most significantly. It should be noted that although the relative shares have declined in many regions, the total domestic production in these regions was still growing (up to 40%), while Eastern Europe, the Caucasus, and Central Asia were the only region with a growth rate of 16%. All countries of Latin America, West Asia, and Africa have shown an increase in the total domestic production of more than 100% with annual growth rates of 3.1%, 2.9%, and 2.5%, respectively.

Some economic events have affected the trajectory of domestic production. A decline in the domestic production in West Asia immediately after 1980 was a result of declining oil exports after the second shock of oil prices, while the current decline in the domestic production in North America corresponds to the economic downturn that accompanied the shock of oil prices there. Significant reductions in the region of Eastern Europe, the Caucasus, and Central Asia were observed during the 1990s in the context of economic dislocation after the collapse of the former Soviet Union. Recently, the impact of the global financial crisis on the domestic production of North America and Europe has been clearly observed. Also, the impact of the economic downturn on the domestic production has weakened in most other regions [29].

The modern global consumption of resources has increased in all categories:

- the total annual consumption of biomass for the period from 1970 to 2017 increased 2.6 times, from 9 to 24 billion tons mainly because of plant growing and livestock grazing;
- the total annual consumption of metal-containing minerals for the period from 1970 to 2017

Table 1. **Effect of Extraction of Primary Processing of Resources**

Resources consumed	Global effect on climate change, %	Global effect of solid particles on health, %	Global effect on water resources, %	Global effect on the loss of biodiversity caused by the land use, %
Biomass	17	0.7	85	80
Metal-containing minerals	10	12	0.3	0.1
Fossil fuels	16	0.5	0.5	0.5
Nonmetal mineral resources	10	0.8	0.1	0.1

Source: Global Resources Outlook 2019. Fact Sheet.

increased 3.5 times, from 2.6 to 9.1 billion tons. The annual increase in consumption of metal ores since 1970 is 2.7% and is a result of the demand for construction, infrastructure, industry, and production of consumer goods;

- the total annual consumption of fossil fuels for the period from 1970 to 2017 increased 2.5 times, from 6 to 15 billion tons. However, the share of fossil fuels in the world consumption decreased from 23% to 16%;
- the total annual consumption of nonmetallic minerals for the period from 1970 to 2017 increased 4.9 times, from 9 to 44 billion tons. The largest shares in this category belonged to sand, gravel, and clay;
- the total annual water production for the period from 1970 to 2010 increased 1.6 times, from 2.5 to 3.9 thousand km^3 per year, although the growth rate of water production decreased. In the second half of the 20th century, a global growth in the water consumption for industry, agriculture, and utilities outpaced the growth of the world population. Between 2000 and 2012, globally, water was used in agriculture (70%), mainly for irrigation, industry (19%), and utilities (11%) of water production [27];
- the total annual use of land resources for the period from 2000 to 2010 increased from 15.2 million km^2 to 15.4 million km^2. The crop area decreased in Europe and North America, but increased in Africa, Latin America, and Asia. The area of world pastures decreased from 31.3 million km^2 to 30.9 million km^2. The total forest area in Africa and Latin America has decreased slightly, while in other parts of the world it has increased a little bit.

Biomass resources are used to produce food, feed, and energy. Food production is a major cause of biodiversity loss, soil erosion, and greenhouse gas emissions. At present, the cultivation and processing of biomass has a share of 90% in the world water consumption and biodiversity loss associated with land use. In 2010, land use entailed the extinction of 11% of species worldwide. In addition, the production and processing of biomass are sources of 30% of greenhouse gas emissions associated with the resource consumption (without changing the size of land use).

Over the past 15 years, the effect associated with metal ore mining and metal production on climate and public health has doubled.

The global production chains in ferrous metallurgy use 25% of the world industrial energy consumption with a corresponding impact on the climate. Another significant energy consumer is the aluminum industry. At the same time, the production of copper and precious metals causes a significant environment pollution with toxic substances.

Most of the problems for the environment are related to processing of non-metallic mineral resources rather than to their extraction. However, the extraction of these resources, especially sand, is one of the critical factors influencing local ecological systems.

Coal, oil, and natural gas are not only sources of energy, but also raw materials for the production of medicines, plastics, dyes, and many other products and materials. Both the extraction and processing, distribution and use of these resources make a significant contribution to environment and atmospheric pollution. The final stage of fuel consumption plays a key role in its effect on the environment and human health. In recent decades, an increase in the capacity of power plants that use fossil fuels has made low-cost energy available, but this has been achieved by harming the environment and human health.

Table 2. **The Regional Structure of Resource Extraction, %**

Region	1970	2010
Africa	7.9	7.0
Asia and Oceania	24.3	52.9
Eastern Europe, Caucasus, and Central Asia	14.7	5.8
Europe	20.9	10.5
Latin America and Caribbean countries	9.4	10.7
Northern America	19.6	9.7
Western Asia	3.2	3.4

Source: Global material flows and resource productivity 2016.

The global reverse circulation of resources in the economy ranges from 8.5 to 9%. An increase in this indicator is considered impossible because of high rates of production, constant increase in reserves, the level of processing (constantly growing, but still low) and the final consumption of extracted resources. These trends have deep roots in the conventional linear economy with its basic principle "take — make — waste."

The circle of those who enjoy the fruits of this kind of resource development still remains limited. At the same time, there are serious disparities in the so-called "resource footprint" of countries, i.e. the total amount of raw materials used by a country to meet its needs. In the high-income countries, this footprint per capita is 60% higher than that of the upper-middle-income ones and more than 13 times higher than that of the low-income countries.

Resource consumption per capita is 27.1 tons per person in the high-income countries, 16.9 tons per person in the upper-middle-income countries, and the world average is 12.3 tons per person. The "resource footprint" shows a clear trend: the higher the income in the country, the greater the consumption of resources.

The economic growth that worsens the state of our planet is realized, in fact, without taking into account socio-economic and environment factors of development. In this regard, the problem is to meet the needs of humanity within the resources available on our planet. The practical implementation of this ambitious but critical task requires the rethinking of the concept of "progress" by politicians, transnational and national corporations, civil society, and all citizens, as well as the introduction and use of innovative approaches to change people's choices, lifestyles, and behavior.

The forecasts for increasing the resource circulation to close the gap, given the pace of business development, are currently disappointing. According to the historical trend of consumption of natural resources in the near future, 100% growth in the absolute consumption is expected. Based on the historical trend, the average world consumption per capita is anticipated to grow by 50%, up to 18 tons per person.

Further transformations require sound policy decisions that necessitate changes in the way of economic and business activities.

In 2017, the annual consumption of resources in the world amounted to more than 100 billion tons, of which only 8.6 billion tons belonged to the recovered resources [29].

The data have shown that the rate at which resource extraction increases is 2—3 times faster than their recovery after use [30]. The world economy has been attracting more resources and materials to build global housing, infrastructure, and heavy machinery to meet the needs of growing world population. Insufficient elaboration of the end-of-life and cycle use conditions as well as poor product design contribute to self-sustaining linearity and entail an increase in the demand for as yet unused resources, thereby relaunching the entire sequence.

Having analyzed the modern social needs of humanity and their impact on the economy, we identify the seven basic needs:

1. **Housing, infrastructure and their maintenance**. To meet this need, the largest amount of resources is used (approximately 38.8 billion tons annually).

2. **Food.** It is the second largest category in terms of resource consumption. Agricultural products, such as crops and livestock, require the use of 21.3 billion ton resources annually. In this case, food products have a very short life cycle in the economy and are consumed quickly after manufacture.

3. **Mobility.** This category requires the use of significant resources, in particular, for building the transport infrastructure and vehicles (cars, trains, aircraft) and for enabling them to move (fossil fuel combustion).

4. **Consumer goods.** This is a diverse and complex group of products that usually have a short and medium service life.

5. **Services**. The consumption of resources to meet the needs of this category is almost insigni-

ficant and includes the use of professional equipment, office furniture, computers, and other infrastructure.

6. **Health care**. In addition to buildings, this category includes the use of capital medical equipment, medicines, hospital equipment, disposable goods, and home care equipment.

7. **Communication**. Expanding communications contributes to the development of the circular economy, through digitization that makes physical products irrelevant and promotes more efficient use of the existing assets, including consumables, housing, and infrastructure.

Urbanization, as a global phenomenon, increases and accelerates the demand for housing, stimulating the dynamics of housing construction around the world. In addition, accumulating physical assets in municipal infrastructure increases the demand for services such as energy and heating, water supply, sanitation, communications, and transportation. The majority of the materials consumed by the world economy each year (52.6 billion tons) are used by society as short-lived products, whose service life expires within the year [31]. The other 48 billion tons of materials are the long-term reserves and considered resources that last a long time [32, 33]. They are mainly buildings, infrastructure, and capital equipment.

It should be noted that in some areas, the forecast based on modeling shows a trend that is opposite to the expected one. However, the growing rate of extraction and use of raw materials displays that these modest improvements in waste recycling are insufficient to sustain the economic growth.

The Club of Rome warning that virtually every pollutant measured as a function of time increases exponentially has not come true, as it has not only stopped growing, but also started declining. According to the United States Environmental Protection Agency (EPA), the total emissions of the six leading air pollutants decreased by more than two-thirds between 1980 and 2014. The share of pollutants decreased as follows: volatile organic compounds by 53%, nitrogen dioxide by 55%, solid particles by 58%, carbon monoxide by 69%, sulfur dioxide by 81%, and lead by 99% [34].

Building a climate-neutral circular economy requires the launch of appropriate policy initiatives, the development of program actions, and the mobilization of industry and the financial sector. This kind of transformation may take a long time (several decades), but the conceptual decisions need to be proposed and made in the coming years.

It should be noted that the modern practice-oriented approach to defining the concept of circular economy has been formulated not only in the academic literature, but also in the initiatives of government circles and the business community of the EU, Canada, and China.

In particular, in the European Union, since 2014, there have been made efforts towards the development of a circular economy: the concept of the program *Towards a Circular Economy: a Zero Waste Program for Europe* (2014); Closing the Loop — An EU Action Plan for Circular Economy (2015) [35, 36].

At the end of 2019, in the context of implementing the UN Sustainable Development Goals, the European Commission as the highest executive body of the European Union, submitted the *European Green Deal* to the European Parliament, the European Council, and the respective committees [37, 38].

As noted in the European Green Deal, in global markets, there is significant potential for low-emission technologies and products that have environment, social, and economic benefits, which protect human health and the environment throughout their life cycle, from the extraction of raw materials to their final utilization (sustainable products).

Obviously, the circular economy already has great potential for new economic activities and job creation. However, as noted above, the global transformations are too slow, inconsistent with economic growth, and their progress is not large-scale and steady.

The implementation of a set of measures in the framework of new policies that aim at increasing

the share of the circular economy helps modernizing the economy and deriving benefits from its opportunities at the domestic and global levels. The key goal of the new policy should be to stimulate the development of leading markets for climate-neutral circular products.

This is especially true for the energy-intensive industries such as metallurgy, chemicals, and cement, as well as the resource-intensive industries such as textiles, construction, electronics, and plastics, which are indispensable to the global economy because they provide key value chains. Accordingly, the decarbonization and modernization of these sectors is rather important.

This, in turn, will require the creation of new business models (based on the lease and exchange of goods and services) and the establishment of minimum requirements to prevent the construction of harmful production.

Experts have classified the five innovative business models that are implemented both separately and jointly in a circular economy: circular supplies, resource recovery, sharing platforms, product life extension, and product as a service [39].

The *circular suppliers* are a model in which nonrenewable (limited) resources are replaced by fully renewable sources. It is based on long-term research and development and deals resources that are completely recycled or biodegradable. Such resources form the basis of a circular system of production and consumption. Today, the leaders in the implementation of this model are such industries as automotive and power engineering. This circular business model has been used by *Ford*, *Fairphone*, *3D Hubs*, *Desso*, *Toyota*, and *Cisco*.

The *resource recovery* is a model based on the use of technological innovations to restore and reuse resources, which ensures the minimization of their losses by reducing waste and increasing the profitability of production from reverse flows. This model is most acceptable for corporations that produce large amounts of by-products and those that have the ability to effectively recover and recycle waste. Among them, there are *Coca-Cola*, *Maersk*, *Michelin*, *Philips*, and *Walt Disney World Resort*.

The sharing platforms are a model that involves the exchange or sharing of goods or assets. It promotes platforms for interaction between product users (individuals or organizations), thereby increasing the level of product use. It is interesting for manufacturers who have a low utilization rate or underutilized capacity. *Patagonia*, *BlaBlacar*, *Nearly New Car*, *BMW*, *Drivy*, *Daimler*, *Lyft* have been using this business model.

The *product life extension* is a model that allows corporations to extend the life cycle of their products through repair, modernization, reconstruction or restoration. It is suitable for industrial equipment manufacturers where the new models provide a slight increase in productivity as compared with the previous ones. This business model is used by *Bosch*, *Caterpillar*, *Volvo*, *Renault*, *Apple*, *BMA Ergonomics*, and *Michelin*.

The *product as a service* is a model in which customers use the product by "renting" it at a fee. It is an alternative option to buying a product, as it provides it for use, for example, through a lease agreement, etc. The business model is used in such companies as *Rolls-Royce*, *Mud Jeans*, and *De Kledingbibliotheek*.

These business models have been gradually being implemented in our country.

An important issue today is ensuring access to the resources needed for clean technologies, digital, space and defense development by diversifying supplies from both primary and secondary sources, which is one of the prerequisites for a major transition to a circular economy.

The digital technologies such as artificial intelligence, 5G mobile networks, cloud computing and edge computing, the Internet of Things are among the crucial factors in the development of the circular economy, which may accelerate and maximally influence the policy of combating climate change and environment protection. Digitalization creates new opportunities for remote monitoring of air and water pollution, optimization of energy and natural resources use.

Thus, in the coming decades, politics and economics should make the activities that contribu-

te to a more environment friendly society economically viable. Today, we often see the completely opposite situation: goods just manufactured soon become obsolete, spoil or go out of fashion. Consumers are willing to buy new products and demand more. This approach brings business profits, but society as a whole incurs losses.

The most obvious step should be to ban subsidizing any activities that are harmful to the environment, for example, subsidies for fossil fuels, transport, mining, forestry, and fisheries.

The abolition of subsidies is one of the obvious and important measures to be taken. Also, it is equally important to allow market prices to reflect real costs. Unfortunately, markets by themselves do not offer environment friendly and resource-saving goods and services. This requires both purely economic measures in the form of taxes, tariffs and fees, green certificates, as well as regulatory measures and stimulation of public procurement. If the production and consumption of such products are stimulated, in the future, it will become competitive and will require less support from government.

In Ukraine, there are ample opportunities to transform the dominant linear economy into the environment friendly and economically efficient circular model. Food and municipal waste has the potential for the development of processing, composting, generation of energy, and production of fertilizers in Ukraine. Renovation may be used in the automotive industry, the household appliances sector, the aviation industry, and the military-industrial complex. However, the current economic mechanisms in the country still focus corporations on the application of the outdated linear model. Landfilling is still more attractive today than investing in preventive measures. To qualitatively improve the situation, serious changes are needed in the field of stimulating investment activity in the framework of the transition to the circular economy principles. The development of the circular economy in Ukraine may give not only a favorable environment effect (a reduction in landfills and waste deposits, but also an economic effect (an increase in energy and resource efficiency), as well as a social effect (the creation of additional jobs, profitmaking in new industries and activities). Thus, the development of the concept of circular economy, as well as its practical implementation, is an important task for researchers and businessmen, government agencies and Ukrainian society as a whole.

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Бобров Є.А. (https://orcid.org/0000-0002-7397-3132)
Університет економіки та права «КРОК»,
вул. Табірна, 30—32, Київ, 03113, Україна,
+380 44 455 5707, krok @krok.edu.ua

СУЧАСНІ ІННОВАЦІЇ В КОНТЕКСТІ ПЕРЕХОДУ ДО ЦИРКУЛЯРНОЇ ЕКОНОМІКИ

Вступ. Актуальними загрозами існування людства є ядерна війна, екологічний колапс і технологічний прорив, які тісно пов'язані як з політикою безпеки, так і з розвитком економіки.

Проблематика. Діюча у світі економічна система використовує за рік такий обсяг ресурсів, для відновлення яких необхідно щонайменше півтора року, здійснюючи таким чином незворотній вплив на екосистему планети.

Мета. Розкрити основні тенденції, пов'язані з переходом до економіки циркулярного типу.

Матеріали й методи. Використано методи аналізу й синтезу, порівняльного аналізу та системного підходу. Матеріалами слугували наукові доповіді міжнародних організацій, приватних і публічних компаній, публікації, присвячені зазначеній проблематиці.

Результати. Зростання світового ВВП забезпечило суттєвий прогрес і дозволило, певною мірою, звільнитися від зубожіння мільярдам людей. При цьому економічне зростання спричинює постійне підвищення попиту на природні ресурси. Це, у свою чергу, призводить до втрати біорізноманіття та проблем дефіциту води, які обумовлюються методами, що застосовуються в ході видобутку та переробки природних багатств. Для розбудови циркулярної економіки, яка є нейтральною для клімату, започатковуються відповідні політичні ініціативи, розробляються програмні дії. Трансформація вже триває, проте концептуальні рішення необхідно розробляти та приймати якнайшвидше.

Висновки. Політика та економіка мають бути спрямовані на те, щоб діяльність, яка сприяє перетворенню суспільства на більш екологічно чисте, ставала економічно вигідною. Найбільш очевидним кроком має стати заборона субсидування будь-якої діяльності, що шкодить навколишньому середовищу. В Україні існують широкі можливості для трансформації домінуючої моделі лінійної економіки в екологічно й економічно ефективну циркулярну модель. Розвиток циркулярної економіки в країні може забезпечити не тільки позитивний екологічний ефект і дати помітний економічний ефект від підвищення енерго- та ресурсної ефективності, а також соціальний ефект від створення додаткових робочих місць, отримання прибутку компаніями в нових галузях і видах діяльності.

Ключові слова: інновації, лінійна економіка, циркулярна економіка.