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## ECONOMIC COMPLEXITY DEVELOPMENT BY IMPLEMENTING PRODUCTION STRATEGIES TO REDUCE RESOURCE CONSUMPTION IN THE CONDITIONS OF A CIRCULAR ECONOMY

### РОЗВИТОК ЕКОНОМІЧНОЇ СКЛАДНОСТІ ШЛЯХОМ ВПРОВАДЖЕННЯ ВИРОБНИЧИХ СТРАТЕГІЙ ЗІ ЗНИЖЕННЯ РЕСУРСОСПОЖИВАННЯ В УМОВАХ ЦИРКУЛЯРНОЇ ЕКОНОМІКИ

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*Бублик М.І., Нашкерська М.М., Піхняк Т.А. Розвиток економічної складності шляхом впровадження виробничих стратегій зі зниження ресурсоспоживання в умовах циркулярної економіки. Оглядова стаття.*

У роботі досліджено шляхи підвищення економічної складності продукції через впровадження виробничих стратегій зі зниження ресурсоспоживання, а також обґрунтовано їх позитивний вплив на розвиток циркулярної економіки. Проаналізовано еволюцію формування понять «циркулярна економіка» та «зелена економіка», наведено їх особливості та відмінності. Проведено класифікацію наукових напрямів вирішення проблем циркулярної економіки. Проаналізовано статистичні дані щодо стану і структури національних рахунків в Україні, в результаті чого було встановлено, які сектори економіки є найбільш ресурсоемними і потребують впровадження виробничих стратегій інвестування в низькоресурсні інноваційні технології циркулярної економіки. Запропоновано включити у Національну стратегію розвитку України стратегічний напрям – розвиток економічної складності через впровадження виробничих стратегій інвестування в низькоресурсні інноваційних технологій циркулярної економіки.

*Ключові слова:* виробничі стратегії, економічна складність, циркулярна економіка, національні рахунки, ресурсоемність секторів економіки

*Bublyk M.I., Nashkerska M.M., Pikhniak T.A. Economic Complexity Development by Implementing Production Strategies to Reduce Resource Consumption in the Conditions of a Circular Economy. Review article.*

The article explores the ways to increase the economic complexity of products by implementing production strategies aimed at reducing resource consumption, substantiating their positive impact on the circular economy development. The concepts evolution of "circular economy" and "green economy" is analysed, highlighting their features and differences. The classification of scientific approaches to solving circular economy problems is provided. Statistical data on the state and structure of national accounts in Ukraine are analysed, identifying the most resource-intensive sectors of the economy that require the production strategies implementation involving investments in low-resource innovation technologies of the circular economy. It is proposed to include a strategic direction in the National Development Strategy of Ukraine, focusing on the economic complexity development by adopting production strategies investing in low-resource innovation technologies of the circular economy.

*Keywords:* production strategies, economic complexity, circular economy, national accounts, resource consumption of the economy

**S**tudying the tools of economic complexity is gaining more and more popularity among scientists, economists, politicians, and environmentalists. Over the past decade, the study of economic complexity has taken on new directions, including the introduction innovation technologies into production processes that can reduce the amount of resources required for production. This reduction in the resource intensity of production helps to reduce the negative impact of economic activity on the environment and the population and contributes to greater satisfaction of consumer demand for high-tech products in the face of restrictions on certain resources, such as oil, gas, agricultural products, etc. The main idea is to move from a

linear model of the economy ("take-create-discard") to a circular model, where materials and resources are kept in the economic cycle as long as possible, reducing waste and costs.

This relevance of this study lies in the need to find the ways to increase the economic efficiency and competitiveness of enterprises and economies in general by developing and implementing innovative production processes that reduce the use of resources (raw materials, energy, water, etc.) and reduce the negative impact on the environment.

### **Analysis of recent researches and publications**

In the last decade, the consideration of economic complexity in assessing the potential for economic development and its components has been gaining popularity in scientific circles [1], in the distribution of income to level the gap between wealth and poverty [2], in assessing the high-intellectual component of output [3-5], in determining the prevalence of exported products and their diversity [6-9], etc. Economic complexity is also taken into account when analysing the effectiveness of solving environmental problems in creating mechanisms for industrial development and implementing production strategies, including strategies for environmentally safe storage, transportation, processing and disposal of manufactured products [10-13].

The Atlas of Economic Complexity, developed in 2011 by Harvard professors Cesar A. Hidalgo and Ricardo Gausman, gained worldwide recognition among scholars [14]. It was a breakthrough in recognising economic complexity as an important tool for assessing the share of knowledge and intellectual labour in the final output of goods and services. Back in 2009, [15] first described the key role of economic complexity in a country's income formation, where they defined the concept of economic complexity as a measure of society's knowledge embodied in the goods and services produced. In [16], the authors included such export characteristics as diversity and prevalence in the calculation of economic complexity. In [17-19], the authors argue that diversity cannot be achieved without using high technologies with a high share of intellectual labour, introducing unique know-how for manufacturing products with a significant concentration of knowledge.

The problems solution in the field of the circular economy was preceded by the research of the physical economics founders, such as L.S. Hryniv [20, 21], S. Podolynskyi [22, 23], M. Rudenko et al. [24] The circular economy problems were studied by the scientists both in Ukraine and in the world [4, 13, 25-27]. They laid the theoretical and methodological foundation for balanced relations between production and consumption aimed at preserving resources. In general, as a result of the analysis of recent research and publications [27-45], the existing problems and methods were grouped into several scientific areas.

1. Limited resources. Scientists [27-32] believe that with the growth of population and economies, the need for natural resources increases, which leads to their depletion, so reducing the resource intensity of production helps to preserve these resources for future generations.

2. Environmental pressure. Scientists [33-36] have found that traditional production processes often cause significant environmental pollution, and in contrast to the linear economy, the circular economy offers the ways to reduce emissions, waste and pollution, contributing to a more sustainable society.

3. Economic efficiency. Implementing the strategies to reduce resource intensity, according to scholars [37-42], helps to reduce the cost of raw materials and energy, increase production efficiency and increase the enterprises profitability.

4. Regulatory pressure. As substantiated in [43, 44], many governments and international organisations are introducing policies and regulations aimed at supporting the circular economy and reducing the environmental impact of production. At the same time, companies that have adapted to these changes are gaining a competitive advantage.

5. Consumer preferences. According to researchers in their studies [45], modern consumers increasingly prefer goods and services produced in an environmentally responsible manner. This gives manufacturers that implement strategies to reduce resource intensity significant competitive advantages, including a positive image, increased opportunities to attract customers, etc.

Thus, the analysed studies point to the indisputable facts that solving this problem is an important step towards achieving sustainable development of each economy, and reducing the environmental burden and ensuring long-term economic growth will result from the implementation of the circular economy principles.

However, nowadays, the previously unresolved parts of the general problem of increasing economic complexity by implementing production strategies to reduce resource intensity in the circular economy include technological barriers, high investment thresholds, the need for infrastructure development, the destruction of regulatory and normative barriers, the lack of sufficient knowledge and skills to implement appropriate strategies, the need for changes in the culture of consumption and waste management behaviour, and the need to change the way the world works. Let us clarify the key aspects of the above-mentioned issues.

Since many new technologies that reduce the resource intensity of production are at the early stages of development and are often too expensive for mass adoption, this creates technological barriers to their widespread application, especially by small and medium-sized enterprises.

As the high upfront investment required to switch to new production processes is an insurmountable obstacle for many companies, this simple lack of financial incentives or access to finance is a significant deterrent to the spread of resource-saving production strategies.

Naturally, the effective implementation of the circular economy requires an appropriate infrastructure, including systems for collecting, sorting, recycling and reusing materials from consumed goods. However, in many countries, such infrastructure is not sufficiently developed.

A significant role is played by the lack of clear regulatory frameworks and incentives to support circular economy models, which significantly complicates their implementation. This includes the lack of regulations harmonisation at the international level, which creates additional difficulties, even for large global companies.

Lack of knowledge and skills plays an important role. For example, many companies and their employees do not have sufficient knowledge and skills to develop and implement new production strategies, as this requires significant investment in education and training.

Cultural and behavioural changes in the transition to the circular economy are also necessary, as both the cult of consumption and production need to change. This applies to both businesses and consumers, who need to adopt new approaches to resource use and recycling.

The availability of a simple and understandable system for assessing the results and methods of measuring the production models effectiveness within the circular economy, as well as identifying and measuring the effectiveness of implemented strategies to reduce resource intensity, is a complex but important task. Developing reliable assessment methods will make it possible to track the progress and impact of these strategies on the economy and the environment, to make a choice in favour of the best ones, and, simply, to stimulate their implementation.

Addressing these outstanding challenges requires a comprehensive approach, including cooperation between governments, businesses, academic institutions and the public. This will help to create favourable conditions for the transition to more efficient and sustainable production models within the circular economy.

*The aim of the article is to find the ways to increase the economic sophistication, efficiency and competitiveness of companies and economies in general by developing and implementing production strategies that reduce the use of resources (raw materials, energy, water, etc.) and reduce the negative impact on the environment, in particular. The set objectives were: 1) to trace the theoretical foundations of the concepts development of the circular and green economies, to compare their features; 2) to identify the ways to introduce resource-saving and knowledge-based technologies based on the economic complexity development; 3) to analyse national accounts statistics on the resource intensity of Ukrainian goods and services according to the matrix of inter-sectoral balance, to determine their status and structure; 4) to build a set of universal provisions for the implementation of production strategies based on resource-saving and high-knowledge technologies to increase the economic complexity of the circular economy.*

### **The main part**

The problem of Ukraine's European integration is directly linked to a quick and successful end to the Russian-Ukrainian war. Building a circular economy aimed at the growth of the entire production and economic complex of our country should be carried out in the project "Reconstruction of Ukraine" on the principles of economic complexity, which are implemented in introducing the resource-saving and knowledge-based technologies for the development of the circular economy. This means that there is an urgent need to recycle and dispose of industrial waste, as well as return own products to the company when they reach the end of their service life or become unusable. This is also important given the prospects for Ukraine's integration into the European Union.

The term "circular economy" dates back to the 1970s and refers to an economic system that aims to reduce resource use, reduce waste and pollution, and reuse materials and products. The circular economy is based on the principle of a closed loop, where waste from one process becomes a resource for another, thereby keeping materials in economic circulation for as long as possible. However, it became widespread and influential much later in the 1980s and 1990s, in particular, due to the work of British economists and environmentalists Walter Staels and Kenneth Bowd [46]. An important contribution to the popularisation and development of the circular economy concept was also made by Ellen MacArthur and the Ellen MacArthur Foundation after 2010 [46].

In general, the green economy was launched at the UN Millennium Summit in 1992 in Rio de Janeiro, when Agenda 21 was adopted [47]. This programme document approved the "green" measures introduction into the national economies of countries as part of a sustainable development strategy. This document resulted in the signing of the UN Framework Convention on Climate Change [48]. All of this contributed to the fact that sustainable development was recognised as one of the most important tasks of humanity.

The term "green economy" dates back to 1989, when it was first used in the UK Government's report "Blueprint for a Green Economy" by a group of scientists: D. Pearce, A. Marcandia and E. Barbier [49].

The green economy also describes an economic system that aims to ensure sustainable development, economic growth and social well-being while preserving and protecting natural resources and the environment. The main principles of the green economy include reducing greenhouse gas emissions, efficient use of resources, developing renewable energy sources and introducing environmentally friendly technologies. There are many interpretations of the concept of "green economy", but in general, as stated in the UN Green Economy Initiative report [50, 51], published in November 2011, it is a policy that promotes the well-being of people by reducing environmental pollution and rational use of natural resources. This document also defined the main goals of the green economy: new jobs creation; resource-saving entrepreneurship; and waste-free production.

In 2008, in the context of the global financial crisis and a possible global recession, the Organisation for Economic Co-operation and Development (OECD) advocated the idea of stimulating national economies around the world by introducing green production [52]. This was supposed to help improve the economy and increase employment, as well as contribute to the fight against climate change, negative environmental changes and poverty. In October of the same year, the United Nations Environment Programme (UNEP) announced the transition to the green economy and launched an initiative to analyse its development [53]. As part of this initiative, a report was made by one of the first authors of the green economy concept [54]. This report was published in March 2009. It outlined the policy measures that needed to be taken to stabilise and improve the global economy. It also formulated an appeal to governments to provide material incentives for green production in order to achieve such goals as economic reorganisation, poverty alleviation, reduction of carbon emissions and counteracting ecosystem degradation. Prior to the UN Climate Change Conference in Copenhagen, in June 2009, the UN issued a statement in support of the green economy, which was supposed to solve all global social problems [55]. Subsequently, in February 2010, at the Global Forum in Nusa Dua, representatives of national governments and UNEP confirmed the effectiveness of the green economy concept [53].

In March 2010 the UN General Assembly adopted Resolution 64/236, which stated that the "green" economy is one of the main topics at the Rio+20 Summit as an effective tool for sustainable development and poverty reduction. In 2010, the Europe 2020 project was approved [55], which aimed to address such global challenges as sustainable growth, reducing population ageing, and the wise use of resources (aimed at meeting the needs of limited resources, not only now but also for future generations, and ensuring environmental protection).

In December 2011, the report "Towards a Balanced and Inclusive Green Economy" [56], prepared by the UN Environment Research Group, was published. It was this document that served as the basis for UNEP's further activity.

In 2012, Rio de Janeiro hosted the Global Conference on Sustainable Development (Rio+20) "The Future We Want" [56], which was one of the most important global conferences of our era on sustainable development. The issues discussed were how to build the green economy in a way that would achieve sustainable development and reduce poverty, and how to help developing countries join the green development. Much attention was also paid to improve the coordination of international efforts to achieve sustainable development. As a result, the document "The Future We Want" [56] was adopted, which was fundamentally different from the previous document. A sustainable development programme through the green economy mechanism was adopted.

The common features of these concepts of economic development include the fact that they are aimed at achieving sustainable development, preserving natural resources and reducing negative environmental impact. Both circular and green economies are aimed at more efficient use of resources and energy. Both concepts involve the implementation of practices that reduce pollution and protect natural ecosystems.

However, there is a number of differences. The circular economy focuses on closed loops of materials and products, where waste is minimised through reuse, recycling and repair. The green economy takes a broader approach, focusing on reducing greenhouse gas emissions, introducing renewable energy sources and environmentally friendly technologies. They also differ in their methodologies. The circular economy is based on the closed-loop methodology, where products and resources are reused and remain in economic circulation for as long as possible. The green economy is based on the methodology of using a variety of strategies to ensure environmental sustainability, including biodiversity protection, emissions reduction and natural resource management. Considering the difference in methodologies, the tools for their implementation also differ. The circular economy uses tools such as the durable goods development, mandatory reuse of resources, and recycling infrastructure development. The green economy is more focused on investment instruments, such as investments in clean technologies, renewable energy, ecosystem conservation and the environmentally friendly transport development, etc. As stated in UNEP documents, investments should be directed in several areas [50-56], including the transition to alternative sources of wind and solar energy, geothermal and biomass energy, increasing energy efficiency in construction and developing smart transport, improving the ecological condition of freshwater, forests, soils and coral reefs, as well as developing sustainable agriculture, where organic production plays an important role.

Thus, while the circular and green economies have much in common in their goal of sustainable development, they differ in their methods and focus of approaches.

The green economy is a targeted government policy and strategic direction aimed at saving resources, protecting the environment and improving the population's overall well-being. It is a fundamental factor that shapes the environmental component of a country's positive image, which directly affects its investment attractiveness for the global business community.

The concept of green economy is based on the following statements [57]: 1) the territory is limited, and it is not capable of constant expansion; 2) resources are exhaustible, and people's needs are unlimited and constantly growing; 3) everything is interconnected. This has formed the main goal of transforming the traditional economy into a socially oriented one, namely the creation and development of green business in the national economies of each country, which is also called ecological, low-carbon, resource-saving, etc. in various sources.

When developing a green business, it is important that the basic principles of the green economy are achieved: equality and fairness in the resources distribution between countries, generations, and genders; caution

about social and environmental impacts; a detailed understanding of the high value of natural and social capital; taking into account the processes of internalising external environmental costs; introducing a separate type of accounting – green accounting – into the system; assessing possible losses throughout the life cycle of products (goods and services); improving management systems in institutions; increasing the efficiency of using all types of resources (natural, material, etc.); developing sustainable consumption and production; and creating green jobs.

The Environmental Productivity Index (EPI), which is a comprehensive indicator of a state's environmental policy and its individual entities, conducted by Yale University (Scotland), is considered an important indicator of the environmental sustainability of the economy.

Reorientation to the green economy includes changes in many types of economic activity in Ukraine's national economy. According to M.I. Bublyk and M.R. Bey in [58], the main tools for transforming the traditional economy into a socially oriented system of economic relations should be divided into three groups: economic, marketing and corporate, and should be used following the sectoral type: primary, secondary, etc. The authors of [59] substantiate the need to build the green (low-carbon) economy for Ukraine's successful integration into the European Union, where the primary sector of the national economy, which is based on agriculture, fishing, forestry and mining industries that create products to meet the primary needs of mankind, is successfully reoriented to manufacturing organic products (without the use of chemical additives).

The secondary sector of the economy, namely industry and construction, needs to use energy resources efficiently. The transition to the green economy will require introducing new (innovation) technologies to increase Ukraine's industry competitiveness. In addition, the green economy involves the intensification of such economic activities as waste processing and recycling. Moreover, waste does not only pose unprecedented threats, but can also be used to increase the competitiveness of production by reducing the cost of raw materials and reusing them. The impact of the green economy on industrial economic activities in Ukraine requires special attention and targeted research to develop promising areas following the example of developed countries that are currently pursuing neo-industrial policies.

The tertiary sector, which plays the role of a connecting link that ensures the green economy concept implementation, can be the fastest to change in terms of successful green business development. This is due to the fact that it is a combination of production and economic activities related to the services provision to both the public and businesses. This area provides for comprehensive research and development, business plans and programmes, and energy-efficient technologies development that can ensure qualitative shifts in the primary and secondary sectors of the national economy towards green development.

Discussions also surround the very concept of green entrepreneurship, strangely narrowing this concept to primitive resource constraints, i.e. resource-saving or resource-efficient entrepreneurship, or, in general, low-carbon entrepreneurship, i.e. diluting the whole essence of entrepreneurship, etc.

We propose to consider the very concept of "green entrepreneurship" as a type of independent, systematic and risky economic activity carried out by business entities on their own initiative in order to minimise (up to elimination) the amount of waste in the course of their own economic activity, while achieving an economic result, i.e. profit.

The burnt land, polluted water and other catastrophic environmental consequences caused by Russia's war against Ukraine are already estimated at a total loss of more than UAH 202 billion. As of May 2022 alone, the Ministry of Environmental Protection and Natural Resources of Ukraine recorded 231 environmental crimes committed by Russia on Ukraine's territory [60]. Already in 2024, during the two years of the war, 180 million tonnes of carbon have been emitted into the planet's atmosphere. This is approximately the same amount of emissions as the country of Malta generates in 80 years. It is known that before the war, business activities had a destructive impact on the environment, economy and society due to their high dependence on resources. 42 billion euros in climate investments in the United States in 2023, 177 billion euros in climate investments in Germany for the next 3 years, and 314 billion euros in climate investments in South Korea until 2030. However, all these billions of euros invested in the fight against the climate crisis are offset by Russia's war against Ukraine [60].

The share of knowledge-intensive products in Ukraine's exports was less than 2%. The rapid development of the industrial revolution, the growth of the world's population, which led to a rapid increase in its need for water and food, and the exponential increase in the amount of waste that accompanies human activities only deepened the crisis in the country's economy.

Naturally, as production volumes increase, the need to use large volumes of renewable and non-renewable natural resources also increases. Although the key goal of business is to make a profit by any means necessary. However, is this really achieved in any way and without addressing any social or environmental goals? Nobody can deny the fact that enterprises in various sectors of the economy often increase the use of limited natural resources and pollute the environment, creating inevitable consequences for their business activities.

However, despite numerous publications by the UN, non-governmental organisations, and research by Ukrainian scientists, today, more than a quarter of a century after the existence of the independent country, green entrepreneurship has not been singled out as a direction for the entrepreneurial activity development, and the economic complexity development by implementing production strategies for investing in low-resource

innovation technologies of the circular economy is not included in the priority strategic directions of the national economy.

The analysis of the state and structure of the national accounts in Ukraine, conducted by the State Statistics Service of Ukraine, based on the inter-industry balance matrix developed by Vasyl Leontief, a Nobel laureate, could show the problem from another angle. In the Ukrainian State Statistics Service, this world-famous Leontiev model is known as the inter-industry balance sheet.

The expediency of using Leontief's model to analyse the resource intensity of the national economy was first substantiated in M.I. Bublyk's work [61], where the volumes of output of goods and services were studied for each type of economic activity by indicators of direct resource consumption, including total consumption, resource consumption, natural resource consumption, fuel consumption, energy consumption, water consumption, waste consumption, electricity consumption, water consumption, emission consumption, discharge consumption, waste consumption, etc. In-depth studies conducted in [61] have shown that the total cost intensity in the national economy is highest in the manufacturing industry (74 kopecks per 1 UAH of output value), while for the supply of electricity, gas, steam and air conditioning it is 62 kopecks per 1 UAH of output value, for water supply; sewerage, waste management – 65 kopecks per 1 UAH of output value, for construction – 71 kopecks per 1 UAH of output value. This indicates a high share of costs in the total value of output, as well as its low-tech nature.

In her work [61], M.I. Bublyk has found that the costs of fuel and energy resources in water supply, sewerage and waste management are extremely high (18.8 % of the goods output in this type of economic activity), and the lowest are in financial and insurance activities (0.09 % of the goods output in this type of economic activity). The average cost of fuel and energy resources was 4.4% of the goods output in Ukraine's national economy.

M. I. Bublyk in her work [61] believes that the high resource intensity of Ukrainian goods and services is several times higher than the corresponding indicators of the leading countries of the world, which causes Ukraine's ratings to be lower each time compared to the leading countries of the world. At the same time, in the European Union, entrepreneurs are trying to optimise production by reducing its resource intensity [11, 34], which complicates European integration processes for Ukraine.

The same opinion is shared by the author of [62], who proposes to use the classical form of the intersectoral balance sheet to assess the impact of green economy development on the national economy as a whole. However, the author of [62] only theoretically models the impact of the green economic activities development on the country's economy in order to assess their possible benefits as drivers, without providing any calculations for the evidence base.

In our opinion, it is important to establish how the green business development in each type of economic activity will affect the economy as a whole and which types of economic activity are advanced (green drivers). It is obvious that the impact of high-tech green investments on the economy will be positive. In Ukraine, some economic activities, especially in the service sector, which cause little or no harm, are already green in nature. We believe that it is important to establish, first of all, in which economic activities the situation is catastrophic and which economic activities require the greatest investment flows in technologies with a high intellectual share.

Table 1 shows the first quadrant of the Leontiev model for 2021 at consumer prices in million UAH, which describes the reproduction processes in the national economy, for each GEA (according to the Classifier of Types of Economic Activities 2010, where A means agriculture, forestry and fisheries; B means mining and quarrying; C means manufacturing; D means supply of electricity, gas, steam and air conditioning; E means water supply, sewerage, waste management; F means construction; G means wholesale and retail trade, repair of motor vehicles and motorcycles; H means transport, warehousing, postal and courier activities; I means temporary accommodation and catering; J means information and telecommunications; K means financial and insurance activities; L means real estate transactions; M means professional, scientific and technical activities; N means administrative and support services; O means public administration and defence; compulsory social insurance; P means education; Q means healthcare and social assistance; R means arts, entertainment and recreation; S means other services).

The table of inter-industry balance in the first quadrant (intermediate consumption) shows in columns the value composition of gross output of goods and services of each GEA by the cost structure of certain types of goods and services used in production (Table 1).

In Table 1, the rows indicate the use of a particular type of goods or services for intermediate consumption during production for each GEA. After analysing the statistical data on the state and structure of national accounts in Ukraine, it was determined which types of economic activity are the most resource-intensive and require investment in innovative green business technologies. The two groups include 2 GEAs with the highest values of natural and water resources intensity (D means supply of electricity, gas, steam and air conditioning and E means water supply; E means water supply; F means sewerage, waste management) and 6 SES with a total share of output of goods and services exceeding 50% of the gross output of the entire national economy (A means agriculture, forestry and fisheries; B means mining; C means manufacturing; F means construction; G means wholesale and retail trade; H means transport).

Table 1. Table of Inter-Sectoral Balance for 2021 at Consumer Prices in Million UAH.

VED	A**	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
A	79330	528	47612	41	40	647	9438	317	1209	3	0	410	29	373	817	2525	811	44	16
B	2497	12068	157821	62386	481	4975	3975	16838	220	56	20	1236	122	242	837	2245	930	189	154
C	44530	22600	395465	11488	5268	64027	57863	38990	6031	4274	1759	4911	8092	3277	5828	4881	13616	1256	1730
D	3467	16090	43551	7454	4529	1064	5446	12636	978	1717	92	8553	733	1052	2323	6365	3120	703	395
E	465	474	4921	1449	2725	1036	456	607	185	29	23	1161	112	998	520	638	619	71	82
F	707	820	2791	603	505	40216	3277	3878	185	120	60	3497	2354	717	695	162	201	158	60
G	690	379	3516	79	114	1248	12800	931	34	557	99	277	383	219	69	69	41	73	87
H	3124	6636	19905	1257	390	3113	17538	19646	162	663	325	438	802	758	2724	495	359	492	151
I	106	134	1743	253	21	551	1267	655	948	276	131	175	1121	1039	916	238	284	545	102
J	373	280	5266	471	170	682	6801	1949	279	30302	1048	844	6457	1241	2976	450	429	1173	566
K	2150	2496	14972	2210	646	4092	18250	3991	455	1243	29431	3976	4239	1091	459	271	460	343	205
L	5750	198	3585	495	146	999	14791	1015	795	1655	1397	6420	1084	447	161	169	209	482	511
M	598	1633	12554	938	254	5264	18614	1372	378	3340	2217	2307	16528	1398	923	1536	452	260	325
N	1112	929	3763	236	331	2880	3471	4149	306	650	795	2319	750	3805	0	54	122	156	156
O	48	325	957	346	74	93	760	513	49	162	100	239	126	88	597	3726	698	153	25
P	3	16	64	17	3	8	34	58	4	6	3	4	21	10	154	1040	179	31	2
Q	82	210	538	114	37	78	111	455	46	22	12	47	18	32	323	127	431	53	16
R	7	24	61	9	6	2	25	56	31	98	3	21	111	52	412	1854	385	1265	501
S	18	203	92	25	13	105	345	49	34	27	18	52	31	70	0	7	19	11	112

*Джерело: складено автором за матеріалами [64]*

The development of economic sophistication of any country is impossible without the accumulation of high-tech and knowledge-based knowledge, without the implementation of productive production strategies, especially in increasingly complex (high-tech) sectors of the economy. The country ranking developed by the Harvard Growth Lab [14], which assesses the current state of countries' productive achievements using the Economic Development Index (EDI), indicates that Ukraine was in the middle of the pack before the war (47th place in the EDI among 133 countries). In order to improve its ranking on the IER, Ukraine needs to increase the volume of high-tech products in its exports, i.e. develop economic sophistication. The Economic Sophistication Atlas also allows us to assess changes in Ukraine's export policy over previous periods and to compare it with other countries. With the outbreak of the Russian-Ukrainian war, Ukraine lost its export potential and worsened its position in the productive knowledge ranking. This low ranking is explained by the low share of participation of computer companies in the development of Ukrainian products. Ukraine's information and communications market is more focused on exporting human capital through outsourcing than on exporting the final product through product companies with established low-resource production strategies.

Thus, the study the circular economy development has established that it is the development of economic complexity by introducing production strategies for investing in low-resource innovative technologies that requires regulatory consolidation as a strategic direction for the development of the national economy, by including it in the National Development Strategy of Ukraine until 2030. The green business will facilitate the manufacturing and sale of high-tech and environmentally friendly products, and the manufacturing of clean products using clean technologies will contribute to the conservation of energy and natural resources, environmental protection and consumption of natural products. This will significantly increase both the competitiveness of goods and services and the economic complexity of exports.

Summing up the research, it is advisable to identify the green business as a real model for the future innovative development of Ukraine's economy in the direction of developing economic complexity, increasing the high-tech nature of goods and services, enhancing export diversification, increasing the export products diversity and their distribution in different countries.

## Conclusions

The study of circular economy development has shown that it is the increase in the economic complexity of products that can be achieved by implementing production strategies aimed at investing in low-resource innovation technologies. The positive impact of such production strategies on the circular economy development is also substantiated. The evolution of forming the concepts of "circular economy" and "green economy" is analysed, their features and differences are presented. A classification of scientific directions for solving the problems of the circular economy is carried out. Statistical data on the status and structure of national accounts in Ukraine are analysed. The study identified which sectors of the economy are the most resource-intensive and require the implementation of production strategies for investing in low-resource innovative technologies of the circular economy. The two groups include two sectors with the highest resource intensity of natural and water resources (D means supply of electricity, gas, steam and air conditioning; E means water supply; F means sewerage, waste management) and 6 sectors with a total share of output of goods and services exceeding 50% of the gross output of the entire national economy (A means agriculture, forestry and fisheries; B means mining; C means manufacturing; F means construction; G means wholesale and retail trade; H means transport). Using the inter-sectoral balance table (Leontief's model), the article establishes that green business is a real (achievable) model of innovative recovery of Ukraine's economy as a result of the Russian-Ukrainian war. The work novelty is the use of the input-output table to assess the resource intensity of all types of economic activity and to

identify production strategies necessary for developing green business and economic recovery due to the destruction caused by the consequences of the Russian-Ukrainian war.

It is proposed to include in the National Development Strategy of Ukraine a strategic direction, i.e. economic complexity development by introducing production strategies for investing in low-resource innovation technologies of the circular economy.

### Abstract

The study of economic complexity tools is gaining increasing popularity among scientists, economists, politicians, and environmentalists. Over the last decade, new research areas into economic complexity have emerged, particularly introducing innovation technologies into production processes capable of reducing resource consumption. Such reductions decrease the negative impact of economic activity on the environment and population while enhancing consumer needs satisfaction for high-tech products despite constraints on certain resources, including oil, gas, and agricultural products. This research relevance lies in the need to identify the ways to increase the economic efficiency and competitiveness of enterprises and economies through the development and implementation of innovative production processes that reduce the use of resources (raw materials, energy, water, etc.) and mitigate the negative impact on the environment.

The study on the circular economy development establishes that increasing the economic complexity of products can be achieved through production strategies aimed at investing in low-resource innovation technologies. The positive impact of such production strategies on the circular economy development is substantiated. The concepts evolution of "circular economy" and "green economy" analysed, and their features and differences are highlighted. The scientific approaches classification to addressing the circular economy problems is provided. Statistical data on the state and structure of national accounts in Ukraine are analysed, identifying the most resource-intensive sectors of the economy that necessitate the production strategies implementation for low-resource innovation technologies of the circular economy. The analysis has revealed two groups: two economic sectors with the highest resource intensity of natural and water resources (D means supply of electricity, gas, steam, and air-conditioning, and E means water supply; sewerage, waste management) and six sectors accounting for more than 50% of the gross output of the national economy (A means agriculture, forestry, and fisheries; B means mining industry; C means processing industry; F means construction; G means wholesale and retail trade; H means transport). Using the inter-industry balance table (Leontiev's model), it is established that green business is a feasible model for the innovative recovery of Ukraine's economy in the aftermath of the Russian-Ukrainian war. The novelty of this work lies in applying the "cost-output" table to assess the resource intensity of all types of economic activity and to determine the production strategies necessary for the development of green business and economic recovery due to the destruction caused by the Russian-Ukrainian war.

It is proposed to include in the National Development Strategy of Ukraine a strategic direction focused on developing economic complexity through the implementation of production strategies investing in low-resource innovative technologies of the circular economy.

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