Anastasiia Tsybuliak
Doctor of Economic Sciences,
Professor at the Department of International Economics,
Business and Management
Private Higher Educational Establishment-Institute
«Ukrainian-American Concordia University»

Цибуляк А.Г.
доктор економічних наук,
професор кафедри міжнародних економічних відносин,
бізнесу та менеджменту
Приватного вищого навчального закладу-інституту
«Українсько-американський університет Конкордія»
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GREEN TECHNOLOGIES AS THE BASIS OF INNOVATIVE DEVELOPMENT IN THE SUSTAINABILITY PARADIGM

ЗЕЛЕНІ ТЕХНОЛОГІЇ ЯК ОСНОВА ІННОВАЦІЙНОГО РОЗВИТКУ В ПАРАДИГМІ СТАЛОСТІ

The green economy aims to use resources sustainably and reduce the negative impact on the environment. At the same time, its goal is not to limit or even reduce economic growth, but rather to restructure the economy in such a way as to "fit" it into the framework of the planet's natural capabilities. "A green economy is an economic system aimed at achieving environmental sustainability and improving the quality of life of people, based on the use of environmentally friendly and energy-efficient technologies, products and services and the principles of environmental responsibility in business and public life. It stimulates innovation, ensures interaction between government, business and society and is aimed at achieving economic growth without harming the environment.

Achieving greener economic growth requires both a policy of "green" innovation and support in the form of targeted industrial and environmental policies to create demand where traditional external factors are not fully reflected in market prices. The challenge is to integrate innovation and environmental policy by ensuring well-balanced combinations of policy measures to support advanced innovation, innovation catching, technology application and diffusion, and domestic technology application.

The change of technological cycles is associated with the development of new means of communication, digital networks, computer programs and genetic engineering. The beginning of each cycle is characterized by an

economic upswing, while the end is characterized by a decline [1–4]. Due to the acceleration of scientific and technological progress, a number of waves of scientific and technological revolutions intersect in time, and the interaction of information technology, biotechnology, nanotechnology and cognitive science (NBIC technologies) is especially significant. The concept of Industry 6.0 manifests itself through: intelligent automation and production systems; sustainable development and green technologies; human-machine interaction, ethics and emotional intelligence; information technology and cybersecurity; machine learning and AI in various sectors. Industry 6.0 goes beyond traditional technological revolutions, representing a new generation of industry, controlled by generative AI and a swarm of heterogeneous robots, and unites a wide range of advanced technologies and innovative approaches [5]. Unlike Industry 4.0, which focuses on technological revolution and automation, and Industry 5.0, which focuses on human-centricity and sustainable development, Industry 6.0 is aimed at global environmental sustainability and intelligent transformation.

Green technologies are technologies based on the convergence of nanotechnologies, biotechnologies, information technologies, and cognitive technologies. They are innovative in nature, contribute to improving the environment by reducing the negative impact on it and, as a result, improve public health. Research in the field of nanotechnology is carried out in four main areas: better understanding of the nature of the nanolevel, ensuring the development of knowledge; economic and social innovations that allow for tangible progress in this area; development of international cooperation to ensure sustainable growth of nanotechnologies; cooperation to implement equal management and control over processes, guaranteeing the settlement of all moral issues.

Green technologies have such features as safety, resource efficiency, environmental friendliness, correspond to the processes of convergence of socio-economic relations, which contribute to the evolution from more primitive methods of production, accumulation and consumption to more economical, intellectually intensive, energy-efficient and socially adapted ones. Green technologies and green services are classified into different categories, including: energy technologies; technologies for saving, recycling and producing water from renewable sources; environmental and pollution-preventing devices and services (waste management, disposal and recycling; disposal and recovery of toxic waste; emission control) [6].

In essence, any measures to reduce the resource intensity of materials and design, not necessarily high-tech, can have a significant positive impact on environmental quality. The future is expected to see the development of a wide range of technologies aimed at increasing the efficiency of transport (e.g., highly efficient, virtually self-driving cars, lighter aircraft) and new building materials. This will be facilitated by the combined use of NBIC technologies, as well as further progress in miniaturization of products. Great

hopes are placed on biotechnology (especially in the field of environmental restoration, including its purification from heavy metals and chemicals) and nanotechnology in agriculture and energy (e.g., in the production of LEDs, nanocoatings for energy storage and production, deep-sea drilling, and in buildings). Further technological progress is predicted in transport equipment and services. Breakthroughs are expected in the field of energy storage devices, which play a special role in the development of renewable energy, as it allows these types of energy to be stored and used over time. The lack of such opportunities today seriously limits progress in the development of solar and wind energy.

An important area of green technology development is "smart cities", which help reduce the severity of urbanization problems. The concept of their creation involves the widespread use of information and communication technologies that will create optimal systems of transport, energy supply, buildings and structures, healthcare, etc., as well as apply universal technologies for various areas of urban economy.

Creating an ecosystem for startups is a prerequisite for the growth of the number of internal "green" innovations. There is a rather complex and long path between the invention and the receipt of innovative products and technologies. Effective legal regulation and institutions, venture funds, support for the commercialization of products and access to markets are needed. Currently, most innovations are the result of long-term corporate investments, and market barriers to the implementation of innovations are high. In the context of geoeconomic confrontation, the implementation of a green transition can be difficult.

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