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Організація Об'єднаних Націй з промислового розвитку

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THE INFLUENCE OF GLOBAL TRENDS ON THE DEVELOPMENT OF THE THEORY OF ECO-INDUSTRIAL PARKS

ВПЛИВ ГЛОБАЛЬНИХ ТЕНДЕНЦІЙ НА РОЗВИТОК ТЕОРІЇ ЕКО-ІНДУСТРІАЛЬНИХ ПАРКІВ

The article examines the influence of global trends on the development of the theory of Eco-industrial parks. Addressing the impact corresponds to the Global Goals of Sustainable Development and will allow the formulation of legislative initiatives for the development of Eco-industrial parks for the post-war recovery of Ukraine's economy. Implementation of the theory of Eco-Industrial Park development can include the development of the territory with the preservation of local natural features, the attraction of companies that strive for high efficiency of use of resources and low level of pollution, management to support financial, environmental and social success, as well as strong ties with surrounding communities through economic development, social and environmental programs. Positive factors of influence in favor of the use of the theory of Eco-industrial parks for the recovery of the economy of Ukraine were determined.

Key words: Eco-industrial park (EIPs), industrial symbiosis (IS), sustainable development, environmentally friendly production, energy efficiency.

У статті досліджується вплив глобальних тенденцій на розвиток теорії Еко-індустріальних парків. Вирішення впливу відповідає Глобальним цілям сталого розвитку та дозволить сформулювати законодавчі ініціативи з розвитку Еко-індустріальних парків для післявоєнного відновлення економіки України. Було проаналізовано досвід Сполучених Штатів, Канади, країн Європи, Азії та Південної Африки. Було визначено, що Еко-індустріальні парки зосереджуються на таких принципах, як енергоефективність, замкнуті цикли використання матеріалів і промисловий симбіоз, який передбачає взаємодіючі системи, а не ізольовані компоненти. Реалізація теорії розвитку Еко-індустріальних парків може включати розвиток території зі збереженням місцевих природних особливостей, залучення компанії, які прагнуть високої ефективності використання ресурсів і низького рівня забруднення, управління для підтримки фінансового, екологічного та соціального успіху, а також міцні зв'язки з навколишніми громадами через економічний розвиток, соціальні та екологічні програми. Було встановлено, що теорія Еко-індустріальних парків розвивалась на протязі останніх десятиліть під впливом різних глобальних тенденцій, включаючи значущі події, такі як Енергетична криза, Третя промислова революція, Велика тихоокеанська сміттєва пляма, Четверта промислова революція, Криза глобальних поставок через COVID-19 і російсько-українська війна. Було визначено позитивні чинники впливу на користь використання теорії Еко-індустріальних парків для відновлення економіки України. До них відносяться: сталість виробництва, ефективне використання ресурсів, мінімізація відходів, зменшення негативного впливу на навколишнє середовище та екологічна чистота і соціальна відповідальність, залучення інвестицій, енергоефективність, розвиток новітніх технологій та інновації виробництва, використання міжнародного досвіду. Теорія Еко-індустріальних парків може бути доцільною для відновлення економіки України в післявоєнний період, оскільки це буде сприяти сталості, інвестиціям, збереженню довкілля та впровадженню інновацій.

Ключові слова: Еко-індустріальний парк (ЕІП), індустріальний симбіоз (ІС), сталий розвиток, екологічно чисте виробництво, енергоефективність.

Problem statement. The development of the theory of eco-industrial parks is an important branch of modern science and practice in the field of sustainable development and environmental protection, which corresponds to the Global Goals of Sustainable Development. Eco-industrial parks (EIPs) are an innovative model of industrial parks that strive to combine efficient production activities with minimization of negative impact on the environment and conservation of natural resources. Determining the impact of global trends will make it possible to formulate legislative initiatives for the development of the EIPs for the post-war recovery of Ukraine's economy.

Analysis of recent research and publications. According to the research results, industrial development took place according to the classical model, the main goal of which was to overcome economic problems and technological progress [1]. Later, the production model was influenced by the availability of transport infrastructure and strategic nodes, which led to the delocalization of supply chains.

However, with the depletion of natural resources, the need for sustainable development and well-being of the world population has become extremely important. Eco-industrial parks began to be considered as a tool for solving these needs by combining environmental goals with economic ones. EIPs were defined as "Communities of manufacturing and service enterprises that seek to improve environmental and economic performance through cooperation in managing environmental and resource issues" [2]. This definition of "Eco-industrial park" is based on the work of the Indigo Development team in 1992 and then expanded for the US Environmental Protection Agency in 1995 [1].

Cote et al. defined EIP as "An industrial system that conserves natural and economic resources, reduces the cost of production, used energy, and processing costs, improves work efficiency, quality, health of workers, public image and generates income from the use and sale of waste" [3].

In parallel with the scientific school of Lowe [4], the concept of eco-industrial parks was further developed, as a combination of the concepts of industrial parks and engineering ecology, in the studies of R. P. Côté and E. Cohen-Rosenthal [5]. According to their definition, an Eco-industrial park is "An industrial system that conserves natural and economic resources; reduces production, materials, energy, costs and liabilities; increases efficiency and quality of work, the health of employees and public image; and provides opportunities to generate income from the use and sale of waste materials" [5]. In their work, the researchers for the first time focus on the need to create an eco-system of industrial symbiosis inside the industrial park for the possibility of its transition to the category of eco-industrial parks [6]. The main difference from Lowe's scientific school is in determining the position of industrial ecology in the system of eco-industrial parks as a leading one. This position is considered incomplete and the existing shortcomings regarding the priority of engineering ecology within the framework of eco-industrial parks are proven. For example, in the study of Gibbs D. and Deutz P., a discrepancy between the principles of engineering ecology (EE) in the framework of eco-industrial parks and reality is noted [7]. This discrepancy is at the heart of the difficulty of implementing EE, which is possible in the case of cooperation between economic

entities within the framework of Eco-industrial parks. In the conditions of a market economy, economic entities cannot implement the principles of EE, which is essentially a link of waste management, without appropriate licensing. The national regulation in the field of waste management creates additional complexity in terms of the actual implementation of the concept of eco-industrial parks, which has priority over the principles of EE. At the same time, the advantages of the concept associated with the implementation of waste reuse gave impetus to further research. The optimization of resource flows within the Kalundborg Eco-industrial Park was described in the Chertow study and developed into the concept of industrial symbiosis (IS) [8]. Since then, industrial symbiosis has been adopted by several private initiatives and public policies around the world as a way to reduce the environmental impact of agglomerated industrial production.

The USA experience in implementing the concept of industrial symbiosis within eco-industrial parks highlights that government support is crucial at the initial stage of EIP implementation. The level of ongoing government involvement directly or indirectly (government policies or tax incentives, increased social pressure) leads to incentives for EIP implementation [9].

Among other scientific schools, the concept of an eco-industrial park with a common waste management system was developed, which was studied R. R. Heeres, W. J. Vermeulen, and F. B. Walle [10]. This concept is justified by higher economic feasibility because the initial development of the EIP in the Dutch cases focused on the creation of pollution prevention projects with the nature of shared utility infrastructure.

Yu F., Han F., and Cui Z the study found that the impact of policies varies across regions in the PRC, and there is no one-size-fits-all approach to promoting IS. For example, in the countries of the European Union, policies have a positive effect on the development of IS through indirect incentives [11].

Formulating the purposes of the article. The purpose of the article is to determine the impact of global trends on the development of the theory of Eco-industrial parks.

To achieve the set goal, the following tasks were solved in this article:

- the analysis of research on the theories of eco-industrial parks was carried out;
- determination of the main stages of development of the modern theory of Eco-industrial parks.

Methodology. In the study, the authors used a systematic approach to the analysis of research on the theories of Eco-industrial parks and used general economic and specific methods of scientific knowledge, including the method of analysis, synthesis, deduction and others.

Presentation of the main research material. Governments, businesses and society are increasingly looking to EIP as they address waste and emissions management issues. Key components of this approach include green design of park infrastructure and plants, clean manufacturing, pollution prevention, energy efficiency and partnerships between companies. EIPs are also intended to benefit neighboring communities to ensure a positive net impact on their development.

Since the early 1990s, numerous experiments have been carried out in the United States, Canada, Europe, Asia, and South Africa, and EIPs have attracted widespread attention

since their theorization, as they are considered a viable alternative to traditional industrial parks worth investing in various interesting practices.

A publication of the Asian Development Bank in 2001 reads as follows: "Eco-industrial park is a community of manufacturing enterprises located together on a common territory. Businesses seek to improve environmental, economic and social performance through cooperation in managing environmental and resource issues. By working together, a community of companies seeks to achieve a collective benefit that is greater than the sum of the individual benefits that each company could achieve just by optimizing its performance".

The concept of Eco-industrial parks was first proposed in the 1970s but gained popularity in the 1990s. Initiatives in this direction have received support from various international organizations, such as the UN and the European Commission. The theory of Eco-industrial parks is based on such principles as industrial symbiosis, energy efficiency, water resources management, emission reduction and the use of alternative energy sources.

For example, in South Korea, IS is part of a national program to implement EIPs, launched in 2005. The program defines eco-industrial parks as industrial parks in which the IS concept is implemented. South Korea has about 1,000 industrial complexes that have fueled rapid economic growth over the past 50 years, but have also been a source of environmental problems. To restructure the national industrial base, the Korean government has developed a three-stage, 15-year plan to convert existing industrial complexes into EIPs. Thanks to the active participation of the government, the institutional approach adopted in the first phase of the Korean EIPs program has successfully initiated the development of industrial symbiosis networks in five pilot sites. During the first five years of piloting, between 2005 and 2010, the program delivered economic and environmental benefits through the development and implementation of 47 IS projects at five pilot sites. Economic benefits from cost savings and profit generation reached US\$189 million. The second phase of the program is still ongoing.

Another example is the Japanese Eco-Town program. Japan has integrated IS into its national urban development policy to maximize economic and environmental benefits from the proximity of industrial and urban areas. Benefits are generated through the reuse of commercial, municipal and industrial waste at the city level. 26 cities throughout Japan were involved in the program. Approximately US\$1.65 billion was invested in 61 innovative waste recycling projects with an average government subsidy of 36%, and 107 recycling plants were built without government subsidy.

The USA experience in implementing the concept of industrial symbiosis within eco-industrial parks highlights that government support is crucial at the initial stage of EIPs implementation. The level of ongoing government involvement directly or indirectly (government policies or tax incentives, increased social pressure) leads to incentives for EIPs implementation.

The infrastructure and planning of Eco-industrial parks are created taking into account the optimal location of enterprises to maximize the synergy between them. This involves sharing resources, transport systems, green areas [12].

The development of the theory of Eco-industrial parks is important for achieving sustainable development and preserving the environment. It requires the integration of scientific research, technological innovation and interaction between businesses and the public sector to create more efficient and sustainable industrial systems.

Eco-industrial parks are based on the sciences related to sustainable development, with industrial ecology as the main discipline supporting the implementation of EIPs. These parks focus on principles such as energy efficiency, closed material cycles and industrial symbiosis, which involves interacting systems rather than isolated components. China's circular economy (CE), introduced in 1998, integrates clean production and industrial ecology into a broader system that encompasses industrial firms. EIPs implementation may include developing the area while preserving local natural features, attracting companies that seek high resource efficiency and low pollution, managing to support financial, environmental and social success, and strong links with surrounding communities through economic development, social and environmental programs.

An approach to ecological planning for the implementation of EIPs, mainly built into the spatial dimension, is proposed. Landscape ecology, a new perspective, focuses on "spatial patterns intertwined with processes and changes" and can be applied to environments with intense anthropogenic disturbance. Both disciplines are deeply rooted in the idea of sustainable development and pay special attention to environmental and ecosystem issues related to EIPs development. Ecosystem factors related to metabolic processes dominate EIPs implementation, and some environmental scientists propose different taxonomies of Eco-industrial parks based on material exchange or symbiotic relationships between firms.

The theory of Eco-Industrial Parks has evolved over the past decades under the influence of various global trends, including significant events such as the Energy Crisis, the Third Industrial Revolution, the Great Pacific Garbage Patch, the Fourth Industrial Revolution, the global supply crisis due to COVID-19 and the Russian-Ukrainian war. A brief overview of the impact of each of these events on the development of EIP theory is provided below:

Energy crisis:

Energy crises, particularly fuel and energy crises, have highlighted the importance of developing more efficient and environmentally friendly production processes.

Consumers and businesses have shown interest in reducing dependence on limited energy sources, which has prompted the adoption of green technologies in industry.

The Third industrial revolution:

Concepts of the Third Industrial Revolution, proposed by Jeremy Rifkin, emphasized the importance of creating sustainable energy systems and the development of the "Internet of Things" to optimize production processes.

This revolution influenced EIPs theory, emphasizing the importance of digital integration and sustainable production.

The Great Pacific Garbage Patch:

The discovery of the Great Pacific Garbage Patch has highlighted the need to reduce waste and plastic pollution.

The EIPs theory has become more focused on reducing the negative impact of production on the environment and the use of secondary resources.

The Fourth Industrial Revolution:

The introduction of information technologies, artificial intelligence and the Internet of Things into production has contributed to the development of eco-industrial parks through increased automation, efficiency and process monitoring.

This revolution has increased interest in the development of innovative, technological and green production processes.

Global supply crisis due to COVID-19:

The COVID-19 pandemic has highlighted the importance of resilience and distributed production chains.

EIPs theory has encouraged businesses to find ways to reduce the risk of supply chain disruptions through more flexible and sustainable production processes.

Russian-Ukrainian war:

Geopolitical conflicts can affect energy security and resource allocation, putting the sustainability of production processes and supply chains at risk.

Thus, in the history of the development of the modern theory of EIPs, the economic category "Eco-industrial parks" was formed as a result of the Third Industrial Revolution and developed in two directions: EIPs with a common waste management system and EIPs with Industrial Symbiosis. As a result, under the influence of technological development, Industrial Symbiosis has become more in demand in the modern world and provides opportunities for the development of a sustainable business model within the EIPs.

Conclusions. In general, the development of the theory of Eco-industrial parks took place under the influence of global trends and challenges that emphasized the importance of sustainable production, the development of new technologies and the preservation of the environment in the face of growing social, ecological and economic challenges. The choice of the most appropriate theory of Eco-industrial parks for the recovery of Ukraine's economy in the post-war period should be based on several factors,

such as specific requirements and features of the country, scientific justification, historical context and needs of society. Here are some arguments in favor of using the theory of Eco-industrial parks to restore the economy of Ukraine:

- the development of Eco-industrial parks contributes to sustainable development, as it includes efficient use of resources, minimization of waste and reduction of negative impact on the environment. This stimulates the stability of production and ensures the long-term development of the economy;

- the development of Eco-industrial parks contributes to the improvement of the quality of the environment and takes into account the social aspects of production. This is important for restoring ecology and improving the quality of life of the population in the post-war period;

- economic recovery requires significant investments. The concept of eco-industrial parks can be attractive to investors because it demonstrates a commitment to sustainability and long-term success;

- the use of efficient production processes and the reduction of resource losses can lead to a reduction in energy and raw material costs, which contributes to increasing the competitiveness of enterprises and the economy in general;

- the development of Eco-industrial parks includes the development of the latest technologies and innovative approaches to production. This can contribute to the creation of new markets and the growth of the production of high-tech goods and services;

- many countries have already successfully used the concept of Eco-industrial parks to develop a sustainable economy. Studying and adapting this experience can be useful for Ukraine.

In general, the theory of Eco-industrial parks may be appropriate for the recovery of Ukraine's economy in the post-war period, as it promotes sustainability, environmental protection and social responsibility, and can also attract investment and promote innovation. However, it is important to develop specific strategies by the conditions and needs of Ukraine.

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