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Innovative and Investment Activities of Enterprises within Eco-Industrial Parks in the Circular Economy Context

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ABSTRACT

The purpose of the study is to substantiate the effectiveness of innovative and investment activities of enterprises within the functioning of eco-industrial parks in the circular economy context. The methodological basis of the research is system and synergistic approaches, the application of which makes it possible to study innovation and investment activities of enterprises that are part of the eco-industrial park as certain subsystems, which in the end, as components of the park, provide a synergistic effect. It is substantiated that the unification of production enterprises within eco-industrial parks consists in a more integrated interaction of enterprises, including through joint investment. The proposed methodical approach to calculating the efficiency of innovation and investment activity of enterprises included in eco-industrial parks and its approval proves the possibility of obtaining a positive effect from investment activities and investment in innovative projects by enterprises united in eco-industrial parks in the context of the circular economy. The analysis of the share of production enterprises that implement innovations, as well as the share of the volume of innovative products sold to the total volume of manufacturing enterprises prove the need to intensify the innovative activity and the introduction and development of eco-industrial parks. The advantages of innovation and investment activities within eco-industrial parks in the circular economy context are highlighted.

1. INTRODUCTION

The idea of developing eco-industrial parks is not new in many countries of the world. However, current conditions of global escalation and the increase in the resources cost make the issue of their development even more relevant. Industrial and eco-industrial parks are centers of attraction of investment resources and centers of high technologies and innovations. The innovative and investment strategy of development, taking into account modern global challenges, acquires a new direction in the direction of improving the quality of life, preserving the environment and ensuring the achievement of sustainable development goals due to more rational use of resources, minimizing the burden on the environment in accordance with the principles of the circular economy.

Eco-industrial parks become the basis for the development of industrial production, as the concentration of companies promotes the attraction of investments and the development of innovations, economies of scale of production reduce the costs of enterprises united in eco-industrial parks, thereby contributing to the development of regions and national economies as a whole.

The issue of the development of eco-industrial parks is relevant for all countries, because in some countries where the rapid development of industrial parks was observed, despite the existing regulatory provisions regarding the impact on the environment, many relaxations were allowed, which over time exacerbated problems with water supply, wastewater treatment, and emissions into the atmosphere, accumulation of waste, etc.

So, for example, for Ukraine, on the territory of which military actions are taking place as a result of the aggression from the Russian Federation, the issue of the development of eco-industrial parks is an urgent issue. This is due to the fact that the destruction of production facilities has already occurred and continues to occur, the access to raw materials is becoming more difficult, channels and logistics routes of its supply are changing, the workforce is moving and business relocation is taking place. According to official data, during the hostilities in Ukraine, 70% of production enterprises reduced or stopped production altogether. The largest number of such enterprises was located

in the industrially developed areas of the Eastern part of Ukraine. One of the ways to preserve and modernize the production potential is the spread of eco-industrial parks. This will make it possible to protect industry from transferring production capacities abroad, stop the process of production decline, and preserve the country's personnel potential.

The outline conditions the problems of the development of eco-industrial parks and the emphasis on innovation and investment activities of the enterprises of its participants.

Due to the entry into the eco-industrial parks, the enterprises included in them will be able to:

- take advantage of favorable location conditions through the use of production and storage facilities, since eco-industrial parks have ready-made production facilities certified in accordance with international standards with the provision of appropriate communications, capacities and environmental safety;
- optimize costs due to transportation and logistics connections, since cooperation within eco-industrial parks makes it possible to create joint supply chains, send products through logistics centers, expand the range of consumers of manufactured products;
- get a connection to engineering networks, increase the efficiency of the use of energy resources;
- reduce management costs and administrative costs due to the performance of the functions of the management company;
- obtain quality services, such as security, cleaning, selection of the necessary qualified personnel;
- increase the efficiency of attracting investment resources in innovative projects;
- optimize production waste using principles of circular economy, etc.

The purpose of the study is to substantiate the effectiveness of innovative and investment activities of enterprises within the functioning of eco-industrial parks in the circular economy context. Achieving this goal became possible thanks to substantiating the feasibility of the study, especially for Ukrainian enterprises that may be relocated from the eastern part to the central and western part as a result of military operations on the territory of Ukraine because of the aggression of the Russian Federation; proving the effectiveness of innovative activities of enterprises of eco-industrial parks in the circular economy context.

2. LITERATURE REVIEW

In today's globalized environment, more and more attention is paid to issues of sustainable development. The study of various aspects of the ecological component of sustainable development is gaining extreme relevance and timeliness. That is why the study of innovation and investment activities of enterprises within eco-industrial parks in the context of the circular economy is an important and timely study that requires the analysis of existing approaches, the identification of problematic aspects and prospects.

Many scientific publications of domestic and foreign scientists are devoted to the issues of innovation and investment activity of enterprises. Based on the results of the analysis of available publications in the Scopus database, 571 articles with the keywords "innovative and investment activity of enterprises" were published (Figure 1).

Publications began in 1991 and have positive dynamics to this day. Considering the dynamics over the last ten years, the following publication activity is observed: 2022 – 33 articles, 2021 – 51 articles, 2020 – 64 articles, 2019 – 66 articles, 2018 – 66 articles, 2017 – 64 articles, 2016 – 60 articles, 2015 – 39 articles, 2014 – 18 articles. The countries where scientific publications on this topic are concentrated are: Ukraine, China, Poland, England, USA, Germany, Italy, Kazakhstan, Czech Republic, Spain, Slovakia and others. Analyzing publishing activity by field of knowledge, the following should be noted: Economics (201 articles), Management (162 articles), Business (118 articles), Business Finance (56 articles), Multidisciplinary Sciences (26 articles) etc.

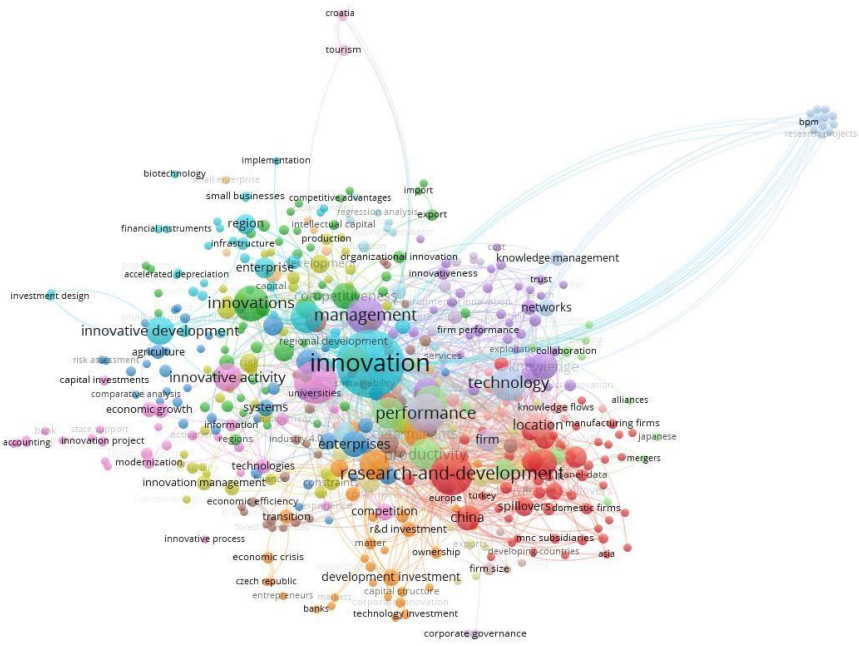

Figure 1. Graphic map of keywords in publications, in which titles the word “Innovative and Investment Activities of Enterprises” is met

Source: compiled by the author based on the analysis of the Scopus database and using the tools of the VOSviewer program

Based on current research by scientists, the authors of the article [1] analyzed the problems of increasing investment activity and determined the influence of investment activity on the innovative activity development of industrial enterprises. The scientist proposed an algorithm for the model of the innovative activity development, within which the groups of indicators are defined according to the criteria of the economic and informational component of the innovative activity model of industrial enterprises.

The study [2] analyzed the current state of scientific, technical and innovative activity in Ukraine, which shows a significant lag behind developed countries. The authors of the article claim that the formation of effective management of the innovative activity of construction enterprises, its strengthening, deployment must begin with the assessment of the influence of external environmental factors on the effectiveness of management activities regarding the formation and use of the innovative potential of the construction enterprise.

Unlike existing approaches, within the framework of the study [3], fundamental problems of the innovative activity as a factor of strengthening economic security of the enterprise in the conditions of globalization and integration of the world economic space are defined. The authors have developed the structure of the management process of innovatively active enterprises, taking into account aspects of the activity safety.

In the course of the paper [4], the current state, problems were analyzed and directions for ensuring the innovative activity of the food industry producers of Ukraine were substantiated. Based on the results of the analysis, the authors identified priority directions and levers of their influence on increasing the innovative activity of food producers in the conditions of the pandemic. Scientists have outlined the problem of ensuring innovative development based on a systemic approach and synthesis of innovative development mechanisms.

Within the framework of studies [5-7] a system for evaluating the effectiveness of the sustainable development strategy of the enterprise in the conditions of decentralization is proposed, the process is outlined for the formation of entrepreneurship of sustainable development, aspects of the formation of the perception and vision of business entities from the border zone are revealed.

The authors of studies [8, 9] investigate marketing communications as a factor of sustainable development, analyze economic and legal aspects of the network readiness of Ukrainian enterprises in the business improvement context, reveal the peculiarities of the management of foreign economic activities of enterprises in the context of sustainability. It is analyzed by scientists [10, 11]. The ecosystem of the VAT administration and assessment of spatial problems of the economic security system of industrial enterprises is provided.

The article [12] is based on the determinants of direct investment in Great Britain by technologically intensive Chinese state-owned enterprises. The authors examine the ways in which investment strategies are used to enter the UK and gain the access to technology.

The scientists [13] analyzed the results of material investments in the enterprises of the Lesser Poland Voivodeship of Poland, in two groups of entities — those that implemented investments at the expense of EU subsidies, and those that financed investments from other sources without using EU aid. The authors consider their study to be unique in the field of analysis and presentation of investment data in enterprises, especially in relation to the companies using EU funds.

Given the existing research, the authors of the article [14] believe that enterprises need to constantly investigate the innovative ability of investment activities, choose competitive investment projects, and constantly increase awareness of investment risk control. Scientists believe that it is necessary to adhere to the investment regime based on the equity capital investment, and to fully use the capabilities of investment intermediaries to achieve effective investment value.

Practical aspects of the functioning of enterprises as part of eco-industrial parks take into account the modern development of the circular economy, which is gaining more and more relevance among the researches of scientists. In Figure 2 presents an analysis of the publication activity of scientists from all over the world, who investigated the issue of the activity of eco-industrial parks in the context of the circular economy. There are not many studies in this direction (according to the Scopus database, 26 articles), the first article appeared in the Scopus database in 2014. Further, publication activity looked as follows: 2015 – 1 article, 2016 – 2 articles, 2017 – 3 articles, 2018 – 5 articles, 2019 – 5 articles, 2020 – 2 articles, 2021 – 5 articles, 2022 – 2 articles.

The world centers of scientific research in the field of eco-industrial parks, based on the results of the Scopus database, are: China, Brazil, England, Italy, the USA, Australia, France, etc. (Figure 2).

Thus, within the functioning of eco-industrial parks [15], the authors present a new modeling structure that allows for designing and evaluating the exchange of materials and energy in an industrial ecosystem. In this scalable model, an algorithm to balance material and energy exchanges and determine optimal inputs and outputs based on the objectives of the industrial symbiosis and the participating industries was developed.

The authors [16] are convinced that eco-industrial parks can play a positive role in reducing the consumption of natural resources and environmental pollution through cyclical economic development, improving the ecological environment and increasing the potential for sustainable development of economic development zones. Scientists analyze the circular economic sustainability of economic and technological development using a three-component diagram. The research findings argue that industrial parks can be scientifically designed to improve the structure, functioning and efficiency of the park's complex ecosystem.

Scientists [17] prove that the policy in the European Union's countries and in the territories of France had a positive effect on the introduction of eco-industrial parks by establishing a set of measures to develop the productivity of industrial symbiosis.

Considering the existing research of scientists, the authors investigated [18] that circular economy is recognized as an effective practice of the global sustainable development. An eco-industrial park is considered an ideal model for circular economy, which is associated with the dynamic flow of energy and materials, as well as the networking of the production and consumption process.

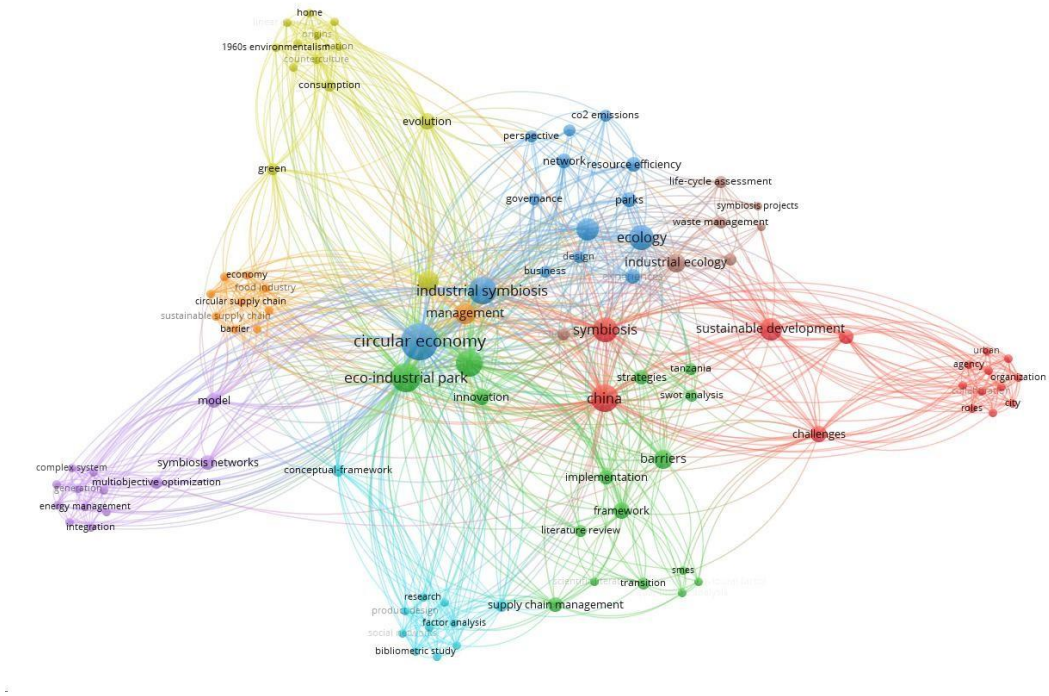

Figure 2. Graphic map of keywords in publications, in which titles the word "Eco-industrial Parks in the Context of Circular Economy" is met

Source: compiled by the author based on the analysis of the Scopus database and using the tools of the VOSviewer program

Scientists [19] believe that in order to preserve the natural environment, circular economy is a suitable way to transition from current economic models to the models of a more sustainable nature. However, from a biological point of view, industrial systems, according to the authors, are inefficient.

We agree with the study of scientists [20], which outlines solutions to the growing conflicts between economic growth, resource scarcity, and environmental degradation, and argues that the eco-industrial park is becoming an important research issue for achieving sustainable development and circular economy. Scientists have proposed a hybrid structure for evaluating the complex benefit of eco-industrial parks from the point of view of cyclical economy and sustainability.

Scientists [21] highlight an excellent strategy of focusing efforts on existing industrial parks, transforming them into eco-industrial parks. The authors present three case studies and highlight related management challenges, such as overcoming backlashes and exploiting network advantages. Ways to improve the technology of product supply chain management in the context of the development of multimodal transport systems are also proposed [22].

However, despite a large number of publications, the study of innovation and investment activities of enterprises within eco-industrial parks in the circular economy context is becoming increasingly relevant and requires further research.

3. METHODOLOGY

We will analyze the effectiveness of innovative and investment activities of enterprises when entering an eco-industrial park for an enterprise that can be both relocated to this region and a local enterprise that previously operated outside the park in the circular economy context. Enterprises (f) that are united by the management company in eco-industrial parks are presented in the form of:

$$f \in F\left\{1,2,...,f^n\right\} \quad (1)$$

where, n – number of such enterprises (f),

Businesses operate in a certain period of time t:

$$t = 0,1,2,...,t^n \quad (2)$$

where, $t = 0$ – this is the previous period of operation of the production enterprise before entering the eco-industrial park;

t^n – n-th time period of operation of the enterprise within the park.

In the previous period, the enterprise had certain indicators that will be used in the model as basic (preliminary) indicators of a specific enterprise, namely:

- R_{f0} – volume of sales of production products;
- C_{f0} – overhead;
- P_{f0} – net profit of the enterprise;
- U_{f0} – loss of the enterprise (if available);
- Q_{f0} – changes in working capital;
- A_{f0} – depreciation, which includes a part of depreciation, which is directed to innovations.

Uniting enterprises into eco-industrial clusters provides an opportunity for joint interaction regarding innovation and investment projects, i.e. the same project can have not one, but several implementation options.

Suppose that investment and innovation projects (i) are presented in the form:

$$i \in I = \left(1,2,\ldots,i,\ldots,m\right) \quad (3)$$

where, m – certain number of innovation and investment projects;

i – investment and innovation project.

An innovation-investment project can start in a certain period ti. Accordingly, from the beginning of such project implementation in the first year, we get τ = 1, and the costs (*K*) of such a project for enterprise (*f*) will correspond to the following:

$$K_{fi\tau} \le K_{fi\tau 0} \tag{4}$$

where, $K_{fi\tau}$ – initial costs of the enterprise for the innovation and investment project;

$K_{fi\tau}$ – costs of the enterprise for the innovation and investment project, which can be reduced under the condition of entering the eco-industrial park.

In addition to project costs, other indicators such as:

- $a_{fi\tau}$ – part of the depreciation, which is directed to the i-th innovation and investment project;
- $B_{fi\tau}$ − profit of the enterprise before the payment of the interest of the tax deduction;
- $M_{fi\tau}$ −loss of the enterprise before the payment of tax deduction interest (the appearance of which must also be taken into account when calculating the implementation of innovation and investment projects);
- $R_{fi\tau}$ – volume of sales of production products under the conditions of the implementation of the ith innovation-investment project.

The i-th project is realized under the condition:

$$t_i + \tau_i - 1 \le T. \tag{5}$$

The selected parameters, as well as the discount rate (*d*), provide the calculation of the net discounted income (NPV_i), where:

$$d_t = \frac{1}{(1+d)^{(t-1)}} \tag{6}$$

The synergistic effect can also be obtained not only as a result of the use of the company's finances, but also as a result of the use of more modern technologies possessed by the enterprises included in the eco-industrial park.

For the enterprise, the implementation or rejection (*Y*) of the i-th innovative investment project for a certain period t is presented as:

$$\sum_t Y_{it} \le 1, i \in I, t_i \le t \le T - \tau_i + 1. \tag{7}$$

Since within the boundaries of the eco-industrial park, as already mentioned, the implementation of an innovation-investment project can be carried out simultaneously at several enterprises, we obtain a subset of the I_f indices.

The volume of sales of production products for (*R*) at the enterprise (*f*) for the period (*t*) is calculated in relation to the data of the enterprise without and taking into account the implementation of the innovation and investment project:

$$\begin{gathered} R_{ft} - \sum R_{fi\tau} \cdot Y_{i\mu} = R_{ft0},\ f \in F,\ i \in I_f, t = 1,2,\ldots,T, \\ f \in F; i \in I_f; t = 1,2,\ldots,T;\ f = 1,2,\ldots,\ f^n; \\ \tau = t - \mu + 1;\ \mu = t_i, t_i + 1, \ldots \end{gathered} \tag{8}$$

During the implementation of the project (*i*), it is planned to increase the profit of the enterprise (*f*), the coefficient of increase in the volume of sales of production products due to the implementation of the innovation and investment project will amount to (n_{ft}) and will be equal to:

$$n_{ft} = \frac{R_{ft}}{R_{f\tau 0} - 1} \tag{9}$$

In this case, the share of reduction of overhead costs (g_f) for the enterprise included in the eco-industrial park and implementing the project will be:

$$g_f \cdot n_{ft}. \tag{10}$$

The increase in the profit of an enterprise that is part of an eco-industrial park and implements an innovative investment project will amount to H_{ft} (in that case, if a loss is observed, then this is the value - G_{ft}), then:

$$\begin{gathered} \sigma H_{ft} - G_{ft} = \sum_i \left(B_{fi\tau} - M_{fi\tau}\right) Y_{i\mu} + g_f n_{ft} \\ i \in I_f; t = 1,2,\ldots,T;\ f = 1,2,\ldots, \\ f^n; \tau = t - \mu; \mu = t_i, t_i + 1, \ldots \end{gathered} \tag{11}$$

Taxes must also be taken into account. Let the coefficient λ be the tax rate on the company's profit. Its consideration in relation to the value of net profit makes it possible to obtain a value by which amount of losses can reduce profit before taxation. The definition of the formula for the net profit of an enterprise that is part of an eco-industrial park and implements an innovation-investment project has the following form:

$$\begin{gathered} \lambda P_{ft0} - U_{ft0} + \lambda H_{ft} - G_{ft} + U_{ft} - \lambda P_{ft} + k_1 Z_{f,t-1} + \\ + 0.5\left(F_{f,t-1} + F_{ft}\right) p - k_1 X_{f,t-1} - k_2 N_{f,t-1} = 0, \\ t = 1,2,\ldots,T,\ f = 1,2,\ldots,\ f^n \end{gathered} \tag{12}$$

where, P_{ft} – net profit of the enterprise f, which operates within the eco-industrial park and implements an innovation-investment project in a certain time period *t*;

U_{ft} – possible loss of enterprise *f*, which operates within the eco-industrial park and implements an innovation-investment project in a certain time period *t*;

$Z_{f,t-1}$ – amount of net profit of the enterprise *f*, which is included in the eco-industrial park and is used in the period *t – 1* and is used at other enterprises of the park $Z_{i0} = 0$ in the innovation and investment project;

k_1, k_2 – accordingly, the minimum interest rate is higher than the minimum, which ensures that the enterprise receives income from investments in other enterprises operating within the eco-industrial park;

F_{ft} – part of the net profit of the enterprise that is not used and remains on the balance sheet of the enterprise *f* until the end of the period, namely *t – 1*;

$X_{f,t-1}$ – enterprise credit *f* in the period *t – 1* from other enterprises participating in the agro-industrial park, for which the enterprise pays interest at the rate k_1;

$N_{f,t-1}$ – enterprise credit *f* in the period *t – 1* from the investor, for which the company pays interest at the rate k_2.

The essence of uniting production enterprises within eco-industrial parks is more integrated interaction of enterprises, including through joint investment. Thus, a part of the net

profit (φ_t) of the enterprise f obtained as a result of the implementation of the innovation-investment project can be used as an investment in other enterprises of the park at a percentage of k_1. Financing of an innovation investment project can be defined as follows:

$$\begin{aligned}&\sum_i (K_{fi\tau} - a_{fi\tau}) Y_{i\mu} - a_f A_{ft} + Q_{ft} - I_{ft} - X_{ft} - N_{ft} + \\ &+ X_{f,t-1} + N_{f,t-1} - V_{ft} = 0, \\ &i \in I_f;\ f = 1,2,n,\ f^n; t = 1,2,n,T; \\ &\tau = t - \mu + 1; \mu = t_i, t_i + 1, \ldots\end{aligned} \tag{13}$$

where, I_{ft} – represents the volume of financial resources at the enterprise *f* of the eco-industrial park and is calculated using the following formula:

$$\begin{aligned}&I_{ft} - \varphi_f \left(P_{ft} + (1 - k_3)\ D_{ft}\right) + L_{ft} + \\ &+ Z_{ft} - Z_{ft} - F_{f,t-1} + F_{f,t-1} = 0, \\ &f\ = 1,\ 2,\ \ldots,\ f^n;\ t = 1,\ 2,\ \ldots,\ T,\end{aligned} \tag{14}$$

where, k_3 – tax on dividends;

V_{ft} – early investments of enterprise *f* in period *t* at the expense of investments from other enterprises of the eco-industrial park;

D_{ft} – dividends received by the enterprise *f* when investing in innovative investment projects of enterprises operating within the eco-industrial park;

L_{ft} – long-term investments of the enterprise *f* in the innovation and investment project of other enterprises operating within the eco-industrial park in the period *t*;

Z_{ft} – volume of loans of enterprise *f* to other projects within the eco-industrial park in the period *t*;

$Z_{f,t-1}$ – return of loans to enterprise *f* from other enterprises of the eco-industrial park in the period *t - 1*;

F_{ft} – part of the net profit of the enterprise that remains on the balance sheet of the enterprise *f* until the end of the period, namely *t*;

$F_{f,t-1}$ – part of the net profit of the enterprise that is not used and remains with the enterprise *f* until the beginning of the period *t*.

At the same time, for the balance between the use and repayment of loans corresponds to the following equation:

$$\begin{aligned}&\sum_f Z_{ft} - \sum_f X_{ft} = 0; \\ &t=1,\ 2,\ \ldots,\ T,\end{aligned} \tag{15}$$

where, X_{ft} – amount of financial resources of the enterprises of the eco-industrial park, which are used at the enterprise *f* in the period *t* and returned to the enterprise in the period *t + 1* with an increase in the form of an interest rate k_1.

In relation to the enterprises of the eco-industrial park, the following pattern is followed, taking into account the limited financing of innovation and investment projects:

$$\begin{aligned}&\sum_f N_{ft} \le N_t \\ &t=1,\ 2,\ \ldots,\ T.\end{aligned} \tag{16}$$

Also, according to the fact that the enterprises of the eco-industrial park have the goal of investing in their own production, which makes it possible to increase the profitability of the enterprise, and not investing in the projects of other enterprises of the eco-industrial park, this is expressed by the following ratio:

$$\begin{aligned}&\left(J_{ft} + L_{ft}\right) a_z \ge Z_{ft} \\ &t = 1,\ 2,\ \ldots,\ T,\end{aligned} \tag{17}$$

That is, this equation shows that the share of loans of the enterprise *f* does not exceed a_z from the amount of investments.

The correspondence between the use of long-term investments and their supply is expressed as follows:

$$\begin{aligned}&\sum_f V_{ft} - \sum_f L_{ft} = 0 \\ &t = 1,\ 2,\ \ldots,\ T,\end{aligned} \tag{18}$$

At the same time, the following dependencies are observed:

$$\begin{aligned}&V_{ft} = \sum_{i \ne f} L_{fjt};\ L_{jt} = \sum_{i \ne f} L_{fjt} \\ &j=1,\ 2,\ \ldots,\ f^n,\ t=1,\ 2,\ \ldots,\ T\end{aligned} \tag{19}$$

where, L_{fjt} – investment of enterprise *j* in the development of enterprise *f*, while $j \ne f$, and dividends (D_{jt}), received by company *j* in period *t* are determined by:

$$\begin{aligned}&D_{jt} = e \sum\nolimits^{f} \sum\nolimits_{(q=1)}^{t} L_{f,q-\Delta t} \\ &j\ \ne f;\ j = 1,2,\ldots,jn;\ t = 1,2,\ldots,T;\ t \ge \Delta f\end{aligned} \tag{20}$$

where, Δf – the time of deviation from investment in capital investments to the time of payment of dividends to the enterprise *f*.

4. RESULTS

Modern challenges require more and more attention to increase the efficiency of the innovation and investment activity, this is due to the increase in energy and raw material threats. If we analyze the statistical data on the introduction of innovations at manufacturing enterprises, then, unfortunately, we cannot speak of positive dynamics in this direction (Figure 3).

The dynamic changes illustrated in the Figure 3 make it possible to state that over twenty years the share of manufacturing enterprises implementing innovations has hardly changed. So, in 2000, this share was 14.8% of the total number of production enterprises, and in 2020, it was 14.9%. The lowest indicators for the share of manufacturing enterprises that introduced innovations were in 2005 – 8.2%, and the highest in 2016 – 16.6%. If we analyze the indicators regarding the share of the volume of implemented innovative products, a negative trend is observed. In 2000, the share of the total volume of sold innovative products was 9.4% of the total, and in 2020 – 1.9%. However, it should be noted that this is almost three times more than in 2017, in which the share of sales of innovative products was 0.7% of the total, which is the lowest indicator for the period under study.

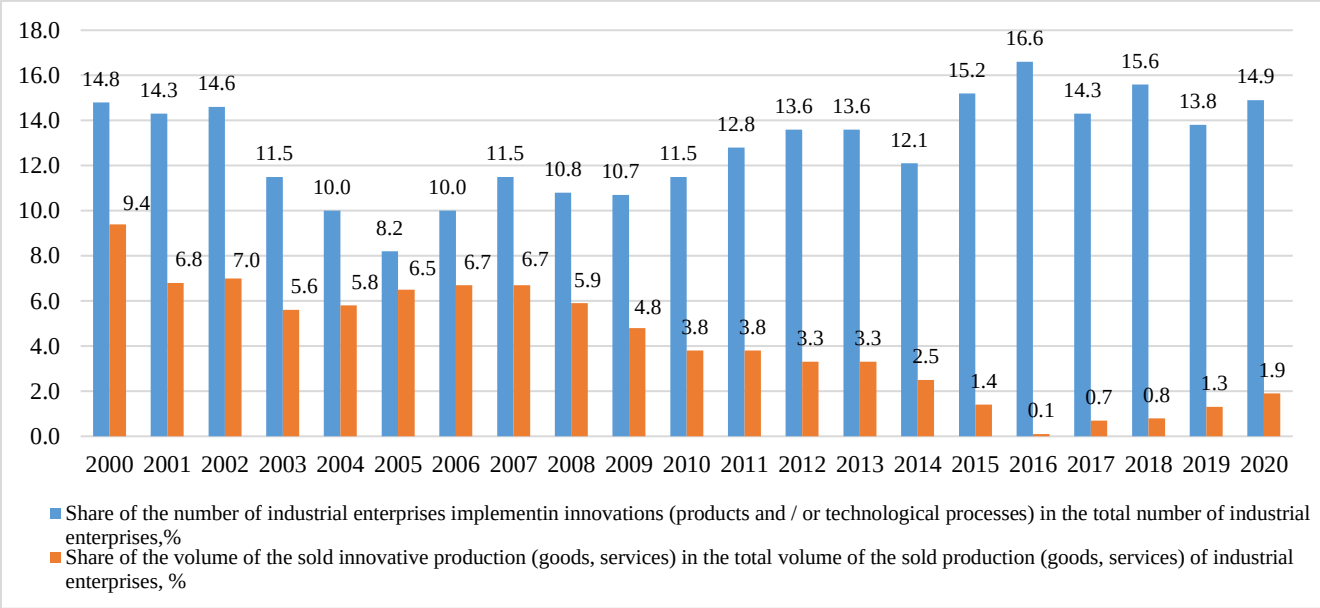

Figure 3. The dynamics of innovation implementation indicators at industrial enterprises, 2000-2020
Source: formed by the authors on the basis of data from the State Statistics Service of Ukraine [23]

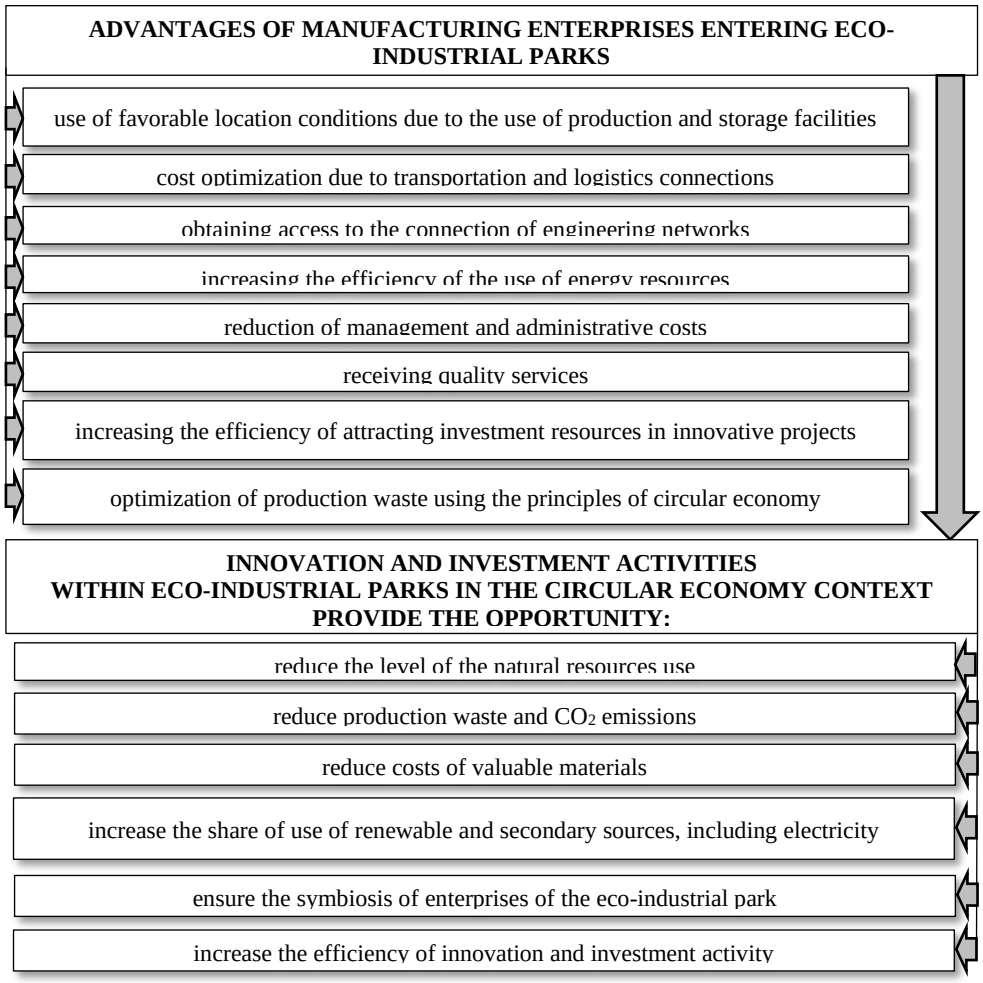

Figure 4. Innovation and investment activity within eco-industrial parks in the circular economy context
Source: developed by the authors

Of course, it can be predicted that during military operations on the territory of Ukraine, the share of manufacturing enterprises that introduced innovations will be much smaller, and also the share of the volume of innovative products sold in the total volume of sales of products of manufacturing enterprises will be smaller. The development of eco-industrial parks, which also provide an opportunity to increase the efficiency of investments, stands in the direction of the intensification of innovative activities and their introduction into production processes.

Innovative development of enterprises can be achieved thanks to their entry into eco-industrial parks and their functioning in compliance with the principles of circular economy. The eco-industrial park provides an opportunity not only to obtain positive results as a result of production synergy, but also through financial cooperation, scientific-technological and innovative cooperation. Principles of circular economy, namely: recovery, sharing, optimization, cyclicality, virtualization and exchange, directly correspond to the principles of the development of eco-industrial parks.

The innovative investment activity within eco-industrial parks in the circular economy context makes it possible (Figure 4):

- reduce the level of the natural resources use;
- reduce the level of production waste and CO_2 emissions;
- reduce costs of valuable materials;
- increase the share of the use of renewable and secondary sources, including electricity;
- ensure the symbiosis of enterprises of the eco-industrial park;
- increase the efficiency of the innovation and investment activity.

To analyze and substantiate the efficiency of innovative investment activities of enterprises within the framework of the functioning of eco-industrial parks in the circular economy context, such enterprises were chosen as: PJSC "Dnipro Metallurgical Plant", LLC "Intertype Ukraine" and PJSC "Arcelormitall Kryvyi Rih". All enterprises are productive, but are at risk of full or partial relocation as a result of the military conflict taking place on the territory of Ukraine because of the aggression by the Russian Federation. The main results of the analysis of economic results of the selected enterprises are presented in Table 1.

Table 1. The main indicators of the production enterprises activity

Indicators	PJSC "Dnipro Metallurgical Plant"			PJSC "ArcelorMittal Kryvyi Rih"			LLC "Intertype Ukraine"		
	2019	2020	2021	2019	2020	2021	2019	2020	2021
Fixed assets, thousands of dollars	315,31	314,08	298,38	4 172,38	4 058,24	3 911,51	5 510,8	6 339,25	7 645,34
Specific weight of fixed assets in assets,%	35,24	32,63	25,46	64,71	50,07	50,72	17,27	19,08	22,05
Depreciation rate, %	41,12	42,66	43,60	67,90	69,21	69,90	66,07	64,38	72,04
Gross investment in fixed capital, thousands of dollars.	96,5	192,5091	255,593	24,07143	221,2364	0	110,3464	286,2436	0
Specific weight of capital construction investments, %	0,00	0,00	45,54	0,77	0,00	0,00	37,37	0,00	0,00
Specific weight of investments for the purchase of new fixed assets, %	99,41	21,78	0,00	94,63	38,59	0,00	62,63	19,76	0,00
Costs for technological innovations, thousands of dollars.	3,703571	0,123636	0	4,178571	9,894545	0	12,63571	29,08727	71,56491
Costs for informatization, thousands of dollars.	3,596429	8,647273	4,392982	0	5,672727	0	6,385714	14,85091	385,0175
Specific weight of software costs, %	12,91	31,46	0,00	0,00	100,00	0,00	0,00	2,08	0,00
Coefficient of autonomy	0,74	0,75	0,82	0,64	1,00	1,00	0,86	0,86	0,83
Coverage ratio (liquidity flow)	2,46	3,23	4,44	1,28	1,20	3,45	3,51	4,23	3,60
Absolute liquidity ratio	0,10	0,25	0,22	0,01	0,01	0,01	0,96	0,91	0,62
Quick liquidity ratio	0,31	0,31	0,28	0,30	0,05	0,09	1,00	1,00	0,69
Coefficient of self-sufficiency	0,59	0,63	0,75	0,22	0,17	0,11	0,72	0,76	0,71
Capital return	2,54	2,68	3,36	0,58	0,73	1,06	0,35	0,33	0,33
Equity turnover	2,73	3,09	3,63	0,80	1,18	1,94	0,36	0,36	0,33
Current asset coverage ratio with own working capital	0,59	0,69	0,77	0,22	0,17	0,71	0,72	0,76	0,72
Maternal security ratio. Own working capital	0,91	1,24	1,37	0,29	0,23	0,82	1,54	1,96	1,55
Turnover of fixed assets	5,64	7,32	11,30	0,83	1,60	2,64	1,28	1,19	1,03
Turnover of material working capital	3,47	4,14	4,78	0,90	0,98	1,36	1,10	0,86	0,00
Capitalization ratio, %	72,62	75,34	81,64	64,48	50,28	49,89	85,87	85,53	83,24
Ratio between capitalization and revenue	0,36	0,32	0,29	1,43	0,78	0,80	2,60	2,61	2,68
Ratio between capitalization and net profit	10,56	5,06	4,95	-74,40	-555,40	40,69	31,97	39,10	37,36
Return on assets, %	8,56	17,18	19,49	-0,60	-0,10	2,09	2,83	2,21	2,34
Return on equity, %	10,68	23,18	24,67	-1,73	-0,18	4,17	3,17	2,58	2,77
Profitability of products (sales), %	6,51	12,06	8,98	18,60	3,18	5,06	14,16	10,71	16,66
oefficient of net profit	0,15	0,16	0,13	2,32	1,27	0,80	1,10	1,12	1,89
Turnover of invested capital	2,46	2,63	2,97	0,62	1,16	1,14	0,36	0,35	0,32
Turnover of working capital	4,48	4,13	4,73	1,53	1,36	1,83	0,69	0,60	0,55
Turnover of accounts payable, times	16,34	11,25	29,32	4,11	8,10	9,86	12,54	7,11	0,00
Accounts receivable turnover, times	22,78	14,99	17,78	8,27	5,88	10,30	4,78	3,12	2,43

Source: formed and calculated by the authors

Presented in the Table 1 data show that enterprises have different results of financial and economic activity. PJSC "Dnipro Metallurgical Plant" has the highest return on assets and equity, as well as the lowest depreciation of fixed assets, but at the same time, this company did not invest in the purchase of new fixed assets and technological innovations in the last period. The main performance indicators of PJSC "ArcelorMittal Kryvyi Rih" testify to the growth of the wear rate, which requires investment in fixed assets. Also, during the researched period, the company invested in the purchase of new fixed assets and technological innovations. Also, special characteristics that distinguish this company from others are low coefficients of absolute and quick liquidity and low profitability of assets and equity capital. LLC "Intertype Ukraine" did not invest in capital construction in the last two years under study either, but invested in the purchase of new fixed assets. At the same time, the company spends quite a lot of money on technological innovations and information.

The presented list of data in Table 1 on selected enterprises provides an opportunity to substantiate the effectiveness of enterprises entering eco-industrial parks. The results of the calculations are presented in Figures 5, 6.

Presented in Figure 5 results of calculations for 2021 prove that PJSC "Dnipro Metallurgical Plant" has the most positive results in terms of indicators of turnover of own capital, investment capital and working capital. Thus, in terms of equity capital turnover, PJSC "Dnipro Metallurgical Plant" has a value of 5.2 times that of LLC "Intertype Ukraine". Regarding the turnover of investment capital, PJSC "Dnipro Metallurgical Plant" is 2.6 times more important than PJSC "ArcelorMittal Kryvyi Rih" and 9.3 times more than LLC "Intertype Ukraine".

The calculations presented in Fig. 6 certify that LLC "Intertype Ukraine" has better results in 2021 according to such indicators as: ratio of absolute and quick liquidity, provision of own working capital, ratio of capitalization and income, as well as ratio of net profit.

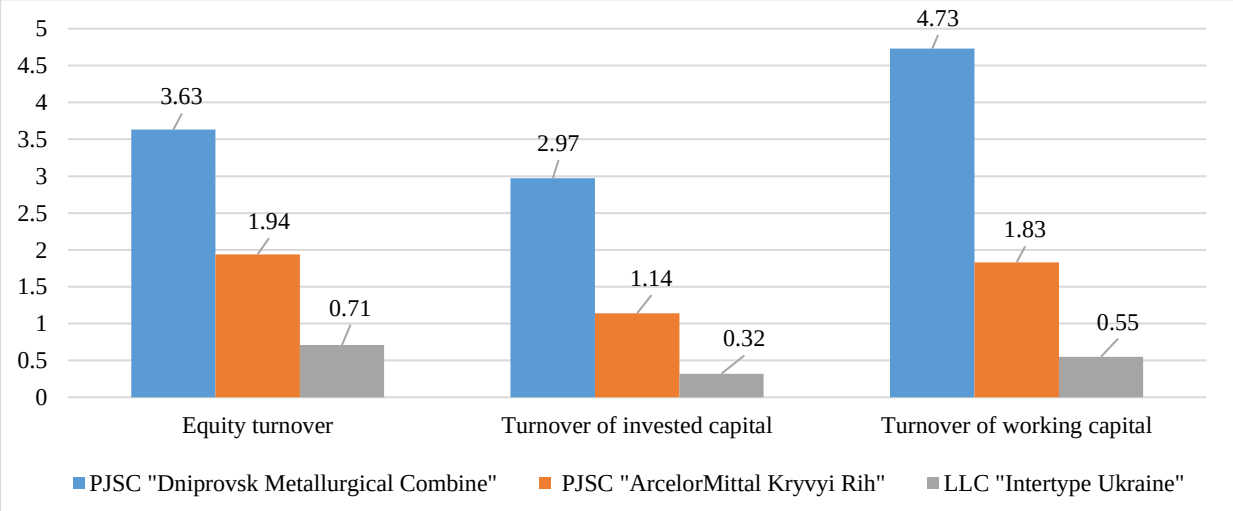

Figure 5. Dynamics of capital turnover indicators at industrial enterprises, 2021
Source: formed by the authors

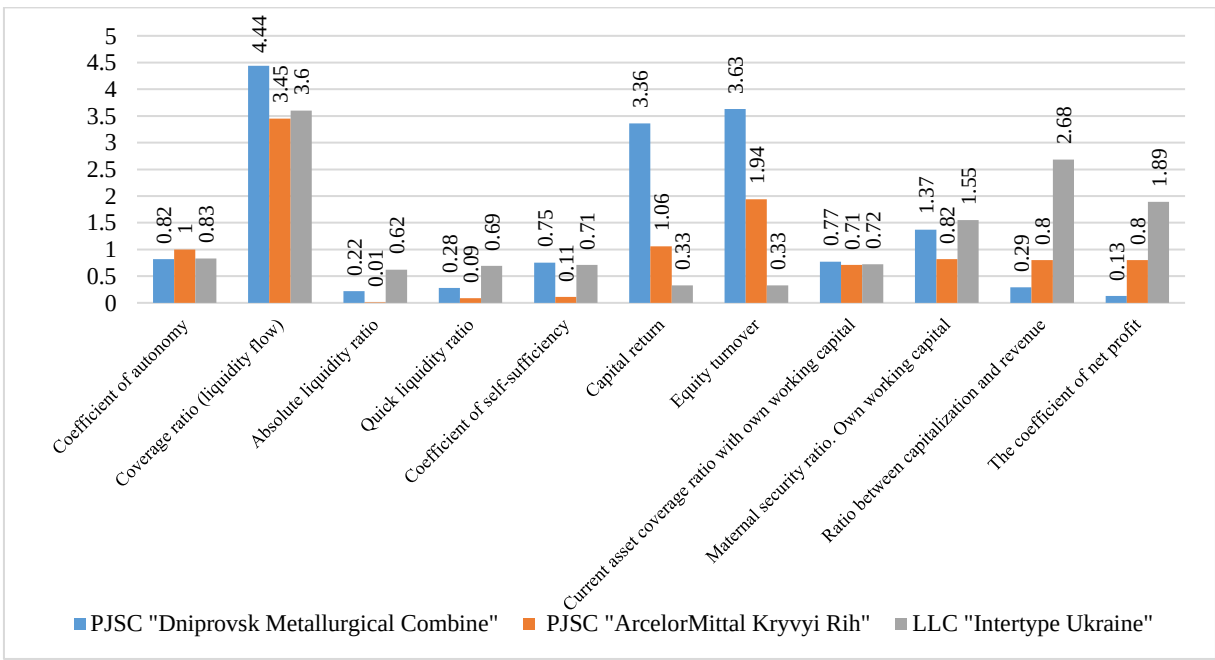

Figure 6. Value of coefficients of economic activity of manufacturing enterprises, 2021
Source: formed by the authors

Also, it should be noted that currently Ukraine has not adopted a separate law on eco-industrial parks, and their formation is planned in the form of both the transition of industrial to eco-industrial parks and the construction of new eco-industrial parks. In relation to industrial parks, the legislation of Ukraine [24] in 2022 introduced changes that act as a powerful driver for innovative and investment activities of enterprises, especially in the conditions of military operations on the territory of Ukraine. These positive changes include:

- firstly, expanding the list of objects that can be included in the boundaries of the industrial park, which can include laboratories for the development of innovative technologies, educational institutions, business campuses and many other objects of an innovative direction, which can significantly activate the innovative direction enterprises of park participants;
- secondly, compensation to management companies and enterprises included in the park of 50% of the costs of connecting to the power grids, which significantly lowers the cost of such procedures and attracts manufacturing enterprises to enter industrial parks;
- thirdly, compensation for the participants of the park and the management company of interest rates for loans for the arrangement of industrial parks, which is becoming even more relevant for the replaced business;
- fourthly, compensation of park participants (at the level of up to 70%) of interest payments on loans in relation to the share of enterprise product exports in the total income from their activities, which is a powerful incentive for the production of competitive products on the international market;
- fifthly, reimbursement of up to 70% of the total capital costs during the first 3 years of investment to park participants in the creation of production, depending on the share of export of products in the total volume of production, which becomes a driver for the development of a new creative business oriented to international markets .

It should be noted that such changes have increased the attractiveness of creating eco-industrial parks in the circular economy context.

5. CONCLUSIONS

The scientific novelty of the study consists in the development of methodological recommendations using systemic and synergistic approaches to justify the effectiveness of innovative and investment activities of enterprises within the functioning of eco-industrial parks in the circular economy context.

Eco-industrial parks are a favorable environment for the operation of replaced companies as well as all other enterprises included in it. It is important to improve the opportunities for attracting investment resources in innovative projects and obtaining a synergistic effect for the entire eco-industrial park, which is especially important in the conditions of circular economy. A systemic synergistic effect arises as a result of the interaction and innovative orientation of enterprises of eco-industrial parks and their support from the management company.

One of the advantages of an eco-industrial park is that enterprises can act not only as partners, but also as investors, while the enterprise receives dividends. And in general, for the enterprises of the eco-industrial park, a synergistic effect is obtained, which makes it possible to intensify innovation and investment activities, reduce overall costs, increase environmental friendliness and efficiency of the enterprises operating within the boundaries of the eco-industrial park.

Innovative and investment activity of eco-industrial parks should be aimed at carrying out scientific research activities in the direction of solving environmental problems in accordance with the principles of circular economy; development and implementation of eco-investment and innovation programs and projects based on creative and innovative solutions; creating favorable conditions for attracting investment resources from diversified sources; rapid implementation of the results of scientific research activities and innovative ideas into industrial activity.

Further research in the direction of substantiation of practical recommendations regarding innovative and investment activities of enterprises within eco-industrial parks is required by issues related to the activation of the introduction of innovative technologies by the enterprises of its participants regarding the use of a closed production cycle in accordance with the principles of the circular economy to maximally minimize the negative human impact on the environment and increase effectiveness of eco-industrial parks as a whole.

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