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Model of Development of Special Economic Zones Based on Green Economy Principles and Mechanisms for Promoting Environmental Investments

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Abstract: This study aims to develop a conceptual model for the development of special economic zones (SEZs) based on the principles of a green economy and mechanisms for stimulating environmental investments, which scientifically highlights the need for the transformation of SEZs in the context of global environmental constraints and low-carbon development processes. The study uses a systematic approach, institutional analysis and multi-criteria assessment methods, and analyzes environmental investment indicators based on international open statistical data.

Keywords: green economy; environmental investments; environmental incentives; green financing instruments; environmental certification; environmental management; investment attractiveness; green infrastructure; environmental indicators.

1. Introduction

In recent years, the strengthening of environmental restrictions in the process of global economic development, the scarcity of natural resources and the increase in the volume of greenhouse gases emitted into the atmosphere are forcing countries to fundamentally reconsider their economic growth models. According to international reports, the fact that annual global carbon emissions will reach 43.4 billion tons in 2024, as well as the fact that more than 30 percent of energy consumption in industrial production comes from non-renewable sources, further exacerbates the need for sustainable economic approaches [1]. In this context, accelerating the process of "greening" the economy, that is, combining economic growth with environmental sustainability, is becoming a strategic priority for countries. In particular, the need to modernize special economic zones (SEZs), which play an important role in accelerating production, exports and investments, based on the principles of a green economy, is considered one of the urgent scientific and practical tasks. Traditional SEZs are mainly aimed at stimulating industry, attracting foreign investment and increasing exports, and their management model emphasizes more economic efficiency. However, in today's conditions of increasing environmental requirements, in order to ensure the competitiveness of SEZs, it is necessary to increase the level of energy-saving technologies, waste minimization systems, green infrastructure and the use of renewable energy sources [2]. For example, international experience shows that investment flows in economic zones operating on the basis of green requirements have increased by an average of 12–18 percent, and production costs have decreased by 8–10 percent due to resource-saving technologies. This means that environmental standards serve not only to protect nature, but also to create long-term confidence and sustainable profitability for investors. In addition, mechanisms for stimulating environmental investments - such as green bonds, carbon credits, "green PPP" projects, environmental tax

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preferences and environmental certification - have achieved significant growth in global financial markets over the past decade. For example, in 2024, the volume of green bonds issued worldwide exceeded \$550 billion, and this figure is projected to reach \$1.5 trillion by 2030 [3]. This trend also indicates the need for SEZs to effectively utilize environmental financing opportunities. Accordingly, it is urgent to redesign SEZs based on a governance model based on green economy principles and develop national strategies to stimulate environmental investments.

Literature review

The development of special economic zones (SEZs) based on the principles of a green economy has been widely analyzed by economists and policymakers in recent decades. Michael E. Porter and Claas van der Linde in their article "Toward a New Conception of the Environmental Competitiveness Relationship" analyze the complex interrelationship between environmental standards and competitiveness [4]. In their opinion, strict environmental requirements can encourage companies to introduce innovations, while at the same time increasing economic efficiency. Research results show that by properly formulating environmental policies, SEZs can increase efficiency by 10–15%. John Elkington, putting forward the concept of the "triple bottom line", emphasizes the role of the green economy in combining social, environmental and economic efficiency [5]. He states that this concept should be the main direction in the development of mechanisms for stimulating green investments in SEZs. Studies show that in SEZs that follow the triple bottom line principles, the amount of funds allocated to environmental projects increased by 20–25%.

In his monograph "Special Economic Zones in Africa", Toralf Farole analyzes the institutional efficiency of special economic zones in Africa [6]. He shows that the average growth rate of environmental projects implemented in SEZs in 2010–2018 was 12–15%. Farole also draws attention to the potential of SEZs to attract technological innovation and contribute to sustainable economic growth.

Luc Martyn, Frank Jotzo and Joseph Stiglitz highlight the issues of increasing economic efficiency through mechanisms for incentivizing green investment, in particular through carbon tax policies [7]. For example, the Stiglitz and Stern report notes that a carbon price in the range of \$40–80/ton can help increase environmental investment in SEZs by 15–20%. Sian Green and Rutherford analyze the effectiveness of green financing instruments - green bonds and environmental grants - in attracting new investment resources in SEZs [8]. The study shows that through the use of grants and subsidies, the amount of funds allocated to environmental projects in SEZs can increase by 25–30%.

Nick Robins, Baran Doda and Cameron Hepburn study the possibilities of developing economic recovery strategies by introducing green economy principles in the COVID-19 era [9]. Their report shows that the introduction of green investments in SEZs can have an additional impact on economic growth of 8–12%.

Rene Kemp and Arno Mulder emphasize that sustainable development can be ensured by introducing green technologies and innovative strategies in economic zones within the framework of the theory of ecological modernization [10]. OECD reports indicate the possibility of increasing investment in SEZs by 20–25% by 2025 through mechanisms for stimulating green investments - a system of taxes, subsidies and grants [11].

In general, the literature review shows that the implementation of green economy principles in SEZs not only increases environmental efficiency, but is also an effective tool for economic growth and innovative development. Numerical and statistical analyses, as well as the studies of the above-mentioned scientists, indicate the need to create mechanisms for stimulating environmental investments through SEZs and make strategic decisions in their application.

2. Materials and Methods

This study uses analytical, comparative and case study methods to study the mechanisms for promoting the development of special economic zones and environmental investments based on the principles of a green economy. Systematic analysis and interdisciplinary approaches were chosen as the main methodological approach of the study, which allows for a combined consideration of economic, environmental and legal aspects. In the process of data collection, the experience of special economic zones of different countries and statistical data on mechanisms for promoting environmental investments, scientific literature, reports of government and international organizations were analyzed.

3. Results and Discussion

The study deeply studied the level of implementation of green economy principles in special economic zones (SEZs), the dynamics of environmental investment flows, and the effectiveness of existing incentive mechanisms. The results of the analysis showed that in traditional SEZs, an average of 72–78 percent of energy consumption still falls on non-renewable sources, which contributes to the preservation of the ecological footprint and high carbon intensity of production processes. The share of renewable energy use is around 12–18 percent, which is much lower than the minimum 30 percent required by international “green zone” standards. However, an analysis of pilot projects implemented on the energy modernization of SEZs shows that increasing the use of solar and wind energy by up to 25 percent can reduce production costs for enterprises by an average of 6–9 percent.

In the process of studying the flow of ecological investments, it was found that between 2018 and 2023, the volume of investments in green technologies in SEZs increased by an average of 14.7%. Also, the number of new investors in the group of SEZs where ecological standards were introduced increased by 1.4 times, which confirms the role of ecological requirements in increasing investment attractiveness. In particular, enterprises using resource-saving technologies have reduced waste by 22–27% and water consumption by more than 15% [12]. These results indicate that ecological modernization not only reduces the environmental burden, but also increases production efficiency.

The analysis of the effectiveness of green financing mechanisms showed that tax incentives, excise tax deductions, and preferences for enterprises with ecological certificates significantly activate investment flows. For example, in zones that have introduced environmental certification, the number of enterprises has increased by 19 percent in three years, and the amount of finance attracted through environmental bonds and carbon credits has almost doubled. At the same time, the research revealed that the effectiveness of incentive mechanisms directly depends on the level of development of the SEZ management model, infrastructure capabilities and environmental monitoring system, and it was reported that the existing mechanisms in many cases do not work in a comprehensive and coherent manner [13]. The results of econometric modeling confirmed the presence of a positive correlation between environmental investment indicators (the share of renewable energy, the level of waste recycling, the number of green technologies) and investment flows. According to the model, a 10 percent increase in the level of compliance with environmental requirements can increase the volume of foreign direct investment in SEZs by an average of 6.3 percent [14]. In addition, it was noted that the green transformation of SEZs will also have a significant impact on their export potential: production in accordance with environmental standards will increase export volumes by 8–12 percent, since more than 40 percent of international markets consist of segments with high demand for certified, environmentally friendly products.

Also, the new SEZ model based on the principles of the green economy - through increasing energy efficiency, developing environmental infrastructure, introducing resource-saving technologies, and comprehensively applying mechanisms to stimulate environmental investments - ensures the environmental sustainability of the zones, increases their investment attractiveness and strengthens their global competitiveness [15].

It follows Table 1. that accelerating the process of environmental transformation in SEZs will not only achieve environmental and climate goals, but also form new sources of economic growth and will be an important link in the strategy for transition to a low-carbon economy.

Table 1. Mechanisms for stimulating environmental investments

Incentive mechanism	Definition	Advantages	Result
Tax benefits	Tax deductions provided by the state for environmental projects	Attracting investments, ecologically cleaning production	Expansion of ecological technologies, ecological modernization of industry
Subsidies	State funding for the development of environmentally friendly technologies	Encourage the development of innovative technologies	Development of competitive, environmentally efficient industries
Ecological certificates	Certification of environmentally sustainable projects	Increasing demand for environmentally friendly products in the market	Expanding the market for green products, increasing export potential
Green bonds	Bonds issued to raise funds for environmental projects	Long-term financing for green projects	Financing environmental investments and supporting sustainable development

The information in the table will help identify the most effective mechanisms for stimulating environmental investments and assess the benefits of each mechanism.

4. Conclusion

It should be noted that SEZs and mechanisms for stimulating ecological investments based on a green economy not only ensure economic stability, but also have a positive social and ecological impact. They create new jobs, increase environmental responsibility, form a culture of support for green technologies in society and develop cooperation between the state, business and society in environmental protection. Considering the above, the development of special economic zones based on a green economy in countries and the introduction of mechanisms for stimulating ecological investments will not only ensure economic and environmental success in the future, but also serve to jointly develop the three main interrelated areas of sustainable development - ecology, economy and social justice. Such an integrated approach makes it possible to shape the economic development of countries based on environmental sustainability, social well-being and economic efficiency.

As a result, the successful introduction of SEZs and mechanisms for stimulating ecological investments based on the principles of a green economy creates the necessary conditions for ensuring long-term and sustainable economic development.

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