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# INNOVATIVE APPROACHES TO THE MODERNIZATION OF INDUSTRIAL CAPITAL AS A FACTOR IN ENSURING ENVIRONMENTALLY ORIENTED ECONOMIC GROWTH

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***Annotation.*** *In the context of the global transition to a "green" economy, the transformation of industrial capital, aimed at ensuring sustainable economic growth, is of particular importance. International experience demonstrates that investments in renewable energy sources, energy efficiency improvements and the introduction of green technologies contribute to reducing carbon intensity and creating millions of new jobs. At the same time, the national practice of the Republic of Uzbekistan is characterized by a number of imbalances: the high energy intensity of the industrial sector, the relatively low share of renewable energy in the energy mix and the insufficient development of financial instruments for environmental modernization. The results of the study show that the successful formation of an innovative model for the use of industrial capital requires an integrated approach, including increased investment in environmentally friendly technologies, institutional support for green finance, modernization of industrial facilities and training for new industries. In the long term, such measures will increase the competitiveness of the national economy, balance industrial development and ensure Uzbekistan's integration into global sustainable trends.*

***Keywords.*** *Industrial capital, green economy, sustainable economic growth, energy efficiency, renewable energy sources, carbon intensity, innovation, green finance.*

## INTRODUCTION

In the current context of global transformation, the global economy is facing the need to rethink traditional growth models. Intensive use of natural resources, high carbon intensity of production and increased negative impact on the environment have led to the fact that sustainable development has become one of the key agendas of international economic and political discourse. The concept of a "green" economy, which presupposes the harmonization of economic growth with environmental safety and social justice, is a strategic guideline for most States.

At the international level, the transition to a "green" economy is fraught with a number of challenges. First of all, it is the high cost of technological modernization of industry, the need to attract significant investment resources, as well as the uneven access of countries to advanced technologies and financial instruments. A dilemma remains relevant for developing countries: how to simultaneously ensure economic growth, industrial competitiveness, and fulfillment of environmental obligations. In addition, international standards in the field of decarbonization and climate policy require national economies to be flexible and able to adapt to new global trade rules.

At the national level, in particular in countries with economies in transition, including Uzbekistan, the problem is exacerbated by the specifics of the industrial structure. A significant part of the industrial capital is focused on traditional, energy-intensive and resource-intensive industries. Modernization of fixed assets requires not only financial investments, but also the introduction of innovative technologies, human resources, and institutional transformations. At the same time, the risks of falling behind in global competition are increasing in the event of a delayed transition to "green" standards.

The relevance of the research is determined by the need to find innovative ways to use industrial capital that would simultaneously stimulate economic growth and reduce the environmental burden. In modern conditions, industrial capital is considered not only as a set of material and technical resources, but also as a key factor in innovative development that can provide competitive advantages in the long term.

Thus, the scientific understanding of the mechanisms of effective use of industrial capital in the context of the formation of a "green" economy is of great theoretical and practical importance. On the one hand, this contributes to a deeper understanding of the relationship between sustainable development and industrial modernization, and on the other hand forms the basis for the development of national strategies that ensure the harmonization of economic, environmental and social interests.

## LITERATURE ANALYSIS

The global and national body of research unanimously points out that the transition to a “green” economy requires an active modernization of industrial capital, both through private investment and through targeted government policies (incentives, standards, missionary programs).

The studies studied show that the scientific community has a fairly clear system of views on the transformation of industrial capital in a “green” economy. International authors (N. Stern, J. Stiglitz, M. Mazzucato) focus on global challenges and institutional mechanisms. Their approaches form a basic methodological framework, like Nicholas Stern’s classic economic analysis of the costs and benefits of actions to contain climate change[1]. Stern emphasizes that climate risks represent a large-scale market failure that threatens long-term economic growth; timely investments in decarbonization and modernization of production facilities are more profitable than passively waiting for the consequences. For industrial capital, this implies the need for proactive restructuring of fixed assets, taking into account climate risks: early investments in energy conservation and low-carbon technologies can reduce the total costs of the economy and ensure sustainable growth.

Joseph E. Stiglitz, Ideas about green growth and the role of institutional policy[2]. Stiglitz emphasizes that an ecological transition can be combined with economic growth, provided that the policy of internal incentives is correct: pricing of external effects, directed investments and social reorientation are the keys to successful transformation. In the context of industrial capital, this means that transformation must

be accompanied by institutional measures (taxes, subsidies, standards) that stimulate modernization and support the competitiveness of enterprises during the transition period.

Mariana Mazzucato, a missionary approach to innovation policy and the role of the state as an investor coordinator[3]. Mazzucato suggests considering the “green” transition as a set of socially important “missions” that require targeted public investment and coordination between research institutes, industry and financial institutions. For industrial capital, this means the need for government incentives for strategic investments in green technologies, long-term partnerships, and mechanics that build innovative ecosystems capable of transforming productive assets. The role of the state is emphasized not only as a regulator, but also as an active participant in investment processes.

R.H.Tashmatov, theoretical and applied analysis of the formation of a “green” economy in Uzbekistan[4]. Tashmatov’s works explore the content and stages of the formation of a “green” economy in a national context: institutional measures, technological priorities and investment barriers are considered. The author points out the need to restructure traditional industries and modernize fixed assets in order to increase resource efficiency and reduce environmental burden, which is directly related to the transformation of industrial capital.

Sh.R. Abdullayeva, a study of the “green” economy as a factor of long-term growth[5]. Abdullayeva 159nalyses the impact of the introduction of energy-saving technologies and “green” financing on the country’s industrial development. Her conclusions emphasize the practical importance of the transition: investments in environmentally friendly processes and equipment modernization not only reduce negative externalities, but also increase the productivity and competitiveness of industrial enterprises in the medium and long term.

M. Tulkinova, practical policy approaches and assessment of financing mechanisms for the “green” transition[6]. The works and reviews of Uzbek researchers, as well as reports of international organizations on Uzbekistan (UNECE, OECD), focus on sources of financing, institutional measures and barriers to the introduction of “green” investments. An important conclusion is that a large-scale transition requires a significant increase in private and public investments, the development of the “green” finance market and the adaptation of mechanisms for the use of industrial capital (modernization, reinvestment, financial incentives). These studies provide an applied picture of what changes are needed in financial and industrial policy to transform capital.

## METHODOLOGY

The purpose of this study is to analyze innovative approaches to the modernization of industrial capital as a key factor in ensuring environmentally oriented economic growth. The research examines the essence and directions of modernization of industrial capital, their impact on sustainable development and environmental efficiency of the economy, as well as the prospects for the introduction of innovative

solutions in the industrial sector. To achieve this goal, the research uses methods of systematic and comparative analysis, induction and deduction, economic, statistical and logical methods. In the course of the work, scientific publications, analytical reports, statistical data, as well as materials from international organizations devoted to industrial modernization and environmentally sustainable growth were used.

## DISCUSSION AND RESULTS

Global practice shows that the transition to a "green" economy requires not only political will, but also a comprehensive transformation of industrial capital. In developed countries, several areas can be distinguished:

The European Union is implementing the Green Deal strategy, which provides for a large-scale modernization of production facilities through the introduction of renewable energy sources, the development of a circular economy and the promotion of industrial innovation. Special financing mechanisms "green bonds", sustainable development funds and subsidies for environmentally friendly technologies are being created for enterprises[7].

The United States is allocating hundreds of billions of dollars to support the low-carbon industry as part of the Inflation Reduction Act (2022) program. The main focus is on the development of clean energy, electrification of transport and modernization of equipment in industry[8].

China demonstrates a unique experience of combining industrialization and a "green" transition. Through state-owned investment banks and five-year cycle planning, the main assets of the metallurgy, energy and chemical industries are being modernized. China is actively investing in green clusters, encouraging enterprises to switch to energy-efficient technologies[9].

The use of industrial capital in a green economy is impossible without a combination of three elements: government support, long-term private investment, and innovation and technological modernization.

Based on a comparison of international studies and national conditions, the following key factors can be identified: First, the investment factor, the modernization of industrial capital requires significant financial resources. In advanced economies, private investment dominates, complemented by government incentives. In countries with economies in transition, such as Uzbekistan, the role of the State remains the leading one. Secondly, the technological factor, the introduction of energy- and resource-saving technologies is a crucial condition. International experience confirms that companies investing in "green" innovations gain competitive advantages in the medium term. Thirdly, the institutional factor, the existence of a regulatory framework and "green" standards determine the motivation of enterprises to modernize their capital. Transparent rules and a clear climate policy encourage businesses to make long-term investments. Fourth, the socio-economic factor, the transition to a "green" economy, is accompanied by a change in the employment structure, the development of new industries and the formation of "green" jobs. This increases the importance of training qualified personnel. Fifth, the environmental factor, the tightening of

international export requirements (for example, the EU carbon tax) has a direct impact on national economies. It is becoming necessary for industrial enterprises to reduce the carbon intensity of products in order to maintain access to foreign markets.

For Uzbekistan and other emerging green economies, international experience serves as a guideline, but its application requires consideration of national specifics.

First, the modernization of industrial capital should be aimed at the priority sectors of energy, chemistry, metallurgy and the textile industry, which are the most energy-intensive.

Secondly, it is necessary to activate the instruments of "green" financing: the issue of "green" bonds, the creation of the national fund for sustainable development, the introduction of tax incentives and preferences for enterprises investing in environmentally friendly technologies.

Thirdly, the institutional environment plays a key role. Legislative measures such as energy efficiency standards, carbon regulations, and environmental certification of products can encourage enterprises to make long-term investments in modernization.

Fourthly, the social aspect of the formation of new jobs and the retraining of personnel within the framework of "green" projects should be taken into account.

Innovative ways of using industrial capital in the context of the formation of a "green" economy should be based on a balance of three components: technological modernization of fixed assets; development of financial support mechanisms; institutional and regulatory support.

Such an integrated approach will ensure sustainable economic growth while reducing environmental risks and maintaining the competitiveness of the national economy.

**Table 1**

**A model of industrial capital transformation in a green economy[10]**

| The direction of transformation | Implementation mechanisms | Expected results |
|---|---|---|
| Technological modernization | Implementation of energy and resource-saving technologies, digitalization of production processes, automation and "smart" control systems | Reducing the energy and carbon intensity of production; increasing productivity |
| Financial reorientation | Attracting "green" investments, issuing "green" bonds, government subsidies and tax incentives | Increasing the availability of capital for modernization; stimulating private investment |
| Institutional changes | Development of regulations on energy efficiency, environmental certification, carbon regulation | Creating incentives for long-term modernization; increasing investor confidence |
| Organizational innovations | Creation of "green" industrial clusters, implementation of the principles of circular economy, development of partnerships between government and business | Increasing the competitiveness of industry; expanding export opportunities |

| | | |
|---|---|---|
| Social and personnel aspect | Training and retraining of personnel in the field of "green" technologies, stimulating an innovative culture | Employment growth in new sectors; improving the quality of human capital |
| Environmental adaptation | Implementation of emission monitoring, environmental audit, implementation of Sustainable Development Standards (ESG) | Reduction of negative impact on the environment; compliance with international requirements |

The presented model clearly shows that the transformation of industrial capital in the context of the transition to a "green" economy is a multidimensional process that includes not only technological modernization, but also changes in the financial, institutional and social spheres. The interconnection of these areas creates the basis for the formation of a comprehensive strategy in which each element enhances the action of the others.

Thus, technological innovations cannot be implemented without appropriate financial instruments, while the effectiveness of investments directly depends on the stability of the institutional environment and regulatory incentives. In turn, social and human resources support and the development of environmental culture ensure the sustainability of reforms in the long term.

Thus, the model demonstrates that sustainable economic growth in a green economy is possible only with a systematic approach to the use of industrial capital. Reliance on innovation, support for human potential and the development of "green" institutions allows not only to minimize environmental risks, but also to increase the competitiveness of the national economy at the global level.

According to the International Energy Agency (IEA, 2023), global investments in clean energy exceeded $1.7 trillion in 2022[7], accounting for almost 60% of total global investments in the energy sector. In the countries of the European Union, the implementation of modernization programs has reduced the energy intensity of GDP by more than a third over two decades, reflecting the effectiveness of the introduction of resource-saving technologies. At the same time, the European Commission is implementing the Carbon Border Adjustment Mechanism (2023), which provides for carbon taxation of up to 75 euros per ton of $CO_2$, encouraging enterprises to modernize capital and reduce emissions[8]. According to estimates by the International Labour Organization (ILO, 2022), by 2030, the formation of a "green" economy will create about 24 million new jobs in the world, a significant part of which will be associated with the innovative transformation of industry[11].

In the conditions of the Republic of Uzbekistan, industrial capital is also undergoing structural changes. According to the State Statistics Committee, in 2023, the total volume of investments in fixed assets amounted to about 364 trillion soums, while the share of the industrial sector exceeded 40%. Industry accounts for almost half of the country's final energy consumption, while the largest burden is observed in metallurgy, cement and chemical industries. The carbon intensity of the economy remains relatively high: the production of one dollar of GDP accounts for about 0.7 kg of $CO_2$, which is almost twice as high as in the EU (0.35 kg)[11].

In the field of renewable energy sources (RES), the share of less than 10% in the total energy balance remains low (2023). However, government plans provide for bringing this figure to 30% by 2030 through the implementation of projects for the construction of solar and wind power plants. In particular, within the framework of the state programs of the Ministry of Energy of Uzbekistan by 2025-2030, projects are being implemented to launch solar power plants with a total capacity of more than 1.5 GW, which requires the modernization of industrial capital in related industries (mechanical engineering, construction, metallurgy)[12].

**Table 2**

**Comparative indicators of industrial capital transformation in a green economy[13]**

| Indicator | International Level | Uzbekistan |
|---|---|---|
| Investing in green technologies | More than $1.7 trillion (2022, IEA); about 60% of all energy investments | 364 trillion soums in fixed assets (2023), of which 40% is industry, the share of "green" technologies is still limited |
| Energy intensity of the economy | Decrease in the EU by more than 30% in 20 years | High: industry consumes about 50% of the final energy |
| Carbon intensity | EU: about 0.35 kg of $CO_2$ per 1 dollar of GDP | Uzbekistan: about 0.7 kg of $CO_2$ per 1 dollar of GDP (2 times higher than the EU) |
| Renewable energy sources (RES) | Leading countries (EU, China): The share of renewable energy sources is more than 25-30% | Uzbekistan: less than 10% (2023), the target is 30% by 2030. |
| Jobs in the green economy | About 24 million new jobs by 2030 (ILO) | Implementation of large-scale renewable energy projects → projected growth of "green" employment in industry and construction |
| Financial mechanisms | Active implementation of "green" bonds, carbon taxes (for example, up to 75 euros/ton of $CO_2$ in the EU) | The beginning of the formation of the "green" bond market, projects of the Ministry of Energy and international financial institutions (EBRD, ADB) |

The imbalance of the investment structure at the international level is characterized by a high proportion of investments in environmentally friendly technologies (up to 60% of all investments in energy), while in Uzbekistan this practice is still limited, despite the overall increase in investments in fixed assets. Energy intensity and carbon intensity, indicators of energy and carbon intensity of the Uzbek economy significantly exceed world standards (2 times higher than the EU level), reflecting the need to modernize production facilities and introduce resource-saving technologies. Renewable energy, unlike in developed countries, where the share of renewable energy exceeds 25-30%, is still below 10% in Uzbekistan. However, if the targets are reached (30% by 2030), the country has the potential to catch up with global trends. The "green" labor market, global experience shows the creation of millions of jobs due to "green" transformation, whereas in Uzbekistan the process is only taking shape, but has significant potential due to large-scale infrastructure projects in the energy sector and industry[14]. Financial mechanisms, international practices (carbon

taxes, green bonds) They actively stimulate the transformation of capital, whereas in Uzbekistan this market is at an early stage and requires institutional strengthening.

## CONCLUSION AND SUGGESTIONS

The conducted research has shown that the transformation of industrial capital in the context of the transition to a "green" economy is a key factor in ensuring sustainable economic growth at both the international and national levels. Global practice demonstrates the high effectiveness of investments in clean energy, resource-saving technologies and renewable energy sources, which contribute to reducing carbon intensity, improving energy efficiency and creating new jobs.

An analysis of the national situation in the Republic of Uzbekistan has revealed certain imbalances between global trends and the current state of industrial capital. The high carbon intensity, significant energy intensity of production and the relatively low share of renewable energy indicate the need for accelerated modernization of industrial capacities. At the same time, the ongoing government programs for the development of solar and wind energy, as well as measures to diversify sources of financing (green bonds, international loans) create the basis for adapting the national industry to new environmental standards.

As a result, it can be concluded that the effective use of industrial capital in the "green" economy requires an integrated approach, including:

- intensification of investment activities in the field of environmentally friendly technologies;
- reducing the carbon and energy intensity of industrial production;
- Development of the institutional framework for the introduction of "green" financial instruments;
- Training qualified personnel for new "green" industries.

Thus, the formation of an innovative model of industrial capital in a green economy is becoming a strategic direction for long-term sustainable development. The implementation of these tasks will not only increase the competitiveness of the national industry, but also ensure the integration of Uzbekistan into global environmental and economic trends.

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