

INVESTMENT SUPPORT FOR SUSTAINABLE INFRASTRUCTURE DEVELOPMENT AS A FACTOR OF NATIONAL ECONOMIC RESILIENCE

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Viktoriiia KHAUSTOVA

Doctor of Sciences (Economics), Professor,
Research Center for Industrial Problems
of Development of the NAS of Ukraine (Kharkiv, Ukraine),
ORCID: [0000-0002-5895-9287](https://orcid.org/0000-0002-5895-9287)
E-mail: v.khaust@gmail.com

Mykola KYZYM

Doctor of Sciences (Economics), Professor,
Corresponding Member of the National Academy of Sciences of Ukraine,
Institute of Demography and Quality of Life Problems of the NAS of Ukraine
(Kyiv, Ukraine),
ORCID: [0000-0001-8948-2656](https://orcid.org/0000-0001-8948-2656)
E-mail: m.kyzym@gmail.com

Olena RESHETNYAK

Doctor of Sciences (Economics), Associate Professor,
Research Center for Industrial Problems
of Development of the NAS of Ukraine (Kharkiv),
ORCID: [0000-0002-1183-302X](https://orcid.org/0000-0002-1183-302X)
E-mail: reshetele@ukr.net

Nataliia TRUSHKINA

PhD (Economics), Senior Research Fellow,
Research Center for Industrial Problems of Development
of the NAS of Ukraine (Kharkiv, Ukraine),
ORCID: [0000-0002-6741-7738](https://orcid.org/0000-0002-6741-7738)
E-mail: nata_tru@ukr.net

Abstract: The paper examines investment support for sustainable infrastructure development as a system-forming factor in enhancing national economic resilience under conditions of increasing security, climate, and economic risks. It is substantiated that in the current environment infrastructure plays a key role in ensuring the continuity of economic processes, the stability of supply chains, and public access to basic services, while its level of resilience is largely determined by the nature, structure, and quality of investment support. The purpose of the study is to substantiate the role of investment support for sustainable infrastructure development as a factor in shaping national economic resilience. Within the framework of the research, a hypothesis is put forward that the enhancement of economic resilience depends not only on the volume of investments but also on a balanced combination of funding sources, capital attraction instruments, and institutional conditions for the implementation of infrastructure projects. The methodological basis of the study includes methods of analysis and synthesis, systemic and structural-logical approaches, as well as comparative and expert-analytical analysis. Based on the generalization of foreign scientific approaches and analytical materials of international organizations, the components of sustainable infrastructure, the main sources and instruments of investment support, and the economic, social, and security effects of implementing relevant infrastructure projects are systematized. The results obtained confirm the feasibility of considering investments in sustainable infrastructure as a

strategic instrument for strengthening national economic resilience and form a basis for further improvement of state investment policy mechanisms in the field of infrastructure development.

Keywords: National Economic Resilience, Critical Infrastructure, Sustainable Infrastructure, Investment Support, Infrastructure Investment, Sustainable Development.

JEL Classification: E62; F21; G24; H54

INTRODUCTION

The current stage of development of national economies is characterized by the growth of systemic risks associated with military threats, climate change, geopolitical instability and chronic underinvestment in basic infrastructure sectors. According to estimates by international financial institutions and analytical centers, the global infrastructure investment deficit by 2040 may reach 15–18 trillion dollars, which significantly limits the possibilities of achieving the Sustainable Development Goals and increases the vulnerability of national economies to external and internal shocks [1; 2]. The problem of investment support for infrastructure development has become particularly urgent for countries with transition and post-crisis economies.

According to OECD data, the annual financing gap for achieving the Sustainable Development Goals in developing countries exceeds 3.9 trillion dollars. And the volume of foreign direct investment in critical infrastructure remains insufficient and unstable, despite their key role in the transfer of technologies, management practices and increasing the overall resilience of economic systems [3].

In the context of the full-scale military aggression of the Russian Federation against Ukraine, infrastructure restrictions have become systemic and have become one of the key factors in reducing the economic stability of the state. According to World Bank estimates, Ukraine's total needs for restoration and reconstruction exceed 486 billion USD, of which almost 155 billion USD are for losses of critical infrastructure. In 2022–2024 alone, more than 700 critical infrastructure facilities were affected, primarily in the energy, transport and utilities sectors, which caused multiplicative negative effects on production, the social sphere and financial stability [4; 5].

At the same time, modern research proves that investments in sustainable and climate-resilient infrastructure not only reduce economic losses from crises and disasters, but also generate long-term financial benefits. In particular, according to estimates by leading analytical centers, the incremental costs of increasing the resilience of infrastructure assets are significantly lower than the potential losses from their destruction, and sustainable infrastructure projects demonstrate 10–20% higher profitability compared to traditional infrastructure facilities under scenarios of energy transition and increased climate risks [6; 7]. An important empirical confirmation of investment barriers and institutional constraints are the results of expert surveys of business representatives and professional associations involved in the implementation of infrastructure projects.

According to the results of surveys conducted among leading business associations, the key constraining factors remain the instability of financing, delays in payment for completed works, imperfection of public procurement procedures, regulatory uncertainty and increased security risks, which significantly reduces the investment attractiveness of infrastructure projects even with international donor support [8; 9]. In this context, investment support for the development of sustainable infrastructure should be considered not only as a tool for post-crisis recovery, but also as a systemic factor in the formation of the resilience of the national economy, capable of ensuring the continuity of the provision of vital services, adaptation to multi-vector risks and long-term economic stability. This is what determines the relevance and scientific and practical significance of this study.

LITERATURE REVIEW

In foreign scientific discourse, the development of sustainable infrastructure is increasingly considered as a key prerequisite for the formation of resilience of economic systems, which is interpreted as the ability to maintain functionality during shocks and ensure rapid recovery with

minimization of long-term losses. In this context, special attention is paid to the growth of climate and combined risks for critical infrastructure. Thus, in the works of G. Forzieri et al. [10], based on empirical research, the strengthening of the cumulative impact of climate extremes on energy, transport and other infrastructure systems in Europe is substantiated, which directly increases the vulnerability of value chains and national economies as a whole.

In parallel, a research direction is developing focused on the economic feasibility of investing in increasing the resilience of infrastructure assets. In the works of S. Hallegatte et al. [11] based on analytical and model assessments, it is shown that investments in resilience can significantly reduce losses from disruptions in the provision of infrastructure services and reduce the costs of post-disaster recovery, while additional capital expenditures to increase resilience constitute a relatively small share of total investment needs. This approach is methodologically important, as it moves the discussion from the sphere of declarative significance of infrastructure to the plane of quantitative assessment of the cost-benefit ratio for the state and investors.

A significant body of research is devoted to financial mechanisms for mobilizing resources for the development of sustainable infrastructure and institutional conditions for reducing investment risks. The World Bank's reports and analytical materials, particularly within the framework of approaches to ensuring the reliability and resilience of infrastructure services, emphasize that the economic effect of investment significantly depends on the quality of governance, institutional capacity and the effectiveness of project cycle management, while weak institutions can neutralize the positive impact of even significant amounts of financing [12]. In this context, infrastructure investment is considered not only as a matter of resource volumes, but as a complex function of institutional quality, transparency and accountability.

Particular attention in the literature is paid to the issue of attracting foreign direct investment in critical infrastructure through the prism of economic security. OECD analytical materials show that FDI can play an important role in overcoming the infrastructure investment deficit, facilitating the transfer of technology and management skills, while increasing the risk of dependence on investors associated with the countries of origin of capital, which necessitates the implementation of "more, better and safer FDI" policies [13]. This is fundamentally important for ensuring resilience, since the stability of infrastructure is determined not only by the physical strength of assets, but also by the manageability of system dependencies and the integrity of network structures.

At the same time, modern research is actively developing an approach to sustainable infrastructure as a separate investment class of assets that requires standardization and the introduction of specialized frameworks. In publications with the participation of experts from international financial and infrastructure organizations, in particular A. Porucznik et al. [14], it is emphasized that standardized approaches such as FAST-Infra contribute to reducing transaction costs, increasing transparency and scaling private capital into sustainable infrastructure projects. As a result, investment in sustainability is increasingly associated with the development of a market-based financing infrastructure that includes standards, metrics, risk assessment tools and reporting.

The generalization of the analysis results shows that the current scientific literature convincingly substantiates the growth of climate and combined risks for critical infrastructure and their macroeconomic consequences [10], develops approaches to quantifying the economic benefits of investing in its resilience [11; 12], expands the understanding of the role of foreign direct investment and the associated economic security risks [13], and also offers tools for standardization and increasing the investment attractiveness of sustainable infrastructure projects [14]. At the same time, existing research does not form a holistic integrated approach that would directly link the structure of investment provision with the level of resilience of the national economy at the systemic level, which necessitates further methodological generalization and deepening of the analysis.

GOAL AND METHODOLOGY OF THE RESEARCH

The logic of this study is based on the realization that in the conditions of increasing structural, security and climate challenges, infrastructure development goes beyond a purely technical and economic task and acquires systemic importance for the functioning of the national economy. In this context, the purpose of the study is to substantiate the role of investment support for the development of sustainable infrastructure as a system-forming factor in increasing the resilience of the national economy.

Based on the set goal, the paper formulates a scientific hypothesis according to which investment support for the development of sustainable infrastructure is not limited to increasing the volume of financing, but is determined by the structure of sources, the combination of financial instruments and the institutional conditions for their attraction; it is this complex configuration of investment mechanisms that ensures increased resilience of the national economy through increased reliability of infrastructure systems, reduced systemic risks and increased adaptive capacity of economic processes. Within the framework of the study, this hypothesis is subject to verification through analytical generalization of foreign scientific approaches and interpretation of the results of expert and analytical materials of international organizations.

Achieving the goal and verifying the proposed hypothesis necessitated the use of a comprehensive research methodology that combines general scientific and special methods of cognition. Analytical and synthetic methods were used to generalize modern foreign concepts of sustainable infrastructure, investment mechanisms and economic resilience. The systemic approach allowed us to consider sustainable infrastructure as a multi-level socio-economic system integrated with financial, institutional and security subsystems of the national economy. The structural-logical method was used to build cause-and-effect relationships between investment provision, infrastructure transformations and economic resilience, which creates the basis for further generalization of the results in tabular form.

Comparative analysis and grouping methods made it possible to systematize the sources and instruments of investment support for the development of sustainable infrastructure, taking into account their economic, social and security effects. The expert-analytical method was used to interpret the results of international reviews and business surveys on investment barriers, risks and incentives in the field of infrastructure development. The information base of the study was formed by publications of foreign scientists, analytical materials of the World Bank, OECD and World Economic Forum, as well as the results of expert surveys, which allowed providing an empirical basis for testing the hypothesis put forward.

The use of this methodology provides a logical transition from a theoretical-analytical review to a generalization of applied aspects of investment support for the development of sustainable infrastructure, which is further implemented through a system of analytical tables and the formation of generalized conclusions regarding the impact of investment mechanisms on the resilience of the national economy.

Thus, the formulated goal, scientific hypothesis, and chosen methodology create a holistic analytical basis for further research into investment support for sustainable infrastructure development. The proposed approach allows not only to identify key investment factors of infrastructure transformation, but also to assess their systemic impact on the resilience of the national economy.

MAIN RESULTS OF THE RESEARCH

The development of sustainable infrastructure in modern conditions is increasingly considered as a basic prerequisite for ensuring the resilience of the national economy [15; 16], since it is infrastructure systems that form the material basis for the continuity of economic processes, access to basic services and the stability of the socio-economic environment. Foreign studies [10; 11] show that the level of vulnerability of economies to crisis shocks significantly depends on the technical

condition, diversification and adaptive capacity of infrastructure networks, in particular energy, transport, digital and utility networks. In this context, sustainable infrastructure should be considered not only as a set of physical objects, but as a complex system that combines technical, economic, environmental and institutional characteristics. A summary of the key components of sustainable infrastructure and their impact on the resilience of the national economy is given in *Table 1*.

As shown in *Table 1*, investments in sustainable infrastructure create a multiplier effect for the economy, combining short-term recovery results with long-term increases in adaptive capacity. However, the realization of such potential directly depends on the nature and structure of investment support. Foreign literature [3] emphasizes that the dominance of one source of financing, in particular the state, significantly limits the scale and pace of infrastructure modernization, especially in countries with a high level of fiscal constraints.

The systematization of sources and instruments of investment support for the development of sustainable infrastructure is presented in *Table 2*, which reflects the relationship between financial mechanisms and expected economic and social effects.

Table 1: Components of Sustainable Infrastructure and Their Impact on the Resilience of the National Economy

Type of infrastructure	Key sustainability characteristics	Investment priorities	Impact on the resilience of the national economy
Energy infrastructure	Decarbonization, diversification of energy sources, energy efficiency	Renewable energy sources (RES), transmission networks, energy storage	Reduction of energy risks, production stability
Transport infrastructure	Reliability, multimodality, climate adaptation	Railways, logistics hubs, green transport	Continuity of supply chains
Digital infrastructure	Cyber resilience, accessibility, redundancy	Broadband networks, data centers	Improved economic governance
Municipal infrastructure	Resource efficiency, adaptability	Water supply systems, thermal modernization	Social stability and quality of life

Source: Compiled by the authors based on the synthesis of sources [2; 10; 17; 18-21].

Table 2: Sources and Instruments of Investment Support for Sustainable Infrastructure Development

Source of investment	Key instruments	Areas of allocation	Expected effects
Public finance	Budgetary programs, guarantees	Core infrastructure	Macroeconomic stability
Private capital	Project financing, investment funds	Commercial projects	Improved efficiency
Foreign direct investment (FDI)	Concessions, mergers and acquisitions (M&A)	Critical infrastructure	Technology transfer
International institutions	Grants, blended finance	Sustainable projects	Reduction of investment risks

Source: Compiled by the authors based on the synthesis of sources [1; 3; 7; 18; 19].

The above generalizations confirm the hypothesis put forward by the study that it is not only the volume of investments that is crucial, but also their balanced structure, institutional environment and combination of financial instruments. It is this configuration that allows reducing risk premiums, increasing investor confidence and ensuring the long-term sustainability of infrastructure systems [7].

The result of the development of sustainable infrastructure under conditions of effective investment support is the formation of a complex of economic, social and security effects that directly affect the resilience of the national economy. A summary of such effects is given in *Table 3*.

Table 3: Effects of Sustainable Infrastructure Development on Enhancing the Resilience of the National Economy

Impact dimension	Nature of the effect	Level of manifestation	Significance for resilience
Economic	Reduction of losses from disruptions	Macro	Stability of economic growth
Social	Accessibility of services	Meso	Social stability
Environmental	Reduction of carbon footprint	Macro	Adaptation to climate risks
Security	Reliability of critical systems	Macro	Continuity of operations

Source: Compiled by the authors based on the synthesis of sources [1; 2; 11; 15-16; 18-21].

The results obtained indicate that investment support for the development of sustainable infrastructure forms a complex effect that goes beyond individual sectors and is manifested in increasing the overall resilience of the national economy. Thus, the analysis confirms the feasibility of considering investments in sustainable infrastructure as a strategic instrument of economic stability and adaptation to modern global challenges.

CONCLUSIONS

The study proves that in the context of increasing military, climatic and geoeconomic risks, the development of sustainable infrastructure acquires systemic importance for ensuring the resilience of the national economy. Infrastructure systems form the material basis for the continuity of economic processes, access of the population to basic services and the stability of the socio-economic environment, and therefore investments in their modernization should be considered not only as a tool for post-crisis recovery, but as a long-term mechanism for increasing the economy's resilience to multi-vector shocks.

The results confirmed the feasibility of treating sustainable infrastructure as a comprehensive system that combines technical, economic, environmental and institutional characteristics and ensures the transformation of investment decisions into the aggregate effects of economic, social and security stability. The generalization of the results by type of infrastructure showed that the contribution of individual sectors to the formation of resilience has different mechanisms of manifestation, but is based on a common logic of the systemic effect.

Energy infrastructure through decarbonization, diversification of sources and increased energy efficiency reduces energy risks and supports the stability of production; transport infrastructure ensures the stability of supply chains through reliability, multimodality and climate adaptation; digital infrastructure increases the manageability of the economy and the stability of management and financial processes through the development of cyber protection, availability and redundancy; municipal infrastructure, focused on resource efficiency and adaptability, directly affects the quality of life of the population and social stability. Overall, it has been proven that investments in sustainable infrastructure create a multiplier effect, combining short-term recovery results with a long-term increase in the adaptive capacity of the economy. At the same time, it has been established that the realization of this potential is determined not only by the scale of financing, but primarily by its structure and the quality of the institutional environment for attracting resources. The systematization of sources and instruments of investment support has shown that public finances perform a stabilizing function and provide financing for basic infrastructure; private capital through project financing mechanisms and infrastructure funds increases the efficiency of commercial project implementation; foreign direct investment through concession mechanisms and mergers and acquisitions contributes to technological transfer and the introduction of modern management practices; international financial institutions, using grants and blended finance instruments, reduce investment risks and increase the investment attractiveness of sustainable infrastructure projects. It is the balanced combination of these sources and

risk-sharing mechanisms that allows reducing risk premiums, increasing investor confidence, and ensuring the long-term sustainability of infrastructure systems.

The results obtained made it possible to generalize the complex effects of sustainable infrastructure development that directly shape the resilience of the national economy. The economic effect is manifested in the reduction of losses from infrastructure disruptions and in supporting sustainable economic growth; the social effect is realized through improved accessibility of vital services and the strengthening of social stability; the environmental effect is associated with a reduced carbon footprint and an enhanced capacity of the economy to adapt to climate risks; the security effect consists in increasing the reliability of critical systems and ensuring the continuity of key sector operations. Taken together, these findings confirm that investment support for sustainable infrastructure development generates an integrated effect that goes beyond individual sectors and is reflected in strengthening the overall stability of the economic system.

Based on the analysis, it is concluded that the proposed research hypothesis is confirmed: investment support for sustainable infrastructure development cannot be reduced to an increase in the volume of financing alone but is determined by the structure of funding sources, the combination of financial instruments, and the institutional conditions governing their mobilization. It is this complex configuration of investment mechanisms that enhances the resilience of the national economy by improving the reliability of infrastructure systems, reducing systemic risks, and strengthening the adaptive capacity of the economy.

The practical significance of the results lies in the possibility of formulating targeted recommendations for key stakeholders in infrastructure policy and the investment process. For public authorities, it is advisable to implement a unified framework for prioritizing infrastructure projects based on resilience criteria, taking into account the criticality of services, the expected reduction in losses from disruptions, the level of climate adaptation and cyber resilience, as well as the multiplier effects for the economy. This approach ensures the concentration of resources in the most effective areas.

For financial and economic authorities and public investment management institutions, it is justified to expand risk-sharing instruments, particularly state guarantees and mechanisms aimed at enhancing the investment attractiveness and financial viability of projects, subject to compliance with transparency requirements, high-quality project preparation, and the availability of measurable performance indicators. Within public-private partnership and concession frameworks, the use of standardized project documentation packages, typical risk matrices, and uniform requirements for ESG, climate resilience, and cybersecurity is recommended, as this reduces transaction costs, increases investor confidence, and shortens project preparation timelines. For regulators and operators of critical infrastructure, it is important to institutionalize requirements for redundancy and service continuity as a prerequisite for access to concessional and blended financial instruments.

For international financial institutions and donors, scaling up blended finance mechanisms in combination with technical assistance for project preparation, reporting standardization, and the assessment of climate and security risks is advisable, as this can activate private co-financing. For businesses, banks, and institutional investors, the development of portfolios of sustainable infrastructure assets using standardized approaches to risk and performance assessment, including climate scenarios and reliability and continuity metrics, appears particularly promising.

Prospects for further research are associated with the methodological deepening of the assessment of investment effectiveness in sustainable infrastructure within the logic of "investments → infrastructure changes → resilience", particularly through the development of an integrated system of economic, social, environmental, and security indicators.

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