

UDC 338.47: 005.5

JEL Classification: O32, O38

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PROSPECTS FOR THE DEVELOPMENT OF THE INNOVATIVE ECOSYSTEM OF UKRAINE IN THE POST-WAR PERIOD

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After deep historical upheavals, Ukraine is on the threshold of a turning point in its post-war development, which requires a comprehensive study of the prospects and challenges that shape its innovation ecosystem. As part of the article, the authors researched strategies for accelerating the development of “green” technologies in Ukraine, which include renewable energy, hydrogen technologies, waste management, and environmentally friendly materials. The mechanisms that will contribute to the emergence and increase of the number of innovative startups dedicated to environmentally sustainable solutions that will contribute to the formation of the innovation ecosystem in Ukraine have been determined. The needs for strengthening the research infrastructure and strategies for attracting investments, which will contribute to the growth of green technologies, are analyzed. Potential ways of Ukraine’s participation in joint projects with international organizations and countries, which will accelerate the integration of green technologies into the post-war innovative ecosystem of Ukraine, are considered. Within the framework of this work, the key role of innovations in solving urgent issues of post-war recovery, reconstruction and sustainable development is emphasized. The aftermath of hostilities underscores the urgent need for recovery and diversification, with innovation at the heart of these transformative efforts. Green technologies, innovative startups and STEM-oriented educational paradigms are becoming key in Ukraine’s transition to sustainable development. In addition, international cooperation is recognized as a powerful catalyst for accelerating the innovative development of Ukraine. Active interaction with global partners promotes knowledge exchange, investment mobilization and implementation of best international practices, which accelerates progress in the development of innovations. As such, this scholarly analysis provides a compelling call to action, emphasizing the need for continued reform, improved education, and strengthened infrastructure. Ukraine, being at a turning point, has the latent potential to harness innovation as a dynamic force for economic revival, resilience and long-term stability in the post-war environment.

Keywords: Ukraine, post-war period, innovative ecosystem, sustainable development, green technologies.

DOI: 10.32434/2415-3974-2023-18-2-176-187

Introduction and problem statement

In the conditions of serious geopolitical and socio-economic challenges that Ukraine has faced in recent years, the country has found itself at a critical stage, which has profound consequences for its future development. The armed conflict in the East of

Ukraine, the annexation of Crimea in 2014, as well as the large-scale Russian military invasion had a significant impact on the country’s development trajectory.

First, the destruction of infrastructure and the loss of human capital during the war significantly

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affected Ukraine's ability to compete in the global innovation environment. Reconstruction and revitalization of the innovation environment is a complex decision that requires strategic planning, allocation of resources and coordination of interests of various stakeholders.

Second, the negative impact of the war on the economy determines the urgent need to stimulate innovation as a means of economic recovery and growth. Ukraine should identify new ways to attract investments, develop startups, and stimulate scientific and research activities. The effectiveness of these efforts will have far-reaching consequences for the economic stability of Ukraine in the post-war period.

In addition, the geopolitical context adds another layer of complexity to this problem. The strategic position of Ukraine as a state that is a kind of “bridge” between Eastern and Western Europe requires a balanced approach to innovation that would balance regional partnerships, trade agreements and geopolitical realities. A country must navigate these complex dynamics to leverage its innovation ecosystem for both domestic prosperity and international impact.

Analysis and evaluation of publications

A country's innovation ecosystem is a complex network of interconnected institutions, stakeholders, policy decisions, and economic resources that enable innovation-driven economic development. The ecosystem includes academic institutions, research centers, government agencies, private enterprises, venture capital and the regulatory framework that defines their interaction. The proper functioning of such an ecosystem is key to a country's ability to generate and leverage innovation, increase industrial competitiveness, promote economic sustainability, and ultimately improve the standard of living of its citizens.

As for Ukraine, the situation in the country demonstrates a complex relationship between geopolitical factors and the development of the innovation ecosystem. Armed conflict, economic turmoil and political uncertainty have not only limited the country's ability to invest in systematization and development, but have also disrupted international partnerships, impeded the spread of technology, and impeded the flow of talent and investment into the country. In this context, the reconstruction and restoration of the innovative ecosystem takes priority from both a scientific and a practical point of view and requires a comprehensive analysis to clarify the challenges and opportunities associated with the post-war reconstruction of Ukraine.

It is worth noting that the development of the innovation ecosystem attracts considerable attention and interest from both the scientific and expert

communities, which indicates the importance of this problem in the modern economic space.

Oh, Phillips Park, and Lee conduct a detailed analysis of innovative ecosystems, highlight their dynamics and features of functioning, which are important for understanding modern innovative and technological development [1].

Kafouros M. I., and Wang C. conducted a comprehensive review of the role of innovation in economic development, emphasizing its direct impact on economic growth [2]. Based on this fundamental work, Kuznetsov and Kuznetsova investigated the innovative ecosystem of Ukraine, emphasizing its importance for stimulating economic growth [3].

The work of Kuzior A. and others is dedicated to the study of the features of the EU innovation policy in the context of sustainable European development, the analysis of the parameters of the national innovation ecosystems of the EU member states and Ukraine in the global innovation environment with an emphasis on factors affecting their intellectual potential and competitiveness. The analysis not only identifies these key factors, but also offers political recommendations, which are especially relevant for Ukraine in the process of post-war reconstruction, regarding the strengthening of the systemic influence of the state on the national innovation ecosystem [4].

Pidorycheva and Antonyuk conducted an assessment of national innovation ecosystems in both EU countries and Ukraine, focusing on their sustainability for development [5, p. 3–19].

Shifting the focus to the urban context, Groom and Kobal Groom in their review (2023) investigated the sustainability and environmental sustainability of cities in the context of the COVID-19 pandemic and the challenges associated with the wartime scenario in Ukraine [6]. In their work, they explored how innovation can overcome uncertainty in the urban environment while aligning with large-scale post-war reconstruction efforts.

Finally, the Human Development Report, which has a holistic perspective, examines the far-reaching impact of the war in Ukraine on human development, including aspects of economic and environmental consequences [7].

At the same time, there is currently a lack of works that consider specific strategies and actions necessary to promote green and sustainable innovations in Ukraine's post-war innovation ecosystem.

The purpose of the article

Therefore, the purpose of this article is to assess the post-war prospects for the development of the innovative ecosystem of Ukraine with a special emphasis

on the promotion and integration of green technologies and ecological solutions into the innovative landscape of the country.

The analysis is aimed at solving a number of interrelated tasks that together contribute to the achievement of the main goal:

- explore strategies and initiatives aimed at accelerating the development and implementation of green technologies in Ukraine, including renewable energy, hydrogen technologies, waste recycling and environmentally friendly materials, as means to promote sustainable innovation;

- investigate mechanisms and support structures to promote the creation and growth of innovative startups that are engaged in the development of environmentally friendly solutions and technologies, thus enriching the innovative ecosystem of Ukraine;

- critically assess existing legal norms and standards related to environmental protection and safety in Ukraine, identifying areas where legal reforms are needed to promote and stimulate environmental innovation;

- investigate the development and implementation of educational programs and institutions aimed at training specialists in the field of ecology and innovation, providing a qualified workforce capable of stimulating the development of «green» technologies;

- analyze the needs for the activation of research and development infrastructure designed for environmental innovations, as well as explore strategies for attracting internal and external investments in this sector;

- explore potential ways of cooperation of Ukraine with international organizations and countries, using their experience and resources to accelerate the integration of green technologies and ecological solutions in the post-war innovation ecosystem of Ukraine.

Presentation of the main material

Against the background of the armed conflict, the integration of solutions in the field of green energy has become an integral part of Ukraine's energy development. In this context, the installation of solar panels has gone beyond government initiatives and has become a pragmatic response to the destruction and, in some cases, destruction of traditional energy infrastructure, including transmission lines, substations and distribution stations, caused by hostilities. These circumstances have pushed local communities in the affected regions to install solar panels in conjunction with energy storage systems, thereby mitigating existing electricity shortages and strategically positioning themselves to potentially supply excess energy to the

state at premium rates after the cessation of hostilities. This active participation in the adoption of solar energy by people with the means to invest underscores its role in shaping the country's postwar energy landscape. However, although some facts indicate the viability of solar energy, a comprehensive analysis based on empirical data is necessary to assess its true benefits in the Ukrainian context. The development of solar energy in Ukraine requires careful analysis compared to traditional methods of electricity production based on fossil fuels, in particular coal and natural gas, in order to identify its multifaceted advantages in terms of environmental sustainability, energy efficiency and economic viability.

Further coverage outlines the multifaceted advantages of solar energy development in Ukraine compared to traditional energy paradigms, substantiating its potential as an effective and sustainable alternative.

Environmental cleanliness: Solar energy is a source of clean energy that does not emit harmful emissions into the atmosphere and does not lead to environmental pollution, which makes it environmentally safe. But don't forget that green electricity, including solar energy, is considered cleaner compared to traditional energy sources such as coal, oil and natural gas. However, it is important to understand that no source of energy is completely clean, and it can have certain negative effects on the environment and human health. But if you compare conventional electricity and green energy, then it is more environmentally friendly.

Unlimited resources: Solar energy is based on solar radiation, which is an unlimited source of energy. This is different from traditional sources, which are based on the extraction of natural fuel, the reserves of which are limited.

Cost reduction: After installing solar panels on the roof of a building or using solar farms, owners can reduce their electricity costs. Under some conditions, this can even lead to a reduction or complete cessation of electricity payments.

Decentralization: Solar panels can be installed on the roofs of residential buildings and commercial facilities, which contributes to the decentralization of the energy system. This helps to reduce energy losses during transportation and increases the stability of the electric power system.

Promotion of sustainable development: The use of solar energy contributes to the reduction of greenhouse gas emissions and promotes sustainable development, helping the country meet its international obligations in the field of ecology and climate change.

Opportunities for income generation: This allows individual owners to generate additional income by selling excess electricity to the grid (known as “green tariff”).

Reduction of energy dependence: The use of solar energy helps to reduce dependence on imported energy sources, as it is a domestic source, access to which is more reliable [8].

With an emphasis on renewable energy, hydrogen technologies, waste processing, environmentally friendly materials, stimulating innovation and international cooperation. The country recognizes the importance of reducing dependence on imports and reducing CO₂ emissions. To achieve these goals, Ukraine implements various measures and programs, such as creating a favorable regulatory environment, establishing green energy tariffs, supporting investors, implementing modern waste processing technologies, and encouraging the use of recycled materials in production. In addition, Ukraine has created innovation funds, competitions and grant programs to support startups and research in the field of green technologies, and actively cooperates with international organizations and countries to accelerate the implementation of green technologies and stimulate innovation [8].

All these factors can also be related to wind energy. In general, green energy in Ukraine can be a more economically profitable and environmentally cleaner alternative to traditional electricity from a fuel source. After all, Ukraine is one of the few countries in Europe that has a very large territory.

This is very good for green electricity, because in some regions there may be solar panel stations, in others wind stations.

Solar projects are more mobile, they can be built in any region. If you look at the insolation map, its level does not fall below three units on approximately 80% of the country’s territory, which looks promising compared to other European countries. The main advantage of SES over wind turbines is that there is no need to carry out long (at least 1 year) and costly wind measurements on the selected site [9].

In any of the regions, regardless of climatic characteristics, specialized companies conduct mandatory wind speed measurements – at least once a year.

Wind generators should be installed in areas where the average wind speed is more than 8 m/s. The blades of large generators start rotating at a wind speed of 4 m/s; maximum efficiency is achieved at 12 m/s.

The main advantage of wind turbines over SES is year-round operation without reducing productivity in the autumn-winter period and at night.

At the same time, we have hydrogen electricity. The Atlas of the Renewable Energy Potential of Ukraine was recently created. He testifies that we can accommodate such a number of renewable sources that will allow us to fully provide for ourselves as a country, not to be dependent on the import of energy carriers here, and to cover a third of the needs of all the countries of the European Union. There are 27

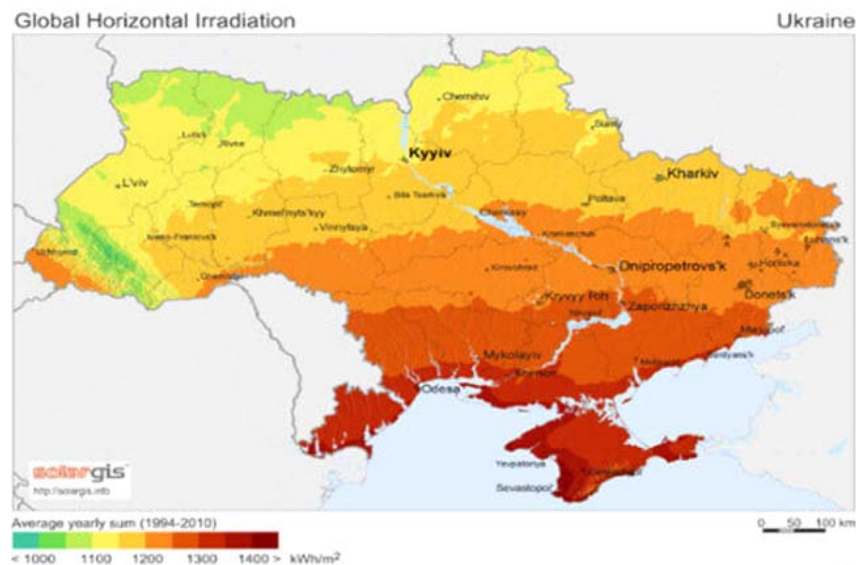


Fig. 1. Climatic characteristics for SPPs (Insolation map of Ukraine)

Source: [9]

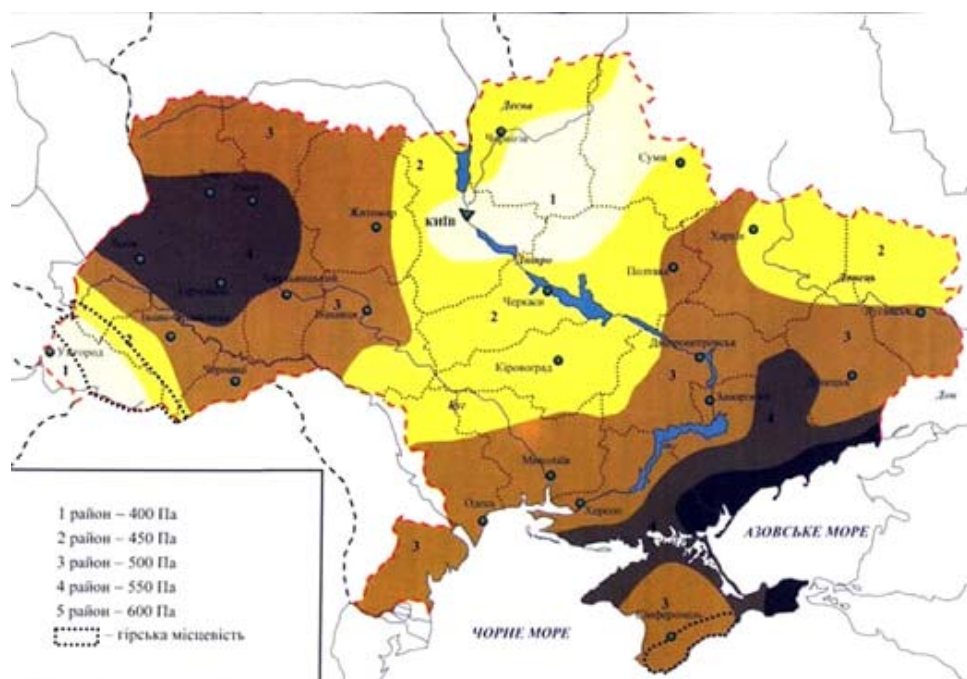


Fig. 2. Climatic characteristics for wind farms (wind map of Ukraine)

Source: [9]

countries. And we will be able to provide at least 7 of them in full. Ukraine has the second potential among European countries in terms of renewable energy. Therefore, we can use the water areas of our Azov and Black seas. Azov is generally great, the depth is up to 30 meters. This makes it possible to install such a number of windmills that even Norway would envy. And the main thing is that we are already connected with the countries of the European Union. We have a common border. And also – our electric and gas systems are connected at separate points [10].

We are also actively building and expanding infrastructure for hydrogen transportation, including road and rail. Our goal is to join the already developed transport corridors in Europe and become an active subject in these processes, not just an object.

The application of hydrogen technologies is broad and covers three main fields: heating, power generation and transport. It is important to consider that hydrogen can be used not only in wheeled vehicles, but also in rail, sea and even air transport. Although aircraft with hydrogen systems for flight are still at the development stage, hydrogen technologies are already being used on ships to ensure their vital activities.

For a full environmental boom, Ukraine needs to establish waste management and use of ecological materials, which are important aspects of sustainable development and environmental security in Ukraine

after the war. To implement this, you need to take comprehensive measures:

- development of environmental strategies and policies: the Government of Ukraine should develop and implement environmental strategies and policies aimed at solving issues of waste and the use of ecological materials. These strategies should define specific goals and measures to reduce waste and increase the use of sustainable materials;

- recycling and reuse: recycling and reuse systems should be developed and improved. This includes the creation of appropriate infrastructure for waste sorting and recycling;

- promoting the use of environmentally friendly materials: the government can provide incentives for the production and use of environmentally friendly materials, for example through financial incentives or tax reductions for companies that use such materials;

- conscious consumption: it is important to raise citizens' awareness of environmental issues and promote conscious consumption. This may include waste education campaigns and encouragement to choose green products;

- innovations and systematization: Innovations in the production and use of ecological materials have great potential for reducing the negative impact on the environment and efficient use of resources;

- international cooperation: Ukraine can

cooperate with international organizations and other countries to exchange experience and technologies regarding waste management and the use of ecological materials [8].

These are only general steps, but their implementation requires the joint efforts of government, citizens, businesses and other stakeholders. To succeed in this field requires decisive action and due attention to environmental issues. Because before the war, there were problems with this, as with all environmental issues.

It is worth noting that the creation of new companies that invent and develop inventions and technologies for environmental protection can help Ukraine after the war. For example, these companies can develop ways to clean air and water, reduce waste, and use solar energy. This will not only contribute to the preservation of nature, but also create new jobs and can make Ukraine stronger after the war.

Today, innovative entrepreneurship plays a key role in the modernization of the economy and contributes to the creation of high-tech industries with high added value and high-paying jobs. This is confirmed by world experience and a report on the startup ecosystem. With access to the Internet and a changing economic environment, startups can grow quickly and impact the status quo. These dynamics show that existing corporate strategies no longer meet the needs of a rapidly changing economy. Ease of access to global markets and rapid adoption of technology have led to rapid growth of startups. For example, in recent decades, startups have created a significant number of jobs, which has led to a positive impact on the development of the economy.

In countries with a developed innovation support system for startups, measures are often implemented to support venture capital, innovation management, consulting services, as well as financial support for business research and development in the form of grants and loans.

In Ukraine, innovative development has been declared a priority for many years, but not only are there still no similar instruments of state support, but also a formalized definition of the term “startup company” in the regulatory and legislative field [11].

Mechanisms and structures of support for environmental startups in Ukraine are of crucial importance for stimulating innovation and developing the country’s innovative ecosystem. Key initiatives include grant and funding programs, incubators and accelerators, technology parks and innovation centers, patent and legal services, networks and communities, education and training, and international cooperation.

Currently, there is support for startups, which is

embodied in the Ukrainian Fund for Startups, which is a state fund launched on the initiative of the Cabinet of Ministers of Ukraine. The mission of the fund is to promote the creation and development of technological startups at the early stages (pre-seed and seed), with the aim of increasing their global competitiveness. The process of selecting startups for granting grants takes place on a competitive basis: companies are evaluated and selected by a board of independent investment experts.

In order to promote environmental innovations and safety in Ukraine, it is necessary to carefully evaluate the legal framework and standards of environmental protection. Despite the fact that laws and regulations on environmental protection exist in Ukraine, the legal framework has shortcomings, in particular, fragmentation, inadequate supervision and insufficient compliance with international standards. Current legislation also lacks financial incentives and support measures for start-ups and enterprises in the field of green technologies. Legal reforms are needed to promote environmental innovation, including improving legislation, creating mechanisms for stimulating innovation, bringing it into line with international standards, and improving the system of environmental monitoring and control. Public participation in the development and improvement of environmental legislation is also crucial to ensure transparency and consideration of public interests.

Regarding the existence of environmental legislation of Ukraine, it is worth noting that it is a whole system of normative legal acts containing environmental legal norms that are able to regulate environmental legal relations arising in the field of the use of natural resources, environmental protection and environmental safety. The system of environmental legislation of Ukraine is quite progressive, because it was created already in the conditions of independence using the experience of world leaders in the field of environmental law. Today, we can safely state that the “legal vacuum” in the field of environmental protection and ecological safety, which was formed immediately after the declaration of independence, has been eliminated. Over the years, Ukraine has adopted several dozen laws and codes regulating the entire range of eco-legal relations in the state, including the “Law on Waste Management” [12], the “Law on the National Register of Emissions and Transfer of Pollutants” [13], “Law on Amendments to Certain Legislative Acts of Ukraine on Improving Legislation in the Field of Subsoil Use” [14].

Ukraine is a party to more than 20 international conventions and bilateral agreements related to

environmental protection. Ukraine's international obligations regarding the natural environment, the use of natural resources and ensuring environmental safety derive from the provisions of already ratified and those that are under consideration of conventions and agreements. Fulfillment by Ukraine of the obligations arising from the mentioned multilateral agreements requires bringing domestic legislation into compliance with the norms of international law and taking into account the existing international practice during the development of new legislative acts.

But Ukraine still needs to strengthen pollution standards to ensure cleanliness and environmental protection in Ukraine after the war. This process includes revising and strengthening norms and standards that determine the maximum permissible level of air, water and soil pollution. It is important to set strict limits on emissions of greenhouse gases such as carbon dioxide and methane, as well as other harmful substances such as hydrogen sulfide, ammonia, heavy metals and other chemical compounds that can negatively affect human health and the environment as a whole. This initiative is aimed at reducing pollution and creating a favorable and safe environment for the residents of Ukraine, as well as preserving the country's natural resources and biodiversity.

Also, the creation of a feedback system is an important element of improving environmental management in Ukraine. This system allows the public to be involved in the process of monitoring and enforcement of environmental laws, and also creates greater openness and accountability of the government to the public.

First of all, it provides citizens with access to information about the state of the environment and the implementation of environmental regulations. This includes the public availability of data on the level of air, water, and soil pollution, as well as the results of monitoring environmental indicators. Citizens should be able to easily find information about environmental indicators in their region.

The second aspect is the opportunity for citizens to file complaints and report violations of environmental regulations. A feedback system should be available so that citizens can report situations where environmental regulations are violated. This allows you to quickly react to problems and take measures to solve them. Such a system promotes the involvement of the public in active participation in the preservation of the environment and improvement of the ecological situation. Since our country is moving to the mobile level, with the help of the Diya application, it will all be very easy to implement.

Another extremely important decision for post-

war Ukraine is the development of education and training of specialists in the field of ecology and innovation. After key moments in its historical trajectory, including the Revolution of Dignity and the protracted conflict in the eastern regions, the annexation of Crimea and large-scale Russian military aggression, Ukraine faced urgent needs that prompted a paradigm shift towards creating a modern educational and training framework adapted to changing needs of the economy and the environment. Ecology has become one of the most important fields in which Ukraine has great potential. On the one hand, the country is rich in natural resources and unique ecosystems that need protection and sustainable use. On the other hand, Ukraine is highly dependent on the use of hydrocarbons and other unstable energy sources, which has a negative impact on the environment and requires the search for new, more environmentally friendly alternatives. In this context, the development of educational programs and educational institutions in the field of ecology becomes a critically important decision. A modern specialist in the environmental field must have not only theoretical knowledge, but also practical skills to effectively solve real environmental problems.

Innovation is a priority solution in the post-war context of Ukraine, which requires a number of imperative actions and strategic measures, including:

- institutional support: to strengthen the innovation ecosystem, Ukraine should focus on strengthening the institutional framework by creating specialized institutions, such as innovation promotion bodies, responsible for organizing and promoting policies, initiatives and programs related to innovation activities;

- investment in R&D: a key measure is to channel significant investment in research and development (R&D) across sectors, with a particular focus on new industries and technology-based innovation. This involves significant financial support for both public and private research and development initiatives;

- educational reforms: An integral part of innovative development is a comprehensive reform of the educational system with the aim of giving priority to STEM education, which will contribute to the training of a qualified workforce capable of catalyzing innovation. Curriculum revisions and improvements to STEM programs contribute to this goal;

- protection of intellectual property: establishing and strengthening strong mechanisms for the protection of intellectual property rights is essential to foster innovation. These measures act as an incentive for entrepreneurs and innovators, guaranteeing them

the security and recognition of their intellectual assets;

– cultivating a startup ecosystem: Developing a strong startup ecosystem through incentives, mentoring programs and funding mechanisms is essential to foster innovation. Startup-friendly policies and infrastructure are key components in this regard;

– public-private cooperation: Effective cooperation between the public sector, academia and private business is crucial. Public-private partnerships (PPPs) facilitate knowledge sharing, technology transfer and commercialization of research results, thereby driving innovation forward;

– streamlining regulatory processes: Streamlining regulatory processes, especially those related to business creation, patent applications and obtaining permits, is essential. This reduces bureaucratic obstacles that often inhibit the development of innovative enterprises;

– access to funding: facilitating easy access to a variety of funding options, such as venture capital, angel investors and innovation grants, is crucial for scaling innovation projects and startups;

– mechanisms for technology transfer: the establishment of technology transfer offices and proactive cooperation between academic institutions and industry play a central role in this process;

– international interaction: proactive interaction with international partners, involvement of research institutions, governments and organizations opens up opportunities for using world experience, sharing best practices and attracting foreign investment in innovative projects;

– innovation clusters: encouraging the creation of innovation clusters and networks that facilitate cooperation between business, academic institutions and research centers, stimulating knowledge exchange, joint research efforts and innovation synergies;

– development of a policy framework: It is necessary to carefully develop a comprehensive innovation policy that would clearly outline the government’s obligations regarding innovation development. It should contain clear goals, strategies and time frames;

– green and sustainable innovation: In accordance with the global imperatives of sustainable development, Ukraine should introduce incentives and support mechanisms adapted to green and sustainable innovation, thus aligning innovative activities with the goals of environmental protection and sustainable development;

– monitoring and evaluation systems: creating reliable systems for monitoring and evaluating the impact of innovation initiatives is crucial. These systems provide accountability, efficiency, and the potential for iterative improvements. The development of

infrastructure for research and development of environmental innovations is a matter of paramount importance in the modern world. Ukraine, like many other countries, is facing challenges related to climate change, environmental pollution and resource depletion. To address these challenges and become a more sustainable and competitive country, Ukraine needs to invest heavily in a research and development infrastructure for environmental innovation.

The development of infrastructure for research and development of environmental innovations is a matter of primary importance in today’s world. Ukraine, like many other countries, faces challenges related to climate change, environmental pollution and resource depletion. In order to solve these problems and become a more sustainable and competitive country, Ukraine needs to actively invest in the infrastructure of research and development of environmental innovations.

An innovative ecosystem with business incubators, venture capital funds and technology transfer offices is necessary for the implementation of research and development works in the market. Improving the research and development infrastructure in the field of environmental innovation is crucial for the advancement of technologies aimed at environmental protection and sustainable development. This article analyzes strategies for attracting investment in this sector, emphasizing the need for large-scale research in such areas as renewable energy and waste processing. Specialized research centers and laboratories equipped with modern equipment are important. The government should create investment platforms and promote collaboration between academia and the private sector. In addition, the creation of an innovation ecosystem is vital to the commercialization of research and development in the market.

The infrastructure for research and development of environmental innovations is not just physical buildings and equipment, but also an ecosystem that unites scientists, engineers, enterprises, technologies and finance. It plays a key role in solving modern environmental problems and developing new technologies that help preserve the environment and create a sustainable future. Research infrastructure includes scientific laboratories, research centers, universities, research stations and other institutions where analysis in the field of ecology is carried out. These facilities are equipped with modern technologies and tools that allow scientists to carry out high-quality evaluations and develop new innovative solutions. On the other hand, the infrastructure for the development of environmental innovations includes incubators, technology parks, accelerators, startups and other

organizations that promote the commercialization of innovative ideas and the creation of new products and services aimed at preserving nature and improving people's quality of life.

Investment is a vital source of funding for the development of infrastructure for research and the development of environmental innovation. The main purpose of investments is to create conditions for sustainable growth and development of this sector. Investments can be made by both public and private investors. State investments can be directed to the creation of basic infrastructure, the opening of new scientific laboratories and research centers, as well as to the support of educational programs and the training of young scientists. Private investments include financing startups, enterprises and projects that specialize in environmental innovation. This can be an important source of funding for the development of new technologies and their introduction to the market. To ensure the development of infrastructure for research and the development of environmental innovations, it is important for Ukraine to attract foreign investors. International cooperation and the attraction of foreign investments can become sources of knowledge, technologies and financial resources for the development of the sector.

Creating a favorable investment climate includes a number of measures:

a) improvement of the legal environment: conclusion of international agreements and creation of a legislative environment that protects investors and ensures their rights and interests;

b) creation of special investment zones: development of special zones where foreign investors can receive certain benefits and support for the development of environmental innovations;

c) transparency and risk management: ensuring transparency and reliable risk management in investment projects, which will attract more investors;

d) marketing and promotion: continuation of marketing initiatives to attract foreign investors and spread information about investment opportunities in the field of environmental innovation;

e) partnerships with international organizations: cooperation with international financial and growth organizations that can provide financial support and expert assistance for infrastructure development;

f) promotion of innovation: development of innovative programs and initiatives that attract investors aimed at creating new environmental technologies and solutions;

g) ensuring sustainability of investments: creation of conditions for long-term and stable development of investment projects in the field of environmental

innovations.

Reconstruction will be financed from all possible sources. The Ukrainian authorities have created a number of funds for this purpose: Small and medium business support fund, Army Support Fund, Fund for recovery and transformation of the economy, Humanitarian fund, State debt service and repayment fund, Fund for restoration of property and destroyed infrastructure.

It is also planned to create a separate Fund for the Reconstruction of Ukraine [15] for reconstruction. The development of infrastructure for research and development of ecological innovations and the attraction of investments in this sector are necessary to achieve sustainable development and ensure the preservation of the environment. Ukraine has the potential to become a leader in the field of environmental innovation, infrastructure and investment are key factors that will help realize this potential. Only thanks to the joint efforts of the government, business, scientific institutions and foreign investors will Ukraine be able to achieve success in the field of environmental innovation and ensure the sustainability of its future.

After analyzing the sexes, you can come to the following conclusions. Cooperation with international partners is one of the most important components of the successful development of Ukraine in the post-war period. After the end of the conflict, the country faces a large number of challenges and tasks, including economic recovery, ensuring stability and improving the quality of life of citizens. In this context, cooperation with international organizations and other countries becomes an important tool for achieving these goals. Further in the text, we will consider why cooperation with international partners is so important for post-war Ukraine and what opportunities it opens up.

One of the first and most important forms of cooperation of post-war Ukraine is cooperation with international organizations, such as the United Nations (UN), the European Union (EU), the International Monetary Fund (IMF) and others. These organizations provide support to Ukraine in restoring the economy, reforming civil society, improving the quality of education and health care, as well as strengthening law and order.

After the war, Ukraine received humanitarian aid from various international organizations and countries. This assistance includes medical assistance, food, equipment for the rehabilitation of victims, as well as housing for displaced persons. International partners are actively involved in efforts to restore the affected areas and support people affected by the

conflict.

Cooperation with international partners also includes financial support for the development of the economy and infrastructure. International loans and investments help restore and develop industry, the transport system, energy and other sectors that are key to the country's sustainable development. International partners also provide support in carrying out reforms in various spheres of society. This includes reforms in the judicial system, the fight against corruption, improving the quality of education and health care, as well as strengthening the right to protection of citizens. Cooperation with international partners also opens up opportunities for attracting foreign investments in various sectors of the economy. International investors may be interested in the development of Ukrainian business, infrastructure, technologies and innovative projects. This contributes to the creation of new jobs, an increase in production volumes, and an increase in Ukraine's competitiveness on the world market. International cooperation in the field of science and education is an important factor for the development of Ukraine's intellectual potential. Ukrainian universities, scientific institutes and laboratories cooperate with well-known international institutions, exchange scientific knowledge and technologies, which contributes to the development of science and education in Ukraine.

Cooperation with international partners also contributes to the strengthening of Ukraine's international relations. It helps the country take an active position in the international arena, cooperate in solving global problems and influence decision-making in international organizations.

Thus, cooperation with international partners is an integral part of the path to sustainable development and prosperity of Ukraine.

Conclusions

As part of the study, the prospects for the development of the innovative ecosystem of Ukraine in the post-war period were analysed.

It is established that, firstly, the destruction caused by the conflict emphasizes the urgent need for economic recovery and diversification, which can be effectively facilitated by innovative solutions and technologies. Second, the introduction of the special status “startup” and other regulatory reforms demonstrate the government's commitment to creating a favorable environment for entrepreneurial activity and innovative growth. Third, Green technologies, innovative startups and a skilled workforce are key components on Ukraine's path to sustainable development in the post-war period.

In addition, international cooperation is becoming

a compelling way to leverage expertise, attract investment, and facilitate knowledge sharing. Proactive interaction of Ukraine with global partners can accelerate its progress in the development of innovations and contribute to the integration of best practices.

In light of these findings, it is clear that Ukraine is at a turning point, with the potential to use innovation as a driver of economic growth and sustainable development in the post-war period. However, the way forward requires continued commitment to reform, investment in education and infrastructure, and a concerted effort to develop a dynamic innovation ecosystem.

The question of determining the key factors and strategies that can contribute to the reintegration of Ukraine into the global innovation ecosystem and ensure sustainable economic growth in the post-war period can become a relevant direction of further scientific research.

REFERENCES

1. Oh, D.-S., Phillips, F., Park, S., & Lee, E. (2016). Innovation Ecosystems: A Critical Examination. *Technovation*, 54, 1–6 [in English].
2. Kafouros, M. I., & Wang, C. (2015). The Role of Innovation in Economic Development: A Review of Recent Literature. *Journal of Innovation and Entrepreneurship*, 4(1), 18. DOI: <https://doi.org/10.1186/s13731-015-0025-7> [in English].
3. Kuznetsov, V., & Kuznetsova, O. (2021). Ukraine's Innovation Ecosystem: A Review of the Current State and Future Prospects. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(3), 91. DOI: <https://doi.org/10.3390/joitmc7030091> [in English].
4. Kuzior, A., Pidorycheva, I., Liashenko, V., Shevtsova, H., & Shvets, N. (2022). Assessment of National Innovation Ecosystems of the EU Countries and Ukraine in the Interests of Their Sustainable Development. *Sustainability*, 14(14), 8487. DOI: <https://doi.org/10.3390/su14148487> [in English].
5. Pidorycheva, I. Iu., & Antoniuk V. P. (2022). Suchasni tendentsii rozvytku ta perspektyvy innovatsiinoi diialnosti v naukomistkykh haluziakh promyslovosti Ukrainy [Modern trends in development and prospects for innovation in knowledge-intensive industries of Ukraine]. *SciHub*, 18, 3–19 [in Ukrainian].
6. Grum, B., & Kobal Grum, D. (2023). Urban Resilience and Sustainability in the Perspective of Global Consequences of COVID-19 Pandemic and War in Ukraine: A Systematic Review. *Sustainability*, 15(2), 1459. DOI: <https://doi.org/10.3390/su15021459> [in English].
7. United Nations Publications (Ed.). (2023). *Report of the secretary-general on the work of the organization 2023*. United Nations [in English].

8. Kuznietsov, M., & Melnyk, O. (2022). Kompleksne vykorystannia vidnovliuvanykh dzherel enerhii [Integrated use of renewable energy sources]. *ela.kpi.ua*. Retrieved from https://ela.kpi.ua/bitstream/123456789/48635/1/Kompleksne_2022.pdf. [in Ukrainian].

9. EDS DEVELOPMENT company. (2020). Vitriani abo soniachni elektrostantsii? Osoblyvosti vykorystannia zemli pid proekty [Wind or solar power plants? Features of land use for projects]. *eds-development.com*. Retrieved from <https://eds-development.com/vitriani-abo-soniachni-elektrostancii-osoblyvosti-vikorystannia-zemli-pid-proekty/>. [in Ukrainian].

10. ECOBUSINESS GROUP. (2020). De vykorystovuiutsia vodnevi tekhnologii: perspektyvy dlia Ukrainy [Where hydrogen technologies are used: prospects for Ukraine]. *ecolog-ua.com*. Retrieved from <https://ecolog-ua.com/news/de-vykorystovuyutsya-vodnevi-tehnologiyi-perspektyvy-dlya-ukrayiny/>. [in Ukrainian].

11. Ukrainian Society (Vol. 80). (2022). DOI:10.15407/socium2022.01_ [in Ukrainian].

12. Zakon Ukrainy Pro upravlinnia vidkhodam : redaktsiia 31 ber. 2023 roku № 2320-IX [The Law of Ukraine on waste management from edit March 31 2023, № 2320-IX]. (2023, March 31). *zakon.rada.gov.ua*. Retrieved from <https://zakon.rada.gov.ua/laws/show/2320-20#Text> [in Ukrainian].

13. Zakon Ukrainy Pro Natsionalnyi reiestr vykydiv ta perenesennia zabrudniuvachiv : pryiniaty 20 ver. 2022 roku № 2614-IX [The Law of Ukraine on National Register of Emissions and Transfer of Pollutants from September 20 2022, № 2614-IX]. (2022, September 20). *zakon.rada.gov.ua*. Retrieved from <https://zakon.rada.gov.ua/laws/show/2614-20#Text> [in Ukrainian].

14. Zakon Ukrainy Pro vnesennia zmin do deiakykh zakonodavchykh aktiv Ukrainy shchodo udoskonalennia zakonodavstva u sferi korystuvannia nadramy : pryiniaty 01 hrud. 2022 roku № 2805-IX [The Law of Ukraine on amendments to some legislative acts of Ukraine regarding the improvement of legislation in the field of subsoil use from December 01 2022, № 2805-IX]. (2022, December 01). *zakon.rada.gov.ua*. Retrieved from <https://zakon.rada.gov.ua/laws/show/2805-20#Text> [in Ukrainian].

15. Pylypenko, Ya. (May 19, 2022). Vidbudova Ukrainy pislia viiny: khto, yak i za chy hroshi [Reconstruction of Ukraine after the war: who, how and with whose money]. *www.epravda.com.ua*. Retrieved from <https://www.epravda.com.ua/columns/2022/05/19/687200/> [in Ukrainian].

Received 09.10.2023.

Revised 19.10.2023.

Accepted 20.11.2023.

Published 25.12.2023.

ПЕРСПЕКТИВИ РОЗВИТКУ ІННОВАЦІЙНОЇ ЕКОСИСТЕМИ УКРАЇНИ В ПІСЛЯВОЄННИЙ ПЕРІОД

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Після глибоких історичних потрясінь Україна перебуває на порозі переломного етапу свого післявоєнного розвитку, що вимагає всебічного вивчення перспектив і викликів, які формують її інноваційну екосистему. В рамках статті авторами досліджено стратегії прискорення розвитку “зелених” технологій в Україні, які охоплюють відновлювану енергетику, водневі технології, поводження з відходами та екологічно чисті матеріали. Визначено механізми, які сприятимуть виникненню та збільшенню кількості інноваційних стартапів, присвячених екологічно стійким рішенням, що сприятимуть формуванню інноваційної екосистеми в Україні. Проаналізовано потреби у зміцненні дослідницької інфраструктури та стратегії залучення інвестицій, що сприятимуть зростанню зелених технологій. Розглянуто потенційні шляхи участі України у спільних проєктах з міжнародними організаціями та країнами, що прискорить інтеграцію зелених технологій у післявоєнну інноваційну екосистему України. В рамках даної роботи наголошується на ключовій ролі інновацій у вирішенні нагальних питань повоєнного відновлення, реконструкції та сталого розвитку. Наслідки військових дій підкреслюють нагальну потребу у відновленні та диверсифікації, де інновації виступають основою для цих трансформаційних зусиль. Зелені технології, інноваційні стартапи та STEM-орієнтовані освітні парадигми стають ключовими у переході України до сталого розвитку. Крім того, міжнародна співпраця визнана потужним каталізатором прискорення інноваційного розвитку України. Активна взаємодія з глобальними партнерами сприяє обміну знаннями, мобілізації інвестицій та впровадженню найкращих міжнародних практик, що прискорює прогрес у розвитку інновацій. Таким чином, цей науковий аналіз містить переконливий заклик до дій, наголошуючи на необхідності продовження реформ, покращення освіти та зміцнення інфраструктури. Україна, перебуваючи на переломному етапі, має прихований потенціал для використання інновацій як динамічної сили для економічного відродження, стійкості та довготривалої стабільності у післявоєнному середовищі.

Ключові слова: Україна, повоєнний період, інноваційна екосистема, сталий розвиток, зелені технології.

PROSPECTS FOR THE DEVELOPMENT OF THE INNOVATIVE ECOSYSTEM OF UKRAINE IN THE POST-WAR PERIOD

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After deep historical upheavals, Ukraine is on the threshold of a turning point in its post-war development, which requires a comprehensive study of the prospects and challenges that shape its

innovation ecosystem. As part of the article, the authors researched strategies for accelerating the development of "green" technologies in Ukraine, which include renewable energy, hydrogen technologies, waste management, and environmentally friendly materials. The mechanisms that will contribute to the emergence and increase of the number of innovative startups dedicated to environmentally sustainable solutions that will contribute to the formation of the innovation ecosystem in Ukraine have been determined. The needs for strengthening the research infrastructure and strategies for attracting investments, which will contribute to the growth of green technologies, are analyzed. Potential ways of Ukraine's participation in joint projects with international organizations and countries, which will accelerate the integration of green technologies into the post-war innovative ecosystem of Ukraine, are considered. Within the framework of this work, the key role of innovations in solving urgent issues of post-war recovery, reconstruction and sustainable development is emphasized. The aftermath of hostilities underscores the urgent need for recovery and diversification, with innovation at the heart of these transformative efforts. Green technologies, innovative startups and STEM-oriented educational paradigms are becoming key in Ukraine's transition to sustainable development. In addition, international cooperation is recognized as a powerful catalyst for accelerating the innovative development of Ukraine. Active interaction with global partners promotes knowledge exchange, investment mobilization and implementation of best international practices, which accelerates progress in the development of innovations. As such, this scholarly analysis provides a compelling call to action, emphasizing the need for continued reform, improved education, and strengthened infrastructure. Ukraine, being at a turning point, has the latent potential to harness innovation as a dynamic force for economic revival, resilience and long-term stability in the post-war environment.

Keywords: Ukraine, post-war period, innovative ecosystem, sustainable development, green technologies.

REFERENCES

1. Oh, D.-S., Phillips, F., Park, S., & Lee, E. (2016). Innovation Ecosystems: A Critical Examination. *Technovation*, 54, 1–6 [in English].
2. Kafouros, M. I., & Wang, C. (2015). The Role of Innovation in Economic Development: A Review of Recent Literature. *Journal of Innovation and Entrepreneurship*, 4(1), 18. DOI: <https://doi.org/10.1186/s13731-015-0025-7> [in English].
3. Kuznetsov, V., & Kuznetsova, O. (2021). Ukraine's Innovation Ecosystem: A Review of the Current State and Future Prospects. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(3), 91. DOI: <https://doi.org/10.3390/joitmc7030091> [in English].
4. Kuzior, A., Pidorycheva, I., Liashenko, V., Shevtsova, H., & Shvets, N. (2022). Assessment of National Innovation Ecosystems of the EU Countries and Ukraine in the Interests of Their Sustainable Development. *Sustainability*, 14(14), 8487. DOI: <https://doi.org/10.3390/su14148487> [in English].
5. Pidorycheva, I. Iu., & Antoniuk V. P. (2022). Suchasni tendentsii rozvytku ta perspektyvy innovatsiinoi diialnosti v nauko-mistkykh haluziakh promyslovosti Ukrainy [Modern trends in development and prospects for innovation in knowledge-intensive industries of Ukraine]. *SciHub*, 18, 3–19 [in Ukrainian].
6. Grum, B., & Kobal Grum, D. (2023). Urban Resilience and Sustainability in the Perspective of Global Consequences of COVID-19 Pandemic and War in Ukraine: A Systematic Review. *Sustainability*, 15(2), 1459. DOI: <https://doi.org/10.3390/su15021459> [in English].
7. United Nations Publications (Ed.). (2023). *Report of the secretary-general on the work of the organization 2023*. United Nations [in English].
8. Kuznietsov, M., & Melnyk, O. (2022). Kompleksne vykorystannia vidnovliuvanykh dzherel enerhii [Integrated use of renewable energy sources]. *ela.kpi.ua*. Retrieved from https://ela.kpi.ua/bitstream/123456789/48635/1/Kompleksne_2022.pdf. [in Ukrainian].
9. EDS DEVELOPMENT company. (2020). Vitryani abo soniachni elektrostantsii? Osoblyvosti vykorystannia zemli pid proekty [Wind or solar power plants? Features of land use for projects]. *eds-development.com*. Retrieved from <https://eds-development.com/vitryani-abo-sonyachni-elektrostancii-osoblyvosti-vikoristannya-zemli-pid-proekti/> [in Ukrainian].
10. ECOBUSINESS GROUP. (2020). De vykorystovuiutsia vodnevi tekhnolohii: perspektyvy dlia Ukrainy [Where hydrogen technologies are used: prospects for Ukraine]. *ecolog-ua.com*. Retrieved from <https://ecolog-ua.com/news/de-vykorystovuyutsya-vodnevi-tehnologiyi-perspektyvy-dlya-ukrayiny> [in Ukrainian].
11. Ukrainian Society (Vol. 80). (2022). DOI:10.15407/socium2022.01 [in Ukrainian].
12. Zakon Ukrainy Pro upravlinnia vidkhodam : redaktsiia 31 ber. 2023 roku № 2320-IX [The Law of Ukraine on waste management from edit March 31 2023, № 2320-IX]. (2023, March 31). *zakon.rada.gov.ua*. Retrieved from <https://zakon.rada.gov.ua/laws/show/2320-20#Text> [in Ukrainian].
13. Zakon Ukrainy Pro Natsionalnyi reiestr vykydiv ta perenesennia zabrudniuvachiv : pryiniaty 20 ver. 2022 roku № 2614-IX [The Law of Ukraine on National Register of Emissions and Transfer of Pollutants from September 20 2022, № 2614-IX]. (2022, September 20). *zakon.rada.gov.ua*. Retrieved from <https://zakon.rada.gov.ua/laws/show/2614-20#Text> [in Ukrainian].
14. Zakon Ukrainy Pro vnesennia zmin do deiakykh zakonodavchykh aktiv Ukrainy shchodo udoskonalennia zakonodavstva u sferi korystuvannia nadramy : pryiniaty 01 hrud. 2022 roku № 2805-IX [The Law of Ukraine on amendments to some legislative acts of Ukraine regarding the improvement of legislation in the field of subsoil use from December 01 2022, № 2805-IX]. (2022, December 01). *zakon.rada.gov.ua*. Retrieved from <https://zakon.rada.gov.ua/laws/show/2805-20#Text> [in Ukrainian].
15. Pylypenko, Ya. (May 19, 2022). Vidbudova Ukrainy pislia viiny: khto, yak i za chyi hroshi [Reconstruction of Ukraine after the war: who, how and with whose money]. *www.epravda.com.ua*. Retrieved from <https://www.epravda.com.ua/columns/2022/05/19/687200/> [in Ukrainian].