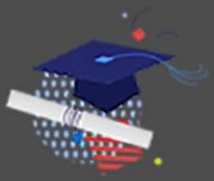
SUSTAINABLE DEVELOPMENT: MODERN THEORIES AND BEST PRACTICES



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Materials of the Monthly International Scientific and Practical Conference (October 31 – November 1, 2024)

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The collection consists of materials from the Monthly International Scientific and Practical Conference “Sustainable Development: Modern Theories and Best Practices”. They represent scientific research results in such scientific areas as financial and economic, managerial and legal, social and cultural, ecological and technical, educational and pedagogical issues of sustainable development on local, regional and international levels.

Keywords: Sustainable Development, Financial Issues of Sustainable Development, Economic Issues of Sustainable Development, Managerial Issues of Sustainable Development, Legal Issues of Sustainable Development, Social Issues of Sustainable Development, Cultural Issues of Sustainable Development, Ecological Issues of Sustainable Development, Technical Issues of Sustainable Development, Regional Features of Sustainable Development, International Cooperation for Sustainable Development, Educational Institutions and Pedagogy for Sustainable Development.

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CONTENT

FINANCIAL AND ECONOMIC ISSUES OF SUSTAINABLE DEVELOPMENT

ENVIRONMENTAL AND TECHNICAL ISSUES OF SUSTAINABLE DEVELOPMENT

INTERNATIONAL COOPERATION FOR SUSTAINABLE DEVELOPMENT

FINANCIAL AND ECONOMIC ISSUES OF SUSTAINABLE DEVELOPMENT

EVALUATION OF COMMERCIAL OPPORTUNITIES OF INNOVATIVE TECHNOLOGY

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Innovative technology is a new or significantly improved method, process, product, or tool that introduces new capabilities to meet market needs, increase the efficiency, quality, or speed of production processes. Innovative technologies can be the result of scientific research, discoveries, new approaches in production, management or product development. They can significantly change the competitive position of the company, opening up new markets or improving the processes of an existing business.

Innovative technologies provide the company with unique advantages over competitors. They allow the company to create products that better meet the needs of customers, adapt faster to market changes, and offer better solutions than competitors. Innovations allow you to reduce production costs by optimizing processes, reducing material consumption, automation and reducing the time to complete operations. This increases production efficiency, which is critical for increasing profitability. Innovative technologies help to improve the quality of the final product. This helps to increase customer satisfaction, reduces maintenance and advertising costs, reduces the risk of complaints and product returns, which has a positive effect on the financial performance of the company. With innovative technology, businesses can create entirely new products or services that open up new market segments. This allows the business to diversify its operations, reducing the risk of dependence on a single product or market. The use of innovations allows the company to remain relevant in the market, constantly improving and responding to new challenges. This ensures sustainable growth and strengthens the market position, increasing the value of the company in the long run. Working with innovative technologies stimulates the interest and motivation of employees. The introduction of the latest technologies often requires staff to learn new skills, which contributes to professional development. Such an atmosphere supports creativity and interest in development, which has a positive effect on productivity. Improving the company's reputation and increasing investment attractiveness Innovative enterprises usually have a positive image among customers, investors and partners. They are perceived as progressive, reliable, and able to adapt to market changes. This increases investment attractiveness and makes it easier to attract additional resources for business expansion.

Assessing the commercial feasibility of an innovative technology is the process of determining its market potential, competitive advantages, attractiveness to investors, and ability to generate profits. Such an assessment helps to understand whether it is worth investing resources in the commercialization of the technology and what strategies are

better to use to promote it to the market.

The main stages of assessing the commercial capabilities of an innovative technology include the following provisions.

1 . *Analysis of market potential.* Identifying the target market: The first step is to identify the primary market that the technology is aimed at. It is important to assess the size of the market, its growth dynamics, and the geographic regions with the greatest demand. Market segmentation: An assessment of which customer segments are most interested in an innovative technology. For example, for biotechnology, these can be medical institutions, research centers, and pharmaceutical companies. Demand for technology: analysis of consumer needs, level of interest in technology,willingness to buy or use an innovation. This includes exploring potential applications of the technology and possible areas of development.

2 . *Analysis of the competitive environment.* Competitor identification: It is important to identify existing and potential competitors who may affect commercial success. Market analysis should cover direct and indirect competitors who may offer similar products or solutions. Technology comparison: An assessment of how much a technology is ahead of competitive products in terms of features, functionality, cost, quality, usability, and more. Barriers to market entry:Identification of constraints that may make it difficult to enter the market, such as high certification requirements, licensing, legal constraints, or the complexity of logistics processes.

3 . *Assessment of technological and functional advantages.* Unique competitive advantages: analysis of the uniqueness of an innovation and its ability to solve problems that other solutions on the market cannot cope with. This can be, for example, high efficiency, cost reduction or ease of use. Adaptability and scalability: It is important to assess how easily the technology can be adapted for other industries or scaled to expand the market base. Patent protectability: The presence of a patent or other forms of intellectual property protects the technology from copying, which is critical for long-term business value.

4. *Financial assessment of commercial potential.* Estimating Implementation Costs: Includes costs for production, marketing, sales, logistics, and product support and development. Projected revenues: estimating the volume of possible sales, calculating the average selling price of the product, forecasting revenue and profitability based on demand. Return on Investment (ROI): An estimate of the return on investment and return on investment. This gives an idea of how quickly the technology can start generating revenue after implementation.

5. *Risk analysis.* Market risks: These are risks associated with changing consumer preferences, price competition, regulatory constraints, and economic fluctuations. Technology risks: include the possibility that a technology may not meet consumer expectations or that it may be quickly supplanted by newer technologies. Financial risks: assessment of possible financial losses due to low demand, exceeding the budget for development or commercialization.

6. *Evaluation of commercialization options.* Direct Sales or Licensing: Determining the best way to monetize a technology. Direct sales require more control over the market, and licensing reduces financial risks but reduces profits. Strategic Partnerships or Joint Ventures: Working with companies that can provide market entry, market presence, or infrastructure. Spin-off or standalone startup: if the technology is fundamentally different from the company's core business,It may be advisable to set up a separate business.

7. *Analysis of the impact on the ecosystem and stakeholders.* Engagement with key stakeholders: This includes exploring how technology will impact customers, partners, suppliers, and other stakeholders. Impact on the market ecosystem: Disruptive technologies can be game-changers in the market, creating new business opportunities or crowding out old solutions.

8. *Study of the regulatory environment.* Legal requirements: assessment of legal aspects, such as certification, licensing, environmental standards, or export restrictions, that may affect commercialization. Funding and support opportunities: Exploring available government programs, subsidies, tax breaks, or investors that may facilitate commercialization.

9. *Checking the interest of the market.* Pilots and Testing: Conducting pilots to test how the market responds to the new technology. This can provide useful information about product adoption, identify weaknesses, and confirm consumers' willingness to pay for new technology. Marketing testing: analysis of market reaction through advertising, demos, consumer surveys. It helps you understand which marketing tools work best.

Innovative technologies are the driving force for the enterprise, which contributes to its effective development, improving productivity, improving product quality and strengthening market positions. Through innovation, businesses can adapt to rapid market changes, create new products, open up new business opportunities, and ensure long-term sustainability.

Evaluation of the commercial opportunities of innovative technology is a multidimensional process that includes analysis of the market, competitors, financial aspects, risks and commercialization strategies. A thorough study of these factors allows you to make an informed decision about the possibilities and ways of implementing the technology, reducing risks and increasing the chances of a successful entry into the market.

EVALUATION OF EFFICIENCY OF INNOVATION ACTIVITY OF AN INDUSTRIAL ENTERPRISE

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The economic efficiency of an industrial enterprise is determined by a set of indicators that characterize the ability of the enterprise to rationally use resources to achieve its goals, in particular profitability, productivity growth and improvement of product quality. The main components of economic efficiency include the following elements.

1. *Financial efficiency*. Reflects the ability of an enterprise to generate profits and use capital rationally. Key indicators of financial performance: profitability (profitability) is the level of income from invested funds (profitability of products, assets, equity, etc.); net profit — the amount that remains after deducting all expenses from total income; Liquidity ratio is the ability of a company to cover short-term liabilities own assets.

2. *Labor productivity.* Labor productivity shows the efficiency of the use of labor

force using the following indicators: output per employee — the volume of production produced by one employee per unit of time; labor intensity is the amount of labor resources required to produce a unit of production; Time efficiency – measures how optimally working time is used without downtime or time overruns.

3 . *Material consumption.* Reflects the amount of material resources required to manufacture a unit of production: Material consumption coefficient is an indicator that determines the ratio of material costs to the total cost of manufactured products; Efficiency of the use of raw materials and materials is an assessment of the rational use of resources, including processing and loss reduction.

4. *Energy efficiency*. Reflects the rational use of energy resources: energy intensity — the amount of energy consumed per unit of production; energy-efficient technologies — the introduction of modern methods of reducing energy consumption in the production of products.

5. *Production efficiency*. It characterizes the ability of the enterprise to organize the production process in such a way as to minimize costs and maximize results. To do this, we recommend using the following indicators: the rate of return on capital is the ratio of the volume of manufactured products to the value of fixed assets (capital); use of production capacities — assessment of the level of utilization of existing production capacities, which allows to reduce the cost per unit of production;Efficiency of labor organization — optimization of production processes, which reduces the cost of time and resources.

6. *Product quality.* Product quality is a critical component of economic efficiency, as high-quality products help to reduce the number of complaints, increase customer satisfaction and customer loyalty. The most important indicators of this component of the efficiency of an industrial enterprise, in our opinion, should be considered the following: defective rate is an indicator that estimates the volume of defective products from the total number of products; Complaint rate — number returns and complaints from consumers; Durability and reliability are indicators that determine the duration and reliability of product use.

7 . *Innovative efficiency*. Assessment of the introduction of new technologies, processes or products to increase the competitiveness of the enterprise is characterized by the following indicators: the speed of innovation is the time it takes to integrate new technologies into production; investment in research and development (R&D) — an estimate of the costs of innovation and its contribution to the overall efficiency of the company; share of new products in the total portfolio — the number of new products compared to the old ones, which shows the level of innovation of the company.

8 . *Social efficiency.* Social aspects affect the image of the enterprise and its attractiveness as an employer are recommended to be assessed by the following indicators: employee satisfaction — the level of employee satisfaction that can have a positive impact on productivity; the level of staff turnover shows the stability of the team and affects the cost of training new personnel; Expenditure on social programs is an investment in employees' well-being, safety, and professional development.

9. *Environmental efficiency.* In modern conditions, it is also important to assess the impact of production on the environment. To do this, you should pay attention to the state of the following indicators: volume of emissions and waste — the amount of harmful substances released into the environment; efficiency of waste disposal — measures aimed at recycling waste that reduce environmental impact; Rational use of

resources is the use of resources, such as water and energy, taking into account their restoration and conservation.

Assessment of the economic efficiency of an industrial enterprise requires an integrated approach, including an analysis of financial, production, innovation, social and environmental indicators. This allows the company to better understand its strengths and weaknesses, optimize costs, increase productivity and adapt to market changes. At the same time, in our opinion, special attention should be paid to the component of innovative efficiency, on which other components largely depend.

Evaluation of the efficiency of innovation activity of an industrial enterprise is a key aspect for determining its impact on the overall productivity, competitiveness and financial results of the company. The effectiveness of innovation activity can be assessed by various criteria that help to understand how successful innovative projects are and whether they correspond to the strategic goals of the enterprise.

The main methods and criteria for evaluating the efficiency of innovation activity of industrial enterprises, in our opinion, should be formed as follows.

1 . *Financial performance.* Financial metrics are one of the most important when evaluating innovation, as they demonstrate the impact of innovative projects on a company's financial performance. Such indicators include: return on investment (ROI) — shows how effectively investments in innovation generate profits; Net present value (NPV) – helps to assess whether innovations provide sufficient added value in view of future cash flows; Internal rate of return (IRR) shows the minimum rate of return provided by innovative investments.

2. *Technical indicators*. These indicators assess the technical progress that has been achieved through innovation: product or process innovativeness — how advanced new products or processes are compared to competitors and the market as a whole; increase in labor productivity — shows how innovations have affected the speed and volume of production without reducing quality; Reduction in the cost of production — measures how much new technologies or production methods have reduced unit costs.

3 . *Economic indicators.* Economic indicators make it possible to assess the overall efficiency of innovations in terms of economic value: the cost saving effect shows how much the company has saved due to innovation projects; Sales and market share growth – An assessment of how innovation is driving market share and new customer acquisition. Reduction of production cycle time - analyzes how quickly it is possible to manufacture products after the introduction of new methods.

4 . *Social and organizational indicators.* Innovations often contribute to higher employee engagement and better working conditions: employee satisfaction and motivation – evaluates how much new methods or technologies increase job satisfaction; Improving corporate culture – assessing the impact of innovation on overall culture, collaboration, and team spirit.

5 . *Environmental performance.* Given the growing importance of sustainable development, environmental aspects are also an important part of the assessment: reduction of harmful emissions and waste – measures the extent to which innovation contributes to reducing the environmental impact of production; Rational use of resources shows whether it was possible to reduce the consumption of energy, water and other resources.

6 . *Innovative indicators.* Evaluation of the effectiveness of innovation activity also includes metrics that determine the speed and frequency of introduction of new ideas: the

number of new products or services — how many new products were created during a certain period; Reducing the time to implement new technologies is an analysis of how quickly a company can adapt and implement innovations in work processes.

7. *Customer metrics.* It is important to consider how innovations affect customer satisfaction: customer satisfaction is an assessment of customer satisfaction with new products, the quality of services, or the level of service; Consumer loyalty is an analysis of how innovations affect repeat purchases and positive customer reviews.

The efficiency of innovation activity of an industrial enterprise is determined not only by financial indicators, but also by technical, economic, social and environmental aspects. Taking into account all these factors allows you to see a complete picture of the impact of innovations on the enterprise and make more informed decisions on the development of innovative projects.

INFRASTRUCTURE TRANSFORMATION IN THE FINANCIAL SECTOR: PATHWAYS TO SUSTAINABLE DEVELOPMENT

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Financial infrastructure is rapidly changing and reshaping the global economic landscape, fueled by technology, regulatory and the pressure to achieve sustainable development (Guley, Koldovskyi, 2023). To realize resilient and sustainable financial systems, digital technologies, green finance, as well as innovative investment approaches need to be fully integrated. Technological innovation, regulatory frameworks and stakeholder collaboration are explored in relation to their role in enabling the goals of sustainability within the financial sector.

Financial infrastructure further advancement of sustainable development. Financial infrastructure is defined as the bedrock of economic activity, which includes banking, payment systems, capital markets and financial regulation. Unprecedented technological innovation, ranging from blockchain, digital payments to AI has recently pushed back the traditional financial processes in terms of high efficiency and transparency. Furthermore, the increasing focus on environmental, social and governance (ESG) criteria has expedited sustainability's entry into the world of financial decision making (Prokopenko et al., 2024). For example, the urbanization policy applied in China has helped drive financial transformation, while regulation can influence finance: the European Union's Green Deal to reach net-zero carbon emissions by 2050 has spurred Europe to adopt green bonds and other sustainable financial products, as a further example.

Despite great variation in experience, examination of the experience in different regions shows the transformation of financial infrastructures have brought about benefits in enhancing financial inclusion, investment in sustainable projects, and the efficiency of capital markets. For instance, mobile money platforms like M-Pesa in Kenya have made bill payments instantly and secured the transfer of money from one wallet to another

wallet and transformed the method of payments and revolutionized the inclusion of financial services through millions of people around the world previously excluded from them through past banking systems. Over 80% of the Kenyan adult population now uses mobile money, facilitating small business growth, reducing poverty (World bank, 2024). Similarly, green finance has had a burst of growth, as shown by a global green bond market of over $1 trillion in 2023, as compared to just a decade ago, with more investment flowing into renewable energy, sustainable infrastructure, and climate adaptation projects. Digital platforms have also facilitated issuance of and trading in green bonds, easing investment in such projects.

Although these advancements exist, harmonizing financial infrastructure change and SDGs still remains a challenge. There is also an uneven dispersal of benefits from technology, with developing countries disadvantaged by not being able to fully engage in the new operating environment of the future financial landscape. For instance, digital payments and fintech services are prevalent in China and the US, but in sub-Saharan Africa where internet connectivity and digital literacy remain far behind, these experiments aren't very far reaching. However, it is not without concern for the way digital technologies can be misused for illegal purposes, like money laundering and cybercrimes, which may not serve the sustainability agenda.

A second challenge is how to build up regulatory frameworks which offer incentives for companies to practice sustainability but also keep finance viable. The first is the European Union's Sustainable Finance Disclosure Regulation, which mandates the financial market participants to disclose how they address the sustainability risks with their investment decisions (IMF, 2023). Yet, the absence of uniform global standards to the point that creates disparity among investors to appraise the sustainability of a project from one location to another. Also, traditional financial institutions might resist the transition to sustainable finance because of high initial cost in adopting new technologies and practices.

To overcome these challenges, a few measures are proposed. Even more than creating new providers of millions in user's KYC, first, it will be essential to close the digital divide in the world by supporting investments in digital infrastructure in developing regions. To fully fund digital literacy programs, and improve internet in underserved areas international development organizations should work with private sector partners. Second, there should be harmonized global standards for sustainable finance that governments should set up to ensure there is stability, and consistency as well as transparency in different markets. That could involve synchronizing disclosure requirements and taxonomies as the EU seeks to build one common classification system for sustainable economic activities.

It, in turn, supports public private partnership which is needed to establish sustainable financial infrastructure. A green infrastructure could, for example, be financed via public private partnerships using private capital in combination with public sector support. Finally, AI and machine learning can be integrated in financial systems to improve risk assessment and fraud detection and help to build a more resilient and sustainable financial ecosystem.

Financial infrastructure transformation creates vast opportunity to advance sustainable development by expanding finance inclusion, green investments, and the efficiency of financial markets. Examples from the real world, like the success of mobile money in Kenya, or the rapid development of the green bond market, show the

opportunity in bringing digital technologies and sustainable practices together in financing systems. However, there are challenges with regards to the digital divide, regulatory fragmentation, and resistance from traditional institutions, and these challenges need to be addressed to realize these opportunities fully. Financial institutions are capable of playing the capital needed to make and develop those recommendations; by doing so, through investing in digital infrastructure, harmonizing global standards, and aligning public and private partnerships, they hold a large potential for leading by example towards a global sustainable development.

Navigating the pathway to sustainable financial infrastructure is challenging, but there is an opportunity to realize a significant contribution of the financial sector to the achievement of the United Nations Sustainable Development Goals and the creation of a more resilient and more inclusive global economy, through focused action and a spirit of collaboration.

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INVESTMENT SUPPORT FOR THE GREEN TRANSFORMATION OF HOUSEHOLDS DURING THE WAR AND IN THE POST-WAR PERIOD

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The problems of sustainable energy supply for household consumers during wartime in Ukraine are exacerbated due to the critical destruction of the power infrastructure caused by constant shelling and, therefore, growing costs of energy companies for its restoration and maintenance. This situation leads to an objective increase in utility prices and deepening energy poverty. To reduce the financial pressure on the state to subsidize socially vulnerable groups of the population, it is promising to introduce strong investment support for the transition of such households to partial or full energy supply using renewable energy (RE) technologies and actively implementing energy-efficient (EE) measures. These technologies and measures reduce the negative impact of rising utility costs and deteriorating reliability of power supply to household consumers while advancing environment quality.

Improved energy policy in the residential sector should financially motivate households to make EE changes and implement green energy technologies, turning households into prosumers. Such support can be implemented in two forms, adapted to the international experience and the particularities of Ukraine's households:

1) providing interest-free loans for the implementation of EE measures and RE technologies (Sotnyk et al., 2022);

2) providing partial compensation for investments in such projects (for example, along the lines of the pre-war "warm loans" program) (CMU, 2011; SAEESU, 2021).

The specific feature of such support should be a focus on financing those households that cannot afford to take measures to improve their energy supply. This focus provides equal rights to the poorest to take advantage of opportunities to increase their energy independence and break the cycle of energy poverty. However, it raises the question of how to manage the budget funds allocated for investment support to maximize the effect at the state, regional, and individual household levels so that these funds do not repeat the fate of utility subsidies, which are consumed without any positive effect for the state and its energy independence. In this regard, the pre-war program of "warm loans" for EE measures (CMU, 2011; SAEESU, 2021) was quite effective, as the state provided partial compensation for the body of the loan taken from a bank to implement such measures, while some regions and municipalities offered additional compensation for part of the loan interest. As a result, public investment in energy savings was leveraged with private household investment at a ratio of 1:3, meaning that for every 1 hryvnia the state invested in compensation payments, households invested 2 hryvnias of their funds (Economic, 2021). However, the problem with this program was the high number of applicants for such loans, which meant that the funds allocated by the

government were insufficient and quickly used up each year.

In wartime, the question of the efficient distribution of public funds is highly acute. Therefore, precise approaches are needed to define and differentiate the levels of state support for investments in households' energy independence. To this end, the minimum percentage of state compensation for "energy independence loans" to the population should be determined based on budgetary capacities and the attraction of donor support from other countries and international organizations and then increased differentially using various coefficients that consider regional peculiarities, the financial situation of households, the technologies and measures planned to be implemented, etc. Table 1 provides a basic list of factors that could be considered at the national/regional level through the relevant coefficients for implementing EE measures and RE technologies in the residential sector.

Table 1

Characteristics of factors and coefficients that may be considered in providing state (regional) investment support for EE measures and the installation of RE technologies in the household sector

The coefficient that considers:	Factors considered in the respective coefficient:
1Economically expedient unrealized potential of RE/EE technology	• natural conditions for the development of RE technology; • types of EE measures (technologies) that allow energy savings in the household sector; • a list of RE and EE technologies that are economically feasible for implementation in the residential sector of the country (region) at the current level of technological progress and their technical characteristics; • the economically feasible potential of implementing specific RE/EE technology in the residential sector of the country (region); • actual level of implementation of a particular RE/EE technology in the country (region).
2 Energy provision of the country (region)	• the total energy demand of the household sector in the state (region); • the energy demand of the household sector in the state (region) met through households' power generation based on RE technologies; • the energy demand of the household sector in the state (region) met through reduced (saved) energy consumption by households due to implementing EE measures.
3 Reliability and quality of energy supply	• status and level of power infrastructure development in the state (region) in the context of public access to energy services; • the quality and reliability of the existing power grids in the state (region), the frequency and duration of emergencies and scheduled outages in the power grids; • the level of destruction of energy facilities and the status of their restoration; • energy losses in centralized power grids.
4 Achieved level of energy supply decentralization	• available transmission capacity of power grids in the state (region); • the degree of decentralization of energy supply (in particular, the installed capacity of decentralized energy facilities) in the state (region), including in the household sector.
5 Impact of RE/EE technology on balancing the energy system of the state (region)	• level of energy system balancing in the state (region); • demand for maneuvering and energy storage capacities; • stability of energy supply based on a specific RE technology in the state (region), including the ability of RE technology to respond quickly to changes in demand and supply; • the installed capacity of maneuvering power plants and energy storage systems in the country (region); • projected reduction in load on power grids as a result of implementing a specific RE technology or EE measure.
6 Promotion of the development of RE/EE technology in the country (region)	• available national, regional, and local programs for preferential loans and tax incentives for investments in specific RE technologies and EE measures; • the existence and level of feed-in tariff for specific RE technology that can be implemented in the household sector; • regularity of feed-in tariff payments for specific RE technology; • the financial burden on the state budget due to feed-in tariff payments for specific RE technology in the household sector; • the financial burden on the state (regional) budget due to the provision of investment financial support for specific RE/EE technology in the household sector.
7 Environmental and social impact of implementing RE/EE	• level of environmental pollution in the state (region) and the potential for its reduction through the implementation of specific RE/EE technology in the household sector;

Additionally, at the household level, it is advisable to consider the following factors for adjusting the amount of investment support provided to specific households:

– complexity of the technical implementation of specific RE/EE technology in the household;

– investment in RE/EE technologies (per 1 kW of installed capacity of the RE plant, specific cost per 1 kWh of energy saved through EE measures);

– timelines for implementing an investment project (RE plant, EE measure) and the project's lifecycle duration (period of receiving benefits);

– the proposed installed capacity of the RE plant and/or energy storage system, the volume of energy savings resulting from the EE measure;

– annual electricity generation by the RE plant and energy savings resulting from the EE measure;

– type of RE plant (off-grid, grid-tied, with or without an energy storage system) and the degree of decentralization of household power supply achieved through specific RE technology implementation;

– household income level;

– level of household expenditures on utilities;

– possibility and stability of household access to the centralized power grid, etc.

The specified coefficients and factors identified for consideration at the state (regional) and household levels should be considered when determining the share of state compensation for investments in RE technology or EE measures for a specific household as follows:

$$CI_{i,j} = CI_b \cdot \sum_{i=1}^{N} (w_i \cdot F_i) \cdot \sum_{j=1}^{M} (w_j \cdot F_j), \quad (1)$$

where $CI_{i,j}$ – the share of state compensation for investment in a particular RE technology or EE measure for a particular household, %; CI_b – base share of state compensation for investment in a specific RE technology or EE measure in the residential sector, %; F_i – coefficient reflecting the influence of the i-th factor on the development of a specific RE/EE technology in the country (region), the unit share; w_i – weight coefficient representing the importance of the i-th influencing factor at the state (regional) level, the unit share, where, $i = \overline{1,N}$, $\sum_{i=1}^{N} w_i = 1$; N – number of coefficients (influencing factors) at the state (regional) level; F_j – coefficient reflecting the influence of the j-th factor on the implementation of a specific RE technology or EE measure at the household level, the unit share; w_j – coefficient reflecting the influence of the j-th factor on the implementation of a specific RE technology or EE measure at the household level, the unit share, where $j = \overline{1,M}$, $\sum_{j=1}^{M} w_j = 1$; M – number of influencing factors at the household level. (1)

The proposed methodological approach will allow the state to co-finance EE and RE projects in Ukraine's residential sector to increase energy independence instead of spending funds on utility subsidies each year, which do not address the issues of energy poverty and sustainable household energy supply in wartime and the post-war period. Consideration of factors such as the existing potential of RE resources and energy efficiency opportunities in the residential sector, the level of energy needs satisfaction, environmental pollution in the respective region, and the potential for its reduction through the implementation of RE and EE projects in households, the state of the regional energy infrastructure, and the specific characteristics of projects at the household level, transforms this approach into a universal tool for effectively allocating

state investment support within the framework of a just energy transition.

The practical implementation of the methodological approach will systematize the investment decision-making process based on clear criteria for assessing RE and EE projects in households and improve the monitoring of investment results, which will allow timely identification of problems and adjustment of investment strategies in line with the national energy policy. As a result, it will contribute to a more efficient and balanced development of RE and EE in Ukrainian households, which in turn will help build a reliable, environmentally sustainable, and cost-effective energy system.

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MODELS OF COMMERCIALIZATION OF DISRUPTIVE TECHNOLOGIES

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The theoretical and methodological essence of breakthrough technologies is to understand their impact on the development of markets, economic systems and society as a whole, as well as to study the approaches and methods used for the development, implementation and commercialization of such technologies. Disruptive technologies are innovations that fundamentally change the structure of the market, replace existing products, or create new market segments, often causing economic, social, and technological transformations.

Disruptive technologies are characterized by the fact that they offer new solutions that, over time, can completely change the structure of the market or form a new one. Distinctive features of such technologies:

- provide radical innovation: fundamental changes in approaches to solving

problems or meeting needs;

- rapid spread: Due to the innovative approach and high demand, disruptive technologies are quickly penetrating the market;

- ability to change market structure: Unlike incremental innovation, disruptive technologies can displace older products and services.

Disruptive technologies significantly increase productivity, reduce costs, and often create new economic sectors. Their implementation is accompanied by the following effects: cost reduction due to new production methods or reduced resource requirements; increasing efficiency through automation, process optimization and reduction of time to complete operations; development of new markets and segments, as they create the possibility of forming new needs or segments of consumers.

Breakthrough technologies go through several stages in their life cycle: from the origin and early development to the peak of implementation and further distribution. According to the theory of innovation cycles, there are the following key phases: the nascent phase: early investment and research that leads to the formation of the underlying technology; Distribution phase: rapid market penetration due to increased demand; Stabilization phase: Once a certain level of maturity is reached, the technology becomes the standard and can be supplanted by other disruptive technologies.

For the effective implementation of breakthrough technologies, various methodological approaches are used:

- cost and risk analysis: evaluation of investments, forecasting potential profits and risks associated with the implementation of technologies;

- methods for assessing commercial potential: SWOT analysis, competitiveness analysis and modeling of market scenarios, which make it possible to determine the potential of the technology;

- innovation ecosystem models: integration of disruptive technologies into interconnected market environments where participants (startups, large corporations, research institutes) interact to maximize benefits.

Disruptive technologies have a major social impact, changing the way we work, interact, consume, and communicate. Socio-economic impacts include:

- changes in the structure of employment: automation reduces the need for some professions, but creates demand for new specialties;

- Improving the quality of life: Access to new technologies contributes to higher levels of health care, education, communication, and other aspects.

- regulatory Challenges: The need for new legislation to manage the ethical, social, and environmental impacts of technology.

To assess and forecast the effectiveness of breakthrough technologies, the following methods are used: technological forecasting: research of market trends and their impact on demand; life cycle analysis: assessment of all stages of technology from development to mass adoption and degradation; Scenario Analysis and Modeling Methods: Simulation of possible implementation scenarios to assess long-term market impact.

Commercialization of disruptive technologies is the process of transforming innovative developments into products or services that can generate profit. To achieve this, there are different models, each with its own characteristics and suitable for different types of market, technologies and resources. Let's consider the main models of commercialization of breakthrough technologies:

1. *Licensing model.* This model involves granting licenses to use the technology to

other companies. It is usually used if the technology developer does not have sufficient resources to enter the market or when he wants to earn passive income. Main advantages: quick access to the market through partners who already have infrastructure; reduction of financial risks and reduction of investment costs; the ability to focus on further development and research. However,Licensing can limit control over the use of technology and its development in the market.

2. *Joint Venture model.* This model involves creating a joint venture with a partner to commercialize disruptive technology. This allows you to combine the resources, expertise, and markets of both parties. Main advantages: co-financing reduces risks; combining knowledge and resources allows you to enter the market faster; distribution of responsibilities and costs for technology promotion. The model is suitable for projects that require significant investment and technical expertise, but requires clear coordination between partners.

3. *Model of internal development (In-House Development).* In this model, the technology developer independently finances and conducts all stages of commercialization: from production to sales. Main advantages: full control over the technology and its implementation strategy; the ability to get maximum profit without sharing with partners; high flexibility in technology modification. However, the model requires significant resources and is suitable only for companies that have sufficient financial and human potential.

4. *Technology Sale model.* In the event that the developer does not have the ability or desire to commercialize the technology, he can sell it to another company. Main advantages: receiving a one-time large income; minimization of risks and costs associated with commercialization; freeing up resources for other innovative projects. This model is suitable for startups that specialize in the development of new technologies, but are not engaged in their production or promotion.

5. *Spin-Off model.* A company can create a separate subsidiary to commercialize a particular technology. This allows you to develop the project separately from the main business and attract investors. Main advantages: attracting external investment while maintaining control over the technology; flexibility in the development of the project as a separate company; the ability to concentrate resources only on the development of breakthrough technology. This model is often used by large corporations that have a resource base for the development of spin-offs.

6. *Open Innovation Model.* In this model, the company cooperates with external partners (other companies, academic institutions, startups) to jointly develop and commercialize technologies. Main advantages: the opportunity to attract new ideas, knowledge and markets; sharing financial and operational risks with partners; quick access to new markets through partnerships. Open innovation is suitable for technologies that require the integration of different expertise and a wide market network.

7. *Startup Incubation model.* Technology incubators and accelerators help startups develop and commercialize disruptive technologies by providing them with funding, expert support, and a network of contacts. Main advantages: attracting investors and venture capital; access to experts and mentors, which contributes to faster development; risk mitigation through the support of experienced partners. The incubation model is suitable for young companies and innovative projects with limited capital.

8. *Crowdfunding model.* Crowdfunding allows you to raise funding for the commercialization of disruptive technology through contributions from a wide range of

investors and consumers. Main advantages: raising funds without attracting large investors; expansion of the market base through pre-sales; testing the market, checking the interest of consumers.Crowdfunding is suitable for projects that may be of interest to a wide range of people, including technologies with a social component.

9. *Service-Based Model.* In this model, technology is not sold as a product, but is used to provide services. For example, artificial intelligence or data processing technologies can be provided as a service (SaaS). Main advantages: constant income due to subscriptions to services; accessibility for customers without the need to purchase expensive equipment; the ability to quickly scale your business. The service model is suitable for technologies that are easily integrated into customers' business processes.

The theoretical and methodological essence of breakthrough technologies includes an understanding of their role in changing economic, social and technological systems, as well as approaches to assessing, implementing and forecasting their impact. Thanks to a comprehensive analysis and the right choice of implementation methods, breakthrough technologies can create a significant economic effect and contribute to the development of society. The choice of commercialization model depends on the type of technology, the company's resources, access to markets and the level of risks. Each model has its own advantages and limitations, and successful commercialization often involves a combination of multiple models to effectively implement disruptive technologies in the market.

METHODOLOGICAL FRAMEWORK FOR CHOOSING OPTIMAL STRATEGIES FOR SUSTAINABLE HOUSEHOLD POWER IN UKRAINE

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The destruction of Ukraine's energy infrastructure due to the war has intensified the issue of sustainable energy supply for domestic households. Numerous outages of electricity, gas, and water supply, both planned and emergency, lead to energy grid overloads, premature wear and tear, and increasing utility costs. As a result, there is a growing need for the decentralization of energy supply for residential consumers, transforming them into prosumers who generate their own energy for personal needs. However, creating decentralized energy supply hubs within individual households requires significant investment amid the growing energy poverty of the Ukrainian population. This situation highlights the importance of developing methodological approaches to selecting cost-optimal energy strategies for homes, which would ensure the most efficient combination of energy sources for sustainable household power supply.

In general, the energy strategy of a household, as an entity not seeking to maximize economic profit, should aim to create the most comfortable living conditions for its

members at the lowest possible economic cost. Thus, a household seeks to minimize its energy expenses while meeting its needs for heating, water heating, cooking, lighting, etc. Modern decentralized power supply technologies offer various options for installing autonomous energy-generating sources in the residential sector, particularly in private homes. For instance, in Ukraine, private households can install small solar and wind power plants with capacities of up to 30 kW and take advantage of the preferential feed-in tariff for selling excess generated but unused electricity, which is available until December 31, 2029 (Verkhovna, 2024).

Another option is installing diesel generators and battery storage systems to cover electricity needs during outages in centralized power grids. However, relying solely on diesel generators and/or batteries does not solve the issue of sustainable household energy supply in the long term or during extended power outages. The cost of diesel fuel, the challenge of safely storing it on the household's premises, and the negative environmental impact of burning it make diesel generators less attractive, although they are an effective solution during short-term emergency outages. Battery storage systems can also provide electricity to households during brief outages, but they require periodic and often prolonged charging, creating additional load on electrical grids that are already operating at their limits during the ongoing war in Ukraine. Therefore, from the perspective of energy security and sustainable power supply, developing household-owned autonomous energy generation using renewable sources is the best option. However, installing small solar and wind power plants requires significant investment, which must be carefully analyzed when forming and selecting the optimal household energy strategy.

To create a pool of potential power supply strategies as part of our research, it is advisable to consider typical groups of private households based on the technologies they can utilize. Table 1 demonstrates typical groups of such households, as well as the components of their costs when using different energy supply technologies. In this study, we consider households that own a private home with autonomous heating connected to centralized gas and electricity networks, as well as a cold water supply.

Table 1

Characteristics of typical groups of private households and their energy costs depending on the power supply technologies used

Typical household group	Components of household energy costs
1 Do not have their own independent power supply sources	• annual total heating costs, which consist of the household's current expenditures on energy carriers for heating, depending on various options for their use during the heating season, as well as fixed costs for equipment maintenance under different heating options in the household (Sotnyk et al., 2024); • annual costs for water heating for household needs; • annual household energy costs for cooking; • annual household costs for lighting and air conditioning; • household economic losses due to emergency and scheduled disconnections from the power supply grids; • annual economic savings from energy-saving measures implemented by the household (excluding the installation of battery storage systems, diesel generators and small renewable energy power plants)
2 Use a battery storage system to meet their own electricity needs	• all costs of the households from group 1; • annual operating costs for maintaining the battery storage (including depreciation costs associated with the purchase, installation, and setup of the battery, as well as its replacement at the end of its service life, and current maintenance costs); • savings generated by shifting peak loads and purchasing electricity during off-peak periods for storage and later consumption (for example, using night tariffs), as well as potential earnings from selling stored electricity during peak hours)
3 Use a diesel generator to meet their own electricity needs	• all costs of the households from group 1; • annual operating costs for maintaining the diesel generator (including depreciation costs associated with its purchase, installation, and setup, as well as current maintenance costs); • annual operating costs for diesel fuel, which account for the purchase price, expenses for setting up fuel storage tanks, and logistical costs for fuel delivery
4 Use both diesel generators and a battery storage system to meet their own electricity needs	• all costs of the households from group 2; • annual operating costs for maintaining the diesel generator; • annual operating costs for diesel fuel
5 Have installed and operate on-grid small solar, wind, or hybrid wind-solar power plant to meet their own electricity needs and sell surplus electricity under the feed-in tariff	• all costs of the households from group 1; • annual operating costs for maintaining the household's on-grid power plant (including annual maintenance and depreciation costs associated with purchasing, installing, connecting to the grid, setting up, and decommissioning the power plant (Kurbatova et al., 2024); • savings from consuming self-generated green electricity instead of purchasing it from an electricity supplier; • annual additional income from selling surplus green electricity generated by the household under the feed-in tariff (Sotnyk et al., 2023)
6 Have installed and operate on-grid small solar, wind, or hybrid wind-solar power plant with a battery storage system to meet their own electricity needs and sell surplus electricity under the feed-in tariff	• all costs of the households from group 5; • annual operating costs for maintaining the battery storage system connected to the on-grid home power plant (including depreciation costs associated with the purchase, installation, and setup of the battery, as well as its replacement at the end of its service life, and current maintenance costs); • savings from shifting peak loads and purchasing electricity during off-peak periods for storage and later consumption when self-generation of green electricity is impossible due to technical reasons or insufficient for household needs
7 Have installed and operate off-grid small solar, wind, or hybrid wind-solar power plant with a battery storage system to meet their own electricity needs	• all costs of the households from group 1; • annual operating costs for maintaining the off-grid home power station (including annual maintenance and depreciation costs associated with purchasing, installing, connecting, setting up, and decommissioning the power plant (Kurbatova et al., 2024); • savings from consuming self-generated green electricity instead of purchasing it from an electricity supplier; • annual operating costs for maintaining the battery storage system connected to the off-grid home power plant (including depreciation costs associated with purchasing, installing, and setting up the battery, as well as its replacement at the end of its service life, and current maintenance costs)

Based on the cost structure of households in each typical group, the selection of the optimal energy strategy from the seven analyzed in Table 1 should be guided by the criterion of minimizing costs. However, non-economic benefits such as improved stability and independence of power supply and positive environmental impacts should also be considered when making the final decision. Overall, this methodology allows for the consideration of natural and climatic conditions, energy prices, household energy-saving measures, the use of green energy generation technologies, state energy and environmental policies, etc., and is an important decision-making tool at both the household level and for adjusting state sectoral policies.

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PROSPECTS FOR THE USE OF THE KAIZEN-COSTING SYSTEM IN UKRAINE

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The kaizen-costing system originated in Japan in the mid-20th century along with the development of the kaizen philosophy, which became the basis for continuous improvement of production processes. The kaizen approach itself began to develop after World War II, when Japanese enterprises needed effective methods to rebuild their economies and increase competitiveness.

Kaizen-costing as a tool for optimizing costs and improving processes gained popularity in the early 1980s in large Japanese corporations such as Toyota. Companies have begun to implement continuous improvement through the active involvement of all employees in the process of minimizing costs and improving quality, which has become an important component of their production philosophy.

So, kaizen-costing was formed as a system at the same time as the spread of kaizen in production processes, around the 70s and 80s of the 20th century. Its main idea is that even the smallest process improvements can lead to significant cost reductions and increased efficiency in the long run.

Nowadays, the kaizen-costing system is a popular tool for increasing efficiency and reducing costs, which is successfully used in many countries, especially in Japan. For Ukraine, its implementation also has prospects, as it allows to optimize processes and increase the competitiveness of companies in the market.

We have formed and substantiated the key prospects for the use of kaizen costing in Ukraine. We propose to include the following provisions.

1. Optimization of production processes. Kaizen-costing is aimed at continuous improvement of production processes by minimizing costs at each stage. This is suitable for Ukrainian enterprises seeking to use resources efficiently. Continuous analysis and

improvement of production processes help to reduce the cost of production, which can be critical for maintaining competitiveness in a highly competitive environment.

2. Involvement of employees in the improvement process. Kaizen-costing involves the involvement of all employees in the improvement process, which creates a culture of responsibility and cooperation. This helps to develop loyalty to the company and encourages employees to actively search for ways to improve, which is a valuable aspect for Ukrainian enterprises, where the problem of insufficient motivation of employees often arises.

3. Reduce costs and increase profitability. One of the main goals of kaizen-costing is to achieve a constant reduction in costs. This is especially true for Ukrainian companies, which often operate with limited financial resources. Reducing costs allows you to increase margins, which is important for financial stability and business development.

4. Flexibility and adaptation to market changes. Kaizen costing is based on flexibility and quick response to change. For Ukraine, this can be an important factor, especially in the context of economic instability. Companies that use kaizen-costing can adapt more quickly to changing market conditions, reducing the cost of restructuring production processes.

5. Improving product quality. Continuous process improvement, which kaizen-implies, affects the improvement of the quality of the final product. This can be a significant competitive advantage for Ukrainian companies, especially in export-oriented industries, where high quality standards are mandatory.

In our opinion, the introduction of kaizen-costing in Ukraine can have a significant economic effect for business due to continuous improvement of processes, cost reduction and quality improvement. However, the success of this approach depends on the readiness of Ukrainian enterprises to change the corporate culture, the involvement of employees in the improvement process and the availability of long-term development plans.

The effectiveness of the kaizen-costing system lies in the continuous improvement and optimization of costs at each stage of production. This ensures a long-term reduction in costs and an increase in product quality, which ultimately contributes to the company's competitiveness. The main elements of the effectiveness of kaizen-costing include the following aspects.

1. Reducing the cost of production. Kaizen-costing helps to reduce the cost of production without reducing its quality. By regularly analyzing costs and finding ways to optimize them, companies can avoid unnecessary costs, thereby increasing business margins. This is especially important for highly competitive industries, where cost reduction is a crucial factor.

2. Continuous improvement of processes. Kaizen-costing involves continuous improvement rather than one-time drastic changes. This allows for a more sustainable effect, as each small improvement in processes gradually adds significant value. This approach also reduces the risks associated with radical changes, as all improvements are tested and tested gradually.

3. Involvement of all staff. Within the kaizen system, all employees, from line personnel to management, are involved in finding ways to improve. This stimulates teamwork and increases motivation, because each employee can contribute to reducing costs and improving processes. Employee engagement also contributes to a better understanding of production processes and contributes to faster implementation of

changes.

4. Improving product quality. Kaizen-costing focuses on reducing costs not by reducing quality, but by optimizing processes. This helps to improve the quality of the final product, which increases customer loyalty and has a positive effect on the company's reputation. High product quality also reduces the likelihood of defects and returns, further reducing costs.

5. Flexibility and adaptation to change. Kaizen-costing allows a company to quickly adapt to market changes through continuous improvement. This is especially true in today's dynamic market, where companies must be flexible and ready for rapid change. Thanks to kaizen-costing, companies can quickly respond to new needs by changing processes and adjusting costs.

6. Reduction of indirect costs. Along with reducing direct production costs, kaizen-costing helps to reduce indirect costs, such as management, logistics, warehouse maintenance, etc. By improving processes, errors, delays, and the need for repetitive operations are reduced, which also reduces overall costs.

Based on these provisions, we can make a final conclusion that the kaizen-costing system is an effective tool for forming the cost of production, which allows enterprises to achieve sustainable growth by optimizing costs and improving product quality. It helps businesses create sustainable competitive advantages and increase profitability. For Ukraine, where many businesses are looking for opportunities to increase productivity and efficiency, kaizen-costing can be a valuable tool on the way to improving operations.

ENVIRONMENTAL AND TECHNICAL ISSUES OF SUSTAINABLE DEVELOPMENT

HARNESSING DIGITALIZATION AND TECHNOLOGY TO PROPEL GREEN ENTREPRENEURSHIP IN THE EMERGING GREEN ECONOMY

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Abstract:This thesis explores the intersection of green economy principles, technological innovation, and digitalization to foster entrepreneurship. As global awareness of environmental sustainability grows, the demand for green products and services is rising. This study investigates how emerging technologies and digital tools can enhance the efficiency, scalability, and accessibility of green ventures. By analyzing case studies of successful green startups, this research highlights best practices and identifies key barriers to entry in the green economy, providing a framework for aspiring entrepreneurs.

Introduction:The transition to a green economy is not only imperative for environmental sustainability but also presents a significant opportunity for innovation and entrepreneurship. This thesis posits that the integration of advanced technologies and digital solutions is essential for the success of green enterprises. It aims to answer the following research questions:

- How can technology and digitalization facilitate the growth of green entrepreneurship?
- What are the challenges faced by entrepreneurs in the green economy, and how can technology help overcome these challenges?
- What role do policy frameworks play in supporting tech-driven green entrepreneurship?

Literature Review:

1.Definition and Principles of a Green EconomyA green economy is generally understood as an economic system that seeks to minimize environmental risks and ecological scarcities while promoting social equity and economic stability (United Nations Environment Programme, 2011). It encompasses three core principles: sustainable resource management, reduced carbon emissions, and the preservation of biodiversity. These principles serve as a foundation for policies aimed at fostering sustainable economic activities.

2. The Role of the Circular EconomyThe circular economy framework has emerged as a critical component of the green economy. It advocates for the redesign of production and consumption processes to minimize waste and maximize resource efficiency (Ellen MacArthur Foundation, 2013). This approach encourages businesses to rethink traditional linear models and embrace practices such as recycling, refurbishing, and

sharing, thus opening new avenues for green entrepreneurship.

3. Sustainable Development Goals (SDGs)The United Nations' Sustainable Development Goals provide a global blueprint for addressing pressing environmental and social issues. Goal 8 emphasizes the need for sustainable economic growth and decent work for all, highlighting the role of innovation and technology in achieving these aims (United Nations, 2015). Entrepreneurs can leverage the SDGs as a framework to align their business models with global sustainability objectives.

4. Innovation and Technological AdvancementThe intersection of technology and green economy principles is critical for driving innovation. According to the World Economic Forum (2020), advancements in digital technology—such as the Internet of Things (IoT), artificial intelligence (AI), and big data—can enhance resource efficiency and promote sustainable practices. This highlights the potential for tech-driven solutions to address environmental challenges while creating new business opportunities.

5. Policy Frameworks and Support MechanismsEffective policies are essential for facilitating the transition to a green economy. Research by the Organisation for Economic Co-operation and Development (OECD, 2021) underscores the need for governments to implement regulatory frameworks, financial incentives, and public-private partnerships that support green innovation and entrepreneurship. These measures can mitigate risks and lower barriers for startups in the green sector.

6. Challenges and Opportunities for EntrepreneursDespite the promising potential of the green economy, entrepreneurs face several challenges, including access to capital, market entry barriers, and regulatory complexities (Kuckertz et al., 2020). Understanding these obstacles, alongside the opportunities presented by green technologies, is crucial for developing effective strategies for success in this emerging market.

Conclusion:

The literature highlights that the green economy is not a singular model but a multifaceted framework that incorporates principles of sustainability, circularity, and innovation. By understanding these frameworks, aspiring entrepreneurs can better navigate the complexities of the green economy, leveraging technology to create sustainable business solutions. This review sets the stage for further investigation into the role of digitalization and technology in advancing green entrepreneurship.

Findings:The research reveals that technology enhances operational efficiencies, reduces costs, and enables better customer engagement for green startups. Digital platforms facilitate access to funding, markets, and resources. However, challenges such as regulatory hurdles, high initial investment costs, and limited awareness of green technologies persist.

Recommendations:Policy recommendations include creating incentives for tech adoption in green startups, enhancing access to funding, and promoting educational programs focused on green entrepreneurship. Future research directions are suggested to explore the evolving role of emerging technologies in the green economy.

INTERNATIONAL COOPERATION FOR SUSTAINABLE DEVELOPMENT

THE IMPACT OF THE WAR WITH RUSSIA ON THE DEVELOPMENT OF TRANSPORT IN UKRAINE

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Ukraine occupies an important place in the global economy, and Russia's military actions on its territory have had a significant impact on world economic relations. The country's transportation sector plays a critical role, connecting cities, industrial centers, rural areas, markets, and ports that provide exports. It acts as the driving force of the economy, integrating production, consumption and trade. At the regional and global levels, the transport system links Ukraine with the rest of the world, which includes financial markets, international trade, investment flows, logistics chains and the latest means of communication.

The war with Russia has had a significant impact on the development of transport infrastructure in Ukraine, creating both significant challenges and certain opportunities for its modernization. The main changes and their consequences cover rail, road, sea and air transport, as well as general logistics.

1 . *Rail transport.* Destruction of infrastructure: As a result of the fighting, the railway infrastructure in the east and south of the country, including tracks, railway stations, bridges and freight terminals, has been severely damaged. This made it difficult to transport both cargo and passengers. Adaptation to European standards: as some traditional routes have become inaccessible, «Ukrzaliznytsia» has accelerated work on integration with the European transport network, which involves a gradual transition to the European track and the creation of convenient logistics routes with EU countries. Transportation of humanitarian goods and evacuation of the population: Rail transport plays a crucial role in the transportation of humanitarian aid and the evacuation of the population from dangerous regions. This obliged «Ukrzaliznytsia» to quickly adapt and ensure safe and stable transportation.

2. Road transport. Destruction of roads and bridges: The hostilities have damaged or completely destroyed many roads, bridges and road infrastructure. This made it difficult to move between regions, especially in the east and south. Reconstruction and rehabilitation: Ukraine has intensified its road infrastructure rehabilitation program with the help of international partners. The reconstruction of roads and bridges in the liberated territories has become a priority, as it is necessary to maintain logistics routes and restore the economy. The growing role of logistics and road transport: due to the blockade of

seaports, road transport has taken over a large part of export traffic. This caused an increase in demand for logistics services, fleet adaptation, and the development of transport companies.

3. Sea transport. Blockade of seaports: Russia has blocked Ukrainian ports on the Black Sea and the Sea of Azov, which has led to significant losses in export potential, especially for industries such as agriculture and metallurgy. Other export routes: Ukraine is forced to look for alternative routes, in particular by developing river transport on the Danube and creating land transport corridors for exports to the EU. The port complex in Reni and Izmail on the Danube River has become an important alternative that is significantly busy. Grain corridor and international support: The grain corridor through the Black Sea was a temporary solution, allowing for some grain exports, but the constant threat of attacks limits its effectiveness. Ukraine is working to establish permanent international arrangements to ensure safe maritime exports.

4. Air transport. Airspace closure: Due to the war, Ukraine was forced to close its airspace to commercial aviation, effectively paralyzing passenger and air cargo transportation. Development of alternative aviation and drones: With the impossibility of operating commercial flights, the aviation industry is adapting to the use of drones, especially for deliveries to hard-to-reach areas. Military drones also play a key role in ensuring security and logistics. International cooperation: During the war, Ukrainian aviation has shifted its focus to coordinating humanitarian cargo and aid through partner airlines and routes through neighboring countries.

5. Logistics and international corridors. Reconfiguration of logistics routes: the blockade of seaports and the destruction of infrastructure led to the reconfiguration of trade routes to the western border of Ukraine. This stimulated the development of border infrastructure with Poland, Romania, Slovakia and Hungary. Integration with the European transport system: European countries are helping Ukraine to modernize transport corridors to integrate them into the EU's common transport system, which contributes to improving logistics and reducing dependence on traditional Russian routes. Development of multimodal transportation: adaptation to new conditions requires the active use of multimodal transportation, which combines road, rail and river transport. This reduces costs and provides greater flexibility for Ukrainian exporters.

6. Financial and organizational challenges. High recovery costs: the destruction of transport infrastructure requires significant financial resources for reconstruction, which has become a serious challenge for the state budget. The recovery is taking place with the support of international partners such as the EU, the United States, and the World Bank. Innovation and digitalization: To improve the efficiency of transport management, Ukraine is actively implementing digital solutions such as electronic documents, real-time cargo tracking, and automation of customs processes. Increasing the role of defense logistics: the war has forced the Ukrainian transport system to adapt to defense needs, which includes the strategic management of the transportation of military and humanitarian goods and the mobility of frontline areas.

The war has already affected approximately 25% of global grain trade, leading to higher prices, food inflation, and reduced access to products in countries that import grain from Ukraine and Russia. The issue of restoration and reorientation of transport routes in Ukraine is key for further research, as structural changes and optimization of the load on roads and customs will become the basis for export growth for Ukrainian producers.

International transport refers to the movement of goods or passengers between several countries with the crossing of at least one border. This includes any mode of transport that involves the international nature of the route, where the points of departure and destination are located in different states.

To analyze the impact of the war on international cargo transportation, it is necessary to take into account the structure of transportation in 2021: the share of rail transport was 51%, road transport – 32%, water transport – 1%, pipeline transport – 16%, and air transport – 0.1%. Since each mode of transport serves specific sectors of the economy, a change in its share can signal factors that threaten the national economy and the ability of transport infrastructure to meet demand.

Over the past few years, the share of road transport in the freight transport market of Ukraine has almost doubled (+57%), while the share of water transport has almost halved (-44%), and rail transport – by 8%. This indicates the active development of road transport, while other modes of transport have lost their positions. This situation may adversely affect the implementation of Ukraine's tasks, since rail and water transport, in accordance with the country's strategic goals, should increase their market share.

The war with Russia has become a serious challenge for Ukraine's transport system, but at the same time it has stimulated reforms, integration with European infrastructure, new logistics approaches and the development of alternative routes. This allows Ukraine to gradually strengthen its transport independence, although long-term recovery requires significant investment and international support.

For the rapid restoration of transport infrastructure, it is necessary to develop criteria for priority financing and organization of reconstruction, overhaul and current repairs. Due to the difficulties in restoring all infrastructure, those elements that are critical to the safety and mobility of people and goods should be financed first.

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