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Strategic Planning for Post-War Reconstruction of Ukraine's Critical Infrastructure: Evolving Approaches, Financial Gaps, and Digital Tools

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ABSTRACT

The article examines the evolution of strategic planning for the post-war reconstruction of Ukraine's critical infrastructure in the context of the ongoing war. Based on the analysis of the Rapid Damage and Recovery Needs Assessment Reports (RDNA1–RDNA4), a trend towards a steady increase in direct losses was identified – from $252 billion in 2022 to $176 billion in 2024, as well as long-term recovery needs over ten years to $524 billion. It was found that the housing, transport and energy sectors suffered the greatest losses, and 72% of the damage was geographically concentrated in five frontline regions and Kyiv region. Key strategic documents at the national level were reviewed – the Law of Ukraine "On Critical Infrastructure", the Categorization Methodology, the National Critical Infrastructure Protection Plan (September 2023) and the DREAM digital ecosystem. Special attention is paid to the analysis of the financial gap: for 2025, the financing needs are $15 billion, of which only $5.5 billion have been provided, and the deficit reaches $9.96 billion (over 60% of the needs). The position of former Prime Minister D. Shmyhal on the need to confiscate frozen Russian assets as the main source of reconstruction is highlighted. It is proven that the lack of a single nationwide recovery plan with legal force, the low absorption capacity of authorities (expenditures at the level of 1% of the budget in the first quarter of 2025) and the incomplete use of DREAM digital tools create systemic bureaucratic inertia, which significantly complicates the coordination of donors and local authorities. Recommendations are proposed to adopt a legally binding national recovery plan, ensure full transparency of projects in DREAM, intensify negotiations on the confiscation of Russian assets, and introduce personal liability for the use of funds.

KEYWORDS

strategic planning, reconstruction, RDNA4, critical infrastructure, DREAM, financial gap, asset forfeiture, National Protection Plan.

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Стратегічне планування повоєнної відбудови критичної інфраструкури України: еволюція підходів, фінансові розриви та цифрові інструменти

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СТАТТЯ

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АНОТАЦІЯ

У статті досліджено еволюцію стратегічного планування повоєнної відбудови критичної інфраструктури України в умовах триваючої війни. На основі аналізу звітів швидкої оцінки завданої шкоди та потреб на відновлення (RDNA1–RDNA4) виявлено тенденцію до неухильного зростання прямих збитків – з 252 млрд дол. у 2022 році до 176 млрд дол. у 2024 році, а також довгострокових потреб на відновлення протягом десяти років до 524 млрд дол. Встановлено, що найбільших втрат зазнали житловий сектор, транспорт та енергетика, а 72% шкоди географічно зосереджено в п'яти прифронтових областях та Київській області. Розглянуто ключові стратегічні документи національного рівня – Закон України «Про критичну інфраструктуру», Методику категоризації, Національний план захисту критичної інфраструктури (вересень 2023) та цифрову екосистему DREAM. Окрему увагу приділено аналізу фінансового розриву: на 2025 рік потреби у фінансуванні становлять 15 млрд дол., з яких забезпечено лише 5,5 млрд дол., а дефіцит сягає 9,96 млрд дол. (понад 60% потреб). Висвітлено позицію колишнього прем'єр-міністра Д. Шмигаля щодо необхідності конфіскації заморожених російських активів як основного джерела відбудови. Доведено, що відсутність єдиного загальнонаціонального плану відновлення з юридичною силою, низька абсорбційна спроможність органів влади (витрати на рівні 1% бюджету в першому кварталі 2025 р.) та неповне використання цифрових інструментів DREAM створюють системну бюрократичну інерцію, яка суттєво ускладнює координацію донорів та місцевої влади. Запропоновано рекомендації щодо ухвалення юридично обов'язкового національного плану відновлення, забезпечення повної прозорості проєктів у DREAM, активізації переговорів про конфіскацію російських активів та запровадження персональної відповідальності за освоєння коштів.

КЛЮЧОВІ СЛОВА

стратегічне планування, відбудова, RDNA4, критична інфраструктура, DREAM, фінансовий розрив, конфіскація активів, Національний план захисту.

1. Introduction

The full-scale invasion of the Russian Federation into the territory of Ukraine, which began on February 24, 2022, caused unprecedented destruction of critical infrastructure facilities – energy systems, transport networks, utilities, communications and other vital facilities. As of the end of 2024, according to the RDNA4 report, prepared jointly by the World Bank, the Government of Ukraine, the European Union and the United Nations, total direct infrastructure damage reached 176 billion USD, and long-term recovery needs over the next ten years are estimated at 524 billion USD [2; 12; 14]. These figures not only demonstrate the catastrophic impact of the war on the economy and social sphere, but also pose a difficult task for the state and the international community – to develop and implement an effective post-war reconstruction strategy capable of ensuring not only the restoration of what was destroyed, but also the modernization of the country in accordance with the principle of "Build Back Better".

Strategic planning for the reconstruction of critical infrastructure in the context of an ongoing war has a number of significant features. It must be based on reliable and regularly updated data on the scale of destruction, which is provided by a series of RDNA reports; it requires clear coordination between national authorities, local communities, international donors and the private sector; it must take into account the security situation in the regions, since a significant part of the damaged facilities are located in the zone of active hostilities or in temporarily occupied territories; and finally, it must be provided with appropriate institutional mechanisms, financial resources and digital control tools.

During 2023–2025, Ukraine and its international partners took important steps towards creating such a strategic framework. The Law of Ukraine “On Critical Infrastructure” was adopted, the National Plan for Critical Infrastructure Protection was approved, the Methodology for the Categorization of Critical Infrastructure Objects was developed, and the DREAM digital ecosystem was introduced for public monitoring of recovery projects. At the same time, an analysis of the practical implementation of these documents indicates the presence of significant problems: the absence of a single nationwide recovery plan with legal force, a chronic financial gap, low absorption capacity of government bodies, and incomplete use of digital tools [5; 11]. In this regard, the article analyzes the evolution of approaches to strategic planning for the reconstruction of Ukraine’s critical infrastructure based on the RDNA1–RDNA4 reports, characterizes key national strategic documents, identifies key financial and institutional problems, and assesses the effectiveness of the DREAM digital ecosystem as a tool for ensuring transparency in recovery.

2. Literature Review

The study of strategic planning for the post-war reconstruction of Ukraine’s critical infrastructure draws on three interrelated clusters of sources: international damage and needs assessments, national regulatory frameworks, and analytical works that address institutional and financial issues. The basic empirical basis for all subsequent work is a series of rapid damage and needs assessment reports (RDNA1–RDNA4), prepared by a consortium of the World Bank, the Government of Ukraine, the European Union, and the United Nations [2; 12; 13; 14]. These reports not only track the trajectory of direct losses – from $252 billion in June 2022 to $176 billion in December 2024 – but also outline medium- and long-term needs spanning 10 years, reaching $524 billion, broken down by sector (housing, transport, energy) and geography, with 72% of losses concentrated in five frontline regions and Kyiv Oblast. In addition, RDNA4 also presents, for the first time, a detailed analysis of the financing gap for 2025 (a deficit of $9.96 billion compared to a total need of $15 billion) [14]. However, as V. Konev rightly points out [5], these assessments are limited: they focus on direct material losses, ignoring secondary effects (degradation of human capital, environmental impact, migration losses), and do not offer a viable mechanism for coordinating priorities between donors and different levels of government. In general, the national legal framework for the protection of critical infrastructure is established based on the Law of Ukraine On Critical Infrastructure [9] defines the main concepts, types of objects and the main principles of their protection. The Categorization Methodology [8] specifies the criteria and procedures for classifying objects into different categories of importance, while the National Plan for the Protection, Security and Resilience of Critical Infrastructure of September 2023 [11] is intended to reflect a three-year course of risk monitoring, threat response and interagency coordination. However, as the study of these documents, carried out by O.O. Magomedov [6], they pay attention mostly to

protection in emergencies, while the processes of reconstruction in the post-war period (not only restoration, but also modernization) are covered fragmentarily. The most thorough criticism of the institutional architecture is given by V. Konev [5], who states: there is no nationwide recovery plan with legal force – it is precisely because of the absence of such, in his opinion, that the interaction between central authorities, local communities, and international donors is blurred.

One of the tools to increase transparency should be the digital ecosystem DREAM (Digital Restoration Ecosystem for Accountable Management), which provides real-time monitoring of restoration projects, their budgeting, performers, and implementation results [3; 4; 10]. The system's promotional information materials and Open Contracting Partnership research [4] highlight the technological revolution of DREAM, which contradicts conventional monitoring methods and provides tools for public oversight. At the same time, critical reviews [5; 6] reveal that DREAM has a systemic weakness: DREAM's effectiveness is determined by the completeness and timeliness of data entry and the political will to ensure it. Significantly, the Ministry of Community, Territorial and Infrastructure Development spent only 1% of its annual budget [5] on restoration in the first quarter of 2025, which indicates that the digital platform is doomed to become a "showcase" rather than a real management tool.

Financial issues of reconstruction are considered in the most detail in the RDNA reports [5; 7; 14] and the materials of the NIVD [7]. The general conclusion from these sources is a chronic underfunding of more than 60% of the total needs for 2025. It is noteworthy that before the publication of the RDNA3, the then Prime Minister D. Shmyhal openly called for the requisition of frozen Russian assets for financing [7], however, as Reuters reports [13], a mechanism for full requisition does not yet exist and a dialogue is underway about the temporary use of profits from these assets. The reports of the Kyiv School of Economics [1] create a regional distribution of direct losses (as of November 2024) and indicate the growth of private finance in distributed generation (solar panels, gas power plants, biogas), however, it is noted that the volumes remain too small against the background of extremely high security risks and lack of access to long-term loans.

Summarizing the literature review, three important gaps can be identified that determine the need for this study. First, most of the existing works (RDNA, KSE, NISD) that have evaluation criteria are devoted to quantitative assessment of needs, but do not offer a holistic model of strategic planning in which sectoral priorities would interact with real institutional capabilities. Second, public management studies [6] provide general principles for protecting CI, but bypass such issues as the reasons for weak absorption capacity in government bodies and systemic bureaucratic inertia. And third, criticism of the DREAM digital ecosystem [5] is mostly journalistic in nature – there is a lack of systematic research that would be able to quantitatively measure the use of the platform and the real effectiveness of raising funds. This article aims to partially address these shortcomings through a systematic analysis of the evolution of approaches (based on RDNA1–RDNA4), an assessment of institutional and financial gaps, and an analysis of the role of digital tools in facilitating transparency in reconstruction.

3. Problem Statement

Despite extensive analytical reporting and legislation, strategic planning for the reconstruction of Ukraine's critical infrastructure faces three interrelated challenges. First, existing needs assessments (RDNA4) show a growing financing gap of almost $10 billion by 2025 [14], but the question of how to fill this gap, including through the confiscation of frozen Russian assets, and how to finance it, remains politically unresolved. Second, strategic documents (Law, Procedures, National Plan) are fragmented, and the lack of a single legally binding national recovery plan creates a situation of uncoordinated action between central authorities, local communities, and international donors [5]. Third, low absorption capacity (only 1% of the budget was spent in the first quarter of 2025 [5]) and underutilization of the potential of the DREAM digital ecosystem slow down the implementation of projects, which risks leading to ossification of bureaucratic inertia. Thus, the scientific problem lies in the gap between the declared strategic goals of restructuring and the real institutional and financial capabilities for their implementation in practice and requires a systematic analysis of events, identification of barriers and development of practical recommendations for overcoming them.

4. Methods and Materials

The methodological basis of the study is a set of complementary approaches. First, an analysis of the dynamics of the rapid assessment of damage and recovery needs reports (RDNA1–RDNA4), which were prepared jointly by the World Bank, the Government of Ukraine, the European Union and the UN, was applied. To ensure data comparability, the method of horizontal analysis (comparison of indicators over time) and vertical analysis (determination of the share of individual sectors in the total damage) was used. Second, a content analysis of key strategic documents of Ukraine was conducted: the Law "On Critical Infrastructure" [9], the National Plan for Critical Infrastructure Protection [11; 12], the Categorization Methodology [8], as well as materials on the DREAM digital ecosystem [3; 4; 10]. Third, an analysis of financial data was carried out according to the RDNA3 and RDNA4 reports [5; 7; 14] (needs, secured financing, deficit). To assess the real ability to use available funds, the absorption capacity coefficient (the ratio of actually spent funds to the planned budget) was used. Fourth, the case study method was used for an in-depth analysis of the efficiency of using funds, using the example of the Ministry of Community, Territorial and Infrastructure Development of Ukraine (expenditures of only 1% of the budget in the first quarter of 2025) [5]. The source base of the study additionally includes reports of the Kyiv School of Economics [1] and expert interviews [6], which allowed us to verify quantitative data and take into account informal practices.

5. Results and Discussion

5.1. Evolution of Damage and Needs Assessments: From RDNA1 to RDNA4

The RDNA Rapid Assessment System was specifically designed to coordinate international assistance and domestic efforts. The first report, RDNA1 (June 2022), covered the first three months of the war: total damage – $252 billion, 10-year recovery costs – $348.5 billion. Housing (40% of damage), transport (31%) and trade/industry (10%) were the most affected. RDNA2 (February 2023) updated the data to February 24, 2023: damage – $289.1 billion, needs – $410.6 billion, priority actions for 2023 required $14 billion (3.5% of total needs). Loss structure: housing 38%, transport 26%, energy 8% [9].

RDNA3 (February 2024) took into account the period up to December 31, 2023 and recorded direct losses at the level of 152 billion dollars (138 billion euros). It was during the presentation of RDNA3 that the then Prime Minister Denys Shmyhal emphasized: "Russia must pay", calling for the confiscation of frozen Russian assets [7]. In 2023, the government allocated 7.2 billion dollars for urgent projects, which made it possible to repair 3,836 apartment buildings, 448 schools, 390 healthcare facilities, 9,200 CI facilities, 2,000 km of roads, 115 bridges [7]. The most comprehensive report is RDNA4 (February 2025), which covered the period from February 2022 to December 2024. Total direct damage reached 176 billion USD (170 billion EUR), which is 24 billion USD more than RDNA3 [2; 12; 14]. Long-term needs for 10 years are estimated at 524 billion USD: housing – 84 billion, transport – 78 billion, energy and mining – 68 billion, trade and industry – over 64 billion, agriculture – over 55 billion, cleanup of the remains of destruction – 13 billion [13; 14]. The dynamics of changes are summarized in Table 1.

Table 1. Evolution of RDNA estimates (2022–2025)

Report	Period	Direct losses, billions of dollars	Needs for 10 years, billions of dollars	Priority sectors
RDNA1	24.02.2022–01.06.2022	252	348,5	housing (40%), transport (31%)
RDNA2	24.02.2022–24.02.2023	289,1	410,6	housing (38%), transport (26%)
RDNA3	24.02.2022–31.12.2023	152	(not listed separately)	energy, transport, housing
RDNA4	24.02.2022–31.12.2024	176	524	housing (84), transport (78), energy (68)

Source: [2; 7; 12; 13; 14].

The updated RDNA2 report, published in February 2023, extended the observation period to 24 February 2023. According to it, direct losses increased to $289.1 billion and long-term recovery needs to $410.6 billion. Priority actions for 2023 were estimated at $14 billion, which was about 3.5% of the

total needs. The structure of losses remained similar: housing – 38%, transport – 26%, energy – 8% [9]. A further analysis conducted within the framework of RDNA3 (February 2024) covered the period to 31 December 2023. This report recorded an increase in direct losses to $152 billion (€138 billion). It was during the presentation of RDNA3 with the participation of the World Bank that the then Prime Minister of Ukraine Denys Shmyhal (currently in office) made a resonant statement, emphasizing that "Russia must pay", and the main source of financing for reconstruction should be the confiscation of frozen Russian assets [7]. Despite the war, in 2023 the government of Ukraine allocated $7.2 billion for urgent reconstruction projects. With this money, 3,836 apartment buildings and 19,091 individual houses, 448 schools, 237 kindergartens, 390 medical and social institutions were repaired, and 9,200 critical infrastructure facilities, 2,000 km of roads and 115 bridges were restored [7]. The most comprehensive and relevant strategic document to date is the RDNA4 report, published in February 2025. It covers the period from February 2022 to December 2024 and shows that the total direct damage reached 176 billion USD (170 billion EUR), which is 24 billion USD more than the RDNA3 estimates [2; 12; 14]. Long-term recovery and reconstruction need over the next ten years are estimated at 524 billion USD. The largest costs will be required by the housing sector – almost 84 billion USD, followed by transport with 78 billion USD, followed by energy and mining (68 billion USD), trade and industry (over 64 billion USD) and agriculture (over 55 billion USD). It is worth noting that the costs of cleaning up and managing the remains of the destruction alone amount to about 13 billion USD [13; 14].

Thus, the dynamics of the RDNA1–RDNA4 reports demonstrate not only the growth of the scale of destruction as the war continues, but also the gradual clarification of the priorities for recovery, where housing, transport and energy play a key role, while financial provision remains a critical challenge, the solution of which requires both the mobilization of domestic resources and an active position of international partners, in particular on the issue of confiscation of Russian assets.

Geographical concentration. Approximately 72% of all damage is in regions close to the front line: Donetsk, Luhansk, Kherson, Kharkiv, Zaporizhzhia, and Kyiv regions. Figure 1 presents a map of the distribution of direct losses by region, $ billion [14].

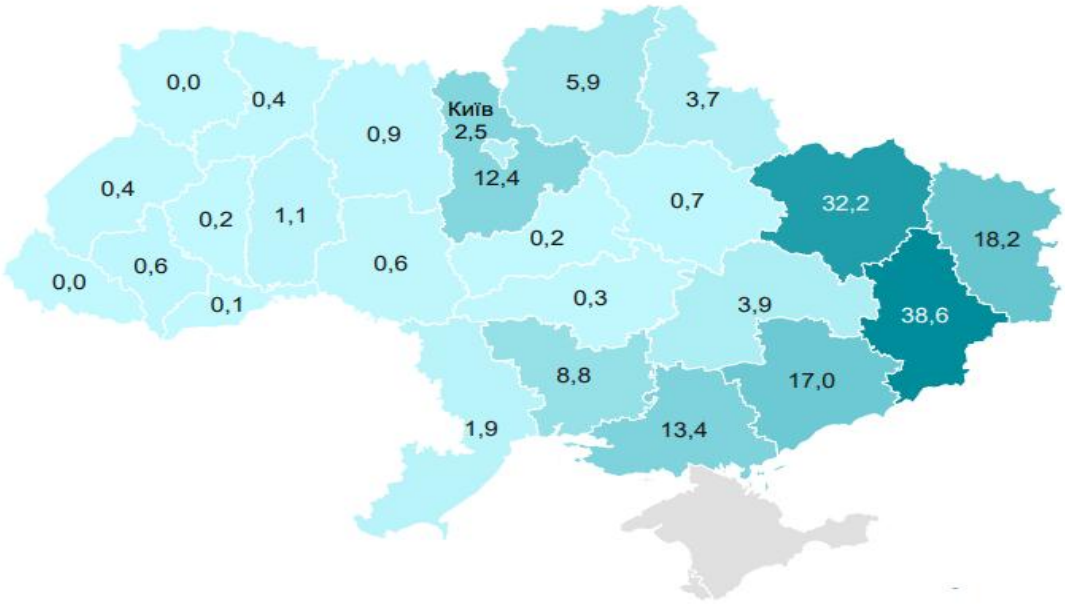

Figure 1. Distribution of direct losses by region, $ billion

Source: [9].

The figure clearly shows that the largest losses are concentrated in Donetsk region (over $20 billion), followed by Luhansk, Kharkiv and Kyiv. This requires a differentiated approach to recovery depending on the security situation.

5.2. Financial gap and sources of coverage

Despite the large-scale needs, the financial gap remains critical. According to RDNA4, for 2025 the financing needs are $15 billion, of which only $5.5 billion has been provided by international partners and the state budget. Thus, the deficit reaches $9.96 billion (over 60% of the needs) [14]. The largest shortages are in energy, industry and services.

Table 2. Financial needs and coverage for 2025 (according to RDNA4)

Indicator	Amount, billion USD
Total needs for 2025	15.0
Financing secured	5.5
Deficit	9.96

Source: [14].

Prime Minister Denys Shmyhal (at the time of writing) has repeatedly emphasized that the main source should be the confiscation of frozen Russian assets [7; 14]. The government is considering the temporary use of income from these assets, but full confiscation has not been politically resolved. The private sector plays an important role: investments in distributed generation (solar panels, gas power plants, biogas) are already being recorded, but their volumes are insufficient [14].

5.3. National-level strategic documents

In addition to the international RDNA assessments, Ukraine has developed its own regulatory framework for the protection and restoration of critical infrastructure. The Law of Ukraine "On Critical Infrastructure" [9] defines the concept of critical infrastructure facilities, their categories and the main principles of protection. The categorization methodology [8] establishes the criteria and procedures for assigning facilities to different categories of importance. The Register of Critical Infrastructure Facilities contains a list of facilities subject to protection and reconstruction after the war.

On September 19, 2023, the Cabinet of Ministers approved the National Plan for the Protection, Security and Resilience of Critical Infrastructure (developed by the State Special Communications Administration) [11; 12]. The plan is designed for three years and provides for: specification of the tasks of CI protection entities, improvement of legislation, monitoring, risk assessment, formulation of the procedure for interaction in crises, ensuring information exchange, strengthening CI resilience, design of population support programs and establishment of international cooperation. At the same time, as noted in the dissertation, the state lacks a single nationwide recovery plan with legal force that would coordinate the actions of all stakeholders (community, CSOs, donors, private investors) [5; 11]. Existing concepts and registers do not create a holistic recovery management architecture.

5.4. DREAM Digital Ecosystem: Transparency or Illusion?

A positive step was the implementation of the DREAM digital ecosystem (Digital Restoration Ecosystem for Accountable Management), which allows for real-time monitoring of restoration projects, involving the public and donors [3; 4; 10]. DREAM provides public access to information on funding, performers, deadlines, and results. However, experts note that its effectiveness depends on the completeness and timeliness of data entry, as well as on the political will to ensure transparency. It is noteworthy that the Ministry of Community, Territorial and Infrastructure Development spent only 1% of its annual budget on reconstruction in the first quarter of 2025, which indicates procedural delays and inefficient spending of funds [5].

5.5. Private sector and international support

With the support of donors, in 2025, the government allocated $7.37 billion. (€7.12 billion) for priority areas: social protection, housing, healthcare, education, energy, transport, water supply, demining, civil protection [14]. The private sector is investing in distributed generation (solar panels, gas power plants, biogas), but these volumes are insufficient due to high security risks, uncertainty of the regulatory environment and limited access to long-term loans. RDNA4 also recommends investing in social service centers and social housing, which requires amendments to the Housing Code and laws on social services, as well as the development of a National Housing Strategy [14].

5.6. Analysis of the implementation of urgent projects: achievements and challenges

Despite the overall deficit, a significant amount of work was implemented in 2023–2024. By the end of 2023, 9,200 utility facilities, 449 heating facilities, 221 water supply and sanitation facilities, 2,000 km of roads and 115 bridges had been completed [7]. However, much of this work was of an emergency rather than a capital nature, which does not address the problem of equipment wear and tear. RDNA4 reports [14] highlight a significant gap between needs and the funding provided; focusing

on immediate needs may not be sufficient for long-term sustainability. The lack of systematic planning means that restored facilities often remain vulnerable to repeated attacks.

6. Discussion and recommendations

The analysis allows us to identify three key problems in the strategic planning of the reconstruction of critical infrastructure in Ukraine.

The first of them is the assessment and financial one: the RDNA4 estimates indicate an increase in losses and needs; however, the financial gap of $9.96 billion for 2025, which is more than 60% of the total needs, remains unmet, and the confiscation of Russian assets has not yet been politically resolved. In this regard, it is recommended to intensify negotiations on the creation of a legal mechanism for full confiscation and expand the attraction of private capital through public-private partnerships and preferential lending.

The second problem is institutional and strategic: the lack of a single nationwide recovery plan disorients donors and communities, and the existing documents are fragmented. Therefore, it is necessary to adopt a legally binding recovery plan that integrates RDNA4, sectoral strategies and the budget process, with annual reporting to the Verkhovna Rada.

The third problem is operational and monitoring: low absorption capacity (only 1% of the budget was spent in the first quarter of 2025), bureaucratic delays, and incomplete use of the DREAM system are hampering project implementation. To overcome this, it is necessary to make it mandatory to publish all projects in DREAM with quarterly reports, introduce personal responsibility of heads of government bodies for failure to implement fund utilization plans, and conduct training for local administrations on working with donor funds.

7. Conclusions

An analysis of the evolution of the RDNA1–RDNA4 reports shows a steady increase in direct damage to Ukraine's critical infrastructure – from $252 billion in June 2022 to $176 billion in December 2024, and long-term recovery needs over ten years – to $524 billion. The largest losses were suffered by the housing sector ($84 billion), transport ($78 billion), and energy ($68 billion), with 72% of the total damage geographically concentrated in five frontline regions and the Kyiv region. The financial gap for 2025 is $9.96 billion, which is more than 60% of the total needs of $15 billion.

Despite the political will of former Prime Minister D. Shmyhal to confiscate frozen Russian assets, a full mechanism has not yet been created, and private investment, in particular in distributed generation, is an important but insufficient source of financing. The strategic framework for reconstruction includes the Law "On Critical Infrastructure", the Categorization Methodology, the National Plan for the Protection of Critical Infrastructure (September 2023), and the DREAM digital ecosystem.

However, the lack of a single nationwide recovery plan with legal force creates chaos in the coordination of actions of donors and local authorities, and the low absorption capacity (only 1% of the budget was spent in the first quarter of 2025) and the incomplete use of DREAM capabilities indicate systemic bureaucratic inertia.

To improve the effectiveness of strategic planning, it is necessary to adopt a legally binding national recovery plan, ensure full transparency of all projects in the DREAM system, intensify negotiations on the confiscation of Russian assets, and introduce personal responsibility of officials for the use of funds.

Prospects for further research are seen in the analysis of the effectiveness of the use of international technical assistance at the regional level and in the development of a methodology for assessing the sustainability of restored critical infrastructure facilities

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