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RESTORATION OF UKRAINE'S HOUSING STOCK THROUGH THE LENS OF GREEN CONSTRUCTION: CHALLENGES, PROSPECTS, AND THE ROLE OF STAKEHOLDERS

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ABSTRACT

Aim of the study

The purpose of the study is to conduct a comprehensive analysis of the State of Ukraine's housing stock before and after the beginning of the full-scale war, and to substantiate the practical strategies for its environmentally oriented restoration in the context of post-war reconstruction, through the integration of green building principles, the identification of key challenges and prospects of this approach, and the determination of the role of key stakeholders in ensuring a sustainable and energy-efficient housing stock.

Material and methods

The study is based on the works of domestic and foreign scientists, publications from the Kyiv School of Economics and the Centre for Economic Strategy, data from the Rapid Damage and Needs Assessment (RDNA) reports, materials from the "Construction, urban planning, modernization of cities and regions" working group of the National Council for the Recovery of Ukraine from the Consequences of War, Ukraine Facility Plan 2024–2027, official statistics from the State Statistics Service of Ukraine, and other relevant online resources.

The following research methods were applied: monographic, statistical, abstract-logical, graphical, and tabular.

Results and conclusions

In this article, the authors have examined the strategic foundations and practical approaches to restoring Ukraine's housing stock in the context of post-war reconstruction through the integration of green building principles. The scale of damage to residential buildings caused by Russia's armed aggression has been analyzed, particularly based on the latest RDNA reports, and the growth rates of damages and reconstruction needs have been identified.

The critical condition of the housing stock has been highlighted, with a significant portion being both morally and technically outdated. The study has substantiated the need not only for physical replenishing of the housing stock but also for its modernization that would have to incorporate environmental, energy-related, and social criteria. The main directions of intervention and the potential benefits of implementing green construction principles have been outlined, including enhanced energy efficiency, reduced dependence on fossil fuels, improved quality of life, job creation, and strengthened energy security. Particular attention has been given to the role of stakeholders at various levels – State authorities, local communities, businesses, international partners, and others – in supporting reconstruction processes.

The authors have emphasized the necessity of a systematic approach to housing reconstruction, grounded in green building principles, energy efficiency, transparency, and cross-sectoral cooperation.

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Keywords: Ukraine, buildings, post-war reconstruction, green recovery, sustainable development, green construction, stakeholder engagement.

INTRODUCTION

The housing sector has proven to be one of the most severely affected by Russia's full-scale military invasion of Ukraine (Andrienko et al., 2025; Ukraine: The Fourth Rapid Damage and Needs Assessment, 2025). The large-scale destruction of housing infrastructure, the demolition of or damage to millions of private and multi-apartment buildings, and the loss of safe and adequate living space for millions of citizens indicate the unprecedented challenges faced by our country. Housing has become both a physical target of attacks and a symbol of lost security, stability, and well-being for many Ukrainian families.

Nowadays, green building is regarded not as a trend but as an essential requirement of contemporary construction practice. There is growing global awareness of the need for rational use of natural resources as well as for environmental conservation. In this context, harmonizing buildings with their environment is becoming critically important. The implementation of innovative technologies aimed at reducing emissions, using environmentally safe materials, enhancing energy efficiency, reusing construction waste, greening the existing structures, and creating new green buildings is increasingly recognized as a critical task of the present day.

This new approach to construction is particularly relevant in Ukraine in the context of green recovery and post-war reconstruction. It covers aspects such as resilience to climate change and natural disasters, compliance with EU legislation, adherence to international standards for energy efficiency, inclusiveness, and other key requirements of modern construction.

The replenishing of the housing stock is not only a priority for post-war reconstruction but also a strategic prerequisite for the socio-economic revival of the regions. It should be guided by the principles of green building, which ensure not only comfort and safety but also environmental responsibility and stewardship toward future generations.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

Both international and domestic researchers are making significant efforts to promote green construction, which can be an important step towards achieving sustainable development of Ukraine. They actively support the idea of integrating green innovations into construction projects, especially in the context of post-war reconstruction. Scientific research is focused on developing innovative solutions to improve energy efficiency, use renewable energy sources and environmentally friendly materials, and reduce negative impacts both during construction and throughout the operational life of buildings.

In particular, the article by Cifuentes-Faura (2023), while focusing on both the short- and long-term aspects of post-war reconstruction in Ukraine, highlights the importance of the green transition as a key factor in enhancing the country's economic efficiency and competitiveness. At the same time, the author underscores that ensuring transparency in the reconstruction process is a necessary prerequisite for achieving the Sustainable Development Goals. We fully concur with the author's view that Ukraine's post-war reconstruction should be grounded in the principles of sustainability, energy efficiency, and digitization, with the objective of creating innovative, environmentally responsible, and resilient territorial communities.

J. Modrzyńska, A. Szpak, and R. Willa emphasize the importance and practical relevance of the *"building back better"* concept in Ukraine's post-war reconstruction, and they underscore the crucial role of international organizations, particularly the United Nations and the European Union, in supporting this process (Modrzyńska et al., 2024).

The study by O. Diachuk and co-authors examines Ukraine's plans to reduce energy consumption in buildings for heating and cooling by two-thirds by 2050, while achieving carbon neutrality and enhancing energy security. The authors emphasize that lowering energy use and attaining zero emissions in the building sector are crucial to the overall decarboniza-

tion of the national economy. We fully support their position regarding the need for comprehensive legislative and policy reforms in Ukraine, the harmonization of building codes with EU requirements, the introduction of effective energy efficiency regulations, and the increased utilization of renewable energy sources (Diachuk et al., 2025).

T. Kryvomaz, I. Chalyi, R. Hamotskyi, I. Ilchenko, and A. Tsyba emphasize the importance of Ukraine's post-war reconstruction potential as a unique opportunity for the country to become a hub of innovation. We concur with their view that green reconstruction is not merely the restoration of destroyed buildings and infrastructure; more than that, it is a process that entails a transition to a new level of development through the integration of best global practices and innovative technologies. This approach allows not only for rebuilding but also for modernizing the country, creating new opportunities for economic growth and enhancing resilience to future challenges (Kryvomaz et al., 2023).

O. Bielenkova, D. Dubinin, Ya. Loktionova, and D. Kalashnikov define green building as a key imperative for the development of the construction sector. They emphasize that digital and environmental innovations, along with adaptability, will continue to shape the future of the construction industry (Bielenkova et al., 2024).

N. Zhuravska and Ya. Avdykovich rightly emphasize the importance of green building not only in the reconstruction of buildings but also in restoring the damaged environment in the context of Ukraine's post-war reconstruction (Zhuravska and Avdykovich, 2023).

U. Andrusiv and Yu. Mazhak examine both the challenges (the need to restore large territories, substantial financial costs, a shortage of skilled personnel, complications in logistics chains, and the risks of ongoing hostilities) and the opportunities (green building, digitization, innovative building materials, and investment attractiveness) for the development of Ukraine's construction industry. They emphasize that green construction has significant potential to become a key driver of recovery and growth in this sector. At the same time, their view that the effective implementation of green building in Ukraine requires active cooperation between government authorities, businesses, and civil society is well-founded (Andrusiv and Mazhak, 2024).

O. Drebot, M. Vysochanska, V. Bilotil, and O. Yaremko analyze the environmental impact of construction and identify global challenges that drive the development of green building. They emphasize the relevance of these challenges for Ukraine, particularly in the context of the war, and justify the need to integrate green construction principles into post-war reconstruction. The article proposes a system of measures for developing the green building market in Ukraine and demonstrates its potential to transform not only the construction sector but also the national economy as a whole (Drebot et al., 2024).

Despite the growing attention of scientists and practitioners to the challenges of implementing green building technologies in Ukraine's construction industry, a number of pressing issues related to the transformation of the construction sector in the context of post-war reconstruction remain insufficiently studied. Particular attention should be given to examining the specifics of residential construction, as well as the issues of reconstruction and renovation of Ukraine's housing stock, taking into account emerging environmental challenges and the requirements of sustainable development.

In the current context of post-war reconstruction, it is critically important to ensure the high-quality and environmentally responsible restoration of destroyed areas − the kind of restoration that would meet European standards for energy efficiency, inclusiveness, and sustainability. The integration of green building principles into the processes of restoring housing infrastructure should serve as a guarantee of its long-term resilience and adaptability to future challenges.

The aim of our research is to conduct a comprehensive analysis of the State of Ukraine's housing stock before and after the beginning of the full-scale war, and to substantiate the practical strategies for its environmentally oriented restoration in the context of post-war reconstruction, through the integration of green building principles, the identification of key challenges and prospects of this approach, and the determination of the role of key stakeholders in ensuring a sustainable and energy-efficient housing stock.

MATERIAL AND METHODS

A set of general scientific and specialized methods was applied to achieve the aim of the research, in particular:

The monographic method enabled a comprehensive review of national and international research, an-

alytical reports (in particular those by the Government of Ukraine, the World Bank, the European Commission, the United Nations, the Kyiv School of Economics, and the Ministry for Communities and Territories Development of Ukraine), and policy documents such as Ukraine Facility Plan 2024–2027 and the Draft Ukraine Recovery Plan (2022). It served to identify key trends, challenges, and strategic directions for integrating green building principles into Ukraine's housing reconstruction process.

The statistical method was employed to analyze quantitative data on Ukraine's housing stock before and after the beginning of the full-scale invasion. These included official data from the State Statistics Service of Ukraine, as well as the Rapid Damage and Needs Assessment (RDNA4) and KSE Institute estimates of direct damage to the housing sector. The analysis focused on the scale, geography, and dynamics of destruction, along with indicators of construction activity and regional disparities.

The abstract-logical method was applied to generalize research findings and to develop theoretical conclusions and practical recommendations for transforming Ukraine's residential construction sector in line with green building principles. This included defining conceptual links between post-war recovery policies, stakeholder engagement, and the Sustainable Development Goals.

The graphic and tabular methods were used to visualize key data on the housing sector and stakeholder interactions. Figures and tables illustrate direct damages to Ukraine's housing stock, the dynamics of damages and recovery needs (RDNA1–RDNA4), the distribution of households by housing age and renovation period, and the roles of stakeholders in green residential construction.

The research is based on the works by domestic and foreign scientists, publications from the Kyiv School of Economics and the Centre for Economic Strategy, data from the Rapid Damage and Needs Assessment (RDNA) reports, materials from the "Construction, urban planning, modernization of cities and regions" working group of the National Council for the Recovery of Ukraine from the Consequences of War, Ukraine Facility Plan 2024–2027, official statistics from the State Statistics Service of Ukraine, and other relevant online resources.

RESULTS AND DISCUSSION

By February 2022, Ukraine's housing stock comprised approximately 20 million housing units, distributed among multifamily buildings, dormitories, and various types of single-family houses. Multifamily buildings predominate in cities, housing nearly 67% of the urban population; in larger cities, this share rises to 79% (Ukraine: The Fourth Rapid Damage and Needs Assessment, 2025).

According to official statistical data, as of January 1, 2022, the country had 8,089,381 residential buildings, of which 38,775 were classified as old and 16,252 as emergency residential buildings (State Statistics Service of Ukraine, n.d.). These figures indicate that even before the war, a certain portion of Ukraine's residential infrastructure was depreciated and required modernization, as most of the housing had been constructed during the Soviet period (Ukraine Facility Plan 2024–2027, n.d.; State Statistics Service of Ukraine, 2022) and no longer met the standards of modern, comfortable living.

The housing sector suffered the most damage as a result of the armed aggression of the Russian Federation against Ukraine (Andrienko et al., 2025; Ukraine: The Fourth Rapid Damage and Needs Assessment, 2025). Massive shelling of Ukrainian cities, towns, and villages has become one of Russia's main tools of warfare, causing extensive damage to housing infrastructure.

Analysts from the Kyiv School of Economics, in cooperation with the Ministry for Communities and Territories Development of Ukraine, the Ministry of Economy of Ukraine, other relevant ministries, and the National Bank of Ukraine, produced a report assessing the scale of direct damage to Ukraine's infrastructure resulting from Russia's military aggression, as of November 2024 (Andrienko et al., 2025).

According to the report, since the beginning of the full-scale invasion, the total direct damage to buildings, infrastructure, and inventories has reached nearly USD 170 billion. This amount increased by USD 12.6 billion, or 8%, compared to the damage estimate at the beginning of 2024 (Table 1) (Andrienko et al., 2025).

Massive rocket and artillery strikes, as a component of Russia's military strategy, have caused extensive destruction of residential buildings in cities and

towns, particularly in settlements near the front line. Direct damage to the housing stock amounts to nearly USD 60 billion, exceeding one-third of the total losses (Table 1). As a result of hostilities, more than half of the housing stock in many cities and towns has suffered significant damage or has been completely destroyed (Andrienko et al., 2025).

The total number of damaged or destroyed residential buildings is about 236 thousand, of which 209 thousand are private (individual) houses, 27 thousand are apartment buildings, and 0.6 thousand are dormitories (Table 2) (Andrienko et al., 2025).

A comprehensive tool for assessing damages, losses, and needs, as well as a decisive basis for planning Ukraine's recovery and reconstruction, is the Rapid Damage and Needs Assessment (RDNA). According to the latest RDNA4 report, prepared by the Government of Ukraine, the World Bank, the European Commission, the United Nations, and other partners, the total direct damage as of 31 December 2024 amounts to approximately USD 176 billion (EUR 170 billion), nearly USD 24 billion higher than in the previous RDNA3 report. The housing sector is among the most affected, representing 33% of the total reported damage. Approximately 13% of the total housing stock has been damaged or destroyed, affecting nearly 2.5 million households in Ukraine. The total reconstruction and recovery needs in Ukraine over the next decade are estimated at USD 524 billion (Table 3) (Ukraine: The Fourth Rapid Damage and Needs Assessment, 2025).

Table 1. Total estimate of infrastructure damages and estimate of housing damage as of November 2024 (Source: compiled on the basis of Andrienko et al., 2025)

Property type	Assessment of damages, USD billion	Share of damages, % of total sum	Previous assessment of damages, USD billion	Dynamics, %
Residential buildings	60.0	35.3	58.9	1.9
Total	169.8	100	157.2	8.0

Table 2. Direct damages to Ukraine's housing stock (Source: Andrienko et al., 2025)

Type of housing units	Initial stock, thousand units	Destroyed, thousand units	Damaged, thousand units	Damage assessment, USD billion
Private (individual) houses	9,163.9	70.7	125.8	9.4
Multi-apartment buildings	180.0	7.0	19.8	49.9
Dormitories	7.1	0.2	0.4	0.7
Total	9,351.0	77.8	146.1	60.0

Table 3. Third (RDNA3) and Fourth (RDNA4) Rapid Damage and Needs Assessments in Ukraine: comparison of indicators (housing sector), USD billion, % (Source: compiled on the basis of The Ukraine: The Fourth Rapid Damage and Needs Assessment, 2025)

Indicators	RDNA3	RDNA4	RDNA4 / RDNA3, +/–	Change, %
Total direct damage, USD billion	152.5	176.1	+23.6	15.5
Total direct damage to housing, USD billion	55.9	57.6	+1.7	3.0
Total loss, USD billion	499.3	588.8	+89.5	17.9
Total loss to housing, USD billion	17.4	21.1	+3.7	21.3
Total recovery and reconstruction needs, USD billion	486.2	523.6	+37.4	7.7
Total recovery and reconstruction needs to housing,USD billion	80.3	83.7	+3.4	4.2
Recovery and reconstruction priorities for the next year, USD billion	15.3	17.3	+2.0	13.1

Figure 1 illustrates the damages, losses, and recovery needs of Ukraine's housing stock as assessed in RDNA1, RDNA2, RDNA3, and RDNA4. The report shows a clear upward trend across these indicators. Total damage to housing rose from USD 39.2 billion (RDNA1) to USD 57.6 billion (RDNA4), an increase of USD 18.4 billion, or 46.94%. Losses increased from USD 13.3 billion (RDNA1) to USD 21.1 billion (RDNA4), an increase of USD 7.8 billion, or 58.65%. Similarly, the recovery needs of the housing stock grew from USD 69.0 billion (RDNA1) to USD 83.7 billion (RDNA4), representing an increase of USD 14.7 billion, or 21.30%.

The greatest damage across all sectors was recorded in the Donetsk, Kharkiv, Luhansk, Zaporizhzhia, Kherson, and Kyiv regions. Damage in these regions amounts to over USD 127 billion, or 72% of the total damage (Ukraine: The Fourth Rapid Damage and Needs Assessment, 2025).

The most severe damage to the housing stock has been observed in settlements located close to the front line and the Russian border, particularly in the Donetsk, Kharkiv, and Luhansk regions of Ukraine (Structural changes and challenges in Ukraine's construction industry: Analysis and forecasts, 2024).

Residential buildings in the large cities of eastern Ukraine have suffered the most, particularly in Mariupol, Kharkiv, Chernihiv, Sievierodonetsk, Rubizhne, Bakhmut, Mariinka, Lysychansk, Popasna, Izium, and Volnovakha. For instance, in Bakhmut and Mariinka, almost no buildings remain undamaged, while in Sievierodonetsk, 90% of the housing has been destroyed. The total number of damaged residential buildings (both single-family houses and apartment blocks) continues to rise due to ongoing hostilities in the Kharkiv, Luhansk, Donetsk, Zaporizhzhia, and Kherson regions, as well as regular missile strikes across Ukraine (Andrienko et al., 2025).

In addition, as a result of the destruction of the Kakhovka Hydroelectric Power Plant in June 2023, approximately 4.8 million square meters of residential space were flooded, corresponding to nearly 36,000 destroyed or damaged buildings, most of which are located in the Kherson region (Structural changes and challenges in Ukraine's construction industry: Analysis and forecasts, 2024).

As previously, the rate of destruction continues to exceed the pace of recovery, although reconstruction is accelerating. The greatest quantitative damage concerns housing: 24,295 apartment buildings and 175,207 private houses have been damaged or destroyed, with approximately 30% having been restored (The recovery spending watchdog (No. 18), 2025).

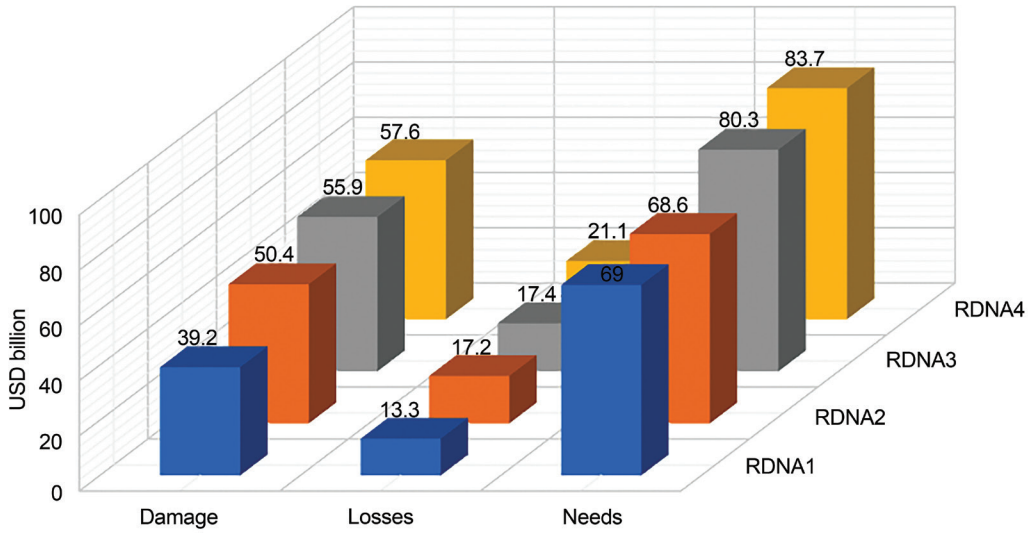

Fig. 1. Dynamics of damages, losses, and recovery needs in Ukraine's housing sector according to RDNA1, RDNA2, RDNA3, and RDNA4 assessments, USD billion (Source: compiled on the basis of Ukraine: The Fourth Rapid Damage and Needs Assessment, 2025)

In order to restore residential buildings to their previous condition, expenditures will be required in the following areas:

- routine maintenance and repair of housing,
- reconstruction or major renovation of residential buildings,
- construction of new buildings,
- restoration of the area around residential buildings (fences, benches, landscaping, sports and children's playgrounds, etc.),
- acquisition of durable household items (appliances, furniture, etc.) (Report on damages to infrastructure from destruction caused by Russia's military aggression against Ukraine as of early 2024, 2024).

In addition to the large-scale need for renovation, a significant portion of Ukraine's housing stock is morally and technically obsolete. Most of the buildings destroyed or damaged as a result of military actions were constructed during the Soviet era and have long outlived their service life. They do not meet modern energy efficiency standards, have outdated design solutions, and suffer from long-standing problems caused by insufficient maintenance and the absence of major repairs (Structural changes and challenges in Ukraine's construction industry: Analysis and forecasts, 2024). It is evident that this creates additional challenges for the reconstruction process, as restoring such buildings requires substantial financial investment, and in many cases, it is more reasonable to replace them with new, more environmentally friendly and energy-efficient housing.

Before the war, Ukraine had approximately 9 million single-family houses, 180,000 apartment buildings, and more than 70,000 public buildings, the majority of which were outdated: over 80% had been built before 1991 (Ukraine Facility Plan 2024–2027, n.d.).

According to the State Statistics Service of Ukraine, most households in both rural and urban areas lived in housing constructed during the Soviet era (State Statistics Service of Ukraine, 2022) (Fig. 2).

According to statistical data as of 2022, over 40% of Ukrainian households lived in buildings that had never been renovated since their construction (State Statistics Service of Ukraine, 2022) (Fig. 3, Table 4).

Most of Ukraine's housing requires urgent modernization and major repairs. The existing housing stock does not meet modern energy efficiency standards, is characterized by insufficient thermal comfort, and suffers from poor indoor air quality. On average, energy consumption in Ukrainian buildings is two to three times higher than in European countries. Significant heat losses occur through poorly insulated building envelopes as well as due to outdated, inefficient technical systems. At the same time, even before

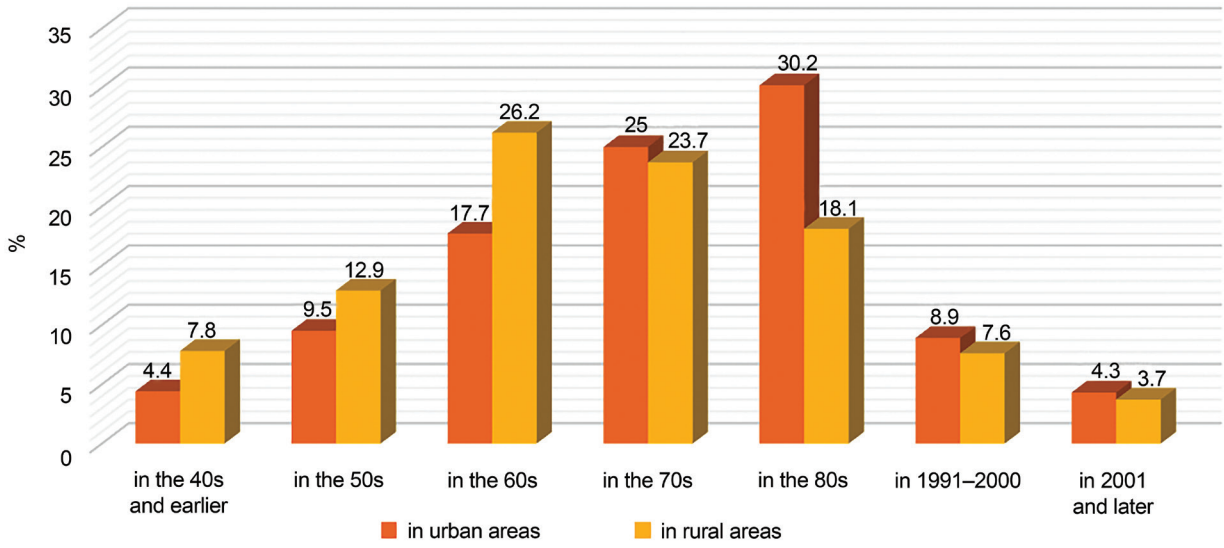

Fig. 2. Distribution of urban and rural households in Ukraine by time of housing construction, %, 2022 (Source: State Statistics Service of Ukraine, 2022)

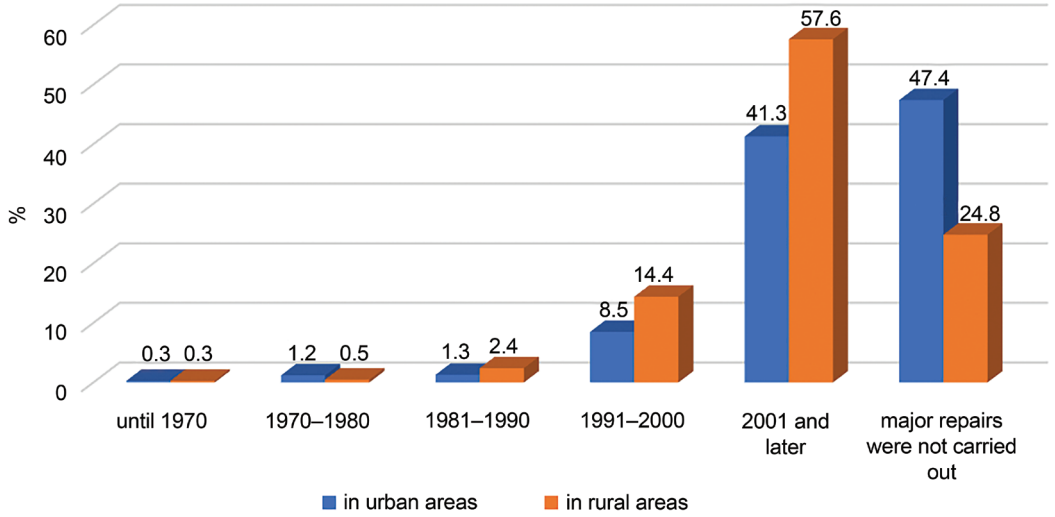

Fig. 3. Distribution of urban and rural households in Ukraine by time of last major repair of their housing, %, 2022 (Source: developed on the basis of the State Statistics Service of Ukraine, 2022)

Table 4. Distribution of households in Ukraine by the time of the last renovation of their housing, %, 2022 (Source: compiled on the basis of the State Statistics Service of Ukraine, 2022)

Number of households (thousands)	14,549.2
Distribution of households (%) by the time of the last major repair of their housing:	100.0
until 1970	0.3
1970–1980	1.0
1981–1990	1.7
1991–2000	10.4
2001 and later	46.5
Major repairs were not carried out	40.1

the war, the pace of energy renovation of the housing stock remained extremely low compared to European countries (Ukraine Facility Plan 2024–2027, n.d.).

Improving energy efficiency in the building sector can bring substantial benefits for both the economy and society. Residential buildings account for nearly 40% of total final energy consumption, with fossil fuels remaining the primary energy source. Up to 60% of this energy is used for space heating. The heavy reliance of heating systems on natural gas is particularly critical, as it accounts for over 70% of energy consumption. Enhancing the energy efficiency of the housing stock could reduce energy consumption by 40–50%. This improvement would not only increase access to energy for vulnerable households, enhance thermal comfort, and improve indoor air quality, but also reduce the burden on the State budget in terms of welfare support. In addition, the development of the energy efficiency sector can stimulate the construction industry, boost the production of energy-efficient building materials, increase tax revenues, and create new jobs (Ukraine Facility Plan 2024–2027, n.d.).

The issues of restoration and development of regions and territorial communities are analyzed in detail in the materials of the "Construction, urban planning, and modernization of cities and regions of Ukraine" working group, which are included in the Draft Ukraine Recovery Plan (2022).

The foundation of recovery and development processes is based on key principles: rebuilding better than before, openness and transparency, European integration, sustainable development, energy independence, inclusiveness, and civil protection (The Draft Ukraine Recovery Plan, 2022).

For each recovery and development sector, including "Construction regulation" and "Housing, energy efficiency, and civil protection," the associated problems, objectives, goals, tasks, implementation stages, and relevant target indicators were identified (Table 5) (The Draft Ukraine Recovery Plan, 2022).

Table 5. Problems and objectives of the Recovery Plan in the directions of "Regulation in construction" and "Housing, energy efficiency, and civil protection" (Source: compiled on the basis of The Draft Ukraine Recovery Plan, 2022)

Directions	Problems	Objectives
Regulation in construction	The need to ensure the comprehensive restoration of infrastructure and housing due to destruction.	Comprehensive restoration of infrastructure and housing stock due to destruction using modern approaches and practices of development of regions / territorial communities / settlements by the principles of sustainable development, in particular: human centre, rational spatial planning, sustainable urban mobility, inclusiveness, energy efficiency, environmental friendliness, creating the environment conducive to better life-work balance.
	Insufficient transparency and publicity of urban planning activities.	Ensuring publicity and transparency of urban planning documentation and implementation of permit and registration procedures.
	There is no management of the building's life cycle.	Effective management of buildings during their life cycle.
	Lack of technical preparedness of the system for assessing conformity with EU requirements in the field of construction.	Implementation of European rules for assessment and verification of the stability of indicators of construction products, which are carried out by designated conformity assessment bodies.
	There is no system for construction and demolition waste management.	Implementation of a system for sustainable management of construction and demolition waste.
Housing, energy efficiency, civil protection	Citizens' homes were destroyed and damaged as a result of the Russian armed aggression against Ukraine.	Restore the living condition of damaged housing and provide compensation in case of inexpediency of housing restoration (significant damage, destruction, etc.).
	Some citizens do not have housing or resources to provide it.	Provide housing for IDPs and people whose homes have been damaged / destroyed as a result of the Russian armed aggression against Ukraine.
	Maintenance and service of apartment buildings is not efficient.	Maintenance and service of residential buildings is carried out in full.
	Insufficient number of structures for civil protection and shelters for the entire population of the country.	Providing the maximum population with protection from dangerous injuries because of hostilities.
	High energy and climate vulnerability of communities due to irrational use of fuel and energy in settlements.	Creating conditions for sustainable energy development of communities and regions of Ukraine.
	High energy intensity of the residential and public buildings sector threatens Ukraine's energy security.	Strengthening Ukraine's energy security by reducing the energy intensity of the residential and public buildings sector in an energy efficient way.

In general, the Draft Ukraine Recovery Plan (2022) contains clearly defined tasks for the restoration of infrastructure facilities and housing stock, the introduction of sustainable management of construction and demolition waste, the overhaul and modernization of existing housing, in particular the implementation of energy efficiency measures, as well as the promotion of sustainable energy development in communities and regions of Ukraine. It is important that these tasks cover not only the post-war recovery period, but also the prospects for further development of the regions.

The issue of housing reconstruction in post-war Ukraine is closely linked to the broader recovery agenda defined within the Ukraine Recovery Conference (URC) process – held in Lugano, London, Berlin, and Rome. These conferences have established the strategic and institutional foundations for Ukraine's sustainable recovery, emphasizing transparency, energy efficiency, public-private partnerships, and the integration of green building principles and technologies into housing reconstruction. In particular, the URC outcomes underscore that rebuilding Ukraine's housing stock has to follow the Build Back Better approach, aligning national recovery policies with the sustainable development and green building principles (Ukraine Recovery Conference, 2022–2025).

It should be noted that before the full-scale Russian invasion, Ukraine's construction industry had significant potential and demonstrated steady growth. In particular, the residential construction sector experienced high demand, and many projects were implemented with both public and private investment (Structural changes and challenges in Ukraine's construction industry: Analysis and forecasts, 2024).

However, even before the war, the pace of new construction was insufficient to replace the depreciating housing stock or to improve the size and energy efficiency of existing units. Between 2000 and 2020, an average of 8.3 million m² of residential space was built annually, equivalent to approximately 185,000 units with an average area of 45 m². Nevertheless, this was insufficient to fully renovate the existing stock or to significantly increase per capita living space (Ukraine Facility Plan 2024–2027, n.d.).

The demand structure for residential real estate in Ukraine has changed markedly. In the frontline regions, construction volumes have declined by nearly 90%, while in central regions they have fallen by as much as 70%. Conversely, western regions have experienced a 15% increase in construction activity, driven by business relocations, the influx of internally displaced persons, and the development of resort properties in the Carpathians (Ozeychuk, 2023).

The primary real estate market has shifted mainly to the western regions of Ukraine. Developers in other areas are largely focused on completing projects that were launched before March 2022. Currently, most investors are hesitant to start new construction projects and are adopting a wait-and-see approach. In the central, northern, and eastern regions, demand for services to rebuild destroyed buildings and structures has increased. Businesses that have suffered property damage need to reconstruct buildings in order to resume operations (Ozeychuk, 2023).

In 2024, the volume of construction work completed in Ukraine increased by 15.5% year-on-year, reaching UAH 204.7 billion. Growth was also observed across specific sectors: in the residential construction sector, the volume of work increased by 7.6% compared to the previous year, reaching UAH 26.6 billion. According to GMK Center estimates, the construction market in dollar terms grew by 14.6% year-on-year, reaching USD 5.1 billion. Nevertheless, this remains 45.2% below pre-war 2021 levels (USD 9.3 billion). It should be noted that these figures do not account for the effects of dollar inflation. Additionally, in 2024, the total area of residential buildings commissioned in Ukraine increased by 32%, reaching 9.8 million m² (Grigorenko, 2025).

In 2025, nine priority recovery sectors have been identified for Ukraine, with the housing sector being the most critical. This includes the continuation of compensation programs for destroyed or damaged housing, as well as its reconstruction (Ministry for Development of Communities and Territories of Ukraine, 2025a).

The restoration of damaged buildings and the construction of new ones will follow advanced international and European practices, incorporating modern energy-efficient solutions and green technologies. A gradual transition to nearly zero-energy buildings will enhance energy security for the population, improve the resilience of buildings to external challenges, and contribute to the decarbonization of energy

consumption. This process will also support Ukraine's integration into the European Green Deal. Achieving these objectives requires further refinement of legislation, particularly through its harmonization with EU directives on building energy efficiency and public procurement (Ukraine Facility Plan 2024–2027, n.d.).

The issue of housing reconstruction has a spatial dimension. Not all settlements where the housing stock has been destroyed can currently be reconstructed. Some settlements remain unsafe for residents to return, and certain territories are still under occupation. Within settlements, it may be necessary to reconsider the planning structure, building heights, or the spatial distribution of housing. Therefore, housing policy should be closely integrated with urban planning and regional development policies, ensuring their implementation at the local level. The most effective approach to restoring housing is through comprehensive development strategies (Verbytskyi and Bobrova, 2022).

During the presentation of the assessment results of damages and needs caused by the Russian invasion of Ukraine, the Deputy Prime Minister for Restoration of Ukraine – the Minister for Development of Communities and Territories of Ukraine, Oleksii Kuleba, stated:

The path to recovery lies not only in the reconstruction of buildings and infrastructure. It is about restoring justice, ensuring security, and creating a future where every Ukrainian can live with dignity and opportunities. Our vision is clear: to rebuild Ukraine as a modern, strong, and resilient nation. (Ministry for Development of Communities and Territories of Ukraine, 2025a).

The recovery and reconstruction of Ukraine should be guided by the principles of *Build Back Better* (United Nations Office for Disaster Risk Reduction, 2017) and *Build Back Greener*, which involve implementing modern approaches to enhance resilience to climate change and natural disasters, ensuring compliance with EU legislation, and upholding standards of energy efficiency, inclusiveness, safety, accessibility, and environmental sustainability. This means creating safer, more environmentally responsible, and accessible buildings for all citizens, utilizing eco-friendly materials and advanced technologies to ensure long-term performance under dynamic environmental and social conditions. Key elements of this process include cooperation with international partners, attracting investments, and providing government support. In particular, ensuring access to natural resources, certifying construction products, and harmonizing standards with European requirements are essential aspects.

One of the key principles of the Build Back Better approach is barrier-free access. This entails not only ensuring that buildings and facilities are free of physical barriers, but also fostering an inclusive environment overall. Such an approach enhances the quality of life for people with reduced mobility, promotes their active participation in society, supports families, and broadens employment opportunities (The recovery spending watchdog No. 19, 2025)

Another key principle of the Build Back Better approach is improving energy efficiency (*The recovery spending watchdog* No. 19, 2025). The process of creating an electronic catalogue of construction products for green building is currently underway (Ministry for Development of Communities and Territories of Ukraine, 2025b; All-Ukrainian NGO Living Planet, 2025). This catalogue will serve as a reliable source of information for implementing energy-efficient green building projects in Ukraine. It contains a list of recommended building materials, products, equipment, and components of internal engineering systems, and will serve as a guide for implementing energy-efficient green building projects (Green Building Council Ukraine, n.d.).

It is already clear that, during reconstruction, the greatest demand will be for construction companies implementing advanced European technologies and using certified materials that comply with modern environmental and building standards. Green construction, guided by the principles of energy efficiency, environmental sustainability, and rational resource use, is becoming the foundation of this approach.

This development trajectory supports the construction of buildings that are not only aesthetically appealing but also functionally efficient, meeting standards of energy efficiency, durability, and resilience to climatic and anthropogenic challenges. Employing innovative solutions within green construction significantly reduces operational costs, enhances residential comfort, and facilitates the integration of Ukraine's real estate market into the European context.

We believe that effective housing reconstruction in Ukraine, within the context of green construction, requires coordinated collaboration among all stakeholder groups.

Today, the term *stakeholder* is widely used in the sense of "an interested person, team, organization, or party" in a process or decision, especially in the fields of management, business, and sustainable development.

The stakeholder concept has become a key tool in management and corporate responsibility, as it allows the interests and needs of diverse stakeholders – such as customers, employees, investors, communities, and others – to be considered in strategic decision-making and the development of business practices (Stankevych et al., 2024).

Construction project stakeholders are groups of individuals and organizations that play a decisive role at all stages of the construction life cycle, from conception to completion (Madushanka, 2023).

Participation of stakeholders in the construction processes has attracted considerable scholarly attention. In particular, S.C. Nissanka, C.I. Malalgoda, D. Amaratunga, and R. Haigh conducted an in-depth analysis of the roles and responsibilities of various stakeholder categories in effectively adapting the built environment to the impacts of climate change. They argue that clearly delineating these roles enhances collaboration among participants and ensures a holistic approach to climate change adaptation in the built environment (Nissanka et al., 2024).

J. Falana, R. Osei-Kyei, and V.W.Y. Tam analyzed the roles of key stakeholders at each stage of the life cycle of net zero carbon building (Falana et al., 2024).

The issue of stakeholders in green building projects was studied by Y.Y. Li, M. Li, P.D. Sang, P.-H. Chen, and C. Li (Li et al., 2022).

Researchers K. Koc, H. Kunkcu, and A.P. Gurgun studied the life cycle risk assessment of green building projects and emphasized the role of stakeholders in managing the associated risks (Koc et al., 2023).

We fully agree with G. Ray and H. Shastri that engaging stakeholders, maintaining effective communication, and fostering collaboration in green building projects can help align project goals, strengthen support, facilitate problem-solving and risk mitigation, and uncover new opportunities (Ray and Shastri, 2023).

We have identified the main groups of stakeholders who may play a key role in the development of green residential construction in Ukraine, particularly in the context of post-war reconstruction (Fig. 4). Each of these stakeholders has the potential to contribute (Fig. 5); however, their harmonious interaction is equally important. Only through joint efforts can investment be secured, innovative technologies and best practices be implemented, and projects be successfully realized. Effective collaboration among these stakeholders will be crucial for creating a resilient housing stock adapted to contemporary challenges. Also, it will contribute to accelerating Ukraine's economic development.

Housing has a strong economic multiplier effect on the wider economy, generating demand for related goods and services, promoting household consumption, and enhancing overall national wealth and productivity. Stimulating the construction of adequate high-quality housing across Ukraine's regions not only builds assets of social and economic value but also creates significant demand for professional services, skilled labor, and advanced construction technologies, including low-carbon and energy-efficient building materials (Ukraine Facility Plan 2024–2027, n.d.).

Housing renovation should be guided by the principles of high-quality construction, energy efficiency, comfort, and ensuring a decent standard of living. The adoption of modern technological solutions and adherence to advanced environmental standards are key to creating a sustainable living environment. In this context, the coordinated interaction of stakeholders – including government authorities, local self-government bodies, developers, designers, research institutions, financial organizations, public associations, and residents – plays a crucial role. Their effective engagement at all stages of housing project planning and implementation not only ensures compliance with technical and social requirements but also facilitates a transition from simply rebuilding what has been destroyed to creating innovative, climate-resilient, and socially oriented living spaces capable of addressing the challenges of sustainable development.

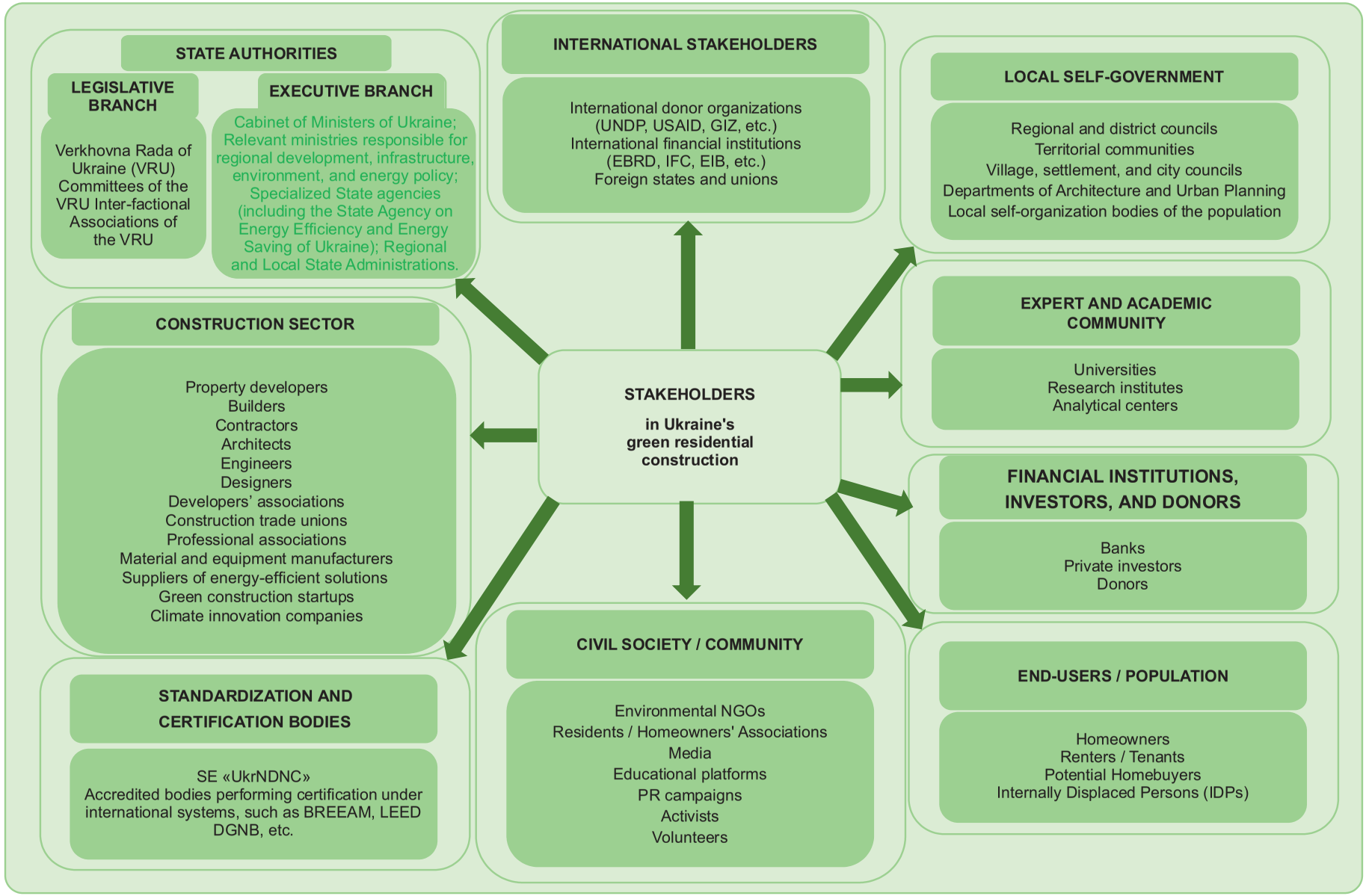

Fig. 4. Stakeholders in Ukraine's green residential construction (Source: own elaboration)

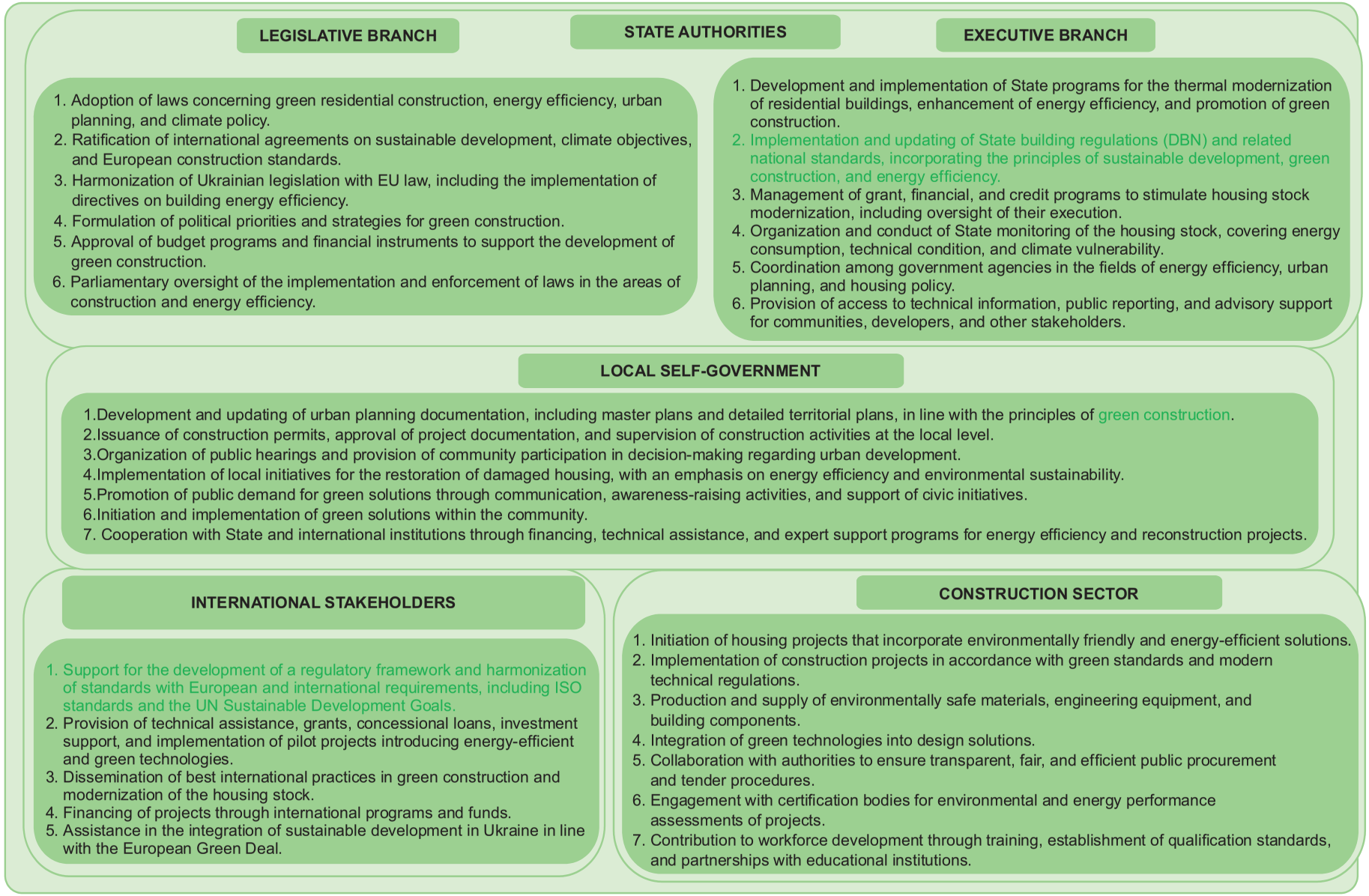

Fig. 5a. The role of stakeholders in green residential construction in Ukraine (part 1) (Source: own elaboration)

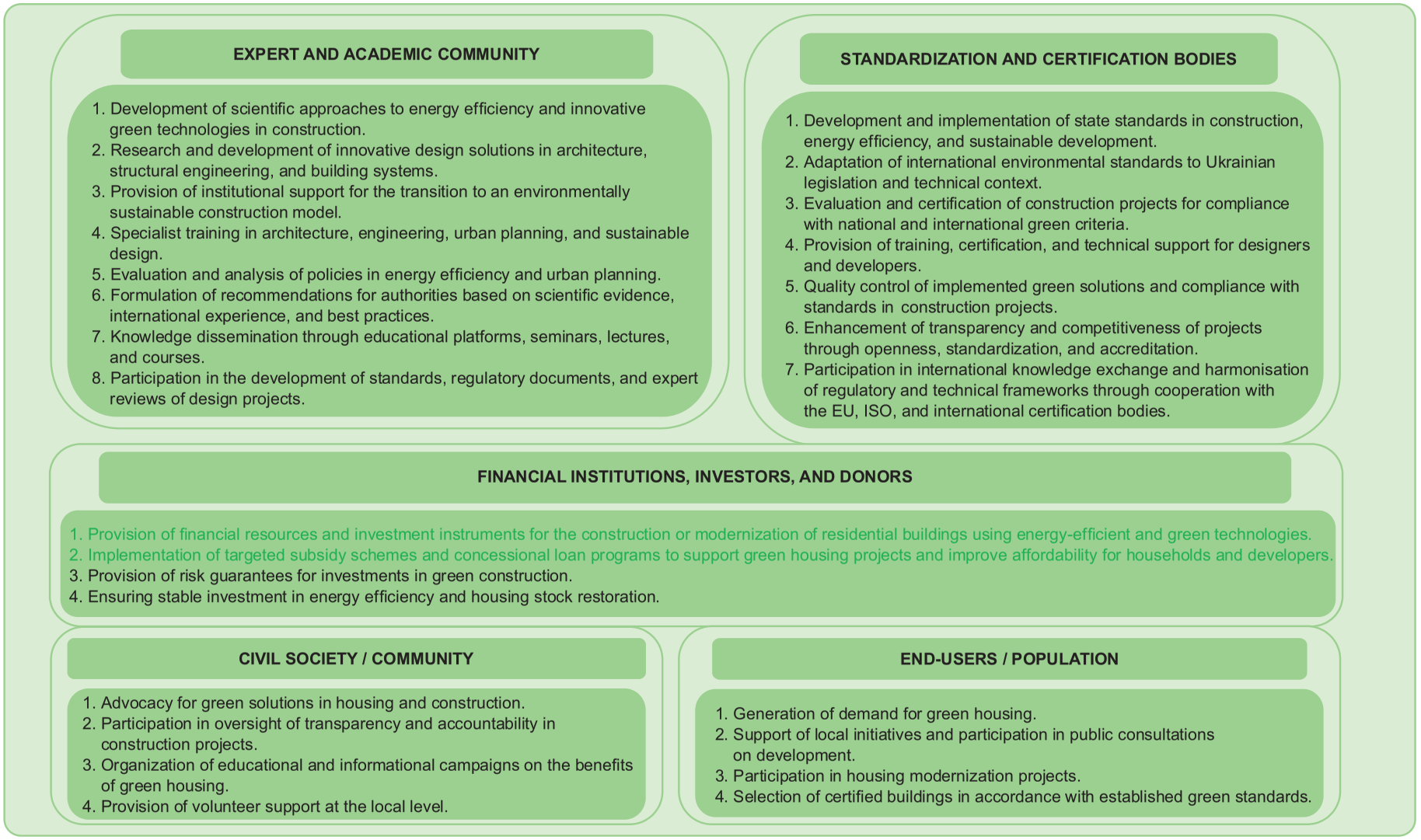

Fig. 5b. The role of stakeholders in green residential construction in Ukraine (part 2) (Source: own elaboration)

Despite the evident advantages of integrating green building principles into post-war reconstruction, a number of challenges and barriers remain. In particular, the implementation of sustainable practices in Ukraine's construction sector is constrained by the high initial costs of green technologies, limited financial resources, and a shortage of qualified professionals. At the same time, the adaptation and harmonization of national regulations with European and international standards remains a challenge, which may slow down the practical application of green construction principles. Another barrier is the low level of awareness and acceptance of green construction concepts among both developers and the general public. Effective management of reconstruction programs is further complicated by institutional fragmentation and coordination gaps between different levels of government. We argue that addressing these challenges should be seen as a key prerequisite for ensuring that Ukraine's post-war recovery not only restores its housing stock but also achieves long-term environmental, economic, and social resilience.

CONCLUSIONS

The scale of destruction of Ukraine's housing stock is unprecedented: more than 236,000 damaged or destroyed buildings, including 209,000 private houses, 27,000 apartment buildings, and 0.6 thousand dormitories.

Direct damages to the housing stock have reached nearly USD 60 billion, while recovery needs exceed USD 83 billion.

The majority of Ukraine's housing stock is outdated, built before 1991, technically and functionally worn out, and does not meet modern energy efficiency standards, making effective restoration impossible without substantial modernization or replacement.

Integrating green building principles into the reconstruction process offers significant opportunities for sustainable development, including reduced energy consumption, lower emissions, improved housing conditions, and economic growth.

The role of stakeholders in green reconstruction is crucial for the systemic transformation of the housing environment. Effective collaboration among public authorities, the private sector, research institutions, civil society organizations, international partners, and other actors ensures the integration of environmental, social, and economic requirements into the reconstruction process. Aligning the interests of these groups supports the development of a balanced sustainable development policy at both local and national levels.

Addressing the existing financial, institutional, and regulatory barriers to the implementation of green building principles is essential for ensuring that Ukraine's post-war recovery evolves into a truly sustainable and resilient reconstruction process.

The restoration of housing infrastructure should be seen not merely as a response to destruction, but as a strategic opportunity for modernization – transforming outdated housing stock into energy-efficient, safe, inclusive, and climate-neutral dwellings that comply with EU standards and the Sustainable Development Goals.

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ODBUDOWA ZASOBÓW MIESZKANIOWYCH UKRAINY Z PERSPEKTYWY ZIELONEGO BUDOWNICTWA: WYZWANIA, PERSPEKTYWY I ROLA INTERESARIUSZY

ABSTRAKT

Cel badania

Celem badania było przeprowadzenie kompleksowej analizy stanu zasobów mieszkaniowych Ukrainy przed i po wybuchu wojny oraz uzasadnienie praktycznych strategii zrekonstruowania tych zasobów, w sposób proekologiczny, w kontekście powojennej odbudowy. W analizie przyjęto, że w procesie realizowane będą założenia zielonego (ekologicznego) budownictwa. Zidentyfikowano kluczowe wyzwania i perspektywy tego podejścia oraz określono role kluczowych interesariuszy w zapewnieniu zrównoważonego i energooszczędnego zasobu mieszkaniowego.

Materiał i metody

Badanie oparto na pracach krajowych i zagranicznych naukowców, publikacjach Kijowskiej Szkoły Ekonomicznej i Centrum Strategii Gospodarczej, danych pochodzących z raportów Szybkiej Oceny Szkód i Potrzeb (RDNA), materiałach grupy roboczej „Budownictwo, urbanistyka, modernizacja miast i regionów" Narodowej Rady Odbudowy Ukrainy po Skutkach Wojny, Planie Pomocy Ukrainie na lata 2024–2027, ofic-

jalnych statystykach Ukraińskiego Państwowego Urzędu Statystycznego oraz innych istotnych zasobach internetowych. Zastosowano następujące metody badawcze: monograficzne, statystyczne, abstrakcyjno-logiczne, a także wizulizacje graficzne i zestawienia tabelaryczne.

Wyniki i wnioski

W niniejszym artykule autorzy przeanalizowali strategiczne podstawy i praktyczne podejścia do regeneracji zasobów mieszkaniowych Ukrainy w kontekście powojennej odbudowy poprzez integrację zasad zielonego budownictwa. Przeanalizowano skalę zniszczeń budynków mieszkalnych spowodowanych agresją zbrojną Rosji, w szczególności w oparciu o najnowsze raporty RDNA, a także określono tempo wzrostu szkód i potrzeb w zakresie odbudowy.

Zwrócono uwagę na krytyczny stan zasobów mieszkaniowych, z których znaczna część jest przestarzała. Badanie uzasadniło potrzebę nie tylko fizycznej odbudowy, ale także modernizacji uwzględniającej kryteria ekologiczne, energetyczne i społeczne. Przedstawiono główne kierunki interwencji i potencjalne korzyści płynące z wdrożenia zasad zielonego budownictwa, w tym zwiększoną energooszczędność, zmniejszenie uzależnienia od paliw kopalnych, poprawę jakości życia, tworzenie miejsc pracy i wzmocnienie bezpieczeństwa energetycznego. Szczególną uwagę zwrócono na rolę interesariuszy na różnych szczeblach – władz państwowych, społeczności lokalnych, przedsiębiorstw, partnerów międzynarodowych i innych – we wspieraniu procesów odbudowy.

Autorzy podkreślili konieczność systematycznego podejścia do odbudowy zasobów mieszkaniowych, opartego na zasadach zielonego budownictwa, efektywności energetycznej, przejrzystości i współpracy międzysektorowej.

Słowa kluczowe: Ukraina, budynki, odbudowa powojenna, zielona odbudowa, zrównoważony rozwój, zielone budownictwo, zaangażowanie interesariuszy