





GREEN CONSTRUCTION AS THE WAY TO ECOLOGIZATION OF THE ECONOMY AND SUSTAINABLE DEVELOPMENT OF UKRAINE

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ABSTRACT

Aim of the study

The purpose of the work is to formulate the foundations for green construction, with the aim of greening the construction industry in particular, and the economy of the country as a whole, in the context of the sustainable development of Ukraine.

Material and methods

The research is based on the works of scientists in the field of green construction, on the data and materials of national and international organisations, on information resources of the Internet, etc. The following methods were used to conduct the study: scientific and theoretical, monographic, comparative analysis, generalization, graphic and tabular presentation, and so forth.

Results and conclusions

In the article, the authors have examined the impact of construction on the environment and the consequences of the development of the construction industry. Also, they have considered and analyzed the global problems of mankind (global warming, lack of natural resources, environmental pollution, demographic situation) as the driving forces for the development and implementation of green construction around the world. It has been substantiated that these problems are relevant for Ukraine, but with certain nuances. Besides, the Russian-Ukrainian war has become a real challenge for Ukraine, and caused a number of additional problems: negative impact on the environment, socio-economic damage, damage and destruction of buildings, thousands of civilian and military casualties, the largest flow of refugees in Europe since the Second World War, etc.

Given that the post-war recovery and development of Ukraine should be green in order to ensure sustainable development, the principles of green construction become necessary in the transformation of the construction industry. The role of green construction in the harmonising relationships within the people – environment – building system has been substantiated. A system of measures to ensure the formation of green construction in Ukraine has been developed and proposed. It has been substantiated and proved that green construction is a way to green not only the construction industry, but also the economy and sustainable development in general.

The main results of the study can be used to introduce the concept of green construction in Ukraine and to ensure the creation of favorable conditions for the functioning of the green construction market.

Keywords: construction industry, global warming, demographic situation, green and circular economy, COVID-19, war, harmonization of ecological and economic policies

INTRODUCTION

The construction industry is a sector of the national economy that is responsible for the construction and reconstruction of buildings, and its development affects the state of the country's economy as a whole, as it is interconnected with all other industries, creating the preconditions for production growth in multiple areas.

The construction industry plays one of the most important roles, providing the population with a significant number of jobs, creating buildings and structures, and solving economic and social problems. But at the same time, it causes environmental pollution, is responsible for the excessive use of natural resources, negatively affects biodiversity, etc. (Figure 1). Moreover, buildings have an impact on the environment. They disrupt balance in the natural environment, at all stages of their life cycle: from design to demolition.

In general, the development of the construction industry – globally and in Ukraine – has both positive and negative consequences (see: Figure 2).

The issues of interaction between society and nature, environmental protection and rational use of natural resources to ensure sustainable development are important guidelines for making effective decisions at all levels and for all sectors of the national economy, including the construction industry (Zubko, 2016).

Obviously, the construction industry today needs to implement the latest construction technologies and practices, as this will reduce the negative impact on the environment and people, improve the efficiency of natural resources management, and ensure the greening of both construction activities and the construction process, as well as the greening of all sectors of the economy in general. Today, green construction is one of the ways to make building practices throughout the world more environmentally-friendly.

The purpose of the present paper is to formulate the basis for green construction in order to make the construction industry (in particular) and the country's economy (in general) more environmentally friendly, in the context of the sustainable development of Ukraine.

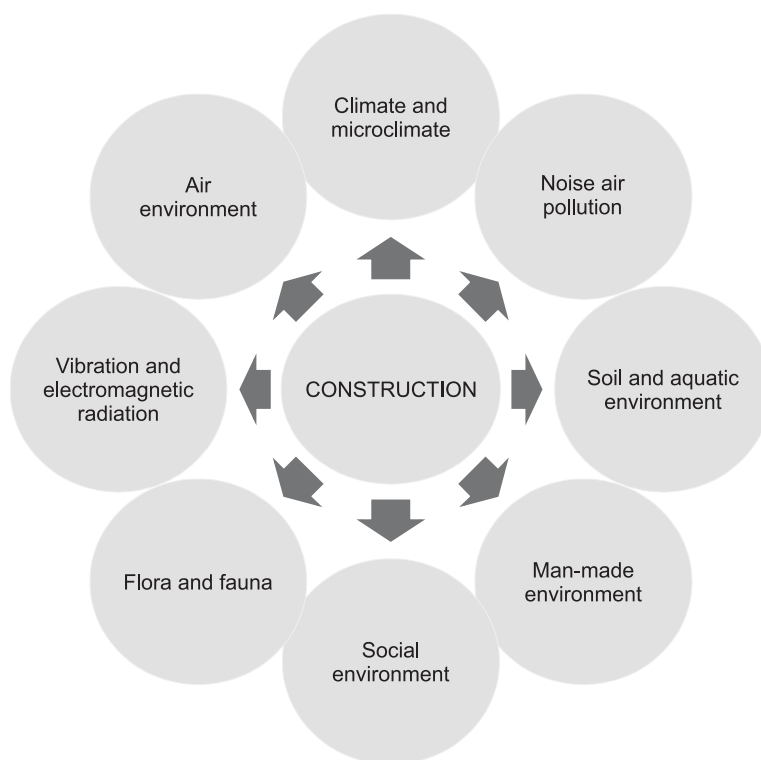


Fig. 1. Impact of construction on the environment (source: elaborated by the authors based on Zubko, 2016)

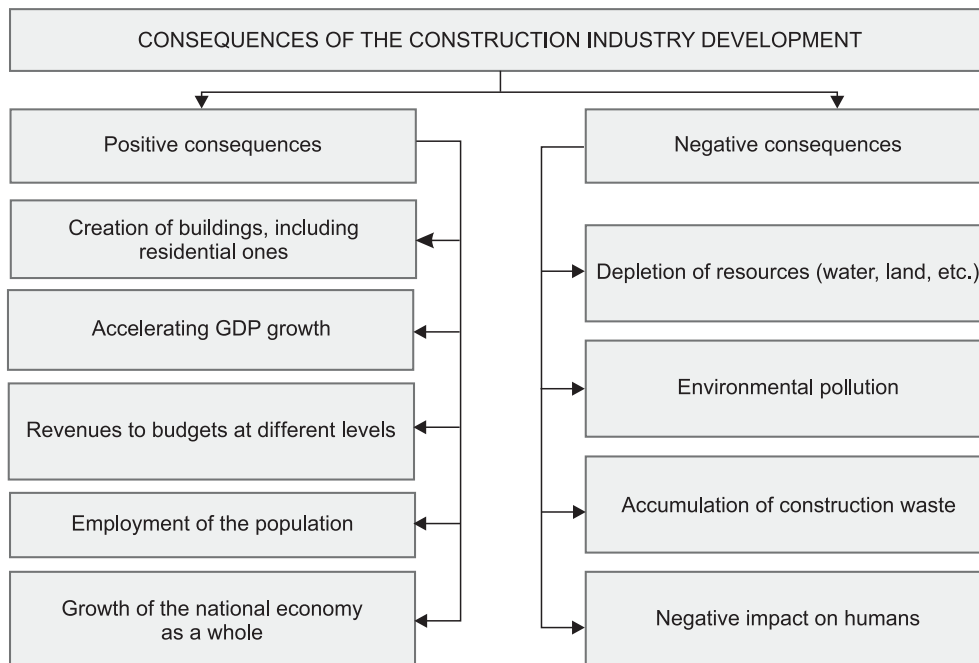


Fig. 2. Socio-ecological and economic consequences of the construction industry development (source: Zubko, 2016, modified and supplemented)

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

A large number of scientists have been working on solving the problems of greening and sustainability of the construction industry for a long time now, given the urgency and diversity of the construction sector's tasks, including environmental ones. A significant contribution to the development of the implementation and development of the concept of green construction in Ukraine was made by O.V. Balueva, N.V. Bibik, O.A. Bilyk, M.L. Varlamova, M.S. Vovk, O.M. Volk, S.O. Mashchenko, Yu.V. Orlovska, L.H. Sarkisian (L.G Sarkisyan), M.V. Shashko, V.S. Chala, T.F. Yakovyshyna, et al.

MATERIALS AND METHODS

The research is based on the works of scientists in the field of green construction, on the data and materials from the World Green Building Council, The Intergovernmental Panel on Climate Change, Architecture 2030, the International Energy Agency, the United

Nations, the UN Human Rights Monitoring Mission in Ukraine, the State Statistics Service of Ukraine, the Ministry of Environmental Protection and Natural Resources of Ukraine, the Ptukha Institute for Demography and Social Studies of the National Academy of Sciences of Ukraine, the Ukrainian Institute for the Future, research by the Centre for Economic Strategy, Kyiv School of Economics, national regulatory framework, information resources of the Internet, etc.

The following methods were used in the study: scientific and theoretical, monographic, comparative analysis, generalisation, graphical and tabular presentation, and so forth.

RESULTS AND DISCUSSION

Reasons for the development and implementation of new trends in the global construction market

Green construction is a resource-efficient method of construction that produces healthier buildings which have less impact on the environment and cost less to maintain. In addition, this approach to construction

takes into account the entire life cycle of a building: siting, design, construction, operation, maintenance, reconstruction, and demolition (Green Building Canada, n.d.).

Green construction can be seen as one of the ways to solve both global and national problems in the context of sustainable development.

Today, taking climate change into account and adapting to it during construction activities is a necessity, as climate change is one of the global threats of 2023 (Alkin, 2022).

There is a consensus among the international scientific community that global warming is caused by human activity, primarily greenhouse gas emissions (NASA, n.d.). According to the Intergovernmental Panel on Climate Change (IPCC) (The Intergovernmental Panel on Climate Change a), humans have never witnessed such severe climate change, and some of these changes are irreversible for hundreds or thousands of years. Scientists are convinced that global temperatures will continue to rise in the coming decades, largely due to greenhouse gases caused by human activity. The IPCC also published its AR6 Synthesis Report in 2023: Climate Change 2023 (The Intergovernmental Panel on Climate Change b), which contains both dire and optimistic conclusions: humanity is indeed on the verge of irreparable damage to the environment, but it is not too late to prevent the worst effects of climate change. The report calls on every country to make efforts to combat climate change. By 2035, it is necessary to reduce carbon dioxide emissions by almost two-thirds, and subsequently reach zero emissions. The task is to phase out the use of fossil fuels and increase investments in renewable energy sources. Many countries have already achieved significant results in reducing emissions and continue to do so. Ukraine is one of those countries. Having said that, total global emissions have increased by 12% since 2010, and 54% since 1990. The largest growth is due to the combustion of fossil fuels and industrial processes (Lamb et al., 2022; Center for Environmental Initiatives Ecoaction, 2023a).

Construction plays a significant role in climate change. Buildings have an environmental impact throughout their entire life cycle, including the production of building materials, construction, operation and demolition. According to Architecture 2030, the

built environment is responsible for about 42% of annual global CO₂ emissions (Architecture 2030, n.d.).

Since limiting global temperature rise to 1.5 degrees Celsius is still possible (Ukrinform, 2023a), it is clear that this will depend heavily on immediate measures taken to reduce greenhouse gas emissions in the construction sector. Thus, today there is a need to change approaches to the construction and operation of buildings.

Strategies aimed at reducing energy use are one of the cornerstones of green building (Green Building Canada, 2021a). According to the International Energy Agency (IEA), the buildings' sector, which includes energy used for constructing, heating, cooling and lighting homes and businesses, as well as the appliances and equipment installed in them, accounts for over one third of global energy consumption and emissions. Direct emissions from the buildings' sector decreased in 2022 compared to the year before, despite extreme temperatures driving up heating-related emissions in certain regions. In 2022, buildings' sector energy use increased by around 1% (International Energy Agency, n.d.).

Buildings account for around 40% of final energy consumption and 60% of electricity consumption in the EU (The European Union a). The level of annual renewal of the building stock in the EU ranges from 0.4 to 1.2% (Center for Environmental Initiatives Ecoaction, 2023b).

The interest in energy efficiency and the development and implementation of renewable energy sources for the modernization of buildings arose as a result of the oil shocks of the early 1970s, which marked the first serious concern for the rational use of resources (Kibert, 2004). Also, the interest in conservation of resources, including energy, is associated with the publication in 1987 of the report of The World Commission on Environment and Development "Our Common Future" (The World Commission on Environment and Development, 1987), prepared under the leadership of Gro Harlem Brundtland and The United Nations Conference on Environment and Development (the Rio Conference, the Earth Summit) in 1992 (United Nations Conference on Environment and Development, 1992), among others.

Incidentally, according to the Cambridge Dictionary, green construction is the activity of making build-

ings in a way that protects the natural environment, for example by using green energy (electricity which is produced with wind, water, or the sun) (Cambridge Dictionary, n.d.).

The construction industry is one of the largest consumers of natural resources, which leads to their further depletion. Construction begins with land alienation, land clearing, cutting of vegetation, and earthworks. Construction activities on construction sites destroy the fertile soil layer, vegetation, and biogeocenoses. Then, during the landscaping, they bring in soil from the land to replace the destroyed layer. Agricultural land is permanently disturbed after it is alienated for the construction of industrial facilities, settlements, roads, communication and power lines, and open-pit mining of natural building materials. During construction work, soils are contaminated with construction waste, cement, lime, paints, oil products, heavy metals and other toxic substances. Heaps of dumped soil change the natural landscape and morphology of the earth's surface, and lead to erosion. During development and transportation, the air is polluted by dust and toxic emissions from construction as well as road machinery and vehicles. In addition, the neighboring areas will also be negatively affected (Malovanyi et al., 2013; Zubko, 2016).

Construction is a serious factor in surface water pollution. First of all, this happens when wastewater from construction sites enters water bodies in an untreated state. Construction sites, warehouses of building materials, and leachate from construction and household waste dumps are the main sources of groundwater pollution (Malovanyi et al., 2013).

During construction and installation works, the air becomes polluted. The main sources of pollution are exhaust gases from vehicles and other construction equipment with internal combustion engines; spraying of cement, limestone, paint aerosols, etc.; burning of waste and residual construction materials (Malovanyi et al., 2013).

The environment is adversely affected by construction materials (in terms of radioactivity, toxicity, and dust generation); construction machinery and transport; organization and culture of production (destruction of the soil layer by temporary access roads, toxic emissions from machinery and transport, noise, vibration, electromagnetic fields) (Zubko, 2016).

As a result, all this combined has a negative impact on the environment and creates unfavorable conditions for people's lives and activities.

Roughly half of the raw materials we extract go into the world's built environment. Construction creates an estimated third of the world's overall waste (Miller, 2021). According to the Law of Ukraine, the Act "On Waste Management", construction and demolition waste is waste generated as a result of major repairs, construction or demolition of buildings and structures (Verkhovna Rada of Ukraine, 2022). The construction sector is responsible for over 35% of the EU's total waste generation (The European Union b). Therefore, one of the major problems of the construction industry is the accumulation, processing and reuse of construction waste. The principles of green construction are precisely aimed at considering the latter not as waste, but as a resource (Green Building Canada, 2021b).

It is estimated that as much as one-third of Canada's total waste is building related. To minimize the impact of this wasteful industry, green builders reduce material usage wherever possible. They also reuse and recycle materials by salvaging, deconstructing, remanufacturing, and refurbishing (Green Building Canada, n.d.).

600 million tons of Construction and Demolition debris were generated in the United States in 2018, which is more than twice the amount of generated municipal solid waste. Demolition represents more than 90 percent of total Construction and Demolition debris generation, while construction represents less than 10 percent (United States Environmental Protection Agency).

In European countries, such as Denmark, the Netherlands, and Germany, there is a direct requirement to use a certain amount of recycled waste products in new construction. In Austria, almost 87% of construction and demolition waste is recycled, and this work is carried out by recycling and demolition operators. In Flanders, there are outright bans on landfills for recycling fractions of construction waste, which means that they take the most radical measures known to combat the disposal of construction waste. In particular, this is due to the high population density of Flanders and the shortage of free land plots at existing landfills. For almost 10 years, the Netherlands has had a law prohib-

iting the disposal of construction waste to landfills if it can be recycled (Hubareva, 2022). In Hungary, construction materials are reused and exchanged between construction firms (Malovanyi, 2021).

The reuse of construction waste is both economically and environmentally beneficial, as it reduces the time and financial costs of creating new construction projects and reduces the environmental impact. In addition, this is how the principles of the circular economy are realized.

It is necessary to ensure that the design of new buildings and the renovation of existing buildings meet the needs of the circular economy at all stages and lead to increased digitalization and climate resilience of building stocks (Center for Environmental Initiatives Ecoaction, 2023b).

Another important reason for the development and implementation of new trends in the construction market is the demographic situation in the world. In 2022, the world's population reached 8 billion (United Nations). Overall, the world's population is growing, albeit at a slower pace. The latest projections by the United Nations suggest that the global population could grow to around 8.5 billion in 2030, 9.7 billion in 2050 and 10.4 billion in 2100 (United Nations, 2022).

This unprecedented growth is due to the gradual increase in human lifespan owing to improvements in

public health, nutrition, personal hygiene, and medicine. It is also the result of high and persistent levels of fertility in some countries (United Nations, n.d.).

According to the UN, it took the global population 12 years to grow from 7 to 8 billion, it will take approximately 15 years – until 2037 – for it to reach 9 billion, a sign that the overall growth rate of the global population is slowing (United Nations, n.d.).

Obviously, an increase in population will lead to an increase in the number of buildings. It is predicted that the largest wave of building growth in human history will be from 2020 to 2060, and by 2060, the area of buildings worldwide will double (Architecture 2030, n.d.; International Energy Agency, 2022). Achieving zero greenhouse gas emissions from new construction will require energy-efficient buildings that use renewable energy sources instead of fossil fuels.

The above reasons can be considered the driving forces (drivers) for the development and implementation of a new type of construction – i.e. the green one (Figure 3).

Driving forces for the development and implementation of green construction in Ukraine

The sustainable development of society has always been and remains one of the priorities of our country. In order to ensure it, it is necessary to introduce new

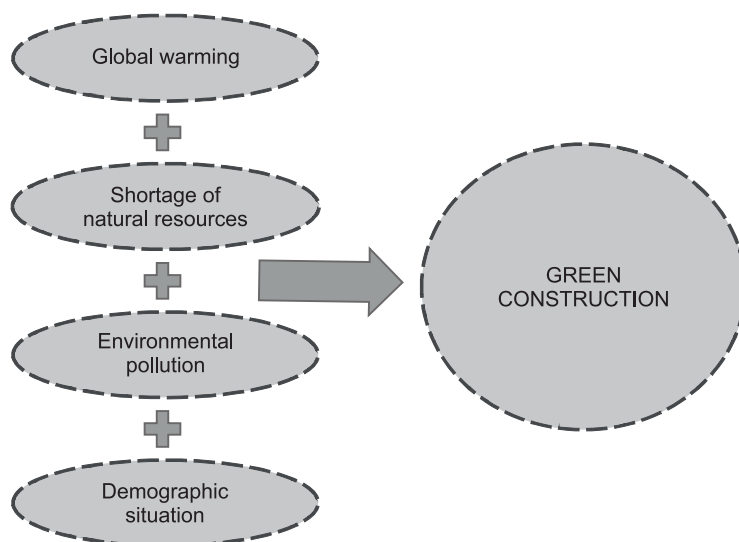


Fig. 3. Driving forces for the development and implementation of green construction in the world (source: Authors' own elaboration)

economic and environmental instruments, technologies, and measures that can facilitate the interaction between economic development and environmental protection.

Developed countries are increasingly paying attention to the advancement of environmentally friendly and energy-saving technologies aimed at minimizing harmful on the environment and saving energy in the construction sector. Increasingly, we are beginning to hear about a new type of construction – the green construction, as well as about green buildings, whose entire life cycle, from planning to construction, operation, maintenance and dismantling, is governed by the principle of sustainability.

Even before Russia's full-scale invasion of Ukraine, our country had favorable prospects for the development of green construction. This was due to a number of reasons, the main ones being:

- a course towards integration into the European space, including reorientation to EU standards in the field of architecture and construction;
- energy supply issues for buildings and structures that are closely related to the country's energy security;
- growing interest of both professionals and the public in green issues (Fareniuk and Shulha, 2017).

These driving forces, that is, the reasons for the development and implementation of green construction (see: Figure 3) apply not only to the world, but also to Ukraine, although with certain nuances, since the Russian war against our country has made adjustments in all areas. In particular, the war posed numerous challenges to Ukrainians in terms of reconstruction of buildings and construction of new housing (Figure 4).

So, first of all, let us start with the most important global environmental problem of our century, which humanity is facing at all levels and which requires an immediate response to protect all of humanity, ecosystems, and all necessary means of subsistence – namely, the climate change. Over the past 30 years, the average annual temperature in Ukraine has increased by 1.2°C. The stretch of time from the end of the twentieth century to the present day is the hottest period in Ukraine for the entire period of meteorological observations (since the 1890s) (Center for Environmental Initiatives Ecoaction, 2020).

In addition, the Russian-Ukrainian war has a significant negative impact on climate change. While many efforts are being made across Europe to reduce greenhouse gas emissions, the military actions in Ukraine have significantly reduced and continue to reduce the results of these efforts, moving the world away from climate neutrality. Greenhouse gas emissions caused by the war exceeded 119 million tons of CO₂! This problem concerns not only Ukraine; it impacts the whole world (Mahera, 2024).

Given that Ukraine is considered one of the most energy-intensive and least energy-efficient countries in the world, the implementation of energy efficiency and energy saving measures, including in the construction sector, can play an important role in mitigating the effects of climate change.

Earlier, during the Soviet era, the availability and low prices of energy resources led to almost complete neglect of both the introduction of efficient low-cost technologies and energy saving in general (The state and prospects of reforming..., 2004). Today, in Ukraine, energy consumption in buildings accounts for approximately 40% of final energy, 31.7% of which is used in residential buildings (The National Council for the Recovery of Ukraine..., 2022). Buildings are mostly poorly insulated and have low energy efficiency, which leads to high energy consumption (Ukraine: a sustainable economic recovery..., 2022). All of this demonstrates the need to decarbonize the building sector.

Construction activities have a significant negative impact on the environment and people through construction materials, machinery, equipment, etc. used in the construction process. In addition, this activity is associated with the accumulation of large volumes of waste.

In general, the large amount of waste accumulated in Ukraine, as well as the lack of effective measures to prevent its generation, recycling, utilization, neutralization and environmentally safe disposal, exacerbate the environmental crisis and become a hindrance to the country's economic development. A huge resource potential is being lost while the already unfavorable environmental conditions are deteriorating (Verkhovna Rada of Ukraine, 2019).

Each year, landfills are replenished by almost 15–17 million tons. Even before the full-scale war in Ukraine, the area of landfills had already reached more

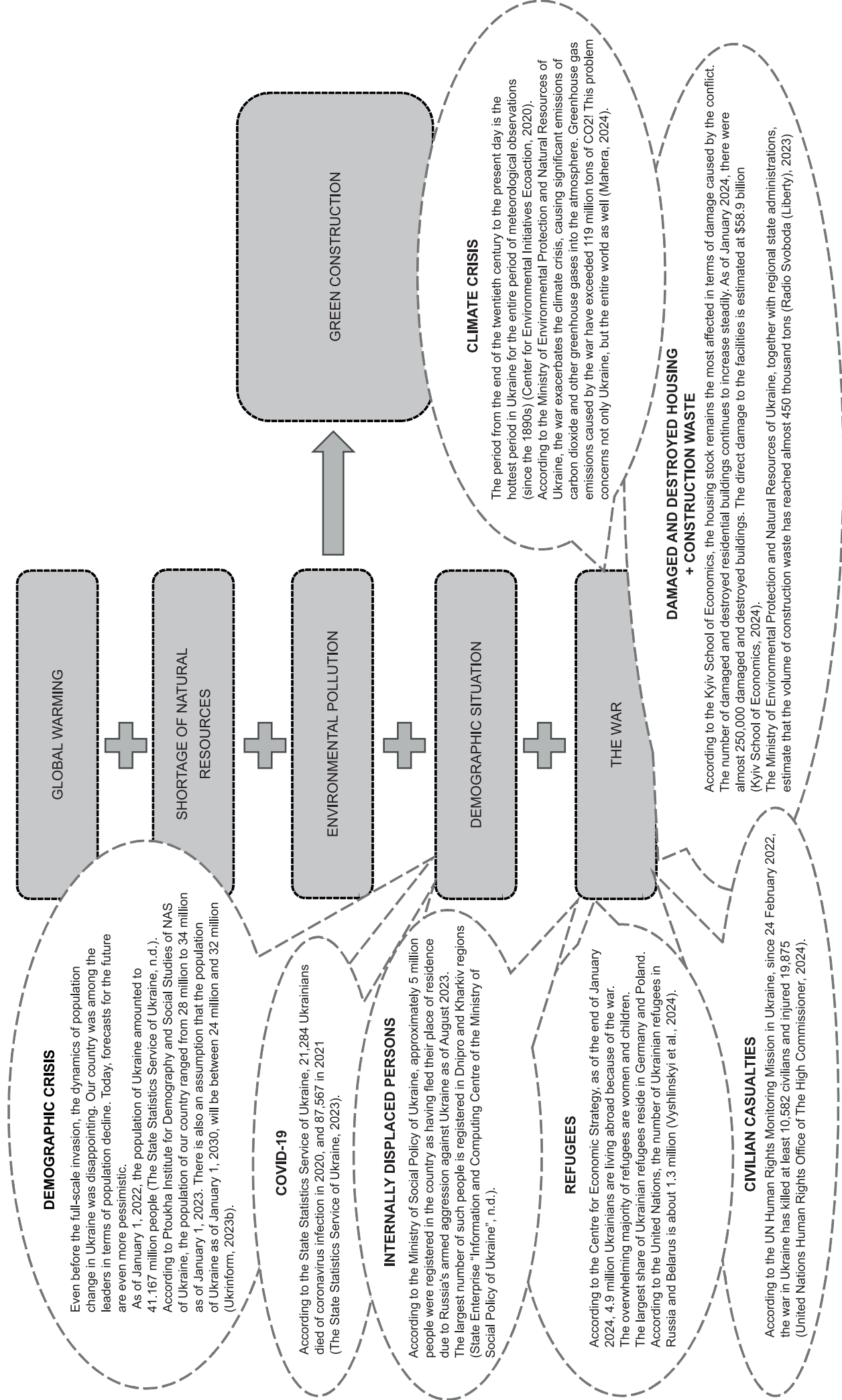


Fig. 4. Driving forces (reasons) for the development and implementation of green construction in Ukraine (source: Authors' own elaboration)

than 8,500 hectares. The garbage crisis was brewing even before 2022, and during the period of active hostilities, the volume of construction waste exceeded all the limits of Ukrainian landfills for storing bulky and construction waste (Nastych, 2023).

Experts at the Ukrainian Institute for the Future estimate that approximately 3.5 million tons of construction and demolition waste are taken to landfills per year. Eighty percent of construction waste is the so-called inert waste: bricks, concrete, crushed stone, sand, etc. Almost 5%, or 350 thousand tons per year, is hazardous waste: phenols (resins, adhesives, etc.), asbestos (roofing, fences), metal lead (sewer pipes), lead-based paints, polychlorinated biphenyls (in gaskets, paints, etc.), polycyclic aromatic hydrocarbons (in chimney bricks), etc. Construction waste also includes wood, glass, paper, plastic, etc. (Lymar, 2020).

The volume of construction and demolition waste generated, according to the environmental report, is almost 1.4 million tons per year, which is almost 33 kg per person per year. However, according to the Ukrainian Institute for the Future, given that Ukraine is a country with an active construction sector and developed industrial infrastructure, the amount of this waste per person will average 175 kg, or almost 7 million tons per year (Lymar, 2020).

Today, due to the massive damage and destruction of buildings, the volume of construction waste has increased significantly and continues to grow.

Waste from the destruction – thousands of tons of bricks, concrete, facade materials and mineral wool, metal and glass, thermal insulation foam, interior decoration materials, fragments of utility networks, sanitary equipment, household items, wood, roofing materials, including resin, roofing material, slate, etc. – are accumulating daily and pose a terrible danger to the environment (Tymochko, 2023).

The Ministry of Environmental Protection and Natural Resources of Ukraine, together with regional state administrations, estimate that the volume of construction waste has reached almost 450 thousand tons (Radio Svoboda (Liberty), 2023). However, the ultimate figure will be known only after the liberation of all Ukrainian territories.

Fortunately, international experience, including European experience, shows that some construction

waste can be reused not only in the process of restoring damaged buildings, but also in the production of building materials. Recycling significantly reduces the burden on landfills and creates employment opportunities for local residents. For example, after the Second World War, materials left over from the end of hostilities were used to rebuild Warsaw. Construction waste was crushed into concrete, and intact whole bricks were reused (Hubareva, 2022; Ivaniuta, n.d.).

Global trends in the development of construction necessitate that the national construction market take into account the experience of developed countries in implementing and supporting innovations and timely and efficient changes in the management of the construction sector. Following the principles of the circular economy, which ensures the recovery and rational consumption of resources throughout the entire life cycle of a building, is one of the most important innovative elements of change in the near future. As a country that intends to join the EU, Ukraine should already take into account the provisions of the European Green Deal, including in the construction sector (Barzylovych et al., 2022).

Recycling of construction waste and its reuse is one of the foundations of the circular economy and one of the principles of Ukraine's green recovery (The Union of Homeowners of Ukraine, 2023).

The new vision of a socio-economic system that functions on the basis of congruence with nature changes the model based on human dominance. Proposed solutions are becoming more and more specific, ranging from general policy guidelines for the green economy to specific mechanisms for transforming business models and the way resources are used within the circular economy. This shows a change in the paradigm of economic knowledge, its adaptation for the purposes of sustainable resource management, the formation of appropriate policies and support for institutional change, and, in fact, gives reason to hope for the realization of the idea of sustainable development, that is, the harmonization of socio-economic processes in accordance with natural constraints (Mishenin and Koblianska, 2020).

The circular economy offers a new, more rational approach to resource management, including waste (Ruda et al., 2021). Circularity will not only help to optimize the use of resources, but will also contribute

to the development of the local economy and job creation. Proactive planning and proactive management of raw materials, water, and energy circulation will create additional positive economic and environmental benefits, such as reduced resource use and minimized waste (Ukraine: a sustainable economic recovery..., 2022).

In the future, war waste management should be subordinated to the task of developing an environmentally friendly green economy in Ukraine (Ivaniuta, n.d.).

In June 2022, the Verkhovna Rada adopted the Law “On Waste Management” (Verkhovna Rada of Ukraine, 2022), which entered into force on July 9, 2023. This long-awaited document launches the waste management reform, bringing our legislation closer to EU legislation.

In September 2022, the Government adopted the Resolution “On Approval of the Procedure for Waste Management Generated by Damage (Destruction) of Buildings and Structures as a Result of Hostilities, Terrorist Acts, Sabotage or Works to Eliminate Their Consequences and Amendments to Certain Resolutions of the Cabinet of Ministers of Ukraine” (The Cabinet of Ministers of Ukraine, 2022), which approved the Procedure for Waste Management Generated in Connection with Damage (Destruction) of Buildings and Structures as a Result of Hostilities, Terrorist Acts, Sabotage or Works to Eliminate Their Consequences. This Procedure applies to restoration work to eliminate the consequences of armed aggression and hostilities during martial law, as well as during the reconstruction period (within 90 days after the termination or lifting of martial law on the territory of Ukraine).

Today, it is necessary to organize the circulation of water, energy, and materials related to the construction process, to give preference to the reuse of materials, and to improve waste management (Ukraine: a sustainable economic recovery..., 2022).

According to data released by the Kyiv School of Economics, the total amount of damage caused to Ukrainian infrastructure as a result of Russia’s full-scale invasion reached \$154.9 billion as of January 2024 (Kyiv School of Economics, 2024). Compared to February 2023, it increased by \$11.1 billion – from \$143.8 billion in February 2023 to \$154.9 billion in January 2024 (Table 1).

The war continues to increase the number of damaged and destroyed housing, infrastructure, industry, energy, healthcare, and education facilities, which leads to an increase in overall losses. Active rocket and artillery shelling of settlements, especially those located near or on the front line, leads to massive destruction of the country’s housing stock.

The housing stock remains the most affected in terms of damage caused by the conflict. The direct damage there is estimated at \$58.9 billion.

As of January 2024, there were almost 250,000 damaged and destroyed buildings, including 222,000 private houses, over 27,000 apartment buildings, and 526 dormitories (Kyiv School of Economics, 2024). The number of destroyed and damaged residential buildings increased by 96.1 thousand from February 2023 to January 2024 (Table 2). The regions with the highest number of destroyed residential buildings include Donetsk, Kyiv, Luhansk, Kharkiv, Chernihiv, and Kherson.

Table 1. Dynamics of the total amount of damage and the amount of damage caused to the housing stock of Ukraine as a result of Russia’s full-scale war against Ukraine, 2023–2024, billion USD (source: compiled and calculated on the basis of Kyiv School of Economics, 2023a, 2023b, 2024)

Amount of damage	February 2023	September 2023	January 2024	January 2024/ February 2023, +/-	January 2024/ February 2023, %
Total	143.8	151.2	154.9	+11.1	+107.7
Housing	53.6	55.9	58.9	+5.3	+109.89
Share of the amount of damage to the housing stock in the total amount of direct losses, %	37.8	36.97	38.0	+0.2 p.p.	–

Table 2. Dynamics of the number of destroyed and damaged housing objects as a result of hostilities and regular shelling, in thousands, 2023–2024 (source: compiled on the basis of Kyiv School of Economics, 2023a, 2023b, 2024)

Type of buildings	February 2023	September 2023	January 2024
Private houses	–	147.8	222.0
Apartment buildings	–	19.1	27.0
Dormitories	–	0.3	0.5
Total	153.9	167.2	250.0

Unfortunately, the war is still ongoing. This means that the amount of destruction and damage will only increase. Accordingly, the amount of losses will also increase. Therefore, it is already clear that many damaged buildings will need to be rebuilt and new ones will have to be constructed. Moreover, this should be done on the principle of “Build Back Better”, i.e., by introducing the best modern solutions and construction technologies.

Russian military aggression not only negatively affects the environment, damages and destroys buildings, causing large material losses, and causes socio-economic damage, but also causes such catastrophic consequences as thousands of civilian and military casualties, a huge number of internally displaced persons, and the largest flow of refugees in Europe since World War II.

Even before the full-scale invasion, the dynamics of population change in Ukraine was disappointing. Our country was among the leaders in terms of population decline. Today, forecasts for the future are even more pessimistic. According to the State Statistics Service of Ukraine, the population of our country reached a historic high of 52.24 million people in 1993, and then began to decline steadily. As of January 1, 2022, the population of Ukraine amounted to 41.167 million people (The State Statistics Service of Ukraine, n.d.) (Fig. 5). On a side note, in 2021, the demographic situation in Ukraine was so difficult that the UN recognized the Ukrainian population as the fastest declining in the world. It could decrease to as little as 35 million by 2050 (Kikot, 2024).

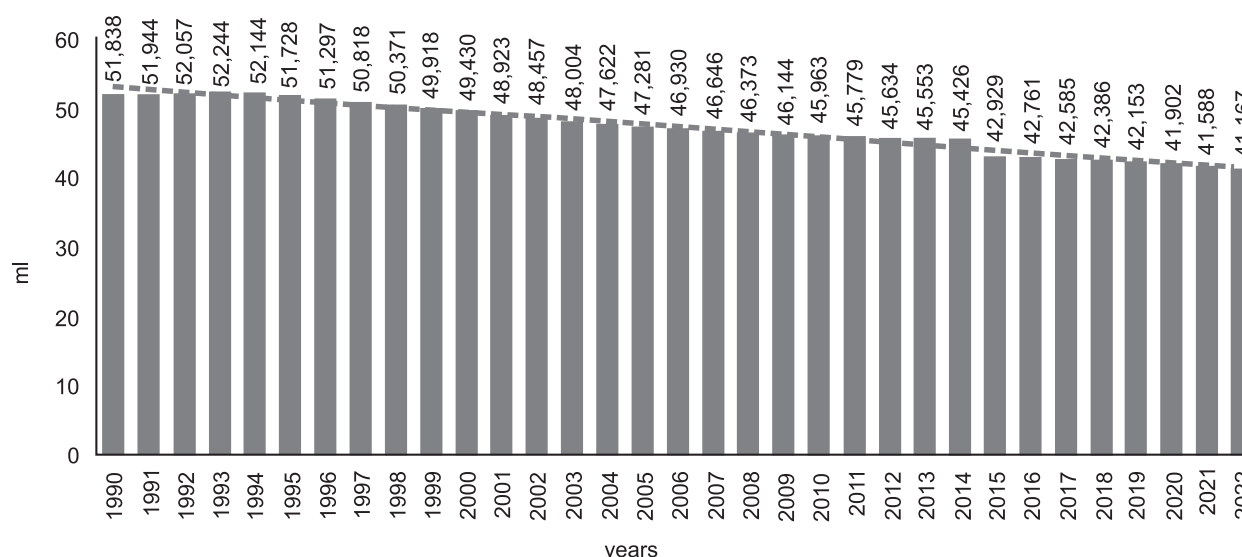


Fig. 5. Dynamics of changes in the population of Ukraine, million people, 1990–2022 (source: developed, based on The State Statistics Service of Ukraine, n.d.)

Notes: according to the All-Ukrainian Population Census as of December 5, 2001. Excluding the temporarily occupied territories.

According to Ptoukha Institute for Demography and Social Studies of NAS of Ukraine, the population of our country ranged from 28 million to 34 million as of January 1, 2023. There is also an assumption that the population of Ukraine as of January 1, 2030, will be between 24 million and 32 million (Ukrinform, 2023b).

It is disappointing that today our country is among the countries with the lowest fertility rate in the world. In 2023, the smallest number of children was born in Ukraine in the entire history of observations – 187 thousand (Landa and Revuk, 2024).

Due to the Russian war and forced evacuation abroad, 0.7 children per woman were born. At the beginning of 2024, there were approximately 35 million Ukrainians. Also, according to demographers, the population will be approximately 30.5 million by the beginning of 2037 (Skotnikova, 2024).

Russia’s war in our country has become another reason for the reduction in the number of Ukrainians. According to the data published in the report of the UN Human Rights Monitoring Mission in Ukraine (HRMMU), since 24 February 2022, conflict-related violence in Ukraine has killed at least 10,582 civilians and injured 19,875 (30,457 total civilian casualties). This number includes 587 killed and 1,298 injured children (1,885 child casualties) (United Nations Human Rights Office of The High Commissioner, 2024) (Figure 6). The actual numbers are likely significantly higher.

Another of the most acute problems faced by Ukraine during the Russian attack is internal forced migration. According to the Ministry of Social Policy of Ukraine, approximately 5 million people were registered in the

country as having fled their place of residence due to Russia’s armed aggression against Ukraine as of August 2023. The largest numbers of such people are registered in Dnipro and Kharkiv regions (State Enterprise “Information and Computing Centre of the Ministry of Social Policy of Ukraine”, n.d.).

According to the International Organisation for Migration, the number of internally displaced persons at the end of 2023 was 3.689 million, half of whom were from Kharkiv and Donetsk regions (International Organization for Migration, 2024).

Damage or destruction of housing is one of the main factors that influenced the decision of internally displaced persons (IDPs) to leave their permanent place of residence and move to safer regions of Ukraine. Accordingly, IDPs primarily need to solve their housing problems. And, unfortunately, not all of them have been able to rent or buy housing on their own.

According to the Law of Ukraine “On Ensuring the Rights and Freedoms of Internally Displaced Persons”, IDPs have the right to “ensure that state executive authorities, local self-government bodies and private entities provide free temporary accommodation (provided that the person pays the cost of utilities) within six months from the date of registration of the internally displaced person; this period may be extended for large families, persons with disabilities, and the elderly” (Verkhovna Rada of Ukraine, 2014).

All people have the right to, and indeed deserve, decent living conditions. Obviously, living in temporary housing is much inferior to living in permanent housing. Of course, that is why it is temporary. It is

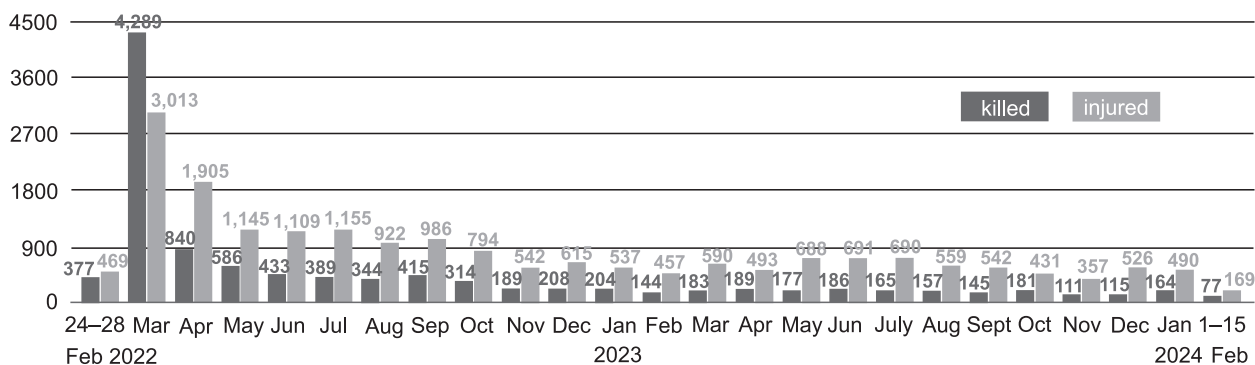


Fig. 6. Civilian casualties since 24 February 2022, by month (source: United Nations Human Rights Office of The High Commissioner, 2024)

certainly great that the state provides the opportunity to obtain temporary housing. However, it is already very important to plan for the creation of a significant number of permanent housing, including for IDPs.

A large number of our citizens were also forced to leave Ukraine and become refugees. A study by the Centre for Economic Strategy (CES) shows that 4.9 million Ukrainians remain abroad as of the end of January 2024. Most of them are women (72 per cent of adults and 65 per cent of all refugees) and children. In Europe, the largest share of Ukrainian refugees reside in Germany (30%) and Poland (22%). Outside of Europe, significant numbers of Ukrainians have been accepted by the United States (280,000), the United Kingdom (253,200), and Canada (210,200) since the beginning of the full-scale hostilities. According to the United Nations, the number of Ukrainian refugees in Russia and Belarus is about 1.3 million (Vyshlinskyi et al., 2024). It is estimated that between 1.4 million and 2.3 million Ukrainians may remain outside Ukraine (Vyshlinskyi et al., 2024).

We should add that, one of the reasons why Ukrainian refugees do not want to return home is the damaged or destroyed housing. For 19 per cent of refugees, their housing has been damaged but can be repaired, while for 5 per cent, their homes have been completely destroyed. Accordingly, the absence of housing or the possibility of living in that houses without obstacles does not encourage Ukrainian refugees to return to their homeland. Incidentally, only a small proportion of refugees (16%) are ready to return to other regions than their home region, and one of the main factors that would encourage them to return to a region other than their own is free housing/reduced

rent or free housing provided by their employer (Vyshlinskyi et al., 2024).

The authors of the CES study note that the non-return of Ukrainians will lead to significant economic and demographic losses. In particular, the total cost to Ukraine's economy under different scenarios would range from 3.9% to 6.31% of pre-war GDP. The economic costs of non-returns will include reduced consumption and reduced production (Vyshlinskyi et al., 2024).

Obviously, the number of migrants who will return home depends on the duration of the war. As a result, their non-return could have a significant negative impact on the demographic situation in Ukraine and on the labour shortage for years to come, even after the war ends.

The COVID-19 pandemic, which has affected all parts of the world and Ukraine in particular, has also contributed to the decline in the Ukrainian population. According to the State Statistics Service of Ukraine, 21,284 Ukrainians died of coronavirus infection in 2020, and 87,567 in 2021, an increase of 66,283 (The State Statistics Service of Ukraine, 2023) (Table 3).

On a side note, according to the World Green Building Council, green buildings play an active role in preventing and controlling COVID-19 (World Green Building Council, n.d.). Overall, in the wake of the pandemic, it has become increasingly clear that buildings have a significant impact on people's health and well-being. Studies have shown that ventilation, heating, and cooling systems can play a key role in the spread of COVID-19 and that buildings should be designed to meet the needs of people and the planet (Orlovska et al., 2023).

Table 3. Dynamics of mortality of the population of Ukraine from coronavirus infection COVID 19, persons, 2020–2021 (source: compiled and calculated on the basis of The State Statistics Service of Ukraine, 2023)

Mortality, causes	2020	2021	2021/2020 +/-
Mortality from all causes, total	616 835	714 263	+97 428
Mortality from COVID-19	21 284	87 567	+66 283
Share of deaths from COVID-19, %	3.5	12.3	+ 8.8 p.p.

Note: excluding the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and part of the temporarily occupied territories in Donetsk and Luhansk regions.

Unfortunately, the pre-war natural population decline, the COVID-19 pandemic, IDPs, migration outflows, and civilian and military casualties may have irreversible consequences for our country. Ukraine as a state should create all the best conditions for the return of its people and stabilisation of the demographic situation. To achieve this, it is important to think about creating safe living and working conditions, ensuring a stable economic situation, and ensuring the competitiveness of jobs with high wages, etc.

The CES report identifies the following as the main factors for refugees returning home after the end of the war: security; availability of housing to live in when they return home; opportunities to earn money; and favourable comparison of general living conditions in the country of residence and at home (Vyshlinskyi et al., 2023).

The role of green construction in harmonising relationships within the people – environment – building system

Since our country intends to focus on the development of a green and circular economy in order to achieve sustainable development, the formation of a green construction market is a necessity, especially in the context of the current situation, which requires urgent and balanced decisions in the construction industry. In turn, green construction can become a driver of economic growth, an increase in green jobs, decent working and living conditions, etc.

Taking into account all the possibilities, principles, advantages of green construction, this new approach of the construction industry can ensure harmonisation of relations within the human – environment – building system by creating safe, comfortable and healthy buildings for living and working, rational use of natural resources, reducing the negative impact of anthropogenic factors and the negative impact of buildings on the environment during their construction, operation, and demolition (Fig. 7).

O.P. Skyba emphasises the need to study the basics and principles of green building “... as one of the ways to harmoniously integrate the artificially created environment of human activity into wildlife” (Skyba, 2023). Yu.B. Shpylova believes that an important component of green building is “...the perception of nature as an ally” (Shpylova, 2023).

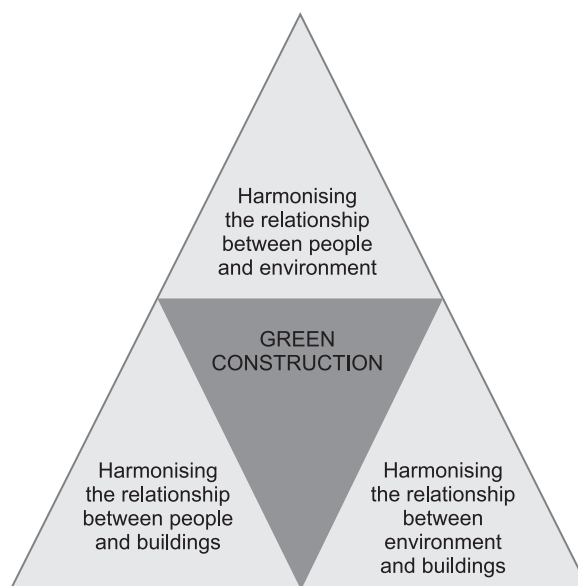


Fig. 7. The role of green construction in harmonising relationships within the people – environment – building system (source: Authors’ own elaboration)

Forming the foundations of green construction in Ukraine

Given the urgency and diversity of the construction sector’s tasks, including environmental ones, a large number of scientists have been working on solving the problems of greening and sustainability of the construction industry for a long time already. Significant contributions to the development of the implementation and development of the concept of green construction in Ukraine were made by O.V. Balueva, N.V. Bibik, O.A. Bilyk, M.L. Varlamova, M.S. Vovk, O.M. Volk, S.O. Mashchenko, Yu.V. Orlovska, L.H. Sarkisian (L.G Sarkisyan), M.V. Shashko, V.S. Chala, T.F. Yakovyshyna, and others.

In particular, in her research (Balueva, 2013), Doctor of Economics O. V. Balueva proposed a sequence for creating a legislative framework for the development of green construction in Ukraine, including the introduction of appropriate amendments to some laws of Ukraine, the adoption of the Law of Ukraine “On the Development of Green Building” and a comprehensive Green Building Development Programme, the draft of which was also developed by the scientist. She noted that the adoption of the Law of Ukraine “On the Development of Green Con-

struction” is an important step towards the formation of an effective legislative framework in the field of green construction, which, based on the requirements of international law and the positive experience of foreign countries, will create conditions for the effective modernisation of buildings and for the use of renewable sources in the existing and newly constructed buildings. Also, it will promote the economical use of natural resources during the construction and operation of buildings, and improve the living standards of the population by reducing the cost of energy. The Green Building Development Programme, according to O. V. Balueva, will bring together the activities of state authorities, local governments and market infrastructure entities to regulate individual elements of the widespread implementation of green construction, and forge them into a comprehensive system. In addition, the researcher substantiates the need to develop our own national green standards, stimulating state support aimed at the widespread introduction of green technologies.

O.M. Volk and M.V. Shashko consider ecological construction as one of the priority areas of innovation in the construction sector. The scientists point to factors that hinder the development of green construction and identify measures to stimulate the introduction of this type of construction in Ukraine (Volk and Shashko, 2012). Also, Yu.V. Orlovska, M.S. Vovk, V.S. Chala, and S.O. Mashchenko in their work (Orlovska et al., 2017) draw attention to the obstacles to the development of the green construction market in Ukraine.

For N.V. Bibik, ecological construction is “a great potential, a prospect for economic growth”, “a path to sustainable development of the country”. She also emphasises the promotion and implementation of new standards (Bibik, 2014).

In the article (Bilyk, 2016), O.A. Bilyk indicates the conditions under which the development of green construction is possible in Ukraine.

Yu.V. Orlovska and T.F. Yakovyshyna (2017) emphasise the need to train qualified specialists (builders, architects, environmentalists, economists) to implement green construction projects, whose coordinated work will contribute to making competent decisions on the design of specific buildings, taking into account the country’s current natural resource potential and

innovative technologies for resource and energy conservation.

L.H. Sarkisian (L.G. Sarkisyan) (2017) identifies the main ways to increase the efficiency of investment in green construction in Ukraine. She believes that the use of green building standards in the development of the economy of Ukraine’s regions will help stimulate both foreign and domestic investment.

In addition, L.H. Sarkisian (L.G. Sarkisyan) and M.L. Varlamova propose to introduce tools that will stimulate the development of green construction in Ukraine into strategic and tactical development plans (Sarkisyan (Sarkisian) and Varlamova, 2018).

However, despite the considerable scientific advancements, some issues remain insufficiently resolved. In particular, this is true of issues related to the study of scientific approaches aimed at developing, improving, systematising and implementing measures at all levels for the purpose of comprehensive and coordinated implementation of the green construction concept, which will contribute to the harmonious and efficient functioning of the green construction market in Ukraine, which require further research.

Unfortunately, the concept of green construction has not yet been implemented in Ukraine. However, it is worth noting that the first steps have already been taken to develop and shape the environmental direction for the construction industry.

We should agree with scientists (Malovanyi, 2013) who believe that the lack of a coordinated and targeted state policy is the main factor that hinders the introduction of energy-efficient technological solutions in construction. According to O.V. Balueva, “without an appropriate legislative framework and stimulating state programmes, the widespread introduction of green construction is problematic” (Balueva, 2014).

Thus, first of all, the state policy plays a crucial role in the development of innovations in construction, as the state, given its powers and capabilities, can facilitate the adoption of appropriate decisions on the implementation of the green construction concept in Ukraine and ensure the creation of favourable conditions for the functioning of the green construction market. Apart from energy efficiency requirements, the current legislative and regulatory framework contains almost no provisions that would ensure the development and formation of green construction in Ukraine.

In our opinion, the formation of the foundations of green construction consists in the development, implementation and execution of measures at the state, regional, local and construction company levels (Figure 8).

Green construction is the way to greening the economy and sustainable development of Ukraine

O.V. Balueva notes: “to ensure the transition from a traditional and resource-dependent economy to an alternative and energy-efficient one, it is necessary to use progressive environmentally innovative approaches that determine the attractiveness and competitiveness of the construction industry” (Balueva, 2014).

Green construction as an innovative approach to building process, implementing the principles of the green and circular economies, can contribute to the transformation (greening) of the construction industry, ensuring its environmental friendliness.

Yu.V. Orlovska, T.F. Yakovyshyna, and Ye.S. Orlovskiyi identify the main principles of the circular economy implemented in the practice of green building in the EU countries (Orlovska et al., 2016).

In turn, the greening of the construction sector will have a positive effect on all other sectors (as construction provides a large number of jobs and uses products from all other sectors of the national economy), and thus lead to the greening of the country’s economy as a whole.

The policy of greening the economy is a tool for modernising and attracting new technologies, which will create new jobs and reduce the negative impact on the environment (Potapenko, 2013).

The state policy of greening the economy facilitates the following:

- compliance with the requirements of the Political Association Agreement with the EU;
- redistributing private capital from old energy- and resource-consuming enterprises to new high-tech, energy- and resource-saving ones;
- creating new jobs;
- reducing the negative impact on the environment (Potapenko, 2013).

The harmonisation of economic and environmental policies will not only ensure sustainable development, but also prevent an environmental catastrophe.

The widespread introduction of green construction will contribute to the processes of greening the economy, spreading energy and resource-saving approaches to the design, construction, and arrangement of buildings, which will lead to an increase in the efficiency of the use of natural resources while reducing the negative impact of buildings on the environment (Balueva, 2014).

Therefore, we believe that green construction is not only a way to green the construction industry, but also a way to green the economy and ensure a sustainable development of Ukraine (Figure 9). In addition, given that Ukraine’s post-war recovery and development should be green in order to ensure sustainable development, the principles of green building are becoming essential in the transformation of the construction industry.

CONCLUSIONS

The current situation, which involves massive damage and destruction of buildings, requires urgent and balanced decisions in the construction sector. However, even before the full-scale phase of the Russian-Ukrainian war, the formation of the green building market was already relevant for our country. In addition, in 2022, Ukraine officially received the status of an EU candidate and intends to become a full member. In addition to the prospects of European integration, this also implies certain responsibilities; in particular, the compliance with the green recovery course. Therefore, the reconstruction should be based on new principles and take into account the best practices and experience that a new approach to construction – the green construction – can provide. It is important not only to provide Ukrainians with a sufficient number of buildings, including residential ones, but also to pay special attention to solving the problems of rational use of resources throughout the entire life cycle of buildings. In the current challenging situation, we should see not only difficulties and obstacles, but also a chance, an opportunity to become a country of green growth in Europe and the world.

For our country, green construction is a great potential, a prospect for economic growth, greening of the economy, and a path to sustainable development of Ukraine.

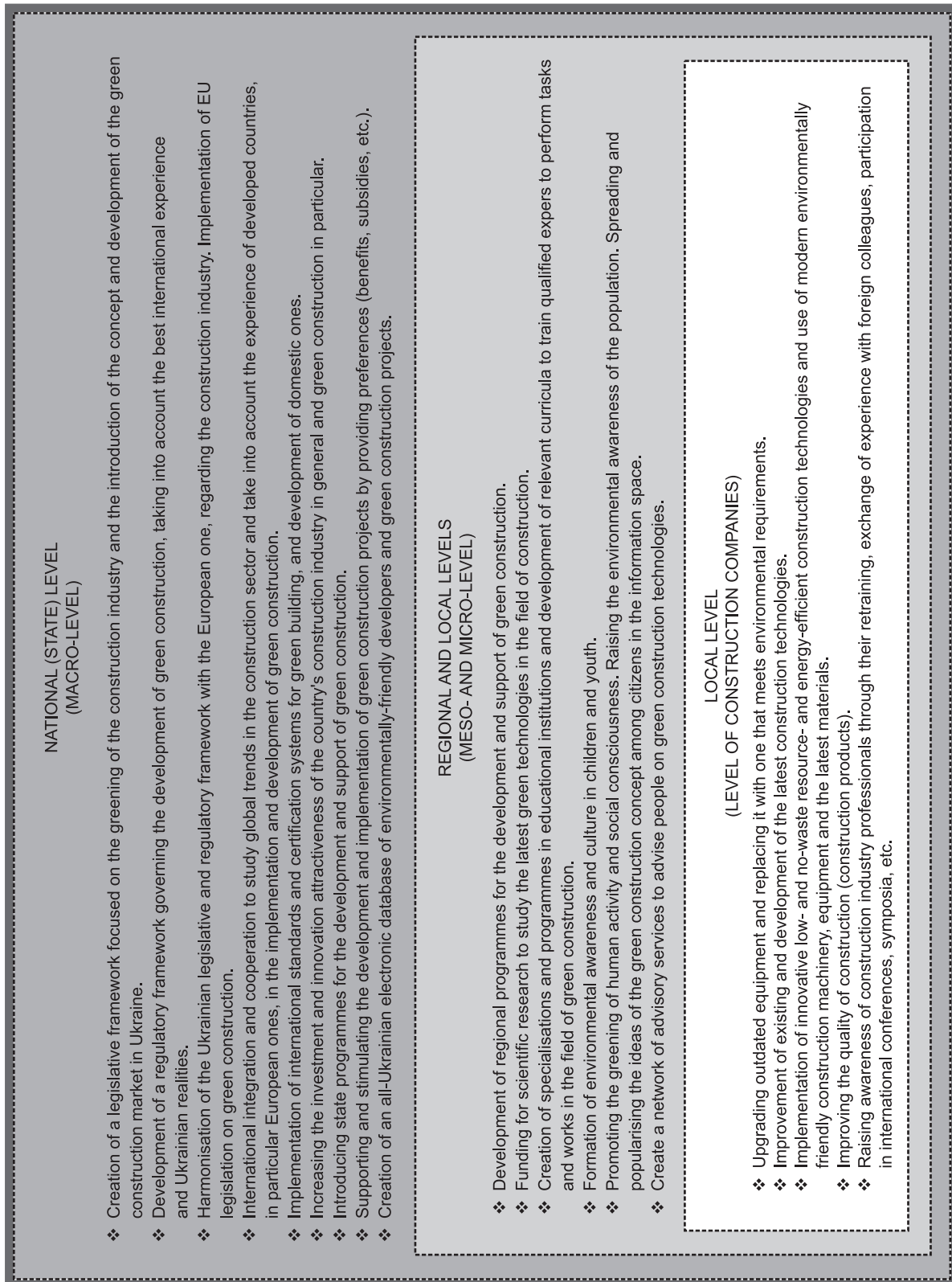


Fig. 8. System of measures to ensure the formation of green construction in Ukraine (source: Authors' own elaboration)

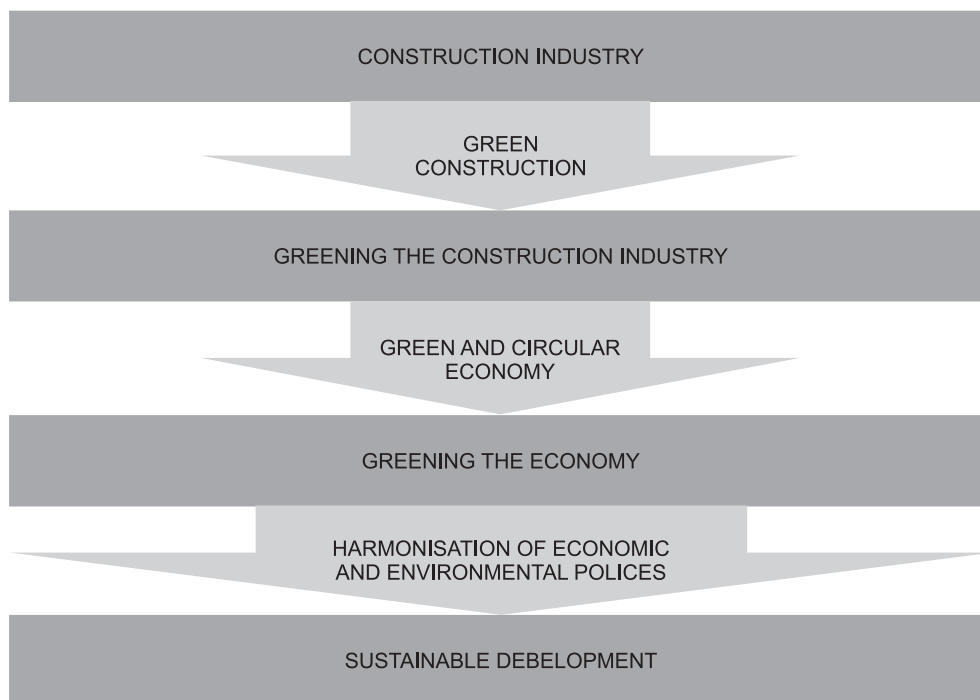


Fig. 9. Green construction is the way to greening the economy and sustainable development of Ukraine (source: Authors' own elaboration)

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ZIELONE BUDOWNICTWO JAKO SPOSÓB NA EKOLOGIZACJĘ GOSPODARKI I ZRÓWNOWAŻONY ROZWÓJ UKRAINY

ABSTRAKT

Cel pracy

Celem pracy jest stworzenie podstaw zielonego budownictwa w celu ekologizacji branży budowlanej w szczególności oraz ogólnie gospodarki kraju, w kontekście zrównoważonego rozwoju Ukrainy.

Materiał i metody

Badania opierają się na pracach naukowców z dziedziny zielonego budownictwa, danych i materiałach organizacji krajowych i międzynarodowych, zasobach informacyjnych w Internecie itp. Do przeprowadzenia badań wykorzystano następujące metody: naukowo-teoretyczną, monograficzną, porównawczą, analityczną, uogólniającą, graficzną, tabelaryczną itp.

Wyniki i wnioski

Autorzy artykułu poddali badaniu wpływ budownictwa na środowisko i konsekwencje rozwoju branży budowlanej. Rozważyli również i przeanalizowali ogólnoświatowe problemy (globalne ocieplenie, niedobór zasobów naturalnych, zanieczyszczenie środowiska, sytuacja demograficzna) jako siły napędowe rozwoju i wdrażania zielonego budownictwa na świecie. Udowodnili że problemy te są w pewnych kwestiach istotne również dla Ukrainy. Ponadto wojna rosyjsko-ukraińska stała się prawdziwym wyzwaniem dla Ukrainy i spowodowała szereg negatywnych zjawisk: ujemny wpływ na środowisko, straty społeczno-gospodarcze, uszkodzenia i dewastację budynków, tysiące ofiar cywilnych i wojskowych, największy napływ uchodźców w Europie od czasów II wojny światowej itp.

Biorąc pod uwagę, że powojenna odbudowa i rozwój Ukrainy muszą być ekologiczne, aby zapewnić zrównoważony rozwój, zasady zielonego budownictwa stają się niezbędne w transformacji branży budow-

lanej. Autorzy uzasadnili jego rolę w harmonizacji relacji w systemie „człowiek – środowisko – budynek”. Opracowali propozycję systemu środków zapewniających rozwój zielonego budownictwa w Ukrainie. Uzasadnili, że jest ono sposobem na ekologizację nie tylko branży budowlanej, ale także gospodarki i zrównoważonego rozwoju w ogóle.

Główne ustalenia z badań mogą zostać wykorzystane do wdrożenia koncepcji zielonego budownictwa w Ukrainie i stworzenia korzystnych warunków dla funkcjonowania rynku tego typu budownictwa.

Słowa kluczowe: przemysł budowlany, globalne ocieplenie, demografia, zielona gospodarka o obiegu zamkniętym, COVID-19, wojna, harmonizacja polityki środowiskowej i gospodarczej

