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## ENVIRONMENTAL RISKS AND PRINCIPLES OF GREEN POST-WAR RECONSTRUCTION OF UKRAINE

**Abstract.** *Russia's invasion of Ukraine is not an accidental phenomenon, but a long hybrid war caused by historical preconditions, which leads to huge losses: human casualties, socio-economic shocks, catastrophic environmental risks and impedes economic progress not only in Ukraine but around the world. The author highlights the scale of environmental risks during hostilities, which negatively affect not only the environment but also the future of mankind, in local development and on a global scale. The pre-war general ecological state of Ukraine is also analyzed. The principles of post-war green reconstruction of Ukraine are determined, i.e. on the basis of sustainable development and taking into account the European green course. The priority tasks for post-war reconstruction of Ukraine on the principles of green economy which will allow Ukraine to be the high-tech, comfortable, safe, healthy and prosperous country are proved.*

**Keywords:** *environmental risks, post-war reconstruction of Ukraine, principles of green economy, European vector, Russian-Ukrainian war*

### Introduction

Russia's invasion of Ukraine has already been called a "catastrophe on top of the catastrophe", adding to existing challenges such as pandemic, climate changes, total digitalisation, food shortages for many countries, an even greater threat to the world and inevitable consequences for society. Military events, destruction of infrastructure and production base of many industrial enterprises in combat zones, destruction of oil depots, damage to water supply and sewerage systems, air pollution with hazardous substances, migration of specialists to safer regions, all led to large-scale environmental risks and threaten to increase the pollution of land resources, water resources systems and air of our state with dangerous substances.

Russia's military actions are undoubtedly an unjustified and unprovoked act of aggression against independent and sovereign Ukraine, as well as a violation of all current

norms of international law on environmental protection, sustainable development, humanitarian law, basic morals and principles of human coexistence.

That is why, despite the fact that the war continues, there was a need to plan for the reconstruction of the country. It is obvious that different areas will have different needs for reconstruction, however, at the national level the basic principles of post-war life must be common to all. Therefore, the main requirement for rebuilding Ukraine is not a return to the pre-war condition, but a restoration that uses the best available technologies and practices by integrating into the European Green Deal, to make the new Ukraine comfortable, safe, healthy and prosperous for all Ukrainians. During the post-war reconstruction of Ukraine, climate modernization should become the central idea of economic transformation, and reconstruction should include a positive experience of environmental policy of post-war reconstruction of advanced countries [12].

The real threat to Ukraine today is that our country is in a conflict with its eastern neighbor, the Russian Federation. Aggressive provocations have been going on for a long time, with tragic consequences: annexation of Crimea (2014), formation of LPR and DPR in eastern Ukraine and constant acts of subversive and terrorist activity [7], which negatively affects the ecological state of the country. Today, many domestic and foreign experts cover their assessments of the impact of war on environmental risks in many reports and references. The Ministry of Environmental Protection and Natural Resources of Ukraine publishes once a week "Key environmental consequences of Russian aggression in Ukraine", the State Emergency Service of Ukraine publishes "Information about major emergencies of man-made, natural and other nature in Ukraine", NGO The Center for Environmental Initiatives "Ekodia" constantly collects analysis of environmental risks from Russian aggression, the UN constantly publishes data about displaced persons, the destruction of industrial infrastructure and environmental risks. However, the issue of environmental risks from Russian aggression remains open, as there are currently numerous environmental crimes committed by the occupiers, and the brutality of today's Russian military aggression is unprecedented.

The aim of the work is to highlight the scale of environmental risks from Russian aggression, to justify the priorities for the postwar recovery of Ukraine's economy on the basis of sustainable development and taking into account the European Green Deal.

### **1. Environmental risks from Russian aggression**

Fighting on the territory of Ukraine, in addition to destroyed cities and interrupted lives, spoils the air, pollutes water bodies and soils, disrupts landscapes, destroys forests and

unique ecosystems, pollutes the Black and Azov Seas, destroys oil depots, captures nuclear power plants, all this leads to environmental threats and risks (Fig. 1), and in the long run will cause enormous damage to the ecosystem throughout Eastern Europe, and will shorten life of Ukrainians. Warfare on the territory of Ukraine, in addition to destroyed cities and interrupted lives, spoils the air, pollutes water bodies and soils, disrupts landscapes, destroys forests and unique ecosystems, pollutes the Black and Azov Seas, destroys oil depots, captures NPP, this all leads to environmental threats and risks (Figure 1), and in the long run will cause enormous damage to the ecosystem of Eastern Europe, and Ukrainians will shorten life. Such facts are recorded by the Operational Headquarters at the State Environmental Inspectorate, which employs more than 70 scientists from around the world. The inspectorate has already dealt with about 300 environmental crimes and estimated more than UAH 200 billion in damages for only a few of them. Subsequently, the total figure will be taken to international courts as part of Ukraine's lawsuit against Russia over military reparations [10]. Among the most important environmental risks from Russian aggression are:



**Figure. 1. The most important environmental risks of Russian aggression**

*Source: author's development based on [3].*

*Threats to nuclear and radiation safety.* Nuclear and radiation safety of facilities in the Chernobyl Exclusion Zone remains a matter of serious concern. Information on the condition of these facilities is not available, as the Chernobyl Radiological Laboratory was looted and destroyed by Russian troops. Zaporizhzhia NPP continues to work in the occupation under the control of the Russian military. Nuclear safety continues to be under threat, as the station's staff is unable to carry out all their duties peacefully under occupation.

Russia's nuclear terrorism has shown how dangerous centralized electricity production can be: the seizure of nuclear power plants and the operation of power units under fire pose many unjustifiably high threats not only to the local population, but also to Ukraine, Europe and the world.

*Fires in natural areas and damage to reserves.* Since the beginning of hostilities in Ukraine, there have been active attempts to create a large-scale fire in the Chernobyl Exclusion Zone, due to the onset of dry, windy weather and the presence of a large number of mines and flares left by the Russian occupiers. Such actions were carried out by targeted shelling of jet artillery, and forest fires in the Exclusion Zone can cause the release of radionuclides into the atmosphere. As a result of fighting around the cities of Gostomel, Bucha, Irpin and Borodyanka, a large number of forest areas also caught fire. According to the European Forest Fire Information System, the total area of the burning or recently burned area is over 7,600 hectares. Mostly forests or fallows [4]. More than 6,400 hectares of forests are burning near the settlements of Narodychi and Radcha, just west of the Chernobyl zone [8]. There is always a high risk of new fires in combat areas. Extinguishing fires during hostilities and in areas controlled by the occupiers will be impossible. Fires can cause irreparable damage to the ecosystems of these areas.

The hostilities led to large-scale fires in the Holy Mountains National Nature Park, the Izyumska Luka Regional Landscape Park and the Black Sea Biosphere Reserve [15]. The fires were partly due to the use of phosphorus bombs, which have an inflammatory effect. Instead of an explosion at the place where the ammunition fell, such bombs set fire to the area and burn most natural and man-made materials. Such bombs were used by Russian troops in the Donetsk, Luhansk and western suburbs of Kyiv. According to the Ukrainian Conservation Group UNCG, 44% of the most valuable nature reserves are located in the war zone, under the temporary control of Russian invaders.

*Damage to water resources.* Russian troops strike targeted infrastructure at water collection, treatment and supply, as well as sewage treatment plants and up to dozens of breakdowns of pipelines and non-functioning pumping stations, leaving hundreds of

thousands people without access to drinking water. Currently, all cities of Luhansk region in the territory controlled by Ukraine are without water and sewerage. Significantly damaged water supply and sewerage facilities in Donetsk, Zaporizhia, Kharkiv and Mykolaiv regions [6].

Russian troops attack port infrastructure along the Black and Azov coasts and ships at anchor, polluting water and spreading toxins at sea. As a result of the above, in addition to the environmental legislation of Ukraine, the UNECE International Convention on the Protection and use of transboundary watercourses and international lakes has been grossly violated. Before the war, Ukraine provided more than half of its wheat supplies under the UN World Food Programme. The blockade of Ukraine's seaports and targeted shelling by Russia over food supply chains in Ukraine are provoking a global food crisis. This will have far-reaching consequences, especially for developing countries.

*Damage to hazardous industrial facilities.* Russia is constantly rocketing oil depots, and the destruction of oil depots and large fires lead to toxic air pollution, pollution of land and water resources with harmful substances throughout Ukraine. Fuel spills, pollution from destroyed military equipment and weapons, as well as exploded missiles and air bombs – all pollute the soil and groundwater with chemicals and heavy metals. Russian troops are increasingly using banned incendiary munitions with white phosphorus, which threatens large-scale fires and chemical pollution of the atmosphere and soil. Shelling and occupation increase the risk of toxic waste emissions from industrial enterprises of Ukraine.

Large-scale Russian aggression in Ukraine has created many environmental risks. The shelling of Ukrainian oil depots, chemical plants and other industrial facilities has a direct environmental impact on the air not only in Ukraine but also in other countries. Also, Russia's current methods of military action grossly violate all norms of international law. Pursuant to paragraphs 1 and 2 of Article 55 of the Additional Protocol to the Geneva Conventions for the Protection of Victims of International Armed Conflicts (Protocol I) of 8 June 1977, the armed forces must adhere to restrictions and principles aimed at protecting the environment from large-scale, long-term and serious damage. Such protection includes prohibiting the use of methods or means of warfare that intentionally destroy the environment or may cause harm to the environment and thereby endanger the health or survival of the population.

## 2. Ecological status of Ukraine before the war

After analyzing the environmental threats from Russian aggression, it is necessary to study the pre-war trends in the main indicators of Ukraine's environmental condition in order to identify the potential for rebuilding the country after the war.

Pre-war achievements on the ecological state of Ukraine can be seen with the help of the international ranking of the world for 2021, assessing their contributions to the fight against climate change. This rating was conducted by the German organization Germanwatch, New Climate Institute and the international network Climate Action Network [5]. Ukraine took 20th place, between the Netherlands (20) and Egypt (21). Since last year, this place has remained unchanged for Ukraine. Among the leading countries in climate protection are Denmark, Sweden and Norway. Austria, South Korea, Saudi Arabia and Kazakhstan performed the worst. This rating is determined by four categories: reduction of greenhouse gas emissions (40%), development of renewable energy (20%), energy consumption (20%) and efficiency of climate policy (20%) (Table 1).

Table 1

### Ranking of individual countries in the world in the face of climate change

Rank	Country	Score	including			
			GHG Emissions	Renewable Energy	Energy Use	Climate Policy
20	Ukraine	60,4	27,27	7,13	18,32	7,68
36	Romania	52,43	27,24	6,3	13,4	5,49
40	Slovak Republic	50,67	26,24	6,48	11,09	6,87
41	Turkey	50,53	24,11	11,3	9,45	5,68
50	Slovenia	43,28	17,82	6,68	10,34	8,44
51	Czech Republic	42,15	20,37	5,84	10,5	5,63
52	Poland	40,63	19,65	5,98	10,2	4,81
53	Hungary	40,41	21,33	5,84	9,63	3,61

Source: author's development based on [9]

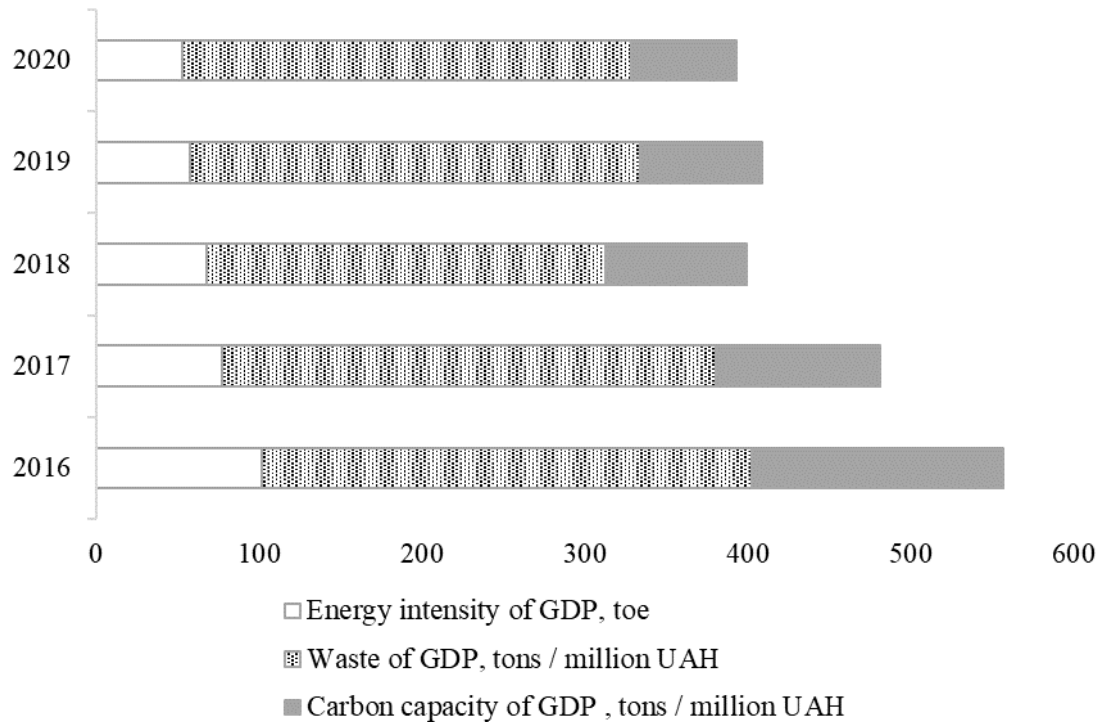
The rating shows that the main disadvantages of the combating climate change are the lack of a clear vision of further steps in the fight against the climate crisis (7.68 points) and the development of renewable energy (7.13 points). The CO<sub>2</sub> emission tax remains critically low – it is among the lowest in the world in Ukraine and has no targeted use, which does not

encourage private polluting enterprises to modernize. The share of renewable energy in the primary energy supply also remains low, although the abandonment of fossil fuels and the development of renewable energy is one of the most important climate decisions.

At present, the main achievement of Ukraine is the reduction of GHG emissions by 63% compared to 1990, which has the greatest impact on the place occupied by the country in the ranking. Also in 2021, the Ukrainian government adopted the National Economic Strategy, where one of the goals is to achieve carbon neutrality by 2060, as well as the Renewed National-Defined Contribution of Ukraine in accordance with the Paris Agreement, in which the government aims to reduce greenhouse gas emissions by 65% by 2030 compared to 1990 (that is 7% compared to 2019). However, there are no plans yet on how and in which sectors these goals will be achieved [1]. Ukraine in general has great potential to reduce emissions through energy efficiency of buildings, industrial modernization, development of sustainable agricultural practices and protection of ecosystems, all of which imply transformation in all sectors of the economy, including green economy.

According to the Strategy of Economic Security of Ukraine for the period up to 2025 adopted on August 11, 2021 № 347/2021, ensuring national economic interests requires the formation and implementation of a strategic course in ensuring economic security, aimed at increasing the competitiveness of Ukraine's economy and on the gradual strengthening of economic stability and, accordingly, the invulnerability of the national economy to external and internal threats [11].

In one of the areas of economic security is the environmental safety of production as one of the tasks of industrial safety. Therefore, we will characterize the available indicators of environmental safety presented in domestic statistics, namely: energy intensity of GDP (total supply of primary energy per million UAH of GDP), waste of GDP (generation of industrial waste per million UAH of GDP) and carbon intensity of GDP (carbon dioxide emissions by industrial enterprises per million UAH of GDP) (Figure 2).



**Figure 2. The main indicators of environmental safety per million UAH of GDP**

*Source:* author's development based on [13]

From figure 2, we see that all indicators are slowly improving: reduction of energy intensity of GDP in 2020 compared to the level of 2016 from 101.7 to 53 toe; carbon capacity of GDP from 154.52 to 64.68 tons / million UAH; waste of GDP from 300.7 to 275.4 tons / million UAH. At the same time, it should be noted the continece factors: significant wear of equipment in the energy sector, as well as in major energy-intensive industries (especially in metallurgy), which causes fluctuations in carbon and energy intensity depending on the dynamics of their development. However, in the field of waste, progress is almost non-existent, trends in industrial waste are virtually unchanged. This is primarily due to the insufficient level of institutional and regulatory environment on waste management; lack of an effective mechanism for managing certain types of waste; shortage of waste disposal facilities; low efficiency of recycling techniques (waste recycling); slow introduction of low-waste technologies and low rates of infrastructure development in the field of waste management, in particular hazardous.

Therefore, after the end of large-scale hostilities and the liberation of territories, the reconstruction of Ukraine must take into account the principles of green reconstruction, as the basis for future strategy of postwar reconstruction.



### 3. Principles of green post-war reconstruction of Ukraine

During the post-war reconstruction of Ukraine, climate modernization, based on sustainable development and taking into account the European Green Course, should become the central idea of economic transformation. The concept of economic recovery, voiced in the Office of the President and the Government, also includes deregulation of business, energy independence, and climate modernization (the creation of new facilities in various industries must take into account the principles of "green economy").

All new industrial facilities in metallurgy, food processing and energy will be built on the principles of the "green economy", namely the minimization of carbon footprint and dependence on fossil fuels, due to significant financial resources of western partners. The European Union has already announced its intention to support Ukrainians in post-war reconstruction. To this the European Council will establish The Ukraine Solidarity Trust Fund. In addition, the United States, Great Britain, Sweden, Spain and other countries have already stated their readiness to financially support the country's reconstruction [2].

The roadmap for the post-war reconstruction of Ukraine should be based on certain principles, compliance with which will bring our economy to the level of advanced countries, in particular, reduce its energy consumption and increase energy efficiency. First of all, it is a question of observance of such principles of the European green course, as refusal of fossil fuels (first of all, coal), reduction of CO<sub>2</sub> emissions, increase of energy efficiency of economy and reduction of energy losses, acceleration of transition to circular economy [16]. The state should support the development of high added value industries and new industries such as:

- construction of energy efficient housing;
- carbon-neutral agriculture and food production;
- steel production based on hydrogen or electrothermal technology;
- energy efficient mechanical engineering;
- decarbonization and decentralization of energetics;
- electronics and electric car industry.

Ukraine will gradually have to return to life and plan the restoration of Ukraine in order to qualitatively restore the country's vital functions for a long period. System solutions for sustainable development of Ukraine must be high quality, efficient and long-lasting. And economic development is an important component in the development of any country, but for a comfortable and quality life you must always remember the need to balance the economy with environmental security and the needs of society. The reconstruction of Ukraine must become high-tech in compliance with all environmental standards. Therefore, the post-

-war reconstruction of infrastructure and the economy must be based on the best available technologies and practices, which will allow our country to move away from the Soviet past and move into a bright and secure future.

Reconstruction and reconstruction of cities and regions should be guided by the principles of sustainable development, namely:

- ✓ development of sustainable mobility (it is necessary to equip all roads with public transport lanes, to develop and implement a plan for the development of cycling infrastructure, to equip 100% of the length of main roads for pedestrians and at least 50% for cyclists. The use of public transport instead of private cars is a key element of a compact city, as well as the ability to reduce emissions of pollutants into the atmosphere;
- ✓ maintaining compactness and versatility in urban planning (creation of multifunctional urban spaces that combine different activities, namely: work, shopping, relaxation, kindergartens and schools, all this will provide decent living conditions and significantly reduce the need for transport);
- ✓ transition to green energy in cities (urban infrastructure planning should be based on local energy sources (waste heat, wind farms, power plants, biomass, etc.)), try to diversify generation sources as much as possible;
- ✓ urban landscaping and priority of nature-oriented solutions (according to the Rules of maintenance of greenery in the settlements of Ukraine, the level of landscaping of urban streets must be at least 25%, and areas near schools – 50%);
- ✓ development of water supply and sewerage systems in settlements taking into account the best available technologies (most of the water supply infrastructure needs complete reconstruction or restoration). And to reduce the burden on the environment, it is necessary to restore these systems based on the best available technologies.

Comprehensive implementation of investment, innovation and organizational measures in the postwar recovery period will allow Ukraine to reach a new level of efficiency in all sectors of the economy, as well as increase the competitiveness of products of individual enterprises and our economy as a whole.

### **Conclusion**

Thus, during military aggression, environmental risks are particularly important. Destruction of infrastructure and production base of many industrial enterprises in combat

zones, destruction of oil depots, damage to water supply and sewerage systems, air pollution with hazardous substances, migration to safer regions, all this has led to large-scale environmental risks that exacerbate and threaten to increase pollution of land resources, water systems and air of our state with dangerous substances.

Economic perspectives for Ukraine's recovery are characterized by uncertainty and will largely be determined by the duration and scale of the war. Huge damage is being done to Ukraine's territories, and significant external funding will be needed to help rebuild the country and the economy after the war. All this requires the formation of strategic goals for reconstruction and the definition of sectoral recovery vectors.

Strategic goals should be formed taking into account the need for post-war reconstruction of the country in the conditions of long-term military threat to preserve the state sovereignty of our country and its territorial integrity, taking into account the European vector and ensuring national interests, that is, the green restoration should become the basis of the Roadmap for the postwar reconstruction of Ukraine.

Ukraine's green recovery must be low-carbon and energy-efficient, nature-oriented, have efficient and clean industrial production, and balanced consumption. In order to ensure all this, all new infrastructure must promote the abandonment of fossil fuels, and the reconstruction of cities and rural areas must take into account social, economic and environmental factors. And to implement large-scale projects, we need to develop partnerships with the G7 and the EU in the mode of technology transfer and access to financial resources. One of the key approaches could be for governments to provide guarantees to their companies to invest in Ukraine [14]. Therefore, the priority tasks for the post-war reconstruction of Ukraine according to the principles of the green economy should be:

- economic recovery should be in line with the Sustainable Development Goals and the European Green Course, and should be primarily aimed at developing high value-added production chains, rather than the resource-export economy;
- all strategic and policy documents at all levels must take into account the provisions of environmental and climate policy;
- restoration of infrastructure, buildings and enterprises cannot take place without compliance with environmental requirements and standards, their compliance will contribute to the future sustainable development of enterprises to ensure economic and environmental safety;

- reduction of control and regulatory functions of the state, liberalization of investments taking into account information and economic security of the state. First of all, numerous legislative and regulatory acts on stimulating foreign investment, creating a system of state guarantees for foreign investors should be reviewed.;
- support of economic stability of regions by granting grants for development of small and average business and restoration of work of an industrial complex taking into account ecological norms;
- accelerate the development of renewable energy sources and strengthen energy efficiency measures in all sectors of the economy from production and transportation to consumption. During the post-war reconstruction of the country to develop leasing programs or soft loans for the purchase of energy efficient equipment;
- the introduction of a circular economy in the context of strengthening economic security will reduce the burden of waste on the environment, reduce landfills; reduction of mining; creation of additional jobs in the regions; reduction of costs for environmental measures (water treatment, waste treatment, etc.);
- further harmonization of Ukrainian and European legislation in the fight against climate change and adaptation to it.

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