



**Report on damages to infrastructure
from the destruction caused by Russia's military aggression against
Ukraine as of January 2024**

April 2024

Table of contents

- 1. Preamble**
- 2. Economic damages due to the destruction of assets. Key findings**
- 3. Assessment of damages to physical infrastructure by area:**

Social sector

- Residential and administrative buildings

- Healthcare facilities

- Educational institutions and scientific infrastructure facilities

- Social protection

- Culture, sports, tourism

Productive sector

- Assets of enterprises, industrial facilities

- Commerce

- Agriculture and land resources

Infrastructure

- Transport infrastructure

 - Road infrastructure

 - Railway infrastructure

 - Aviation sector

 - Ports and shipping sector

- Postal operators

- Transport vehicles

- Digital infrastructure

- Energy sector

- Housing and utilities sector

Financial sector

Annexes

PREAMBLE

This report presents the results of an assessment of the damages to Ukraine's economy caused by Russia's military aggression. **The report covers the period from February 2022 to January 2024.** Damages mean complete or partial destruction to the physical infrastructure of Ukraine as a result of the full-scale war.

The assessment of damages was carried out within the framework of the National Council for the Recovery of Ukraine from the full-scale war by the analytical team of Kyiv School of Economics (KSE) together with the Ministry of Communities, Territories and Infrastructure Development, the Ministry of Economy of Ukraine, the Ministry of Health of Ukraine, under the coordination of the Ministry for Reintegration of the Temporarily Occupied Territories of Ukraine and in cooperation with other relevant ministries and the National Bank of Ukraine.

The overall damages assessment was carried out in accordance with the World Bank methodology and close cooperation with the World Bank dedicated team, taking into account a significant amount of microdata collected by the relevant authorities and local civil and military administrations since the beginning of the full-scale war.

The assessment methodology involves the use of direct and indirect methods, statistical data and certain assumptions, in particular regarding the extent of damages in areas where active hostilities are still ongoing, where physical inspection is limited due to danger (e.g. mined areas), or which are located in the territories occupied by the aggressor. To estimate the value of damaged or destroyed assets, average values are calculated based on data from the State Statistics Service, relevant ministries, the Prozorro system, etc., with adjustment factors applied according to the level of damage to the assets. Information from financial statements relevant as of the latest available date is used to assess the value of damaged or destroyed assets of large commercial facilities and identified institutions.

At the same time, information on the actual (compared to the previous assessment) state of damage to facilities in Ukraine's liberated and government-controlled territories is used as a "proxy" to clarify assumptions about the level of damages and the extent of destruction.

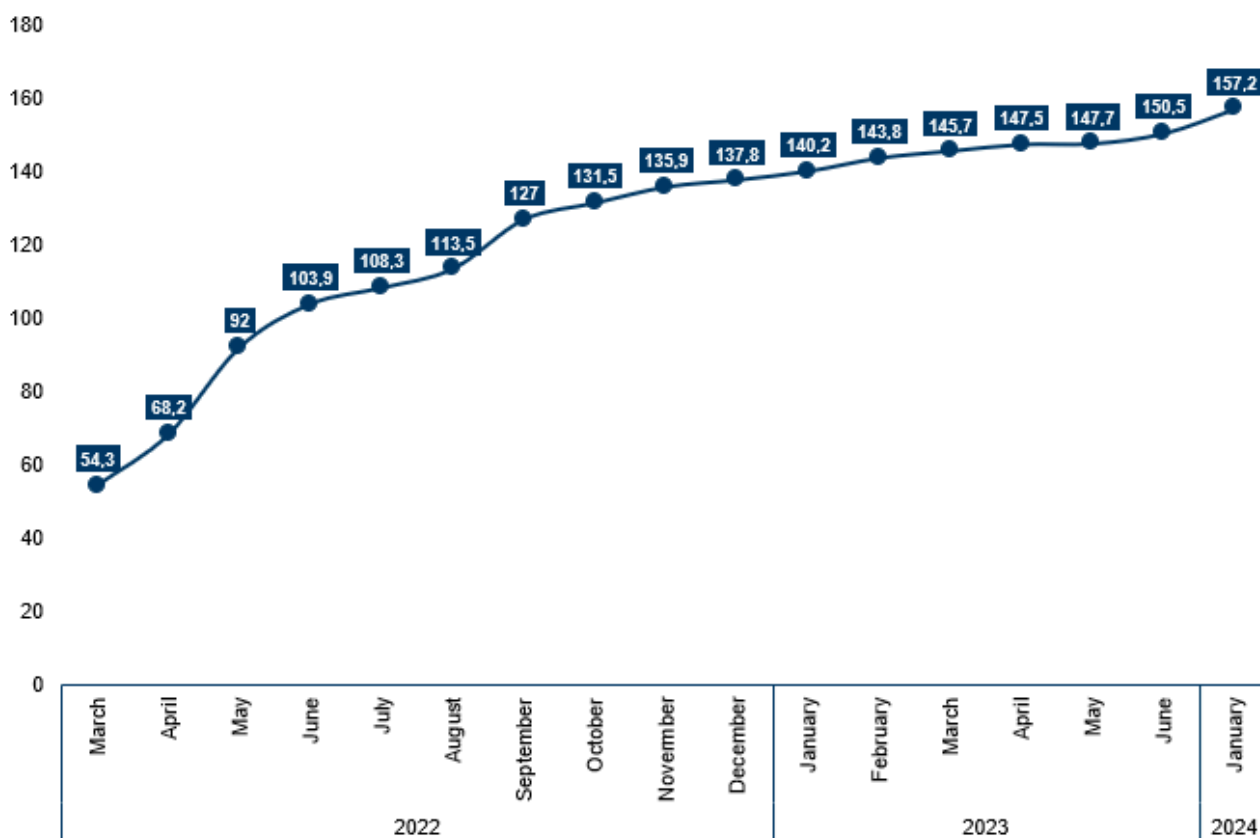
The research methodology is described in more detail in the materials of the working group "Audit of damages incurred as a result of the full-scale war" at the link:

<https://www.kmu.gov.ua/storage/app/sites/1/recoveryrada/ua/audit-of-war-damage.pdf>.

Economic damages due to the destruction of assets. Key findings

Since the beginning of the full-scale Russian military invasion, the total amount of **damages** to residential and non-residential real estate and other infrastructure has amounted to more than **\$157 billion** (at replacement cost).

Dynamics of the aggregate estimate of damages to the Ukrainian economy, \$ billion

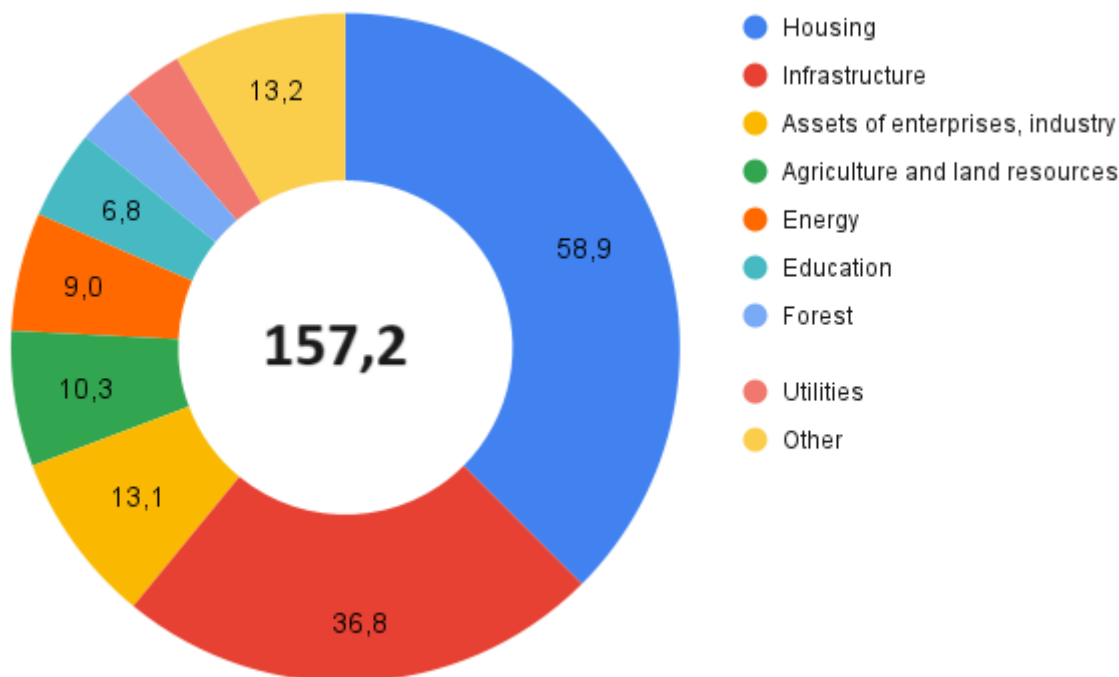


Source: Kyiv School of Economics

Residential buildings accounted for the largest share of total **damages**, 37.5% or \$58.9 billion and infrastructure 23.4% or \$36.8 billion. Damages of assets of industry, construction and services amounted to at least \$13.1 billion and continue to rise. Another \$10.3 billion was due to damages in the agricultural sector as a result of the full-scale war. Meanwhile, the energy sector's damages are also growing significantly, amounting to \$9.0 billion.

The total damages from destruction and damage to public sector facilities (social facilities and institutions, educational, scientific and healthcare institutions, cultural facilities, sports facilities, administrative buildings, etc.) amounted to about \$13.7 billion.

Damages by type of property, \$ billion



Source: Kyiv School of Economics

Total estimate of infrastructure damages as of January 2024

Property type	Assessment of damages, \$ billion	Share of damages by property type, % of total sum
Residential buildings	58.9	37.5%
Infrastructure	36.8	23.4%
Assets of enterprises, industry	13.1	8.3%
Agriculture and land resources	10.3	6.5%
Energy sector	9.0	5.7%
Education	6.8	4.3%
Forest fund	4.5	2.9%
Communal services and utilities	4.5	2.9%
Transport vehicles	3.1	2.0%
Healthcare	3.1	2.0%
Culture, tourism, sports	3.1	2.0%
Trade	2.6	1.6%
Administrative buildings	0.5	0.3%
Digital infrastructure	0.5	0.3%
Social sector	0.2	0.1%
Financial sector	0.04	0.01%
Total	157.2	100%

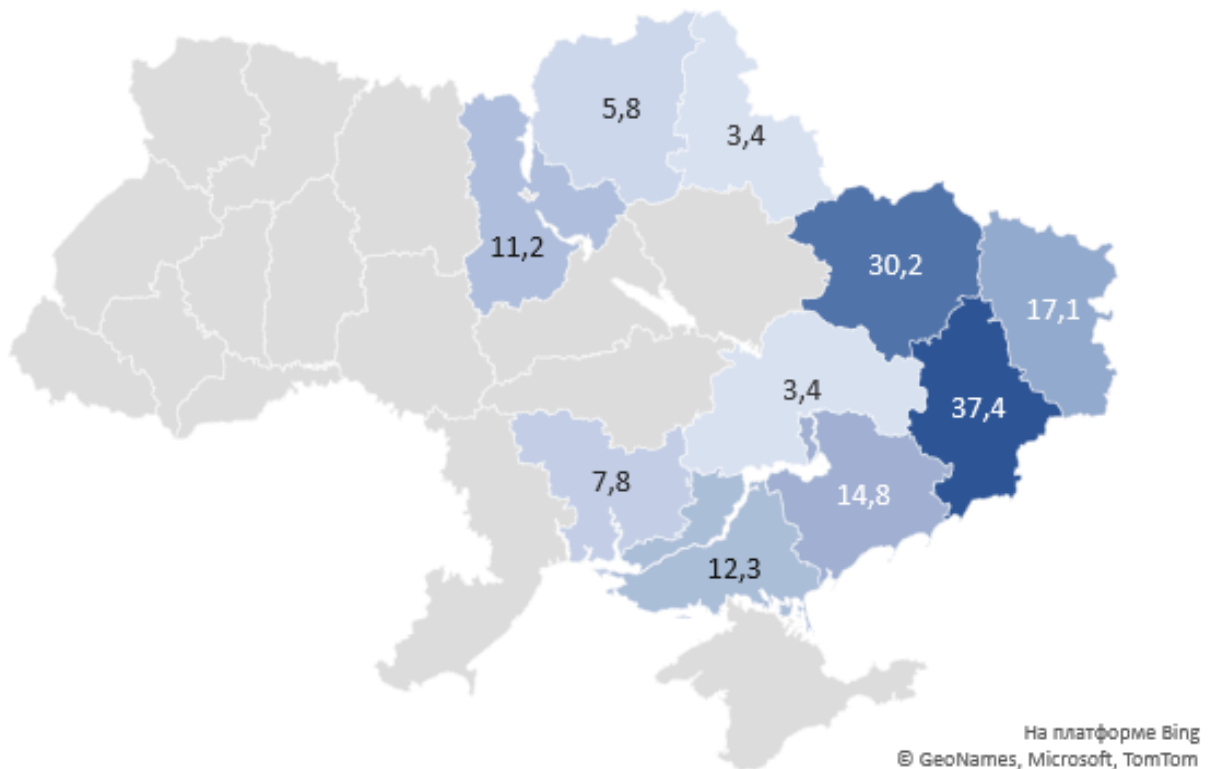
Source: Kyiv School of Economics

The explosion of the Kakhovka hydroelectric power station in January 2024 caused at least \$2 billion in damages. The main sectors affected by this terrorist attack are housing (\$1.03 billion), energy (\$586 million), transport infrastructure (\$311 million), industry (\$105 million), and agriculture (\$25 million).

The damages and losses caused by the hydroelectric power station explosion are included in sector sections of the report.

In the first weeks of the full-scale war, in late February and early March, hostilities took place in 10 regions. As of June 2023, hostilities continued in Kharkiv, Luhansk, Donetsk, Kherson and Zaporizhzhia regions. The regions of Ukraine most affected by the hostilities are those where the fighting occurred: Donetsk, Kharkiv, Luhansk, Mykolaiv, Zaporizhzhia, Kyiv and Chernihiv regions. The cities that suffered the most during the full-scale war are: Maryinka, Mariupol, Irpin, Kharkiv, Chernihiv, Sievierodonetsk, Lysychansk, Vuhledar, Sumy, Rubizhne, Izyum, Mykolaiv, Bakhmut, Volnovakha.

10 most affected regions of Ukraine, \$ billion



Source: Kyiv School of Economics

Total estimated damages by region as of the beginning of 2024¹

Regions	Estimated damages, \$ billion
Donetsk	37.374
Kharkiv	30.224
Luhansk	17.127
Zaporizhzhia	14.773
Kherson	12.277
Kyiv	11.188
Mykolaiv	7.853
Chernihiv	5.773
Sumy	3.398
Dnipropetrovsk	3.369
Kyiv city	2.135
Odesa	1.471
Khmelnytsk	1.195
Zhytomyr	1.004
Poltava	0.672
Vinnytsia	0.480
Ivano-Frankivsk	0.384
Lviv	0.219
Rivne	0.215
Kirovohrad	0.149
Cherkasy	0.128
Ternopil	0.119
Chernivtsi	0.073
Volyn	0.015
Zakarpattia	0.011

Source: Kyiv School of Economics

There are summary tables with data for each sector/industry at the end of the report in annexes.

¹ Not all categories of losses are subject to decomposition at the regional level

SOCIAL SECTOR

Residential and administrative buildings

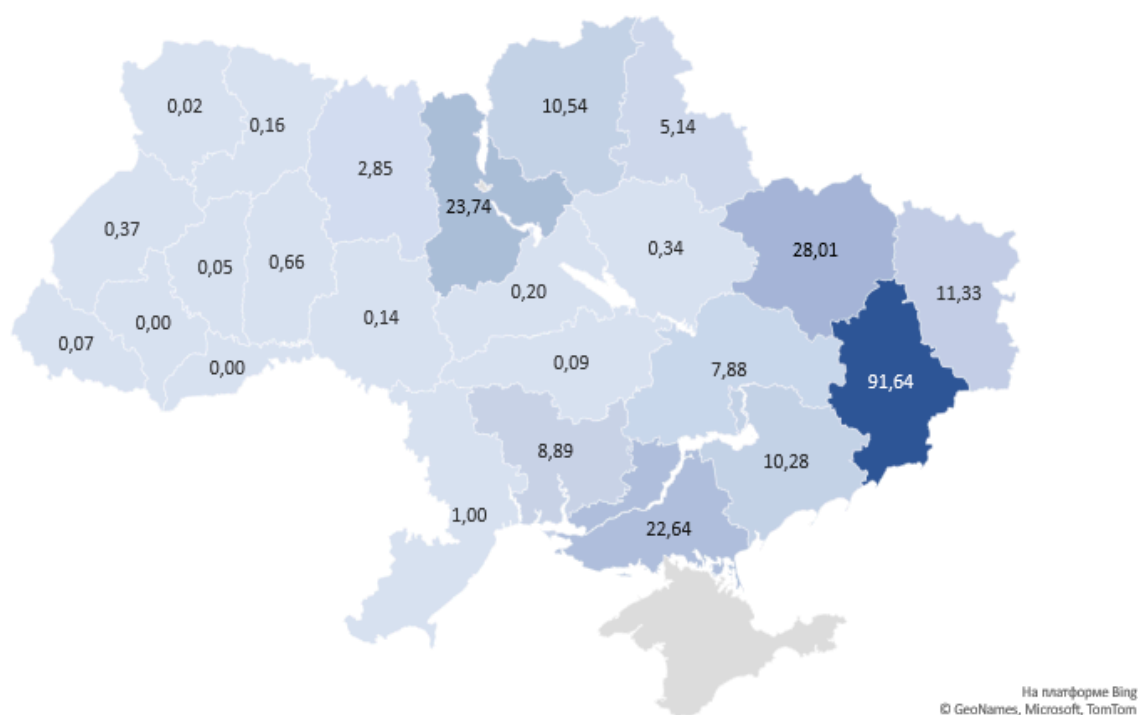
Active shelling of cities with rockets and artillery is part of Russia's tactics of warfare, which leads to significant destruction of housing in cities and towns, especially those located near the front line. As of January 2024, more than 50% of the housing stock in a significant number of cities and towns was damaged or destroyed as a result of the Russian Federation's hostilities. This requires not only the restoration of individual buildings but also the comprehensive restoration of cities, the development of new urban planning documentation and other measures.

The most heavily damaged housing stock was found in the cities of Mariupol, Kharkiv, Chernihiv, Sievierodonetsk, Rubizhne, Bakhmut, Maryinka, Lysychansk, Popasna, Izyum and Volnovakha. For example, according to preliminary estimates, 90% of the housing stock in Sievierodonetsk was damaged, while cities such as Bakhmut and Maryinka have almost no undamaged buildings. At the same time, the number of damaged residential buildings (both multi-storey and individual houses) is increasing due to the ongoing active hostilities in Kharkiv, Luhansk, Donetsk, Zaporizhzhia, Kherson regions and the temporary occupation of part of Ukraine's territory, as well as throughout the rest of the country due to regular rocket attacks.

According to preliminary data from the regional military administrations, as of January 2024, the total number of destroyed or damaged housing facilities is **about 250 thousand buildings**, of which 222.6 thousand are private (individual) buildings, 27 thousand are multi-storey buildings, 0.53 thousand are dormitories.

As a result of the explosion of the Kakhovka hydroelectric power station, almost 36,000 residential buildings were at risk of flooding, most of which are located in the Kherson region (with varying degrees of flooding — completely flooded, partially flooded and possibly flooded). About 1,000 buildings at risk are multi-storey buildings, and the rest are private buildings².

Regional distribution of the number of destroyed or damaged housing stock, thousand units



Source: Kyiv School of Economics

² This publication has been prepared using data provided by the EMITTER project, which is implemented with the financial support of the European Union. Its contents are the sole responsibility of the project and do not necessarily reflect the views of the European Union.

The total area of damaged or destroyed facilities by shelling is **88.9 million square meters**, which is **8.6% of the total area of the housing stock** of Ukraine. According to preliminary estimates, 16.9 thousand residential buildings (with a total area of 15.6 million square meters) were partially damaged (the degree of destruction is less than 10%); 84.5 thousand residential buildings (with a total area of 48.12 million square meters) were moderately damaged (the degree of destruction is more than 10% or less than 40%); 65.8 thousand residential buildings (with a total area of 25.24 million square meters) were completely destroyed (the degree of destruction is more than 40%).³ Based on the results of detailed site-specific technical inspections of buildings, this ratio may vary.

The area of buildings in the flood zone totalled another 4.8 million square meters.

Thus, the housing of about 1.4 million households (about 3.4 million people) is damaged or destroyed.

According to preliminary estimates, the value of damages for the residential buildings is \$58.94 billion. This is more than a third of Ukraine's total damages as of January 2024.

Just to return the housing to its previous condition, it will be necessary to incur expenditures in the following areas:

- current repair of residential buildings;
- major repairs or reconstruction of residential buildings;
- new construction;
- restoration of the adjacent territory near residential buildings (fences, benches, landscaping, children's and sports grounds, etc.);
- purchase of durable goods (furniture, household appliances).

In addition, according to preliminary data, 630 administrative buildings were destroyed or damaged as a result of hostilities, including 580 buildings of state and local authorities and 50 administrative service centers. According to preliminary estimates, damage to administrative buildings is **\$0.54 billion**.

Healthcare facilities

Damages to healthcare facilities amounted to \$3.12 billion. In total, at least 1,203 healthcare facilities have been damaged or destroyed since the start of the full-scale war.

As part of the project, the calculation of damages includes an assessment of damage to healthcare facilities, including hospitals, polyclinics, dentists, consultative diagnostic centers, medical offices, obstetric stations, outpatient clinics, rehabilitation and health centers, laboratory and blood centers, and outbuildings of healthcare facilities. Damages to private healthcare facilities were calculated separately.

The data on the destruction of the relevant healthcare facilities were obtained from the Ministry of Health for public facilities, microdata for private facilities, and open sources.

Damage to healthcare facilities accounts for about 2% of Ukraine's total damages. In terms of types of healthcare facilities, the full-scale war has destroyed or damaged most outpatient clinics (426) and hospitals (358), with hospitals accounting for 76% of the total damage to the sector. More than half of the damage to the healthcare sector is concentrated in three regions — Mykolaiv, Donetsk and Chernihiv.

Educational institutions and scientific infrastructure facilities

The education sector is one of the most affected by the war in terms of the number of destroyed, damaged and lost infrastructure facilities. In total, almost 3,800 educational institutions were

³ The distribution of data on the degree of damage was based on the analysis of site-specific data and expert assumptions.

damaged as a result of the hostilities, and the educational process in schools and other institutions was suspended for a long time in many regions.

This has forced the government to cut spending on education from the state budget in order to allocate part of the money to more urgent needs, such as defense, disaster relief and increased social protection needs.

Damages to educational institutions amounted to \$6.8 billion. In total, at least 380 educational infrastructure facilities have been destroyed, and 3,429 were damaged as a result of the hostilities. The educational institutions whose damage is being assessed under the project include: pre-school (kindergartens), secondary (schools), out-of-school, pre-university (colleges and technical schools), higher (institutes, universities, academies) and specialised educational institutions.

The main damages in the field of education related to secondary, pre-school, and vocational education institutions are due to their prevalence and attractiveness for use by the aggressor's forces during hostilities. Despite the fact that active hostilities took place in 11 regions, educational institutions were damaged in 21 regions.

The largest damage from destruction and damage to educational institutions were in Donetsk, Kharkiv, Kherson, Mykolaiv, Dnipro and Zaporizhzhia regions.

Among the damaged and/or destroyed educational facilities the largest number of schools (1888) and kindergartens (1285).

Social protection

As a result of large-scale hostilities in various regions of Ukraine, social welfare institutions have suffered, including destroyed and damaged social centers, geriatric facilities, sanatoriums, children's homes and camps, residential institutions, and homeless shelters.

Over the course of more than two years of full-scale warfare, damages to the state's social welfare institutions have amounted to \$0.2 billion (at replacement cost).

The methodology used to analyze damages includes destruction and damage to social welfare institutions under the jurisdiction of the Ministry of Social Policy of Ukraine. The assessment is based on the data on destruction and damage to social welfare institutions provided by the Ministry of Communities, Territories and Infrastructure Development of Ukraine.

Social centers (48), sanatoriums (46) and residential institutions (31) accounted for the largest share of the total number and cost of damages.

Among social welfare institutions, the smallest number of destroyed or damaged institutions and, accordingly, damages were documented compared to other infrastructure facilities in the country. The damaged social welfare institutions are located in Kyiv and the following regions: Kyiv, Donetsk, Dnipropetrovsk, Zhytomyr, Zakarpattia, Zaporizhzhia, Luhansk, Mykolaiv, Sumy, Odesa, Kharkiv, Kherson, and Chernihiv regions. Destroyed social welfare institutions are located in Luhansk, Donetsk, Zaporizhzhia, Kyiv, Mykolaiv, Sumy, Kharkiv, Kherson, Chernihiv regions and Kyiv city.

Culture, sports, and tourism

Since the beginning of the large-scale invasion, the cultural sphere has suffered the greatest historical losses in the history of independent Ukraine. For every country, culture is the basis of self-determination for every citizen, and the destruction of cultural facilities such as museums, historical buildings, monuments and artworks by prominent people is a very painful blow to Ukrainians, as with the destruction of each cultural facility, a part of the history of Ukraine and the Ukrainian people is lost.

Due to the high intensity of hostilities in eastern and southern Ukraine, as well as regular rocket attacks across the country, most cultural and sports institutions have ceased operations or

significantly reduced their work. As a result, 12.5 million people in at least 6 regions of the country (Donetsk, Zaporizhzhia, Luhansk, Mykolaiv, Kharkiv, Kherson) have lost access to services, and another 13 million people in 7 regions have limited access to them.

According to the registers of national cultural heritage, there are about 15.5 thousand cultural heritage sites in Ukraine, of which about 1.2 thousand are sites of national importance and 14.3 thousand are local. These sites are categorized into eight types: historical, architectural, archaeological monuments, landscape, monumental art, urban planning/urban development sites, landscape gardening sites, and science and technology sites.

Among the most painful losses of this full-scale war on the cultural front are the Holy Dormition Sviatohirsk Lavra, which is included in the UNESCO World Heritage List, the museum of Hryhoriy Skovoroda, author of world-famous philosophical and artistic works, and even a collection of Scythian gold found by archaeologists in the 1950s. In addition, other important cultural and religious sites have suffered significant damage, including the Mykolaiv City Palace of Culture “Korabelnyi”, the Mariupol Drama Theatre, the Kharkiv National Academic Lysenko Opera and Ballet Theatre, the Museum of Antiquities in Chernihiv, the Kharkiv Slovo Building and many others. At present, the assessment of cultural heritage losses is based on an object-by-object list of damaged/destroyed facilities provided by witnesses and local administrations, which creates risks of incomplete data on the list of damaged facilities. Due to the lack of access to most of the damaged objects due to their location in the areas of hostilities, the list is incomplete and continues to increase.

Since the beginning of Russia's military aggression, 348 religious sites, 771 houses of culture/palaces of culture, 83 museums, 157 hotels and restaurants, and 8 stadiums have been damaged in Ukraine according to documented losses, mostly located in 14 regions of the country: Dnipro, Donetsk, Zhytomyr, Zaporizhzhia, Kyiv, Luhansk, Lviv, Mykolaiv, Odesa, Sumy, Kharkiv, Kherson, Chernihiv and Kyiv city.

As of June, the share of **damages to culture, sports, and tourism totalled \$2.4 billion**. In total, at least 1,804 cultural facilities, 348 religious buildings, 343 sports facilities, and 164 tourism facilities have been damaged or destroyed since the start of the war.

An important methodological limitation of this calculation is that the financial value of cultural facilities is calculated without taking into account the actual value of the cultural value of these facilities, given the difficulties in calculating such value remotely, as well as the lack of a single and comprehensive register of cultural buildings that would contain detailed data on cultural heritage, art objects, and a list of museum artifacts in each of the facilities. Also, given this limitation, the current stage does not include the loss of libraries, museum collections, costs of relocation of museum collections, etc.

Projects for the restoration, conservation, and museumification of cultural heritage sites are developed individually for each site, taking into account the totality of survey data and best international practices, which requires the involvement of international experts; the cost estimation of such projects takes time and is based primarily on the results of a comprehensive survey and thorough documentation.

The valuation of damaged or destroyed cultural property is complicated by the difficulty of indirectly assessing the value and cost of the interior decoration of religious and other cultural institutions, art objects, decorations, exhibits, icons, frescoes, etc., contained in the buildings. Accordingly, the value of damaged cultural objects may be changed in accordance with the establishment of the possibility of restoration of these objects and their cost.

PRODUCTIVE SECTOR

Industry, construction and business services

The total damages to enterprises' assets are estimated at \$13.1 billion. In total, at least **426** large and medium-sized private enterprises, as well as state-owned enterprises and tens of thousands of small private enterprises, have been damaged or destroyed since the start of the full-scale war. The true figure is likely to be higher, as not all enterprises are reported, especially those in the temporarily occupied territories.

Enterprises could be divided into two groups. The first was those destroyed by accident or “along” with the shelling of military units and settlements. The second was destroyed intentionally as part of targeted strategic missile strikes. In addition to transport and energy infrastructure facilities described in the relevant sections, these are primarily military and dual-use production facilities. Unlike the first group, which is concentrated in the frontline regions, the second group is evenly distributed throughout Ukraine.

Damages include:

- Damage of fixed assets (the original valuation is used since it is not possible to purchase an asset at its carrying amount in most cases);
- Damage of capital investments in progress;
- Damage to inventories of finished goods and intermediate materials (in most cases, the inventories were located close to the main production facilities).

Depending on the availability of data, losses are calculated in one of the following ways:

- This estimate is used for private enterprises for which the owner has reported its own estimate of damages after verification.
- The financial statements, as of the latest available data, are used for large and medium-sized private enterprises for which the existence and level of damage are known. We distinguish between destruction (100%) and damage (40%).
- We use estimates provided by the ministries and agencies that manage the respective companies (if available, otherwise financial statements are used, as in the case of private companies) for public utility companies.
- The indirect calculation based on the level of damage to residential property in the regions is used for small private enterprises as an interim indicator.
- The value of assets (through ratios to revenue based on the financial statements of legal entities) was first estimated for individual entrepreneurs, and then damages were calculated similarly to small private enterprises.

The main conclusions regarding the damage enterprises are as follows:

1. Business assets are the third largest item of infrastructure damage. It accounts for almost 8.4% of total damages.
2. In terms of industries, metallurgy suffered the most. In particular, two of the largest enterprises on the list of damaged/destroyed were destroyed — Azovstal and Illich Iron and Steel Works (both in Mariupol, see the list in Annex 6).
3. In terms of regions, the Donetsk region suffered the most, accounting for almost half of the total damages incurred by the enterprises. Significant damage was also caused in the Kharkiv, Luhansk, and Kyiv regions.

Commerce

The information on damages of **retailers** was obtained by analyzing data from two waves of a study conducted by the Ukrainian Council of Shopping Centers (the first wave was conducted jointly with the Association of retailers of Ukraine).

The study was conducted through a standardized online survey (CAWI) of top managers of retail companies. Representatives of 271 companies took part in the survey, including both chain and non-chain companies. A number of respondents were interviewed twice - during each of the study waves.

The retail outlets include the following:

- Shops;
- Pharmacies;
- Kiosks;
- Petrol stations.

However, retailers' damages are not limited to the damages at their retail outlets. Thus, the issue of damages included the following items:

- Damage to the building/premises of the company-owned outlets, engineering networks and finishing/repair;
- Damage to equipment;
- Damage to inventories in retail outlets (at purchase prices);
- Damage to warehouses, production, office buildings/premises owned by the company and equipment therein;
- Damage to inventories in warehouses (at purchase prices);
- Other damages.

The damages incurred by retailers reached **\$2.19 billion**, not including the damages of individual entrepreneurs.

Another source of damages in the retail sector is damages of **shopping centers (SCs)**. Shopping centers are not participants in the retail market, but provide space for retailers to carry out their professional activities.

According to the ICSC definition, a shopping center is a retail property that is planned, built and managed as a single entity, comprising units and "communal" areas, with a minimum gross leasable area (GLA) of 5,000 square meters.

According to the Ukrainian Council of Shopping Centers (UCSC), which maintains a register of shopping centers and provided data on their damages, there are 286 shopping centers in Ukraine, of which 9 were destroyed and 22 damaged.

The amount of damages incurred by the shopping centers as a result of the hostilities is **\$378 million**.

The expert assessment of the damage took into account the area and nature of the damage, based on the construction cost of \$800-1100 per 1 sq. m, depending on the type of facility. The calculation of the shopping center's direct damages does not include tenants' damages (equipment and goods).

Thus, the **total amount** of damage to commerce since the beginning of the full-scale war in Ukraine is **\$2.57 billion**.

Agriculture, land resources and forestry

As of the beginning of 2024, the amount of damages incurred by the Ukrainian agricultural sector amounted to \$10.3 billion.

Estimates of **damages** to the agricultural sector and agricultural infrastructure include the following main components: damage to agricultural machinery; damage to elevators and other grain storage facilities; livestock damages from animal deaths and forced slaughter due to the inability to keep animals; damage to perennial crops plantations; damages to beehives and other beekeeping assets; and damages to inputs and finished products due to the destruction and theft.

The abovementioned damages are estimated using indirect methods, a combination of relevant state and regional statistics, as well as data from surveys of agricultural producers conducted in 2022.

The largest share of damages was due to the destruction and damage to agricultural machinery, resulting in estimated damages of over **\$5.8 billion**. The second largest category was losses due to the destruction and theft of finished products, with the total value of destroyed and stolen products estimated at \$1.9 billion.

The infrastructure for storing agricultural products has suffered significant losses. The total capacity of the destroyed granaries reaches 11.4 million tonnes of output, and the capacity of the damaged granaries reaches 3.3 million tonnes of simultaneous storage capacity. The cost of restoring the damaged facilities is estimated at \$1.8 billion.

According to the Zoï Environment Network, the total area of forest fires in the areas where active hostilities took place is almost 298 thousand hectares. This area of forest fires in 2023 exceeds the average annual area of forest resources destroyed by fires throughout Ukraine by more than 50 times. According to the KSE's calculations based on the State Statistics Service of Ukraine, the average annual area of forest plantations lost due to forest fires is 5270 hectares. During the available 11 years of observations of the volume of forest resources lost due to fires (2010-2020), the highest value was recorded in 2020. At that time, the area of forest plantations destroyed reached 28 thousand hectares. One of the key factors behind this volume of forest fires is the difficulty in extinguishing forest fires in areas where active hostilities are or have been taking place. Even in the liberated territories, fighting forest fires is significantly complicated by the threat of mine contamination.

Forest damages due to forest fires are estimated at more than 82.9 million cubic meters of timber with an estimated value of \$4.5 billion.

INFRASTRUCTURE

Transport infrastructure

Infrastructure facilities became one of the key areas that suffered the greatest attacks by the aggressor with the unfolding of a full-scale war against Ukraine. In particular, in the first weeks of the full-scale war, Russian troops carried out massive shelling of aviation infrastructure, primarily airfields, not only for the military but also for civilian and military-civilian (dual) purposes. Subsequently, railway infrastructure, including power substations, became the target of active attacks.

Thus, road infrastructure facilities suffered the greatest damage, both in absolute and value terms. Firstly, because they are naturally targeted during artillery attacks, and secondly, because Russian tanks have been actively moving along Ukrainian roads throughout the entire period of military aggression. In particular, motorways were used as communication lines between Russian troops in Ukraine and their rear in Russia and Belarus.

Since the beginning of the hostilities in Ukraine, 19 airports and civilian airfields have been damaged; at least 126 railway stations and stations have been damaged.

According to preliminary estimates, **the total amount of damages to transport infrastructure in Ukraine was \$36.8 billion.**

Road infrastructure

A detailed analysis of the condition of the roads damaged by shelling and tank traffic is possible only with a specialized technical inspection, which is not possible in a situation where active hostilities are still ongoing in a large part of Ukraine, and some roads and bridges are located on the temporarily occupied (after 24.02.2022) territory.

However, analyzing the map of hostilities and comparing it with the road network allows us to make preliminary calculations of the approximate length of roads damaged by the full-scale war, both as a result of rocket attacks and tank movements. According to a study (Damaging Effect of Moving Tank Loads on Flexible Pavement, Journal of Engineering, 2010), the damaging effect of a tank can reach 2.36 times the damaging effect of a standard axle load from civilian vehicles. In this study, T-72 tanks were used, which is a good approximation in the case of the full-scale war in Ukraine, as most tanks are similar in physical characteristics or even heavier. The surface layer of the roads is severely damaged by metal tracks. Also, the destructive effect of tank braking is 2.38 times greater than the destructive effect of the tank's weight on the road's stretching. Finally, the destructive effect of tank maneuvers is 1.22 times greater than the effect of the destructive effect of the tank's weight on the road's tension. What is important is that the effect of the tank's stress is not only horizontal but also vertical, and the maximum stress, according to the study, is at a depth of up to 3 meters, which affects the degree of destruction not only of the surface layer of the road.

The peculiarity of road assessment is also that the average cost of damage and restoration of one kilometer of road in a city is usually significantly more expensive (the difference can be one-third or more) compared to the cost of roads outside the city, since road construction in cities, in addition to the construction of the roadbed, also involves the construction of communication networks, sidewalks, lighting, etc.

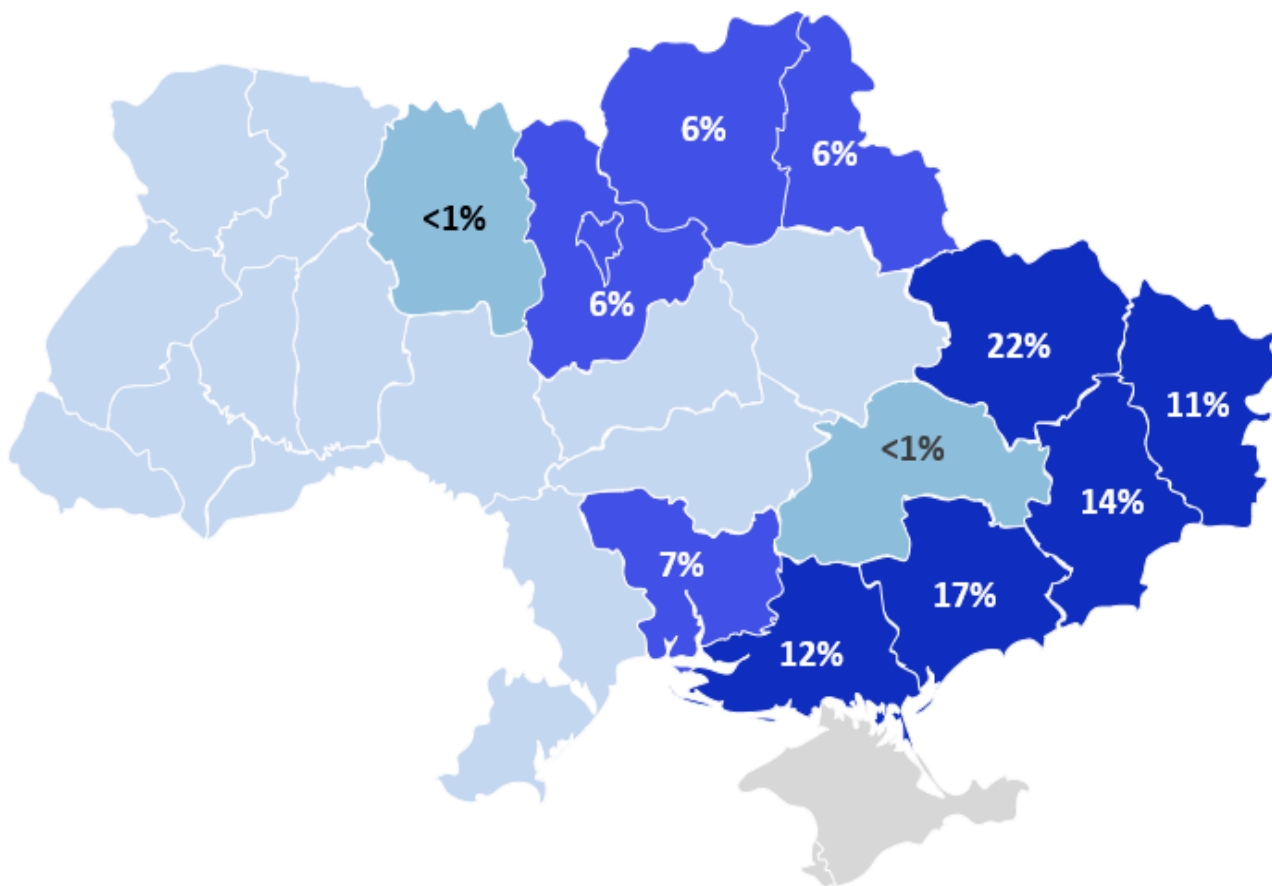
According to preliminary estimates, a total of **25,400 km of roads and 344 bridges and bridge crossings of state, local or municipal importance** were damaged due to the hostilities (for bridges and roads, see the Ministry of Infrastructure). According to the Ministry, a preliminary review of the condition of roads in the de-occupied regions (Chernihiv, Kyiv, Sumy, and Kharkiv regions) confirms the information on preliminary estimates of significant damage to the road structure due to the passage of tanks and other heavy military equipment, which will require the reconstruction of a significant part of the damaged roads. Preliminary estimates show that the level of damaged roads (state and local roads, as well as municipal roads) varies from 0% to 95% and averaged approximately 10% of the total number of roads in the areas occupied by Russian troops or where hostilities took place (are taking place).

According to Ukravtodor, the weighted average cost of road reconstruction in 2021 (taking into account different categories of roads) was about UAH 29 million per 1 km of road (excluding the cost of restoring bridge crossings). With this in mind, a preliminary estimate of the total damages due to direct road destruction could be around **\$26.7 billion** in equivalent, at prices as of the end of 2021.

We also conducted a study that found that 290.3 km of roads were flooded as a result of the destruction of the Kakhovka hydroelectric power station, which increases the estimate of total losses by \$0.3 billion, bringing the total damages to **\$27.0 billion**. Damage and destruction of bridges and bridge crossings add another **\$2.6 billion** in infrastructure damages.

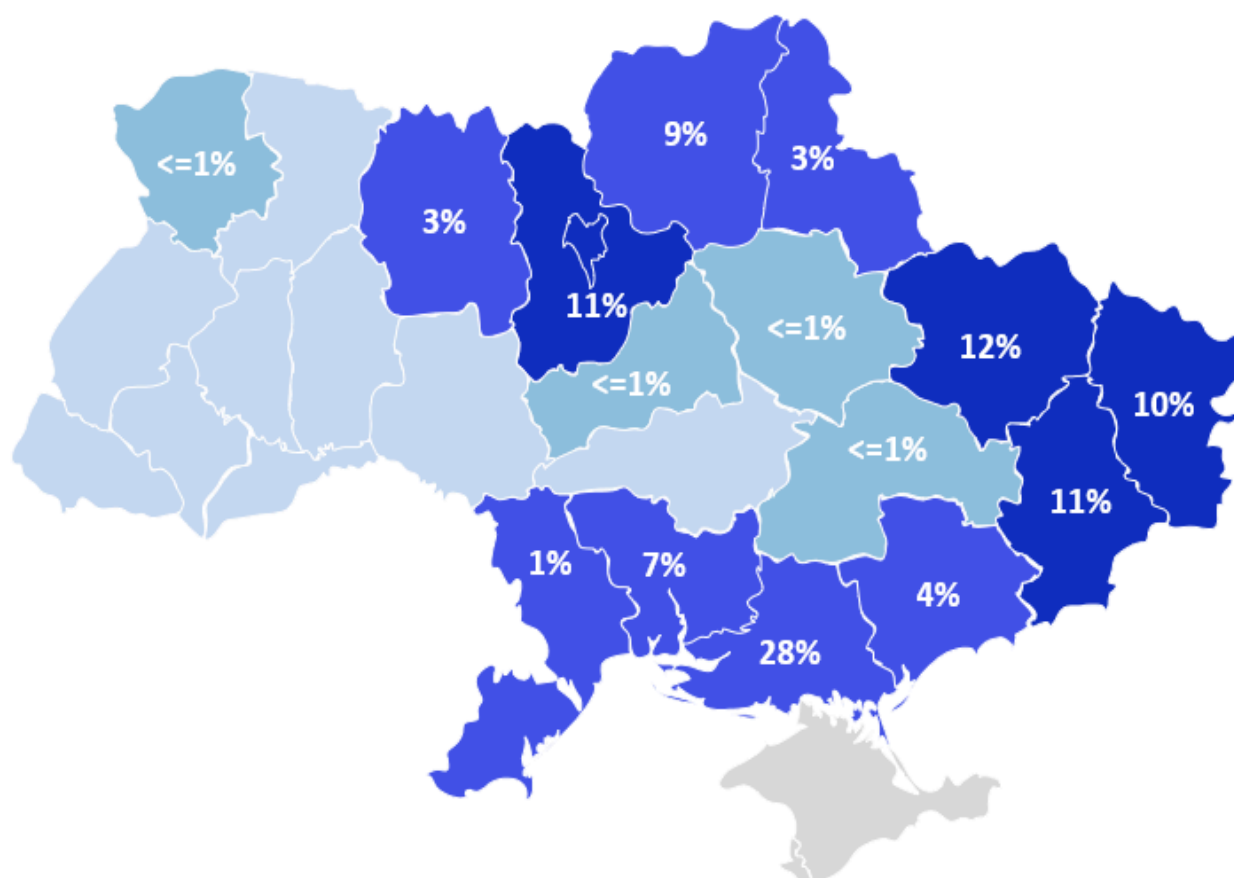
Since the beginning of the full-scale war, some work has been done to restore roads and bridges. In particular, 78 artificial structures on roads of national importance were reopened in 2022 (most of them in Kyiv (20), Chernihiv (20) and Kharkiv (17) regions), and 2 since the beginning of 2023 (3 more bridges are in the works). In addition, 2200 km of state and municipal roads were cleaned in 2022 (including about 612 km in Kharkiv, 588 km in Mykolaiv and 516 km in Kyiv regions).

Distribution of damages to roads by regions



Source: Kyiv School of Economics

Distribution of damages to bridges and bridge crossings by regions



Source: Kyiv School of Economics

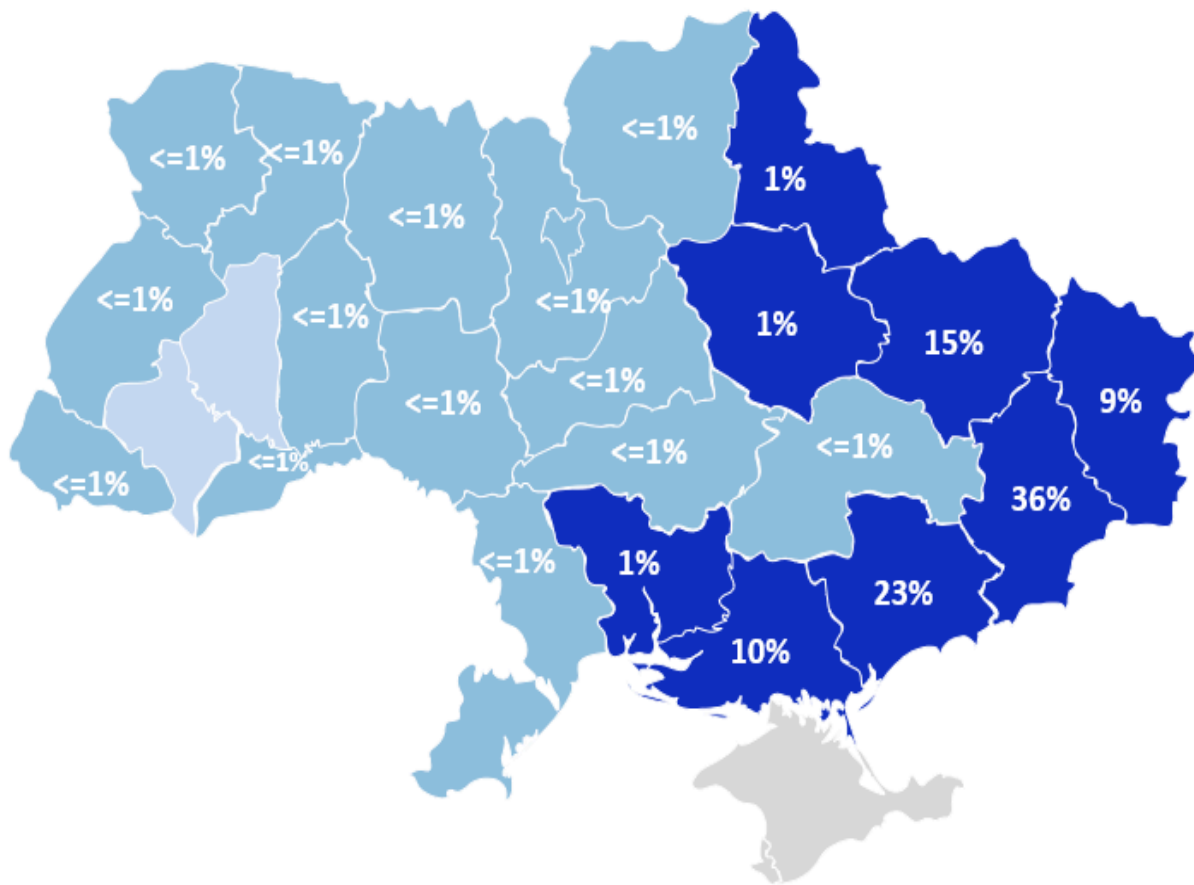
Railway infrastructure

Since the outbreak of the full-scale war, the Ukrainian railway has tangibly demonstrated its role as a critical infrastructure facility, taking the brunt of the free of charge evacuation of millions of Ukrainian citizens (as well as a large number of businesses) who were stranded in the war zone; as well as the delivery of critical materials and equipment to these regions. In response, the Ukrainian railway has become an active target for Russian shelling and attacks.

According to preliminary estimates, the total length of the damaged railway track is up to 507 km; the number of damaged railway stations and yards is 126, of which more than 53 were damaged or destroyed in government-controlled areas and the rest in non-government-controlled areas. In addition, more than 700 km of railway tracks are located on the temporarily occupied territory (after 24.02). The total number of damaged, destroyed and lost buildings belonging to Ukrzaliznytsia is estimated at 5,500 and about 4,000 structures. At the same time, there is reason to believe that all movable property of Ukrzaliznytsia that was not removed from such territories in time can be considered completely lost (destroyed or stolen by the troops of the aggressor country).

Thus, the total direct damages in this sector are estimated at **\$4.3 billion**.

Distribution of damages to the railway infrastructure by regions



Source: Kyiv School of Economics

Aviation sector

The aviation sector began to suffer losses from military aggression even before it actually began. On February 12, global insurance companies notified Ukrainian carriers that they would stop insuring their aircraft due to the high threat of an invasion by Russia. This led to the risk of cancellation of international carriers' flights to Ukraine, and following a working meeting with the leadership of the Office of the President of Ukraine, the State Aviation Administration of Ukraine, SE "Ukraerorukh", Boryspil International Airport and Ukrainian airlines, the government expressed its readiness to support air carriers by providing additional financial guarantees to support the aviation market.

With the outbreak of hostilities, the airspace over Ukraine was immediately closed, and air traffic was suspended. At the same time, Russian troops began active rocket attacks on all key airfields in Ukraine, trying to deprive the country of its air defense capabilities. As a result, 19 out of 35 airfields were damaged, including 12 civilian and 7 dual-purpose airfields (excluding military airfields). Some of the airfields were hit several times.

Similar to the situation with roads, detailed information on the state of damage/opportunities for repair of airfields at most airports can only be established after detailed technical surveys, which, in turn, are possible only after the end of active hostilities at/in the area of airports (for those located in central, southern, eastern, and northern parts of Ukraine). However, according to preliminary estimates, the total amount of damages to the aviation sector (airports, airfields, aircraft, air navigation equipment) was about **\$2.04 billion**.

Ports and shipping sector

The total **damages** to port infrastructure and related businesses was estimated at **\$0.85 billion**. This estimate included both seaport infrastructure and inland waterway transport facilities that were damaged as a result of the full-scale war. The total losses also included damage to port infrastructure caused by the accident at the Kakhovka hydroelectric power station.

In total, property in at least four ports have been destroyed or damaged since the start of the full-scale war. For example, a grain terminal in Mykolaiv's Nika-Tera port was destroyed, and the river ports of Nibulon were damaged significantly due to the destruction of the Kakhovka hydroelectric power station.

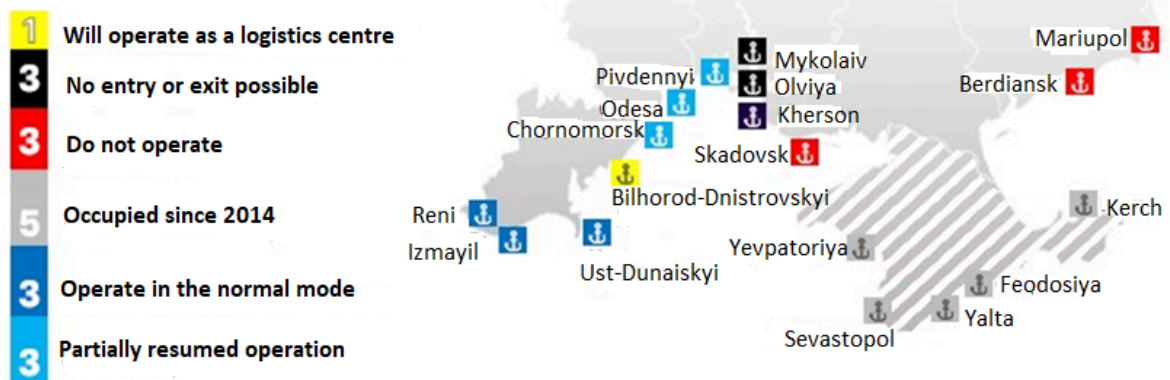
The moderate damage to ports is due to two factors. Firstly, a port is a rather complex and spatially distributed facility consisting of many large parts. Therefore, it is impossible to completely destroy such a facility with a few precise missile strikes. Secondly, the aggressor captured or used its own friendly cargo ships to export stocks of grain, ferrous metals, etc., and needed working ports for this purpose. For example, the Metinvest Group reported that the occupiers planned to export 200,000 tonnes of products worth \$170 million from Mariupol's factories. In turn, as for grain, 400-500,000 tonnes (also worth hundreds of millions of dollars) were reported stolen from four occupied southern regions, which is more than a third of local stocks.

Status of Ukrainian ports

PORTS OF UKRAINE DURING WAR

TOP LEAD

Ukrainian ports almost do not work due to occupation, blockade, mine danger and piracy from Russia's side



Source: UA War Infographics

Postal operators

The total **damages of postal operators** were estimated at **\$13 million**. This amount is based on data from Ukrposhta and Nova Poshta, which have the lion's share of the market. In total, since the beginning of the full-scale war, several hundred post offices, dozens of terminals/depots and vehicles, as well as a large number of parcels for which the operators are financially responsible, have been destroyed or damaged.

Vehicles

In the territories and cities where the most fierce fighting took place, public transport infrastructure was destroyed, and people were left without private vehicles that were damaged or destroyed as a result of rocket and artillery fire.

According to analytical calculations, the damages incurred by utilities and private carriers, including destroyed vehicles, amounted to \$0.83 billion, including trolleybuses, trams and buses. **Damages of private passenger vehicles amounted to approximately \$1.9 billion, or 212,000 cars. In addition, 1,629 firefighting vehicles worth \$89 million were lost.** The estimate of private passenger car losses was based on available data on the officially registered number of passenger cars and does not take into account possible losses of passenger cars not registered in Ukraine.

Damages of municipal transport were calculated using both indirect methods, taking into account a number of assumptions and using accurate data on damaged/destroyed municipal property provided by the military administrations.

The greatest damages to municipal property, which includes municipal (public) transport, were incurred in Luhansk and Donetsk regions, as well as in the city of Kharkiv. This was due to the fact that the Russian Federation mercilessly used heavy weapons to strike at civilian infrastructure. This resulted in the loss of an estimated 60% of public transport in the Donetsk region and over 70% in the Luhansk region. The industry in these two regions had been actually completely destroyed, providing urban and suburban passenger transport services.

Most private cars were also lost in these two eastern regions of Ukraine.

Significant damages were caused to citizens as a result of the explosion of the Kakhovka hydroelectric power station. In particular, the damages were estimated at **\$37 million or 4,000 cars**.

In addition, the damages to vehicles included the destroyed Mriya aircraft worth \$300 million. Indeed, the cost of building a new aircraft of the model may be higher. At the same time, the damages to air passenger transport are likely to be higher due to the possible destruction of other civilian/cargo aircraft during the shelling of Ukrainian airfields; however, in the absence of detailed information on the location of such aircraft at civilian airfields, this assessment will be made at a later stage.

Digital infrastructure

The total **damages** of telecom operators are estimated at **\$510 million**.⁴ The digital infrastructure sector includes:

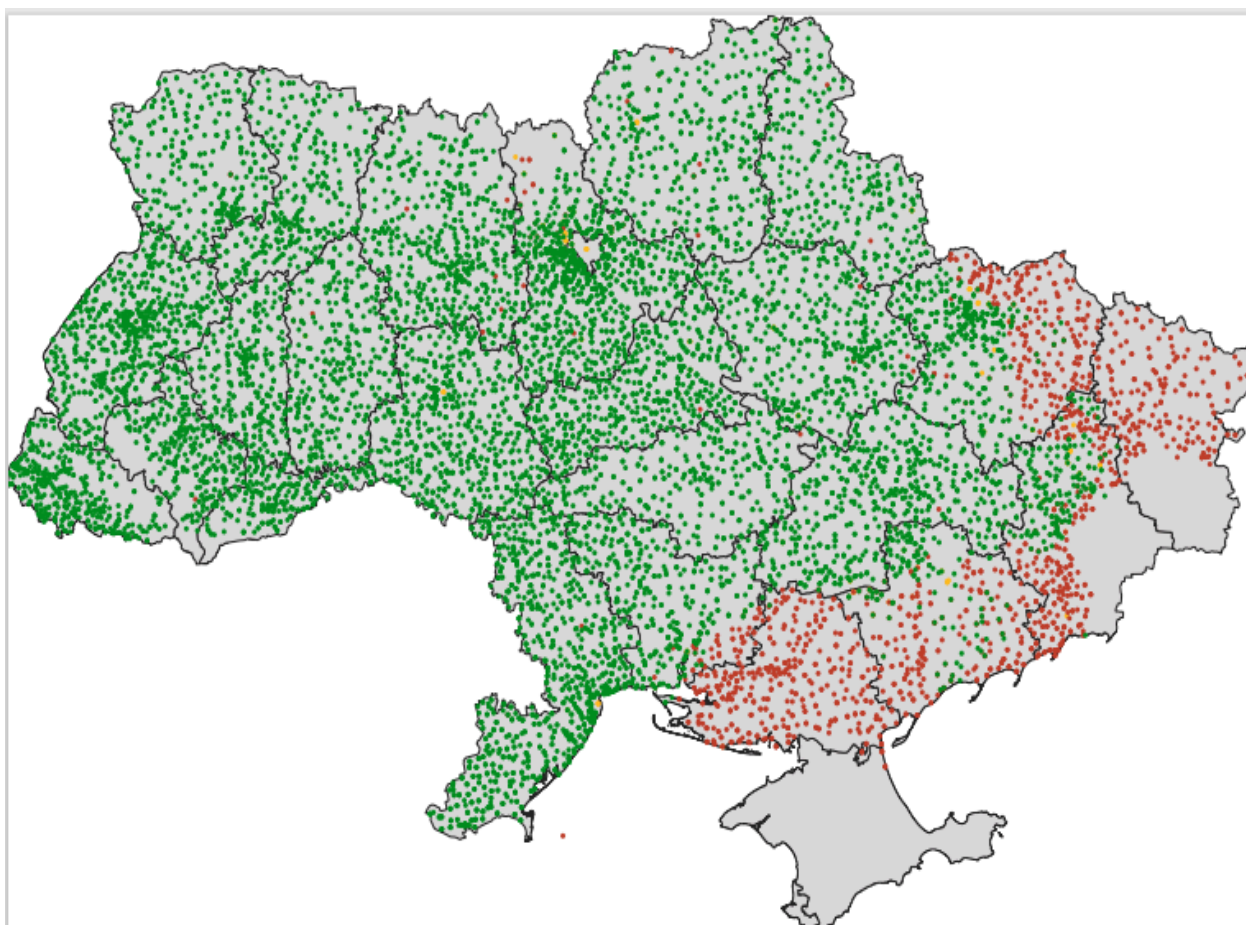
- Internet networks of fixed-line operators;
- Radio networks of mobile operators;
- Backbone networks;
- Technical and related means of electronic communications.

At least 726 operators of electronic communications with fixed access to the Internet suffered damages and losses as a result of the hostilities. After the de-occupation of settlements, the destruction of networks reaches 100%. Across the country, the quality of data transmission via fixed-line Internet access networks has decreased by an average of 13% (as of 01.05.2022).

There is no access to mobile communications in 12.2% of settlements and in 3.1% partially available. There are 3,534 mobile operator base stations out of service, which is almost 11% of the total. Over the past month, the total number of out-of-service base stations increased by 700. The quality of data transmission via mobile Internet access networks across the country has decreased by an average of 26% (as of 01.05.2022).

⁴ The estimates have not been updated from the previous report due to the lack of new comprehensive data.

Distribution of non-operational mobile base stations as of May 2022



Source: Kyiv School of Economics

The determination of the value of losses for owners of digital infrastructure or its components (including construction in progress) differs in different categories. The following classification was used for these purposes:

- National companies, electronic communications operators that provide electronic communications services to citizens of Ukraine throughout its territory;
- Medium-sized companies providing electronic communications services in several regions;
- Small companies providing electronic communications services within a region.

The damages of the national companies were determined based on the results of an inspection/survey of the destroyed or damaged electronic communications network infrastructure facilities, and whether they were accessible (even if possible in the officially uncontrolled territories). The amount of damage was determined in physical units (km, units, etc.) and was also estimated in monetary terms based on an approximate estimate of the cost of restoration work.

The damages of medium and small companies are calculated through the estimated cost of restoring/reconstructing networks or through the average monthly fee for 24 months.

Energy sector

As of January 2024, direct damage to the Ukrainian energy infrastructure was estimated at \$9.0 billion.

Both direct and indirect methods of calculating the cost of lost and damaged facilities were used to assess the damage in the energy sector.

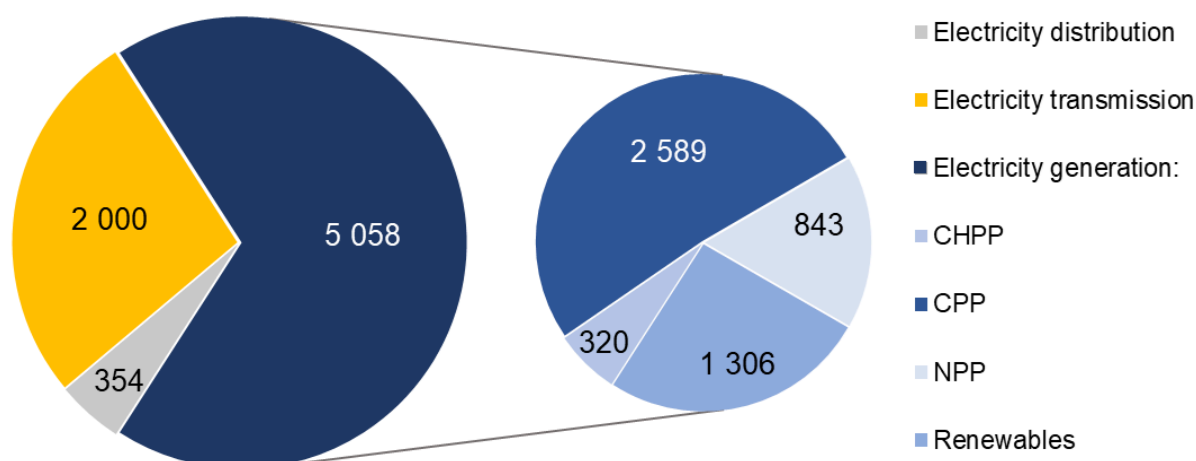
The cost of damaged facilities is based on the original book value of fixed assets, the cost of current repairs, and the cost of restoration (the market value of replacing the destroyed facilities).

Basic information on losses in the energy sector is provided by the Ministry of Energy of Ukraine. To assess losses at certain large facilities, an individual approach is used based on information from open sources, owners and managers of enterprises. Data on damage to power generation facilities was collected on an aggregate basis, as well as from open sources, due to the high risk of dissemination of information on detailed damage to critical infrastructure facilities in a time of war.

The current assessment is complicated by the lack of detailed information on damage to facilities that are currently under occupation or to which access is physically impossible due to constant shelling and/or significant mine risks.

The **electricity generation and transmission sector** has suffered the most from Russian aggression in the energy sector. The Russian Federation continues to carry out targeted and large-scale attacks on facilities that ensure the production, transmission and distribution of electricity. **The preliminary estimate of the total amount of damage** to these facilities is **over \$7.4 billion**. According to public statements by the Prime Minister of Ukraine, the Ministry of Infrastructure and the Ministry of Community and Territorial Development (now the Ministry of Reconstruction), all coal-fired power plants (CPPs) and hydroelectric power plants (HPPs) under the control of Ukraine, as well as 13 combined heat and power plants (CHPPs) have been affected since the beginning of the full-scale invasion.

Direct infrastructure damage to electricity facilities, \$ million



Source: Kyiv School of Economics based on data from the Ministry of Energy of Ukraine, energy companies, open data

Large power generation facilities suffered a significant amount of damage. One of the massive attacks during the winter of 2022-2023, according to the Prime Minister of Ukraine, resulted in significant damages to 9 units of coal-fired power stations, and at least one of them was completely destroyed by a direct missile hit. Overall, the Project team **estimates the damages to thermal power generation** at **\$2.6 billion** for TPSs and **\$333 million** for CHPPs. **Damages to hydroelectric power plants and pumped storage power plants (PSPPs) are currently estimated at \$1.1 billion.** At the same time, the cost of restoring the lost capacity of such power

plants may significantly exceed the damage assessment due to significant physical wear and tear and technological obsolescence of the damaged and destroyed equipment.

In early June, the Russian Federation blew up and completely **destroyed the Kakhovka dam, including the hydroelectric power plant. The damages caused by its destruction were estimated at \$586 million.** The cost of **building a new hydroelectric power plant of similar capacity will be about \$1 billion.**

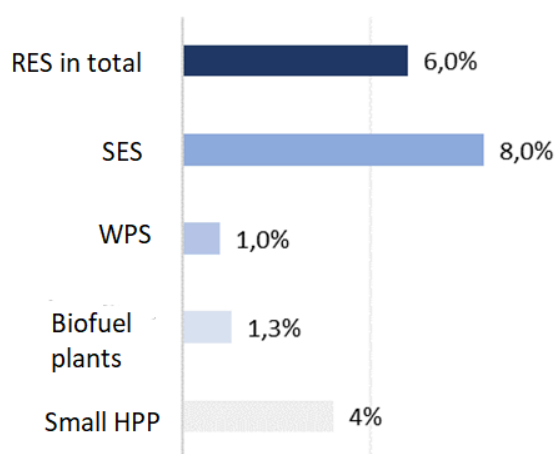
In addition, the largest nuclear power plant in Europe, Zaporizhzhia NPP (ZNPP capacity was more than 10% of the total capacity of the Ukrainian power system before the Russian full-scale invasion), remains occupied by the Russian military and is still under limited control of the SE NNEC Energoatom. The occupied nuclear power plant does not supply electricity and meets its internal needs from the Ukrainian power grid, as well as from diesel generators in emergency cases. The IAEA and the Ministry of Energy call the nuclear safety situation threatening.

In addition, the territories occupied by the Russian Federation after February 24, 2022, include Vuhlehirsk, Zaporizhzhia and Luhansk TPSs, and fierce fighting is taking place around Kurakhivska TPS Sloviansk TPP, which is situated close to the frontline, is being shelled by the Russian Federation regularly too.

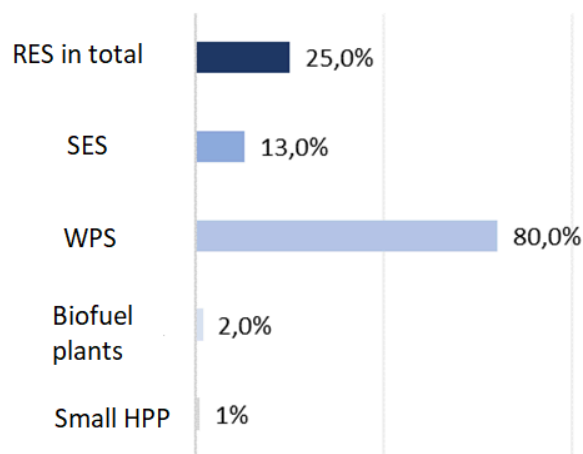
Renewable energy producers are also suffering significant losses. According to the Energy Charter Secretariat, 13% of solar generation capacity is located in the occupied territories, and 8% has been damaged or destroyed; about 80% of wind generation is occupied, and some of it has been damaged by shelling; 2% of bioenergy capacity is under occupation, and at least 4 biogas plants are known to have been destroyed.

The KSE team estimated the **damages of renewable electricity producers** (excluding large hydropower plants and pumped storage plants) to be \$220 million. This business also suffered significant financial losses. The occupied facilities have not been generating electricity for a year, generating no revenue. Such losses are multiplied by the impossibility of commissioning new unfinished facilities in which resources, including loans, have been invested. According to industry associations, by the end of 2022, only wind farms with a total installed capacity of about 800 MW should have been completed and commissioned.

Destroyed or damaged WPS facilities



Occupied WPS facilities



Source: Energy Charter International based on open data

The continuation of active hostilities in a large part of Ukraine, as well as targeted massive attacks by the Russian Federation, also led to damage and destruction of electricity transmission and distribution facilities. **According to preliminary estimates, the amount of damages caused by the full-scale war to the Transmission System Operator was estimated to be \$2 billion, and damages to the distribution system operators are estimated at over \$350 million.**

In the first months of the full-scale invasion, the Russian Federation targeted oil and oil product processing and storage facilities. Since February 24, 2022, 32 oil depots of various sizes and modernisation, as well as the fuel stored there, have been damaged or completely destroyed. According to estimates, the **damages caused to the fuel storage sector** are almost **\$266 million**. In addition, the aggressor repeatedly attacked the facilities of the only major oil refineries that were active — Shebelynka (Kharkiv region) and Kremenchuk (Poltava region) — almost totally destroying them. Corresponding damages are taken into account in the section "Assets of enterprises, industrial facilities".

Municipal services and utilities

The housing and utilities infrastructure (communal services and utilities), which is an important part of the life support systems of settlements, has become one of the targets of Russian missile and artillery strikes. Constant shelling and hostilities have made it impossible or significantly complicated to carry out repairs, resulting in prolonged shutdowns of heating and water supply systems. In some towns, residents still do not receive utility services and do not have adequate access to drinking water.

For example, due to the damage to the water supply system, most districts of Mykolaiv were left without a centralized water supply for a long time. The water supply system was restored only after the liberation of Kherson in November 2022, and until then, the city had only technical water, with drinking water delivered from other cities as bottled water through the retail network. In addition, the housing and utilities sector of the cities under heavy artillery shelling suffered significant damage. The heating and water supply sectors experienced constant interruptions in the cities due to forced power outages and a drop in voltage on equipment, which led to the need to install generators and accelerated the deterioration of assets.

According to preliminary estimates, as of January 2024, damages to heat supply facilities (excluding CHP plants), water supply and sewage, and municipal waste management facilities were \$4.5 billion.

During the full-scale invasion, **10 combined heat and power plants were completely destroyed** and another **15 damaged** in the areas where hostilities are taking place. For example, the destroyed Kremenchuk CHP plant (Poltava region) covered about 70% of the city's needs, i.e. about 180,000 residents, who could have been left without heat and hot water for the entire heating season if not for timely repairs. The value of direct losses caused by the destruction or damage to the CHPP is included in the Energy section.

In addition, according to preliminary data from regional military administrations, 863 boiler houses were partially damaged or completely destroyed as a result of the hostilities, most of them in Kharkiv, Kyiv, Chernihiv, Donetsk and Mykolaiv regions. 183 district heating stations were partially damaged or completely destroyed, and more than 355 kilometers of heating networks were completely destroyed.

According to preliminary estimates, more than 1,947 linear kilometers of water supply networks were destroyed, and 25 water treatment plants were partially damaged or completely destroyed. In addition, 182 water pumping stations were destroyed or damaged. Most of them are in Kharkiv, Luhansk and Donetsk regions. In addition, 159 wells have been destroyed or damaged, most of them in the Kharkiv region.

Laboratories that analyzed the state of water supply in the region were also destroyed or damaged. Thus, preliminary estimates indicate that about 3 such facilities were destroyed/damaged.

According to preliminary estimates, more than 582 linear kilometers of sewerage networks were damaged, and 183 sewage pumping stations were partially damaged or completely destroyed, most of which are located in the Kharkiv region. A total of 51 sewage treatment plants are also believed to be destroyed or damaged.

According to preliminary estimates, 33 landfills for household waste have been destroyed/damaged as a result of Russia's invasion of Ukraine. Three waste sorting lines were

also completely destroyed. The vehicles used for waste removal, more than 222 garbage trucks, were also destroyed. In addition, more than 23,000 household waste containers were destroyed.

FINANCIAL SECTOR

The full-scale war has had a major impact on the financial sector, especially on its main component — banks. They were affected both directly and through problems with the business of their clients (especially borrowers). **Damages** to the financial sector, including damage to real estate, amounted to **\$44 million**.

Initially, banks were forced to reduce the number of branches in areas where there was a threat to staff safety. At the beginning of March, only 21% of branches of systemically important banks were operating in or near the war zone, and 60% in Ukraine as a whole. However, due to the de-occupation of the northern regions, as of mid-June 2022, 85% of branches were already operating. After the de-occupation of certain territories in the East and South, banks began to reopen branches there as well.

In any case, due to the fall in demand for services, banks were forced to optimize their branch networks. According to the National Bank of Ukraine (NBU), which published its Financial [Stability](#) Report for June 2023, since the beginning of the invasion, banks have closed about 1,500 branches, or 20% of the total number (in regions where active hostilities are taking place, this share reaches two-thirds). In the autumn and winter, banks suffered from power outages, but over time, the institutions managed to establish autonomous operation of 45% of their branches.

Bank property came under fire. According to the NBU's surveys of banks, as of December 2023, the residual value of bank property that was lost, destroyed, or over which control was lost was **\$21 million** (compared to June, the estimate was reduced due to the liberation of the territories). Approximately half of this is real estate, and the other half is other property (ATMs, furniture, computers, etc.). Financial institutions do not have accurate information about the destruction or loss of the remaining property. It will only be possible to make a final assessment of the damage after the full-scale war is over or at least after the territories are liberated. No new destruction has been reported in the last year.

Russians have been robbing banks in the occupied territories. By the beginning of May 2022, the amount of banknotes lost due to robberies or seizures of branches was **UAH 470 million**. Banks destroyed another **UAH 60 million** of national currency banknotes and took them to the NBU for further exchange.

ANNEXES

Annex 1. Assessment of damages to residential buildings as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
Multi-apartment buildings	pcs	180 003	6 862	27,97
Individual buildings	pcs	9 163 897	68 693	5,07
Dormitories	pcs	7 114	135	0,33
Damaged				
Multi-apartment buildings	pcs	180 003	19 276	21,26
Individual buildings	pcs	9 163 897	118 480	3,01
Dormitories	pcs	7 114	390	0,27
Damaged and destroyed as a result of the accident at Kakhovka HPP				
Multi-apartment buildings	pcs	н.д.	1 001	0,03
Individual buildings	pcs	н.д.	35 426	1,00
Dormitories	pcs	н.д.	1	0,00
Total damages to infrastructure	x	x	x	58,94

Source: data of the State Statistics Service, data of the Ministry of Development of Communities and Territories of Ukraine, Order of MinRegion No. 53 dated 17.02.2022, data of regional military administrations, official exchange rates of the NBU, market data; calculations of MinRegion together with KSE

Annex 2. Assessment of damages to the healthcare sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
Hospitals	pcs	1 135	89	0.94
Polyclinics, dentistry, diagnostic centres	pcs	1 138	31	0.12
Outpatient clinics	pcs		82	0.06
Blood centres	pcs	28	3	0.01
Other (medical offices, laboratories, medical warehouses, dormitories, forensic bureaus)	pcs		94	0.12
Damaged				
Hospitals	pcs	1 135	337	1.43
Polyclinics, dentistry, diagnostic centres	pcs	1 138	117	0.19
Outpatient clinics	pcs		276	0.08
Blood centres	pcs	28	6	0.01
Other (medical offices, laboratories, medical warehouses, dormitories, forensic bureaus)	pcs		249	0.15
Total damages to infrastructure	pcs	x	1284	3.12

Source: Data on the number of damaged public healthcare facilities - MoH; Data on the number of damaged private healthcare facilities - public sources; Data on the cost of replacing one healthcare facility is calculated using several methods: (1) For facilities for which the number of square meters and/or beds is known, the data of the Ministry of Regional Development on the average cost of construction of 1 square meter of healthcare facilities is used; (2) For facilities for which the number of square meters and/or beds is unknown, the following is used

Annex 3. Assessment of damages to the social protection sector as a result of the full-scale war

Types of costs	Measurement unit	Number of damaged facilities	Damage assessment, \$ mln.
Damaged and destroyed			
Children's homes	pcs	6	3
Residential institutions	pcs	31	55
Geriatric facilities	pcs	14	9
Social centres	pcs	48	44
Homeless shelters	pcs	1	-
Health resorts	pcs	46	79
Children's camps	pcs	14	16
Institutions for people released from prison	pcs	0	-
Total damages to infrastructure	pcs	160	207

Source: number and cost of damaged facilities - Ministry of Reconstruction; amount of additional social protection expenditures required - Ministry of Social Policy; KSE calculations

* Number of damaged facilities and their estimated cost according to the Ministry of Reconstruction

Annex 4. Assessment of damages to education and science as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
Secondary education institutions	pcs	13 991	212	0.82
Institutions of pre-school education	pcs	13 875	116	0.25
Vocational education institutions	pcs	694	15	0.16
Higher education institutions	pcs	386	3	0.03
Institutions of professional higher education	pcs	248	11	0.05
Out-of-school education institutions	pcs	1 351	19	0.10
Specialised education institutions	pcs	310	0	0.00
Secondary education institutions	pcs	273	3	0.01
Institutions of pre-school education	pcs	н. д.	1	0.00
Damaged				
Secondary education institutions	pcs	13 991	1 676	2.61
Institutions of pre-school education	pcs	13 875	1169	1.00
Vocational education institutions	pcs	694	166	0.71
Higher education institutions	pcs	386	86	0.40
Institutions of professional higher education	pcs	248	133	0.25
Out-of-school education institutions	pcs	1 351	140	0.30
Specialised education institutions	pcs	310	20	0.04
Institutions of special education	pcs	273	36	0.06
Adult education institutions, including postgraduate education	pcs	н. д.	3	0.00
Total damages to infrastructure	x	x	3 809	6.79

Source: Ministry of Education and Science; Ministry of Reconstruction; National Academy of Sciences; KSE calculations

Annex 5. Assessment of damages to culture, sports and tourism as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
Religious institutions	pcs	N/A	34	0,1
Sports culture	pcs	16 199	59	0,4
Cultural sphere	pcs	34 340	291	0,3
Tourism sector	pcs	N/A	50	0,0
Damaged				
Religious institutions	pcs	N/A	336	0,1
Sports culture	pcs	16 199	284	0,3
Cultural sphere	pcs	34 340	2 860	1,9
Tourism sector	pcs	N/A	114	0,1
Total damages to infrastructure		x	4 028	3,1

Source: Ministry of Reconstruction data on the number and value of damaged facilities, State Statistics Service data on the initial number of facilities; other - KSE calculations

Annex 6. Largest affected industrial assets (according to available information on damaged assets)

No	Enterprise	Sector	Status	Damage assessment, \$ mln.
1	Illich Iron and Steel Works of Mariupol	Metallurgy	Damaged	2 385
2	Azovstal	Metallurgy	Destroyed	1 777
3	Motor Sich	Mechanical engineering	Damaged	450
4	Avdiivka Coke Plant	Coke and chemicals	Destroyed	414
5	Ukratnafta	Oil refining	Destroyed	405
6	Zorya - Mashproekt	Mechanical engineering	Destroyed	264
7	Ukrainian power machines	Mechanical engineering	Damaged	181
8	Philip Morris Ukraine	Cigarette production	Destroyed	154
9	Antonov	Aircraft construction	Damaged	151
10	LYNIK	Oil refining	Destroyed	126
11	Organic Systems	Food industry	Destroyed	121
12	Novokramatorsk Machine-Building Plant	Mechanical engineering	Damaged	113
13	Rubizhne Cardboard and Packaging Plant	Paper production	Destroyed	98
14	Mykolaiv Alumina Plant	Metallurgy	Damaged	97
15	Dnipropetsstal	Metallurgy	Damaged	87
16	Sandora	Food industry	Damaged	82
17	Odesa Oil Refinery	Oil refining	Damaged	77
18	Odesa Port Plant	Chemical industry	Damaged	77
19	Energomashspetsstal	Mechanical engineering	Damaged	76
20	Coca-Cola Beverages Ukraine	Food industry	Damaged	75
21	Severodonetsk Azot Association	Chemical industry	Damaged	70

No	Enterprise	Sector	Status	Damage assessment, \$ mln.
22	Zaporizhzhya Iron Ore Plant	Mining and quarrying	Лише запаси	65
23	Kakhovsky plant of electric welding equipment	Mechanical engineering	Destroyed	57
24	Farmak (products warehouse)	Pharmaceuticals	Лише запаси	54
25	Road construction "Altkom"	Construction	Damaged	52
26	Kub-Gas	Gas production	Destroyed	50
27	Mondelís Ukraine	Food industry	Damaged	48
28	Optimusagro Trade	Food industry	Damaged	44
29	Kharkiv Tractor Plant	Mechanical engineering	Destroyed	42
30	Vetropak Gostomel glass factory	Production of non-metallic materials	Damaged	42
31	Zeus Ceramics	Production of non-metallic materials	Destroyed	42

Source: KSE calculations, reports of destruction of individual facilities, open data

Annex 7. Assessment of damages to the industrial sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Large and medium-sized private enterprises	pcs	5 270	92	7,0
Small private enterprises and individual entrepreneurs	pcs	N/A	N/A	4,3
State-owned enterprises	pcs	1 665	348	1,7
Total damages to assets	x	x	x	13,1

Sources: reports on the destruction of individual facilities, municipalities (level of destruction in cities), State Statistics Service; KSE calculations

Annex 8. Assessment of damages to retail as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
Retail facilities	pcs	40 277	н.д.	1,5
Shopping centres	pcs	329	9	0,3
Damaged				
Retail facilities	pcs	40 277	н.д.	0,7
Shopping centres	pcs	329	22	0,2
Total damages to assets	x	x	x	2,57

Source: State Statistics Service, Ukrainian Council of Shopping Centers, Association of Retailers of Ukraine

Annex 9. Assessment of damages to agriculture and land resources as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
Agricultural machinery	pcs	764 323	130 603	5,43
Grain storage facilities	capacity, th.t.	75 084	11 351	1,7
Dead animals (including poultry and fisheries)	th.heads	203 292	1 899	0,1
Destroyed apiaries	bee colonies	2 272 740	86 902	0,0
Perennial crops	ha	197 100	16 364	0,4
Destroyed and stolen inputs	t.	962 951	135 993	0,1
Destroyed and stolen finished agricultural products	t.	254 86 613	4 037 542	1,9
Aquaculture and fishing facilities	од.	2102	228	0,03
Damaged				
Slaughter of animals due to the impossibility of keeping them	th.heads	203 292	11 963	0,1
Dead and missing bees	bee colonies	2 272 740	192 526	0,0
Agricultural machinery	pcs	764 323	50 521	0,4
Grain storage facilities	capacity, th.t.	75 084	3 341	0,1
Total damages to infrastructure	x	x	x	10,3

Source: calculations of the KSE Agrocentre (Centre for Food and Land Use Study)

Annex 10. Assessment of damages to the transport sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed/damaged				
trolleybuses	pcs	2 980	344	0,03
trams	pcs	1 922	152	0,2
buses	pcs	241 426	13 812	0,6
passenger cars*	mln.pcs	10,10	211 680	1,9
fire trucks	pcs	4 216	1 629	0,09
Mriya aircraft	pcs	1	1	0,3
Total damages to infrastructure**	<i>pcs</i>	x	227 618	3,13

Sources:

Number of cars registered in Ukraine https://dostup.pravda.com.ua/request/statistika_kilkosti_zarieiestrov;

Data on losses of municipal transport - for four regions (Kharkiv, Donetsk, Luhansk, Dnipro) – information from military civilian administrations; for other regions - KSE assumptions

data on trolleybus and tram fleet:

http://www.ukrstat.gov.ua/druk/publicat/kat_u/2021/zb/10/zb_Transpot.pdf

data on the bus fleet: https://dostup.pravda.com.ua/request/statistika_kilkosti_zarieiestrov

Data on the cost of restoring the Mriya aircraft - Ukroboronprom

*only officially registered private cars are taken into account, excluding cars imported without customs clearance into the territory of Ukraine

**at the current stage, the following are not taken into account: (1) loss of trucks; (2) loss of other vehicles, including those owned by the authorities; (3) loss of aircraft (except for the Mriya aircraft, the loss of which is publicly available)

The assumption for the calculation is that the average replacement cost of one unit of public transport is 1/3 of the replacement cost (the cost of purchasing similar objects at ProZorro tenders in 2021, at the exchange rate at the end of 2021). For buses: we take the average between the cost of a bus and a minibus, since the exact structure of the bus fleet is not known (the distribution between large buses and mini-buses).

Annex 11. Assessment of damage to infrastructure as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
Airports	pcs	34	9	1,5
Property of postal operators	x	x	x	0,002
Damaged				
Roads of national importance	thousand km	47	8 855	9,4
Roads of local importance	thousand km	120	8 625	9,2
Municipal roads (cities and other settlements)	thousand km	270	7 883	8,4
Bridges and bridge crossings	pcs	11 076	344	2,6
Assets of UZ	other	N/A	-	4,3
Infrastructure of seaports and inland waterway transport (ports; berths; warehouses; terminals; movable property)	other	N/A	-	0,85
Airports	pcs	34	9	0,3
Air bases	pcs	1	1	0,04
Ukraerorukh	pcs	N/A	1	0,2
Property of postal operators	x	x	x	0,01
Total damages to infrastructure	x	x	x	36,8

Source: Roads - KSE calculations; Railways - UZ data and calculations, KSE calculations; Aviation - official statistics, public data, KSE calculations; Seaports and inland waterway transport infrastructure - MIU data; Postal operators - Nova Poshta, Ukrposhta; KSE calculations.

Annex 12. Assessment of damages to digital infrastructure as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Damaged				
Fixed line operators	pcs	4 162	726	0,3
Mobile operators	x	x	x	0,2
Total damages to sector	x	x	x	0,5

Source: Ministry of Digital Transformation, NCCIR, telecom operators

Annex 13. Assessment of damages to banks as a result of the full-scale war

Types of costs	Damage assessment, \$ bln.
Destroyed/damaged*	
Property of banks	0,025
Cash in bank branches	0,018
Total damages to assets	0,044

Source: National Bank of Ukraine

* at the current stage, the section includes only data on bank losses; excludes direct damages and indirect losses of other financial institutions

Annex 14. Assessment of damages to the housing and utilities sector as a result of the full-scale war

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Destroyed				
CHPP and TPS	pcs	87	10	(see energy)
Boiler houses	pcs	19 025	263	0,128
Heating networks	linear m.	18 987 083	354,99	0,774
Central heating stations	pcs	5 523	139	0,017
Water treatment plants	pcs	400	7	0,175
Sewage treatment plants	pcs	967	23	0,690
Water pumping stations	pcs	5 646	109	0,191
Sewage pumping stations	pcs	2 908	63	0,189
Water supply networks	linear m.	98 076 470	1 947 026	0,535
Sewerage networks	linear m.	37 053 200	582 863	0,748
Wells	pcs	22 134	125	0,014
Laboratories	pcs	N/A	4	0,001
Clean water tanks	pcs	2 129	33	0,033
Water towers	pcs	6 947	101	0,02
Containers for household waste collection	pcs	N/A	23 145	0,014
Garbage trucks	pcs	3 669	222	0,045
Landfills for household waste disposal	pcs	5 969	12	0,036
Waste sorting lines	pcs	34	3	0,005
Container sites	pcs	N/A	813	0,001
Biogas plants	pcs	21	3	0,005
Damaged				
CHPP and TPS	pcs	87	15	(see energy)
Boiler houses	pcs	19 025	573	0,012
Heating networks	linear m.	18 987 083	0	0,000
Central heating stations	pcs	5 523	144	0,024
Water treatment plants	pcs	400	18	0,180
Sewage treatment plants	pcs	967	28	0,336
Water pumping stations	pcs	5 646	73	0,051
Sewage pumping stations	pcs	2 908	120	0,144
Water supply networks	linear m.	98 076 470	-	0,000
Sewerage networks	linear m.	37 053 200	-	0,000
Wells	pcs	22 134	34	0,002
Laboratories	pcs	N/A	2	0,000
Clean water tanks	pcs	2 129	4	0,002
Water towers	pcs	6 947	38	0,003
Containers for household waste collection	pcs	N/A		0,000
Garbage trucks	pcs	3 669		0,000
Landfills for household waste disposal	pcs	5 969	21	0,025
Waste sorting lines	pcs	34	2	0,001

Types of costs	Measurement unit	Initial number of facilities	Number of damaged facilities	Damage assessment, \$ bln.
Container sites	pcs	н.д.	97	0,000
Biogas plants	pcs	21	0	0,000
Damaged as a result of an accident at Kakhovka HPP				0,050
Total damages to infrastructure				4,5

Source: State Statistics Service, Ministry of Reconstruction, regional military administrations, official NBU exchange rates, market data, expert assumptions, etc.

Annex 15. Assessment of damages to the energy sector as a result of the full-scale war

Sub-sector	Damage assessment, \$ bln.
Electricity generation, including:	7,41
Electricity generation, including:	5,06
TPS	2,59
CHPP	0,32
NPP	0,84
RES	1,31
Electricity transmission	2,00
Electricity distribution	0,35
Oil and gas sector, including:	1,20
Gas transmission	0,78
Gas distribution	0,15
Storage of oil and oil products	0,27
Coal mining industry	0,41
Total damages to infrastructure	9,0

Source: data from the Ministry of Energy of Ukraine, data from regional military administrations, Energy Charter Secretariat, official NBU exchange rates, market data, expert assumptions, etc.