UNITED NATIONS
HUMAN RIGHTS
OFFICE OF THE HIGH COMMISSIONER

Ukraine

Attacks on Ukraine's Energy Infrastructure: Harm to the Civilian Population

UN Human Rights Monitoring Mission in Ukraine

Bulletin

September 2024

EXECUTIVE SUMMARY

1. Between 22 March and 31 August 2024, the Russian Federation armed forces launched nine waves of long-range and large-scale coordinated attacks on Ukraine's electric power system, damaging or destroying numerous power generation, transmission, and distribution facilities. The strikes had reverberating effects causing harm to the civilian population and the country's electricity supply, water distribution, sewage and sanitation systems, heating and hot water, public health, education, and the economy.

2. This harm will take years to fully repair and restore, requiring significant resources from public and private sectors in an economy already burdened by the armed conflict. The attacks have caused additional population displacement and have disproportionately impacted groups in a situation of vulnerability, such as older persons, those with disabilities, households with lower incomes, and the internally displaced, with women particularly affected. Any additional attacks will further compound this harm.

3. The upcoming winter period, when electricity consumption increases due to below-freezing temperatures, will exacerbate the foreseeable consequences of these strikes. While Ukrainian authorities, energy companies, and humanitarian and recovery agencies are engaged in immense mitigation efforts to avert a humanitarian crisis, Ukraine will face a significant electricity deficit in the winter, with daily power cuts during the cold months leaving civilians without the electricity they need to power homes, run water pumps and allow children to study online. Some areas may lose heating.

4. Quantitative data on the pervasive and interconnected civilian harm resulting from the attacks is still limited and only reflects what has been measured in the short term. Long-term effects, including attributable excess morbidity, will be measured well into the future and will likely exceed the harm already experienced.

5. Nonetheless, considering the number of regions affected, the coordinated nature of the attacks, the high precision of the weapons involved, and the sheer scale of harm inflicted on civilians and interconnected civilian systems supplying the population with services essential to their health and survival, the United Nations Human Rights Monitoring Mission in Ukraine (HRMMU) has assessed that these attacks have been of a widespread and systematic nature. Furthermore, there are reasonable grounds to believe that multiple aspects of the military campaign to damage or destroy Ukraine's civilian electricity and heat-producing and transmission infrastructure have violated foundational principles of international humanitarian law.

METHODOLOGY

- To prepare this bulletin, HRMMU conducted site visits to seven power plants and substations[1] damaged or destroyed during the 2024 attacks and 28 communities directly affected by the strikes. The team held 44 meetings with authorities, 13 with the private sector and state-owned[2] energy companies, and conducted 65 interviews with think tanks, technical specialists, academic experts, NGOs, educational and medical workers, and residents. HRMMU further conducted a detailed review of cross-sectoral technical assessments, including those conducted by agencies engaged in humanitarian response and recovery activities.[3]

- This bulletin focuses on attacks specifically directed at debilitating Ukraine's country-wide electricity production and transmission capacity. As such, it does not cover attacks on other energy-related facilities, such as oil and gas production or storage, or the continuous damage to electricity equipment resulting from ongoing shelling and other attacks in frontline areas, whether they occurred in territory controlled by Ukraine or the Russian Federation.[4]

- To avoid inadvertently disclosing sensitive information, HRMMU has not included names of specific infrastructure facilities, details of the strikes, or locations in this report.

BACKGROUND

- Prior to the onset of the full scale armed attack of the Russian Federation on 24 February 2022, Ukraine produced 44.1 gigawatts of available electricity, through its nuclear, thermal, and hydroelectric power plants and renewable sources.[5] Pre-war electricity consumption needs required approximately 26 gigawatts of electricity during winter.[6] Ukraine exported the surplus.

- The occupation of Ukrainian territory by the Russian Federation reduced the electricity generating capacity of Ukraine by approximately 18 gigawatts. The Zaporizhzhia Nuclear Power Plant, occupied in March 2022, previously met around 20 per cent of the electricity needs of Ukraine. Large thermal and hydroelectric power plants in eastern Ukraine further supported the overall electricity production of Ukraine.[7]

- Ongoing frontline hostilities since 2022 consistently damaged electricity distribution lines and substations, regularly leaving hundreds of thousands of consumers per day without power in nearby communities.[8] Technicians face serious security risks when attempting to repair damages near the frontline.

- In October 2022, Russian armed forces started deliberately targeting electricity infrastructure facilities. From October 2022 through February 2023, Russian armed forces launched at least 13 waves of attacks with long-range cruise and ballistic missiles and loitering munitions on the electricity infrastructure across 19 of 24 regions of Ukraine and Kyiv.[9] The attacks primarily targeted power substations responsible for electricity transmission across the country, and some power generating facilities. The strikes caused power, heating, and water supply outages putting millions of civilians at risk during the winter, disrupting education for millions of children, creating new flows of displacement, and killing at least 116 civilians and injuring at least 379.[10]

  Between 10 October and 31 December 2022, the average Ukrainian household spent a cumulative total of five weeks without electricity.[11]

- By April 2023 the Ukrainian power system had lost nearly half of its available production capacity from occupation and destruction. In addition, 42 out of 95 high-voltage transformers were damaged, disrupting distribution to the civilian population.[12]

- The UN Independent International Commission of Inquiry on Ukraine concluded that the attacks on electricity infrastructure in 2022-2023 were widespread, systematic, and disproportionate, constituting the war crime of excessive incidental civilian harm and potentially a crime against humanity.[13]

- On 24 June 2024, the International Criminal Court (ICC) issued arrest warrants[14] against high-ranking Russian officials,[15] on charges of war crimes[16] and crimes against humanity[17] in relation to the 2022-2023 campaign of strikes against electric power plants and sub-stations. The Pre-Trial Chamber noted that "the Chamber will always consider the effect of said actions on the safety and security of civilians, including the most vulnerable, such as [older persons], women and children." The Chamber further noted that "conduct similar to that addressed in the warrants of arrest, which amounts to violations of international humanitarian law, appears to be ongoing".[18]

- By the winter of 2023-2024, Ukraine could only generate around 17.8 gigawatts per hour of electricity. That winter, peak consumption reached 18.5 gigawatts per hour.[19] The deficit was managed through electricity imports, reversing the country's previous status as a net electricity exporter.[20] Between February 2023 and early 2024, attacks continued to occasionally damage electricity infrastructure.

CAMPAIGN OF ATTACKS BEGINNING IN MARCH 2024

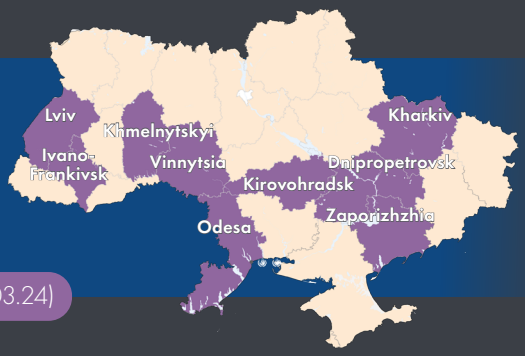
- On 22 March 2024, the Russian Federation resumed a large-scale, coordinated campaign of attacks on Ukraine's electricity infrastructure.[21] Between approximately 4:30 and 6:30 a.m. on 22 March, the Russian Federation launched 88 cruise, ballistic, and repurposed surface-to-air missiles, and 63 loitering munitions and drones[22] at targets including electricity infrastructure across the country. The munitions were launched from the air, the ground, and the sea. Electricity infrastructure was damaged or destroyed in at least Odesa, Ivano-Frankivsk, Lviv, Vinnytsia, Dnipropetrovsk, Khmelnytskyi, Kirovohrad, Kharkiv, and Zaporizhzhia regions. Immediate power outages affected around 1.5 million people across the country and disrupted heating and water supply in some cities and towns.[23]

- Although the Russian Federation did not directly strike nuclear power plants in Ukrainian government-controlled territory, fluctuations in the national power grid caused by the attacks, as well as attacks on important transformer substations, led in some cases to the temporary shutdown or disconnection of nuclear reactor units, raising concerns about risks to the stable operation of nuclear facilities in Ukraine.[27] On 29 August 2024, the director of the International Atomic Energy Agency (IAEA) stated he was "increasingly concerned about the growing vulnerability of Ukraine's energy infrastructure, and the potential impact this is having on the safety of all Ukraine's operating nuclear power plants".[28]

On 22 March, the Russian Federation launched

88 cruise, ballistic, and repurposed surface-to-air missiles

63 loitering munitions and drones



Regions where electricity infrastructure was damaged or destroyed (22.03.24)

- From March through August 2024, the Russian Federation launched nine waves of such large-scale, complex and coordinated strikes,[24] striking critical power generation plants, substations, and electricity transmission systems across Ukraine, causing severe damage and destruction. On 26 August, the Russian Federation launched one of its largest aerial attacks since the onset of the full-scale invasion, with more than 100 missiles and 100 drones across numerous regions in Ukraine, primarily targeting energy and other infrastructure. Power cuts were implemented nationwide to stabilize the grid, lasting into September.

- Since March 2024, the attacks have struck facilities in 20 of the 24 regions under Ukrainian control, including Kyiv.[25] HRMMU recorded 36 strikes on power generation facilities, including 25 on thermal power plants (TPPs) and combined heating power plants (CHPPs)[26] in nine regions, seven on hydroelectric plants (HEPPs) in five regions, two on renewable energy facilities in one region, and two on heating plants in two regions. HRMMU also recorded at least 101 strikes on power distribution and transmission facilities in 17 regions. Many energy facilities were struck repeatedly, some until the point of total destruction.

- Statements from both Russian and Ukrainian authorities, information from private and government energy companies, open-source videos and photos assessed as credible and reliable, and HRMMU observations during site visits indicate that each wave involved numerous high-precision, high-yield cruise and ballistic missiles, loitering munitions, and reconnaissance drones and targeted multiple electricity facilities across the country in a well-coordinated and synchronized manner. The munitions were launched simultaneously from multiple locations utilizing land, aerial, and sea-based delivery platforms, requiring high-level planning and coordination of several branches of the Russian armed forces.

- While the attacks in 2022-2023 mainly targeted electricity transmission facilities, the 2024 attacks to a much larger extent targeted electricity generation facilities. According to a major energy company, the 2024 attacks damaged three times more of its TPP power units than in the winter of 2022-2023.[29] Attacks on hydroelectric power plants and dams also nearly tripled in 2024, according to the Office of the Prosecutor General of Ukraine.

Since March 2024, HRMMU recorded:

- **36** strikes on power generation facilities (including 25 on thermal power plants, 7 on hydroelectric plants, 2 on renewable energy facilities, and 2 on heating plants);
- at least **101** strikes on power distribution and transmission facilities.

Damage to electricity infrastructure facilities

- The attacks seriously damaged or destroyed key electricity production plants and transmission facilities. By June 2024, 73 per cent of the power-generating units of TPPs in Ukraine were rendered inoperative due to severe damage.[30] Twenty hydroelectric generation units were also rendered inoperative.

- HRMMU conducted site visits to seven damaged power plants and substations. At one major thermal power plant, HRMMU witnessed extensive damage caused by the multiple missile strikes that caused the plant's protective roofing to collapse and destroy power-generating equipment beneath it. At another, HRMMU documented how the turbine workshop, transformer stations, and all power units had been damaged during recent attacks.

- In several cases, HRMMU documented how Russian armed forces attacked the same facility multiple times. For example, a major thermal power plant had been seriously damaged in winter 2022-2023. Its operations were partially restored a year later, after lengthy repairs. However, multiple missiles struck the plant in one of the 2024 attacks. Workers were again able to partially restore production. Only weeks later, multiple missiles struck the facility again, halting electricity production completely.

An energy facility damaged by an attack.

Civilian casualties resulting from strikes

- Attacks on electricity infrastructure facilities killed at least 18 (15 men, two woman and one girl) and injured at least 84 civilians (43 men, 32 women, six girls and three boys) in the immediate vicinity of the strikes. Two of the killed and seven of the injured, all men, were civilian workers of the facilities themselves.

Attacks on electricity infrastructure facilities resulted in:

at least **18** civilians killed

at least **84** civilians injured

Immediate electricity, water, heating and hot water outages

- The strikes on energy infrastructure caused immediate power outages in nearby areas. In some areas these outages lasted multiple days. Beginning on 22 March, power outages in major cities such as Kharkiv and Odesa disrupted the water supply, central heating, public transportation and telecommunications for two to three days. The air raid alarm system lost power in Kharkiv, requiring emergency personnel to alert residents about incoming threats by physically circulating in the city.

Country-wide electricity deficit

Some parts of the country, including Kyiv, faced blackouts lasting **12** hours or more daily.

- The cumulative effect of the repeated attacks on Ukraine's electricity grid was an increasing electricity deficit. By July, electricity providers estimated that Ukraine had lost approximately nine gigawatts of production capacity due to the 2024 strikes alone,[31] equivalent to roughly half of the country's peak electricity consumption during the winter of 2023-2024.[32]

- By May 2024, the electricity deficit forced Ukrainian authorities to institute rolling power cuts across the country.[33] The destruction of thermal and hydroelectric power plants, which can increase or decrease output depending on consumption, meant the electricity grid could not meet electricity demand during peak consumption hours.

- Some parts of the country, including Kyiv, faced blackouts lasting 12 hours or more daily.[34] In late June, authorities announced they would prioritize electricity supply to frontline communities as a humanitarian measure.[35]

REVERBERATING & LONG-TERM HARM TO CIVILIANS & CIVILIAN OBJECTS

- The reverberating effects of the attacks on electricity infrastructure have caused serious and long-term harm to the civilian population and civilian objects. They have also affected the enjoyment of social and economic rights, such as adequate housing, health, and education, with differential effects on women, older persons, and persons in a situation of vulnerability, including households with lower incomes.

- The widespread harm was eminently foreseeable. Ukraine is a heavily industrialized and urbanized country with a post-Soviet legacy of centralized electricity and heating systems and significant housing stock in high-rise apartment buildings.[36] The attacks on power plants dramatically decreased electricity production nationwide with direct structural consequences on centralized systems for heating, water and sewage.

- From the onset of the electricity shortage, living conditions in Ukraine deteriorated, as cooking, cleaning, and food storage dependent on electricity became more difficult. Since women in Ukraine spend substantially more time per week on unpaid domestic work, they have been disproportionately affected, with half of women reporting that electricity cuts have had a major impact on food preparation and storage.[37] Individuals with low mobility, older persons, and families with small children struggled to safely leave or reach apartments in high-rise buildings with elevator service cuts. Widespread traffic light outages created road hazards for drivers and pedestrians, while commuters faced challenges reaching their employment due to public transport disruptions. Telecommunications became unstable or inaccessible as mobile data networks were overloaded each time electricity outages cut Wi-Fi connections.

- The civilian population is likely to feel the effects of these attacks for months, if not years. The necessary repairs require technically complex equipment that must be custom-ordered, produced, and delivered.[38] Energy company executives have warned that some of the destroyed equipment can take 12 months or more to manufacture and install.[39]

- The effects will worsen significantly during the upcoming winter. The Ukrainian winter season lasts from mid-October to mid-April, with every region experiencing days below negative 10°C, sometimes dropping below negative 20°C.[40] The cold weather and shorter daylight hours mean that demand for electricity increases by 20-25 per cent during the winter.

- While Ukraine is undertaking significant and costly mitigation measures, they are not sufficient to substitute lost generation capacity this year.

- Ukrainian electricity transmission company announced in June that the population should expect a difficult winter with electricity shortages of more than 30 per cent due to a deficit of three to six gigawatts during peak hours.[41] Ukrainian authorities predicted that the deficit would cause a few hours of daily power outages during the winter.[42] Other experts told HRMMU this deficit equates to expected winter power outages of between 4 and 18 hours per day.

- The extent to which the civilian population will suffer the effects of these attacks during the upcoming winter depends on several factors. While the energy companies are working to repair as much of the damaged equipment as possible, it is not clear exactly how much electricity generation capacity can be restored in time for winter. The extent of the power outages will also significantly depend on how cold the winter will be.[43] Finally, the impact on civilians will depend on whether the Russian armed forces launch new attacks against energy infrastructure facilities. Technical experts interviewed by HRMMU said that the most serious impact on civilians could be moderated if the power outages were limited to a few hours on a scheduled basis. If new attacks lead to prolonged emergency blackouts, the impact will likely be severe.

- The following sections provide a framework for understanding the cumulative harm to the civilian population as the impact of the attacks radiates through a complex chain of interconnected and interdependent systems. A technical assessment of damage has been published by UNDP.[44]

IMPACT ON CIVILIAN INFRASTRUCTURE CRITICAL TO THE CIVILIAN POPULATION

Water distribution systems

- Water utilities require electricity to distribute water to homes, businesses, and industry. As most municipal water utilities lack backup energy sources to ensure consistent supply in the case of prolonged power outages,[45] they will prioritize water supply to firefighters, food manufacturers, and district heating, and provide scheduled water supply with lower pressure to consumers.[46]

- Residents of high-rise buildings without independent generators lose all access to water and sanitation when electricity is cut, as electricity is required for water pumps to distribute water to higher floors. In below-freezing temperatures, the above-ground pipes in these buildings can freeze without water flow, causing severe structural damage. Without safe water supply, people's housing is rendered inadequate.

- It becomes more difficult to provide alternative access to water when multiple pieces of critical infrastructure are destroyed over time. In Mykolaiv, drinking water infrastructure was destroyed in attacks in 2022, requiring residents to retrieve clean water from pump rooms or temporary drinking water distribution points. With electricity cuts, the pump rooms only work intermittently, limiting water access and requiring residents to queue for water. After the breach of Kahkovka Dam in 2023, residents from a nearby town have relied on an alternative water reservoir with declining supply and deteriorating water quality. As a mitigation measure, town administrators installed water pumping stations; however, following the 2024 attacks, the electricity required for them to function is not always available meaning the water supply was disrupted. Many communities were impacted in a similar way following the Kahkovka Dam breach.

Mykolaiv resident collects water at drinking water distribution points.

Heating systems

- Ukrainian homes are heated through various means, including centralized district heating, electric heating, boilers, and solid fuel. Centralized district heating provides heat and hot water to the vast majority of urban households. For example, nearly 95 per cent of Kyiv's three million residents rely on centralized district heating, which is delivered to consumers in high-rise buildings using electric pumps.[47] Without emergency electricity supply, millions of urban residents could be left without heat.[48]

- A significant portion of the heat for centralized district heating comes from thermal power plants and combined heat and power plants, which also send excess heat from the electricity production to heat nearby households. Several of these plants have been seriously damaged or destroyed, particularly during the 2024 attacks. Since 2022, 18 large combined heat and power plants (CHPPs) have been damaged or destroyed.[49] Both major CHPPs in one city were destroyed in the 2024 attacks.[50] Further, sudden shutdowns of heating network pumps resulting from the power outages cause long-term systemic damage to heating systems, with repercussions for years to come.

- Damage to power generating facilities discontinues heating and hot water supply for communities solely dependent on excess heat from neighboring power plants. For example, the nearly 20,000 residents of a town in the central region are fully dependent on hot water and heating supply from a nearby TPP. Although administrators hope repairs will restore electricity production before winter, interlocutors in multiple regions stressed to HRMMU that if attacked again, there is no alternative heating source. Without an adequate heating supply, people's housing may become uninhabitable.

- The more than 10,000 residents of a town in an eastern region lost heat and hot water after nearly all electricity-producing units of the nearby TPP were damaged. Although local administrators were seeking support from international organizations to install alternative heating devices, they warned that if the situation could not be resolved before the upcoming winter, the civilian population would have to be evacuated. HRMMU documented that other towns reliant on TPPs and CHPPs face similar challenges.

- A cold spot assessment highlighted Kharkiv and Sumy regions as most at-risk for heating loss, due to a combination of severe winter conditions, high population density, socio-economic vulnerabilities including the substantial presence of IDPs and older persons, and significant damage to electricity infrastructure.[51] Donetsk and Kherson regions also face heightened challenges due to cumulative damage to electricity infrastructure coupled with increased conflict incidents, severely limiting their capacity to cope with winter conditions.[52]

- Authorities and humanitarian agencies are currently undertaking mass mitigation efforts to repair damaged infrastructure and ensure alternative, decentralized heating.[53] In rural and frontline areas, some households will rely on autonomous gas heating or solid fuel, with firewood, winter clothing, blankets, and other supplies distributed by humanitarian support agencies.[54]

Sewage and sanitation management systems

- The operation of the sewage, sanitation and water treatment system depends on electricity. Most of Ukraine's sewage management systems are not prepared for prolonged blackouts lasting more than three days.[55] If sewage treatment is disrupted, waste must be pushed away from treatment plants to avoid backup, flooding and major equipment damage. This can lead to sewage backup in streets, or the release of raw sewage into open water such as the Dnipro River.[56] Technical specialists and some local administrators have warned HRMMU of the potential breakdown of local sanitation systems and associated health risks (detailed below).

- The disruption to electricity and interconnected infrastructure systems affects public health in numerous foreseeable ways, including the effective functioning of hospitals and clinics, and negative health consequences due to lack of heat, water, and telecommunications.

- Hospitals and healthcare clinics rely on electricity for life-saving medical equipment and procedures and cold storage of medication. Although healthcare facilities throughout Ukraine are required to have access to reliable backup generators, running on generator power is not sustainable for prolonged periods or for all equipment. The head of the health department in a southern region told HRMMU that some medical facilities are forced to use 700 liters of fuel per day to power generators. After an attack on a thermal power plant in Dnipro, for example, electricity supply was interrupted for three days. The personnel and patients in a district hospital had to be transferred to other medical facilities. Simple operations such as the movement of patients between floors also become complicated as generators do not generally power elevators. Health services in smaller clinics have been reduced or rescheduled due to lack of sufficient backup energy supply.

- Persons with disabilities or those with medical conditions that require electrical assistive devices at home for life support, such as nebulizers, oxygen machines, or insulin pumps, face increased health and safety risks during blackouts. Electricity cuts also degrade medications that require refrigeration, such as insulin.

- Heating is essential to the population's health and survival and the impact of the attacks on the interconnected systems needed for the existing heating infrastructure in Ukraine creates serious health risks. Severe cold weather exposure increases mortality and injury risk through hypothermia or frostbite, or by exacerbating chronic conditions like heart disease, strokes, and respiratory illnesses.[57] Those risks are particularly high amongst older persons or those with an already fragile health condition. Some mitigation measures for rural or stand-alone homes, such as burning charcoal or wood, and using generators fueled by diesel, or electric heaters when power is available, bring additional health and safety risks, including exposure to toxic substances harmful to children and others in situations of vulnerability, fires and burn risks.[58]

- Drinking water treatment also requires electricity. Prolonged power outages increase the possibility of untreated water spreading infectious diseases. Protracted disruption to electricity supplies can negatively impact the ability of water and wastewater service providers to meet health and safety standards. Considering that an estimated 70 per cent of the population relies on surface water, estimates suggest that the recent attacks on energy infrastructure put over 10 per cent of the population (3.7 million people) at risk of consuming contaminated drinking water.[59] Risks increase for infants and young children, older persons, immune-compromised individuals, and those with important comorbidities.

- Electricity cuts affect mental health in some individuals by increasing psychological distress, including panic, anxiety, fear, and a sense of isolation. These effects are heightened for those with existing mental health conditions like depression, those with disabilities, and displaced individuals.

- Energy infrastructure workers have also told HRMMU that their mental health has deteriorated because of the attacks. Some specialist technicians must remain on duty at their stations or behind nearby sandbags, even during an attack. One engineer told HRMMU: "We are tired and stressed. No one knows if we will return home alive today after work."

> *We are tired and stressed. No one knows if we will return home alive today after work.*
>
> One of energy infrastructure workers who must remain on duty at their stations or behind nearby sandbags, even during an attack.

IMPACT ON POPULATION MOVEMENT & DISPLACEMENT

- The deteriorating energy situation is also driving internal and cross-border population movement, as it did in the winter of 2022-2023. In August 2024, the National Bank of Ukraine revised their forecast regarding population movements, citing significant destruction of the Ukrainian energy system, which resulted in prolonged power outages and increased risks for the heating season. They projected that an additional 500,000 people will be displaced from Ukraine in 2024 and 2025.[60]

- Border monitoring carried out by UNHCR and its partners indicated a slight rise in departures from Ukraine due to lack of access to electricity, water, and heating beginning in April 2024.[61] That rise then starkly increased by June 2024 to 25 per cent of respondents, as country-wide energy blackouts became more frequent. In July, nearly half (49 per cent) of those individuals interviewed at the border departing Ukraine reported they were leaving due to the energy situation affecting their access to electricity, water and heating. During the summer period, energy-related reasons were the second most important factor contributing to departures, in addition to broader concerns related to the volatile security situation. Most of those departing for energy-related reasons are intending to stay abroad temporarily, but for unknown periods.[62]

IMPACT ON EDUCATION

- Electricity is needed to power schools and to provide internet access for the 1.7 million children in Ukraine who attend school online full or part-time due to safety risks from the conflict.[63] In July 2024, UNICEF estimated that between 78 and 311 million hours of study were lost per month due to power outages.[64] The cumulative effects of hostilities and lack of electricity are adversely affecting children's ability to receive quality education, and will continue into the 2024-2025 school year.

- School administrators told HRMMU that only schools with emergency shelters have generators. One administrator explained that although access to a generator would help teachers better organize their work, students without Internet access due to electricity cuts would still be unable to join the lessons.

In July 2024, UNICEF estimated that between 78 and 311 million hours of study were lost per month due to power outages.

- A school director in Kharkiv told HRMMU that their 270 students all study online, as their school was damaged by an attack and does not have a shelter. When power cuts began in the spring, fewer students could follow live online classes. Teachers either held extra sessions to reach children on other power cut schedules, or children were left to watch video-recorded classes.

- Teachers consistently lauded the resilience of their colleagues and students but noted the serious impact on children of losing direct interaction with teachers and peers for such a prolonged period.

IMPACT ON THE ECONOMY

- Strikes on energy facilities and the resulting electricity deficit have adversely affected the Ukrainian economy through a reduction in anticipated gross domestic product (GDP), consumer and producer inflation, an increase in electricity costs, and losses in business revenues and taxes from energy facilities. The full scope of the economic impact, including on employment, small businesses, and poverty rates, is not yet known.

- After the first waves of attacks in March 2024, the National Bank of Ukraine in April estimated a decrease of 0.6 per cent GDP growth.[65] In June 2024, electricity prices rose by 63.6 per cent.[66] The Ministry of Economy estimated that high electricity costs would contribute 1.2 per cent to consumer inflation and 6 per cent to producer inflation.[67]

- By May 2024, power companies had incurred losses estimated at over USD $18 billion, with the electricity generation sector hardest hit.[68] Small and medium sized business consulted in a limited survey conducted by UNDP in July 2024 reported around 30 per cent losses in revenues.[69]

- Towns economically dependent on power plants have lost tax revenue. For example, a town adjacent to a destroyed TPP has lost the plant's environmental tax contributions and receives less income tax from employees whose salaries have been reduced. Administrators told HRMMU that the town's budget will be halved. Another town told HRMMU its budget decreased by 60 per cent due to reduction of personnel at the nearby TPP and problems with electricity and water supply.

DISPROPORTIONATE IMPACT ON GROUPS IN SITUATIONS OF VULNERABILITY

Transportation of a patient of the geriotric center in Mykolaiv.

- The attacks have disproportionately harmed groups with specific vulnerabilities, including older persons, persons with disabilities or low mobility, persons or households with lower income, and internally displaced persons.

- Many persons with low or no mobility, as well as older persons, are effectively trapped in their apartments when power cuts halt elevators, making their housing inaccessible. One person described that they "feel like prisoners". Those who attempted climbing multiple flights of stairs risked falls, and high summer temperatures increased concerns of heatstroke and fainting. Authorities told HRMMU that in one region, where social protection staff are primarily women, they face serious difficulties evacuating older persons and those with disabilities from high-rise buildings when power to elevators is cut. Delivery of humanitarian food aid and carrying water up several flights of stairs is also difficult for social workers.

- Healthcare and other public services are limited for those with mobility challenges when elevators cannot run on generator power. For example, a charity worker told HRMMU about an older woman with low mobility who could not reach the third-floor operating ward for her planned surgery until electricity was restored hours later.

- People with physical limitations do not always have battery-powered equipment, making performing daily tasks more difficult and sometimes dangerous, including individuals with hearing or visual impairments who rely on electronic devices. Blackouts further hinder the access of persons in a situation of vulnerability to critical information about assistance, services and news.

- Since women carry out a larger proportion of care work, they will likely bear the responsibility for meeting the additional needs of persons in a situation of vulnerability.[70] Research shows that when blackouts result in women spending more time on care work and domestic tasks, they are less likely to participate in the labor force.[71]

- Collective IDP sites, homeless shelters, and geriatric centers require electricity to provide adequate service to residents, including heating. In Mykolaiv, a geriatric center was left without electricity for 20 hours, creating challenges for food, medicine storage, central water supply, cooking, hygiene and cleaning. Management of an IDP center told HRMMU in April that electricity outages had already hurt its 200 residents who relied on one generator and one small electric stove. Residents had to purchase fuel for the generators themselves, and food spoilage occurred during the blackouts. Management of another IDP center told HRMMU that power cuts inhibited residents from cooking, washing clothes, and storing food.

IMPACT ON THE NATURAL ENVIRONMENT

- The attacks on power plants and the resulting electricity outages have also caused direct and indirect harm to the natural environment, the full scale of which is yet unclear. Strikes on thermal and combined heating power plants cause major fires that are difficult to extinguish and release persistent and dangerous chemicals into the air. Increased diesel generators used in towns and cities cause local air pollution.

- Regular public statements by Russian Federation officials from the Ministry of Defense and armed forces made clear that the intended target of the attacks detailed in this report was electricity infrastructure, and that they had struck the designated targets.[72]

- The complex and coordinated nature of the strikes, the number of attacks across the country, and their regular official acknowledgment are indicators that the attacks against the electricity network are of a widespread and systematic nature, with the apparent aim to damage or destroy Ukraine's country-wide electricity generating, transmission, and distribution capacity.

- International humanitarian law relies on three main principles for the protection of civilians and civilian objects: distinction, proportionality, and precaution. The Russian armed forces' attack on electricity infrastructure in Ukraine likely violated all three principles.

Distinction

- Attacks on civilian objects are a violation of international humanitarian law. While electricity infrastructure facilities may be used in some cases for both civilian and military purposes, (e.g. by directly providing electricity to a weapons manufacturing plant or military base), a factual assessment of each target must be undertaken to determine definitively whether a civilian object has effectively become a military objective.[73] It may not be justified to consider an energy facility to be a military objective, particularly if the primary aim of its destruction is to diminish its contribution to the overall electricity grid, a gain which would be too remote, hypothetical or indeterminate to be considered a "definite military advantage".[74]

- The attacks on energy-generating facilities, particularly combined heating power plants and those producing output heat, may deprive the civilian population of heating during the winter season. In these circumstances facilities producing consumer heating could be considered as objects indispensable to the survival of the civilian population. International humanitarian law prohibits attacks on such objects, including with the motive to cause population displacement.[75]

- Further, the attacks may have been launched to intimidate and create panic among the population by depriving civilians of critical services and forcing them to leave their places of residence. Attacks whose primary purpose is to terrorize the population are prohibited,[76] and attacks on dual-use objects must be directed to their military use, rather than intended to weaken the morale of the population or to spread terror among civilians.[77]

Proportionality

- In such cases where otherwise civilian objects have been determined to be military objectives, the principle of proportionality must be applied. Attacks that may be expected to cause incidental harm to civilians or civilian objects which would be excessive in relation to the concrete and direct anticipated military advantage are a violation of international humanitarian law.[78]

- A legal determination of whether an attack has caused excessive incidental civilian harm requires further information about anticipated military advantage and specific data on incidental civilian harm. However, a military campaign to damage or destroy the entire electricity system of a country appears to entail remote, hypothetical, or speculative military gains, rather than the substantial and relatively close advantage required to justify the attacks.[79]

- The civilian use of Ukraine's energy infrastructure, in particular its life-sustaining functions, should also be considered. Terminating or impairing its civilian use could render the attack unlawful even if it had become a military objective.[80] Further, the reasonably foreseeable cumulative, reverberating, and longer-term effects on civilian lives, health and objects, such as those detailed in this report, are relevant to such a proportionality assessment.[81] In any case where the disproportion is not clear, the interests of the civilian population should prevail.[82]

Precaution

- All feasible precautions should be taken to avoid or minimize incidental loss of civilian life, injury to civilians, and damage to civilian objects.[83] The Russian Federation's attacks on electricity infrastructure continued unabated from March to August 2024, despite public information about the reverberating effects on the civilian population and interconnected civilian systems. On the contrary, previously damaged locations were struck repeatedly until they became nonoperational. HRMMU therefore assesses that adequate precautionary measures were not taken to mitigate civilian harm when launching these attacks, in violation of international humanitarian law.

To the Russian Federation

- Immediately cease attacks on the electricity infrastructure critical to the civilian population of Ukraine.

To the Ukrainian authorities

- Continue emergency mitigation and winter preparedness efforts alongside long-term strategic planning for electricity generation and network stability;
- Sustain attention and assistance to those groups in a situation of vulnerability to the consequences of electricity shortages, including older people, people with disabilities, families with children, and those internally displaced.

To the international community

- Support efforts to repair and restore electricity-generating and transmission capacity to meet the short, medium and long-term needs of the population;
- Sustain attention and humanitarian assistance to populations affected by electricity infrastructure attacks, including those internally displaced;
- Support accountability efforts for violations of international humanitarian law and international human rights law, including those related to attacks on electricity infrastructure.

1. HRMMU conducted field visits to thermal and hydroelectric power plants and electricity substations in multiple regions of Ukraine.
2. Including UKRENERGO, DTEK, and others.
3. Including United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), World Health Organization (WHO), United Nations Environment Programme (UNEP), United Nations High Commissioner for Refugees (UNHCR), UN Women (UNW) and the United States Centers for Disease Control and Prevention (CDC).
4. During the reporting period, HRMMU recorded five reported attacks affecting two power generating facilities and 29 affecting power transmission or distribution facilities in territory occupied by the Russian Federation. HRMMU has not been able to establish the exact circumstances of these attacks.
5. Nuclear power forms the basis of Ukraine's energy production and covers more than half of consumption needs. Thermal and other power plants provide additional maneuverable electricity, that can be increased or decreased depending on consumption needs. UNDP, "Towards a Green Transition of the Energy Sector in Ukraine: Update on the Energy Damage Assessment" (hereinafter: UNDP 2023 Assessment), June 2023, available at: undp.org/sites/g/files/zskgke326/files/2023-06/undp-ua-energy-damage-assessment.pdf; Kyiv School of Economics, "Assessment of Damages and Losses to Ukraine's Energy Sector due to Russia's Full-Scale Invasion" (hereinafter: KSE Report 2024), May 2024, available at: KSE_Impact-of-the-war-on-energy_ENG-1.pdf.
6. Energy consumption decreased due to multiple factors, including occupation of territory, population displacement, and in the winter of 2023-2024, mild weather conditions.
7. UNDP 2023 Assessment; WASH Cluster Ukraine, "Assessment of Ukrainian Water Supply and Sewage (WSS) companies' preparedness and needs for the winter period and upcoming lack of electricity" (hereinafter: WASH 2024 Assessment), 10 July 2024; KSE Report 2024.
8. Ministry of Energy of Ukraine, data available at: https://map.ua-energy.org/en/resources/85a0e29e-e9aa-4e5d-8f97-01ba4bf0ed59/.
9. OHCHR, "Report on the Human Rights Situation in Ukraine: 1 August 2022 – 31 January 2023", 24 March 2023 (hereinafter: OHCHR Report March 2023), available at: https://ukraine.un.org/sites/default/files/2023-03/23-03-24-Ukraine-35th-periodic-report-ENG.pdf; Report of the Independent International Commission of Inquiry on Ukraine, A/HRC/52/62 (hereinafter: A/HRC/52/62), 16 March 2023, available at: https://www.ohchr.org/en/hr-bodies/hrc/iiciihr-ukraine/index. For an analysis of the munitions used in the attack, see Odell, A., Welander, F., Hörnedal, A., & Lackenbauer, H., 2024. Russian attacks on the Ukrainian power system, Report No. FOI-R--5596--SE. Swedish Defence Research Agency, 14 August, pp. 27-33.
10. OHCHR Report March 2023, supra; According to a comprehensive assessment carried out by UNDP in 2023, twelve million people were left with no or limited electricity, and disrupted water and heating during the winter period. UNDP 2023 Assessment, supra.
11. According to estimates based on UKRENDERGO data, UNDP 2023 Assessment, supra.
12. UNDP 2023 Assessment, supra.
13. A/HRC/52/62, supra.
14. International Criminal Court, "Situation in Ukraine: ICC judges issue arrest warrants against Sergei Ivanovich Kobylash and Viktor Nikolayevich Sokolov", 5 March 2024, available at: https://www.icc-cpi.int/news/situation-ukraine-icc-judges-issue-arrest-warrants-against-sergei-ivanovich-kobylash-and; International Criminal Court, "Situation in Ukraine: ICC judges issue arrest warrants against Sergei Kuzhugetovich Shoigu and Valery Vasilyevich Gerasimov", 25 June 2024, available at: https://www.icc-cpi.int/news/situation-ukraine-icc-judges-issue-arrest-warrants-against-sergei-kuzhugetovich-shoigu-and.
15. Warrants issued against the former Minister of Defense, Chief of the General Staff of the Armed Forces and former commanders of the Long-Range Aviation of the Aerospace Forces and the Black Sea Fleet.
16. Directing attacks at civilian objects, Article 8(2)(b)(ii) of the Rome Statute; Causing excessive incidental harm to civilians or damage to civilian objects, Article 8(2)(b)(iv) of the Rome Statute.
17. Other Inhumane Acts, Article 7(1)(k) of the Rome Statute.
18. International Criminal Court, 25 June 2024, supra.
19. Consumption was reduced compared to pre-war levels, due to various factors including occupation of territory and population displacement.
20. Electricity imports are limited by regulations to a maximum 1.7 gigawatts. KSE 2024 Report, supra.
21. See daily update of military operations, Telegram channel of the Ministry of Defense of the Russian Federation, 22 March 2024, https://t.me/mod_russia/36901.
22. According to official Ukrainian sources, 92 of the 155 munitions were intercepted. Official Telegram channel of the Commander of the Air Force of the Armed Forces of Ukraine, 22 March 2024, https://t.me/ComAFUA/238.
23. Statement by the Office of the President of Ukraine, 22 March 2024, available at: https://t.me/OleksiyKuleba/4172.
24. Attacks were launched on 22 March, 29 March, 11 April, 27 April, 8 May, 1 June, 20 June, 22 June, and 26 August 2024.
25. HRMMU documented attacks in the Ivano-Frankivsk, Vinnytsia, Lviv, Donetsk, Dnipropetrovsk, Sumy, Kyiv, Kharkiv, Kherson, Zaporizhzhia, Kirovohrad, Chernivtsi, Cherkasy, Khmelnytskyi, Rivne, Poltava, Odesa, Mykolaiv, Zhytomyr, and Chernihiv regions and Kyiv city.
26. Combined heating power plants produce both electricity and heat simultaneously. Thermal power plants also generate byproduct heat, which is used locally, often fueling centralized district heating and hot water in nearby areas.
27. See, for example, IAEA, INFCIRC/1242, "Communication from the Permanent Mission of Ukraine to the Agency", 28 August 2024, available at: https://www.iaea.org/sites/default/files/publications/documents/infcircs/2024/infcirc1242.pdf.
28. International Atomic Energy Agency, "Update 247 – IAEA Director General Statement on Situation in Ukraine", 29 August 2024, available at: https://www.iaea.org/newscenter/pressreleases/update-247-iaea-director-general-statement-on-situation-in-ukraine.
29. DTEK, Event "The Future of Ukrainian Energy: Dialogue with NV", 23 July 2024.
30. DiXi Group, "Russian War against Ukraine: Energy Dimension", 3-9 June, available at: https://dixigroup.org/wp-content/uploads/2024/06/russian-war-against-ukraine_2024_06_10-eng.pdf.
31. Ministry of Energy of Ukraine, Event "The Future of Ukrainian Energy: Dialogue with NV", 23 July 2024. UKRENERGO, 18 July 2024, https://t.me/Ukrenergo/3062.
32. NV, "Energy crisis in Ukraine: Zelenskyy appeals for European support amid Russian devastation", 11 June 2024, available at: Ukraine lost 80 percent of heat generation and a third of hydro generation - Volodymyr Zelensky / The New Voice of Ukraine (nv.ua); KSE 2024 report, supra.
33. High temperatures and accelerated maintenance of nuclear power plants exacerbated the electricity deficit during the summer period. Energoatom, 13 June 2024; INSO, July 2024.
34. For example, blackouts lasted 78 percent of one workweek in June, with additional emergency outages in Kyiv and twelve other regions.

https://dixigroup.org/wp-content/uploads/2024/06/russian-war-against-ukraine_2024_06_10-eng.pdf.

35. Cabinet of Ministers of Ukraine, "Government expands list of facilities for priority power supply: Prime Minister", 18 July 2024, available at: https://www.kmu.gov.ua/en/news/uriad-rozshyryv-perelik-obiektiv-iakym-harantuietsia-priorytetne-elektropostachannia-premier-ministr.
36. An estimated 70 per cent of Ukraine's population lives in urban areas, primarily in multi-storied buildings.
37. UN Women, Rapid Gender Analysis of Ukraine, 4 May 2022, p. 18; UNDP, Human Impact of the Energy Crisis in Ukraine: Rapid Assessment.
38. Ministry of Energy of Ukraine, Event "The Future of Ukrainian Energy: Dialogue with NV", 23 July 2024.
39. DTEK and UKRENERGO, ibid.
40. Ukraine Shelter Cluster, "Winterization Recommendations 2024-2025" (hereinafter Shelter Cluster recommendations 2024), 9 July 2024, available at: https://sheltercluster.org/ukraine/documents/winterization-recommendations-2024-2025.
41. Ukrainska Pravda, "It won't be easy": Ukraine's power transmission operator announces electricity situation forecast for winter", 27 June 2024, available at: https://www.pravda.com.ua/eng/news/2024/06/27/7462855/; Information from the Ministry of Energy of Ukraine, UKRENERGO, and the National Bank of Ukraine, cited in UNDP in Ukraine, "Human Impact of the Energy Crisis in Ukraine: Rapid assessment" (hereinafter: UNDP 2024 rapid assessment), forthcoming.
42. HRMMU meeting with Ministry of Energy of Ukraine, 20 September 2024.
43. UNDP 2024 rapid assessment, supra; Event "The Future of Ukrainian Energy: Dialogue with NV", 23 July 2024; RBC Ukraine, "Blackouts in Ukraine", 25 June 2024, available at: https://www.rbc.ua/rus/news/sezon-grafikiv-chi-skasuyut-ukrayini-vidklyuchennya-1721917702.html.
44. UNDP 2024 rapid assessment, supra.
45. WASH 2024 assessment, supra.
46. WASH 2024 assessment, supra.
47. INSO, July 2024; UNDP 2024 rapid assessment, supra.
48. UNDP 2024 rapid assessment, supra.
49. KSE 2024 report, supra.
50. Alternative heating solutions are currently being developed, though they require significant resources and speed for successful implementation by winter. KSE 2024 report, supra.
51. REACH, "Ukraine's Cold Spot Risk Assessment 2024/2025 available here: https://repository.impact-initiatives.org/document/reach/7a432729/UKR2215_Winterisation-2024-25_Cold-spot-assessment.pdf.
52. Ibid.
53. Kyiv City Administration, cited in Interfax, "Kyiv restored two-thirds of its own generating capacity after missile attacks continues repairing equipment", 6 July 2024, available at: https://en.interfax.com.ua/news/general/998346.html.
54. Shelter cluster recommendations 2024, supra.
55. WASH 2024 assessment, supra.
56. WASH 2024 assessment, supra.
57. WHO, "Ukraine: 2023-2024 Winter Risk Assessment", available at: https://www.who.int/docs/librariesprovider2/default-document-library/risk-assessment-winter-in-ukraine_fin.pdf.
58. Shelter cluster recommendations 2024, supra; World Health Organization, Winter in Ukraine: People's health cannot be held hostage", 21 November 2022: https://www.who.int/europe/news/item/21-11-2022-statement---winter-in-ukraine--people-s-health-cannot-be-held-hostage.
59. These figures are based on an assessment carried out for HRMMU by the U.S. Centers for Disease Control and Prevention (CDC) using data from: REACH Ukraine, Multi-Sector Needs Assessment (MSNA), 1 August 2024, available at: https://www.impact-initiatives.org/resource-centre/.
60. The National Bank of Ukraine's inflation report released in May 2024 projected 200,000 people to move abroad in 2024, but for a net return of 400,000 people in 2025. The report released in August projected 400,000 people to move abroad in 2024, and for a further 300,000 people to leave in 2025, with a net return projected only in 2026. See: National Bank of Ukraine, "April 2024 Inflation Report", 2 May 2024, available at: https://bank.gov.ua/en/news/all/inflyatsiyniy-zvit-kviten-2024-roku; National Bank of Ukraine, "July 2024 Inflation Report", 1 August 2024, available at: https://bank.gov.ua/en/news/all/inflyatsiyniy-zvit-lipen-2024-roku.
61. UNHCR, "Energy & Population Mobility: Thematic Update July 2024", July 2024.
62. Ibid.
63. Figures provided by the Ministry of Education.
64. UNDP 2024 rapid assessment, supra.
65. National Bank of Ukraine, Inflation Report April 2024, 15, 22, 39 available at: https://bank.gov.ua/admin_uploads/article/IR_2024-Q2_eng.pdf?v=7. Information from the Ministry of Energy cited in UNDP's 2024 rapid assessment indicated a likely 0.7 per cent decrease.
66. UNDP 2024 rapid assessment, supra.
67. UNDP 2024 rapid assessment, supra.
68. KSE 2024 Report, supra.
69. UNDP 2024 rapid assessment, supra. Note that the business survey data is based on a sample that is not statistically representative, and its results are for illustration only.
70. UN Women, Rapid Gender Assessment of Ukraine, 4 May 2022.
71. UNDP 2024 rapid assessment, supra.
72. For example, see: Official Statement by the Ministry of Defense of the Russian Federation, acknowledging long-range high precision strikes on Ukrainian energy infrastructure. 22 June 2024: https://t.me/mod_russia/40160.
73. The infrastructure must make an effective contribution to military action, and the military advantage resulting from its destruction, capture or neutralization must be "definite and cannot in any way be indeterminate or potential", and must be not be solely political, psychological, economic, financial, social or moral in nature. Article 52(2), Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (hereinafter Protocol I); Prosecutor v. Germain Katanga , Case No. ICC-01/04-01/07, Judgment pursuant to article 74 of the Statute , March 7, 2014, para. 893; Commentary to Additional Protocol I, para 2024; HPCR Manual, Commentary on Rule 1(w), para. 4.
74. Article 52(2), Protocol I.
75. Article 54(2), Protocol I.
76. Article 51(2), Protocol I.
77. ICTY, Final Report to the Prosecutor by the Committee Established to Review the NATO Bombing Campaign against the Federal Republic of Yugoslavia , 8 June 2000, paras. 47, 55, 74, and 76.
78. This military advantage should be substantial and relatively close, rather than long-term or remote. Article 51(5)(b); Article 57, Protocol 1; Commentary to Additional Protocol I, para 2209; ICRC Rules of Customary International Humanitarian Law, Rule 14.
79. ICRC 1987 Commentary on Additional Protocol I, para. 2209.
80. ICTY, Prosecutor v. Prlic et al., IT-04-74-T, Judgment (Trial Chamber), 29 May 2013, Vol. 3, paras 1582–84. HPCR Manual, Commentary on Rule 22(d), p. 119, para. 7; Tallinn Manual 2.0, Commentary on Rule 101, para. 3, p. 445.
81. Whereas a single attack on a military objective may be considered lawful despite incidental damage to civilians, a pattern of military conduct through repeated attacks may result in the cumulative effect of such acts excessively jeopardizing the lives and assets of civilians, entailing a violation of international law. ICTY, Prosecutor v. Kupreskic et al., Judgment, 14 January 2000, para 526.
82. ICRC 1987 Commentary on Additional Protocol I, para 1979.
83. Article 57, Protocol I; ICRC Customary Rules of International Humanitarian Law, Rule 15.