

Situation overview

The escalation of hostilities in Ukraine on 24 February 2022 has led to a rapid expansion of conflict-affected areas and an increase in the number of conflict incidents in proximity to heating infrastructure. Conflict incidents in the vicinity of these sites and objects increase the risk of damage that may result in threats to human health and service functionality.

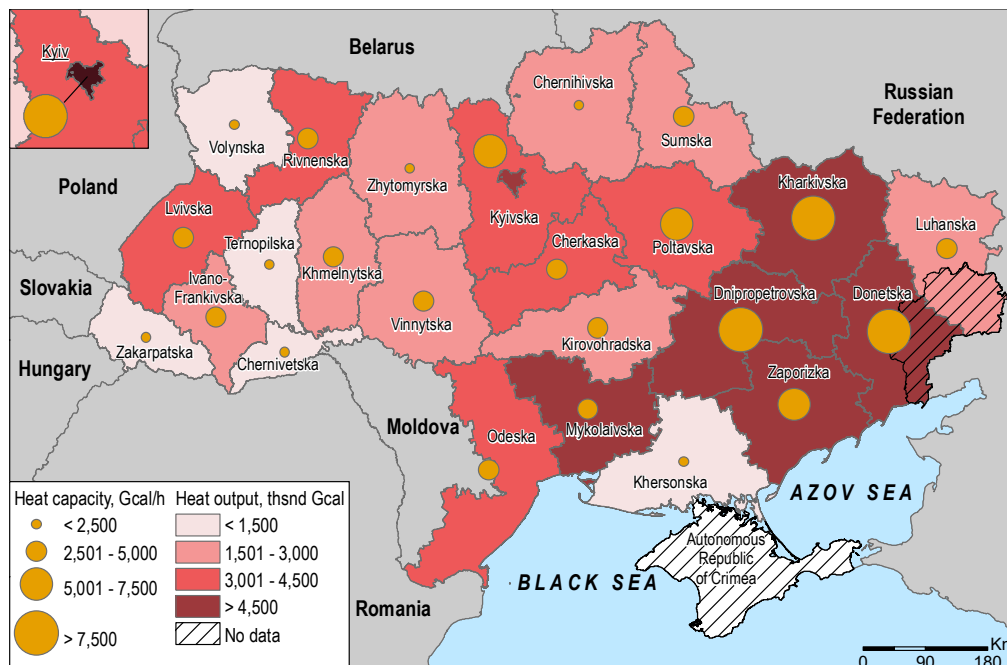
According to the Ministry for Communities and Territories Development of Ukraine, as of July 12, **345 objects of critical heating infrastructure were affected, namely: 336 boiler houses** (324 damaged and 12 destroyed) and **8 combined heat and power plants** (4 destroyed and 4 damaged) and **1 heat plant was damaged** ([link](#)).

Due to significant heating infrastructure damage, preparations for the 2022/2023 winter season may be complicated in Ukraine, especially in areas affected by the conflict.

Heating infrastructure

To understand winterisation, the spatial distribution of residential and non-residential buildings connected to central heating systems as well as heating infrastructure indicators might be of crucial importance. On average, **45% of buildings in Ukraine are connected to the central heating system** ([link](#)), to which the heat is supplied from two main types of facilities – **combined heat and power plants (CHPPs)** that is designed to produce heat and electricity simultaneously and **heat plants** ([Graph 1](#)). While both mainly rely on natural gas, the former has a bigger capacity and uses more coal for heat production. Smaller thermal power plants (TPPs) are scattered around the city.

Map 1. Heat productivity. Data source: ([link](#)).



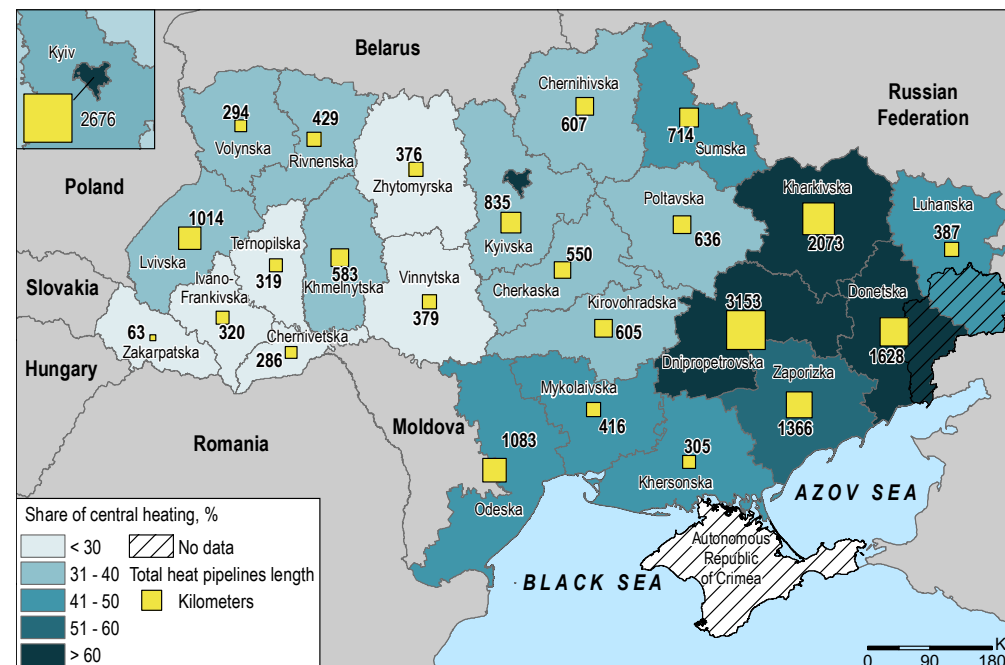
Data sources: State Statistical Service of Ukraine (data for 2020)

The highest share of residential buildings equipped with central heating facilities are in Zaporizka, Donetsk, Dnipropetrovska and Kharkivska oblasts and Kyiv city ranging from 55,8 to 98,7 % ([link](#)). Consequently, industrially developed urban regions in Eastern Ukraine harbour the largest amount of heating infrastructure ([Map 2](#)). The installed **heat capacity (power of heat generating facility to produce a certain amount of heat energy per unit of time)** of central heat supply systems differs substantially among the regions, with the national average of about 4500 Gcal/h ([link](#)). Two regions - Donetsk and Kharkivska oblasts - where this heat capacity was substantially higher than the national average as of 2020 (>10,000 Gcal/h), have been heavily affected by hostilities since 24th February 2022 ([Map 1](#)).

Heat output indicates the amount of heat energy generated and supplied to consumers by centralized heat generating facilities. The largest amount of heat was generated by centralized heating facilities in Donetsk, Kharkivska, Dnipropetrovska oblasts and Kyiv city in 2020 ([link](#)). **Heat output in Kyiv is four times higher than the country's average** and more than 30 times higher than the country's minimum heat output recorded for Zakarpatska oblast. Moreover, Zaporizka oblast, most of which is currently occupied, is ranked in the top five in both heat capacity and supply indicators.

Heat pipeline networks, particularly aboveground, are exposed to damage from artillery shelling and air strikes. Country **average heat pipelines length per oblast is estimated in 844 km**, while mean value for Western Ukraine only slightly exceeds 400 km. **Seven oblasts have more than 1000 km of heat network.** Four of those oblasts are partly under occupation or situated right at the frontline and therefore have experienced more intense shelling than others. This could have implications for the preparedness of the heat network for the upcoming winter period.

Map 2. Heating infrastructure. Data source: ([link](#), [link](#)).



Data sources: State Statistical Service of Ukraine (data for 2020); Ministry for Communities and Territories Development of Ukraine

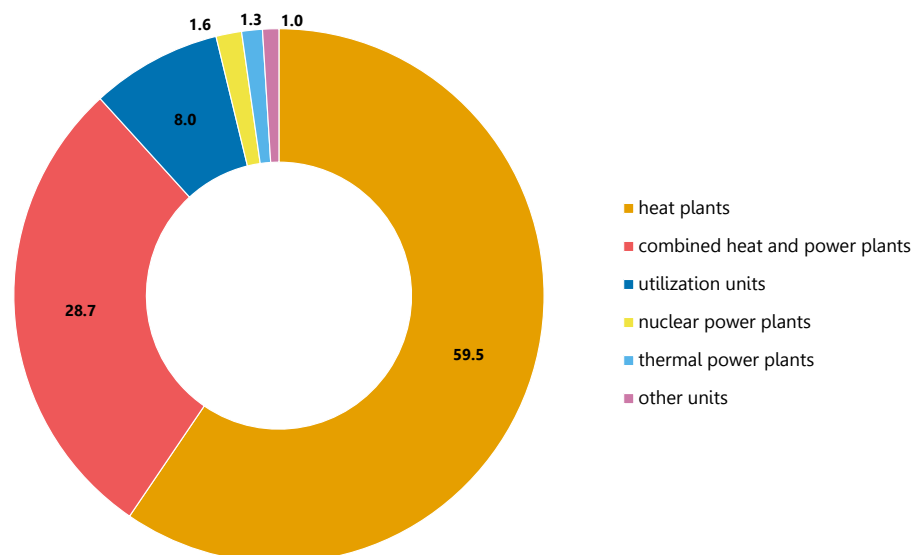
Heating infrastructure

Most electrical substations, much like electricity consumers, are concentrated close to big cities and industrial centres. The highest number of high-voltage substations (220+KV) are in Donetsk oblast, some of which have been occupied since 2014, followed by Dnipropetrovska and Kyivska oblasts.

Since 24 February there were numerous cases of electricity outages due to the damaged powerlines and substations (Graph 2), but some of them have a particularly high impact on people and the wider economy. One of the highest concerns was related to damage to a high-voltage powerline feeding former Chornobylska nuclear power plant (NPP) that happened in March 2022 and might affect the safety of nuclear materials. Another affected facility is the new Kreminska substation in Luhanska oblast, which was connected to the network in 2020 in order to enhance electricity supply to the northern part of the oblast. At the end of April, it was forcibly disconnected from the Ukrainian electrical grid, which caused a blackout for all of Luhanska oblast (link).

Another large substation in the region, Donbaska, was reported to be on fire at the beginning of July (link). Some electric substations in the cities were also severely damaged in the conflict. For instance, as a result of bombardment in Brovary near Kyiv in April, more than 25 thousand people were left without electricity, including the local hospital. Although subscribers regained electricity in a couple of hours, full restoration of the affected 110 KV substation might not be completed until next year (link). A similar situation occurred in Kharkiv in March, where one of the 110 KV substations was repaired only two months after it was damaged (link). Besides that, hundreds of smaller electric substations were affected by military actions just in Mykolaivska oblast (link). In Central and Western Ukraine, at least eight of the impacted electric substations were used by Ukrzaliznytsia for feeding main railway lines. It caused disruption in connection for tens of thousands of train passengers.

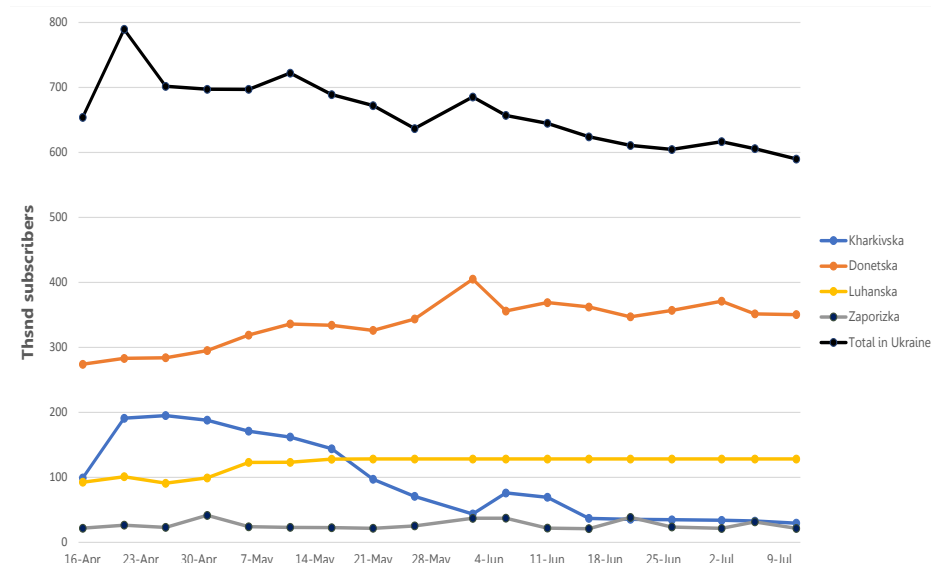
Graph 1. Power plant heat output share by type (2020, %) (link)



Regional overview

Official reports from Government portal (link) show increased intensity of military action is usually followed by a higher number of subscribers without access to electricity (Graph 2). For instance, in Donetsk oblast since May 2022 more than 300 thousand households went without electricity, even though on average 10 thousand subscribers were connected to the grid daily. In Luhanska oblast the number of disconnected subscribers since the beginning of May is over 120 thousand. Also, about 24 thousand households in Zaporizka oblast haven't had consistent electricity access since the beginning of April. In contrast, the situation in Kharkivska oblast improved substantially when the number of households without access to electricity decreased from 150-200 thousand in mid-April – mid-May to 30-35 thousand in the first part of July. In total throughout the country, as of the beginning of July about 600 thousands subscribers remained without electricity supply, while on some days of March this number reached almost 1 million.

Graph 2. Electricity outages, thousand subscribers. Data source: (link).



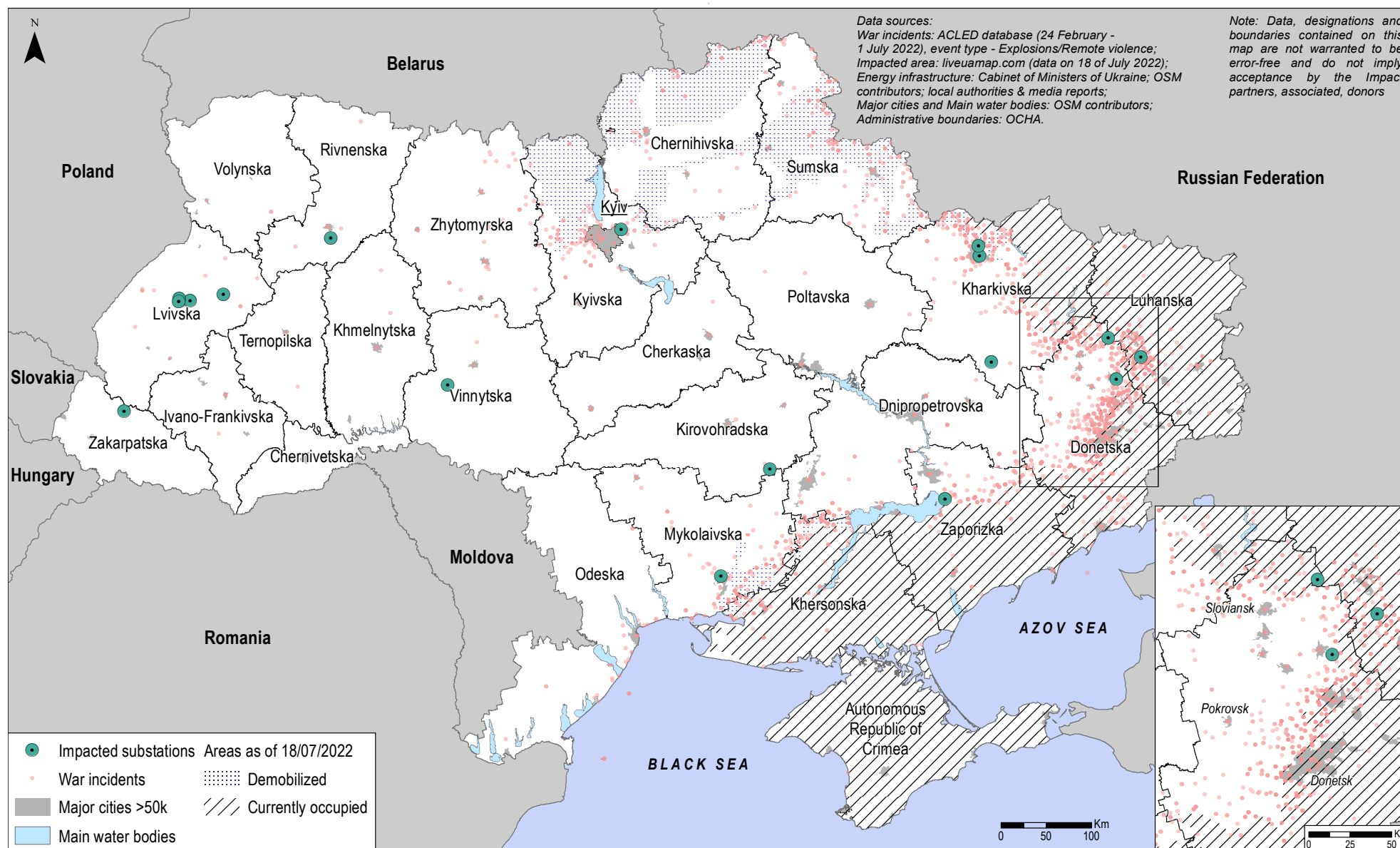
Mykolaivska oblast

The only urban settlement occupied in the region as on 13th of July is Snihurivka with about 12,000 inhabitants. The town doesn't have centralized heat production and supply system and only 5% of people are connected to the gas supply network (link). As such, citizens have to increasingly rely on individual electricity facilities to meet their demands.

Mykolaiv city has two big suppliers of heat energy – Mykolaivoblteploenergo and Mykolaivska CHPP. Moreover, Mykolaivoblteploenergo supplies heat energy also to the neighbouring city Ochakiv, an important seaport, which has been under constant shelling since the conflict escalation. Another heat supplier, Mykolaivska CHPP provides heat for 40% of Mykolaiv's citizens as well as some industrial enterprises, using as a fuel natural gas only (link). Numerous air strikes and artillery shelling resulted in damage to 20% of the heat plants of Mykolaivoblteploenergo along with other infrastructure loss. One solution consider-

Regional overview

Map 3. Energy infrastructure in proximity to conflict



Regional overview

red by city authorities to decrease risk of heat infrastructure damages is the conversion of aboveground heating pipelines to underground ([link](#)).

A key issue that might hinder winterisation preparedness in Mykovaiv is shortage of fresh water necessary to fill the heating system ([link](#)). The main water pipeline from the Dnipro river flows through occupied Khersonska oblast and has been damaged since April. Utilization of fresh water from newly drilled artesian wells might only be a medium-term solution due to its high cost ([link](#)).

Northern Ukraine

Here, the most impacted settlements in terms of centralized heating facilities are Chernihiv and Okhtyrka, where both local CHPPs suffered significant damage ([link](#)). Chernihivska CHPP was brought back to the communal property after 20 years of exploitation in poor working conditions. Although, it was designed to use both coal and natural gas, but due to complicated logistics and restoration work schedule it's foreseen that plant will work on natural gas in the next heating period 2022/23 there ([link](#)). It's more expensive than using coal, but has less impact on air quality in the city.

The situation in Okhtyrka is distinct, since many buildings in the town are damaged along with completely destroyed local CHPP that supplied heat energy to more than 20,000 citizens, 67 public and 150 commercial organizations ([link](#)). Restoration of heating plant require more time than what is left before the upcoming heating period. To solve the problem, local authorities started to issue permission for multi-storey buildings to switch from centralized to individual (one-apartment) heating system. As of mid of July, 14 multi-apartment buildings received such decisions ([link](#)).

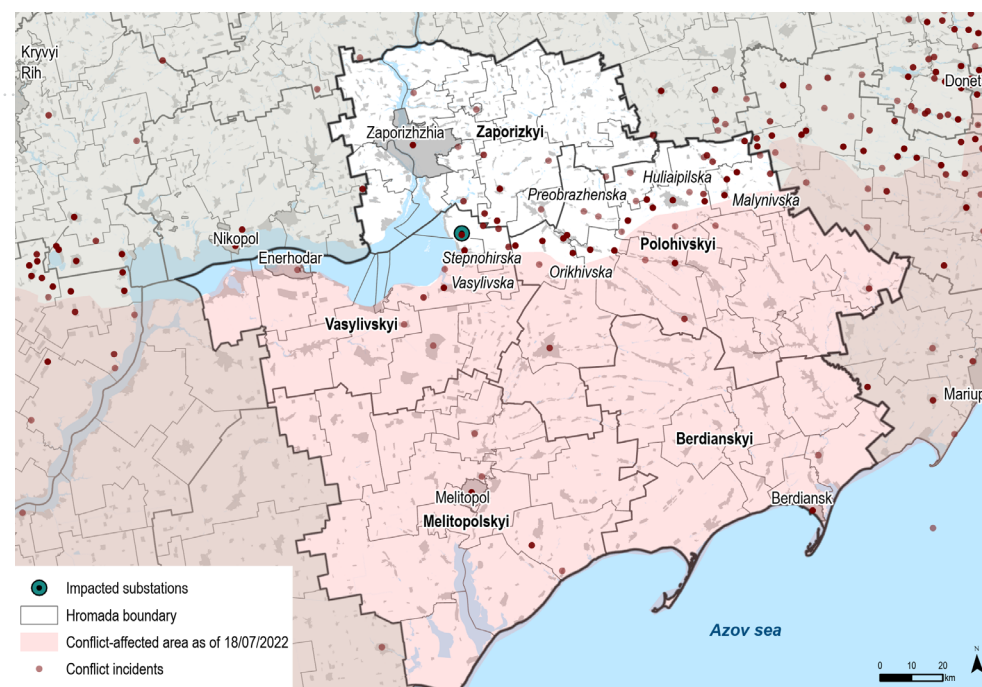
Kharkiv

Being a big industrial centre, Kharkiv relies mainly on the centralized heat supply system. Kharkivska CHPP-5 provides heat energy for about 25% of citizens, which might experience disruption if the plant is disconnected from the electricity grid. It happened on 5th of June as a result of shelling when a high-voltage power line was damaged, and CHPP had to be shut down ([link](#)). Another important heat supplier for Kharkiv is communal enterprise "Kharkivski heating networks". It comprises two CHPPs and heating plants of different capacity which provide heating energy to more than 6,200 residential building and 50% of Kharkiv's citizens with hot water. About 25% of all heating plants need restoration works before the next heating period, while the most damaged infrastructure is situated in Kyivskyi and Saltivskyi districts of the city ([link](#)).

Zaporizka oblast

Due to constant shelling, gas and electricity supply systems have been impacted in Zaporizka oblast, so currently some utility systems are not ready for the heating period. Repairs to heating infrastructure are impossible in Polohivskyi and Vasylivskyi raions (Huliaipilska, Preobrazhenska, Orikhivska, and Stepanohirska hromadas) close to active hostilities ([Map 4](#)). 5 out of 7 boiler houses in the region are located in potentially dangerous areas, which may complicate this year's heat supply process ([link](#)). The local authorities are considering the possibility of decentralizing the heat supply system, introducing the additional and reserve capacities necessary for this. A complete transition to electric heating is impossible in Zaporizka oblast, so other options for providing heat to homes are being considered ([link](#)). The possibility of installing additional equipment in small boiler houses for the use of alternative fuel options is also being developed.

Map 4. Regional overview of Zaporizka oblast



Due to the shelling in the Zaporizka oblast on 20 July 2022, 82 settlements (21,552 subscribers) remain without energy supply, and 268 settlements (226,678 subscribers) - without gas supply ([link](#)) ([Map 4](#)).

Key takeaways

- Conflict escalation has caused significant damage to public utilities, gas and energy infrastructure in most oblasts in Ukraine
- Population is at risk of losing access to heating due to potential war-related damage to centralized heating systems or energy infrastructure
- Hostilities lead to the inability to repair damage, thus further impacting functionality of these systems
- Contingency solutions are critical as there is a constant risk of further damage during the winter months