# Ukraine’s energy security 2025

## A pre-winter assessment

International Energy Agency



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# Ukraine's energy sector continues to be a major target of Russian missile and drone attacks

As Ukraine enters its fourth winter of the war, energy infrastructure continues to be targeted by Russian attacks. Ukraine's natural gas and power infrastructure remain vulnerable, with an increasing number of missiles and drones striking critical plants and pipelines. At the same time, evolving tactics and technologies are present persistent challenge for Ukraine's air and passive defences.

Energy security is central to Ukraine's overall security. Ensuring that Ukrainian citizens retain access to heat and power is of the utmost importance, especially during the cold winter months. While Ukraine has made strong strides in rebuilding and strengthening the resilience of its energy system this past spring and summer, the situation remains fragile, and the risk of huge disruptions and widespread destabilisation remains – particularly if Russia further intensifies targeted attacks or temperatures in the months ahead are colder than expected.

This analysis builds on the IEA's September 2024 report, *Ukraine's Energy Security and the Coming Winter*. It provides an update on the latest developments through October 2025 and proposes key actions that Ukraine and its partners can take to address urgent energy security vulnerabilities this winter and bolster longer-term energy resilience.

# Despite significant progress in 2025 on restoring power systems, risks remain elevated

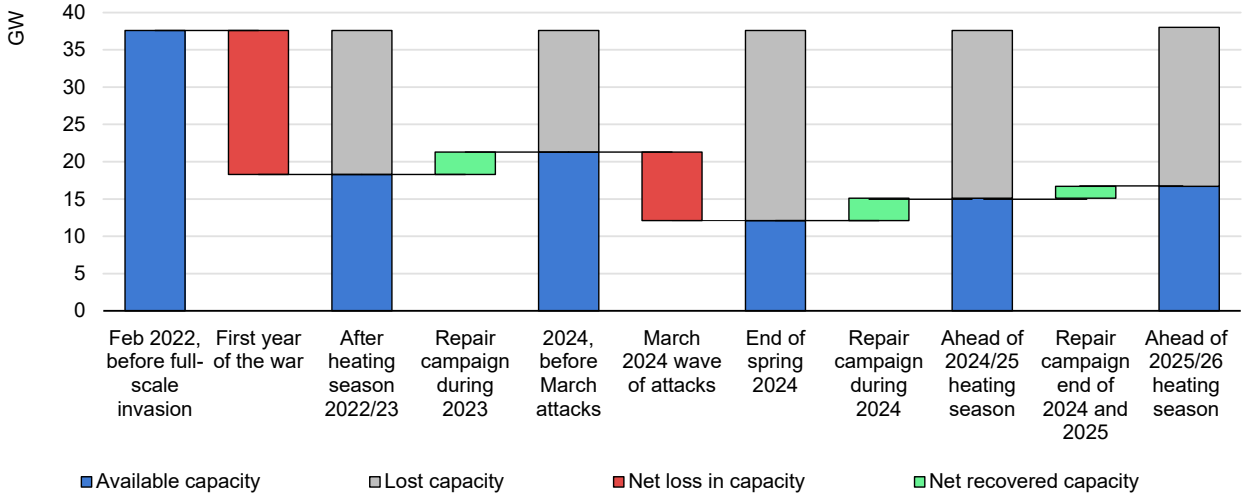
Since the end of the last heating season, Ukraine has extensively worked to restore damaged power system infrastructure while adding further distributed generation and battery storage capacity.

Before 2022, Ukraine's available dispatchable power generation capacity was roughly 38 gigawatts (GW). Losses in the first year of war due to occupation, destruction and/or damage amounted to 19 GW, and after additional concentrated attacks in spring 2024, capacity declined to just 12 GW. Ahead of the 2024/2025 winter, Ukraine was able to restore 3 GW, and it has continued to repair and add additional capacity throughout the past year.

The country's electricity mix remains highly dependent on the three remaining operational nuclear power plants located in western and central Ukraine. Together, they account for 50%, or 7.7 GW, of the country's electricity generation capacity.

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**Available installed capacity of dispatchable power generation in Ukraine**




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Sources: IEA analysis based on exchanges with DiXi Group, ENTSO-E, the European Commission, Green Deal Ukraina, the Kyiv School of Economics; UNDP (2023), Update on the Energy Damage Assessment June 2023, Towards a green transition of the energy sector in Ukraine; Ukrainska Pravda (2024), Russia has destroyed 9.2 GW of Ukrainian power generation, EU ambassador says; EnergoReforma (2024), Енергетикам на початок ОЗП вдалося відновити приблизно 3 ГВт пошкодженої РФ генерації – радник прем'єра; DiXi Group (2025), Summer Outlook on Electricity and Interfax-Ukraine (2025), Ukraine to restore 3.2 GW of damaged energy facilities by year end - Energy Minister.

Ukraine's electricity security continues to benefit from the sector's interconnection with the European grid following its synchronisation in March 2022. This integration has proven vital, enabling imports during peak demand periods while allowing exports that help stabilise Ukraine's grid and generate revenues when domestic generation is sufficient. In 2024, Ukraine imported a record 4 436 gigawatt-hours (GWh) of electricity, reflecting the extensive damage to its domestic generation capacity. In the first nine months of 2025, import levels declined as generation capacity gradually recovered, and Ukraine became a net electricity exporter between June and September – sending 635 GWh abroad in September alone, the highest monthly level since the full-scale invasion began. However, this trend is beginning to change with the increasing number and intensity of Russia attacks, with Ukraine relying more heavily on imports for much of October.

Over the past year, progress has been made in expanding cross-border capacity for electricity trade. Since December 2024, firm import capacity has been set at 2.1 GW during winter months and 1.7 GW in the summer, while export capacity increased from 550 MW to 650 MW. The available trade capacities are now recalculated weekly by the six regional transmission system operators, providing greater flexibility to respond to system conditions and maximise available capacity. However, further expansion remains constrained by grid congestion in both Ukraine and neighbouring EU countries. Additionally, there is a risk that interconnections may not deliver power to those most in need, with Russian attacks on energy infrastructure increasingly splitting well-supplied western regions from those in the east near the frontlines, which often have electricity deficits.

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Ukraine has also managed to add large-scale energy storage capacity over the past year. DTEK, Ukraine's largest private sector energy firm, launched the country's first energy storage system complex in September 2025, with a capacity of 200 megawatts (MW) and a total storage of 400 megawatt-hours (MWh). Under the project, there are six facilities across the country, together capable of powering 600 000 homes for two hours. This will enhance electricity security and system balancing. Wind energy projects are also moving forward; more than 700 MW of new capacity are currently under development, including DTEK's nearly 400 MW Tyligulska Wind Farm expansion on the Black Sea coast, which is scheduled to go online in late 2026.

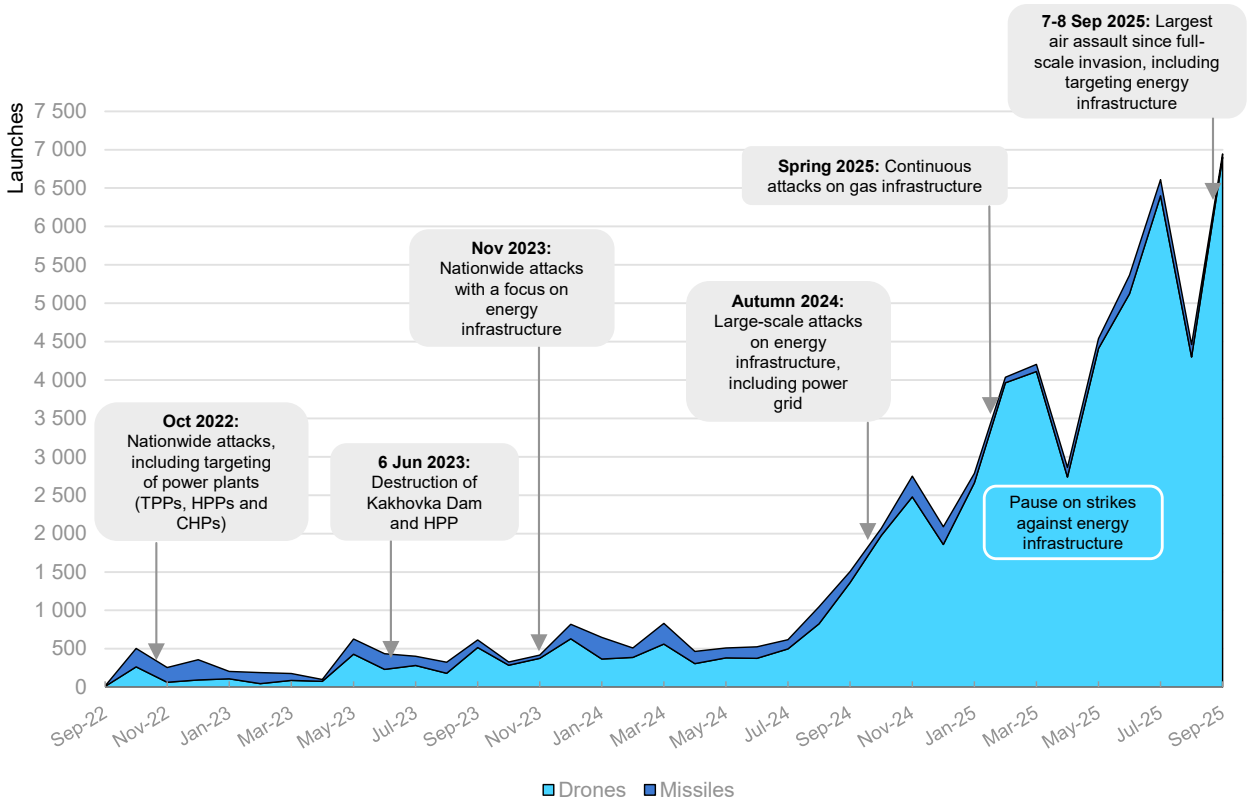
Going into October 2025, Ukraine's Ministry of Energy had anticipated that 17.6 GW of total generation capacity would be available ahead of this heating season. While the winter of 2023/2024 saw peak demand reach 18 GW, demand fell to 16.5 GW during the 2024/2025 heating season, driven mainly by milder temperatures. However, a colder-than-average winter could see demand rise to 18 GW or more.

The situation is also constantly changing as Russian attacks on power infrastructure continue, despite the institution of a pause on strikes against energy infrastructure in the spring. According to Ukraine's Ministry of Energy, the country's power sector saw over 3 100 disruptions due to Russian aggression between March and September 2025.

Attacks have recently ramped up, in line with what has become a seasonal pattern. On 7-8 September 2025, Russia conducted its largest-ever air attack on Ukraine since the beginning of its full-scale invasion in February 2022, significantly impacting energy infrastructure. During that attack, 19 drones severely damaged the recently rebuilt Trypilska Therman Power Plant, which had initially been destroyed in spring 2024. Russia continued to escalate its drone campaign against energy infrastructure throughout September – deploying almost 6 900 drones, a substantial increase from 2024 levels. On 10 October 2025, another massive attack by Russia targeted energy infrastructure across Ukraine, causing serious damage to several thermal power plants in Kyiv and leaving 800 000 residents without power.

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### Monthly Russian attacks on Ukraine per weapon type




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Sources: IEA analysis based on dataset available on kaggle (2025), Massive Missile Attacks on Ukraine, compiled by Petro Ivaniuk and publicly available statements on drone and missile attacks by the Ukrainian Ministry of Defence and the Ukrainian Government.

# Gas production also made a strong recovery, but new attacks have left a substantial supply deficit

Natural gas plays an important role in ensuring heat and electricity supply security in Ukraine, and gas-fired power plants are an important provider of flexibility for the power system. As with the power sector, natural gas infrastructure has been widely damaged by missile and drone attacks.

In early 2025, the country's gas sector was heavily targeted, resulting in a 40% loss in production, temporary shutdowns and the need for higher gas imports to cover demand for the upcoming heating season. Storage levels were already low compared with recent years (in April 2025, they were 80% lower than in 2024). Going into the summer, Naftogaz – Ukraine's national oil and natural gas company – announced a 2025 storage target of 13.2 billion cubic metres (bcm). That was up from 12.8 bcm in 2024 and put its import needs at a minimum of 4.6 bcm.

Between April and September 2025, net storage injections surged by 70%. This strong increase brought Ukraine's gas storage levels (including buffer gas) very close to the target,

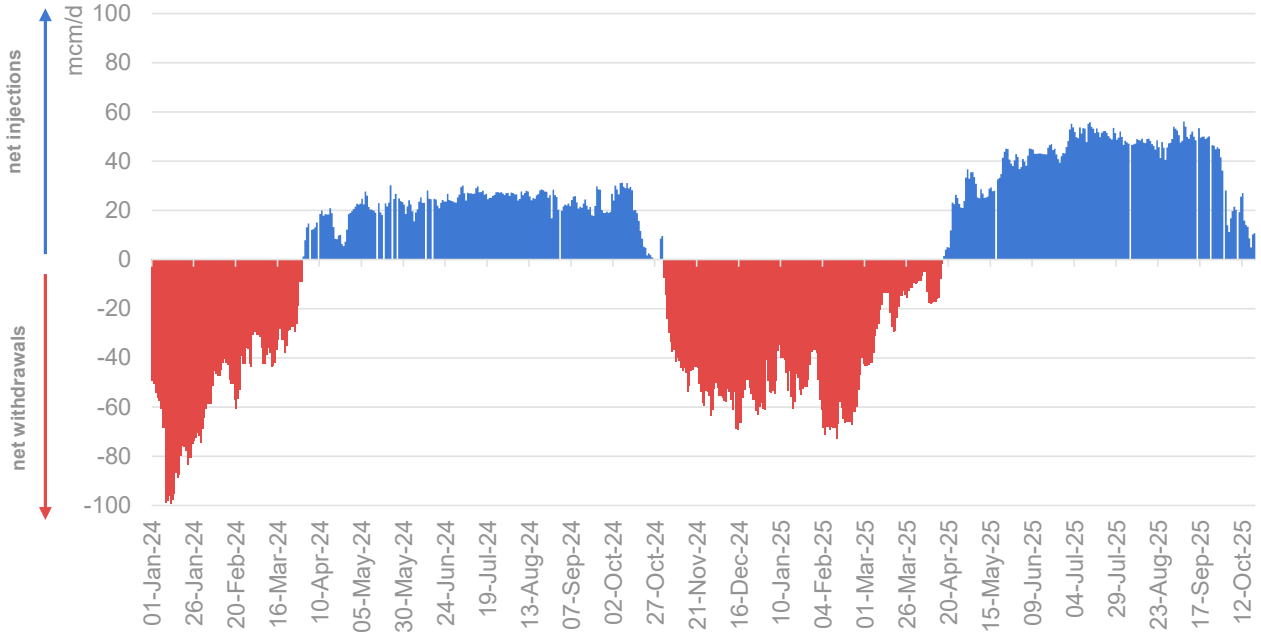
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with 13 bcm of gas injected into storage as of 16 October 2025. Most volumes came from Hungary, Poland and Slovakia, but Ukraine also began to look to imports of liquefied natural gas (LNG) from the United States as another option. About 400 million cubic metres (mcm) of US LNG was shipped by September via Lithuania and Poland, with further volumes planned by the end of 2025.

In order to purchase this gas, Ukraine has had to rely on loans and grants, including an EUR 500 million loan from the European Bank for Reconstruction and Development (EBRD), backed by the European Commission; an EUR 300 million loan from the European Investment Bank (EIB); and a grant of EUR 83 million from Norway.

Ukraine was able to use the spring and summer as an opportunity to fully recover production capacity. Then, on 3-4 October 2025, Russia carried out its biggest attack on Ukraine's gas infrastructure since the beginning of the full-scale invasion, severely damaging production facilities in the Kharkiv and Poltava regions. According to government sources, almost 60% of gas production is currently offline as a result. Another attack on 16 October further damaged gas production in eastern Ukraine, as well as a gas processing plant. Naftogaz was able to quickly secure a EUR 62 million loan from Ukraine's Oschadbank for further gas imports, and it is in talks with the EBRD and others regarding further loans and grants. However, if Russia continues to attack gas production infrastructure at the same rate, Ukraine may need to increase its reliance on imports, with at least an additional 4.4 bcm needed before March 2026 to get through the current heating season. A colder-than-expected winter could further exacerbate the gas deficit.

**Net storage injections and withdrawals in Ukraine, January 2024 – September 2025**




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Sources: Aggregated Gas Storage Inventory (2025).

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Meanwhile, Ukraine's district heating sector, which relies heavily on natural gas for water heating, also continues to be a major target. By the end of 2024, at least 18 combined heat and power plants, over 800 boiler houses and 354 kilometres of heating pipes had been attacked. As another heating season approaches, Russia has begun to target smaller thermal power plants (TPPs) and combined heat and power plants near the frontlines.

# As Ukraine heads into another heating season, six measures can help improve energy security

Air defence remains the best method to protect Ukraine's critical energy and civilian infrastructure. However, there are other steps that can be taken to increase Ukraine's energy security ahead of and during the coming winter. The IEA proposes six key actions for Ukraine and its partners to help address ongoing energy security challenges.

## Action 1: Boost protections for critical energy infrastructure and continue improving equipment supply chains

Strengthening the security of critical energy infrastructure across Ukraine is vital to maintaining capacity this winter. A multilayered defence strategy, whereby air defence is combined with passive defence measures, can serve as a strong means of protecting key energy facilities. Ukraine has been investing in lighter passive defence – such as gabions and sandbags, as well as anti-drone netting – as well as a second level of protection whereby reinforced concrete structures are erected around important infrastructure such as substations and autotransformers. These measures, combined with air defence, have successfully repelled some recent attacks. However, further investment remains necessary as Russia continues to update its attack strategies and increase the number of drones and missiles deployed.

Efforts to optimise supply chains for key energy equipment also remain crucial, as regular attacks increase the need for frequent repairs and repurposed parts tend to wear down faster. The logistics around commissioning and shipping crucial spare parts, vehicles and equipment remain cumbersome due to administrative and regulatory bottlenecks, equipment compatibility issues and funding gaps. Given the ongoing importance of importing and delivering spare parts, Ukraine should continue assessing which materials already in the country could be repurposed, while working closely with international partners – such as the Energy Community's Energy Support Fund and the G7+ Energy Coordination Group, to speed up deliveries and sourcing. Adjusting funding mechanisms to cover not only equipment, but also delivery, installation and technical adaptation, would also close key gaps.

Additionally, accumulating stocks of spare parts and vehicles would allow Ukraine to flexibly respond to shifting attack patterns. Strategic stockpiles, both in Ukraine and neighbouring countries, could expedite the delivery of emergency equipment while ensuring that not all

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stockpiles could be targeted. Finally, stronger coordination between Ukraine's energy sector stakeholders and the State Customs Service to anticipate new equipment imports and adjust regulations – particularly for dual-use energy equipment – would allow them to reach their destinations sooner.

## Action 2: Further increase and decentralise power supply

It is more complicated and costlier for Russia to target and attack wind turbines and small gas plants, for example, than larger, more centralised power plants. As a result, continuing to decentralise the power system and add distributed generation strengthens Ukraine's energy security and makes the grid more resilient to attacks. This is laid out in the IEA's roadmap, *Empowering Ukraine through a Decentralised Energy System*, which highlights the vital role of distributed energy resources in addressing the country's power deficit while also enhancing the resilience and flexibility of its energy systems.

Over the past year, businesses and households have continued to add distributed gas generation, large-scale diesel generators and solar PV capacity, reflecting a consistent shift towards decentralised energy as a tool to enable stable energy supplies. Meanwhile, batteries and energy storage systems are playing an increasingly crucial role in strengthening Ukraine's energy security, particularly during emergencies and grid disruptions.

Speeding up the pace of private sector investment in distributed energy resources, including batteries, would help Ukraine further diversify its power mix and quickly increase system resilience. Mechanisms such as the state-owned Export and Investment Fund of Denmark (EIFO), which backs the DTEK Tyligulska Wind Farm; the EBRD; and the European Commission's Ukraine Renewable Energy Risk Mitigation Mechanism can play a significant role in supporting Ukraine's energy sector, enabling urgently needed investment in critical infrastructure and making large-scale distributed energy projects bankable by helping to reduce risks.

## Action 3: Keep optimising the use of electricity connections with Europe while stabilising domestic grids

Since Ukraine's synchronisation with the European grid in March 2022, cross-border capacity for electricity trade has steadily expanded, while the shift to a weekly recalculation since June 2025 has improved flexibility in the range of several hundreds of megawatts. This has allowed TSOs to respond to real-time system conditions and maximise opportunities both for imports during peak demand and exports when generation is sufficient.

Even so, realistic options to increase interconnection capacity beyond current levels appear limited in the near-term. Cross-border transmission capacities are constrained by grid congestion in both Ukraine and neighbouring EU countries. In the short-term, the focus

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should be on maximising the use of existing infrastructure, continuing regulatory improvements to optimise capacity calculations, and complementing grid connections with distributed solutions to improve resilience during periods of peak demand. At the same time, both Ukraine and its European partners should work together to address bottlenecks in their respective transmission networks to unlock additional cross-border capacity. Accelerating grid infrastructure projects throughout the region will be critical for the next several years and beneficial for further integration.

Meanwhile, power sector stakeholders must signal to Ukraine's partners, as well as to investors, that regulatory stability, transparency and strong corporate governance remain priorities despite the acute challenges of ongoing Russian attacks. Maintaining and strengthening corporate governance for Ukraine's energy companies in accordance with OECD and EU standards will allow for both predictability and cooperation, two pillars for tackling energy security challenges.

## Action 4: Continue to fill gas storage, diversify imports and buy smart

Additional steps can be taken to ensure Ukraine will be able to fully meet its winter gas demand needs, thereby safeguarding energy security. Further increasing the volume of gas stored would help prevent winter supply crunches. Fortifying critical gas infrastructure is also crucial for ensuring stable supplies throughout the winter. While Ukraine's vast underground facilities are resilient, above-ground assets such as compressors remain exposed. Meanwhile, turning to multiple suppliers and utilising varied import routes, such as the Vertical Corridor and the Lithuania-Poland gas interconnectors, would reduce risks, including from damaged infrastructure. Prioritising the reinforcement of key heating infrastructure and encouraging local backup systems would also help maintain supply during disruptions.

The large storage capacity Ukraine has today presents opportunities as well. These can be maximised by buying gas when prices are low and avoiding rigid storage targets, while managing price risks with hedging and long-term contracts. Securing deals with countries and traders to store more gas in Ukraine would also help improve the stability of the storage system, while ensuring that volumes are accessible and available for purchase should Ukraine need them. If Ukraine's partners can work together to reduce the risk premium associated with storage, this could boost uptake and help Ukraine manage future winter supply uncertainty. From reinforcing infrastructure to purchasing gas for storage, ongoing international funding from Ukraine's partners will be crucial.

Meanwhile, efficiency measures can simultaneously help manage gas demand, along with robust contingency planning that ensures energy priorities are met during demand peaks or in the event of supply shortages.

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## Action 5: Prepare backup options for winter heating and keep decentralising

Making sure citizens have backup options for winter heating is of utmost importance, particularly in the east, where attacks have been concentrated, and rural areas. Alongside smaller combined heat and power units, liquid petroleum gas heaters, wood and coal stoves – and backup fuel supplies for them – are key. A colder-than-average winter combined with further attacks would exacerbate underlying weaknesses in Ukraine's district heating network, such as aging infrastructure and rising inefficiency.

Decentralisation also has a strong role to play in heating. Households and businesses have started installing biomass boilers and heat pumps, particularly in smaller towns. Combined with municipal-level cogeneration units, which can be used for both backup electricity as well as heat, towns and cities can strengthen the resilience of their systems and reduce their dependence on bigger thermal power plants that remain vulnerable to Russian attacks.

## Action 6: Continue coordination efforts between Ukraine and its partners to address pressing needs

Ukraine's energy system faces challenges year-round, but winter brings increased vulnerabilities. As the government and energy companies work hard to protect, maintain and repair access to energy, Ukraine's partners should endeavour to streamline coordination efforts and make sure Ukraine has the support it needs to carry out the recommendations above. International financial institutions, partner governments, non-governmental organisations and industry stakeholders will need to work together closely to address both the immediate risks and medium-term challenges that Ukraine faces across the electricity, gas and heating sectors.

This winter is likely to be a difficult one, and Ukraine will need to utilise every possible means of keeping power and heating accessible for its citizens. These actions are underway, but in order to further reduce underlying risks and strengthen resilience, Ukraine and its partners must continue to proactively monitor the situation, rapidly assess changing needs and be ready to act quickly as needed.

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