

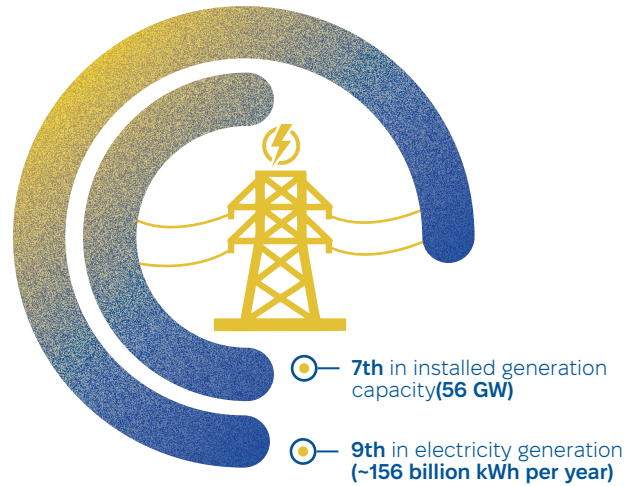


CHAPTER 1

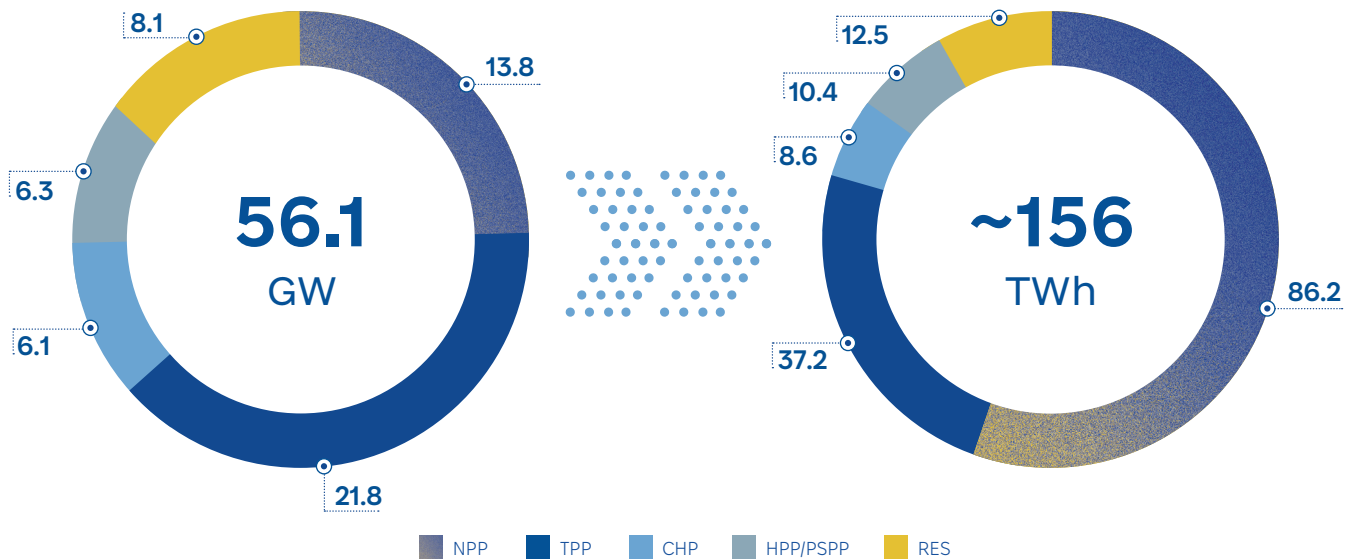
Electricity Generation in the Context of War: Critical Consequences and Areas of Recovery

1.1. Current state of the power system

Before the full-scale invasion, **Ukraine's energy system was one of the largest among European countries** and ranked 9th in terms of electricity generation, approximately 156 billion kWh per year. The basis of Ukraine's energy mix was nuclear generation - 13.8 GW of installed capacity (24.6% of total) accounted for over 55% of electricity generation in 2021. Thermal generation using coal and natural gas played a significant role - 27.9 GW of installed capacity (49.8% of total) provided 29.1% of generation. RES developed dynamically - in 2021, the installed capacity of RES amounted to 8.1 GW (14.4% of total) and the volume of electricity generated by RES was 8.1% of the total generation.



Installed capacity, GW, and electricity generation, TWh in 2021



Ukraine's energy sector has suffered some of the biggest losses as a result of the war, in particular due to massive shelling and destruction of power generation facilities. **As of September 2024, the total loss of generating capacities due to Russian attacks, which began in**

March of the same year, exceeded 9 GW. In addition, approximately 18 GW of generation capacity has been occupied by Russian forces, including HPP, TPP, RES, and the largest nuclear power plant in Europe — Zaporizhzhya NPP (6 GW).

\$16.1bn

Direct losses to Ukraine's energy sector due to Russia's full-scale invasion

\$50.5bn

Energy sector rehabilitation needs, which include the complete reconstruction of destroyed facilities based on the principle of "rebuilding better than before"

Detailed information on the destruction of Ukraine's energy sector as a result of Russia's full-scale invasion is available in the KSE analytical report https://kse.ua/wp-content/uploads/2024/06/KSE_Impact-of-the-war-on-energy_ENG-1.pdf (May 2024).

Electricity production in Ukraine is dominated by NPPs, which generate stable volumes of electricity, and RES, which depend on weather conditions. **This energy mix does not ensure a balance between generation (supply) and consumption (demand), as seasonal and daily weather variations significantly increase the risk of imbalances in the energy system.** Previously, thermal

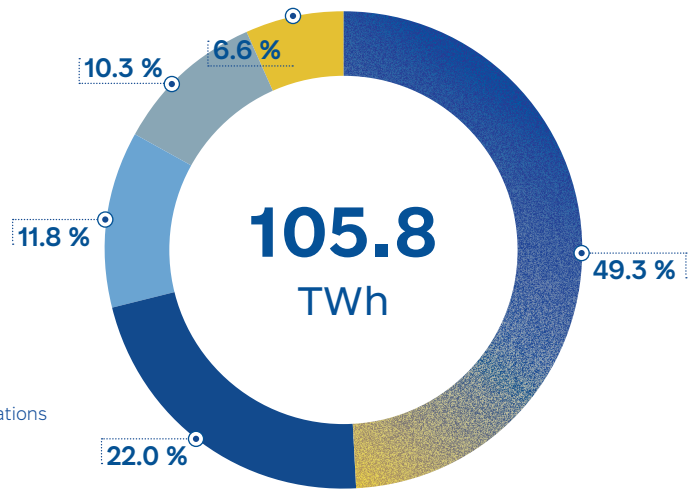
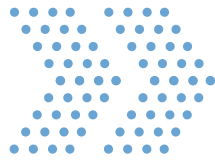
and hydropower generation served as stabilizers, allowing the system to handle peak loads. Now, to address the deficit, Ukraine relies on electricity imports from ENTSO-E or balances consumption through power outages. This is one of the key challenges that must be resolved.

CHALLENGE:

Balancing the power system, considering seasonal and daily fluctuations and regular massive Russian attacks

Total available installed capacity (GW) and structure of electricity generation (TWh), 2023

≈18
GW



■ NPP ■ TPP ■ HPP and PSP ■ RES ■ CHP and Block Stations

Source: NEURC public data

Despite the ongoing hostilities as the energy sector remains one of the main targets of Russia's military aggression, Ukraine is conducting **the largest repair campaign of energy facilities in the history of its independence and is commissioning new generation facilities.**

Further recovery of Ukraine's energy sector is expected to become the foundation for the development of the country's economy as a whole. The cornerstones of this effort are the full **integration of Ukraine's energy markets with European ones and the attraction of foreign private capital to the Ukrainian energy sector.**

The government and the private sector, together with international partners, are focusing their efforts on restoring and developing energy infrastructure:

- In 2022, about 312 MW of new RES capacities were built, and in 2023, about 350 MW were commissioned (SPP, WPP, biogas plants and small HPP¹);
- In 2023, DTEK invested about \$300 million in energy infrastructure, and USAID provided \$475 million

in emergency assistance to strengthen Ukraine's energy sector;

- During the Ukraine Recovery Conference in Berlin (URC-2024), 12 cooperation agreements were signed with financial institutions and energy companies, including memoranda of understanding with Siemens Energy AG, Deutsche Bank AG, GE Vernova, Voith Hydro and Ukrainian companies to develop the production and supply of energy equipment².
- In addition, several important financial commitments were made during URC-2024 to support Ukraine's energy system³:
 - The United States and Germany agreed to provide \$824 million and €30 million respectively to support Ukraine's energy infrastructure;
 - The World Bank provided an additional grant of \$47 million for the purchase of thermal equipment for Kharkiv, including 1,000 generators and solar panels.

¹ - <https://www.kmu.gov.ua/news/herman-halushchenko-ukrainska-enerhetyka-naroshchuie-potuzhnosti-vde-i-stane-klimatychno-neitralnoiu>

² - <https://www.mev.gov.ua/novyna/urc-2024-za-koordinatsiyi-minenerho-ukladeno-12-uhod-pro-spivpratsyu-z-partneramy-dlya>

³ - <https://www.kmu.gov.ua/news/na-konferentsii-z-vidnovlennia-ukrainy-bulo-ukladeno-bilshe-100-mizhnarodnykh-uhod-premier-ministr>

1.2. Prospects for the development of electricity generation

Despite the challenges facing Ukraine’s energy system, its capacity losses as a result of the Russian criminal attacks and the resulting destruction of infrastructure, Ukraine is working to ensure that its consumers have electricity now and in the future. Although the war is ongoing, Ukraine is fulfilling its international obligations and not abandoning its climate goals. The green recovery in the energy sector aims to create a new architecture of the energy system based on **sustainability, green transition principles, and energy affordability.**

An important element of building a sustainable and resilient energy system is the **development of distributed generation capabilities**, which reduce the system’s dependence on centralised electricity and decrease the vulnerability of heat suppliers to enemy attacks. In addition, generating energy closer to the point of consumption minimises electricity and heat losses during transportation, making energy supply more efficient.

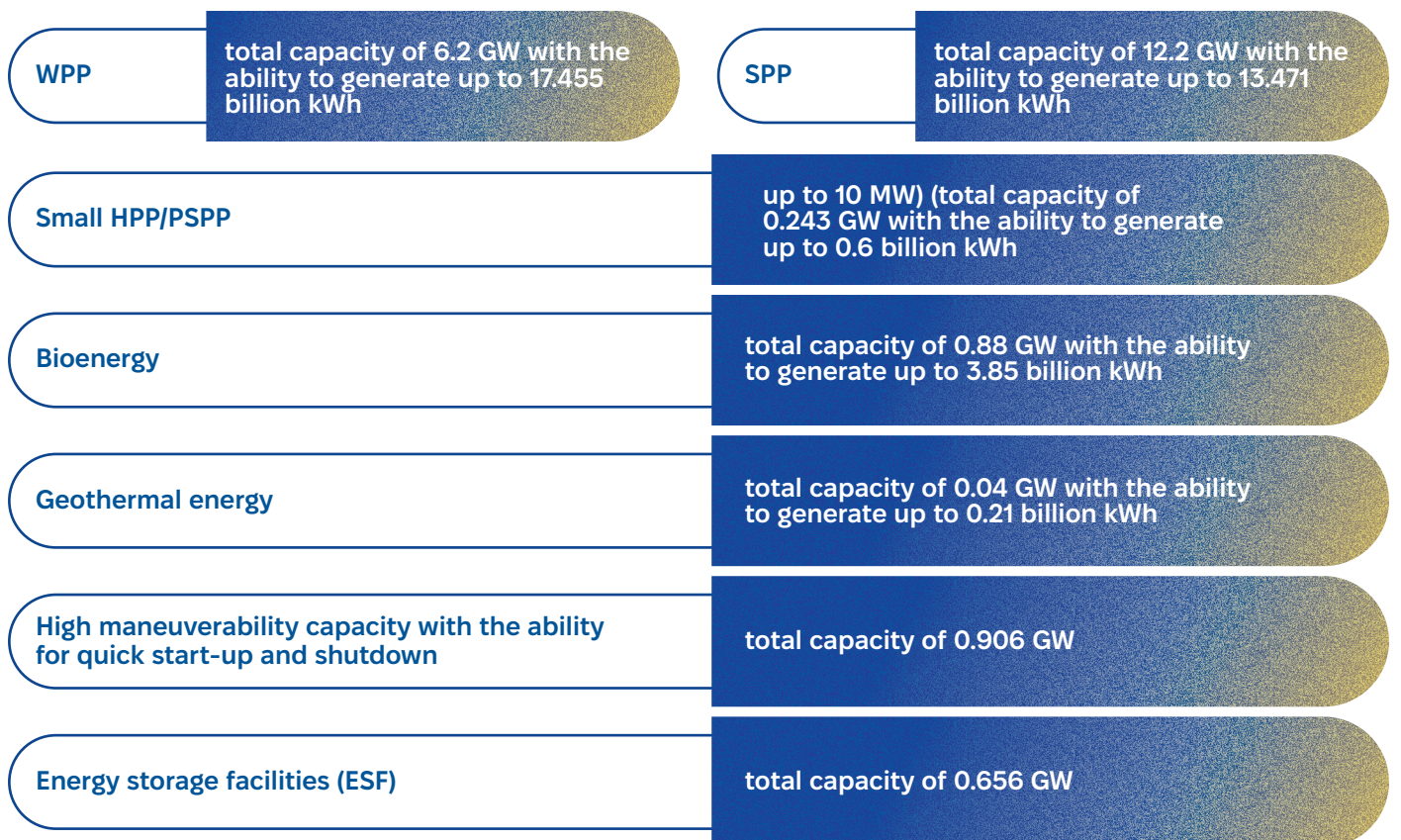
During the war, **nuclear power generation has demonstrated its foundational role in Ukraine’s energy system.** Despite the ongoing attacks on energy infrastructure with missiles and drones, nuclear power plants have not been directly targeted. As of the second half of 2024, nuclear generation produces about 60% of Ukraine’s electricity and remains the base source for

power generation. Its criticality in stabilizing the system reflects that **Ukraine needs to implement nuclear power development projects now to meet the growing need for affordable and low-carbon energy, as it rebuilds its economy after the war.**

At the same time, **RES remains one of the most promising areas for the development of the domestic energy sector**, as they not only contribute to the green transition of Ukraine’s economy, but also simultaneously increase energy security and resilience of the entire energy system. Additionally, RES are important for the gradual integration of Ukraine’s energy market with the EU market (EU Green Deal), which prioritises green energy production while reducing CO₂ emissions within the framework of the Fit for 55 package⁴.

In 2024, the Government approved the National Energy and Climate Plan until 2030⁵ and the National Renewable Energy Action Plan up to 2030⁶. Among its other objectives, the plan aims to achieve **a RES contribution of at least 27% in the gross final energy consumption structure by 2030.**

According to the National Renewable Energy Action Plan until 2030, Ukraine plans to increase its total RES capacity by **21.1 GW** of installed capacity, namely:



⁴ - <https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal>

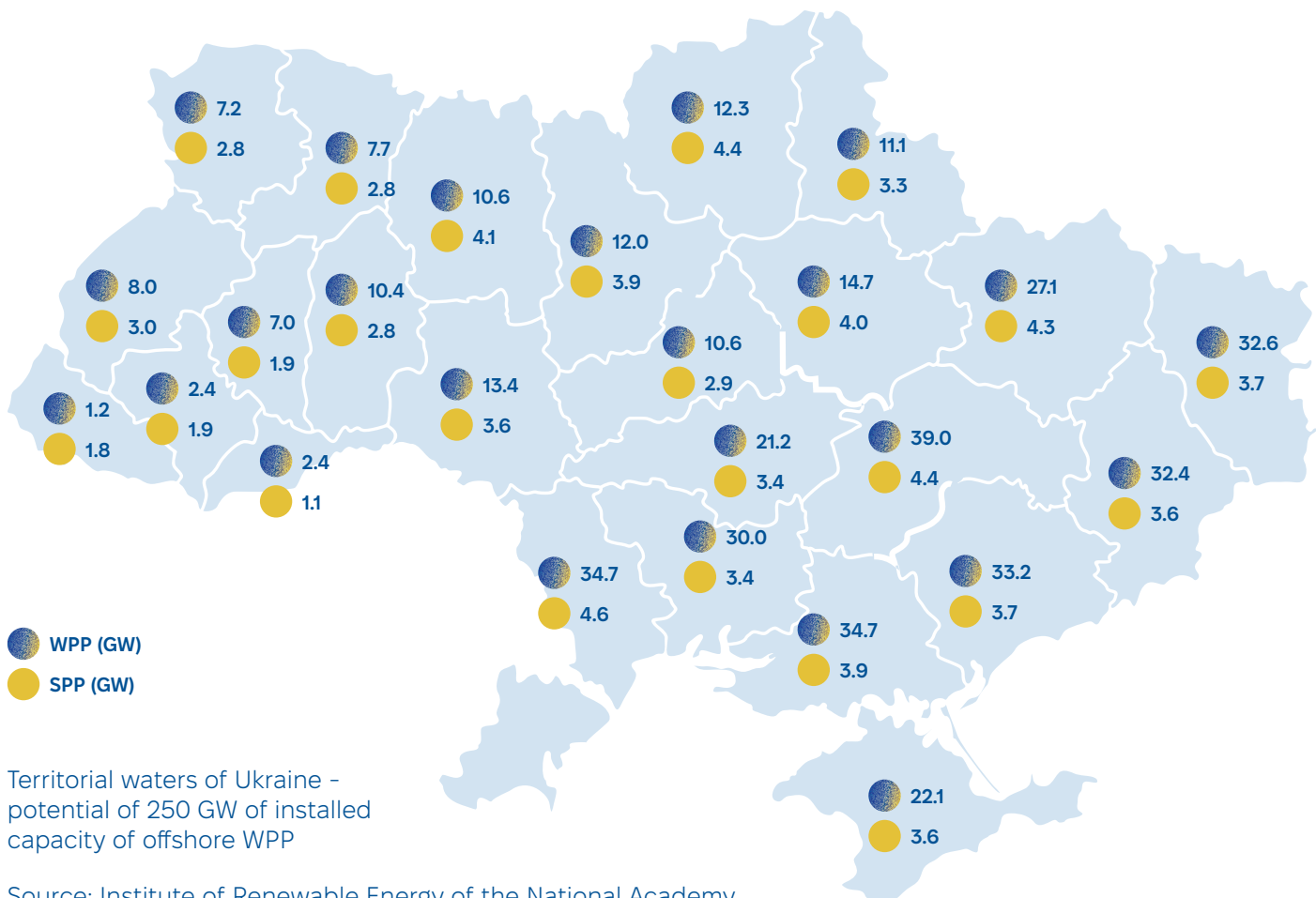
⁵ - <https://me.gov.ua/Documents>

⁶ - <https://zakon.rada.gov.ua/laws/show/761-2024-%D1%80#Text>

Ukraine is one of the most promising countries in Europe for the development of RES - **the potential for the construction of RES throughout Ukraine is more than 750 GW of installed capacity⁷:**

- more than 83 GW for SPP;
- more than 680 GW for WPP.

Geography of RES energy potential



Source: Institute of Renewable Energy of the National Academy of Sciences of Ukraine

These capacities are sufficient to produce more than 2,200 TWh of electricity annually, which is equal to ~80% of the annual electricity consumption of all EU countries. This makes Ukraine an important partner for

the EU's green transition and the decarbonisation of the European economy, through the export of green energy and green hydrogen.

⁷ - <https://www.ive.org.ua/wp-content/uploads/atlas.pdf>