2 Main market features

This chapter provides an overview of the main features of Ukraine's electricity sector. It begins with a short review of the sector's history. This is followed by a description of the electricity supply chain from generation to consumption, which includes a survey of the main market participants, an examination of the country's changing electricity generation capacity and energy mix, a summary of market support measures for generation using renewable energy sources and an outline of plans for developing the network, including the integration of Ukraine's electricity market with EU markets.

Electricity is one of the most widely used forms of energy and an essential part of modern life. In developed economies, households and businesses rely on the uninterrupted supply of electricity. The production of almost all goods requires the use of electricity in some form or another.

A key feature of electricity is that it cannot currently be stored economically on a large scale.[1] This means that its production and consumption must be balanced at all times. Any imbalance can result in power losses or blackouts, with serious economic and social consequences. Keeping power systems in balance is made difficult by constant variations in both generation and consumption.

In most countries, the electricity sector is generally highly regulated for safety reasons and to minimise the risk of supply interruptions to consumers. Regulation is also used to protect consumers from high prices, especially from parts of the system operated by natural monopolies. The scope of price regulation varies between countries, often going well beyond limiting the pricing power of natural monopolies.

The main actors in the electricity market are producers/generators, suppliers/retailers, traders, consumers and network operators. They interact with one another in different marketplaces, mostly the wholesale and retail markets.

Producers or generators are typically large entities operating multiple power plants and selling their output on the wholesale market. Small-scale generation by individuals, small businesses and communities is growing worldwide, but in most countries it accounts for a tiny proportion of overall production. Producers can be differentiated in terms of flexibility; power plants that use different fuels have substantially different capabilities to adjust output rapidly. Nuclear power plants (NPPs), for instance, are generally unable to substantially adjust output at short notice, while gas-fired and hydro power plants are far more flexible. Flexible output is essential for balancing power systems in real time.

Suppliers or retailers buy electricity from producers on the wholesale market and sell it on the retail market to end users. Suppliers procure fixed amounts of electricity on the wholesale market but provide fully flexible supply (subject to the technical limits of connections) to their customers.

Electricity consumers range from large industrial consumers to other businesses and public entities to individual households. In the retail market, consumers and suppliers conclude supply agreements. Industrial consumers with sufficiently large demand for electricity can and often do purchase directly on the wholesale market, but this requires a certain level of market expertise.

Network operators ensure the transport of electricity from the point of generation to the point of consumption. Two types of electricity networks exist: transmission and distribution. Transmission networks carry electricity over long distances at high voltages. Distribution networks run at lower voltages and take electricity from the transmission system into homes and businesses. The electricity network is generally considered a natural monopoly and is operated by a single company over a certain area. As such, transmission and distribution tariffs are typically regulated.

Understanding the current state of competition in Ukraine's electricity market requires some knowledge of the historical context. This chapter provides a brief historical overview of electricity sector reforms in Ukraine since the country's independence in 1991, followed by an overview of the sector's main elements: consumption, generation, transmission, distribution, supply activities and cross-border flows.

2.1. Electricity sector reforms

Ukraine started to build an independent energy sector in 1991 amid the dissolution of the Soviet Union, of which it had been part. At the time, the Ministry of Power and Electrification proposed reforming the sector by introducing the British power market model, aiming to restructure and create a wholesale market for electricity.

Following this proposal, in May 1994, then-President Leonid Kuchma issued a decree to unbundle the vertically integrated state monopoly, which controlled the entire supply chain, and introduce competition in electricity generation by establishing a national wholesale market (Lovei, 1998[1]). In 1994, independent energy regulator the National Energy Regulatory Commission (NERC)[2] was established. It was given responsibility for issuing and monitoring licences for electricity generation, high- and low-voltage transmission, wholesale market operations, and setting retail prices and network tariffs (Lovei, 1998[1]). Following the establishment of the wholesale market in 1996, power production, transmission, distribution and regulated supply were operationally separated.

Under the new market model, Ukraine established Energorynok, a state-owned company acting as a single buyer in the wholesale market. It purchased electricity from generators at regulated prices and sold it to unregulated suppliers and to regional electricity supply and distribution companies known as *oblenergos* (OECD, 2019[2]) (OECD, 2019[2]). *Oblenergos* sold electricity to consumers at regulated retail prices based on the costs of generation, transmission, distribution and other factors.

The reform laid the foundations for competition in electricity generation and supply in three ways. First, several generators and suppliers were licensed to produce and sell electricity. Second, the wholesale market proved its ability to evaluate hourly bids, dispatch power accordingly, determine financial claims and obligations, and carry out financial transactions to settle claims among market participants. And third, the NERC set the tariff for access to high- and low-voltage networks. Yet despite the new structure, the main promises of the reform – attracting investment and the depoliticisation of electricity price setting – were not fulfilled (Lovei, 1998[1]). A key factor in this is likely to have been the economic instability the country experienced following the dissolution of the Soviet Union.

The electricity sector liberalisation of the 1990s was expected to be coupled with privatisation, but that did not proceed as expected. The government launched its first privatisation of coal mines in 1996, followed by that of *oblenergos* in 1998 (IEA, 2006[3]). However, only six of the country's 27 *oblenergos* were fully privatised by 2001, while the remaining 21 were only partly privatised. Difficulties occurred due to a lack of agreement within government on the privatisation process, concerning issues such as the size of ownership stakes to be retained by the state (Lovei, 1998[1]).

A second attempt to reform the sector took place in 2002. The Cabinet of Ministers of Ukraine (CMU) issued a decree outlining a new market design based on three types of transactions: bilateral contracts, standard agreements through an exchange, and a balancing market.[3] However, implementation of this market design was delayed due to the need for legislative changes. Attempts were made to pass the required legislation but were ultimately unfruitful until Ukraine joined the Energy Community in 2011 and reforms started to be implemented.

In 2004, the government decided to increase state control over the energy sector, with the aim of improving the management of power sector enterprises. It reconsolidated the electricity and coal industries into large, vertically integrated companies. Two new entities were created: the Energy Company of Ukraine, which re-acquired operational control over electricity retail companies with stakes varying from 25% to 100%, and Coal of Ukraine, which consolidated state-owned coal mines (IEA, 2006[3]). The latter was soon abolished and its assets were transferred to the Ministry of Coal Industry.

In 2011, a new government formed under President Viktor Yanukovych made a second attempt to privatise *oblenergos*. The CMU adopted a decree permitting the sale of 13 *oblenergos*, with a further ten added in 2012 (Baker McKenzie, 2021[4]). A large-scale sale of *oblenergos*' shares was planned for November 2014. However, only 25% of the shares of *oblenergos* Zakarpattiaoblenergo, Vinnytsiaoblenergo and Chernivtsioblenergo were sold. In August and September 2017, the State Property Fund of Ukraine sold further minority stakes (25%) in *oblenergos* Dniproenergo, Dniprooblenergo, Kyivenergo (which also had distribution activities), Zakhidenergo and Donetskoblenergo (Baker McKenzie, 2021[4]). Overall, the sale of *oblenergos* proved difficult as the state was often unable to sell their shares, and even when shares were sold, *oblenergos* typically remained under majority government control.

This second attempt to privatise *oblenergos* occurred in tandem with a further reform of Ukraine's energy sector. In February 2011, Ukraine officially joined the Energy Community (European Commission, 2010[5]), with the aim of reshaping its energy sector in line with the European model. Following Ukraine's accession to the body, the wholesale market reform proposal previously initiated by the Cabinet of Ministers was enacted in a new market law. In 2013, Ukraine's government took the first step towards liberalising the electricity market and adopted a new law on the functioning of the electricity market[4] outlining the main features of the future market. The following year, Ukraine signed an association agreement with the EU[5] that entailed complying with the Third Energy Package and integrating its electricity system with the European Network of Transmission System Operators for Electricity (ENTSO-E). To this end, in 2017 the government introduced the Electricity Market Law (EML),[6] which envisaged the replacement of the single-buyer market model with competitive market elements. After the entry into force of the EML, the main institutions responsible for its implementation (the Cabinet of Ministers, the NERC, the Ministry of Energy, the Transmission System Operator [TSO] and the Market Operator [MO]) started preparing secondary legislation for the new market model. Several documents to regulate the new market were developed, including the Market Rules,[7] the Day-Ahead and the Intraday Market Rules (DAM/IDM Rules), the Retail Market Rules, the Transmission Network Code, the Distribution Network Code, the Commercial Metering Code and the Licence Terms and Conditions.

The new framework entered into force in two phases in 2019. The first was the opening of the retail market to competition on 1 January. The second was the establishment of the wholesale market on 1 July. In practice, it meant switching from a single-buyer model to a competitive market structure with bilateral contracts and day-ahead, intraday and balancing markets. Energorynok, the market operator under the previous model, was assigned liability for debts accumulated during the operation of the single-buyer model. In its place, two new companies were created: the Guaranteed Buyer (GB) and the MO. The GB was tasked with taking over and paying for electricity from renewable energy producers under the feed-in-tariff (FiT, also referred to as the "green" tariff) mechanism, and the MO became responsible for the operation of the DAM and the IDM. Transmission system operator Ukrenergo received new tasks, including operating the balancing and ancillary services markets, registering bilateral agreements, and serving as a settlements and commercial metering administrator. The energy regulator became responsible for adopting the Market Rules, the DAM/IDM Rules and the Retail Market Rules, developing transmission, distribution and commercial metering codes, and drafting licensing terms (OECD, 2019[2]). The structure of Ukraine's electricity sector is described in detail in Chapter 3.

2.2. Overview of the electricity sector

As detailed in the previous section, Ukraine's electricity sector has undergone considerable structural reforms since its creation. This section provides an overview of main elements of the sector: consumption, generation, transmission, distribution, supply activities and cross-border flows.

Box 2.1. Main electricity market participants

Ukrhydroenergo is a state-owned hydro power company managed by the Cabinet of Ministers of Ukraine. It operates ten plants located across the Dniester and Dnipro rivers, generating around 6.7% of Ukraine's total electricity production.

Energoatom is a state-owned company under the management of the Cabinet of Ministers of Ukraine that operates four NPPs that generate about half of the country's electricity.

DTEK Group, founded in 2005, is the largest vertically integrated private holding company in Ukraine. It is involved in the production, supply and distribution of natural gas and electricity, and coal mining.

Centrenergo is one of the largest thermal generating companies in Ukraine, operating three thermal power plants. Centrenergo is state-owned and managed by the State Property Fund.

Ukrenergo is the only TSO in Ukraine. It is responsible for transmitting and dispatching electricity through high-voltage networks. Under the new market model, Ukrenergo also operates the balancing and ancillary service markets, registers bilateral agreements, and serves as a commercial metering and settlements administrator. Ukrenergo was certified by the National Energy and Utilities Regulatory Commission (NEURC) under the independent system operator (ISO) unbundling model.

Distribution system operators (DSOs) are responsible for distributing and dispatching electricity to end users. There are 32 DSOs in Ukraine, eight of which are controlled by the State Property Fund.

Suppliers (under free prices) are economic entities purchasing electricity on the market and selling it to consumers at free (unregulated) prices.

Universal service suppliers (USSs) are electricity suppliers with a legal obligation to supply residential and small, non-residential consumers at regulated prices. There are 25 regional USSs, six of which are state-owned.

Ukrinternenergo (supplier of last resort) is a state-owned supplier that provides services to consumers in exceptional circumstances, such as the cancellation of their supplier services or a failure to select a supplier. It may supply electricity for no more than 90 days at regulated prices.

The GB is a state-owned company responsible for ensuring public interest in increasing the share of electricity generation from renewable energy sources by buying electricity from producers eligible for green tariffs and selling it on the market.

The MO is shareholding company whose shares are 100% owned by state and which operates the DAM and the IDM.

Traders are economic entities purchasing electricity for resale on the wholesale market.

Energy storage operators were introduced in Ukrainian legislation in 2022 to sell electricity released from energy storage facilities to provide ancillary and balancing services. As of March 2023, no energy storage operator licences had been granted.

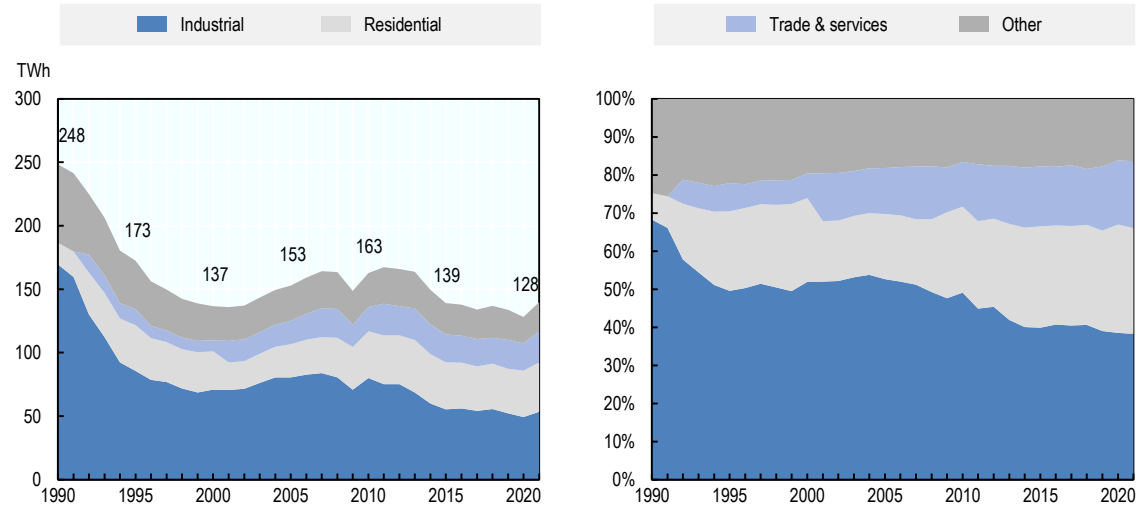
Sources: NEURC (2021[6]), The regulator publishes the results of monitoring the functioning of the retail electricity market in the first quarter of 2021, https://www.nerc.gov.ua/?news=11683; NEURC (2021[7]), The regulator publishes the results of monitoring the functioning of the wholesale electricity market in the second quarter of 2021, https://www.nerc.gov.ua/?news=12053; OECD (2019[2]) Snapshot of Ukraine's Energy Sector: Institutions, Governance and Policy Framework, https://www.oecd.org/eurasia/competitiveness-programme/eastern-partners/Snapshot-of-Ukraines-Energy-Sector-EN.pdf; Verkhovna Rada (2017[8]), Law of Ukraine about the Electricity Market, No. 2019-VIII, https://zakon.rada.gov.ua/laws/show/2019-19.

2.2.1. Electricity consumption

Ukraine's electricity system was built largely to power energy-intensive industries during the Soviet era. After the country's independence in 1991, electricity consumption decreased significantly following a sharp decline in industrial production. Consumption stabilised in the early 2000s when Ukraine entered a period of economic growth. The global economic crisis of 2008-09 led to another, albeit shorter-term, drop in consumption. Economic growth was disrupted again in 2014 following Russia's occupation of Crimea, the Donetsk and Luhansk regions.

In 2020, amid the COVID-19 pandemic, electricity demand reached a historic low of 128 TWh, around half of its 1990 level. Consumption rebounded in 2021 but fell sharply following Russia's large-scale invasion of Ukraine in 2022.

Figure 2.1. Gross electricity consumption by sector, 1990-2021

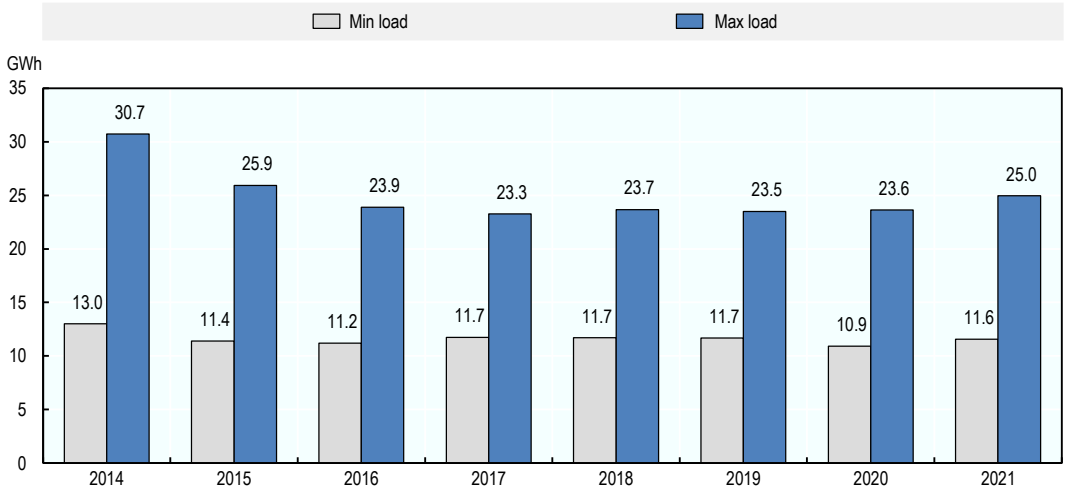


Note: Other includes transport, agriculture and power plants' own use.
Source: Ukrenergo (2022[9]), Electricity consumption by consumer groups, https://map.ua-energy.org/en/resources/742384e9-83c7-44f4-8c0b-0cd74b56561b/.

The structure of consumption has also changed dramatically since the 1990s. For example, the share of consumption accounted for by industrial use dropped from 68% in 1990 to 38% in 2021, while the share of residential consumption increased from 7% to 28% over the same period. Further, consumption by the trade and services sector grew strongly, accounting for 18% of total use in 2021, whereas consumption by the agricultural sector dropped from 11% to 3%.

In addition to overall consumption, it is worth considering the minimum and maximum levels of hourly consumption (often referred to as load). The larger the difference, the more economically challenging it is to ensure an adequate level of installed capacity and generation. Figure 2.2 shows that the difference between minimum and maximum load has decreased from 17.7 GWh in 2014 to 13.4 GWh in 2021. This is due to significant decrease in maximum load over the years.

Figure 2.2. Minimum and maximum and hourly load (IPS), 2014-21



Source: Ukrenergo (2023[10]), Hourly electricity balance of the IPS of Ukraine, https://map.ua-energy.org/en/resources/8998f2ed-379f-4fa9-9076-88782b32ee4f/.

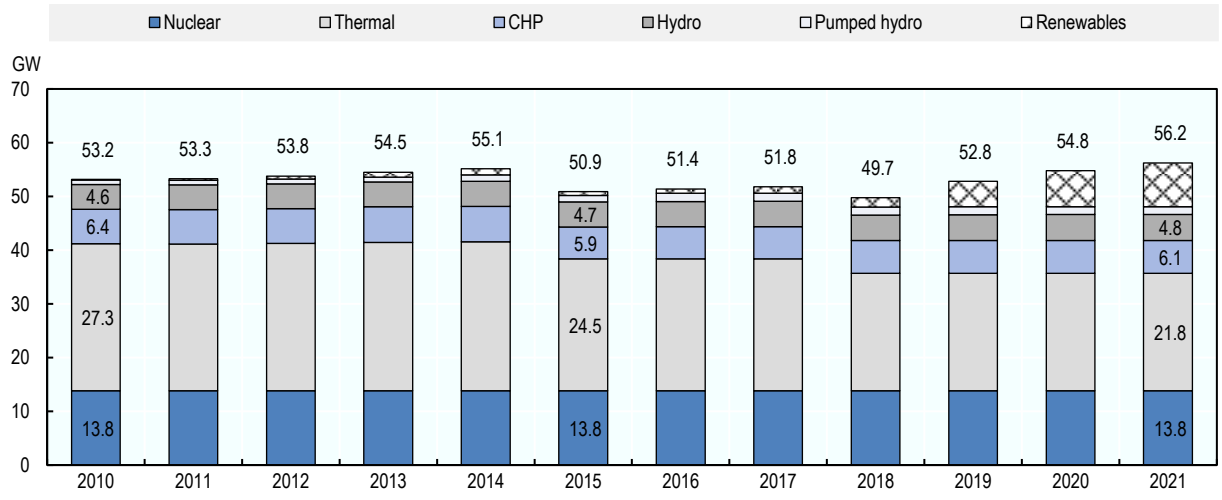
2.2.2. Generation capacity

As noted above, it is difficult to assess and verify the current state of Ukraine's generation fleet due to ongoing attacks on energy infrastructure. Before Russia's large-scale invasion in 2022, Ukraine's generation fleet was largely comprised of power stations built during the Soviet era, having not changed drastically since Ukraine's independence apart from an increase in generation capacity from renewable energy sources (RES).

NPPs (with installed capacity of 13.8 GW) serve as baseload power plants, operating continuously to meet minimum demand. Demand above this baseload is supplied largely by thermal power plants (21.8 GW). Run-of-river hydro power plants (4.8 GW) and pumped-storage hydro power plants (1.5 GW) typically serve demand increases associated with peak periods. Electricity production by combined heat and power (CHP) plants (6.1 GW) is, by design, driven mostly by demand for heating. Renewable capacity (excluding large hydro power) comprises mainly solar and wind power plants.

The development of installed capacity over the 12 years between 2010 and 2021 is shown in Figure 2.3. It has been largely stable except for a marked drop in thermal capacity that has been more than offset by an increase in renewables capacity.

Figure 2.3. Installed generation capacity by technology, 2010-21



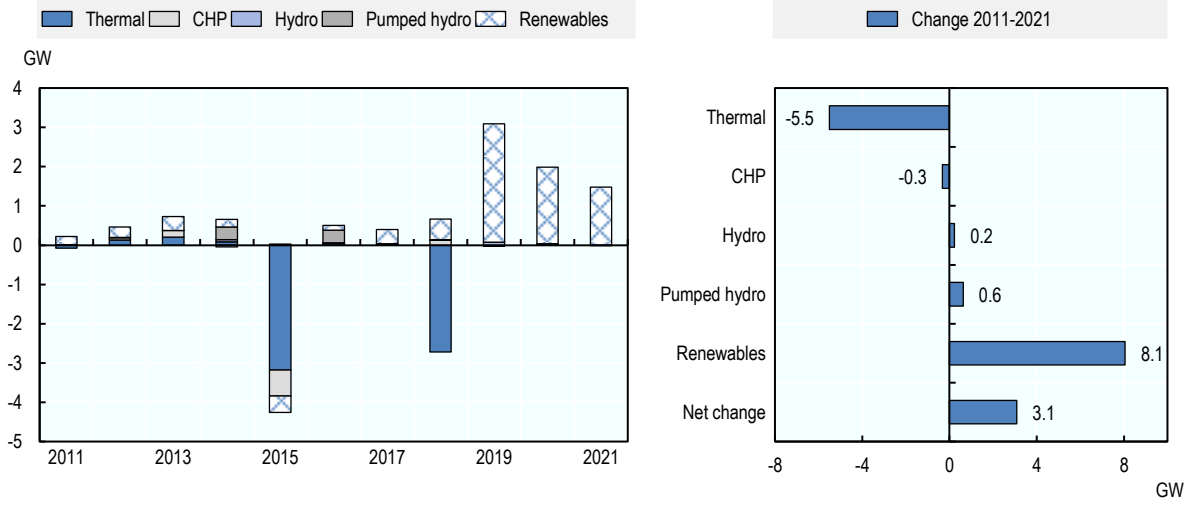
Source: Ukrenergo (2022[11]), Installed electricity production capacity by power plant types (Ukrenergo) – Energy Map, https://map.ua-energy.org/en/resources/c51a16bc-e990-40db-b790-63624d823daa/.

The first drop in thermal capacity was due to Russia's attacks in 2014 and the subsequent occupation of Ukrainian territory. Ukraine lost around 4.2 GW of generation capacity, mostly coal-fired thermal plants but also CHPs, solar and wind power plants. The second drop, in 2018, was due to the classification of some thermal generation units as "not available".

Most of the new capacity added during the past decade is based on RES. The main driver has been solar (photovoltaic) power, followed by wind. RES investments have been driven by a FiT support scheme introduced in 2009-10 that is generous by international standards. Falling capital costs of solar and wind installation have made the FiT even more attractive to investors in subsequent years.

The yearly changes in installed capacity are shown below.

Figure 2.4. Change in installed capacity, 2010-21



Note: Nuclear capacity is not shown as it remained constant over the period.
Source: Ukrenergo (2022[11]), Installed electricity production capacity by power plant types (Ukrenergo) – Energy Map, https://map.ua-energy.org/en/resources/c51a16bc-e990-40db-b790-63624d823daa/.

Nuclear power

Ukraine is one of the world's most reliant countries on nuclear energy. In 2021, 55% of its electricity production came from NPPs (Economichna Pravda, 2022[12]). Ukraine's nuclear generation serves as the baseload supply, generating a relatively stable amount of electricity throughout the year. This is also due to NPPs' limited technical flexibility to change output and their high efficiency at full load.

Box 2.2. Uranium

Ukraine is rich in uranium deposits, and in recent years domestic production has met close to 40% of its uranium ore needs. At the end of 2021, Ukraine's government approved a programme to make the country self-sufficient in uranium by 2027.

Ukraine's uranium is produced by state-owned enterprise Eastern Mining & Processing Plant (EMPP), one of Europe's biggest uranium ore extraction and processing enterprises. EMPP extracts uranium ore and produces natural uranium concentrate. It has encountered considerable financial problems in the past due to non-payment by Energoatom. In December 2020, it stopped production due to strikes related to wage arrears (LigaNews, 2020[13]). In response, the government proposed a merger between EMPP and Energoatom to facilitate debt settlement (Government Portal, 2021[14]). The idea was strongly supported by the Ministry of Energy but reportedly opposed by Energoatom's management because of EMPP's financial problems (OilPoint, 2021[15]).

Ukraine relies on other countries for nuclear fuel enrichment as it has no enrichment capacity. All nuclear fuel cells are produced abroad and imported. Ukraine had previously fully relied on TVEL, a division of Russia's Rosatom, for nuclear fuel supply. In 2005 Ukraine began implementing a strategy to diversify its supply of fuel for NPPs, licensing nuclear fuel produced by Westinghouse Electric.

Until 2021, Ukraine also relied on the Russian Federation for storage of nuclear waste. Following construction of a long-term storage facility, the Centralised Spent Nuclear Fuel Storage Facility, spent nuclear fuel from the Khmelnytskyi, Rivne and South-Ukrainian NPPs is stored in Ukraine. (Zaporizhzhia NPP has its own dry storage for waste nuclear fuel.) This contributes to Ukraine's energy independence in the nuclear sector and is expected to save Energoatom USD 150-200 million annually in storage costs.

Sources: World Nuclear News (2022[16]), Ukraine pushes for domestic uranium supply, https://www.world-nuclear-news.org/Articles/Ukraine-pushes-for-domestic-uranium-supply; OECD (2019[2]), Snapshot of Ukraine's Energy Sector: Institutions, Governance and Policy Framework, https://www.oecd.org/eurasia/competitiveness-programme/eastern-partners/Snapshot-of-Ukraines-Energy-Sector-EN.pdf; Economichna Pravda (2021[17]), The first batch of nuclear fuel was taken to the Central Storage Facility, https://www.epravda.com.ua/news/2021/11/25/680135/.

In February 2022, Ukraine had four nuclear power stations with 15 reactor units, all owned and run by Energoatom. Twelve were commissioned between 1980 and 1989, one in 1995 and two in 2004. The older units have already reached their designed lifetime of 30 years. With major investments and upgrading, Energoatom managed to extend the operating lifetime of 11 units by 10-20 years (Ukrenergo, 2019[18]). In 2020, Energoatom adopted a development strategy to modernise its facilities and further extend the lifetime of its power plants (Energoatom, 2020[19]).

The Khmelnytskyi NPP is home to two unfinished reactors on which work stopped in 1990, when construction was 75% and 28% complete, respectively. In September 2021, Energoatom and US nuclear power company Westinghouse agreed on joint completion of one of these reactors and on construction of four new AP1000 reactors at established sites in the country (World Nuclear Association, 2023[20]). In June 2022, the scope of the agreement was extended, increasing the number of planned reactors to nine (World Nuclear Association, 2023[20]).

Thermal power

Thermal power plants in Ukraine produce electricity from coal, oil and gas. Biomass and biogas are classified as renewables sources rather than thermal.

In February 2022, there were 12 thermal power plants (excluding CHP plants) in Ukraine with unit capacities ranging from 150 MW to 800 MW (The Accounting Chamber, 2021[21]).[8] The plants are of Soviet design and were commissioned between 1958 and 1977. Most of the units were modernised after 2000. Some plants are designed to be able to run on both coal and natural gas, with coal being the primary fuel. Power plants using only natural gas (with capacity of 4.6 GW) have rarely been used during the past decade. Some 2.5 GW of installed capacity is in preservation, which means it is not readily available for production. In total, out of 21.8 GW installed capacity, 15.4 GW was in active use as of 2021.

Ukraine also has three large CHP plants with four units of 100-120 MW and five of 250-300 MW.

Box 2.3. Coal

Historically, Ukraine relied on domestic coal production for its metallurgy industry, as well as for electricity and heat production. The metallurgy industry and power plants use different types of coal that are not interchangeable.

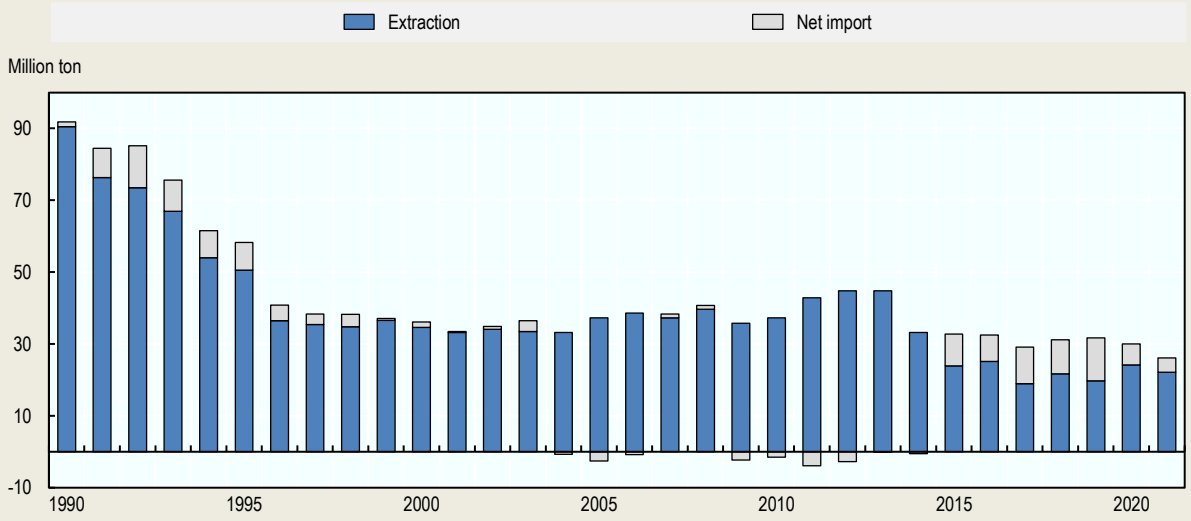
Ukraine's coal-fired power plants use two types of coal: A-grade (anthracite) and G-grade (gaseous). The share of installed capacity running on A-grade coal was 65% in 2021, with G-grade coal making up the remaining 35%.

In 2014, Ukraine lost control of 95 coal mines in the coal-rich Donetsk and Luhansk regions, including all its anthracite mines. The extraction of steam (energy-grade) coal fell from 45 million tonnes in 2013 to 24 million tonnes in 2015, a 46% drop, but coal demand by power plants fell by only 20-25%, requiring imports to fill the gap.

In 2020, domestic extraction covered 80% of Ukraine's demand for steam coal. At that time, most coal imports originated from the Russian Federation, including DTEK's imports from its mines there. In November 2021, the Russian Federation stopped exporting coal to Ukraine.

Domestic production of gaseous energy coal is split between DTEK (75%) and state-owned mines (25%). The price of DTEK's domestically extracted coal is lower than the cost of imports. DTEK's costs are also considerably lower than those of state-owned mines, which have historically relied on state subsidies to remain operational.

Figure 2.5. Coal extraction and net imports for energy production, 1990-2020



Sources: AMCU (2016[22]), Report on the results of a comprehensive study of the electric energy and thermal coal markets, http://reform.energy/media/120/81404676e3df44fcb1d2c0c437906798.pdf; Slovo i Dilo (2021[23]), Russia suspends supplies of thermal coal to Ukraine, https://www.slovoidilo.ua/2021/10/29/novyna/ekonomika/rf-prypynyaye-postavky-enerhetychnoho-vuhillya-ukrayiny-nardep; State Statistics Service of Ukraine, 2021 data, https://www.ukrstat.gov.ua/operativ/operativ2021/energ/drpeb/EBTS_2021_en.xls.

Renewables

Ukraine's renewables generation capacity consists mainly of hydro, solar and wind power plants.

Most of the country's large hydro power plants are concentrated along the Dnieper and Driester rivers. All major hydro power stations are owned and managed by Ukrhydroenergo (Ukrenergo, 2019[18]). As of February 2022, seven large run-of-river (4.6 GW) plants and two pumped hydro plants (1.2 GW) were operating in Ukraine. Most were built during the Soviet era but were extensively modernised in the 2000s.

Ukraine has more than 160 small hydro plants with total installed capacity exceeding 150 MW. Many are refurbished Soviet era facilities.

Most of Ukraine's solar and wind power plants were commissioned in 2019-21 and are located in the south of the country. More than 1 100 solar installations are in place, ranging from small rooftop installations with capacities of around 25 kW to large plants with capacities of up to 240 MW. Total installed solar capacity is 6.4 GW. DTEK Renewables, one of the largest producers, operates three solar parks: Tryfoniv (10 MW), Nikopol (200 MW) and Pokrovsk (240 MW).

Wind power has developed at a slower pace than solar power. In 2021, total installed capacity was approximately 1.5 GW. DTEK Renewables is also a leader in the wind segment, owning and operating the Botievska (200 MW), Prymorskaya (200 MW) and Orlivska wind farms (100 MW). Several foreign investors also operate wind power plants of various sizes, including Ukraine Power Resources, Güriş, EuroCape New Energy, Elementum Energy and SyvashEnergoProm.

Electricity produced from biofuels plays a minor role in Ukraine, with total capacity amounting to only around 0.3 GW.

Support for renewables

Since 2009, electricity generation from RES has been supported through a FiT system. It has been available for solar, wind, alongside small, mini and micro hydro, geothermal, biomass and biogas power plants. Large hydro power plants with generating capacity of at least 10 MW have not been eligible for this support.

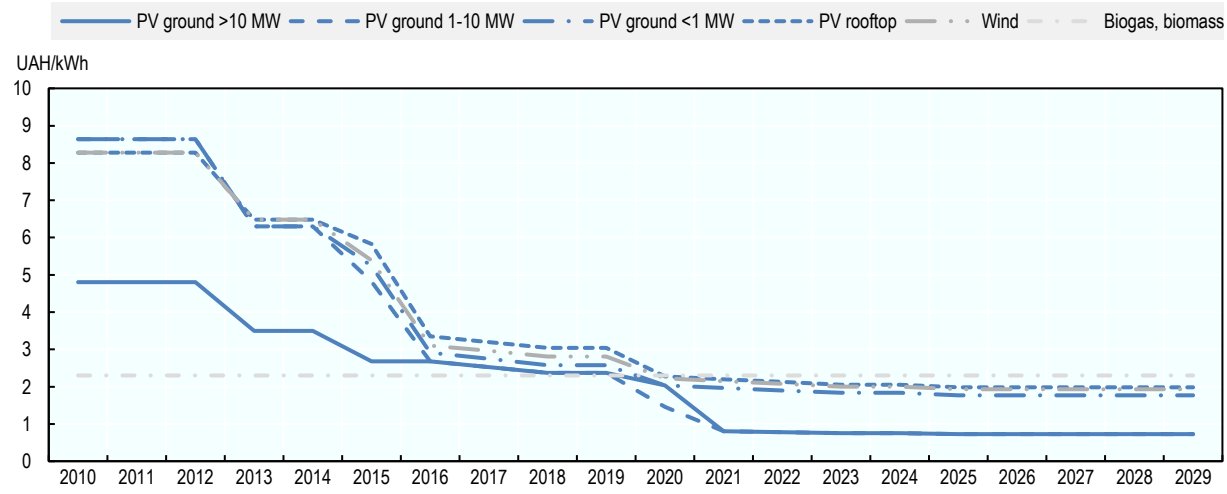
The FiT is paid by the GB, which buys the output of eligible RES producers and sells it on the wholesale market. Surplus electricity from residential photovoltaic installations is bought by USSs.

The initial FiT for RES was among the most generous in Europe. For instance, ground-based solar panels with up to 12 MW capacity received 0.0612 EUR/kWh in France (PV Magazine, n.d.[24]), while a similar solar panel in Ukraine received between 0.14 EUR/kWh (if commissioned in 2015) and 0.04 EUR/kWh (if commissioned between 2024 and 2029) (Baker McKenzie, 2021[4]).

The FiT was set until 2029 but not as fixed value but had a built-in decrease and a currency adjustment.[9] In 2020, the government adopted a new law, effective from 1 August 2020, reducing the FiT by between 2.5% and 60%, depending on the type of renewable energy generated, the size of plants and the date of their commissioning.[10] The 60% reduction was applied to ground-based solar power plants commissioned between 2021 and 2029 with capacities above 1 MW. For small solar and wind plants with capacities of up to 1 MW commissioned in the same period, the tariff reduction was 2.5% (Baker McKenzie, 2021[4]).

The FiT, including the adjustment introduced in 2020 are presented below.

Figure 2.6. Feed-in-tariffs for renewables



Source: Verkohvna Rada of Ukraine (2023), https://zakon.rada.gov.ua/laws/show/555-15#Text.

Further changes were proposed in August 2021, when the Ministry of Energy published a draft law introducing a new feed-in-premium (FiP) instead of the FiT. According to the draft law, eligible RES producers would sell their electricity on the market and the state budget would directly cover the difference between the market price and the FiP in a move aimed at solving the GB and TSO's debt problems (CMC, 2021[25]). The market price would be defined by NEURC and based on either the hourly price on the DAM, the average monthly or the average annual price on the DAM. Existing RES producers with "green" tariffs would be able to switch to the new FiP or remain under the old FiT scheme until 2029. RES auctions and the FiP scheme have not yet been put into practical use.

Ukraine intends to further increase the share of RES in its generation mix. According to the draft National Action Plan for the Development of Renewable Energy until 2030[11] and the National Energy Strategy of Ukraine until 2035,[12] the share of electricity production from RES should reach 25% by 2035, twice the level of 2021. In addition to the question of how to achieve the target, this raises questions about the technical ability of the power system to accommodate a higher share of RES production (USAID, 2021[26]) and the need to analyse scenarios for the cost-effective integration of intermittent or fluctuating RES (wind and solar) into the existing generation mix. For the period until 2025, it found that proactive RES curtailment would be the least costly and most feasible flexibility option.

2.2.3. Transmission and distribution

The transportation of electricity is provided by the transmission and distribution systems. The transmission system consists of high-voltage power lines connecting power plants and stations to various substations, from which the distribution network connects to consumers. The length of Ukraine's transmission system is more than 24 000 km (Ukenergo, 2020[27]), while that of its distribution networks is 818 000 km (NEURC, 2022[28]).

The electricity transmission system is operated by Ukrenergo, the state-owned TSO. Ukrenergo's functions include operational and technological control of the power system, and the transmission of electricity from points of generation to the distribution networks.

Box 2.4. The Third Energy Package

The Third Energy Package came into force in September 2009, aiming to complete the European Union's transition towards a single European energy market. The legislation covers five areas: unbundling, independent regulators, the creation of the Agency for the Co-operation of Energy Regulators, cross-border co-operation, and open and fair retail markets.

Ukraine committed to implementation of the *acquis communautaire* on 1 February 2011 following the adoption of the Energy Community Treaty and, consequently, becoming a member of the Energy Community. The Energy Community aims to create an integrated, pan-European energy market that includes the European Union and its neighbours. Contracting parties agree to adopt the Third Energy Package within a defined timeline.

Since the adoption of the treaty, Ukraine has made significant efforts towards its implementation. According to the Energy Community Secretariat, as of 2022, it had transposed 64% of relevant EU legislation into national law and implemented 68% of required electricity sector legislation. As outstanding issues, the Energy Community Secretariat identified implementation of the Regulation on Wholesale Energy Market Integrity and Transparency and a compliant cross-border capacity allocation. It also recommended continued efforts towards market integration with neighbouring EU member states and Moldova.

Sources: European Commission (2009[30]), Third energy package, https://energy.ec.europa.eu/topics/markets-and-consumers/market-legislation/third-energy-package_en; Energy Community Secretariat (2022[31]), Ukraine Annual Implementation Report, https://www.energy-community.org/dam/jcr:1731cc05-e414-47a8-95f8-4fb793fe0abd/IR2021_Ukraine.pdf.

The electricity transmission network used to be separated into two zones – the Integrated Power System (IPS) and the smaller Burshtyn Energy Island (BEI). On 24 February 2022, the two trade zones were merged.[13] This was intended as a temporary measure to prepare for the synchronisation of Ukraine's network with the ENTSO-E system but was made permanent with the implementation of emergency synchronisation that took place on 16 March 2022 (ENTSO-E, 2022[29]).

On 17 December 2021, Ukrenergo was certified as a TSO under the Independent System Operator model by NEURC.[14] Hereby, NEURC took into account the Energy Community's assessment of Ukrenergo's

compliance with European regulations.[15] The certification asserts that Ukrenergo is fully independent from supply and production interests.

Ukrenergo is responsible for investing in new infrastructure capacity, such as substations and transmission lines, to enhance the efficiency and reliability of power grids, ensuring RES integration with the power system, and overseeing technical compliance with ENTSO-E standards and requirements. Annual investment in such infrastructure in Ukraine is worth up to EUR 163 million (Ukrenergo, 2021[32])

Following market liberalisation in July 2019, Ukrenergo also became responsible for operating the balancing and ancillary markets, registering bilateral agreements, and serving as the settlements and commercial metering administrator.

Ukrenergo co-ordinates electricity import/export activity with neighbouring countries, it determines the net transfer capacity available for cross-border trading and – with neighbouring TSOs – the mechanism to allocate it. Integration of Ukraine's power system with the ENTSO-E system is one of the key strategic goals of Ukrenergo; the aim is to increase the reliability and sustainability of the Ukrainian system, expanding electricity trading possibilities, increase competition in the domestic market, and create opportunities for operation within the European energy market (Ukrenergo, 2023[33]).

Box 2.5. Network Development Plan 2021-30

Ukraine has a relatively high network density and an electrification rate of nearly 100%. But most of the network was built during the 1960s and 1970s, and is in need of modernisation. According to a 2018 study, 64% of power equipment was more than 40 years old and 22% was between 30 and 40 years old. As a result, transmission and distribution networks suffer losses estimated at more than 14% of injected electricity.

To address the issue of ageing equipment, in January 2021 NEURC approved an ambitious network development plan for 2022-31. It envisages EUR 2.5 billion of investment[1] to increase the reliability and security of the transmission network and to move towards full integration with the ENTSO-E system. According to the plan, Ukrenergo will increase substation capacity by renovating existing substations and building new ones, reconstruct more than 1 500 km of 220-330 kV transmission lines, and build more than 3 200 km of 220-750 kV lines. In addition, it plans to facilitate the integration of renewables by building 750 km of new 330-750 kV lines, a new 750 kV substation, and a 220 MW energy storage system.

1. In addition to the 10-year network development plan, the regulator has also approved Ukrenergo's annual investment programme. For 2020, approved investment amounted to more than UAH 3.2 billion (excluding VAT). It is financed largely through loans (60%) and only to a lesser extent through general tariff revenues (33%) and revenue from capacity allocation (4%).

Source: Ukrenergo (2021[34]) Grid, https://ua.energy/transmission-and-dispatching/networks/; Flanders (2018[35]), Ukrainian energy market: Overview of the sector and future projects, https://www.flandersinvestmentandtrade.com/export/sites/trade/files/market_studies/Ukrainian%20Energy%20Market_0.pdf; Ukrenergo (Ukrenergo, 2021[36]), Transmission system development plan for 2021-30, https://ua.energy/peredacha-i-dyspetcheryzatsiya/plan-rozvytku-oes-ukrayiny/; NEURC (2020[37]), Annual Report, https://www.nerc.gov.ua/pro-nkrekp/richni-zviti.

The EML introduced a regulatory framework closely resembling the system used in the EU. One important element of the transition to the European market model was the unbundling of electricity supply and generation from distribution, which took effect on 1 January 2019. As a result, each *oblenergo* was split into two separate entities – an electricity supplier (retailer) and a distribution system operator (DSO) (OECD, 2019[2]). The state continues to hold shares eight of the country's 32 DSOs through the Ministry of Energy.[16]

DSOs are responsible for delivering electricity to end users, while suppliers buy from producers, traders or other suppliers and sell it to end users. In line with international practice, DSOs in Ukraine are considered natural monopolies, thus their tariffs are regulated by NEURC. The distribution of electricity to consumers and its supply are both subject to the issuance of an appropriate licence by NEURC.

2.2.4. Electricity suppliers

In Ukraine, there are three types of suppliers: commercial suppliers, USSs, and a supplier of last resort (SoLR). The latter two types serve approximately 44% of all consumers (OECD, 2019[2]).

Commercial suppliers buy electricity on the wholesale market and sell it to industrial and business consumers at freely negotiated prices. At the end of 2021, there were 955 licensed electricity suppliers, of which only 30% (287) were active suppliers to consumers (NEURC, 2022[38]). The biggest by customer base are DTEK Kyiv Energy Services, Lvivenergozbut, DTEK Dnipro Energy Services, Enera group[17] and Kharkivenergozbut.

USSs supply in their assigned region households at fixed prices set by the CMU and small businesses at prices approved by NEURC. There is one USS per region, 25 in total. In addition, USSs may also act as commercial suppliers and supply non-household consumers at freely negotiated prices throughout the whole territory of Ukraine. Some of the largest commercial suppliers are in fact also USSs.

The state-owned Ukrinterenergo is assigned SoLR, it supplies electricity to consumers in special situations such as the cancellation of their supplier services or their failure to select a supplier, and can do so for no more than 90 days at a regulated price (OECD, 2020[39]).

2.2.5. Cross-border trade

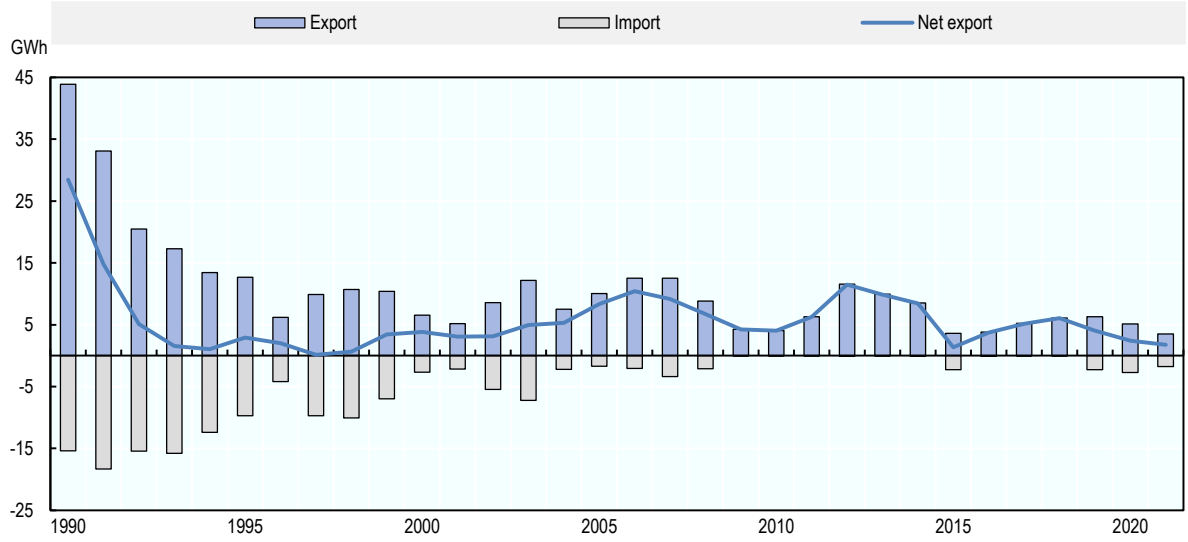
Ukraine has been traditionally a net exporter of electricity. In 2021, it exported more than double the amount of electricity it imported, selling 3 495 GWh and buying 1 694 GWh (Ukrenergo, 2022[40]). Most exports originated from the BEI and went towards Poland, Romania, the Slovak Republic and Hungary, at 3 334GWh, compared with 415 GWh of imports from the Slovak Republic, Hungary and Romania. In the IPS, imports (from the Russian Federation and Belarus) were higher than exports, at 1 278 GWh vs. 981 GWh (Ukrenergo, 2022[40]). Since May 2021, electricity imports from the Russian Federation and Belarus have been banned for national security reasons.

Ukrenergo conducts auctions for cross-border capacity allocation unilaterally but is in the process of negotiating with EU TSOs to start joint capacity allocation in accordance with EU rules.

On 24 February 2022, the IPS was disconnected from the energy systems of Russia and Belarus. On 27 February 2022, Ukrenergo and Moldelectrica – Moldova's TSO – sent a request to continental European TSOs for emergency synchronisation with the ENTSO-E system. With the support of the European Commission, EU member states, their regulatory authorities, European TSOs and ENTSO-E, emergency synchronisation was implemented on 16 March 2022. At the initial stage, the interconnection was of a technical nature and did not allow for cross-border trade On 7 June 2022, after fulfilment of the key conditions, continental TSOs agreed to Ukrenergo's request for the gradual opening of commercial flows on the interconnections with Ukraine (ENTSO-E, 2022[43]).

The first commercial flows started in midsummer 2022 across Ukraine's borders with the Slovak Republic and Romania. As of February 2023, the trade capacity from the Ukraine-Moldova power system to the Continental Europe power system had reached 400 MW and 700 MW in the other direction (ENTSO-E, 2023[44]).

Figure 2.7. Ukraine's electricity exports and imports, 2021



Sources: Ukrenergo (2022[41]), Volume of electricity exported/imported from/to the IPS of Ukraine, https://map.ua-energy.org/en/resources/8462ca14-63b1-4686-b613-b5f056d32d69/; Ukrenergo and NEURC (2022[42]), Hourly electricity imports and exports, https://map.ua-energy.org/en/resources/56df70b0-6bc1-4c7d-a82f-284cf723438d/.

Ukraine began the project to synchronise with ENTSO-E in 2017, signing the Agreements on the Conditions of the Future Interconnection of the Power System of Ukraine and Moldova with the Power System of Continental Europe. Since then, synchronisation has been one of the main priorities of Ukrainian energy policy for a number of reasons.

Technical synchronisation allows Ukraine's power grid to end its dependence on the Russian grid operator for frequency maintenance, improving energy security in the country. Full synchronisation would create increased commercial opportunities for imports and exports and enhance competition. The direction of trade might change seasonally, and in the long term will depend heavily on available surplus capacity and the cost structure of generation in Ukraine. In a reference scenario analysed by (Zachmann and Feldhaus, 2021[45]), cross-border transmission would increase the consumer surplus by EUR 0.9 billion annually and boost the TSO's congestion rent by EUR 300 million. However, achieving these benefits will require a functioning domestic market. In addition to technical complexities and practical challenges, such as establishing new transmission lines and maintaining grid stability, successful full synchronisation will also require extensive electricity sector reforms (see also Feldhaus, Westphal and Zachmann (2021[46]) and Zachmann and Feldhaus (2021[45]).

Emergency synchronisation led to an important change in the structure of Ukraine's electricity market, unifying the IPS and BEI as a single trade zone. This has the potential to enhance competition by reducing market concentration and market power. This is particularly true for the former BEI trade zone, where there was only a single electricity producer and very few suppliers of significant size.

The potential benefits of synchronisation are wide-ranging, from enhanced energy security, market integration and energy efficiency to decarbonisation and increased competition. However, only a functioning and competitive electricity market can be effectively integrated and provide the full benefits of synchronisation. Competition can thus not only be fostered by successful synchronisation, but it is also a precondition for it, making competition a key element of any market assessment under the current circumstances.

These issues are discussed later in this report, including synchronisation's possible effects on competition and on the broader functioning of the market.

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Notes

[1] Pump-storage power plants can store electricity indirectly, but can be built only in places with a specific topography. There also several emerging technologies for large-scale storage, but they are currently expensive and/or not yet fully proven in commercial applications.

[2] The NERC was replaced by NEURC in August 2014 by Decree of the President of Ukraine No. 694/2014.

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[6] Law of Ukraine No. 2019-VIII "On the electricity market", 13 April 2017, https://zakon.rada.gov.ua/laws/show/2019-19#Text.

[7] NEURC Decision No. 307 "On the approval of the Market Rules", 14 March 2018, https://zakon.rada.gov.ua/laws/show/v0307874-18#Text.

[8] Excluding assets in territories not controlled by Ukraine (including the Donetsk and Luhansk regions, and the Autonomous Republic of Crimea).

[9] To reduce currency exchange rate risks for investors, the FiT is linked to the EUR/UAH rate and is updated every quarter.

[10] Law of Ukraine No. 810-IX "On Amendments to Certain Laws of Ukraine related to Improvements of the Terms of Support for Production of Electricity from Renewable Energy Sources", 21 July 2020, https://zakon.rada.gov.ua/laws/show/810-IX#Text.

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[16] These are Zaporizhiaoblenergo (60%), Odesaoblenergo (25%), Kharkivoblenergo (65%), Cherkasyoblenergo (46%), Mykolayivoblenergo (70%), Khmelnitskoblenergo (70%), Sumyoblenergo Public JSC (25%) and Ternopiloblenergo JSC (51%). See CMU Order No. 1 222-r, 15 September 2021, https://zakon.rada.gov.ua/laws/show/1222-2021-%D1%80#Text.

[17] Enera Group unites four regional electricity supplier companies: Enera Sumy, Enera Chernigiv, Enera Vinnitsa and Enera Skhid.