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LEAPFROGGING TO A NEW ENERGY FUTURE: ECONOMIC POLICIES FOR AFFORDABLE, SECURE, AND CLEAN ENERGY IN UKRAINE

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ABSTRACT

Russia's full-scale invasion of Ukraine has caused enormous human suffering and economic damages. Thousands of civilians have been killed or injured and large population displacements have triggered a massive humanitarian crisis. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) estimates that 14.6 million people need help. Russia's attacks have also caused large damages to Ukraine's housing stock, transport infrastructure, industrial facilities, and energy capacities. The total cost of reconstruction and recovery has been estimated at US$486 billion (230% of pre-war GDP) over one decade (World Bank, 2024 and IMF, 2024).

The challenges of the war notwithstanding, the government is striving to maintain the operation of the country's energy system. Before the invasion, Ukraine has been running a sizable energy system consisting of multiple power generation plants (150.3 TWh in 2019), district heating facilities, networks of natural gas pipelines and gas storage, as well as a workforce skilled in energy technologies. The government estimates that Russia's strikes have destroyed half of its electricity generation capacity. Daily lives in homes, schools, hospitals and workplaces are disrupted. In the short term, the imperative has been to repair physical damages and expand interconnections with the EU electricity grid, as an effort to secure the supply of energy to people and businesses.

With well-designed reforms, international support, private investment – and, crucially, peace – Ukraine can leapfrog to a sustainable energy future. At present, decisionmakers in the energy sector are fighting day-to-day battles to keep the lights on and houses warm. Winning these daily battles and setting course towards a long-term vision will be critical to pave the way for affordable, secure, and clean energy in Ukraine.

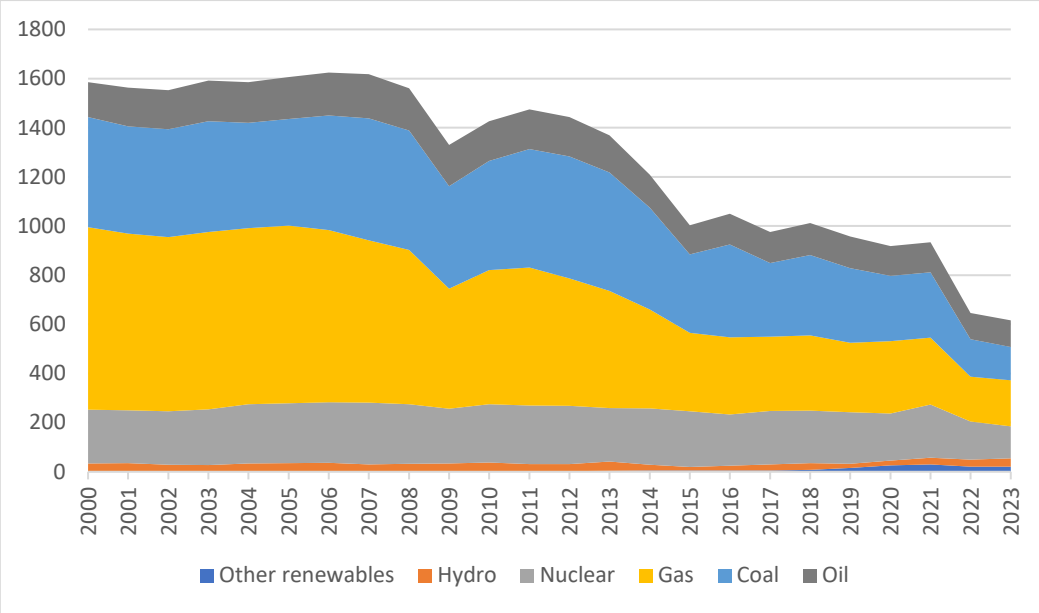
To illustrate:

- Phasing down fossil fuel subsidies, which lower the tariffs of utilities for all households irrespective of their incomes, can support the switch to renewables and increase fiscal space, in combination with means-tested social support. The recent increase in electricity prices was a crucial step in this direction.
- Setting a deadline beyond which the sales of combustion engine vehicles and gas boilers will be prohibited would encourage the adoption of electric vehicles (EVs) and heat pumps.
- Replacing feed-in tariffs with auction-based procedures would help to allocate renewable energy production licenses more cost effectively.
- Supporting multiple forms of contracts in the electricity market (such as contracts for difference, power purchasing agreements, spot and forward market transactions, net metering, net billing, and a market for electricity storage) would provide the flexibility for different players to cooperate.
- Establishing a national Emission Trading System (ETS), eventually linked to the EU ETS, can provide further impetus to investments into clean energy.

1. SECURING ENERGY DURING THE WAR

Ukraine's energy consumption has dropped by almost half since Russia's military invasion in 2014 (Figure 1). The drop in primary energy consumption has been especially severe in 2022 (-31%), in line with the contraction of real GDP (-29.1%). The use of natural gas fell by 33%, nuclear electricity declined by 28%, and the consumption of coal saw the largest decline (-43%) following the military occupation of coal mines in eastern regions. This decline in energy consumption slowed in 2023 thanks to government recovery efforts, with higher supply of renewable energy partially compensating lower use of coal and nuclear power (Energy Institute, 2024)

Figure 1 – Ukraine's primary energy consumption has sharply dropped (in TWh)



Note: Input-equivalent energy, in terawatt-hours, based on gross generation and not accounting for cross-border electricity supply.
Source: Energy Institute (2024).

Electricity infrastructures have incurred heavy damages from Russian military strikes. The government estimates that Russia's strikes have destroyed half of its electricity generation capacity. Electricity generation by the state-owned company Ukrhydroenergo, notably on the Dnipro River, has been severely disrupted after the destruction of the Kakhovka Dam. Nuclear power has declined due to the Russian occupation of the Zaporizhzhia Nuclear Power Station in southeastern Ukraine – the largest nuclear plant in Europe. The power transmission infrastructure has also been severely impaired. In government-controlled territories, crucial high-voltage transformers have been damaged or destroyed by missiles or drones. In war zones, although timely information is not available, the power transmission infrastructure there is likely facing similar or even more severe challenges.

Other sources of energy have also suffered considerable damages. The gas sector has been relatively spared from military attacks, including gas pipelines that ensure the transit of Russian gas. By contrast, the district heating sector has been subject to shelling in locations where hostilities are most frequent. Coal production has declined by 35% due to the hostilities in the Donetsk, Luhansk, Kherson, and Zaporizhzhia oblasts, where coal mines are concentrated (UNDP, 2023). As a result, the use of coal in thermal power plants has been reduced significantly.

The challenges of the war notwithstanding, the government is striving to maintain the operation of the country's energy system. Ukraine has focused on measures to ensure energy security, including protection of existing infrastructure, rapid repairs, boosting domestic gas production, and securing electricity imports from neighbouring countries. Air defence systems have been critical in protecting the electricity infrastructure, imported equipment was vital for repairs, and the successful synchronization of the country's electricity grid with the European power transmission system was key in expanding electricity imports.

In addition, the development of decentralized generation is underway. Cogeneration plants, gas turbines, generators, and diesel generators are being imported. The government is preparing a preferential lending programme for households as well as small and medium-sized enterprises to purchase alternative energy generating units. The government and businesses also work to save electricity by reducing consumption through a revision of the suburban electric train schedule and switching off air conditioners and external lighting on buildings and the surrounding area.

2. LEAPFROGGING TO A NEW ENERGY FUTURE

Leapfrogging from fossil fuels to renewables can lead Ukraine to a more sustainable energy future. Russia's attacks have reportedly destroyed or significantly damaged 90% of Ukraine's thermal power plants capacity and 60% of hydro facilities, severely disrupting daily lives. Imports of electricity from the European Union bring relief, but this will not suffice. Putting generation capacity back online will be essential to normalize the situation. This does not necessarily mean rebuilding the damaged coal-fired and gas-fired facilities, which represented 40% and 15% of generating capacity, respectively, before Russia's invasion. Ukraine can leapfrog directly to low-carbon technologies such as wind, solar, hydro, biomass, and geothermal, for which it has significant potential.

A focus on renewables would improve the country's security, among various benefits. Investing in renewables would reduce Ukraine's reliance on imported fossil fuels. Only limited quantities of oil and gas are extracted domestically, making it necessary to cover 70% of consumption with imports. Switching to renewables would reduce the reliance on imported fossil fuels and thus improve security in periods of geopolitical tensions. In addition, switching to renewables could help to reduce the electricity prices paid by consumers. This is because the levelized costs for renewables are lower than those for hard coal and natural gas, particularly when a carbon emissions tax is applied. However, the

investment decision would need to also consider costs other than power generation, such as balancing costs and the need to upgrade the transmission and distribution networks.

Switching to renewables poses challenges that can be addressed. Transitioning from thermal to renewable power introduces issues such as wind speed variability and sunlight fluctuations. These can be managed with lithium batteries, pumped hydro storage, and flexibility procedures such as electricity imports and exports. Converting electricity into hydrogen can also help address long-term generation variability. Switching to renewables will require adjustments of the electricity transmission grid and the distribution network, as in other countries. In addition, district heating will need to be modernized, because Ukraine currently mainly relies on thermal steam from its generation plants to produce heat used in buildings. Alternative sources like biomass or heat pumps will be necessary. While these challenges are significant, they can be solved with existing technologies.

Together with foreign aid, ambitious policy reforms will be crucial to secure a better energy future. The United States and EU countries are already providing significant foreign aid to Ukraine, both financial and in infrastructure support. Large support is also being provided by the G7+, the International Monetary Fund (IMF), the World Bank, and the European Bank for Reconstruction and Development (EBRD). Together with foreign aid, economic policy reforms will be key to sustain the recovery. In their seminal research, De Long and Eichengreen (1991) found that the Marshall Plan was not large enough to have significantly accelerated the European recovery after the Second World War, but that it did play an important role in the economic reforms that set the stage for post-war economic growth. Examples abound both of success and failure to return to economic development after a severe external shock. Past lessons highlight the importance of structural policies in the labour and product market (Duval et al., 2007), tax policy (Arnold, et al., 2011), business development, and integration in global supply chains (Gal et al., 2019). Such reforms are also key for the energy sector.

Policy reforms for Ukraine's energy sector should focus on leapfrogging to affordable, secure, and clean energy:

- **Affordable energy access** is part of the social contract and an essential aspect of socioeconomic stability. Providing affordable access to all households must be a key first step of the post-war policy focus.
- **Energy security** is also critical to encourage the return of displaced workers to their former workplaces and attract foreign investment. The energy crisis of 2022 in Europe has brought to the fore the importance of securing energy supplies, as underlined by the REPowerEU initiative.
- **Clean energy** will be a key pillar for a sustainable post-war recovery of Ukraine, helping to increase competitiveness and reduce the country's environmental footprint.

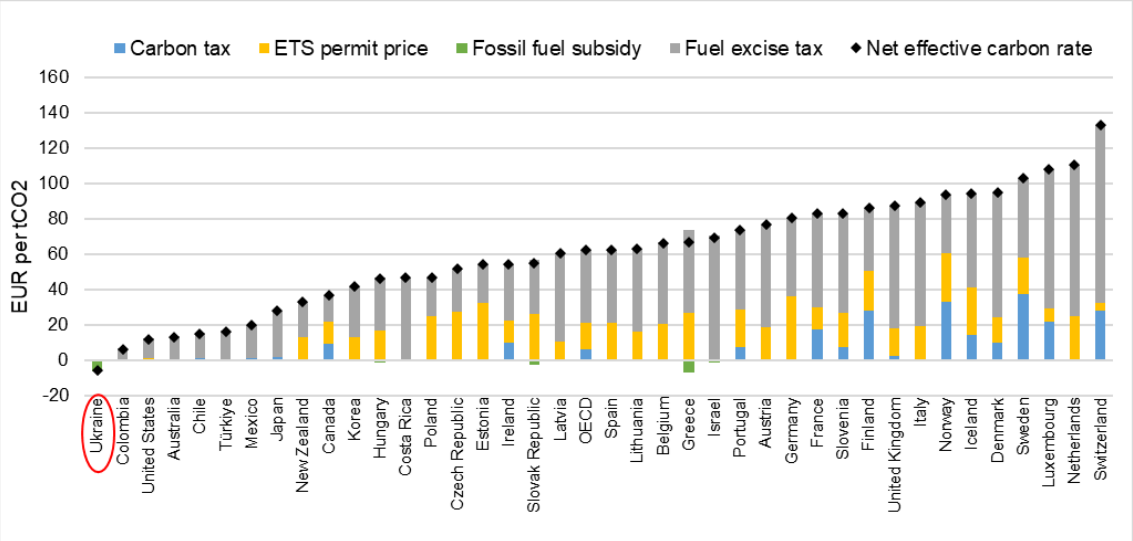
Combined with foreign aid, these policy reforms will go a long way towards leapfrogging to a better energy future in Ukraine.

3. FIGHTING ENERGY POVERTY

A key post-war objective will be to ensure affordable energy access. Once peace is restored, Ukraine's population will have suffered a severe period of hardship. There will be large groups of war veterans and injured people, persons displaced from their homes, returning refugees, and workers searching for work in a changed economic landscape. Having access to affordable energy will be essential to post-war inclusive growth. Hence, the post-war government will need to aim at ensuring affordable energy access for all households.

Consumers pay higher energy prices. In the past, Ukraine typically kept retail electricity prices below cost-recovery levels, in an attempt to fight energy poverty. Electricity distribution companies had been required to sell electricity at a single tariff set by the Cabinet of Ministers, irrespective of a consumer's location and income level, under the regulations of the Public Service Obligation (PSO). Low tariffs benefited all consumers, including well-off households. In addition, Ukraine has maintained energy taxes at levels too low to generate significant government revenue, and too low to reflect environmental externalities, such as carbon emissions[1] (Figure 2).

Figure 2 – Effective carbon rates have been negative in Ukraine



Note: Data are for 2021. Net effective average carbon rates are calculated as weighted average carbon prices across sectors net of fossil fuel support. The measurement of "fossil fuel subsidies" only considers the budgetary transfers that decrease user prices; unpriced externalities and tax expenditures are not included.
Source: OECD Net Effective Carbon Rates Database.

[1] Ukraine has only a very low carbon tax – UAH 30/ton for emissions from stationary sources and all types of fuels that exceed 500 tons of CO2 per year.

The Ukrainian authorities have hiked electricity prices several times since mid-2023.

- Until mid-2023, electricity tariffs for the population were kept at the equivalent of US$0.038 per kWh – among the lowest in the world.
- In June 2023, in the midst of Russia's invasion, they were almost doubled to the equivalent of US$0.07 per kWh.
- In early June 2024, they were once again raised to the equivalent of US$ 0.107/kWh, also with the aim of generating revenue helping energy producers to invest in repairs.

Higher prices are being accompanied by better-targeted income support. Since 2018, Ukraine has started providing cash transfers instead of discounted tariffs for water, heat, gas, and electricity, thereby incentivizing reduced consumption and cost savings. For example, the Housing Utility Subsidy has since then been paid directly to households as a cash transfer rather than being deducted from utility bills (Midões, 2021). To enhance social protection in Ukraine, the World Bank has initiated a project financed by a US$1.2 billion loan to provide additional support to 29 social assistance programmes targeting the most vulnerable people and mitigating the risk that the war triggers a further increase in poverty.

Overall, the government is improving the targeting of social assistance and reducing the number of subsidy recipients. This will remove the existing disincentive to increase labour earnings – through the extensive and intensive margins – as currently millions of households face a negative tax wedge when they increase their working hours and therefore lose their social assistance. The right balance needs to be found between combatting poverty and encouraging labour-market participation.

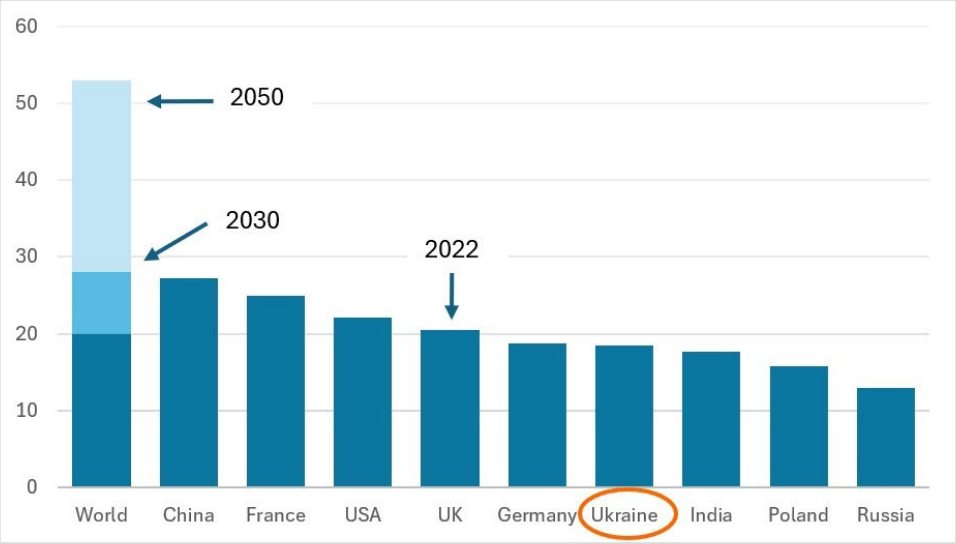
4. INVESTING IN LOW CARBON ENERGY

Ukraine's heavy dependence on fossil fuels reflects its policy settings. According to the International Energy Agency (IEA) and the IMF, Ukraine provides large fossil fuels subsidies, mostly benefiting the natural gas and electricity sectors. In 2023, the Ministry of Energy of Ukraine adopted the Energy Strategy 2050, which aims to phase out fossil fuel subsidies by 2030. The recent hikes in electricity prices are already contributing to lower fossil fuel subsidies and will provide power generation companies with the additional earnings necessary to invest in low-carbon facilities.

Electrification of energy consumption will be key. Ukraine's strategy envisions that renewable energy sources will be at least 25% of the energy mix by 2030, and that Ukraine will decarbonise its electricity generation by 2050. Like in other countries, reducing the dependence on fossil fuels will imply a fast increase in electrification. The share of electricity in final energy consumption was only 18.5% in 2022, somewhat less than in other countries. Electrification of uses would involve, inter alia, switching from combustion engine vehicles to electric vehicles, and from gas boilers to heat pumps. It would also include manufacturing industries switching from coal, oil, and gas to electricity. All these changes could lead to a large switch from fossil fuels to electricity – and to clean electricity if renewables are used to generate it and to move towards net zero carbon emissions (Figure 3).

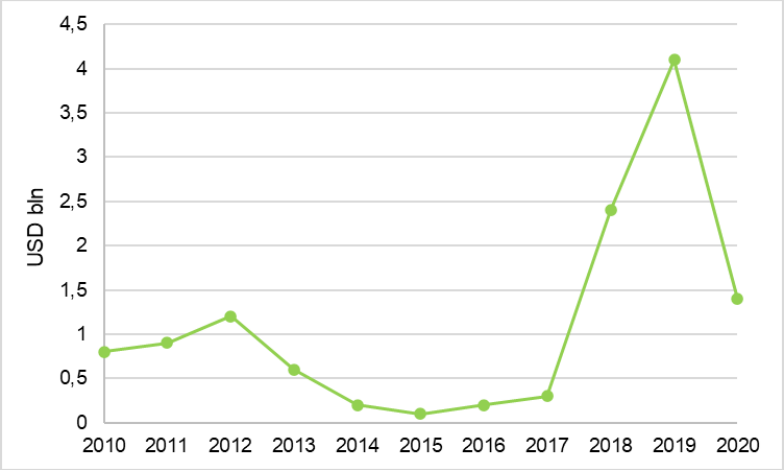
Before Russia's invasion, Ukraine had already introduced strong incentives to develop renewable energy sources. According to the Ukrainian Association of Renewable Energy, approximately US$12 billion was invested in renewable energy in Ukraine in 2010-2021 (Figure 4). As of 2021, almost one third of these renewable energy investments were from foreign investors (Hmyrin, 2021). The introduction of feed-in tariffs in 2009 was the main policy initiative that triggered a wave of investment. Domestic investors were the first to enter the renewable energy sector, followed by foreign entities as the government pegged tariffs to the euro and pledged to buy 100% of the renewable energy produced under this scheme until 2030. The outbreak of the war in 2014, the devaluation of the national currency, and the failure to meet the government commitment to keep the feed-in tariff pegged to the euro undermined further investment as of 2020-21.

Figure 3 - Share of electricity in final energy consumption, %



Source: Enerdata and International Energy Agency

Figure 4 – Pre-war increase of investment in Ukraine's renewable energy



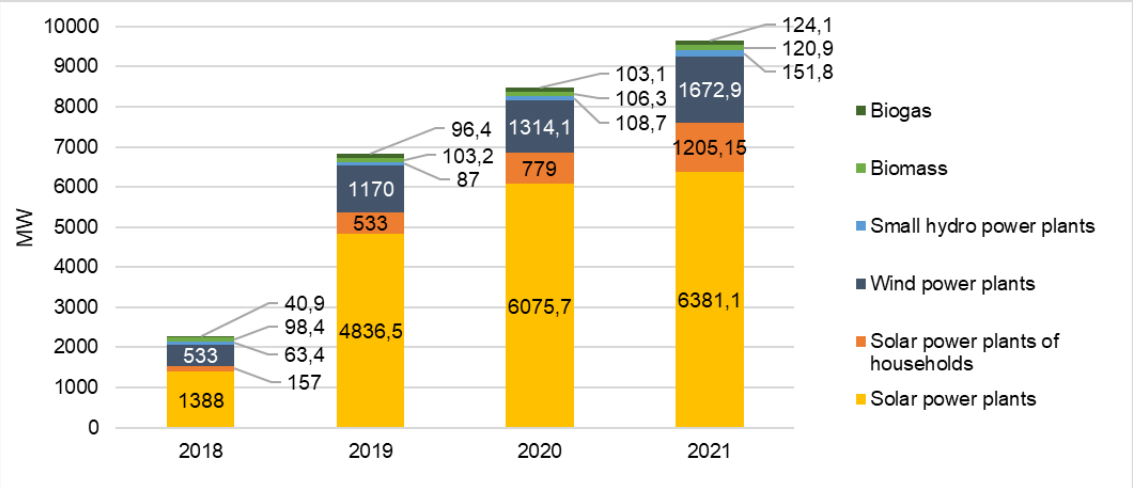
Source: EPravda (2021).

Despite these challenges, the renewable energy sector has increased its capacity. During 2020-2021, Ukraine faced many challenges in the renewable energy sector including uncertainty about the settlement of government payment arrears to renewable energy producers, the coronavirus pandemic, and instability in the legislative process. Nonetheless, the sector has continued to increase its capacity (Figure 5). According to the National Commission for State Regulation of Energy and Public Utilities (NCREPU), the total capacity of renewable energy projects as of the end of 2021 reached 9656 MW:

- Wind power capacity (WPP) of 1673 MW,
- Solar power capacity (SPP) of 6381 MW,
- Household solar projects (SPPh) of 1205 MW,
- Biomass power of 152 MW,
- Biogas power of 124 MW,
- Small hydroelectric power (sHPP) of 121 MW.

Figure 5 – Ukraine's renewable energy capacity

(2018-2021, excluding large hydropower plants)



Source: Omelchenko (2022).

Ukraine should make the most of its renewable energy potential after the war. Ukraine has a large renewable energy potential: solar – 83 GW, onshore wind – 438 GW, and offshore wind – 250 GW (Figure 6). A sizable share of the capacity potential is located in the territories currently occupied by Russia (25% of renewable energy capacity potential in June 2023) (Energy Charter Secretariat, 2023). A fraction of the existing renewable energy capacity has been destroyed or damaged, as it is concentrated in the southern and southeastern regions of Ukraine, where active hostilities are ongoing.

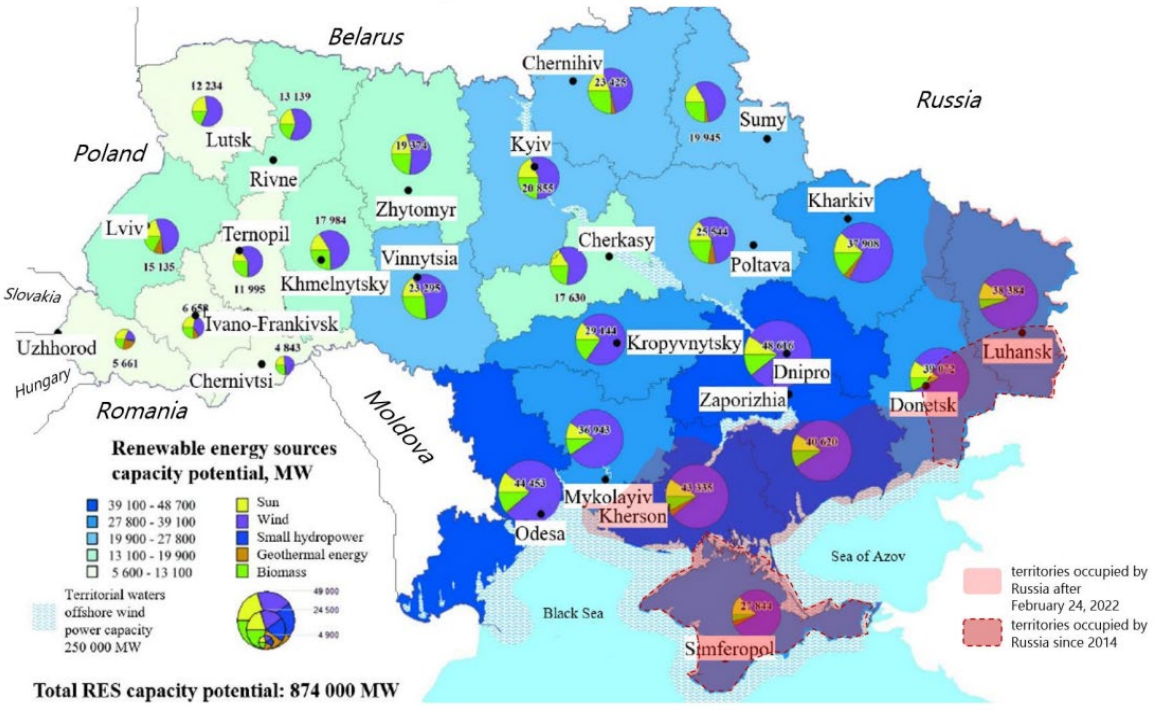
Despite the war, solar energy is expanding. Ukraine has already built considerable experience in solar energy and further investment could be forthcoming. For the time being, large-scale solar energy projects have been put on hold due to the impact of the war and risks for investors. By contrast, small-scale solar power projects developed privately by

households and taking advantage of the feed-in tariff are becoming more important, thus helping to ensure energy security of consumers during electricity shortages. In addition, the number of prosumers – farms and enterprises that produce their own off-grid energy – is growing. At the beginning of 2022, there were more than 45,000 prosumers in the solar energy industry. Their number has continued to grow reaching more than 54,000 in 2024. The installation of small solar energy projects with energy storage systems helps to ensure the uninterrupted operation of prosumers' own enterprises and supports them in becoming energy self-sufficient. This helps to ensure the continuous operation of socially important facilities, such as water supply, food storage, transport hubs, telecommunication networks, and medical institutions.

Ukraine has sought to maintain its drive towards wind energy. Wind farm projects are highly supported by the current government and have proved to be resilient. As an illustration, DTEK Tyligulska Wind Farm, a project supported by the European Commission and the governments of Ukraine and Denmark, is the world's first wind farm built during a war. It already has 114 MW of capacity produced by 19 turbines. DTEK Group and Vestas signed a Memorandum of Understanding (MOU) to complete the construction of this wind farm. According to the MOU, the second project stage will consist of "64 wind turbines (of 6 MW each) with a total capacity of 384 MW". These new wind turbines "should be gradually connected to the grid from the end of 2024". Investments for this second phase "amount to €450 million and are to be financed by the company and leading banks under state guarantees".

Figure 6 – Renewable energy sources capacity potential in Ukraine

Source: Taken from Energy Charter Secretariat September 2022.



Source: ECS based on Atlas of RES potential in Ukraine, Renewable energy institute of Ukraine and publicly available data

Ukraine is actively seeking ways to make renewable energy projects more financially attractive. A key strategy has been the implementation of feed-in tariffs, a form of government subsidy that offers renewable energy operators a guaranteed price for the energy they supply to the grid. This provides a measure of financial stability and can significantly enhance the profitability of these projects. However, in time of war, the government's capacity to consistently fulfil these tariff payments is strained, resulting in an accumulation of debt to private renewable energy producers. Despite these challenges, the focus remains on creating a supportive and sustainable financial environment that encourages further investment in Ukraine's renewable energy sector.

Additional electricity market designs are available to reduce investment risk and attract more private investments in renewable energy capacities. In some cases, they are already being applied. This includes auctions of new renewable energy locations, power purchase agreements (PPAs), and contracts for difference (CFDs). They make it possible to reduce uncertainty for renewable energy producers and give more guarantees for the revenues received from energy sales. In addition, Ukraine is experimenting with net billing and net metering, which both contribute to enhancing the return on investments of renewable energy and incentivize energy conservation. While these mechanisms do not eliminate the impact of price fluctuations, they can still provide significant benefits. For instance, they allow producers to offset their energy costs by feeding excess energy back into the grid, which can lead to substantial savings over time. Furthermore, these mechanisms can provide a more predictable revenue stream compared to selling energy on the open market, as they often involve long-term agreements at fixed prices. On 30 June 2023, Ukraine adopted the Law of Ukraine No. 3220-IX – "On introduction of changes to certain laws of Ukraine as on the recovery of energy safety and green transformation of the energy system of Ukraine" – covering key rules on net billing and introducing numerous other amendments to Ukrainian legislation in respect of renewables. As of today, the regulatory policy and the procedure for the sale and accounting of electricity using the net-billing mechanism for the owners of solar power plants in Ukraine have already been agreed. Ukraine is slowly making progress in that direction. For example, in May 2024, for the first time in Ukraine, a hospital – the Khmelnytskyi Medical and Diagnostic Center – began selling electricity generated by solar panels on its roof to the grid.

To create favorable conditions for renewable energy investments, the following policy initiatives should be considered:

- **Stability and transparency of the regulatory framework**. As a starting point, clear and consistent rules, as well as transparent and fair procedures, are essential to ensure the confidence and trust of private investors.
- **Phasing out fossil fuel subsidies.** Reducing subsidies to fossil fuels would expand fiscal space and create a level playing with other energy sources. It would also help the government to raise its own investments into the country's energy future.
- **Phasing in fossil fuel taxes to reflect carbon externalities.** As in many other European countries (Figure 2), Ukraine should gradually increase the taxation of carbon emissions, with a combination of carbon taxes, ETS allowances, and excise duties on fuels.

- **Access to sustainable finance**. Regulators should facilitate access to sustainable finance by creating favorable financing mechanisms. These may include partnerships with international financial institutions; frameworks for dedicated financing models, such as grants, cofinancing, and low-interest loans in hryvnia, Ukraine's national currency; and incentives for local banks to provide financing options for renewable energy investments. Cooperation with Ukrainian municipalities is needed to ensure that these mechanisms are effectively implemented.
- **Acceleration of permitting and approval processes.** Government regulations need to be implemented efficiently, especially the permitting and approval processes for renewable energy projects by setting clear timeframes, establishing a single center for project approval, and ensuring effective coordination between relevant government agencies. Municipalities should be supported to design and implement their renewable projects without the need to obtain approval from the national authorities. That would make it easier for municipalities to access funds.
- **Strengthening of the grid infrastructure**. Renewable electricity production requires modernizing the electricity network to ensure an efficient energy transmission and the connection of new production points for renewable energy producers.
- **Energy storage solutions:** Energy storage is required to balance supply and demand. In addition to batteries, exploring alternative storage options like pumped hydro storage, compressed air energy storage, or even hydrogen storage can contribute towards mitigating intermittency. Combining wind and solar farms with complementary generation profiles can also help balance intermittent supply. For instance, wind tends to be stronger at night, while solar peaks during the day. Even though nuclear plants may not modulate output rapidly, they can still play a role. Operating nuclear plants at varying power levels during off-peak hours can compensate for renewable energy fluctuations. Co-locating solar panels or wind turbines near nuclear facilities could optimize land use and grid integration. Last but not least, accurate weather forecasting and load prediction can help nuclear plants adjust their output in anticipation of renewable energy generation changes.
- **Improving education and training**. Investing in human capital, training, and education programmes are key to develop a skilled workforce capable of supporting the renewable energy sector, including specialized training programs for technicians, engineers, and policy makers to improve their understanding of renewable energy technologies and project management.
- **Platforms with information on the Ukrainian renewable energy sector**. Potential investors in the renewable energy sector need transparent and easily accessible information on investment opportunities, regulations, and market conditions. Online platforms, investment portals or information centers to provide comprehensive information are important pillars to meet this demand.
- **International cooperation and partnerships**. Sharing best practices and exchanging knowledge with other countries, industry associations, and international organizations are further measures to attract foreign investment in the renewable

energy sector. Participating in international conferences, exhibitions, and fairs to showcase Ukraine's potential in the field contributes to this objective.

The role of nuclear power should be scrutinised in comparison with renewable options. Before Russia's invasion, Ukraine operated 15 Soviet-designed pressurised water reactors. Ukraine's comparative advantage in nuclear energy is supported by a local supply chain that includes uranium mining and processing, as well as facilities for spent nuclear fuel storage. Nuclear energy may have a crucial role to play in Ukraine's future energy system, particularly if electrification is to be expanded. However, this does not mean constructing new reactors. The primary focus should be on enhancing security, ensuring proper maintenance, and extending the operational life of existing nuclear power generators. Building new nuclear plants should be considered only based on careful scrutiny and a comparison with renewable sources. This should also apply to the plans for the building of nine new nuclear power units announced in late 2023.

5. ENERGY POLICY IN THE CONTEXT OF EU ACCESSION NEGOTIATIONS

Ukraine's energy policy already considers the accession negotiations with the European Union. The European Council has decided to grant Ukraine the status of candidate country on 23 June 2022, based on its European perspective and efforts made so far to adopt EU rules. Accession negotiations are ongoing, and Ukraine is working to transpose the EU *acquis* into its own legislation. This includes a commitment to formulate an energy policy conforming to EU principles. For this purpose, Ukraine has approved a National Energy and Climate Plan (NECP) to delineate its vision for achieving a decline of GHG emissions by 65% by 2030, zero emissions in the energy sector by 2050, and economy-wide climate neutrality no later than 2060. This NECP identifies the contribution of Ukraine to the EU climate plans and explains how it will achieve the objectives set out under EU agreements, such as targets for renewable energy. The NECP takes into account the disruptions to Ukraine's energy system and offer prospects for rebuilding it after the war.

For EU accession, Ukraine's energy taxes will need to be reformed in line with EU rules. The EU Energy Taxation Directive was adopted in 2003 and has not been revised since then as this requires the unanimous approval of all EU member states and political momentum has been lacking. The present Directive sets very low minimum tax rates on motor fuel, heating fuel, and electricity. These tax rates are outdated and not aligned with the EU's decarbonization targets. Proposed reforms of the EU Energy Taxation Directive would set minimum tax rates based on their carbon content rather their energy content. It would withdraw existing exemptions (such as aviation) and raise tax rates to send a price signal to carbon emitters. Ukraine would have to respect the minimum tax rates in the existing EU Energy Taxation Directive and its future amendments, if any.

The EU Emission Trading System (ETS) plays a key role in pricing carbon emissions. The sectors currently covered by the EU ETS are electricity, manufacturing industry, intra-EU aviation, and maritime transportation arriving at and departing from EU ports. Facilities emitting greenhouse gases must hold emission permits, which can be bought at the

prevailing market price (about EUR 70/tCO2 in early-July 2024). Some facilities can obtain free emission permits based on their historical levels of emissions as part of provisions enacted to protect the EU economy from the risk of "carbon leakage", as a transition mechanism until full implementation of the EU Carbon Border Adjustment Mechanism (CBAM).

Ukraine will need to establish a national ETS. The EU-Ukraine Association Agreement signed in 2014 entails Ukraine launching a national emission trading scheme. In early 2024, the government committed to launch a pilot mode for such a scheme in 2025. Necessary prerequisites for the launch of the national ETS include a system of monitoring, reporting and verification (MRV) of Ukraine's greenhouse emissions, as well as the approval of the updated Nationally Defined Contributions under the Paris Agreement (NDC-3), which should reflect Ukraine's ambition and commitment to reduce emissions in line with the EU's 2030 target. Given the continuation of martial law, enterprises are still entitled to delay the submission of reports on emissions under the MRV. Therefore, the probability of starting the pilot phase is already shifting because, in order to launch the ETS, it is necessary to have enough verified data on the volumes and dynamics of emissions that will be obtained only after the start of operation of the MRV system. The launch of the Ukrainian ETS is a long-term, phased process that should be based on a roadmap for harmonizing the Ukrainian ETS with the EU ETS. A scarcity of domestic funds for decarbonization and limited access to low-carbon project financing instruments could make it difficult to abate emissions and save on the cost of emission permits. Implementation of the ETS in Ukraine will face also other difficulties such as a weak institutional framework and corruption risks.

To join the EU ETS, Ukraine will need to align its domestic legislation and institutions with the applicable EU standards and requirements. This could involve a transition period of about 12 years (Zinchenko et al, 2023). It is important to define the competent authorities responsible for shaping ETS policy and implementing it, as well as the functioning of the MRV registry and administration. The transition period consists of three main stages:

1. **The first stage will be to strengthen the MRV system of greenhouse gas emissions from the sectors covered by the ETS.** This system should be in place for at least three years before launching the ETS and should be consistent with the EU's MRV rules. Such timing is set to allow businesses to establish all procedures related to monitoring and reporting, enable governmental bodies to establish the operation of the registry and conduct verification checks, and get acceptance of the Ukrainian MRV system from European partners (Zinchenko et al, 2023).
2. **The second stage is to launch a test period of the ETS.** The test period is intended to refine the procedures and mechanisms of the ETS, such as the allocation of emission allowances, the operation of the registry, the auctioning platform, and the market oversight. The test period should also allow the participants to familiarize themselves with the functioning of the market and the market processes, such as trading, compliance, and enforcement. During the test period, a temporary price for CO2 emissions should be set at an economically justified level, taking into account the participants' ETS carbon payments based on their emission levels. This approach can help prevent extreme price volatility and ensure that the price of emissions reflects their true environmental cost during the initial stages of the ETS. Once the ETS becomes fully operational, the price of CO2 emissions will be determined by the market through the trading of allowances. Such market-based approach ensures that emissions are reduced

where it is cheapest to do so, and the price of CO2 emissions reflects the cost of reducing emissions in the economy.

3. **The third stage is to gradually align the Ukrainian ETS with the EU ETS, both in terms of scope and price.** This stage should involve the expansion of the ETS to cover more sectors and gases, as well as the harmonization of the emission caps and the auctioning rules with the EU's. The final goal is to achieve a full integration of the Ukrainian ETS with the EU ETS, which would enable the mutual recognition and exchange of emission allowances between the two systems. To avoid economic shocks from a sudden increase in CO2 prices, the alignment process should be done gradually and in consultation with the stakeholders.

By joining the EU ETS, Ukrainian exporters to the EU market could avoid being subject to the EU Carbon Border Adjustment Mechanism (CBAM). CBAM was introduced as part of the "Fit for 55" climate package. According to it, EU importers must report direct carbon emissions from the production of imported goods and pay for these emissions equally to what is paid by companies in EU Member States under the ETS mechanism. Ukraine is among the countries that are most exposed to the effects of CBAM due to its export specialisation in carbon-intensive goods such as iron, steel, aluminium, cement, fertilizers, and electricity. Goods imported from third countries are exempt from the CBAM if their production has already been effectively subject to a carbon pricing system that is fully linked with or similar to the EU ETS. At present, out of 8 countries outside the EU with a national ETS, only Switzerland is exempt from the CBAM thanks to a mechanism associating the Swiss ETS with the EU's. So, to avoid bearing the cost of CBAM, Ukraine is designing plans to accelerate its decarbonisation and introduce a price on carbon emissions under the Ukrainian ETS, followed by aligning it with the EU. However, the establishment of an ETS in Ukraine cannot be considered only as a tool to avoid the CBAM.

Ukraine's ETS should be developed first and foremost with the objective of transforming the country's energy system. As shown by the experience of other countries, carbon pricing together with non-pricing measures provides strong incentives to progress toward a more affordable, secure and clean energy system. By switching away from fossil fuels, and tapping its considerable renewable energy potential, Ukraine would benefit from more affordable, secure and clean energy. Establishing an ETS in Ukraine would raise the country's effective carbon rates from presently very low levels. Establishing a domestic ETS and, overtime, participating in the EU ETS, will send strong incentives to switch to new energy sources. This would provide not only significant benefits to all Ukrainian citizens and companies, but it would also strongly align the country with the long-term objectives of the Paris Agreement to contain the rise in global temperatures.

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