



SHIELD

Review of Ukraine's
energy sector policy
priorities, energy
infrastructure stock-
take and the potential
for green hydrogen
production

EXECUTIVE SUMMARY

Overview of Ukraine's Energy Sector

Ukraine's energy sector has undergone significant transformations in recent years, primarily driven by geostrategic shifts. Russia's invasion of Ukraine in 2014 and 2022 significantly heightened energy security risks, particularly for natural gas and nuclear fuel imports, and drove energy independence policies. Concurrently, Ukraine's strategic choice to integrate with the EU prompted the liberalization of the country's energy markets and facilitated the deployment of renewables.

Historically, Ukraine has been a major energy consumer with a highly carbon-intensive economy. However, since 2014, the country has transitioned towards a more diversified energy mix. By 2023, zero-carbon electricity comprised 70% of the country's generation. This shift was driven, on the one hand, by a growing share of renewable energy, along with legacy nuclear and large hydro power. On the other hand, the growing share of clean generation can also be attributed to Russia's seizure of fossil-fuel power plants in Crimea and Donbass since the start of invasion in 2014.

The full-scale invasion in 2022 drastically altered Ukraine's energy landscape. Major power infrastructure, including the Zaporizhzhia nuclear power plant, was seized or damaged, causing a loss of approximately 25% of renewable energy capacity and leaving only 13 GW of the pre-war 39 GW total power capacity operational. This led to estimated direct losses of about USD 22 billion and foregone revenues of USD 18 billion. Despite these challenges, Ukraine managed to enable the deployment of distributed power generation and renewable energy projects, enhancing resilience and energy security. Since

2022, around 700 MW of new capacity has been commissioned.

Ukraine has historically been an electricity exporter to the EU, trading with Poland, Romania, and Hungary. The country's integration with the European electricity grid (and the European Network of Transmission System Operators for Electricity, ENTSO-E) has played a critical role in stabilising electricity supply despite ongoing attacks on infrastructure. High energy prices in the EU created opportunities for Ukraine's electricity exports at the beginning of the energy crisis. However, damage to the grid has led to fluctuating prices and prolonged blackouts. The power generation attacks in 2024 significantly exacerbated the situation, causing electricity prices to triple compared to the 2021 levels, as Ukraine, facing a supply deficit, became dependent on emergency electricity imports from the EU. This marked a major shift from its previous role as a regional electricity exporter to an importer reliant on external support.

Renewable Energy Development

Ukraine has substantial renewable energy potential, with wind energy offering the greatest potential, primarily onshore, where estimated annual generation potential ranges from 970-1,200 TWh. The assessments of offshore wind potential are more limited and highly uncertain, with estimates varying from 110-980 TWh. Solar PV potential is considerably lower, estimated at 70 to 100 TWh per annum. Yet, solar PV has so far dominated deployment. Overall, the deployment of renewables has been uneven, both geographically and across technologies.

Currently, only around 2% of wind potential is being utilised, compared to 10-25% of solar potential.

Policy support has played a critical role in driving renewable energy deployment in Ukraine. Instruments such as feed-in tariffs (FiTs) facilitated investments in the past, leading to a surge in investments and enabling the rapid development of the sector within just a few years. Between 2017 and 2020, investments tripled from approximately EUR 3 billion to around EUR 9 billion, resulting in a total installed capacity of 9.5 GW by 2020. However, those recent policy inconsistencies, such as retroactive changes to feed-in tariff (FiT) and political interference in the sector, have caused investment uncertainty. At the same time, development banks became hesitant to finance new projects unless more cost-effective and sustainable support schemes were adopted, such as auctions.

Conversely, feed-in tariff combined with weak regulatory oversight in the permitting process incentivised the over-deployment of technologies with a higher tariff. Solar PV deployment exceeded the 2020 national target threefold, while other technologies with lower FiTs were significantly under-invested in, such as wind and bioenergy. Such a flat-rate high-premium support scheme led to a suboptimal deployment of renewables. For instance, solar PV prevailed onshore wind instalment even in northern regions, despite low solar irradiation.

Notably, since Russia's first invasion of Crimea in 2014, 57% (or 4 GW) of renewable energy capacity has been deployed in regions adjacent to combat zones, while only 13% was deployed in the areas neighbouring the EU. This suggests that investors prioritised financing projects in more solar and

wind-endowed areas over the risks associated with proximity to conflict zones in south east.

Long-Term Energy Policies and Strategic Outlook

Ukraine's integration with the EU is considered to be a top priority for the Ukrainian government. It is perceived to be a significant driver for the transformation of the country's climate and energy policies. Since Ukraine received the EU candidate status and started official negotiations in 2023, the adoption of the EU acquis, that requires the country to achieve maximum alignment with the EU's cross-sectoral legislation, has become even more critical. Another important driver is the country's reconstruction. While Ukraine has been receiving emergency funding to cover short-term infrastructure needs, cooperation partners and international financing institutions have set conditions, requiring longer-term investments to align with a 'green recovery' approach.

To guide the energy sector amidst the full-scale invasion, Ukraine has adopted new legislation on energy sector transformation and a new strategy for the energy sector and renewables targets. This has paved the way for new support schemes, including auctions for capacity quotas, feed-in premiums, access to the wholesale market and guarantees of origin, although most of those are yet to be fully implemented. The devastating attacks on power generation in 2024 prompted the government to consider a more resilient energy system design, leading to the development of its first Strategy for the Development of Distributed Energy to 2035.

The adopted draft Energy Strategy of Ukraine to 2050 envisions increasing renewable electricity's share to 25% by 2030 and 50% by 2050, with wind expected to be the leading source of new capacity. Yet, despite the country's heightened

security vulnerabilities, the Strategy envisions a centralised energy system with nuclear power as the backbone. Notably, this would require approximately USD 130 billion for nuclear investment, compared to around USD 35 billion in solar and wind, and estimated USD 33 billion in bioenergy. The latter technology has also abundant potential and is being considered for flexible thermal generation.

Prospects for hydrogen production

Ukraine's renewable energy endowment suggests a significant potential for green hydrogen production. Yet, to date, research on the country's actual potential for green hydrogen production remains inconclusive, with limited evidence available to fully assess its economic viability—despite some estimates suggesting output could reach as high as 44 Mt per year.

The EU accession process could facilitate the adoption of a favourable policy for green hydrogen. The EU's own 'green' agenda, with a target of 10 Mt of imports by 2030, could provide new economic opportunities for developing the sector and exports in Ukraine, particularly through Central European Hydrogen Corridor.

Conversely, the hydrogen sector faces significant legal and regulatory challenges. First, Ukraine's domestic legislation does not provide definitions for hydrogen and its possible compounds, except for 'biohydrogen'. Secondly, the regulatory framework remains incomplete regarding hydrogen, as state authorities lack the legal authority to establish policies or regulate market participants. Furthermore, existing natural gas regulations are not applicable to hydrogen due to its distinct chemical characteristics. Consequently, the absence of regulatory oversight prevents the integration of hydrogen projects into

gas transmission development plans and tariff-based financing, hindering infrastructure expansion and market creation. Completing the 2019 reform of energy markets in line with the EU's Third and the Fourth Energy Packages could facilitate overcoming some of the regulatory challenges and provide clarity and confidence to developers and investors, while also supporting Ukraine's EU accession process.

However, to overcome some of the challenges and to have a common vision, Ukraine has been working on sectoral policies for hydrogen. Particularly, the draft Hydrogen Strategy 2050 outlines ambitious targets for hydrogen production, consumption, and export. By 2050, Ukraine aims to consume 1-1.5 Mt of low-carbon hydrogen domestically and export 1.5-2 Mt. The strategy focuses on industrial applications, particularly metallurgy and fertilizers, aligning with EU decarbonization targets and mechanisms like the Carbon Border Adjustment Mechanism (CBAM). Hydrogen is also identified as a key option for transport solutions. The strategy outlines plans to position Ukraine as a major hydrogen exporter to the EU, leveraging existing gas pipeline infrastructure.

While the draft Hydrogen Strategy 2050 provides a theoretical roadmap for green hydrogen development—in the absence of a full understanding of actual production potential by regions—other policy documents do not explicitly prioritize green hydrogen in Ukraine's current transport, agricultural or industrial strategies. However, its potential role is implied in the context of broader goals related to environmental sustainability, energy efficiency, and decarbonization. The policy documents emphasize aligning with EU regulations on sustainability, renewable energy, and decarbonization. Through this alignment, the government hopes to indirectly stimulate the growth of green hydrogen sectors in Ukraine.

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