Renewable Energy Sources in the Ukrainian Electricity Mix – Opportunities and Challenges

Abstract

Ukraine's electric mix is one of the most carbon intensive in Europe. The majority of the country's electricity is produced by outdated, inefficient thermal and nuclear power plants, whose fuelling is subject to geopolitical pressure. Past and present policies have thus far favoured a status quo, inefficiently tackling the climate and political challenges plaguing the electric system. Despite a significant potential, production from renewable energy sources remains marginal and project development in this field is slowed down by unstable and ambiguous policies. Nonetheless, a clarification of Ukraine's short and long-term energy policy coupled with a clear and efficient fight against corruption could put the country's energy transition back on track towards the goals of the Paris Agreement, along with widespread benefits for the Ukrainian society.

Introduction

In an early 2021 article, Svitlana Chekunova of the Razumkov Center, an independent Ukrainian think-tank, highlighted some of the challenges faced by the Ukrainian electric system: "*the existing electricity market model is functioning with distortions in all of its segments and in the conditions of financial instability of the state-run energy generating companies, debt crisis, unfavorable investment climate, unstabilized renewables*"[1]. In addition to these significant market design flaws, the current electric mix is one of Europe's most carbon intensive, relies on geopolitically sensible imports to fuel and maintain key assets, and suffers from a lack of political, financial and strategical stability.

Amidst these critical challenges, the Ukrainian electric mix lies at a major crossroad. The country's contribution to the Paris Climate Agreement implies a significant shift in its production mix, phasing away fossil fuels and enhancing the role of low-carbon assets. In this regard, what role could renewable energy sources to lower the electric mix's carbon footprint? Which political, financial and social barriers would need to be lifted for such sources to gain momentum in the mix? Which would be the required policies necessary to these evolutions? After an assessment of the challenges the Ukrainian electric mix currently faces and an analysis of their climate, political, social and economic implications, this paper will examine the electricity production potential of three renewable energy sources – solar photovoltaics, wind and biomass – in the country, as well as the technical feasibility and implications of a Ukrainian electric mix where a significant part of production would be handled by renewable sources. Preceded by an

[1] Svitlana Chekunova, "Improving the Wholesale Electricity Market Model in Ukraine", Razumkov Centre, 2021 - https://razumkov.org.ua/en/articles/improving-the-wholesale-electricity-market-model-in-ukraine

analysis of past policies aimed at the electricity sector and of their inefficiency to effectively liberalize and decarbonize Ukraine's electric mix, the paper will be concluded by a series of policy proposals aimed at a Paris Agreement-compatible electricity mix through an increased role of renewable energy sources.

A carbon intensive and import dependent electricity mix slowing the country's development

Amidst a troubled political, economic and social landscape, Ukraine's electricity mix represents more of a challenge than an opportunity. This is linked to a strong carbon footprint of production assets, an important reliance on foreign powers likely to wield geopolitical levies to fuel and maintain a large part of its power plants, and multiple years of mismanagement notably affecting the efficiency of the electric grid.

Among these issues, the decarbonization of the Ukrainian electricity mix is one of the most pressing and challenging to address. The country's energy sector, representing 45% of its overall CO_2 emissions,[2] is one of the most carbon intensive globally[3]. As of 2017, Ukraine's power production sector emitted 2.6 times more CO_2 per kWh than the OECD average. The installed capacity is dominated by thermal power plants. Natural gas-powered thermal power plants represented 39% of the country's installed capacity as of August 2021, surpassing nuclear (25%) and coal (11%). The remaining share is covered by renewables sources: hydroelectric facilities (12%), solar (11%) and wind (3%)[4].

The installed mix needs to be put in perspective with the actual electricity generation, as power plants operate at very different capacity factors. In this regard, nuclear energy represents the backbone of the country's electric mix. According to Eurostat data, nuclear power plants generated 55% of the country's electricity in 2019, and 54% in 2020[5]. The Ukrainian nuclear fleet was built during the Soviet era, based on the same model as the Chernobyl plant. The 15 operating reactors are considered to be largely outdated and present major safety hazards[6]. Beyond these concerns, the current fleet is heavily exposed to external political pressures as Russian companies are responsible for the supply of over half of its fuel needs and the treatment of most of its waste[7].

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[2] University of Oxford database - https://ourworldindata.org/co2/country/ukraine

[3] This data on the Ukrainian energy sector's carbon footprint includes electricity and heat production. While reliable data specific to the electricity mix's carbon footprint is scarce, analysing emissions data from both heat and electricity generation remains relevant, as a large part of Ukraine's thermal power plants are combined plants generating both electricity and heat.

[4] Ukrenergo statistical data

[5] Eurostat, "Net electricity generation by type of fuel - monthly data" dataset, data available for Ukraine from October 2017 to August 2021. https://ec.europa.eu/eurostat/web/products-datasets/-/nrg_cb_pem

[6] Child et al., The role of storage technologies for the transition to a 100% renewable energy system in Ukraine, Energy Procedia 135, 2017

[7] Diachuk et al., Long-term modelling and forecasting in Ukraine: Scenarios for the action plan of energy strategy of Ukraine until 2035, Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine, Technical University of Denmark, 2019

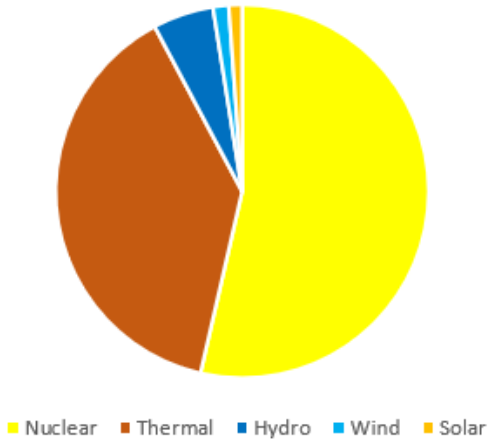

Figure 1 - Electricity generation in Ukraine in 2020. Source - Ukrenergo

Geopolitics also affect the rest of the electricity mix, leading to an increased reliance on carbon intensive solutions. Ukraine depends almost exclusively on Russia for its natural gas imports. As such, since 2017 and the rise of separatism in Donbass followed by the annexation of Crimea by Russia, the Ukrainian government has sought to limit the country's dependence on these imports by significantly reducing its consumption of natural gas. Power generation from this source has been drastically limited ever since, with coal compensating the displaced generation. Moreover, carbon-intensive bituminous coal has been preferred to generate electricity compared to the relatively cleaner anthracite coal produced in the Donetsk and Luhansk separatist oblasts[8].

Despite a significant growth over the past three years fuelled by wind and solar, renewable energy sources (RES) remain marginal in Ukraine's electricity mix. Hydroelectric dams account for 5% of the country's annual production while wind and solar both produced approximately 1%. The contribution of biomass remains negligible[9].

Since the rise of separatist factions in the Donbass region, which concentrates a large majority of the Ukraine's coal production facilities, Ukraine has resorted to import coal from Russia to sustain its electricity and heat production[10], putting the country at risk of political pressure previously experienced with natural gas imports and exposing it to commodity prices variations. The dependence vis-à-vis Russia for its nuclear production creates similar risks.

Moreover, the energy sector accounts for 12% of Ukraine's GDP. This means that decisions in this field have wide-reaching social, political and economic implications. In

[8] Yang, Cela, Yang, Innovative energy policy to transform energy systems in Ukraine, Mitigation and Adaptation Strategies for Global Change, Springer Nature, 2019

[9] Eurostat, Ukrenergo

[10] Natural gas and coal-based combined heat and power plants cover a large majority of Ukraine's heat consumption. As such, while the role of these installations is marginal in the electric mix, their fuelling remains critical to meet the country's domestic and industrial heat demand. More information on the subject is available in a 2018 study of the Flanders government (https://www.flandersinvestmentandtrade.com/export/sites/trade/files/market_studies/Ukrainian%20Energy%20Market.pdf).

order to minimize social opposition, policy makers have often minimised the ambitions of the reforms they have undertaken, thus maintaining an inefficient and carbon intensive status quo. The frequent interference of politics actors in the energy sector, conflicts of interest, generalized corruption and the lack of independence of regulatory structures such as the National Commission for State Energy and Public Utilities Regulation (the national regulator, abbreviated NEURC) further diminish the efficiency of decision-making in the energy sector[11].

Finally, beyond the production of electricity, its transmission and dispatch to consumers is plagued with inefficiency. The electric grid operated by Ukrenergo, the national transmission system operator (TSO), has suffered from under-investment, inefficient management and lack of maintenance for years. This prolonged situation has led to a strong depreciation of assets and made Ukraine's transmission grid one of the least efficient in Europe with up to 12% of losses (2.5 more than the OECD average). This low grid efficiency coupled to a limited supply of flexibility solutions and volatile transmission tariffs heavily limits the TSO's capacity to integrate a large share of RES in the generation mix[12].

A significant renewable electricity generation potential, associated with benefits largely exceeding the energy sector

Ukraine's geographical position is extremely favourable for RES. Firstly, the country benefits from large flat areas, low land prices and a high level of solar irradiation giving it a strong potential for electricity production from photovoltaic (PV) panels[13]. With an equivalent installed capacity, Ukraine could surpass the production of Germany[14]. Today, a rising number of both Ukrainian and foreign developers are showing an interest for this solar potential, including historical industrial players in the country such as DTEK Group, a major coal and gas producer also operating thermal, solar and wind power plants[15]. Despite slowdowns incurred by the COVID-19 pandemic, the country installed over 2 GW of solar capacities in 2019 and over 1.5 GW in 2020[16]. According to low carbon[17] and carbon neutral[18] scenarios in Ukraine, developed in scientific literature,

[11] Antonenko, Nitsovych, Pavlenko, Takac, Reforming Ukraine's Energy Sector: Critical Unfinished Business, Carnegie Europe, Carnegie Endowment for International Peace, 2018
[12] Organisation for Economic Co-operation and Development (OECD), Snapshot of Ukraine's Energy Sector, 2019
[13] Kurbatova, Khlyap, State and economic prospects of developing potential of non-renewable and renewable energy resources in Ukraine, Renewable and Sustainable Energy Reviews, Volume 52, 2015
[14] Volkova, Using solar power, possibilities for Ukraine, Tavria State Agrotechnological University, 2017
[15] Organisation for Economic Co-operation and Development (OECD), Snapshot of Ukraine's Energy Sector, 2019
[16] Ukrenergo
[17] Diachuk et al., Long-term modelling and forecasting in Ukraine: Scenarios for the action plan of energy strategy of Ukraine until 2035, Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine, Technical University of Denmark, 2019
[18] Child et al., The role of storage technologies for the transition to a 100% renewable energy system in Ukraine, Energy Procedia 135, 2017

solar PV could provide between 23% and 45% of the country's energy needs by 2050. This growing industry could also benefit from the know-how of Ukrainian silicon manufacturers, who used to represent up to 10% of the global production of this essential component of solar panels. However, Ukraine remains very far from reaching its significant production potential. A comparative approach shows that the country's current annual electricity production from PV barely matches Germany's over a winter month[19].

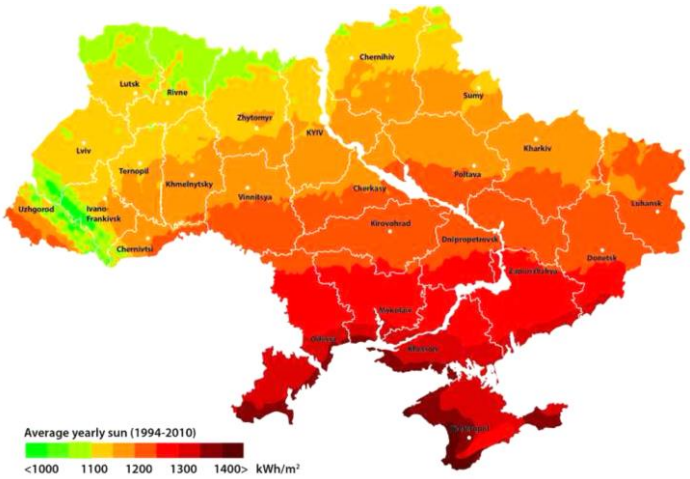

Figure 2 - Solar irradiation in Ukraine
Source: Kurbatova et al., 2015

Wind energy boasts a strong production potential in Ukraine as well, with the Black Sea coastline and Carpathian Mountains receiving strong, predictable wind flows. The country also has a lengthy know-how, having connected its first wind farm to the grid as early as 1997[20]. Nonetheless, project development remains slow and limited, leading to a modest installed capacity of 1.45 GW as of August 2021.

Geopolitics have not spared the development of renewable energy in the country, with separatism and territory losses in 2014 leading to the loss of half of the country's wind generation capacity at the time[21]. Nevertheless, the very high acceptability rate within the population and a lower "not in my backyard" (NIMBY) effect compared to European states such as Switzerland or Estonia could make it economically interesting and relatively easier to build wind farms in Ukraine than elsewhere in Europe. Ukraine would greatly benefit economically and in terms of CO_2 emissions reduction from expanding its wind production capacities. By 2050, wind energy could account for 26% to 39% of total electricity generation in low-carbon and carbon neutral scenarios, contributing to the decarbonization of both the electricity mix and the industrial sector through green hydrogen[22][23].

[19] Based on production data for Ukraine's production in 2019 and Germany's production in November 2019.
[20] Kharlamova G., Nate S., Chernyak O., "Renewable energy and security for Ukraine: challenge or smart way?", Journal of International Studies, Vol. 9, No 1, pp. 88-115, 2016
[21] Ukrenergo
[22] Kudria et al., Resource potential for wind-hydrogen power in Ukraine, 2021
[23] Green hydrogen can be an effective solution to decarbonize hard-to-abate sectors such as fossil-fuel intensive industries. More on the subject: https://www.enpg.ro/will-hydrogen-take-up-natural-gas-role-in-the-energy-mix/

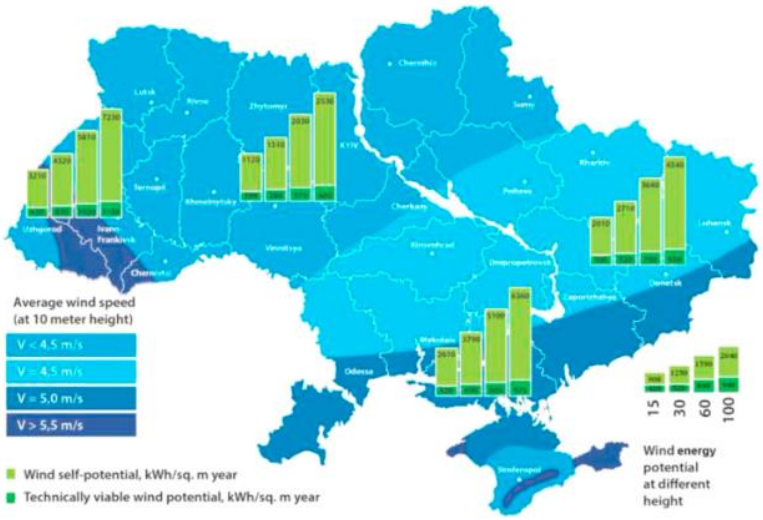

Figure 3 - Wind speeds in Ukraine and associated production potential
Source: Kurbatova et al., 2015

Ukraine's historical position as an agricultural powerhouse could also contribute to the decarbonization of the electricity sector. If properly collected and channelled, agricultural waste could be turned into biogas and biomethane, powering the country's underused natural gas power plants, instead of the currently widespread usage of such waste to generate domestic heat inefficiently. However, the Ukrainian legislation does not have any specifications when it comes to the collection and use of such waste despite supporting electricity production from this source through a feed-in tariff[24]. Another underused electricity generation source in Ukraine is geothermal electricity, which has a lot of potential in the Carpathians[25].

The prospects of integrating such capacities inf the electricity mix are solid, as shown in multiple institutional and academic papers. With current and planned policies, it is estimated that a moderate growth of RES could make them account for up to 31% of the overall electricity generation by 2035. More ambitious studies find that it would be feasible and economically profitable for the system to rely on renewable sources for 91% to 100% of its generation by 2050, using batteries, demand-side management and pumped hydroelectric storage for intraday storage and power to gas combined with Ukraine's significant existing natural gas storage facilities for seasonal storage[26][27]. These studies also show that the curtailment of renewable production would remain minimal in a scenario in which such sources would cover 100% of supplies, thanks to prementioned flexibility solutions as well as the strong complementarity of wind and solar production.

Besides being technically feasible and economically profitable, a high penetration of renewables in Ukraine's electric mix would create significant and widespread benefits for the country's economy and society. Diversifying energy generation away from fossil

[24] Jiang et al., Utilization of Crop Residue for Power Generation: The Case of Ukraine, 2019
[25] Kharlamova G., Nate S., Chernyak O., "Renewable energy and security for Ukraine: challenge or smart way?", Journal of International Studies, Vol. 9, No 1, pp. 88-115, 2016
[26] Naftogaz, "LNG prospects in Ukraine", presentation by Oleksandr Laktionov at the 2nd Energy Panel of the Eastern Partnership, Brussels, 2018
[27] Chepeliev, Diachuk, Podolets, Transition towards High Share of Renewables in Ukraine: Linked Energy System and CGE Model Approach, 2018

fuels and nuclear plants would be a great opportunity for the country to create new local industries less reliant on volatile commodity prices, with less history of conflicts of interest and corruption and with a long-term global demand for clean energy production and storage assets. An important number of qualified jobs would also be created, notably in rural areas lacking economic attractivity[28].

Inefficient policy efforts, lacking ambition to meet the country's needs and goals

Despite a strong RES-based electricity generation potential and the associated environmental, social and economic benefits, unstable and sometime counterproductive policies, inadequate market design, as well as widespread anticompetitive behaviours could block RES deployment, despite some recent more positive developments.

An inefficient market design and legislative framework

The country has seen significant changes in its electric system since it joined the Energy Community in 2011. The country has pledged to implement the European Union's Third Energy Package, implying a full liberalization of retail and wholesale electricity markets. The 2018 law on the energy market was adopted with this precise objective. It led Energorynok to lose its monopoly on purchases and sales on the wholesale market in July 2019, paving the way for market-based pricing. The bill was also aimed at eliminating cross-subsidies, developing a day-ahead and intraday trading market. Finally, it reformed grid tariffs, basing them on a regulatory asset base pricing meant to boost investment and improve maintenance. The whole legislative bill was estimated to increase investments in generation assets by at least a factor of ten compared to its initial level and to double those in grid infrastructure[29].

Unfortunately, the objectives of these market organization efforts have only been partly achieved and remain insufficient to attract more RES investments. While the legislative bills reforming the electricity market have been passed, they are yet to come into force on multiple fronts. For instance, retail markets remain heavily subsidized, where cross-subsidies lead industrial consumers to pay for a part of retail consumer bills.

In addition, despite numerous anti-corruption and political reforms, conflicts of interest and corruption remain major issues in the energy sector, as well as the rest of the country. Some institutions are under heavy political influence such as the regulator NEURC which is fully controlled by the ministry of finances and whose members are

[28] Child et al., The role of storage technologies for the transition to a 100% renewable energy system in Ukraine, Energy Procedia 135, 2017
[29] Energy Community Secretariat, Annual Implementation Report of Ukraine, November 2020

named by the presidential administration[30]. Moreover, markets where liberalization is underway remain extremely opaque which annihilates all reform efforts. Subsidies supporting renewable growth attract corrupt firms and it is doubtful that environmental and economic reasons will be the only factors to determine the winners of the first RES auctions[31].

The grid also continues to charge extremely high and volatile tariffs while using its income inefficiently. Under the current organizational situation of Ukrenergo, the depreciation of grid assets, the lack of effective maintenance and the subsequent increase in losses could make it necessary for Ukraine to start importing electricity regularly within 15 years despite having a significant domestic production capacity[32]. Moreover, recent reforms have made it unclear as to who is responsible for the purchase of electricity produced from renewable sources and benefiting from public financial support mechanisms. The TSO has temporarily taken up this role in the name and place of the "Guaranteed Buyer", but this shift has led to multiple delays and non-payments. This financial situation and the subsequent uncertainty are unsustainable both for Ukrenergo, renewable energy producers and their financers[33].

Unstable support schemes and a lack of long-term strategy

Beyond these attempted reforms of Ukraine's electric system, the national government has introduced generous subsidies in an effort to enhance the share of RES in its overall generation. The first feed-in-tariff (FIT) for renewable energy production in Ukraine was introduced in 2009 and later reformed in 2015. This type of support scheme grants producers a fixed income per kWh of production for 20 to 30 years. The fixed income is specific to each technology and additional premiums are allocated to producers whose installations integrate a high share of components manufactured in Ukraine. The value of the FIT for each technology is set by NEURC, and the production of support-eligible plants has priority in the TSO's dispatch[34]. This policy is supposed to put Ukraine on track to the objective of renewable generation set in the National Energy Strategy of Ukraine, aiming at achieving an 11% RES penetration in the energy mix by 2020 and 25% by 2035. However, this 25% objective would only be translated by 14% of RES in the electric mix in 2035[35].

Unfortunately, this financial stimulus has only been mildly efficient, notably due to its instability. Ukraine has developed a bad reputation when it comes to the stability of its support schemes towards RES in the past years. The FIT introduced in 2009 was accompanied by tax cuts on materials required for the building of RES power plants and

[30] Child et al., The role of storage technologies for the transition to a 100% renewable energy system in Ukraine, Energy Procedia 135, 2017
[31] Organisation for Economic Co-operation and Development (OECD), Snapshot of Ukraine's Energy Sector, 2019
[32] Prokip, Liberalizing Ukraine's electricity market: benefits and risks, Kennan Institute, The Wilson Center, 2019
[33] Organisation for Economic Co-operation and Development (OECD), Snapshot of Ukraine's Energy Sector, 2019
[34] Trypolska, Support scheme for electricity output from renewables in Ukraine, starting in 2030, Economic Analysis and Policy 62, 2019
[35] Government of Ukraine

on a share of their profits. In 2014, the Ukrainian supreme court declared these tax cuts illegal, bringing them to a sudden halt. This change greatly affected the trust of project developers in the Ukrainian government's ability to provide long term visibility on their investments as the economics of multiple existing plants were affected in the middle of their operating life[36].

In addition, auctions due to be launched in 2020 as a gradual replacement of FIT-based support schemes for large renewable projects have been announced repeatedly but are yet to be deployed in effect despite being one of the essential elements of the Energy Strategy of Ukraine. This chaotic framework has inevitably led to a further slowdown of the growth of RES in Ukraine and further increased its delay in the energy transition compared to the rest of the world. The RES development targets for 2020 have already been missed and there is currently no visibility on the launch date of the next set of auctions[37][38].

Finally, political will to phase out coal and nuclear production units, which could allow a greater penetration of RES, remains limited. While their phase out has begun, subsidies to the coal sector are yet to be eliminated and regulated sales are still the norm for hydroelectric and nuclear producers which leads to market distortions[39]. On the nuclear front, the government has recently signed an agreement with US company Westinghouse to build new reactors in Ukraine as well as to complete unfinished projects in a bid to add multiple gigawatts of nuclear capacity in the coming years[40][41][42].

A narrow and ambitious path towards a decarbonized and liberalized energy sector

Ukraine and its energy sector currently stand at a major crossroad. Energy is a critical sector of the country's economy, accounting for a large share of the country's GDP. Mismanagement, corruption, conflicts of interest and a lack of effective policy have made a resource-rich country dependent from foreign contributions for a significant share of its production assets. Numerous geopolitical, financial and technical risks currently threaten Ukraine's security of supply, with consequences affecting numerous parts of the society: cross-subsidies harm businesses and make end-consumers used to artificially cheap prices, corruption and incomplete reforms make the energy system inefficient, and the mismanagement of the electric grid could lead to an unsustainable wall of investments. A pathway towards a liberalized and decarbonized system that would unlock widespread benefits for the Ukrainian society as a whole is not out of reach however, although it would require a strong political will and a robust judiciary system.

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[36] Ukrainian Wind Energy Association (UWEA), Ukrainian Wind Market Overview 2014, 2015
[37] Government of Ukraine
[38] https://www.pv-magazine.com/2021/09/03/ukraine-drafts-rules-for-renewable-energy-auctions/
[39] Prokip, Liberalizing Ukraine's electricity market: benefits and risks, Kennan Institute, The Wilson Center, 2019
[40] https://info.westinghousenuclear.com/news/energoatom-and-westinghouse-advance-clean-energy
[41] https://www.energy.gov/ne/articles/westinghouse-help-optimize-12-ukrainian-reactors
[42] https://www.world-nuclear-news.org/Articles/Energoatom-plans-rapid-start-to-AP1000s

The backbone of Ukraine's energy policy is the Energy Strategy of Ukraine, which was adopted in its current version in 2017, detailing the country's goals up to 2035. In order to take full advantage of the cost reduction of RES and to provide more visibility to market players, Ukraine could launch a revision of its Energy Strategy by the end of 2021 and publish an updated strategy by the end of 2022. This time could be used to launch a large-scale, transparent consultation process that would maximize the uptake of the strategy by the civil society and market players. Ideally, the revised strategy would set sufficiently ambitious objectives for the sector to reach carbon neutrality by 2050-2055, relying on renewables for a majority of its production and a residual 20% to 40% from nuclear power plants. This energy roadmap could also be associated with a larger carbon neutrality strategy encompassing all economic sectors.

In addition to these macroscopic goals, finalizing the implementation of the European Union's Third Energy Package needs to be a priority for Ukraine. Harmonizing the political and technical framework of the country's energy system will enable better relations with the EU as part of its Eastern Partnership and within the Energy Community, unlocking access to financing and know-how from other member states. Moreover, this clarification of the energy sector's legislation would bring much needed visibility and stability to investors. While the implementation of the Third Energy Package would be accompanied by the complete deregulation of wholesale and retail markets, poorer households would need to be the subject of specific attention (including financial support if needed) in order to avoid increasing inequalities.

Under this renewed political framework, Ukraine could then start phasing out subsidies and regulated sales obligations for all coal, natural gas, nuclear and large hydro-based electricity producers by 2025. This would give a level playing field for RES, paving the way for a phase out of all coal-based electricity production by 2032. This measure would need to be accompanied by specific socio-economic support mechanisms to workers and companies whose activity would be affected by the measure, similar to the European Commission's "Coal Regions in Transition Initiative"[43].

The energy strategy of Ukraine could serve as a basis for the reform of support schemes to renewable electricity production. The existing FIT could be limited to geothermal and biomethane plants, mini and micro-hydro and small PV projects (<1 MW), with decreasing rates to take into account economies of scale and technological progress. Meanwhile larger and more mature renewable projects would compete in biannual, transparent, technology specific auctions, awarding the best bids a 20-year feed-in-premium based power purchase agreement. These auctions would be organized and managed by the government and NEURC, and a 5-year agenda of the evolution of all support schemes would need to be published to give investors the necessary visibility on upcoming opportunities. Self-consumption, local procurement of labour and materials as well as the deployment of energy communities and energy storage solutions could lead to specific bonuses within the support schemes.

As the backbone of the electric system, the national grid would need to be the subject of specific reforms and overhauls in order to accompany the sector's

[43] https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/coal-regions-transition_en

decarbonization effectively. Firstly, an audit of past grid tariff reforms would need to be put in place swiftly as a basis for further evolution. The decision to change tariffs to ensure a large-scale modernization and digitalization of the grid, the implementation of grid connection procedures for new producers as well as predictive maintenance schemes would then be made by NEURC by the end of 2022. The opportunity of a complete privatization of Ukrenergo would also need to be assessed, while maintaining a regulation of its activities by NEURC.

Finally, a significant emphasis would need to be put on the separation of powers within the energy sector, notably concerning the influence of politics in the industry. A starting point in this regard would be to prohibit the ownership of any assets related to the energy sector by elected officials and public servants during their time in office and for a period of 2 to 5 years after holding office. This measure would need to be accompanied by a continued fight against corruption and conflicts of interest with a close focus on the energy sector. To this effect, the complete financial, political and administrative independence of NEURC would need to be ensured, giving it the ability to better monitor and report anti-market behaviours on the electricity markets, with sanctions including the forced unbundling of companies.

Overall, renewable energy sources present a strong potential contribution to the decarbonization of Ukraine as a whole by enabling a significant reduction of the electricity sector's greenhouse gas emissions. In addition to these climate benefits, a stronger share of RES in the country's electric mix could help reduce its geopolitical dependence vis-à-vis foreign powers and help the Ukrainian society bounce back after suffering a steep economic and social decline due to the loss of significant parts of its territory to Russia and separatist movements, followed by the coronavirus pandemic.

The country will however not be able to access these benefits without a major overhaul of the management of its whole energy system. Long-term planning, regulatory and financial visibility for RES, a stronger fight against corruption as well as a swift and complete implementation of the Third Energy Package seem to be absolute prerequisites for the country to succeed in its energy transition and for the whole Ukrainian society to benefit from this shift towards a decarbonized electric mix.