SELECTED HIGH-IMPACT MEASURES

Increasing RES electricity generation through competitive auctioning of feed-in premiums

by Clemens Stiewe

Low Carbon Ukraine

Implemented by
Berlin Economics

Supported by:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
based on a decision of the German Bundestag

Motivation and project background

This policy proposal is part of a series which was elaborated in the framework of the project Low Carbon Ukraine (LCU) supporting more ambitious paths for selected energy and climate policy areas.

The idea to develop the present ten "Policy Proposals" arose in the course of LCU's support for the Ministry of Energy of Ukraine in setting up a National Energy and Climate Plan for Ukraine. While Ukraine's climate targets are partially very ambitious, we often observed a lack of underlying analysis and concrete policy measures to achieve those targets. For the most crucial topics, we provide a comprehensive analysis and propose concrete policy measures based on international experience.

Each Policy Proposal was written in a multi-stage process: a first draft of LCU experts or invited professionals was discussed over summer and early autumn 2020 with Ukrainian experts and stakeholders. Results of those discussions were taken into account when updating the Policy Proposals. It is important to note, that the presented results reflect the view of the authors and not necessarily the position of the BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety).

We hope that the present analysis and proposals will contribute to a fruitful and constructive discussion and help Ukraine to develop ambitious, yet realistic energy and climate policies.

Dr. Georg Zachmann, project leader
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Low Carbon Ukraine is a project with the mission to continuously support the Ukrainian government with demand-driven analysis and policy proposals to promote the transition towards a low-carbon economy. It is part of the International Climate Initiative (IKI) and is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) on the basis of a decision adopted by the German Bundestag. The project is implemented by BE Berlin Economics GmbH.

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Executive summary

Thanks to generous feed-in tariffs (FITs) for renewable energy sources (RES), Ukraine has seen a remarkable surge in RES capacity addition in recent years. In 2020, 10% of electricity has been generated by RES (incl. hydro) in Ukraine. In order to rein in the spiralling costs of RES support, Ukraine has adopted an auctioning system for RES support. From 2021 on, this system will be used to determine support levels for utility-scale RES on a competitive basis.

In December 2020, the Ministry of Energy of Ukraine announced draft quotas for the first RES auctions in 2021 and indicative annual quotas for 2022 until 2025. According to the Ministry, 365 MW of RES capacity would be auctioned in 2021, and quotas would then slightly increase from 420 MW in 2022 to 570 MW in 2025.

In this Chapter, we show that at moderate electricity consumption growth, the current deployment path will increase Ukraine's RES share in electricity generation to around 21% in 2030. This path is insufficient to significantly move forward on decarbonising Ukraine's electricity sector. It moreover conflicts with the country's ambition to become a producer of green hydrogen. We estimate that doubling the currently planned auction volumes would allow Ukraine to achieve a 30% RES share in electricity generation in 2030, helping Ukraine to keep pace with global decarbonisation efforts.

A more ambitious deployment is feasible with policy measures that help to reduce the integration cost of renewables. To foster the integration of RES into the electricity market, we propose the introduction of a feed-in premium (FIP) scheme. For new RES plants, this FIP scheme would entail the obligation to sell the generated electricity on the wholesale market, rendering the intermediary step of selling electricity to the single offtaker Guaranteed Buyer (GB) unnecessary. Introduced together with balancing responsibilities for RES, a FIP scheme would incentivise RES to deliver better generation forecasts and allow them to sell or buy electricity on all short-term markets to react to forecast updates. These regulatory changes would reduce RES imbalances, ensure a more efficient dispatch of Ukraine's electricity system and hence reduce the need for costly balancing energy.

To incentivise the market entry of flexible generators that are needed to balance RES fluctuations, we argue that minimum and maximum price caps on Ukraine's electricity wholesale market should be phased out. We show that eliminating price caps is consistent with the objective to achieve low average prices and would help to address the high market concentration on Ukraine's electricty market.

The status quo of Ukraine's renewables support scheme

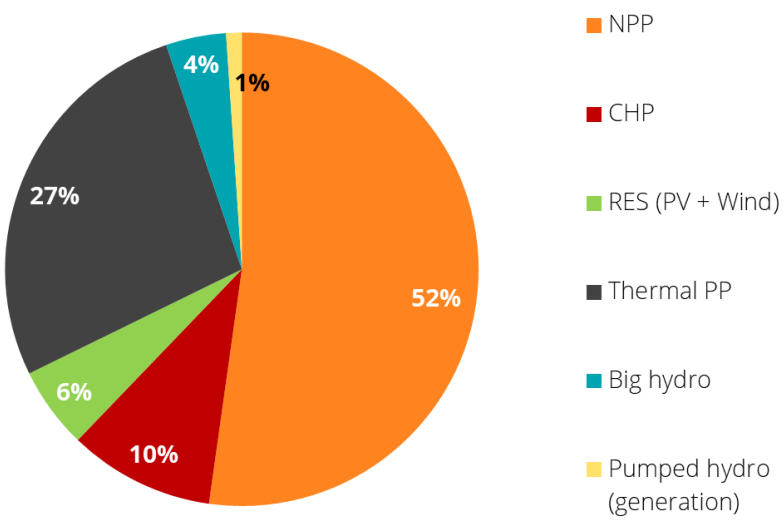
RES support has been effective in promoting deployment but has led to high costs

In 2009, the Ukrainian government implemented a feed-in tariff (FIT) scheme for certain types of renewable energy sources (RES). Under a FIT regime, the government legally guarantees investors to buy the electricity they produce and pay them a specified tariff over a certain period of time.

Ukraine's FIT scheme guaranteed eligible producers prices from 10 to 15 EURcts/kWh (IMEPOWER, 2019). It has proven to be effective in attracting investment: Since the scheme was introduced, RES capacities have increased rapidly from less than 100 MW in 2009 to 8.5 GW in December 2020. In 2020, wind and PV accounted for 6% of electricity generation (see Figure 1). RES producers in Ukraine that are eligible for FIT would sell their electricity to the single offtaker Guaranteed Buyer (GB), who then resells all RES electricity at the regular day-ahead market (DAM) or on the bilaterals segment. This means that the actual subsidy for the RES producer is the difference between the FIT and the DAM/bilaterals price, with lower (higher) wholesale prices implying higher (lower) total RES support cost. FIT subsidies are financed both through a tariff surcharge – which has a direct impact on final consumer prices – but also through proceeds from electricity sales from state-owned generating companies.

In recent years growing concern has been voiced that these subsidies for renewables may become too costly. Moreover, there are concerns that the high FIT expenditures could lead to increasing electricity prices for consumers. The government has reacted to these concerns by introducing a RES auction regime in which feed-in prices for new RES plants shall be determined via auctions from 2021 on. Existing installations, which have been granted FITs before the end of 2019, will nevertheless continue to receive FIT for the guaranteed period until 2030, when the FIT scheme for existing installations will be eventually phased out.

Figure 1: Electricity generation mix Ukraine, 2020



Source: Ukrenergo

An auctioning system for RES should help to reduce support cost

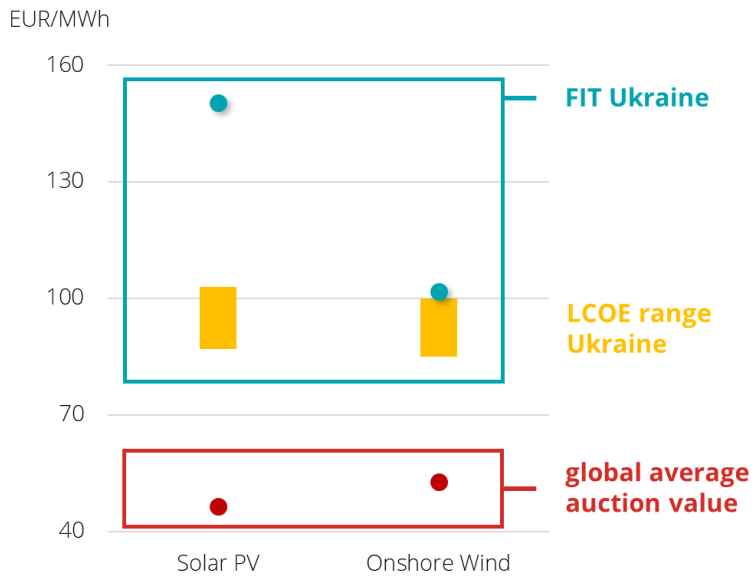
The new scheme foresees that each year, auction volumes (in MW of installed capacity) will be put up for auctioning. There is a separate quota for wind, solar and for "other RES" installations, with the latter comprising of small hydropower, biomass/-gas and geothermal installations. While wind turbines larger than 5 MW and solar plants larger than 1 MW are obliged to participate in the auctions, smaller RES projects can participate on a voluntary basis. However, they can also opt for the fixed FIT tariff but would then have to accept a shorter support duration. Auction participants should submit closed bids containing the technical bids (the installed capacity of the project) and the price bid (the supported price in EUR/kWh). Starting with the lowest price bid, successful bidders are selected until the auction quota is exhausted. Auction volumes shall be set annually for five years. In December 2020, the Ministry of Energy of Ukraine announced draft

quotas for the first RES auctions in 2021 and indicative annual quotas for 2022 until 2025. According to the Ministry, 365 MW of RES capacity would be auctioned in 2021, and quotas would then increase from 420 MW in 2022 to 570 MW in 2025.

High country risk explains generous support levels to some extent – but PV FITs have clearly been excessive

As the FIT scheme for larger installations expired at the end of 2019, many investors tried to still benefit from the generous support levels. Figure 2 shows that the margin between guaranteed FIT and estimated Ukraine-specific levelised costs is significant especially for PV. Figure 2 also shows average global auction values for 2019 to give an indication of how Ukraine's high country risk inflates the costs of capital and therefore justifies above-average support levels to some extent. The 2019 FIT cut-off has led to an increase of installed RES capacities of 4 GW in 2019 – 3 GW of which were PV – alone. This has more than tripled the total installed capacity compared to 2018. With the adoption of the Law 810-IX "On Amendments to Certain Laws of Ukraine on Improving the Conditions for Promoting Electricity Generation from Renewable Energy Sources" on July 21, 2020, FITs will eventually be retroactively lowered and imbalance responsibilities will be phased in earlier than previously planned (Radchenko, 2020).

Figure 2: Comparison of 2019 Ukrainian FIT[1], LCOE[2] and global average auction values



Source: Mantzos *et al.* 2019, IMEPOWER 2019, IRENA 2020, Own calculation

Policy proposal

Ukraine's auction scheme foresees two technology-specific auctions, one for wind and one for PV, as well as one technology-open auction for "other" RES generators that are neither wind nor PV. In this third auction, biomass/-gas, geothermal and small hydro plants would compete for feed-in prices. In addition to that, the Law 810-IX states that the Cabinet of Ministers of Ukraine can call technology-neutral and/or specific auctions for "other RES". We estimate RES shares in electricity generation implied by the Ministry of Energy's draft quotas until 2025 and show how much RES capacity should be auctioned if Ukraine were to reach a 30% RES share in electricity generation in 2030.

[1] FIT levels before retroactive changes. The Law 810-IX lowers FIT for PV >1 MW commissioned between 2015 and 2019 by 15% and for wind (turbine >2 MW) by 7.5% (Radchenko 2020).

[2] LCOE range calculated using POTEnCIA modelling tool (Mantzos *et al.* 2019) with discount factor range 13%-16%.

I. Extrapolating the current deployment path

Ukraine plans to gradually increase auction volumes from 365 MW in 2021 to 570 MW in 2025

In a first step, we show which RES shares could result from the currently discussed RES quotas. We use the planned quotas of 365 MW for 2021 and the indicative 5-year-quotas, which increase from 420 MW in 2022 by 50 MW a year to 570 MW in 2025, and extrapolate the increase of 50 MW per year from 2026 onwards (see Table 1). According to this heuristic, 820 MW would be put up for auctioning in 2030. We assumed an average time lag between being auctioning and commissioning of the RES capacity of one year, which means that only volumes auctioned until 2029 affect the 2030 electricity generation. In the third, technology-neutral auction category for "other RES", we expect one technology to dominate. This is in line with European experience on technology-neutral auctions (Pakalkaite, 2020). Given Ukraine's large agricultural sector and the entailing potential for utilising agricultural residuals as well as the geographical limitations to expand small hydro capacities, we assume a 90% share of successful biomass/-gas bids in this category. This, however, is conditional on biomass developers being able achieve levelised costs below EUR 120/MWh – the new ceiling price for this auction category recently set by the Law 810-IX (Radchenko 2020). Levelised costs for biomass plants tend to be close or above this threshold for two-digit discount rates (Mantzos *et al.* 2019). By applying average 2016-2018 Ukrainian capacity factors for wind, PV, biomass and small hydro plants we estimate a potential trajectory of total RES electricity generation until 2030 (Ukrenergo, 2020). We assume electricity generation from large hydro power plants, currently at 6 TWh/year, to remain constant.

Table 1: Planned 2021 RES quotas and indicative quotas for 2022-2025

Auction category	2021	2022	2023	2024	2025
Wind	150	170	190	210	230
Solar	155	170	180	190	200
Other RES	60	80	100	120	140
Total	365	420	470	520	570

Source: Teusch, Soshenko 2020

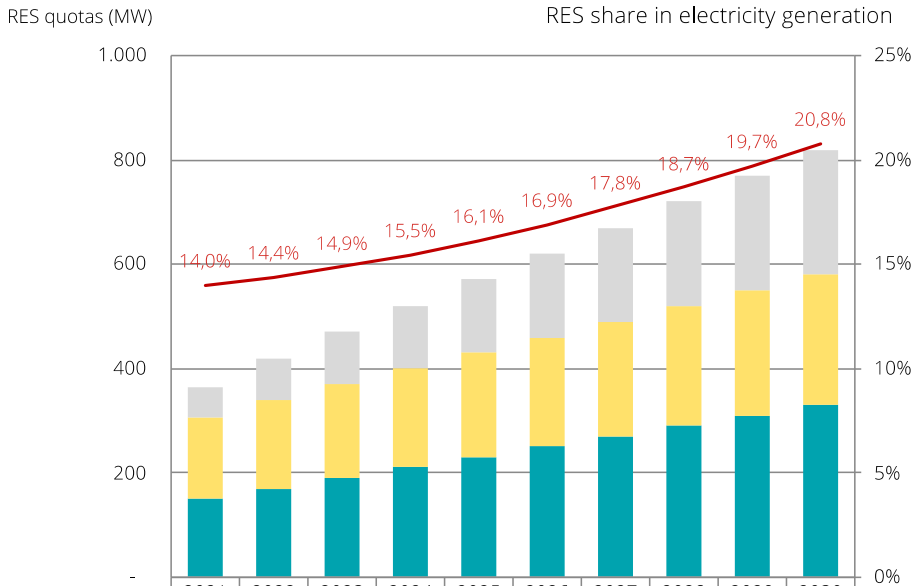
The estimated RES shares take 8.5 GW of installed RES capacities for end-2020, reported by Ukraine's State Agency for Energy Efficiency and Energy Saving of Ukraine, into acccount. After the retroactive changes to FITs, it remains unclear how many pre-PPA projects registered until December 2019 will be eventually realised. Due to this uncertainty, we did not include them in our estimations.

At moderate electricity consumption growth, the extrapolated current deployment path would result in a 21% RES share in electricity generation in 2030 (incl. hydro)

For translating annual RES generation into RES generation shares, one needs to make an assumption on the development of electricity consumption. The recent Covid-19 crisis has had a negative impact on electricity consumption in 2020, which declined by 4% compared to 2019. Assuming a moderate average annual consumption growth of 2% from 2021 onwards, total gross electricity consumption would reach 170 TWh by 2030. Assuming constant net exports and accounting for pump storage consumption, total electricity generation in 2030 would amount to 176 TWh.

As shown in Figure 3, the extrapolated current deployment path would hence imply that even though total RES generation (incl. large hydro) increases from 14 to 37 TWh (+75%), the RES share in electricity generation only increases by 50% from 14% in 2021 to 21% in 2030. This is due to the growth in electricity consumption, which offsets some of the effects of RES deployment.

Figure 3: RES shares according to extrapolated current deployment path



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total	365	420	470	520	570	620	670	720	770	820
Other RES	60	80	100	120	140	160	180	200	220	240
PV	155	170	180	190	200	210	220	230	240	250
Wind	150	170	190	210	230	250	270	290	310	330
RES generation share (incl. hydro)	14,0%	14,4%	14,9%	15,5%	16,1%	16,9%	17,8%	18,7%	19,7%	20,8%

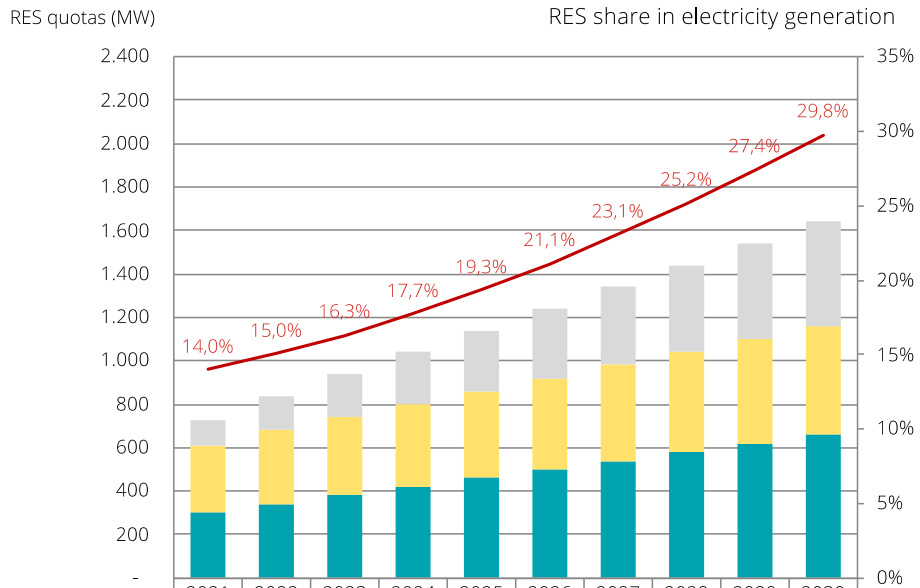
Source: Own calculation

II. Auction volumes to achieve a 30% RES share in 2030

To achieve a 30% RES share in 2030, current auction volumes would need to be doubled

In order to achieve a 30% RES share electricity generation in 2030, the currently planned annual quotas would have to be doubled (see Figure 4). As similar target shares are being discussed in the framework of Ukraine's updated Nationally Determined Contributions, our estimate serves as a guidance for the neccesary deployment to achieve those targets. Scaling up the currently planned quotas by the factor of 2 preserves the RES technology mix envisioned by the Ministry of Energy. The Ministry's decision to assign higher wind volumes is reasonable as it helps to balance to RES technology mix, which is currently heavily skewed: Since FITs have been especially favorable for PV developers, the recent surge in installations was largely due to PV additions. A higher share of wind electricity generation would lead to a more equal distribution of total RES generation throughout the day and mitigate the problematic decrease of residual load during noon, when PV infeed peaks. This would relieve pump hydro plants, which are now being dispatched to consume excess PV electricity during noon. This new dispatch routine constrains the usual rountine of pump hydro consuming excess electricity during low-demand hours at night. A simultaneous deployment of wind and PV also reduces the additional operational reserves needed to balance RES fluctuations (Ziegenhagen, 2013).

Figure 4: RES quotas to achieve a 30% RES share



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total	730	840	940	1.040	1.140	1.240	1.340	1.440	1.540	1.640
Other RES	120	160	200	240	280	320	360	400	440	480
PV	310	340	360	380	400	420	440	460	480	500
Wind	300	340	380	420	460	500	540	580	620	660
RES generation share (incl. hydro)	14,0%	15,0%	16,3%	17,7%	19,3%	21,1%	23,1%	25,2%	27,4%	29,8%

Source: Own calculation

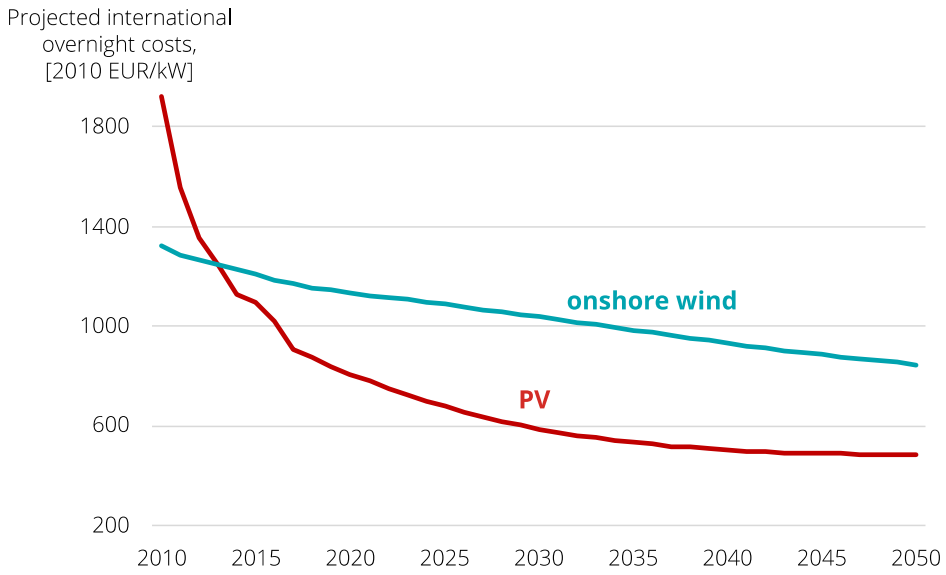
Translating decreasing technology costs into lower support cost

The investment costs for PV and wind have decreased significantly in recent years (Lazard 2019). In the next years, build costs are expected to further decline (see Figure 5).

With Ukraine's large available areas for building wind and PV plants and its considerable solar irradiation and wind resources, these two technologies are the prime candidates for producing electricity at low cost.

While the rapid deployment of PV and wind have driven cost reductions in recent years, a more mature market and thus reduced financing costs together with technology improvements are likely to further drive down costs. International experience shows that these cost reductions can translate into lower auction bids and hence less RES support (IRENA, 2020).

Figure 5: Projected international overnight capital costs for onshore wind and PV



Source: Mantzos *et al.* 2019

Ensuring competitive auctions is not trivial – authorities should review the auction design after the first auction rounds

While technology costs are falling globally, it is not trivial to also achieve lower auction results in Ukraine. Translating decreasing overnight cost into lower support levels depends on ensuring competitive auctions and lower risk premiums for RES investors. Ukraine should therefore closely monitor the auctions and adjust auction design and volumes if necessary.

Potential solutions to increase competition and mitigate risks include reviewing prequalification requirements to ensure all bidders have fair chances of participating. Providing transparent guidelines and the training of civil servants can help to mitigate administrative risks (Schenuit *et al.*, 2018). The fact that DTEK acts as the distribution company in many parts of Ukraine and is likely to be an auction participant as well illustrates that ensuring equal chances of grid connection and transparent connection procedures for all auction participants is another important factor to mitigate risks and increase competition. Moreover, authorities might prolong the available time for realising the project in case too strict deadlines or excessive fines deter bidders from participating. If the technology-specific auctions lack liquidity, mixed-technology auctions for PV and wind as included in the Law 810-IX may be an option to increase competition (Hanke, Tiedemann, 2020).

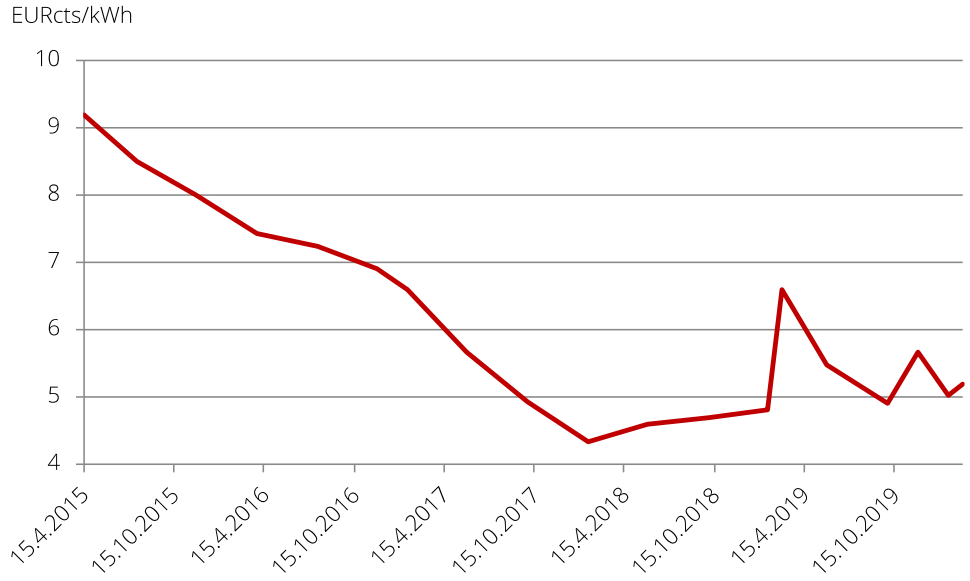
The investment risk faced by RES developers is a crucial factor to take into account. If investors perceive that the risks associated with a project are high, they are likely to look for a higher return on their investment as a compensation (Schenuit *et al.*, 2018). Higher risk premiums lead to higher bids – and eventually to higher electricity tariffs. It is therefore in the hand of the Ukrainian government to reduce the country-specific risk premium by pursuing a stable and consistent energy policy.

Background info

German PV auctions

In recent years, Germany has seen a decline in PV bid prices. Under the competitive bidding scheme in PV auctions, support payments decreased from 9 EURcts/kWh in 2015 to 5 EURcts/kWh in 2020. This significant decline is due both to high levels of competition and declining technology cost. This reduction in bid prices will only affect tariffs with a certain delay though as today's total RES support costs are heavily influenced by older, more expensive RES plants – which is why the tariff surcharge for renewables support that is borne by consumers is still rising. As older plants are increasingly falling out of the support scheme, the peak of RES support cost is in sight. As a result of decreasing technology cost, support levies and hence electricity prices are expected to fall in the 2020s (Fabian, H., Peter, F., Graichen, P., 2020).

Figure 6: Average awarded bid prices in German PV auctions, 2015-2020



Source: Bundesnetzagentur

Introduce a feed-in premium system

In Europe, feed-in premium (FIP) support schemes are increasingly complementing the traditional FIT schemes. FIP schemes require RES electricity to be sold directly to the organised segments of the electricity wholesale market, with RES operators then receiving a feed-in premium on top. The introduction of FIP schemes together with direct RES marketing is often accompanied by extending balancing responsibilities for RES producers (CEER, 2018). FIPs are often introduced as an option to existing FIT schemes, i.e. operators are allowed to switch between the two remuneration schemes on an annual or monthly basis. The Law 810-IX obliges Ukraine's Cabinet of Ministers to submit a draft law that allows RES to leave the GB balancing group, sell their electricity on the wholesale market and receive the difference between market price and auction price/FIT as a premium. We support this initiative:

When coupled with increased balance responsibilities, a FIP scheme could reduce system balancing costs and foster the integration of RES into the electricity market.

A feed-in premium system would expose RES to market signals and ensure a more efficient dispatch of power plants

A viable option would be to make the FIP scheme compulsory for RES investors participating in the auctions and allow existing RES to switch to the FIP scheme, as envisioned in the Law 810-IX. The law also foresees complete balance responsibilities for RES in the GB balancing group to be introduced from 2022 on. For RES in the proposed FIP scheme or existing RES that voluntarily switch to the FIP scheme– i.e. they leave the GB balancing group and hence need to join a regular balancing group – the same responsibilities should apply. It is important to note that the introduction of RES imbalance responsibilities, although necessary from a system perspective, might mean that RES operators include these costs in their auction bids, leading to higher auction prices (Anatolitis, Grundlach, 2020).

Imposing the same degree of accountability on all balancing groups and allowing RES operators to join those balancing groups together with conventional generators would prevent the current pooling of highly volatile generators into one balancing group and hence ensure a more decentralised scheduling of resources. These balancing groups would be able to adjust their positions on the spot market – e.g. after intraday generation forecast updates – and hence reduce the need for costly regulating power.

In case that a balancing group is unable to successfully adjust their positions and would deviate from its generation schedule, it would have to pay a significant imbalance price. Ideally, this imbalance price should represent the costs of activating the regulating power that is necessary to rein in the deviation of supply and demand caused by that balancing group (Hirth, Ziegenhagen, 2015).

Given the substantial delays in FIT payments from the GB to RES producers, the counterpart risk perceived by RES investors is especially high in Ukraine, which increases the risk premium and results in higher bids (Schenuit *et al.*, 2018). A more timely remuneration through direct marketing would serve as an incentive for existing RES to change to the FIP scheme.

FIPs moreover incentivise RES producers to respond to market price signals: When electricity supply is low or demand is high, RES operators can strike higher prices for providing electricity and hence balancing supply and demand.

In Germany, where the FIP scheme is compulsory for new RES plants commissioned since 2016, the premium is calculated as the difference between awarded auction bid price and average wholesale market revenues (EEG, 2017). RES producers therefore have a guarantee to always receive their awarded bid price. Yet, in situations of excess demand and high prices on the wholesale market, RES producers could sell for prices that even exceed the supported price. In that case, the GB would have to pay no premium at all. In cases of excess supply (e.g. on very windy and sunny days with low demand), wholesale market prices could turn negative – i.e. generators must pay to produce.

To prevent that RES are paid the entire supported price plus the revenues for not producing in such situations, we suggest not to pay RES support during hours of negative spot prices in Ukraine. This would resemble the Danish RES support design, were no premiums are paid if spot prices for the respective hour are not positive (Garzón González, Kitzing, 2019). For negative prices to occur, the price caps currently in place would first need to be phased out.

We propose that no premiums are paid for hours of negative spot prices

Under such a "sliding" FIP scheme the GB would only have to pay RES producers the difference between awarded auction bid price and average wholesale market revenues for the respective RES technology. Average revenues could be calculated by the GB separately for every RES technology as in the German case: Multiply the average hourly contracts on Ukraine's electricity exchange (in UAH/MWh) with the RES infeed during that hour per technology (wind, PV and other). Summing up these products for every hour of the month and dividing it by the monthly sum of the respective hourly RES infeed (in MWh) would then give a proxy for the average revenue per MWh that a certain RES technology has achieved on the wholesale market during one month (EEG, 2017). The longer the averaging period, the higher the exposure of RES operators to market risks.

A special case of a two-sided or symmetrical "sliding" FIP is a Contract for Difference (CfD). Under a CfD scheme, applied e.g. in the UK, the awarded auction price also represents the maximum remuneration: If wholesale electricity prices are higher than the auction strike price, RES producers pay back their additional income to the contract counterparty (Woodman, Fitch-Roy, 2019).

The GB's high indebtedness, which is due to chronic delays in payments within the complex PSO mechanism, could be reduced with a FIP scheme – the payables to RES producers would only be a small share of today's figure. Further reducing the counterpark risk of the GB through the provision of long-term RES support strategies, as well as expansion targets and deployment forecasts, is crucial in this regard (Schenuit *et al.* 2018). The regulatory effort to introduce such a system is comparably small as the main instrument to determine premiums is already in place with the new auction system. In the medium term, DSOs or the TSO could take over the task of remunerating RES producers from the GB.

Background info

The Guaranteed Buyer's role in Ukraine's RES support system

Currently, all RES operators in Ukraine sell their electricity to the single offtaker GB and are being paid the guaranteed FIT per kWh produced. The GB then resells all RES electricity that it has bought from RES producers at the DAM or bilaterals segment. The difference between FITs (or future awarded auction prices) is the premium that is financed by TSO tariff surcharges and electricity sales from state-owned companies. At fixed support (i.e. FIT) levels, the level of wholesale prices therefore determines how much one kWh of green electricity is subsidised in Ukraine.

Since RES producers are selling only to the GB, they are pooled into one balancing group. This entails a responsibility for the GB to act as the balancing responsible party for all RES. If RES generation deviates from forecasts the GB would incur an imbalance and pay for it according to the prices on the balancing market. The financial responsibility of RES for their imbalances (i.e. the differences between expected and actual generation) was originally to be phased in slowly until 2030. The Law 810-IX now significantly speeds up the introduction of imbalance responsibilities for RES in the GB balancing group: RES plants above 1 MW will be fined for 50% of their imbalances from 2021 and for 100% from 2022 onwards (Radchenko, 2020). This regulatory change aims at increasing incentives for RES to deliver more accurate generation forecasts to the GB on the day ahead as well as more precise intraday forecast updates. The lack of financial responsibility has so far led to large aggregate forecast errors and imbalances. The resulting uncertainty regarding RES electricity generation in turn leads to a suboptimal and inefficient dispatch of power plants as well as a higher need to balance electricity demand and supply in very short time frames.

Phase out price caps to incentivise investment into flexible generation

To ensure that the electricity system can safely take up higher shares of intermittent RES electricity generation, the auctioning of RES capacities should be combined with measures that increase the electricity system's flexibility and hence allow for a better balancing of fluctuating RES generation. Options to increase system flexibility not only comprise of technical measures, such as building flexible generators or storage, but also include regulatory changes to better make use of the existing flexibility, e.g. via improved electricity market design.

An increased RES penetration means a higher share of non-dispatchable and intermittent generation in the electricity system. To ensure that demand is always met by supply, unforeseen fluctuations in RES electricity generation due to changing weather conditions need to be covered by demand- or supply-side flexibility providers. On the demand side, flexibility providers could be interruptible loads such as industrial consumers. On the supply side, flexibility can be provided by fast-ramping generators such as gas turbines, hydro plants, battery storage facilities or curtailment. When RES generation is higher or lower than expected, these flexibility providers are dispatched to rapidly ramp up/down their generation.

Ukraine's current electricity system relies on coal flexibility – to achieve a cost-efficient RES integration, more economical flexibility options are needed

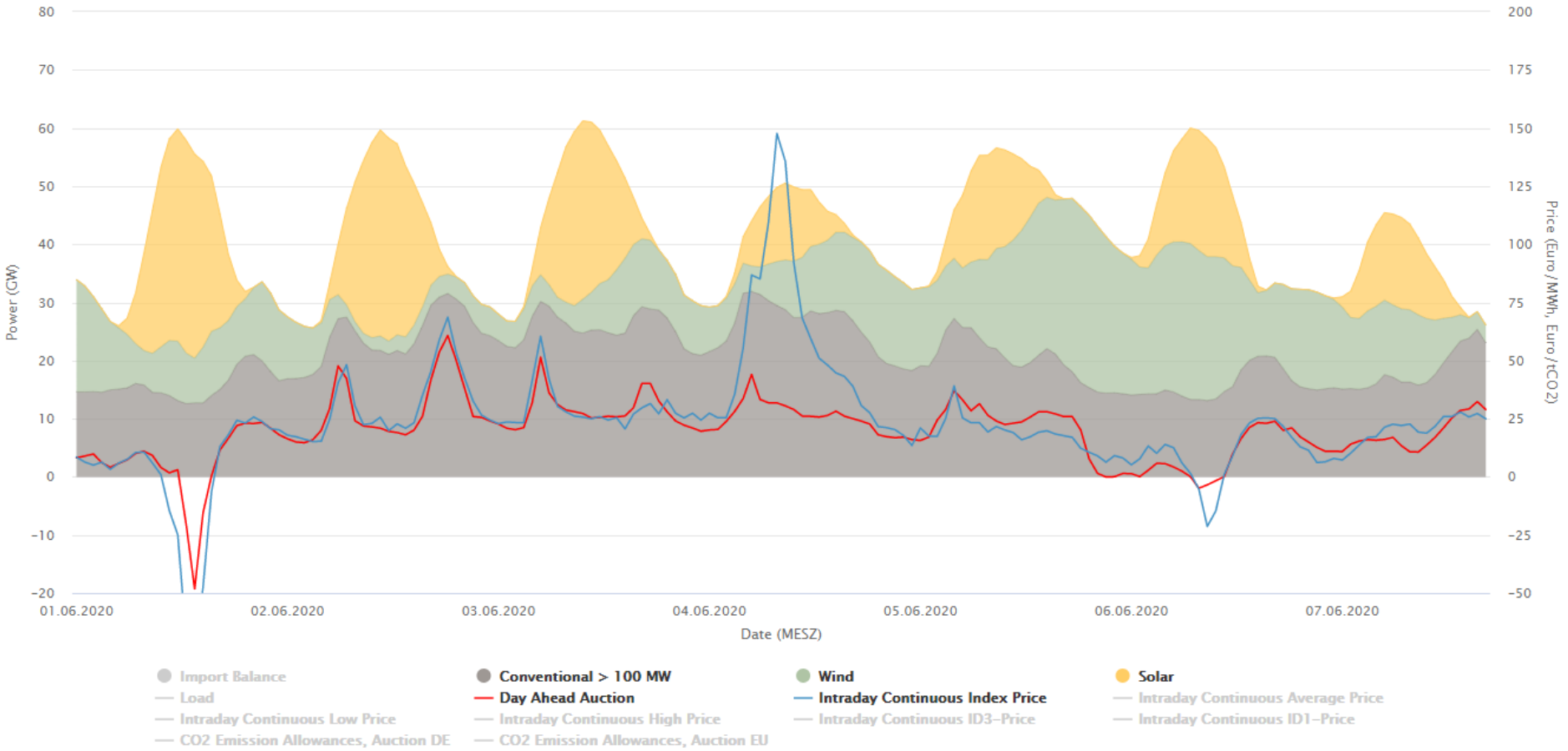
As of 2020, the only supply-side providers of flexibility in the Ukrainian electricity system are hydro, pump-storage and thermal power plants. Although the installed capacities of hydro (4.6 GW) and pump-storage (1.5G GW) can in theory provide significant flexibility at low cost, the irregular availability of water in the Dnieper and Dniester rivers limits the hydro balancing potential. This is true especially during summer, when PV generation and thus balancing needs are highest. From a technical point of view, Ukraine's 19.3 GW of thermal plants (of which 15.5 GW are coal- and 3.8 GW are gas-fired) offer sufficient flexibility to balance high RES shares. Their high average minimal load of 66%, however, means that many thermal units need to be kept spinning to provide sufficient up- and downwards flexibility, thus pushing inflexible nuclear units – which incur less variable cost and emissions – out of the system. Relying on Ukraine's current thermal fleet as the main provider of balancing services could therefore lead to both higher operational costs and higher emissions.

To keep the costs of a large-scale RES deployment in check, better balancing providers are needed. Electricity market design should incentivise the market entry of players providing those services. **Phasing out price caps should be the first step to attract investment into flexible generation capacity.**

The spot market should allow scarcity prices, which serve as an investment incentive for flexible generators or storage

Investment signals for flexible generators or storage depend on high, so-called scarcity prices that result from situations of excess demand – with higher RES shares, those situations are seen more often. During those scarcity events, prices are rising significantly for a short period of time. Flexible generators that only start up to meet this peak demand are therefore allowed to recover their fixed costs of capital (IRENA, 2017). Figure 7 shows a scarcity event on the German electricity market in the first week of June 2020: On Wednesday, wind generation was up to 4 GW below its forecast. High demand hence led to intraday prices rising up to 148 EUR/MWh.

Figure 7: Electricity production and spot prices in Germany in week 23, 2020



Source: B. Burger, Fraunhofer ISE, energy-charts.info

In the same week, one could also observe the opposite situation of excess supply, when spot prices turned negative on Monday due to low demand and strong PV infeed (Next Kraftwerke, 2020). With prices being able to reach both very high and very low levels, it was possible to achieve low average prices of 19 EUR/MWh (day-ahead) and 25 EUR/MWh (intraday) during this week. Allowing for scarcity prices to materialise thus serves as a signal for new players to enter the market while being consistent with the objective to achieve low average prices.

The German experience shows that it is possible to provide investment incentives through scarcity prices and achieve low average spot prices at the same time

In the context of Ukraine, this in turn means that attracting the desired investment and market entry of flexible generators will be very difficult with the current wholesale market price caps in place. The observable tendency to limit price fluctuations by setting maximum and minimum prices may be explained by the objective of keeping average prices at a low level. As shown in the German example, however, this objective can also be achieved without strict minimum and maximum prices. Eliminating price caps would moreover help to address the elephant in the room – the high market concentration on Ukraine's electricity market. When cost-recovery on short-term markets is likely, new, non-incumbent players will enter the market.

Still, due to the high regulatory and policital uncertainty in Ukraine, even a wholesale market that fully allows for scarcity prices might not be enough to incentivise the desired level of investment. Moreover, the overcapacity of Ukraine's current power plant park might water down investment signals: As higher RES shares drive down prices and load factors of conventional generators in a system with overcapacity, forecasting the frequency of scarcity events and hence potential revenue becomes difficult for investors (IRENA, 2017). Reinforcing investment signals by using sensible capacity mechanisms would therefore be a potential second step. Without allowing for scarcitiy prices to realise in the first place, however, providing flexibility via capacity mechanisms alone would potentially inflate network costs and hence electricity tariffs.

Effects of decarbonising Ukraine's electricity generation

I. Energy security

Ukraine's dependence on imported fuels, i.e. natural gas, coal and uranium has been perceived as a threat to the country's energy security for a long time. Especially net coal imports have increased significantly in recent years (IEA 2019). Higher RES shares in electricity generation would allow phasing out many of the old and depreciated coal-fired power plants and substantially reduce Ukraine's dependency on fuel imports.

II. Internal energy market

Higher RES shares could also prove beneficial for Ukraine's electricity market as less demand would need to be served by thermal power plants. With wind and PV bidding on the wholesale market at marginal costs close to zero – as no fuel cost is associated with their power generation – and nuclear providing cheap baseload generation, the remaining peak demand will primarily be served by hydro and thermal power plants, with the latter being the most expensive source in terms of marginal cost. The least efficient, i.e. most expensive thermal plants would therefore be pushed out of the merit order by increasing RES shares. As wholesale market prices are determined by the marginal costs of the most expensive power plant needed to serve demand, this means that wholesale electricity prices would eventually decrease.

References

Anatolitis, V., Grundlach, P. (2020). 'Auctions for the support of renewable energy in Ukraine'. AURES II. Available at: http://aures2project.eu/wp-content/uploads/2020/11/AURES_II_case_study_Ukraine_final.pdf

Council of European Energy Regulators (2018). 'Status Review of Renewable Support Schemes in Europe for 2016 and 2017'. Council of European Energy Regulators (CEER). Available at: https://www.ceer.eu/documents/104400/-/-/80ff3127-8328-52c3-4d01-0acbdb2d3bed#page=11&zoom=100,109,664

EEG (2017). 'Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare-Energien-Gesetz - EEG 2017). Available at: http://www.gesetze-im-internet.de/eeg_2014/EEG_2017.pdf

Fabian, H., Peter, F., Graichen, P. (2020). 'The German Power Market. State of Affairs in 2019'. Agora Energiewende. Berlin, Germany. Available at: https://www.agora-energiewende.de/fileadmin2/Projekte/2019/Jahresauswertung_2019/A-EW_German-Power-Market-2019_Summary_EN.pdf

Fraunhofer ISE (2020). 'Energy charts. Fraunhofer-Institut für Solare Energiesysteme ISE'. Breisgau, Germany. Available at: https://www.energy-charts.de/ (Accessed: 12 August 2020)

Garzón González, M, Kitzing, L. (2019) 'Auctions for the support of renewable energy in Denmark'. AURES II. Available at: http://aures2project.eu/wp-content/uploads/2019/12/AURES_II_case_study_Denmark.pdf

Hanke, A.-K., Tiedemann, S. (2020). 'How (not) to respond to low competition in renewable energy auctions'. AURES II. Available at: http://aures2project.eu/wp-content/uploads/2020/06/AURES_II_Policy_Brief_End_Rationing.pdf

Hirth, L., Ziegenhagen, I. (2015) "Balancing power and variable renewables: Three links" Renewable and Sustainable Energy Reviews, 50, 1035-1051. doi: https://doi.org/10.1016/j.rser.2015.04.180

IEA (2019). 'World Energy Statistics and Balances'. Paris, France.

IMEPOWER (2019). 'Feed-in (Green) Tariffs in Ukraine per Draft Law 8449-D'. Available at: https://www.imepower.com/feed-in-green-tariffs-in-ukraine-per-draft-law-8449-d/ (Accessed: 28 August 2020)

IRENA (2017). 'Adapting market design to high shares of variable renewable energy'. International Renewable Energy Agency, Abu Dhabi. Available at https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/May/IRENA_Adapting_Market_Design_VRE_2017.

IRENA (2020). 'Renewable power generation costs in 2019'. International Renewable Energy Agency, Abu Dhabi. Available at: https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019

Lazard (2019). 'Levelised Cost of Energy Analysis Version 13.0'. Lazard. Available at: https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf

Mantzos, L., Wiesenthal, T., Neuwahl, F., Rozsai, M. (2019). ,The POTEnCIA Central scenario: An EU energy outlook to 2050 (No. JRC118353)'. Joint Research Centre. Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC118353

Next Kraftwerke (2020).'Marktanalyse Spotmarkt & Regelenergie. Market Watch 2020 – KW23'. Available at: https://www.next-kraftwerke.de/strommarkt-analyse (Accessed: 15 July 2020)

Pakalkaite, V. (2019). 'Technology-neutral auctions. Myth or reality?'. ICIS. Available at: https://www.strommarkttreffen.org/2019-04-12_Pakalkaite_RES_auction_designs_and_results-comparison_across_EU.pdf

Radchenko, V. (2020). '2020 FITs restructuring in Ukraine'. CMS Cameron McKenna LLC. Available at: https://ua.boell.org/sites/default/files/2020-06/Presentation%20MOU%20Update.pdf

Schenuit, C., Dünnwald, A., Hove, A., Xinnan, W. (2018). 'Money well spent – Effective allocation of financial support and enhancement of market integration of renewable energies'. Deutsche Energie-Agentur GmbH (dena). Berlin, Germany. Available at https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2018/The_Economies_of_support_for_renewables.pdf

Teusch, S., Soshenko, O. (2020). 'Quotas And Schedule Of The First Renewable Energy Auctions In Ukraine Presented By The Ministry Of Energy'. Radcliffe Partners. Available at: https://www.mondaq.com/renewables/1013608/quotas-and-schedule-of-the-first-renewable-energy-auctions-in-ukraine-presented-by-the-ministry-of-energy

Ukrenergo (2019). 'Звіт з оцінки відповідності (достатності) генеруючих потужностей'. Ukrenergo. Available at: https://ua.energy/wp-content/uploads/2020/03/Zvit-z-otsinky-vidpovidnosti-dostatnosti-generuyuchyh-potuzhnostej-2019.pdf

Woodman, B, Fitch-Roy, O. (2019). 'Auctions for the support of renewable energy in the UK'. AURES II. Available at: http://aures2project.eu/wp-content/uploads/2019/10/AURES_II_UK_case_study.pdf

Ziegenhagen, I. (2013). 'Impact of increasing wind and PV penetration rates on control power capacity requirements in Germany'. Masterarbeit am Institut für Infrastruktur und Ressourcenmanagement, Universität Leipzig.

Implemented by

Berlin Economics

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

Low Carbon Ukraine is a project with the mission to continuously support the Ukrainian government with demand-driven analysis and policy proposals to promote the transition towards a low-carbon economy.

This project is part of the International Climate Initiative (IKI) and is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) on the basis of a decision adopted by the German Bundestag. The project is implemented by BE Berlin Economics GmbH.

All results of the project are available online on www.LowCarbonUkraine.com.

We are grateful for your feedback on this Policy Proposal. Please get in touch via info@LowCarbonUkraine.com.

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