dena
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FINAL REPORT

System transformation for an optimised integration of renewable energies in Ukraine

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Summary

The project **System transformation for an optimised integration of renewable energies in Ukraine** by dena together with the consultancies Elia Grid International (EGI), iC consulenten (iC) and the Ukrainian Transmission System Operator (TSO) Ukrenergo has revealed important measures for policymakers and the TSO to further integrate renewable energy into the system. The analysis of the status quo in the electricity sector shows a variety of aspects that should be addressed. In the following report, they are clustered into the integration of renewable energy sources (RES) into the grid, general conditions as well as the market design.

The main aspect has been grid-focused consulting, which subsequently led to the identification of policy-related challenges and recommendations. Following a close collaboration including five expert workshops, a gap analysis report for the transmission grid was created. Alongside the document at hand, this additional document analyses the situation of the Ukrainian TSO and emphasises important fields that would benefit from improvements (Annex II). The challenges can be mainly characterised by spatial differences between arising renewable generation and load centres, flexibility and balancing issues due to the large proportion of inflexible conventional generation assets in combination with ramping rates from RES, the necessity to consider increasingly decentralised and multi-stakeholder electricity generation by control systems and data management, ensuring the system stability.

Based on the analysis of the grid-focused consulting, the policy-related analysis has laid the foundation for further steps to work on the regulatory framework. Aspects regarding the overall conditions and market design were identified through an extensive as-is analysis, expert interviews and a policy workshop with more than fifty participants where ideas on how to deal with the current situation and upcoming challenges were discussed. Also here, a separate report (Annex IV) emphasises the need and options for improvement. In general, the rapid developments driven by RES deployment require policymakers to take actions to provide a robust framework and a suitable market design. While initial steps have been taken, the necessity to continuously act and modify rules persists. Therefore, recommendations to policymakers particularly focus on:

- providing a reliable country strategy to enable scenario building processes that allow for long-term grid planning,
- ensuring financing for existing and upcoming investments in the grid to maintain, extend and innovate the grid according to need,
- establishing a legal framework for grid operator tools that facilitate the necessary handling of grid challenges, especially redispatch and curtailment measures,
- setting up formats to increase public awareness for the need to modernise and extend the grid, as well as back it up using systematic processes to ensure the infrastructure development stays on track,
- improving the policy dialogue to work on consistent and consolidated targets for RES technology and action pathways,
- developing a well-suited support system for RES since they require well-balanced decision-making; the intended auction system is very ambitious and will be difficult to implement as it requires many specifications to continue increasing investments in RES; alternatives to auctions are possible and should be considered,
- continuing to work on the market design and balancing market to improve the initiated transformation by ensuring enhanced liquidity in combination with setting rules for balancing responsibilities.

The identified gaps and recommendations underline the urgency to continue the initiated cooperation. Experts from Germany shall continue to support this journey and knowledge transfer from a long-lasting transformation phase where peer-to-peer support between knowledgeable stakeholders will address important issues constructively. Close collaboration with and between ministries, regulators and other institutions can strongly enhance the progress of RES integration. Although it is challenging and ambitious, the integration of renewable energy is necessary – especially considering Ukraine's association agreement with the EU and its climate target ambitions.

Based on the **System transformation** project, the German Energy Agency plans to extend the work with the newly formed circle of partners to continue to support the Ukrainian energy transformation.

Zusammenfassung

Das dena-Projekt **System transformation for an optimised integration of renewable energies in Ukraine** hat in Zusammenarbeit mit den **Beratungsunternehmen Elia Grid International (EGI)** und **iC consulenten (iC)** sowie dem ukrainischen Übertragungsnetzbetreiber Ukrenergo wichtige Maßnahmen zur weiteren Integration erneuerbarer Energien (EE) für die ukrainische Politik und den Netzbetreiber aufgezeigt. Diese lassen sich in die Themenfelder **Integration in das Stromnetz, allgemeine Rahmenbedingungen** und **Marktdesign** einteilen.

Fokus des Projekts war die Beratung zur **Optimierung der Stromnetze und die Identifizierung politischer Herausforderungen und Empfehlungen**. Die Analyse des Übertragungsnetzes legte den Schwerpunkt auf Bereiche, die von Maßnahmen besonders profitieren würden (s. Annex II). Die identifizierten Herausforderungen liegen zum einen in der räumlichen Verteilung von Erzeugungs- und Verbrauchszentren erneuerbarer Energien. Außerdem sind sie charakterisiert durch Fragen, die sich mit Blick auf Regelleistung und Flexibilität durch einen hohen Anteil inflexibler konventioneller Erzeugungsanlagen in Kombination mit steilen Gradienten aus EE (Erneuerbare Energien)-Anlagen ergeben. Notwendig sind außerdem ein Kontrollsystem und Datenmanagement, das die Systemsicherheit aufgrund der zunehmend dezentralisierten und von vielen Akteuren getriebenen Stromerzeugung gewährleistet.

Auf Basis der stromnetzorientierten Beratung hat die sich anschließende politikbezogene Analyse Schritte zur künftigen Weiterentwicklung des Regulierungsrahmens formuliert. Aspekte der allgemeinen Rahmenbedingungen und des Marktdesigns wurden durch eine Ist-Analyse, Experteninterviews und einen Policy-Workshop identifiziert (s. Annex IV). Die Entwicklungen durch das schnelle Wachstum erneuerbarer Energien erfordern, dass politische Entscheidungsträger Maßnahmen ergreifen, die einen robusten Rahmen und ein geeignetes Marktdesign schaffen.

Empfehlungen an die politischen Entscheidungsträger sind insbesondere:

- Formulierung einer zuverlässigen **nationalen Strategie**, um die Erstellung von Szenarien für eine **langfristige Netzplanung** zu ermöglichen
- Sicherstellung von **Investitionen in das Stromnetz**, um dieses bedarfsgerecht zu erhalten, zu erweitern und erneuern
- Schaffung eines **Rechtsrahmens** für Instrumente, mit denen Netzbetreiber den aufkommenden Herausforderungen begegnen können, insbesondere Maßnahmen wie Redispatch und Einspeisemanagement
- Konzipierung von Formaten und systematischen Prozessen, um die **Öffentlichkeit** für die Notwendigkeit von Infrastrukturmodernisierung und -ausbau zu sensibilisieren
- Verbesserung des **politischen Dialogs**, um an konsistenten und konsolidierten Zielen für die Entwicklung von erneuerbaren Technologien und Maßnahmen zu arbeiten
- Entwicklung eines geeigneten **Fördersystems für erneuerbare Energien**
- Weiterentwicklung des **Marktdesigns und Regelleistungsmarkts** durch Erhöhung der Liquidität in Verbindung mit verbindlichen Regeln zum Ausgleich (Fahrplan vs. Erfüllung)

Im Anschluss an das Projekt sollen Experten aus Deutschland die Weiterentwicklung begleiten und Erfahrungen weitergeben, indem in weiterer Zusammenarbeit ein Peer-to-Peer-Austausch zwischen sachkundigen Akteuren organisiert wird und wichtige Fragen konstruktiv angegangen werden. Obwohl es eine Herausforderung und ehrgeiziges Ziel ist, bleibt die Integration erneuerbarer Energien notwendig – insbesondere im Hinblick auf das Assoziierungsabkommen der Ukraine mit der EU und ihre Klimaziele.

Die Deutsche Energie-Agentur plant, die Arbeit mit dem entstandenen Partnerkreis auszuweiten, um die ukrainische Energiewende weiter zu unterstützen.

1 Bringing Renewables Into the Grid – The System Transformation Project

The primary aim of the "System transformation for an optimised integration of renewable energies in Ukraine" (short: System Transformation Ukraine) project is to transfer German experiences with the energy transition to Ukraine. The country is currently in a situation that resembles Germany's at the beginning of the energy transition. A feed-in tariff led to the rapid development of renewable energy sources (RES). The highest potential for producing green electricity is located in the southern parts of the country, whereas the main consumption areas are located in the central and northern regions. At the same time, many technological assets are beyond their working life, and the legal framework is trying to keep up with the speed of new trends. A small proportion of renewables poses challenges for the transmission grid, and bottlenecks are already arising. Therefore, two main goals have been set for the System Transformation Ukraine project:

- transfer knowledge on how to manage the integration of RES in the transmission grid and
- outline the need for action to the policymakers as well as draft initial approaches to adjust the regulatory framework.

This shall form the basis to enable policymakers to take the right steps and learn from Germany's experience. It should be understood that the integration of renewable energy is a challenging ambition but worth the effort in the end.

The project is funded by the German Federal Ministry for Economic Affairs and Energy (BMWi) and implemented by dena.

Project set-up

The transmission system operator (TSO) plays a key role in the transformation of the energy system. A TSO has system responsibility for the reliable but also cost-efficient operation the grid. The project was therefore carried out with Elia Grid International (EGI), which is a consultancy firm and subsidiary of the TSO Elia (Belgium) and 50Hertz (the TSO in northern and eastern Germany). The TSOs' expertise in overcoming practical challenges in the integration of renewables ensured a constructive bottom-up identification of gaps and necessary actions. During the project, EGI analysed the status quo and held five expert workshops for Ukrenergo to work on relevant topics.

The integration of RES raises technical issues for the grid operator as well as policy-related challenges. To identify critical issues in this regard, a collaboration with a consultancy firm in this field was established. As a local knowledge carrier in Ukraine, iC consulenten (iC) was able to gather and connect with the relevant stakeholders locally. In addition to a policy focus analysis of the status quo, a workshop covering important topics was held with numerous participants from the sector preceded by expert interviews. Furthermore, during the workshop, German experts provided impetus on relevant topics and participated in intensive exchanges with Ukrainian stakeholders outside the sessions.

Together with the consultants and the Ukrainian TSO Ukrenergo, the German Energy Agency (dena) established a steering committee of important Ukrainian electricity market participants. In close cooperation with the steering committee, the focus for the project approach was discussed, defined and supported during the duration of the project. In addition to dena, EGI, iC, Ukrenergo and 50Hertz, representatives from the Ministry of Energy and Environmental Protection (MinEcoEnergo), the National Energy and Utilities Regulatory Commission (NEURC), the State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE) and the Ukrainian Association of Renewable Energy (UARE) were permanent partners. By gathering important representatives, a network to work on the transformation was established. Further cooperation with every stakeholder is planned and desired.

This document provides the project overview and describes the general gaps and recommendations. These gaps and recommendations can be derived from German experience to analyse the need to advance the transformation.

In Chapter 2, a high-level description of the current situation in the electricity sector in Ukraine is presented. Chapter 3 discusses grid-related challenges and requirements. Chapter 4 describes the gaps and necessary initial steps to improve the conditions to integrate RES into the electricity system. A closer look is taken at other market aspects in Chapter 5. As there are many international stakeholders active in the Ukrainian energy transition (see Annex I), corresponding publications for further analysis are dealt with in Chapter 6.

Generated outcomes

The project delivered a variety of outcomes and led to the creation of various analyses and reports. Both the grid consultant EGI and the policy consultant iC analysed their respective fields. The workshops were also kept as a record. The final reports summarise the findings and provide recommendations. For an overview, please see Table 1.

	Grid-focused consulting by EGI		**Policy-focused consulting by iC**	
Status quo analysis	As-is report based on the entire supply chain and key challenges for integrating RES into the transmission grid	See Annex II	Status analysis of the Ukrainian renewable energy market and stakeholders	See Annex IV
Workshop report	Results of the workshops and expert interviews are incorporated in the final reports			
Final report	Gap analysis regarding preparedness for RES integration, comparison with German best practises and recommendations to the TSO.	See Annex III	Definition of strategic areas to be addressed and recommendations for policy actions	See Annex V

Table 1: Overview of the project documents

2 Electricity Sector Status Quo

Ukraine is facing a time of a radical transformation of the electricity system. The status quo described here serves as the basis to survey current and future grid issues as well as policy fields that must be addressed. The most relevant topic-related research aspects are discussed briefly afterwards.

The international need to reduce emissions by increasing the proportion of renewable energy is also highly relevant to the Ukrainian electricity market. Following the Paris agreement, Ukraine agreed to reduce its CO_2 emissions by 50 % by 2050 in comparison to 1990. The basis for the implementation of a significant volume of especially wind and solar photovoltaics (PV) must now be established and is already being developed. Ukraine has set the goal for reaching a proportion of 11% of renewable energy in the country's total final energy consumption by 2020 and a proportion of 25 % of the total primary energy supply by 2035.

The electricity generating system

The development of renewable energy began in 2008. Since then, the capacity of the installed RES plants has increased. Lately, the number of projects has increased even more. One reason for this rapid growth is an attractive feed-in tariff that was established in 2009 and which led to larger waves of projects in 2014 and after 2016. An announced system change to auctioning resulted in a steep increase of new projects, as feed-in tariffs will only be granted to existing installations in the future. However, those RES producers also need to have drawn up PPAs to remain eligible for the green tariff. The 4500 MW by 2025 target of new wind and solar PV installations was reached in 2019 with projects requests to connect to the grid totalling approximately 11000 MW.

Today, the generation system essentially consists of 40 power plants (59 GW in total, 49.7 GW, excluding temporary occupied territories). Hydro, pumped storage and thermal power plants make up the biggest proportion, whereas there are four large nuclear power plants and five large CHP plants (see Figure 1). There are also renewable energy power plants, whose proportion is growing. Looking at production, more than half of the electricity comes from nuclear power plants. Moreover, about one-third is produced by coal-fired plants. The main production sites date back to the Soviet era and can, therefore, be considered aged. There is a significant need to modernise or decommission and replace the current generation capacities starting in 2025. Without modernisation, the plants that produce the most of the electricity consumed will have to be decommissioned by 2035.

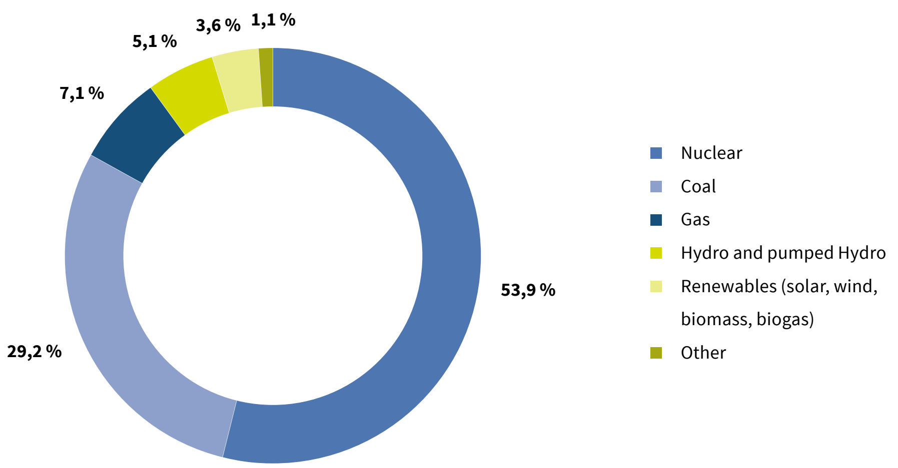

Figure 1: Electricity generation in Ukraine by type, 2019 (MinEcoEnergo 2020)

The electricity grid

The vision for the Ukrainian energy transition comprises the national balance reaching 70 % green energy by 2050, the phasing out of coal-fired power plants and the reduction of the proportion of nuclear generation. Looking at the amount of land, the potential for renewable energy is fairly high. The conditions for installing wind and solar PV are especially good in the south-eastern regions. The centres with high demand, in contrast, are located in the northern and western parts of the country, a source of high demand on the transmission grid.

The grid is divided into two parts and is essentially in almost complete synchronous operation with the Russian, Belarussian, Moldovan and the Baltic States' grids. In this network, assets in Russia play an important role for Ukraine regarding secondary reserves for balancing services. In contrast, four percent of the grid ("Burshtyn Island") is connected to Europe and runs synchronously with the ENTSO-E transmission grid. Ukraine's total interconnection capacity amounts to 5.4 GW, most of which is interconnected with Russia; in total, less than 1 GW is interconnected with Europe.

Just like the generating assets, the transmission grid with its high-voltage overhead lines (220 kV and above) requires improvement: almost all the parts, including half of the substations, have outlived their estimated 25-year service life, some are even older. Many aspects of the transmission grid require refurbishment.

The electricity market

Starting on 1 July 2019, a new market model was introduced. In the context of liberalisation and unbundling, a competitive market was the set goal for the future. The former single-buyer model for all electricity produced was dropped in favour of a buyer model that promotes renewable energy in particular. For instance, the "guaranteed buyer" must buy electricity produced under the green tariff and sell it on the market.

The new core elements in the market model can be seen in Figure 2 and are represented by a retail market, a market of bilateral agreements, a day-ahead and intraday market, as well as a balancing and ancillary services market, the latter of which is not yet in place. There was already a "guaranteed buyer" to purchase all the electricity produced. The types of consumers who participate in the market can mainly be divided into industrial customers, small and medium businesses, as well as households. Industrial consumers are to procure their electricity from the competitive market, whereas service suppliers serve businesses and households.

For households (~30 % of consumption), there is a state-regulated consumer tariff, whereby the government guarantees residential consumers a constant price after the introduction of the new market model. In contrast, the price for industrial consumers (~42 % of consumption) increased by 20 – 30 %. One reason for this is that industrial consumers can buy only 10 % of the installed nuclear power plant capacity, as 90 % of this supposed cheap electricity is reserved for households and electricity from thermal power plants and renewable energies is more expensive on the market.

Overall, the free market is basically only applied to small generators. Large electricity producers (governmental nuclear and hydro) are still under the "guaranteed buyer" regime and do not participate in the competitive market. Due to this reservation of cheap electricity, only rather pricy electricity enters the oligopolistic market. An auction system is under discussion and should be launched with the implementation of the new market design. One reason for the delay is an ongoing mediation process regarding the future of feed-in tariffs. The auctions will be launched once these discussions are settled.

Given the current status, the following chapters will present activity options to better move forward with the integration of RES and its consecutive market design. Furthermore, German experiences and procedures are provided to allow more in-depth insight into the respective topics.

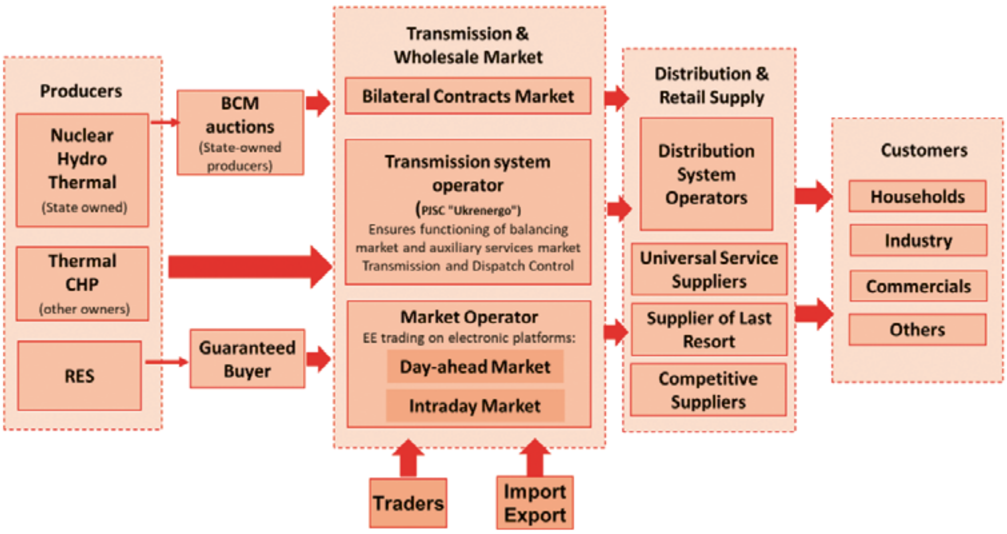

Figure 2: General electricity market model after 1 July 2019 (iC Consulenten 2019, Annex IV)

3 RES Integration Into the Grid

The rising proportion of RES requires drastic changes to the grid. These changes address a variety of areas: the development of the grid itself, the balancing of the changing transmission grid, the consideration of increasing distributed generation and ensuring the system stability at the same time. As the transmission system operator in Ukraine, Ukrenergo is confronted with the task of considering, catching up and adapting to the changes already taking place and that lie ahead. But other stakeholders are also facing the transformation, especially policymakers, who must define a suitable framework to provide appropriate conditions. This chapter addresses challenges for the grid and extracts suggestions for policy actions.

Besides the aspects discussed in chapter 2, the general problem with the grid set-up can be described as follows:

- There is significant potential for large shares of RES in southern Ukraine, whereas consumption centres are located in the northern and western areas of the country. Sufficient transmission capacity must be ensured to overcome this regional difference while avoiding congestion and the need for high levels of curtailment.
- The current electricity generation system, which is dominated by nuclear and coal power plants, is considered largely inflexible. However, it now faces high ramping rates of variable RES. Therefore, the system will require flexibility in every sense of the term.
- The centralised generation of electricity in conventional power plants will gradually be replaced by decentral generation from RES. The traditional system to feed electricity into the transmission system will progressively evolve into a system with greater feed-in into the distribution levels, creating bidirectional and highly volatile flows. Requirements for respective control systems and new data management will arise.
- By connecting RES to the grid and necessarily using inverters, the grid faces further changes. Stability must be ensured continuously, but technical aspects such as voltage provision or securing rotational inertia must also be rethought. Therefore, new grid technologies will also have to be considered.

Analysing the relevant gaps concerning the transmission system

While consulting the TSO Ukrenergo, the analysis showed that the possible activities to address the challenges described above could be clustered into different areas as defined in Figure 3.

- To analyse necessary infrastructure developments, the topic **System Transformation & Planning** describes measures to improve the grid development and support processes.
- Ensuring the operational security by, for instance, implementing tools and associated interfaces or processes regarding congestion management is in the focus of the topic **Grid & System Operation**.
- Considering advice and making use of the TSO's knowledge make this institution a possible enabler for the energy transition, which is explored in the topic **TSO Positioning & Strategy**.
- The market design can also promote the energy transition; moreover, flexibility issues must be addressed by, among other things, the balancing market and ancillary services which are part of the topic **Market Design & Flexibility**.
- Technical aspects also bring requirements regarding the regulatory framework and financing issues, which have an impact on the grid operators in general – this is looked at in the topic **Regulation & Finance**.

Gaps and corresponding recommendations directly to the Transmission System Operator in the relevant fields are described in a separate report. **Refer to Annex II for the Gap Analysis Report for Ukrenergo by EGI.**

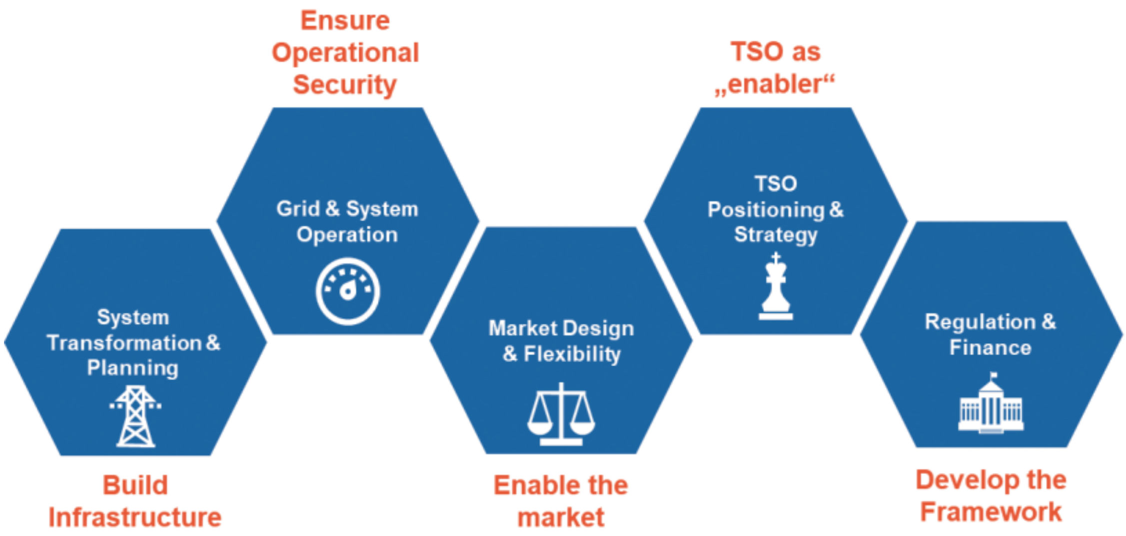

Figure 3: Topics in the grid analysis (EGI 2020, Annex III)

From grid-related gaps to policy-making: Starting points for enabling the transformation

While enabling the TSO to adopt required changes during the transformation, the relevant institutions in the country must be prepared and accordingly adjust, too. While analysing the function and activities of Ukrenergo within Ukraine, it is necessary to highlight that officials must take certain important steps. In contrast to the gap analysis with actions for the grid operator, the following aspects must be addressed by policymakers.

3.1 Provide a strategy to allow for scenario building

For grid planning, grid operators need to rely on political targets and the corresponding framework to make decisions for the future. Numerous targets for the sector must be encompassed to formulate scenarios. Scenarios are important and necessary to anticipate future developments and act in time. Moreover, they allow various solutions to be considered while also enabling an analysis of the tools and the substantial grid extension, such as an analysis of the plausibility of locational signals for RES or the configuration of bidding zones.

Nevertheless, a long-term political strategy must allow the grid operator to formulate its own strategy. A clear strategy and a set of scenarios make it possible to adapt the grid planning can to upcoming changes in the long run. Measures like building new infrastructure are always projects that require a long planning period before they are completed. Therefore, it must be possible to make early considerations using scenarios. If this is not done, risks arise due to serious delays and a lack of infrastructure. A politically consolidated formulation for the future political direction is necessary to avoid an infinite set of necessary scenarios which will subsequently prevent grid planning. The necessity for a consistent and consolidated overall national strategy is further described in chapter 4.1.

When scenario development is enabled, valid options to analyse and possibly consider could be locational signals or the configuration of bidding zones different from the current set-up[1]. Incentives to allocate generating or consuming facilities to suitable locations or zones can lead to the reduction of a significant number of additional power lines, saving time and money. However, this is a highly complex and political debate. Decisionscannot be made based on a few assumptions. Therefore, the initiation of a comprehensive analysis of the feasibility of locational incentives in Ukraine to identify possible regulatory measures can be recommended. Analysts from scientific institutes, for instance, could work with the grid operator and draft solutions that fulfil economic, political and other criteria within the next few years.

The provision of a strategy and the development of scenarios are accompanied by decisions with a rather long-term perspective or a growing penetration of RES, respectively. A decision on the coupling of markets, the allocation of cross-border capacity or capacity mechanisms are topics to be discussed with a broader range and with the increasing proportion of renewables in the transmission grid, as well as intensified market model stability. Meanwhile, extending the interconnectivity with neighbouring countries should be a constant aspect during the continuous development of the system as it involves the integration of the national grid into the European network. Positive effects, such as those regarding adequacy issues or business models of an increasing proportion of energy from RES, can be expected.

German best practice

Existing design parameters allow grid operators to conduct comprehensive analyses of future system developments. For instance, the 50Hertz Energy Transition Outlook 2035[2](English description by the Renewables Grid Initiative) looks into the future and formulates five different scenarios around political targets and possible developments. The guiding questions are: What scenarios of the energy transition are conceivable and not unrealistic? Which are the consequences of different developments for the power generation system and power flows? What are the drivers of grid expansion? What would arise from alternative paths? How robust are the individual grid expansion measures? Are they needed in different scenarios? Here, long-term measures can be identified over a broad range of likely future developments, allowing grid operators to make sustainable decisions in a generally uncertain environment. As a result, it is possible to extract policy recommendations from the TSO point of view, which can then support policy decisions.

[1] These aspects represent exemplary possibilities to allocate facilities; other measures can also be considered (e.g. different charges for generators to locate and connect to the grid at certain locations).
[2] Renewables Grid Initiative (2017).

3.2 Ensure financing for necessary investments in the grid

Investments in modern technologies are inevitable – also to best utilise the existing infrastructure where possible. Furthermore, investments in grid extension and restructuring are unavoidable. The financial situation for the grid operator must be resolved.

New facilities that use RES and future consumption assets (e.g. electric vehicles, heat pumps) will change the entire grid situation. The technical difference between feeding the grid with electricity produced from RES versus conventional technologies requires activities to keep the grid stable in a different manner.

Large amounts of investments cannot be borne by the periodical income from grid tariffs alone. In this regard, setting up a sustainable regulation scheme allowing new and large investments to enhance the existing grid, build new capacities and make use of new technologies must be discussed.

From a regulatory perspective, investments in the grid are regulated with a cost-plus mechanism today.[3] An incentive-based regulation will be introduced in 2020/21. In the interest of efficiency, it would be favourable to replace the cost-plus regime by incentive regulation. Still, challenges due to the integration of RES must be – as mentioned – taken into consideration.

[3] In general, NEURC approves the network tariff, whereas the ministry (MinEcoEnergo) approves the grid needs.

German best practice

Looking at the growing proportion of power generated from RES and an increasing need for investment in the infrastrucutúre, a correlation between both trends can be observed (see Figure 4). Although this is of course not the only reason for rising infrastructure costs, the energy transition itself and the necessary modernisation of the grid required (and will continue to require) investments. The new regulation system was implemented in 2009. Since then, efforts have been made to keep the economic costs reasonable despite the changing environment. Here, the tools implemented fulfil the special requirements due to the integration of RES.

The implemented incentive regulation system[4] uncouples grid operator costs and revenue. Some of the arising operational and capital costs are included in the incentive mechanism, whereas some are passed through without efficiency targets. This must be discussed and defined thoroughly for the different kinds of costs. When new overhead lines or substations with a larger capacity become necessary to integrate RES into the grid, they can be considered additional elements in the regulatory scheme[5]. Those investments should be evaluated and approved as additional costs by the regulating authority when they are necessary from a system point of view. In the future, financial resources should also be acquired from the capital market, for instance, to finance a large volume of new investments.

In this regard, the regulatory framework must be adjusted to the transformation phase and ensure the possibility of financing investments in the grid to close the gap between the investment needs and income from the network tariff. At the same time, a basic principle persists: The framework must be a reliable constant for grid operators.

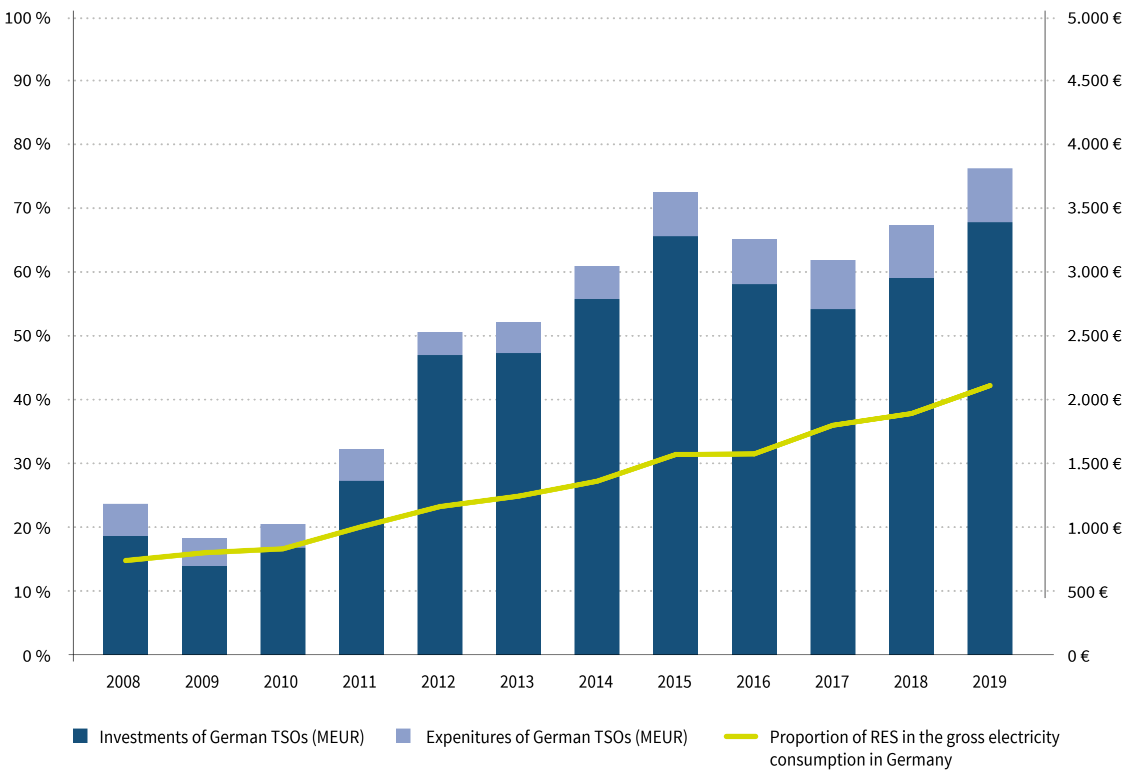

Figure 4: Proportion of RES in the gross electricity consumption in Germany and Expenditures and Investments of German TSOs (MEUR) (Umweltbundesamt 2020, and Bundesnetzagentur/Bundeskartellamt 2020)

[4] Bundesnetzagentur (2020).
[5] Bundesnetzagentur (2015).

3.3 Define necessary tools during the transformation

Feed-in at new locations and modified exposure to load flows increase grid requirements. If the grid capacity is not yet extended to transmit power to load centres or neighbouring countries, load flows must be managed progressively, leading to a need to "cut off" generating assets. Tools must be established.

With the rising generation from RES, the transmission grid development will be decreasingly driven by load growth. The grid planners will be progressively required to adapt to new challenges. The development of RES is rather decentral; its scale and speed of development are more difficult to predict. Where conventional power plants are built in single places with a high predictable feed-in, wind and solar PV installations are spread over various locations of the grid – partially with low connected capacity, but also regionally with high capacity and varying feed-in.

What was seen in Germany will also apply to the Ukrainian electricity grid: Congestions will increase. Tools for **congestion management** must be established and given to grid operators as options to operate the grid safely and keep the transmission grid within its technical limits. The tools to manage generating assets are especially understood to be **redispatch** measures and the **curtailment** of RES. During redispatch measures, the flow of electrical current is modified by decreasing the feed-in of a certain power plant in front of a congested line and increasing the feed-in of another plant behind it respectively to solve the overload. Curtailment of RES allows the reduction of renewable feed-in if the grid cannot transmit the electricity to be injected at certain nodes. Each of those measures must be compensated. The prices for Germany have increased strongly with progressive changes in the grid.

German best practice

Grid extension has proven to be one of the key elements to reduce the rise of necessary measures and the cost involved, as well as to avoid large amounts of congestion. However, interconnectors and power flow controllers are also among the potential tools. Again, to identify arising congestions and associated costs early on, predictions from scenarios help to make necessary actions for grid operators visible as timely as possible (chapter 3.1). It must be considered that grid extension is not a short term action but a task that lasts for years.

As a result, a combination of early identification of grid extension and other physical measures together with the establishment of rather short-term instruments for congestion management like redispatch and curtailment of RES is an unavoidable step in the system transformation. At the same time, grid operators must be empowered to execute these measures and have them reflected in their revenue for the rising costs of interventions and compensation of market players.

The Federal Network Agency (Bundesnetzagentur) and Federal Cartel Office (Bundeskartellamt) publish an extensive annual report to assess a secure and sustainable energy supply and the level of competition. This report also analyses developments in the grid, among other things. System and security measures are not only explained but also presented in detail. The 2018 version[6] is available in English, see part C chapter 5, page 119.

[6] Bundesnetzagentur/Bundeskartellamt (2019).

3.4 Set up formats to raise public awareness regarding grid modernisation

The system transformation for the integration of RES will sooner or later be the focus of public attention. Knowledgeable stakeholders can help communicate with interested parties and prepare public relation work to strengthen public acceptance. Integrate them and raise public awareness for system transformation measures.

This applies to RES being built as well as to new infrastructure. The lack of grid capacity will slow down the transition and also translate to economic losses. Successful stakeholder management will increase the speed of infrastructure development.

Looking at the progress, the **Paradox of Participation** illustrates the rising public interest and will to engage in planning processes as time goes on when, in reality, the possibilities to interact are numerous at the early stages (see Figure 5). As a project progresses, the possibilities to influence details decrease. Public interest to intervene can eventually reduce the speed of the project's implementation. Therefore, efforts to integrate all kinds of stakeholders should be made as early as possible to develop measures together and, for example, build power lines in accordance with public interests.

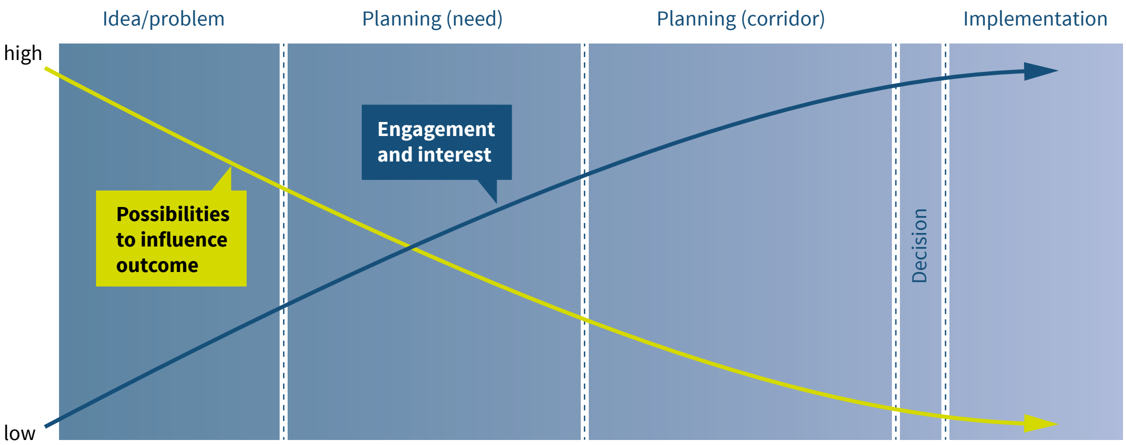

Figure 5: Participation paradox (Germanwatch e.V. 2015)

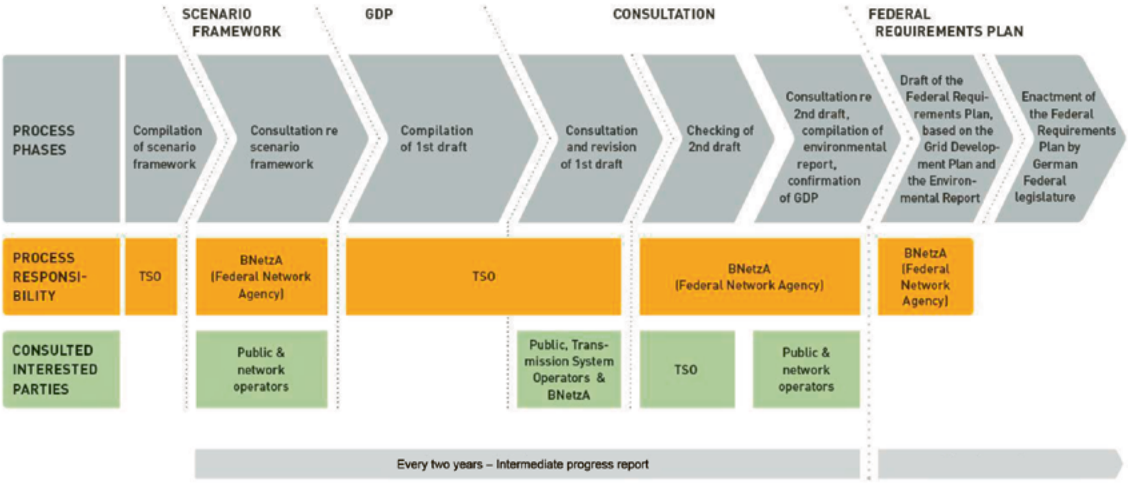

Figure 6: The grid development plan process including consultation (50Hertz/Amprion/Tennet TSO/TransnetBW 2019)

German best practice

An extensive network development process for the transport system has proven to be very constructive in this context. Through many stages from scenario building to concrete legal planning, a network development plan is a tool to implement needs. When developing scenarios and calculating the necessary power lines, a global consultation with public participation can and should be established to integrate the population, gather ideas and listen to desires. The scenario framework as well as the first and second draft of the network development plan itself are consulted before the regulatory authority eventually approves the plan. Subsequently, political steps write defined needs into law. The network development plan is to be elaborated by the grid operator and mainly reviewed and approved by the regulatory authority. The process steps for the grid development plan are described in Figure 6.

The consultations are conducted by the TSOs and the regulator, respectively. The TSOs, for example, provide informational material about the process and projects, but can also go on information tours to come into contact with the population. The background information of a certain grid project by the TSO 50Hertz, for instance, is presented on a detailed web page including materials[7].

The feedback received by the regulator can be published (German)[8]. The drafts receive a high number of answers, showing public interest to be included in the discussion on grid measures. For example, the consultation of the first draft of the current grid development plan generated more than 900 answers. A more detailed description (English) is available for the second draft of the discussed development plan: 2nd draft of the grid development plan 2030 (2019 version)[9].

A successful approach for early stakeholder involvement in the policy-making process has been realised with the German Energy Transition Platforms, which are presented in chapter 4.1.

[7] 50Hertz (2020).
[8] 50Hertz/Amprion/Tennet TSO/TransnetBW (2020a).
[9] 50Hertz/Amprion/Tennet TSO/TransnetBW (2019).

4 RES Integration by Improved Conditions

Apart from the grid focus, the following section outlines the major overall policy gaps and challenges with its causes and effects for the Ukrainian energy system. Based on these issues, recommendations are made to overcome these barriers and to target a harmonised, sustainable energy strategy. Several references and indications from the respective German experience are provided. They should help stakeholders to make more in-depth considerations and enhance decisions towards approved policy solutions for the successful integration of renewable energy in the market.

A clear national strategy and commitment to sustainable development as well as the diversification of the energy mix are important signals to further push the rising proportion of generation from RES. Moreover, it will attract investors and foreign direct investments. The existing "green tariff" in Ukraine has facilitated this process resulting in many European investors and local companies entering the market and contributing to the increase of renewable energy capacities in Ukraine.

There is an urgent need to continue the dialogue with Ukrainian and foreign market participants. At the moment, policy developments are progressing without regular communication between policymakers and the market, between the national authorities, as well as with the international partners and organisations regarding possible strategies for the development and integration of renewables in the coming years. This results in reluctance or doubts regarding further investments in renewables.

One of the government's priorities is to reduce energy prices for end consumers, which would be a reason to introduce auctions for RES, but also to think about changes in the existing funding scheme. Using high feed-in tariffs to support renewable energy is partially responsible for the high end-consumer prices. This has led to certain discussions on potential changes to the existing feed-in tariff model and for the power plants already in operation. Recently, a business-government dialogue started discussing the potential reduction of the current feed-in tariff level, which is favoured by policymakers. At the moment, the outcome is still uncertain, and this dialogue has not led to compromises, resulting in general investment restraints.

It seems that among market players and policymakers, there is no consistent positive connotation of renewable energy. One of the reasons for this perception is that there are no validated statistics, no reliable forecasting data and thus no awareness of the socio-economic advantages of renewables regarding job creation, domestic value creation, local value chains, environmental benefits and the reduction of external costs. Well-founded official data, statistics and comparisons of the socio-economic effects of conventional and renewable market segments can provide an impressive demonstration on the benefits of the energy transition to the public. As an example, Figure 7 shows the number of jobs created in the German renewable energy sector in relation to the employees in the domestic lignite industry. That official data makes it possible to form an objective opinion and achieve greater consensus in favour of the energy transition.

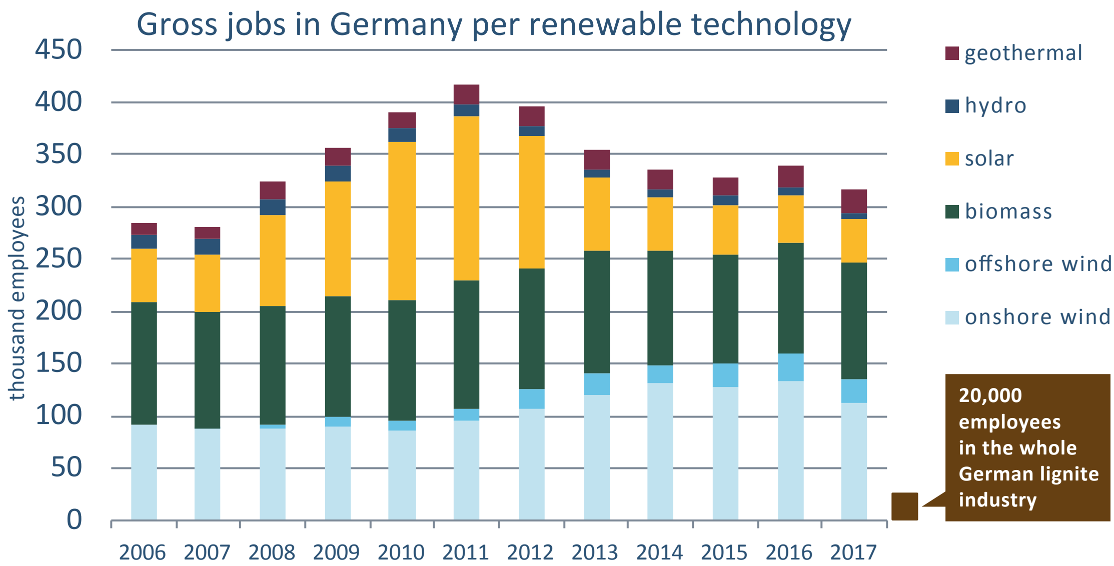

Figure 7: Employment in the German renewable energy sector (Own adaption of Navigant 2019)

4.1 Consistent, consolidated overall national strategy

Renewable energy targets must be carefully aligned with the overall Ukrainian energy and climate protection strategy. That means not only committing to a clear position for renewables, but also assigning the future role of coal and nuclear power in the energy system. A consistent and binding energy strategy and energy action plans towards 2025, 2030 etc., give market participants strong signals for safe and sustainable investments.

There is a strong need to align and harmonise the relevant strategic documents to assign clear priorities of energy sector developments. Above all, the recently announced and very ambitious "Ukrainian green deal" aiming at 70% renewables by 2050 must be broken down into sectoral roadmaps and actions as well as interim renewable deployment and integration targets to be reached by 2025, 2030, 2040.

As a precondition for a feasible integration of increasing proportions of renewables and implementable action plans, official renewable energy deployment scenarios and prognoses must be elaborated. On the grid side, reliable forecasting systems for the integration of an increasing number of RES generators must be implemented. This results in the need for improved grid capacity management and clear rules on the balancing responsibilities (see chapter 5.2).

Related to the discussion about consultations in chapter 3.4, a requirement for the effective, sustainable integration of renewables is the continuous dialogue between policymakers, market players, grid operators, science and civil society about energy system developments. Early involvement of stakeholders ensures transparent processes and political participation from the beginning. This gives stakeholders reason for basic trust in the early stages, e.g. in terms of surcharges in consumer energy prices, economic benefits, and finally results in long-term investments. Among policymakers, business and civil society, a common understanding should be established, that the energy transition can only succeed as a joint effort.

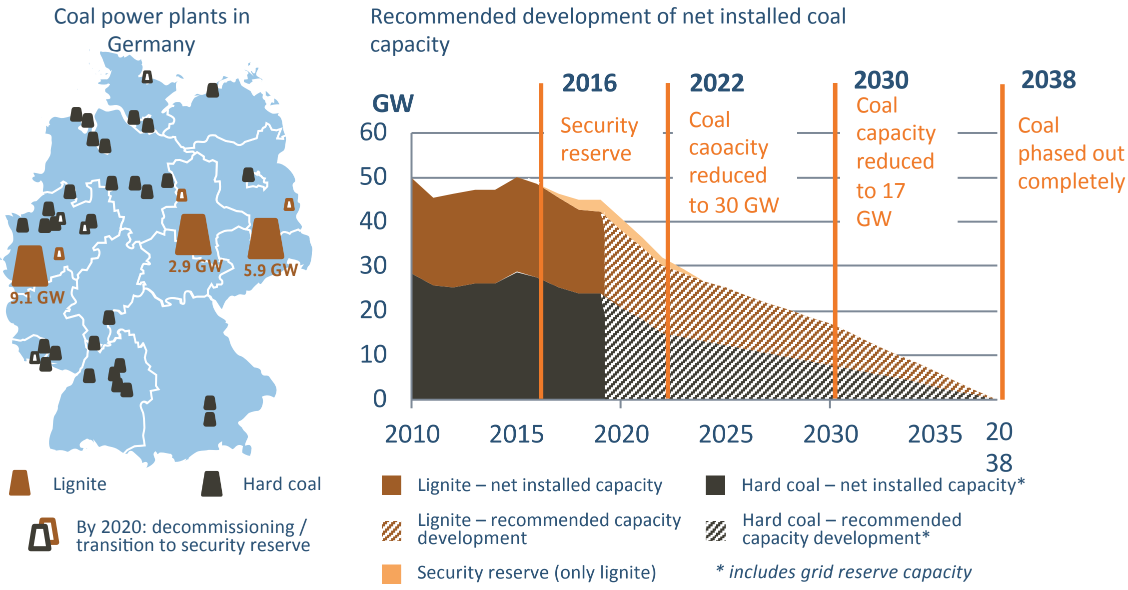

Figure 8: Plan for the German coal phase-out by 2038 (Navigant 2019)

German best practice

Besides the necessary public consultation processes for large RES and grid projects, the German Energy Transition Platforms[10] are a good example of successful stakeholder involvement. The Ministry of Economic Affairs and Energy (BMWi) constantly exchanges information with representatives from the federal states, business and industry, society, science and research in high-level dialogue platforms. In 2011, BMWi conducted a broad consultation on the electricity market of the future across various thematic platforms and working groups. The focus was on the question of which electricity market design can guarantee a secure, cost-effective and environmentally compatible supply of electricity even with a high proportion of renewable energies. The platform dialogues resulted in the formulation of comprehensive recommendations which helped introduce the electricity market reform with the aim to integrate renewables and pave the way for an electricity market 2.0 fit for accommodating a growing proportion of renewables.

Regarding developments in the energy sector, the federal government aims to achieve the specified climate targets (55 % CO_2 reduction by 2030 compared to 1990) with a variety of measures in the Climate Action Programme 2030[11] including innovation, support, legally binding standards and requirements, and carbon pricing. The programme comprises climate actions in the energy and industry sector, as well as in the areas of buildings, transportation and agriculture. The Climate Action Programme will be implemented in legislation in 2020.

The German phase-out of coal by 2038 is based on a long and comprehensive dialogue within the Coal Commission[12] (formally "Commission on Growth, Structural Change and Employment"), see Figure 8. High-level scientific and policy experts and representatives of the concerned federal states together with the German government have discussed and negotiated a roadmap for shutting down coal plants in different stages while implementing a comprehensive structural programme to transform the regional economies, invest into low-carbon solutions, offer new employment options and compensate coal plant operators. As a result of the Coal Commission's work in early 2020, the **Coal Phase-out Act** has been put into legislation, providing a clear roadmap, actions and financial budget for the structural change.

Already in 2000, the German nuclear phase-out was agreed with the energy industry in the framework of a long-term transition roadmap, see Figure 9. The last German nuclear power plants will be shut down at the end of 2022. After the shutdown of a nuclear power plant, it will take up to 25 years for the decommissioning of the plant and the decontamination of the site.

[10] BMWi (2020).
[11] The (German) Federal Government (2019a).
[12] The (German) Federal Government (2019b).

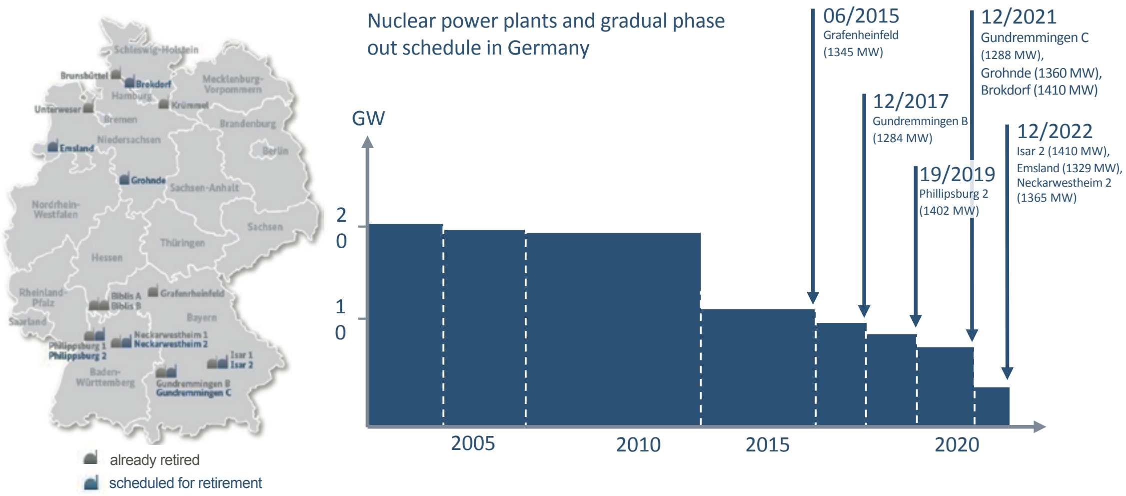

Figure 9: Path towards nuclear phase-out in Germany from 2000 to 2022 (Navigant 2019)

As seen in the German example, the phase-out of nuclear and coal power plants is an integral part of the long-term energy strategy and accompanied by comprehensive structural change support (see details on the German "coal commission" in the information box). Implicitly, the coal phase-out should go hand in hand with strong market stimuli to replace carbon-intensive capacities with renewable energy alternatives. Similarly, the CO_2 price is an effective instrument to attract investments in low carbon technologies and make them competitive. Relevant socio-economic side effects must be considered early on, e. g. the financial discharge of low-income citizens (and small-scale enterprises). A deeper investigation of the situation, greater description of actions and a more detailed analysis can be found in Annexes IV and V.

German best practice

A key component of the German Climate Protection Programme is the carbon pricing[13] to be implemented in 2021. Besides the ETS carbon pricing for the energy sector and energy-intensive industry, Germany will introduce a price on CO_2 emissions for the transport and building heating sectors, which are dominated by the use of fossil fuels and responsible for around 32 % of German CO_2 emissions. The carbon price should start with a fixed price of €25/allowance (tonne of CO_2 equivalent) for transport and heating fuels such as petrol, diesel, heating oil, natural gas and coal and should increase to €55 in 2025. The German Federal Government will reinvest the revenue from the CO_2 price in climate protection measures or return it to the citizens in the form of relief elsewhere. The agreed price level resulted from a broad consensus-finding process. According to estimations on real climate change costs, the German Environment Agency[14] estimates that the CO_2 price level should be relevantly higher, i.e. between €180 and €205/t CO_2-eq to compensate for damages from climate change.

[13] Clean Energy Wire (2019).
[14] Umweltbundesamt (2019).

4.2 Ensuring long-term investments and an innovation environment

The overall investment environment relies on a stable policy framework with reliable instruments and rules without retrospective changes. This turned out to be highly relevant regarding the RES support schemes. Moreover, energy pricing must be transparent and needs to reflect the real cost. This ensures open communication and reliability regarding the costs for the energy transition.

The reform of the electricity market has led to number of policy, technical and economic challenges with strong impacts on the renewable energy market players. The change in government in 2019 and the new government's initiation of changing the market rules has put the implementation of many renewable energy projects at risk and might affect power plants already in operation. These sudden changes as well as the uncertainty as to how and when the RES auction scheme will be launched and designed have led to a loss in trust on the part of the consulted market players. There is a strong need for long-term political and regulatory framework conditions that allow market participants to make reliable investment decisions.

Solid regulatory frameworks and a free market alone often offer grounds for research and innovation; however, they are promoted if the state offers additional favourable conditions, such as R&D support schemes or test fields. In Germany, special support for implementing field tests are called "regulatory sandboxes", which can substantially support the testing of innovations under real-life conditions and hence help to gather experience with market implementation. Furthermore, testing within the regulatory sandboxes helps to understand which regulatory environment must be set up to accommodate innovations.

German best practice

New technologies and business models offer a vast range of opportunities, but they often also have major effects on consumers, companies and society, which are difficult to assess in the short term. In the framework of the German Energy Research Programme, the "Regulatory Sandboxes for Energy Transition"[15] ideas competition was established to speed up the technology innovation transfer from research to application. Such real-world testing environments are operated for a limited period of time and across a set area. They are intended to allow for the testing of new technologies and business models, which are only partially compatible with the existing legal and regulatory framework. The purpose of regulatory sandboxes is to learn about the opportunities and risks that a particular innovation carries and to develop the right regulatory environment to accommodate it. For testing innovations in the appropriate legal framework, occasionally experimentation clauses for regulatory sandboxes are temporarily set up allowing experiments to be conducted. The focus of the first call for tenders in 2019 is "sector coupling and hydrogen technologies", "large-scale electricity storage systems" and "energy-optimised districts".

[15] BMWi (2020a).

5 RES Integration Into the Market

Coming from a grid focus to overall aspects in the previous chapters, this section outlines the challenges of the current renewable electricity integration into the Ukrainian energy market from a market design perspective. The prevalent need to establish a favourable framework for RES integration is described with a focus on the two evident issues: the RES support mechanism and the market design, including the balancing needs. For both issues, the main action fields are determined and recommendations for smooth RES deployment are made.

The electricity market reform was implemented in mid-2019 with the aim to shift from the previous "single buyer" model to a new liberalised electricity market and to create an effective competitive electricity market consistent with the basic requirements of EU legislation. During the launch of electricity market reform and change of government in 2019, numerous structural market issues started to arise, presenting a risk for new and existing investments.

The central element of the electricity market reform is the RES auction scheme to be introduced in 2020. Concerning this new support instrument, there are still a lot of open questions and necessary implementation rules to be defined to guarantee a smooth launch.

One of the central goals connected with the electricity market reform is the reduction of end consumer electricity prices. In this context, there is an ongoing discussion on how Ukraine should deal with the increasing costs from the old feed-in tariff system for renewable electricity. Policymakers are considering potential changes to the existing feed-in tariff model and for the power plants in operation to reduce costs. These changes may lead to a serious breach of trust among market participants and a corresponding decrease in investments in RES.

While the auction system design and the way for continuing the green tariff system must be considered carefully, other support schemes suitable for the Ukrainian energy market situation should be taken into consideration.

5.1 Wisely choose the right RES support system

There are different options to support RES facilities (e.g. feed-in tariff, feed-in premium, auctioning). Ukraine has chosen an auction mechanism to replace the current feed-in tariff scheme as the forthcoming tool to integrate RES into the system. Now the new scheme must be set up thoughtfully, open questions must be resolved quickly, and rules established reliably. Still, the auction system should be brought into question, as its design risks to be inadequate, which would collapse the expansion of RES. Other mechanisms can still be considered and implemented in the RES promotion system and (at least partly) replace an auctioning mechanism for a certain period of time.

Design for the renewable energy auction system

While the Ukrainian auction system will be introduced shortly, there are still a lot of open questions regarding the auction design and implementation specifics. Addressing these issues thoroughly beforehand is a requirement for implementing auctions for renewable energy and establishing reliable and understandable conditions. The system must be designed well to attract investors and further incentivise investments in RES.

Above all, there is a need to set up annual support quotas for each renewable energy technology and plant size category. In turn, this requires a clear overall target for annually installed renewable energy capacity, as well as a consensus between government and market players on the (pre)conditions for renewable energy purchasing (price, terms etc.).

Furthermore, the auction scheme should establish competitive rules, allowing adequate validation periods to prove preconditions for grid connection and encouraging new market players to realise their projects. Additionally, proof of bankability could minimise risks in the case the projects are not realised. Another grid-favourable auction model could be the combined auction on RES capacity, including developed, grid-connected land plots, which gives advantageous locational signals to investments in renewables. Further preconditional or ex-post coefficients can stimulate projects in certain geographic locations or from small project developers with less economic performance (e.g. cooperatives). The German reference yield model[16] could be an example of how to adopt this. More regulatory requirements before the upcoming launch of RES auctions are specified in Annex V.

From feed-in tariffs to feed-in premiums

Besides the auction mechanism, **other supporting mechanisms** allowing for the cost-effective deployment of renewable energy should be proved and considered, such as feed-in premiums, surcharges, taxes, regulatory policies/prohibitions, etc. These alternatives could present attractive, reliable instruments for potential investors and could facilitate the market development of renewable electricity.

Above all, a necessary action seems to be to rethink the existing feed-in tariff system, as it will be too costly to continue in its present form and at the current remuneration level. The prevalent renewable energy market in Ukraine is still at an early stage. It needs smooth policy stimuli to approach competitive market structures, enhance the liquidity of the market and obtain a critical mass of energy actors and diversity of actors.

It is, therefore, recommended to transform the present feed-in tariff into a feed-in premium, which could also offer a good intermediate solution towards the auction system. With the feed-in premium, the economic costs are reduced while allowing for the economic operation of the RES installation. The feed-in premium can be the primary support scheme for small- and medium-size producers, while the auction system focusses on larger scale projects. With the feed-in premium (FIP) scheme, renewable electricity will be sold directly on the electricity spot market, and RES producers receive a public-funded premium on top of this market price (see Figure 10). Either a fixed FIP (independent of market prices) with predetermined floor and cap levels or a sliding FIP with variable support levels depending on the evolution of market prices is an advisable scheme (see Table 2). The public-funded market premium provides incentives to feed electricity into the grid when demand is high and the market price is above average monthly price, or to reduce feed-in when prices are low/negative.

[16] BMWi (2016).

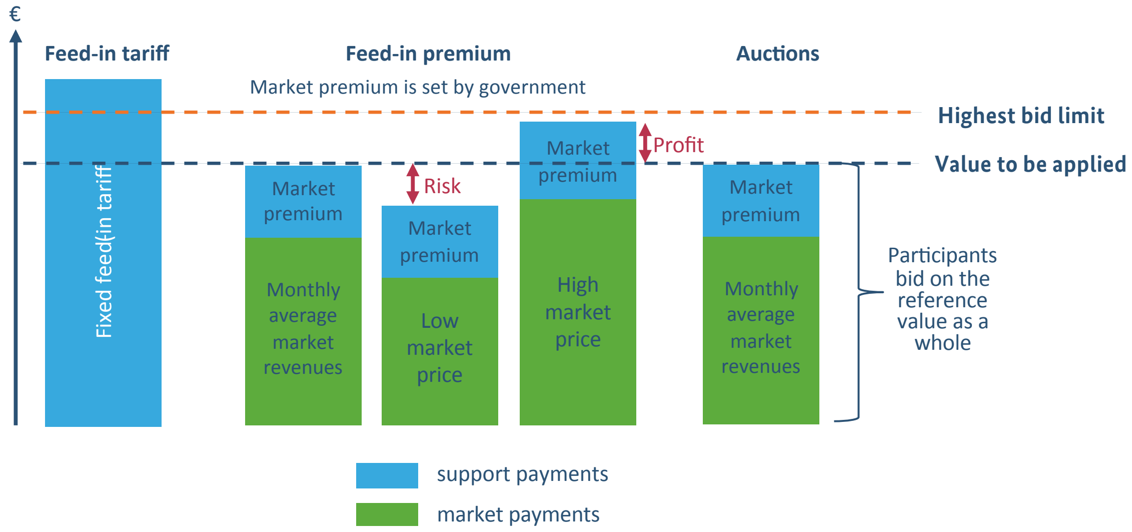

Figure 10: Remuneration mechanisms under the German Renewable Energy Sources Act 2017 (Navigant 2019)

	Feed-in tariff	Feed-in premium	Auctions
General principle	Fixed remuneration is paid to RES generators per unit of electricity generated and fed into the grid, independent of the electricity demand.	RES generators sell their electricity directly on the market (normally through a service provider). The public-funded market premium is paid on top of this market price with a predefined maximum remuneration cap.	The auction market mechanism determines the level of remuneration competitively instead of administratively. Auction participants bid on the reference value/value to be applied. Only the market premium (difference between monthly average and reference value) is paid as support.
German design (see EEG 2017)	Predominant mechanism for small-scale RES installations (up to 100 kW) with fixed tariff and annual degression adjustment.	With the revision of the Renewable Energy Sources Act (EEG) 2014, the sliding feed-in premium (FIP) has replaced feed-in tariffs (FIT) for new installations (except for small installations).	RES auctions are implemented for wind and PV installations from 750 kW, for biogas plants from 150 kW.

Table 2: Outline of the RES support mechanisms feed-in tariffs, feed-in premiums and auctions, including the German approach (non-exhaustive overview of the main parameters)

For the adjustment of the existing feed-in tariffs (or introduction of feed-in premiums), the following key requirements have been identified in particular:

- Determination of support time and premium levels according to technology type, size and eventually location of projects
- Stimulation of innovative, grid-favourable or sustainable technology options with additional technology bonuses
- Support for project developers with marketing and selling electricity on the spot market thanks to extra management bonuses
- Introduction of a degression mechanism for the FIT/FIP, floor and cap levels respectively, to adapt the remuneration levels in time and according to the deployment status of the renewable technology
- Guaranteed grid connection and priority dispatch to all qualified RES generators

Overall, approved RES support schemes show that continuous (annual) evaluation of the mechanisms is necessary to monitor the progress of renewable energy and to adapt the supporting rules and procedures if required.

German best practice

The (2017) Renewable Energy Sources Act[17] (EEG) is Germany's legal framework governing renewable energy funding. It is the regulator, Bundesnetzagentur, that sets the level of funding the operators receive. Since 2017, these rates have been determined by auction. During an auction, operators of renewable installations bid the amount of funding they need to generate biogas, wind or solar energy. The lowest bid wins. The transition from fixed funding rates set by the government to competitive auctions ensures that the expansion of renewable energy continues in a controlled manner and at the lowest possible cost. The goal is to maintain the high level of market-player diversity that has characterised the German energy transition. Small and medium-sized installations are exempt from the auctions and remunerated via feed-in tariffs/feed-in premiums.

5.2 Continue to work on market design including a balancing market

The market design is the basis to successfully integrate renewable energy into the system. The recent launch of a new market model has started moving in the right direction, but further enhancements are necessary. A sophisticated balancing system will promote the future of RES and increase market liquidity.

The penetration of RES in the market leads to certain effects: The market price will generally decrease[18], decreasing the profitability of conventional generation assets and increasing overall price volatility. Negative prices can occur, penalising production inflexibility. These effects should not be considered bad or harmful. From a system point of view, these effects are normal during the transformation. They will eventually result in positive final outcomes, investments in new and flexible solutions, and perhaps incentivise the flexibilisation of conventional power plants, which pretend not to be flexible at all. At the same time, adequacy must be ensured.

[17] BMWi (2017).
[18] A dropping market price does not mean that the overall costs for electricity decrease as well.

Enhancing market liquidity is a key aspect. There must be enough competitors to ensure a working market with sufficient competition. Therefore, all types of generation should be traded on the market rather than receiving fixed prices by an entity like the "guaranteed buyer". This would distort competition and prevent the functioning of the market. However, RES generators must still receive continuous[19] promotion in addition to income from the market (e.g. feed-in premium). Moreover, grid availability plays a crucial role in increasing the number of possible competitors in the market.

Placing RES in a proper support system (see chapter 5.1) and implementing an accurate balancing responsible party (BRP) concept can enhance liquidity. While such a concept is stated in the new market rules, crucial elements are still being developed. If all types of generation above a certain threshold (e.g. 100 kW) are traded on the market, then each producer (or its representative: a balancing responsible party[20]) is responsible for their own imbalances. This creates financial incentives for maintaining balance. In combination with a proper day-ahead and intraday market, necessary trades can be executed on the spot markets to avoid imbalances at the time of fulfilment and the activation of balancing reserves. 15-minute metering and clear settlement rules would support this. The prices for imbalances must incentivise market players to not play with wholesale prices.

German best practice

The balancing responsibility concept has proven to support the balancing market in a way that reduces the necessary balancing reserve (see Figure 11). Incentivising market participants to use services from the balancing market as little as possible prevents the oversizing of the balancing market. Still, the balancing market needs to be designed with sufficient liquidity and the inclusion of numerous participating parties. This can be achieved by properly adjusting the balancing market design. In addition to the allowance of small bid sizes and the possibility to aggregate distributed resources (pooling) and let them participate in the market, procurement of balancing services close to fulfilment facilitates almost real-time forecasting for the respective assets. A 15-minute settlement period promotes taking these short-term actions. An IT platform by the German TSOs[21] is the digital hub for balancing reserve in Germany.

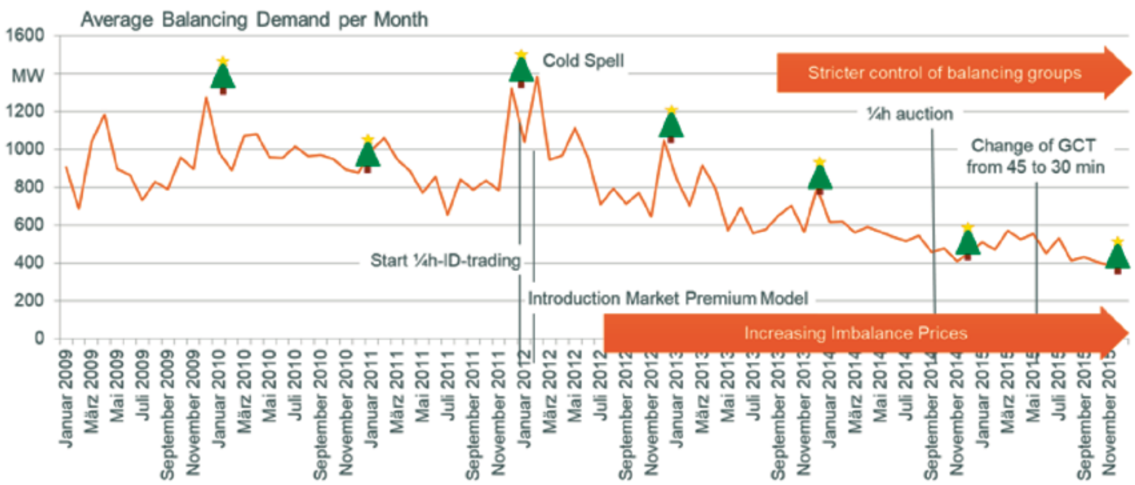

Figure 11: Paradox of the German balancing market: Increasing amount of RES over the years vs reserve requirements (50Hertz 2020, Annex III)

[19] With respect to the contracted funding period.
[20] So-called "balancing responsible parties" are the head of a balancing group and thereby liable for imbalances within the group. A balancing group can consist of (conventional and/or renewable) producers and consumers. Not every generator is balanced individually, but the sum of the whole balancing group, in the end, must be balanced. Existing imbalances and resulting frequency deviations in the grid must be taken care of by the transmission system operator who will use services from the balancing market to cure the technical imbalances. The activation of those services is later cleared by charging the balancing responsible party the balancing energy during the settlement of the balancing group.
[21] 50Hertz/Amprion/Tennet TSO/TransnetBW (2020b).

6 Current Analysis and Publications on the Proposed Action Fields and Measures

The project analysis has revealed several fields that must be addressed. Policy measures to integrate RES into the grid as well as requirements in terms of general conditions and market design were identified. As a consequence of proposing action fields, a joint follow-up will focus on putting theory into practice and keep transferring German experiences. To define appropriate succeeding steps, research of ongoing activities in Ukraine will illustrate which stakeholders are working on initiatives that correlate to the given present recommendations.

The many challenges in Ukraine, including its energy supply, have led a lot of international players to settle in Ukraine since the late 1990s. Quite a few see the modernisation of the energy supply as the key to the economic upswing of Ukraine.[22] Hence, there is a multitude of analyses and studies on various aspects of the energy supply and, of course, in recent years, on decarbonisation in that context.

[22] The Ukraine through German eyes" https://www.giz.de/en/worldwide/302.html.

A list of the main stakeholders working on the subject of energy supply is attached in Annex I. Beyond the "German best practices" described in the previous chapters, individual analyses and studies relevant to the proposed measures will be the subject of the following. It is our view that no other stakeholder has dealt comprehensively with the grid and its key role in enabling the modernisation and decarbonisation of the energy supply. However, a great many have touched upon aspects of these issues. Therefore, we consider an assessment of those relevant before initiating the implementation of measures. Conducting such an assessment and developing a comprehensive roadmap for action for Ukrainian officials, however, must be part of another project.

In light of those considerations, the following selection of international analyses and studies touch on aspects of the given recommendations:

- Danish Energy Agency (DEA) / Ukrainian-Danish Energy Centre:
  - Long-term Energy Modelling and Forecasting in Ukraine", 2019

- International Renewable Energy Agency (IRENA):
  - "Remap 2030 Renewable Energy Prospects for Ukraine", 2015 – only the key findings

- Institute for Economics and Forecasting and Heinrich Boell Foundation Ukraine (HBS):
  - "Transition of Ukraine to the Renewable Energy by 2050", 2015
  - "Ukraine and EU: Towards a decarbonisation partnership", 2019

- Low Carbon Ukraine (Berlin Economics) (LCU):
  - "Monitor of Electricity Market Opening – Issue No.4 – July 2019-February 2020"
  - "Monitor of Electricity Market Opening – Issue No. 3 – July 2019"
  - "Quarterly Monitoring Report on the Implementation of Ukraine's Energy Action Plan – Issues Nov. 2019; Dec. 2019; Mar. 2020"
  - Policy Briefing 02/ 2018 "Location selection and wind-solar mix"
  - Policy Briefing 04/2019 "RES development in Ukraine – Stabilizing the support for renewables"
  - Policy Briefing 06/2018 "A Scenario-based 2035 Forecast of Electricity Demand in Ukraine"
  - Policy Briefing 05/2019 "Local curtailment charges for RES"
  - "Overview: Risks of opening the Ukrainian Electricity Market"
  - "Renewable Energy in Ukraine, Dec. 2019"
  - "RES quotas for 2020–2024"
  - "Curtailment of renewable electricity as a flexibility option"
  - "Policy Paper: Limiting the cost of feed-in-tariff subsidies"
  - "Ukraine on the way to a functioning electricity market – what is in place, what is missing?"
  - "Recommendations on energy storage regulatory framework – comments to the draft law #2582", Mar. 2020

All the above reports were published within the last five years. They either shed light on the probable developments of RES in Ukraine, which are a prerequisite to model and adjust the grid transformation path, they or deal with specific aspects of RES integration into the grid, market design aspects, upcoming regulatory framework changes or necessary regulatory frameworks changes.

Figures

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BMWi (2017): The Renewable Energy Sources Act (EEG) 2017. https://www.bmwi.de/Redaktion/EN/Downloads/renewable-energy-sources-act-2017.pdf?__blob=publicationFile&v=3 (Accessed: 04/05/2020).

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Bundesnetzagentur/Bundeskartellamt (2020): Monitoringbericht 2019. https://www.bundesnetzagentur.de/SharedDocs/Mediathek/Berichte/2019/Monitoringbericht_Energie2019.pdf?__blob=publicationFile&v=6 (Accessed: 23/07/2020).

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Abbreviations

BMWi	German Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie)
DEA	Danish Energy Agency
dena	German Energy Agency (Deutsche Energie-Agentur)
EGI	Elia Grid International
FiP	Feed-in premium
FiT	Feed-in tariff
HBS	Heinrich Boell Foundation Ukraine
iC	iC Consulenten
IRENA	International Renewable Energy Agency
LCU	Low Carbon Ukraine
MinEcoEnergo	Ministry of Energy and protection of the Environment
NEURC	National Energy and Utilities Regulatory Commission
RE	Renewable Energy
RES	Renewable Energy Source
SAEE	State Agency on Energy Efficiency and Energy Saving of Ukraine
TSO	Transmission System Operator
UARE	Ukrainian Association of Renewable Energy

Annexes

Annex I
Active Stakeholders in the Ukrainian Electricity System

Due to the considerable potential for climate protection in almost all sectors, various international and Ukrainian actors are actively working on further improving the Ukrainian energy system. They are conducting intensive studies, financing new projects and providing training and best-practice solutions. Several of these projects focus on the dependency on Russia for energy imports, the insufficient use of domestic energy production potential and a lack of energy efficiency. The goals of additional projects include decreasing the efficiency of the Ukrainian energy system and trying to stimulate possible energy market reforms. Some projects have a more practical approach and aim to renovate and replace crucial energy infrastructures and provide training for key system operators, such as Ukrenergo. The most prominent actors in alphabetical order are:

Austrian Energy Agency (AEA): The AEA is a non-profit scientific association based in Vienna that accompanies its customers from politics, economy and administration on their way to the energy future. It develops strategies for a sustainable and secure energy supply, provides consultancy and training, supports implementation and is the networking platform for the energy industry. The AEA also manages the Austrian Energy Partnerships[8] with Central and Eastern European countries. These energy partnerships are funded by the Austrian Federal Ministry of Agriculture, Regions and Tourism[9] and aim to develop environmentally friendly energy sectors and try to point out ways to phase out the use of nuclear energy. The idea is to make use of Austrian know-how and the large number of technology providers in these areas. Therefore, an essential factor of the energy partnerships is the holistic approach that builds on three levels: information and networking activities, capacity building and policy advice and demonstration projects.

European Union (EU): Ukraine is a priority partner for the EU, and on 24 November 2016, the European Commission and Ukraine signed a new Memorandum of Understanding[10] on a strategic energy partnership between the EU and Ukraine. This partnership should increase cooperation in all areas of energy policy and will support energy sector reform[11] in Ukraine. The Energy Efficiency Fund[12] will support the energy-efficient renovation of multi-apartment buildings. Together with the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD) and the World Bank, the EU also aims to modernise the Ukrainian energy transportation system. The EU4Energy Programme[13] improves the quality of energy data and statistics, shapes regional policy-making discussions, strengthens the legislative and regulatory frameworks and improves access to information in the partner countries.

[8] Austrian Energy Agency (AEA), Österreichische Energiepartnerschaften mit Ländern in Mittel- und Osteuropa: https://www.energyagency.at/projekte-forschung/eu-internationales/detail/artikel/oesterreichische-energiepartnerschaften-mit-laendern-in-mittel-und-osteuropa.html.
[9] Austrian Federal Ministry of Agriculture, Regions and Tourism, Energiepartnerschaften: https://www.bmlrt.gv.at/umwelt/strahlen-atom/antiakwpolitik/energiepartnerschaften.html.
[10] European Commission (2016), Memorandum of Understanding on a Strategic Energy Partnership: https://ec.europa.eu/energy/news/eu-ukraine-summit-eu-and-ukraine-intensify-energy-partnership_en?redir=1.
[11] Ukraine Government Portal, Energy Sector Reforms: https://www.kmu.gov.ua/en/reformi/ekonomichne-zrostannya/reforma-energetichnogo-sektoru.
[12] European Energy Efficiency Fund: https://www.eeef.eu/home.html.
[13] EU Neighbours: https://euneighbours.eu/en/east/stay-informed/projects/eu4energy-programme.

Energy Community: The Energy Community[14] is an international organisation which brings together the European Union and its neighbours to create an integrated pan-European energy market. The mission is to establish a stable regulatory and market framework capable of attracting investment in electricity generation and networks, create an integrated energy market allowing for cross-border energy trade and integration with the EU market, enhance the security of supply to ensure stable and continuous energy supply that is essential for economic development and social stability, improve the environmental situation in relation with energy supply in the region and foster the use of renewable energy and energy efficiency and develop competition at the regional level and exploit economies of scale.

German Energy Agency (dena): dena is Germany's centre of expertise for energy efficiency, renewable energy sources and intelligent energy systems. In the German-Ukrainian energy cooperation[15] project, dena promotes the intensive bilateral exchange of energy policy ideas and operational training for key energy sector players. The focus of this joint activity is on modernising the Ukrainian electricity grids and municipal heat supply, as well as increasing energy efficiency in the Ukrainian building sector. The aim is to make the energy sector more efficient and gradually switch to renewable energy sources – in order to reduce dependence on energy imports at the same time. dena intends to use German experience and technology to accelerate this process.

Germanwatch: Germanwatch is an independent development and environmental organisation which lobbies for sustainable global development and has been involved in the cooperation with Ukraine since 2017. Together with Ecoaction, the organisation published European Experience and Recommendations on Coal Phasing Out[16] in 2019. The authors use quantitative data and policy analysis to examine the transformation experiences of Germany, Romania, the Czech Republic and Ukraine. Visualisations of the recommendations and checklists top off the publication and make it a useful tool for political decision-makers in various European countries.

Gesellschaft für Internationale Zusammenarbeit (GIZ): GIZ is a federal German company that supports numerous projects[17] that improve energy efficiency and promote sustainable construction and the environmentally friendly renovation of public buildings. They are also involved in several projects which aim to improve the climate and the environment, improve cooperation at government level and promote closer ties with the EU.

Heinrich Boell Foundation Ukraine and Institute for Economics and Forecasting: The Heinrich Boell Foundation is part of the Green political movement and focuses on ecology, sustainability, democracy, human rights, self-determination and justice. It is also active in Ukraine with a regional office in Kyiv. In its publication Transition of Ukraine to the Renewable Energy by 2050[18], the regional office of the Heinrich Boell Foundation in Ukraine shows how the transformation of RES can succeed by 2050. The publication contains the results of alternative development scenarios of the Ukrainian energy sector for the year 2050. The "Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine" partnered on the project. The research was conducted in cooperation with organisations in civil society, as well as public institutions, professional associations and independent experts.

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[14] Energy Community, who we are: https://energy-community.org/aboutus/whoweare.html.
[15] German Energy Agency (dena), Energiewende und Modernisierung in der Ukraine: https://www.dena.de/en/our-place-in-the-energy-transition/international-energy-transition/osteuropa-zentralasien/country-focus-ukraine/.
[16] Germany Watch (2019), European Experience and Recommendation on Coal Phasing Out: https://germanwatch.org/en/taxonomy/term/944.
[17] Gesellschaft für Internationale Zusammenarbeit (GIZ) https://www.giz.de/de/weltweit/302.html.
[18] Heinrich Boell Foundation Regional Office in Ukraine (2017). Transition of Ukraine to the Renewable Energy by 2050. Retrieved from https://ua.boell.org/sites/default/files/transition_of_ukraine_to_the_renewable_energy_by_2050_1.pdf.

International Energy Agency (IEA): The mission of the IEA is to work with governments and industry to shape a secure and sustainable energy future for all. The IEA has published multiple reports and analyses over the past years. In 2006, 2012 and 2015 they published a country report[19] on current Ukrainian energy policies. In 2018, the IEA published the Renewable Energy and Energy Efficiency Policy Framework in Ukraine[20]. They also release several energy-related statistics about Ukraine in publications such as the World Energy Outlook, Coal Information 2019 or Natural Gas Information 2018.

International Renewable Energy Agency (IRENA): The REmap Programme of the International Renewable Energy Agency develops roadmaps for individual countries as to how they can consistently increase their share of renewable energies by the year 2030. The report REmap 2030 – Renewable Energy Prospects for Ukraine[21], published for Ukraine in 2015, was part of the International Climate Initiative (IKI) and was funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). A key finding of the paper is that increasing the proportion of renewable energy from 13.2 % (Reference National Renewable Energy Source Action Plan) to 21.8 % (REmap 2030) by 2030 would lead to savings of USD 175 million per year.

KfW Development Bank: The German state-owned KfW Development Bank provides governments, public enterprises and commercial banks with financing and promotes the development of various countries. In Ukraine, the KfW supports the connection and synchronisation of the electricity grid with Central Europe, including the adoption of EU regulations for the electricity market. A mandate agreement with the European Union (EU) for just under EUR 9 million was signed at the end of 2019[22]. The synchronisation of the Ukrainian grid with the Central European grid should be completed by 2026 – and should bring Ukraine closer to the EU economically and politically. In the past, the KfW has realised multiple projects to upgrade Ukraine's key transmission infrastructure belonging to the state enterprise Ukrenergo.

KPMG: In 2019, the internationally operating company KPMG wrote the report Renewables in Ukraine[23]. This report illustrates the history and current status of the Ukrainian market for renewable energies. The report also provides a forecast of how the market will develop in the coming years and what investment opportunities will arise. Furthermore, it provides a brief description of the legal and regulatory framework for RE, including a description of the regulatory environment for investment in RES.

Low Carbon Ukraine (Berlin Economics): The Low Carbon Ukraine[24] project is part of the International Climate Initiative[25] (IKI) and is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The consulting firm Berlin Economics[26] is responsible for the implementation of the project, the aim of which is to identify and address relevant energy policy issues in the context of policy briefings, policy papers, sector strategies and evaluation reports. The project results are to be co-authored by Ukrainian experts, if possible, to ensure the political relevance of the topics dealt with, optimise the use of local knowledge and strengthen the political ownership and analytical capacities of the Ukrainian authorities and civil society sustainably and in the long term. Furthermore, a monitoring report on the implementation of the Ukraine Energy Action Plan is published every quarter. These reports assess Ukraine's progress in implementing the 206 action plan measures. The progress of each sector is evaluated on a scale of 0 % to 100 %. A brief description of the sectors provides an overview of the regulatory changes made in recent months.

[19] International Energy Agency, Country Reports: https://webstore.iea.org/country-studies?pagenumber=5.
[20] International Energy Agency, Renewable Energy and Energy Efficiency Policy Framework in Ukraine: http://www.unece.org/fileadmin/DAM/energy/se/pp/eneff/9th__Forum_Kiev_Nov.18/13_Novembe_2018/RE_DEVCO/03_Borys_Dodonov.pdf.
[21] IRENA (2015). REmap 2030 Renewable Energy Prospects for Ukraine. Retrieved from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Apr/IRENA_REmap_Ukraine_paper_2015.pdf.
[22] KfW Entwicklungsbank, Eine Perspektive für die Energiewirtschaft der Ukraine [cit. 23.12.2019]. Retrieved from https://www.kfw-entwicklungsbank.de/Internationale-Finanzierung/KfW-Entwicklungsbank/%C3%9Cber-uns/News/News-Details_559296.html.
[23] KPMG, Renewables in Ukraine [cit. July 2019]. Retrieved from https://home.kpmg/content/dam/kpmg/ua/pdf/2019/08/Renewables-in-Ukraine-Report-2019-en.pdf.
[24] Low Carbon Ukraine: Policy advice on low-carbon policies for Ukraine. Retrieved from: https://lowcarbonukraine.com/.
[25] Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit: https://www.bmu.de/themen/klima-energie/klimaschutz/klimaschutzinitiative/internationale-klimaschutzinitiative/.
[26] Berlin Economics: https://berlin-economics.com/de/home/.

Ministry of Ecology and Natural Resources of Ukraine: The National Energy Efficiency Action Plan[27], the National Renewable Energy Source Action Plan[28] and the Energy Strategy of Ukraine 2035[29], developed by the Ukrainian Ministry of Environment, show possible transformation paths for Ukraine up to 2020 and 2035, respectively. These action plans aim to outline the quantitative indicators as well as clearly identify the necessary instruments. In the document "Energy Strategy of Ukraine 2035", for example, 206 measures were identified and are to be implemented in the next few years. The measures include e. g. increasing domestic natural gas production, modernising the energy infrastructure, increasing the proportion of renewable energies to up to 25 % of energy consumption, integrating the Ukrainian electricity and gas markets into ENTSO-E and ENTSO-G and many other measures to reduce emissions.

On 21 January 2020, the ministry presented the draft of the Ukrainian Green Deal[30]. This green deal shows how Ukraine wants to become climate neutral by 2070 and which targets have been set for the year. The share of renewable energies is to be increased to 70 % by 2050, and the replacement of coal-fired power plants is to be reduced or even completely stopped. The proportion of electricity generated by nuclear power is to be reduced from the current 54 % to 20 – 25 %, requiring the construction of new nuclear plant power capacities. Moreover, efficient energy markets that are firmly integrated with the European market are to be established. A key focus is also on increasing energy efficiency and reducing energy imports.

Organisation for Economic Co-operation and Development (OECD): The OECD tries to promote economic growth, prosperity and sustainable development. Within the project Supporting Energy Sector Reform in Ukraine[31], the OECD published the Snapshot of Ukraine's Energy Sector: Institutions, Governance and Policy Framework[32] in 2019, which provides an overview of the architecture of the Ukrainian energy sector, analyses the country's energy mix, covers the entire regulatory framework of the sector and identifies the main players and their role in the various markets. It also includes a case study of the Ukrainian electricity sector, focusing on the market structure and processes, including electricity generation, transmission and distribution. The report also looks at the introduction of the new electricity market in July 2019 and the main components of the reform while identifying potential challenges and policy considerations.

Razumkov Centre: The non-governmental think tank founded in 1994 conducts research in various fields. One major focus is the energy sector where multiple articles[33] have been published about the electricity imports from Russia, the international dimension of North Stream2 and the general role of the energy sector as a driver of Ukraine's economy.

State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE): This agency is a central executive authority governed and coordinated by the Cabinet of Ministers of Ukraine and is responsible for developing and implementing energy efficiency and renewable energy government policy. The SAEE established multiple international co-operations[34] and projects with different international actors to further develop the Ukrainian energy system.

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27 State Agency on Energy Efficiency and Energy Saving of Ukraine, National Energy Efficiency Action Plan Through 2020. Retrieved from: https://saee.gov.ua/documents/NpdEE_eng.pdf.
28 State Agency for Energy Efficiency and Energy Saving of Ukraine, National Renewable Energy Action Plan. Retrieved from: https://saee.gov.ua/en/documents/401.
29 Razumkov Centre (2017), Energy Strategy of Ukraine for the Period up to 2035 "Security, Energy Efficiency, Competitive-ness". Retrieved from: http://razumkov.org.ua/uploads/article/2018_Energy_Strategy_2035.pdf.
30 Ministry of Energy and Environmental Protection of Ukraine (2020): Ukraine New Deal, https://menr.gov.ua/news/34424.html.
31 OECD, n.d., Supporting Energy Sector Reform in Ukraine. Retrieved from https://www.oecd.org/eurasia/competitiveness-programme/eastern-partners/supporting-energy-sector-reform-ukraine.htm.
32 OECD (2019). Snapshot of Ukraine's Energy Sector: Institutions, Governance and Policy Framework. Retrieved from https://www.oecd.org/eurasia/competitiveness-programme/eastern-partners/Snapshot-of-Ukraines-Energy-Sector-EN.pdf.
33 Razumkov Centre, Research Areas: http://razumkov.org.ua/en/research-areas/energy?start=10.
34 State Agency on Energy Efficiency and Energy Saving of Ukraine, International Cooperation, Retrieved from: https://saee.gov.ua/en/activity/mizhnarodne-spivrobitnytstvo.

Ukraine-Denmark Energy Centre (UDEC): This programme aims for sustainable and inclusive economic growth by strengthening the framework conditions for sustainable energy investments, helping Ukraine to achieve its renewable energy, energy efficiency and energy independence objectives. Within the joint project, an online tool[35] has been developed to investigate various long-term Ukraine scenarios. Partners in the project were the Ukrainian Ministry of Energy, the Ukrainian-Denmark Energy Centre, the Danish Energy Agency and the Technical University of Denmark (DTU). The online tool made it possible, for example, to compare the scenario for the Energy Strategy of Ukraine 2035 action plan with a “frozen policy” or a “low carbon society” scenario. The report Long-term Energy Modelling and Forecasting in Ukraine[36] published in 2019 presents the main input data, methodology and results of the project.

United States Agency for International Development (USAID): USAID is an independent agency of the United States federal government that is responsible for administering civilian foreign aid and development assistance. The energy and energy security programs[37] aim to improve Ukraine’s energy efficiency and reduce the country’s critical dependence on energy imports. USAID works with Ukrainian leaders to reform Ukraine’s extremely energy-intensive municipal heating sector by strengthening the legal, regulatory, and institutional frameworks necessary to improve heating services. USAID also assists Ukraine’s efforts to create a social safety net to keep heat affordable for vulnerable populations. There are several projects and programs currently ongoing. The Energy Security Project (ESP)[38] with the implementer Tetra Tech, ES Inc. seeks to provide affordable, reliable, resilient and secure energy to Ukraine’s citizens. The Energy Sector Transparency Project with DiXi Group aims to reduce opportunities for corruption in the energy sector and increase transparency by empowering public watchdogs and consumers. The goal of the Ukraine Energy Regulatory Support Program[39] is to help enhance the ability of the National Energy and Utilities Regulatory Commission (NEURC) to regulate the electricity and natural gas sectors in Ukraine by learning from international best practices. This programme is with the American non-profit organisation National Association of Regulatory Utility Commissioners (NARUC).

World Bank: The World Bank, the German Government and the European Union are the main donors of the Energy Efficiency Fund[40], which will help the Ukrainian residential sector to reduce gas consumption. With the Second Power Transmission Project[41], the World Bank also provides loans to improve the reliability of the transmission system and support the implementation of the wholesale electricity market in Ukraine. The project helps the national energy company Ukrenergo to design and implement high-priority transmission system rehabilitation measures and upgrades, increasing the system’s reliability. The Energy Technology and Governance Program[42] is a partnership with the United States Energy Association (USEA). It assists the TSO Ukrenergo in transmission system planning, static and dynamic analysis through technical assistance and participation in regional workshops with other TSOs.

[35] Times-Ukraine: https://timesukraine.tokni.com/.
[36] Diachuk, O., Podolets, R., Yukhymets, R., Pekkoiev, V., Balyk, O., & Simonsen, M. B. (2019): Scenarios for the Action Plan of Energy Strategy of Ukraine until 2035. Retrieved from https://ens.dk/sites/ens.dk/files/Globalcooperation/long-term_energy_modelling_and_forecasting_in_ukraine_english.pdf.
USAID, Ukraine/ Energy and Energy Security [cit.16.03.2020]. Retrieved from https://www.usaid.gov/ukraine/energy-energy-security.
[38] Energy Community, Energy Security Project: https://energy-community.org/regionalinitiatives/infrastructure/donors/National/USAID_UE_TETRA.html.
[39] National Association of Regulatory Utility Commissioners (NARUC), Ukraine Energy Regulatory Partnership: https://www.naruc.org/international/where-we-work/europe-and-eurasia/ukraine/.
[40] European Energy Efficiency Fund: https://www.eeef.eu/home.html.
[41] World Bank, Second Power Transmission Project: https://projects.worldbank.org/en/projects-operations/project-detail/P146788.
[42] USEA, [cit.16.03.2020]. Retrieved from https://www.usea.org/program/etag.

The Annexes II to V can be found under the following links:

Annex II

elia grid international (egi)

▶ System transformation for an optimised integration of renewable energies in Ukraine – AS-IS Report

Annex III

elia grid international (egi)

▶ System transformation for an optimised integration of renwable energies in Ukraine – Gap Analysis

Annex IV

Ic consulenten Ukraine (ic)

▶ Policy consulting for optimsed grid integration of renewable electricity in Ukraine - Status analysis of the Ukrainian renwable energy market and stakeholders

Annex V

Ic consulenten Ukraine (ic)

▶ Policy consulting for optimsed grid integration of renewable electricity in Ukraine - Final Report and Recommendations

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