Energy Cooperation Ukraine-Poland to Strengthen Energy Security

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Abstract. The article analyzes the prospects of cooperation between Poland and Ukraine in the field of electric power transmission. In particular, the characteristics of the «Burshtyn Energy Island» are enlightened, which includes Burshtyn TPP, Kalush CHPP and Tereble-Ritsk HPP that are detached from the power system of Ukraine and operate in parallel with the European system ENTSO-E. This island serves as an importer of Ukrainian electric power to European countries through Hungary and Slovakia, respectively, and is synchronized with the European Network of System Operators for Electricity Transmission (ENTSO-E). The main problem of the international transmission of electric current of Ukraine is determined, which is that the whole energy system of Ukraine works within the international energy union of the CIS and Baltic IPS / UPS. At the same time, the integration of Ukraine into the markets of Western European countries requires the break of established connections under the IPS / UPS system and the parallel increase of communications under the ENTSO-E system through Poland, Slovakia, Romania and Hungary. The prospect for the development of the Energy Bridge project, which provides the supply of electric power from the Khmelnitsk NPP to Poland through the Khmelnitsk NPP - Rzeszow, is described. It is proposed the stages for the further development of energy security in the information direction on the introduction of Smart Grid technologies, in which energy companies will be able to manage the whole network as the only flexible digital system, and end users - to clearly regulate their own electricity costs.

1 Introduction

The global requirements for reducing greenhouse gas emissions by 2020 determine its reduction of 80%. The European Union is actively involved in solving this problem. Accordingly, it is implemented the policy of increasing the share of electricity from renewable sources to 20% and increasing energy efficiency up to 20% as part of a unified European strategy to ensure sustainable development, competitiveness and availability of

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energy and the reliability of its deliveries. In this case, the growth of electric current consumption is expected. Thus, in Poland this growth will be at least 50% for the next 20 years. On the other hand, for the EU energy industry the basic problem is the problem of the withdrawal of out-of-date energy equipment (the so-called problem of «aging stations») that was determined and announced by the RWE Group in 2007.

The steady growth of electricity consumption, aging of generating capacities and their forced modernization with regard to environmental requirements; all these factors influence on governments of European countries, including Poland, to actively pursue their implementation in addressing these problems. Thus, the Polish government initiated the formation of the CENTRAL system, which united the operating systems of Poland, Hungary, Slovakia and the Czech Republic in order to enter the power system of Western Europe. Taking into account these requirements and trends in the world and European energy, we will characterize the purpose of the study, which is oriented towards the definition of Polish-Ukrainian cooperation in the energy sector in order to assess and develop Ukraine's energy security.

According to the purpose, the following tasks are defined:

1. To assess the energy potential of Poland and Ukraine and the technical conditions for cooperation in the development of the Unified Energy System;
2. To determine the division of responsibility for the development of the energy sector in guaranteeing the energy security of Ukraine and Poland;
3. To identify the basic problems in ensuring the availability of sustainable growth and reliability of electricity supply.

2 Poland's energy potential

Poland's energy sector is the most powerful in Eastern Europe. Poland has a significant amount of coal reserves, which determines the structure of generating capacities. Thus, 55 plants (97% of generation) are using coal. However, equipment at power plants is outdated (20% of generating equipment has already been functioning for more than 20 years), and the work of heat stations leads to environmental pollution [1]. With the possibility of exporting electricity, the country has the highest growth of electricity consumption in Europe. Poland takes active efforts to enter western economy. In 1998, the intentions of reorganizing the energy sector and adapting the acts on regulation of the energy market to the requirements of the EU standards were announced with the aim to implement within next 4 years. Taking into account the EU requirements, including in terms of ecology, the government plans to upgrade over 8.6 GW of generating equipment. The focus is on Envon's construction of a gas fired cogeneration plant. The implementation of this program determines the participation of the World Bank and the European Bank for Reconstruction and Development, which are involved in projects, including the construction of new non-coal mines, and the introduction of clean technologies for the modernization of existing coal stations [2].

Over the past few years, Poland has been working very hard on the energy independence of the country. Diversification of energy supply sources has become one of the main elements of national security of the country. The Polish government focuses on the maximum independence from Russia in the gas sector (2/3 of the gas Poland has received from Russia), given the experience of the Russian gas wars against Ukraine in 2005-2006 and 2008-2009.

To achieve energy independence in 2009, Poland began to build a LNG terminal for receiving liquefied natural gas at Świnoujście in the Baltic Sea. In 2019, this terminal will begin to receive industrial volumes of gas in accordance with the 20-year contract of

Poland with Qatar. In addition, Poland began intensively develop gas connections with Germany, the Czech Republic and Slovakia, which makes it possible to reverse the gas from Europe in case of such need. The Polish government is also negotiating with Scandinavian countries for setting up gas supplies from the North in the project pipeline Baltic Pipe. Polish Mining and Gas Extraction Company (PGNiG), responsible for ensuring the country's gas, tries to achieve a state in which 1/3 of the country's needs for gas will be provided from its own production, 1/3 will be supplied from Russia, and the remaining 1/3 will be from the supply of liquefied natural gas and natural gas from Scandinavia. Poland's efforts to diversify gas supplies have already yielded results: Russia's Gazprom agreed three years ago to cut gas prices to Poland by 15%.

Poland provides its electricity needs through the work of power plants operating on domestic coal. However, given the demands of the European Commission to reduce carbon dioxide emissions into the atmosphere, Poland intends to build two nuclear power plants in the coming decades. In particular, the construction of the power unit of the first nuclear power plant should start its functioning in 2019, and its commissioning - by the end of 2024. Instead, the construction of the second Polish NPP should be finished in 2035.

Despite the focusing on traditional energy sources, Poland is gradually trying to develop alternatives. According to the energy policy strategy, by 2030 the share of renewable energy sources in Poland should increase to 20%.

In Poland energy companies are considered strategically important for the security of the country, and therefore most of them are either state-owned or the state holds a controlling shareholding. Among the largest energy companies in Poland (PGNiG, PERN Przyjazn, LOTOS, PKN Orlen, PGE, Naftoport, Tauron), only one oil company (PKN Orlen) can be called private. However, the state has almost 28% of the shares and may affect the company's policy. Despite the fact that the state has controlling stakes in most energy companies in the country, their management has a wide discretion and the state is unnecessarily trying not to interfere in their activities and development. Although the majority of Polish energy companies are successful and actively invest and develop their capabilities abroad, the main objective is still the energy security of Poland.

3 Development of energy sector in ensuring the energy security of Ukraine and Poland

Over the past twenty years, Ukraine has not introduced new generating capacities, and despite this, Ukraine remains one of the largest energy interconnections in Europe. It consists of 365 licensed power generating companies, of which 7 major energy companies provide almost 90% of the total electric power production, while 7 regional electric power systems and 40 licensees carry out the transmission of electricity to local power grids. Since 2000, in Ukraine the so-called «Burshtyn Energy Island» has been created and is being functioning and includes Burshtyn TPP, Kalush CHPP and Tereble-Ritsk HPP, which are separated from the power system of Ukraine and operate in parallel with the European system ENTSO-E.

This island serves as an importer of Ukrainian electric power to European countries through Hungary and Slovakia, respectively, and is synchronized with the European Network of System Operators for Electricity Transmission (ENTSO-E) via the electricity grid of 110-750 kV (figure 1).

It should be mentioned that it is the main problem of the international transmission of electric power in Ukraine. Now the entire energy system of Ukraine works as part of the international energy union of the CIS and Baltic IPS / UPS. At the same time, the integration of Ukraine into the markets of Western European countries requires the break with established connections under the IPS / UPS system and the parallel increase of

communications under the ENTSO-E system through Poland, Slovakia, Romania and Hungary.

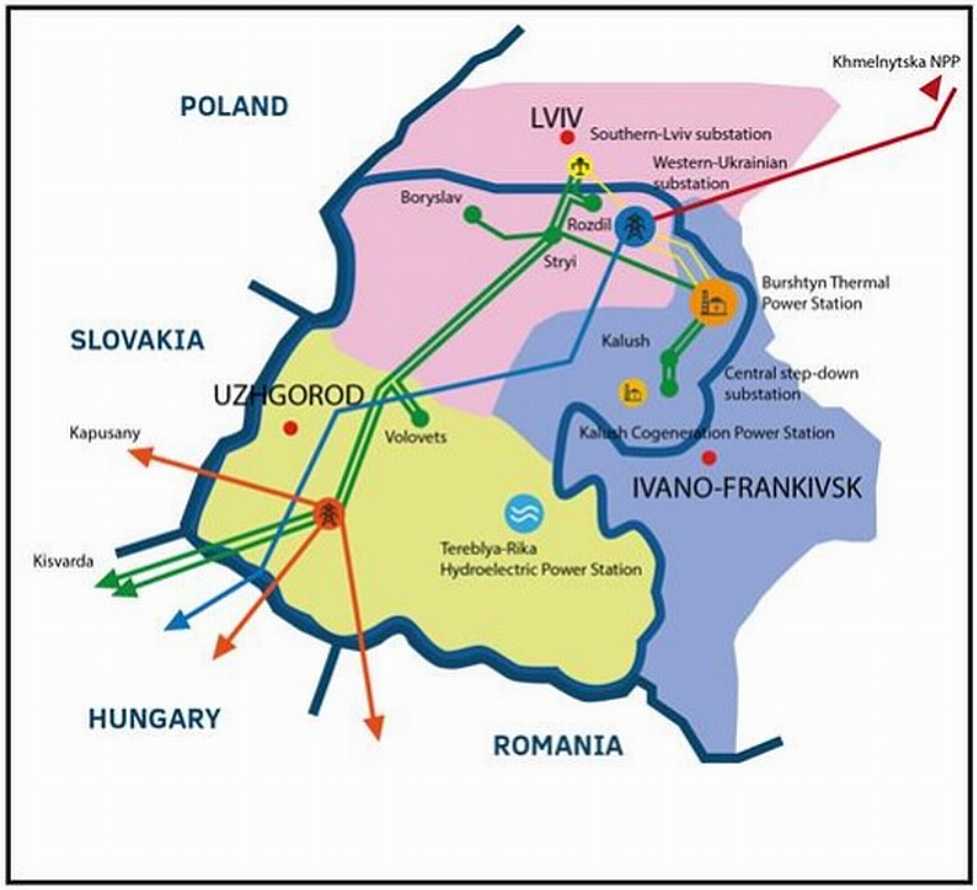

Fig. 1. The export potential of the Burshtyn Energy Island

The first step in solving this problem was the merger of the Ukrainian and Moldovan energy systems under the ENTSO-E scheme in 2016. On the basis of this association, on June 27, 2017 an agreement on the connection of the Ukrainian power system to the continental Europe's grid was signed in Brussels [3].

The signing of this agreement obliges Ukraine to fulfill European conditions and requirements for synchronization of these systems. Accordingly, Ukrenergo started to develop an Action Plan, including an assessment of the current technical state of the UES facilities in Ukraine, the possibilities for joint coordination of these systems, and the development of a common position on the list of technical measures at the UES facilities in Ukraine, which will provide the precondition for ensuring such synchronization and harmonization of technical rules and standards for the safe and coordinated operation of these systems when connected.

The next step was the development of the Energy Bridge project, which provides the supply of electric power from the Khmelnitsk NPP to Poland through the Khmelnitsky NPP - Rzeszow (figure 2).

It should be mentioned that this idea was not a new; «Power Bridge» was implemented during the Soviet period in order to supply the electricity to Poland and further to the

socialist countries of Eastern Europe, which allowed the export of 30 billion kilowatt-hours of electricity annually. In fact, this is a revival of the previous Soviet project, but adapted to modern technical and legal requirements.

The «Energy Bridge» provides for gradual implementation of these technical measures:

- restoration of 750 kV within Rzeszów power transmission line;
- modernization of the Khmelnitsk NPP open switchgear, in order to satisfy safely disconnect the second power unit of the power station from the united power grid of Ukraine and its connection to the ENTSO-E. It is planned to mount a block transformer on the third unit of the station;
- reconstruction of the substation «West-Ukrainian» for the purpose of partitioning the voltage in the network by classes: the 330 kV voltage class will remain to fulfill the tasks in Ukraine, and the voltage class 750 kV will be oriented towards exports to Albertirsa.

Fig. 2. Logistic chain of the Energy Bridge project

Thus, logistic approaches to the implementation of this project will ensure the full operation of the power unit of the Khmelnitsk NPP by the two main interstate lines, and the throughput of such a Euro-bridge will amount to 2,000 MW on each side and will additionally provide 1 GW of nuclear power to the existing export potential of the «Burshtyn Energy Island», which today is provided exclusively by thermal generation (550 MW).

Implementation of the Energy Bridge project will allow:

within 3-4 years significantly increase of the export potential of Ukraine electricity to Europe;

to guarantee long-term electricity exports to the EU countries for at least 20 years;

increased use and increase of maximum capacity of nuclear power units, including South-Ukrainian NPP and Zaporizhzhya NPP;

foreign direct investment in the completion of the third and fourth power units of Khmelnitsk NPP;

development of real instruments to attract financial resources to ensure progress and success of the domestic energy infrastructure development;

formation and support of local budgets through taxes and dividends totaling 3.5 million euros, while the state budget is planned about 2.9 billion euros.

4 Smart Grid concept as perspective energy cooperation between Ukraine and Poland

An urgent approach to solving some of the problems of the modern world energy is the introduction of the Smart Grid system (fig. 3).

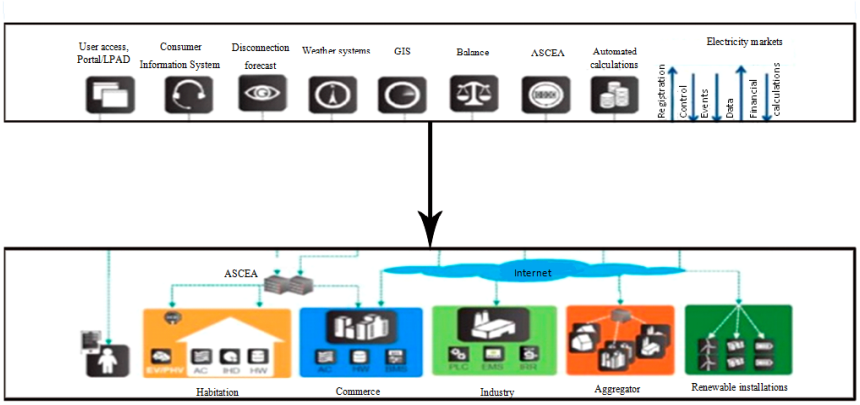

Fig. 3. Information and energy component of energy logistics with the introduction of Smart Grid

Implementation of this system allows to reduce the level of electricity consumption by 9% due to energy efficiency improvement of the energy system itself. In addition, modern networks in their technical design are rather rigid (generation, network, consumer) and one-sided (manufacturer-consumer). Taking into account the fact that by the 2030 it is planned to double the demand for electricity consumption; this technology can actually reduce the problem of energy supply to consumers. In fact, the Smart Grid system transforms the analog power network into a high-precision, intelligent communication component of the grid. Energy companies will be able to manage the entire network as the only flexible digital system, and end-users - to clearly regulate their own electricity costs.

In order to develop this technology in 2010 China invested $ 7.32 billion, the United States invested $ 7.09 billion, Japan - $ 849 million, South Korea - $ 824 million, and Spain invested $ 807 million. In Europe more than 400 systems Smart Grid projects are implemented with the overall cost of more than 4.5 billion euros.

For Ukraine, the introduction of Smart Grid system in addition to financial problems requires urgent solution for technical problems. Thus, the outdated equipment of the power grids at all levels of the power system, as well as the significant development of alternative energy (wind and solar), which requires complex prediction of its stochastic nature in balancing the power grid itself, does not allow rapid introduction of Smart Grid technology.

In addition, there is a need to transfer Ukrainian networks from 6 (10) kV to the level of 20, which is complicated by the unsatisfactory technical state of the networks and their sub-optimal configuration. The same problem has not been worked out at the normative level; there is no relevant normative and technical basis for the design and operation of networks with a voltage class of 20 kV.

Despite these problems, the implementation of the Smart Grid system is already in the process of technical implementation in Ukraine. In particular, the Electricity Transmission Project-2 [3], initiated for implementation, was launched. The purpose of this project is enhancing security, reliability and effectiveness of electricity transmission, improving

compensation of reactive capacity in power grids to create technical conditions for approximation of the Power System of Ukraine integration into the European Network of Electricity Transmission System Operators (ENTSO-E) and allow Ukraine to become an important, full-fledged player in European electricity markets.

The project consists of the following components and subcomponents: (1) Rehabilitation of Transmission Substations. Replacement of out-dated high voltage equipment, installation of gas-insulated switchgears, and replacement of auxiliary power equipment, protective layering and substation control and automation systems in selected high voltage transmission substations. (2) Electricity Market Enhancement. This component consists of four subcomponents: 2.1: Installation and connection of reactive power compensation devices for selected high voltage transmission substations. 2.2: Introduction of Smart Grid through purchase and installation of Smart Grid solutions 2.3: Provision of support to the Balancing Market through purchase and installation of hardware and software for the proper functioning of the Balancing Market of electricity, ancillary services market and fulfilment of administrative settlement services, administration of commercial settlement, as well as other services of the System Operator based on the Electricity Market Law of Ukraine. 2.4: Support for institutional development of the Project Implementing Entity (UE) by: (a) establishing a corporate-wide management information system (MIS) in the Project Implementing Entity; (b) providing technical assistance to the Project Implementing Entity on procurement. Its financing is provided by the IBRD with the assistance of the Clean Technology Fund for an amount of $ 48.425 million [4].

It is planned to implement a number of pilot technologies and SmartGrid projects at the level of the System Operator: Observability - 100% real-time observation of the operation of electrical substations in order to calculate the future operating modes of the network in real time, RES Forecasting - implementation of the system for forecasting electric current generation, Grid CIM Modeling & Transparency - Creating an Integration Platform for Data Collection across the Power System, Virtual Power Plant & Demand Response & V2G-Leveling Effects of Stochastic Generation Generation with RE (renewable energy).

4 CONCLUSIONS

The Polish experience in reforming of the sector is particularly valuable for Ukraine, given the similarity of the power systems of the two states and the close initial conditions before the start of the reform. Such cooperation will minimize the risks of introducing a competitive model of the electricity market in Ukraine. In addition, the introduction of Smart Grid technologies in Ukraine will increase the security of electricity supply to consumers; reduce technological losses of electricity in the network and the level of CO2 emissions. It will also ensure the technical capacity of transmission and distribution system operators to work effectively in the new competitive energy market, taking into account the growing share of distributed renewable energy.

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