WARSAW SCHOOL OF ECONOMICS
ECONOMIC AND SOCIAL COLLEGE

Aleksandra Ściborek MA

OPERATION OF GRID COMPANIES ON THE POLISH ELECTRICITY MARKET (BASED ON THE EXAMPLE OF THE LUBLIN BRANCH OF PGE DISTRIBUTION)

Field: economic studies
Discipline: economics

Supervisor:

dr hab., prof. SGH Piotr Jeżowski

Warsaw, May 2023

SUMMARY

1. Reasons for taking up the topic

Key factors in the process of transformation of the electricity market are often considered to be the successful privatization of electricity companies and the effects of energy sector liberalization reforms in Europe, as well as positive effects of the development of competitive energy markets in the US. Deregulation of the electricity sector and liberalization of energy trade have become indispensable elements of economic policy.

The political changes that took place in Poland after 1989 and the introduction of a market economy provided the impetus to undertake structural transformations in the electricity sector. Until 1990, the sector was a nationwide state natural monopoly with a vertically integrated structure. It was only the act of 24 February 1990 – Energy Law that enabled vertical decomposition of the electricity sector. An organizational separation of the electricity sector into three subsectors followed: generation, transmission and supply of electricity. This act defined the target model for the Polish energy sector and normalized the rules for its operation.

The legal unbundling of distribution system operators carried out on 1 July 2007 was intended to remove significant legal barriers to the entry of electricity traders into the market and to eliminate threats to the formation of the public utility mission of distribution companies.

In connection with the introduction of the principle of third party access (TPA), it became necessary to separate trading companies and grid companies performing the function of electricity transmission and distribution from the operations of the existing vertically integrated electricity companies.

Grid companies engaged in the licensed activity of distribution system operators, under national law, distribute electricity and are responsible for the distribution system traffic, the current and long-term security of operation of this system, taking care of the technical condition of the distribution grid and its development, as well as for balancing energy and power in the system. Distribution companies also have a key role to play in developing a competitive retail market. A distribution system operator is also tasked with collecting metering data necessary for balancing market operations and managing the exchange of information to enable customers to switch electricity sellers.

Today's electricity industry faces various problems and challenges. Due to the depletion of energy resources, the need to reduce losses arising during the generation, transmission and distribution of electricity, the tightening of emission standards, and the emergence of distributed micro and small energy sources on a larger scale in the system, which, in addition to their obvious advantages, bring difficulties and risks to traditional power grids due to instability, the idea of creating smart grids and the transformation of traditional control and measurement apparatus into smart metering devices arose.

The rapid development of distributed energy resources combined with new technologies, including ICT, is significantly shaping the energy market. These elements will to a large extent affect the distribution grid while shaping the new role of distribution system operators (DSO) in the energy market. New challenges for DSOs include: the new role of a grid company as a facilitator of market development using the flexibility of distributed energy sources, data management, cooperation between the transmission system operator (TSO) and DSOs, new IT and ICT technologies, the development of smart grids, consumer activation and energy clusters.

The necessary adaptation of distribution grids to current and future tasks requires identification of the problems facing distribution companies and an assessment of the costs of necessary technological adjustments. The aforementioned issues demonstrate that the operation of distribution companies in the electricity market poses many key issues for analysis, of socio-economic importance.

2. Purpose and thesis of the dissertation

The purpose of the dissertation was to analyse and evaluate the new role of grid companies in the conditions of the developing energy market while ensuring the security and reliability of energy supply, and to outline the prospects for the development of distribution companies with an assessment of the potential opportunities and threats, as well as the costs associated with technical progress and innovation economy in the energy industry. The main focus has been on defining the future role of grid companies in a functioning electricity market. The analysis was carried out on the example of a selected branch of a distribution company – the Lublin Branch, as part of PGE Dystrybucja S.A.

The main thesis of the dissertation is that the progressing organizational, legal and regulatory transformations impose on grid companies a new role in the electricity system and tasks in the field of data management, implementation of new technologies determining the

direction of transformation of the electricity sector (distributed generation, technologies supporting the development of RES, and in the longer term, energy storage and hydrogen economy) and financing the development of electricity grids. Meeting these challenges is a prerequisite for a well-functioning electricity market and ensuring energy security.

The dissertation seeks to answer the following research questions:

1. What are the consequences of deregulation of the electricity market on the organization of the electricity industry and security of energy supply?
2. What are the key problems of transformation of grid companies and what is the essence of the balancing market?
3. What are the necessary directions of technological transformation of distribution grids dictated by the requirements of climate policy, development of RES and activation of the demand side?
4. What conditions are necessary for the further development of the Lublin Branch as part of the DSO?

3. Scope of analysis and research methods used

The dissertation seeks to analyse and evaluate the new role of grid companies in the conditions of the developing energy market while ensuring the security and reliability of energy supply, and to outline the prospects for the development of distribution companies and the costs associated with technical progress and innovation economy in the energy industry.

The primary data source for the dissertation were materials and statistics from PGE Dystrybucja S.A. Lublin Branch. Existing materials and statistical data from the Energy Regulatory Office (ERO), the Energy Market Agency (EMA), the Ministry of Environment and Climate (MoE&C), and Polskie Sieci Elektroenergetyczne S.A. (PSE), the Society for Energy Trading (TOE), Eurostat and the OECD were used and analysed.

The research questions were answered by means of analysing historical data using already existing studies and reports, as well as forecasts for the development of grid subsectors of the energy sector. Analysis of the collected data made use of the historical-comparative method, as well as the content analysis method and the analysis and evaluation of available statistical data.

In approaching the theory of regulation, the author relied heavily on the views of A. Szablewski and P. Jeżowski. On the other hand, in terms of organizational and legal foundations, the analysis was based on studies of domestic and foreign literature on the

subject, as well as European Union and Polish laws on the restructuring and regulation of the electricity industry.

The research problem addressed in the dissertation corresponds to the author's interests and is related to her professional work. This work covers the status of EU and national regulations and statistical data analysis as of 3 July 2021.

The empirical part is a case study covering a part of a selected electricity grid company, i.e. the Lublin branch of PGE Dystrybucja S.A. against the backdrop of the whole company. Different approaches to the analysis result from the ownership supervision and dependence of the Lublin Branch on PGE Dystrybucja S.A. This means that the natural source of data for the detailed analysis was the source materials of PGE Dystrybucja S.A. in terms of the development plan, strategy and financial needs, as well as of the Lublin Branch in terms of resources, grid infrastructure, business area and operating income and expenses. In order to maintain clarity in depicting areas of the economic performance account, income and expenses are presented in two systems: calculation-based and type-based.

In order to examine the strategic position of the Lublin Branch in the energy market, a macro-environment analysis was carried out using the PESTEL method and a micro-environment analysis using Porter's 5 forces method. Meanwhile, the situation inside the Lublin Branch was analysed using the SWOT method.

4. Structure of the dissertation

The dissertation consists of four substantive chapters. Chapter 1 discusses the theoretical underpinnings of the deregulation process of energy sectors, as well as the practical possibilities of applying the recommendations of the deregulation movement in the electricity industry. The analysis covered privatization of the electricity industry, vertical decomposition of the sector, the principle of third-party access to the grid, the powers of new operators of grid-connected renewable energy installations, and price deregulation.

Chapter 2 shows the process of building the electricity market in Poland and its structure and functioning. In addition to analysing the structure of the national electricity system and its main areas, the process of switching energy vendors is discussed here, and the essence of security of energy supply under conditions of deregulation of the electricity sector is defined.

Chapter 3 analyses the regulation of grid companies in the electricity market in the EU and Poland. The chapter was intended to show the key problems of operating grid enterprises

in the face of new challenges. Special attention was paid not only to the traditional tasks of grid companies, but also to the new responsibilities imposed by the emergence of prosumers, energy clusters, electromobility, energy storage, and smart metering, among others. This provided the backdrop for an attempt to analyse and assess the costs of the necessary technological and organizational adjustments, and to identify the potential development risks of the selected electricity grid company.

Chapter 4 is an analysis and evaluation of the role, operation and prospects under the new conditions of the Lublin Branch as part of a grid company. The purpose of this analysis was to identify the factors that determine the financial health and efficiency of the branch, both in the local market and in the balancing market. In this chapter, an analysis of the structure of income and operating expenses, as well as the cost of technological adjustment of the distribution system was carried out against the background of an outline of the development plan of the considered branch of the grid company. A sample cost-benefit analysis of AMI system implementation is shown in selected pilot areas that meet the requirements of the ERO president's position. The final result of the research conducted in Chapter 4 is an assessment of the strategic position of the Lublin Branch in the distribution sector.

5. Research results and conclusions

The theoretical and empirical considerations carried out as part of the dissertation led to the following conclusions.

From theoretical considerations, it is clear that an important dimension of energy market reconstruction has been the changes taking place in the area of regulation. The aim of the reforms being implemented was to change the way the state interacts with the existing natural monopoly and to ensure the security of energy supply. The transformation of the energy market architecture has taken place through demonopolization, privatization and price deregulation. There is no doubt that natural monopoly required such reforms, but in order to achieve concrete results, a change in the way prices were regulated was needed.

The goal of demonopolization was not only to increase the efficiency of the competitive market by improving cost efficiency of electricity companies, but also to improve the efficiency of investment processes by triggering investment incentives to expand generation and grid capacity.

As a result, market competition has forced companies to take risks while keeping them from making grid investments. Not entirely competitive energy market and the regulator's inability to meet its commitment to regulate prices caused distortions in the correct economic relationships within companies and posed a risk of inappropriate investment.

EU legislation has indicated a complex path for the transformation of the electricity market, the construction of which has taken place in several stages determined by the various energy packages. The first stage set by Directive 96/92/EC of 19 December 1996 introduced competition into the energy market. The second stage set by Directive 2003/54/EC continued the process of bringing competition to the market. The third stage, on the other hand, represented a further step toward liberalization and empowerment of the customer in the market and was set by the Third Energy Package adopted on 13 July 2009.

The EU considers climate neutrality – which requires smart infrastructure and renewable energy sources – to be its supreme goal. The Fit for 55 package of legislative proposals released in 2021 as part of the European Green Deal shows that the EU has developed a new strategy for building the energy market in the run up to 2050. The package, in its current form, will not only result in exorbitant implementation obligations for member states to achieve climate neutrality in the near future, but also means enhancing the Commission’s oversight of the implementation of climate policy. The EU’s move toward the latest technologies and its ambitious climate policy is bound to exacerbate the existing problems already faced by the coal-based electricity industry.

An analysis of domestic regulations has shown that due to the dynamically changing EU regulations, the legal acts governing the operation of the electricity market in Poland are constantly being modified. The national regulatory framework being introduced are aimed primarily to ensure the security of energy supply, sustainable development and increased competitiveness of domestic businesses. However, national legislation imposing new tasks and obligations on DSOs puts them increasingly at risk of generating adequate regulated revenue from their distribution operations. At the same time, regulations insufficiently highlight the problems facing the electricity sector, as well as insufficiently support its development. It is also important to introduce statutory provisions and solutions in downstream documents that would support the investment process and grid development for RES connection.

In the light of EU and national regulations, specific areas were analysed: adaptation of grid systems to changes in the scope of distribution services, smart grid, prosumers and

energy clusters, energy storage, electromobility, distribution fee design and smart metering, which are important for the future role of DSOs.

The new model of regulating DSOs is an opportunity for the development of grid companies. It guarantee the stability of their operation in terms of the operating revenues they receive, taking into account an effective system of fixed and variable charges and dynamic tariffs or a system of purchasing regulated services by DSOs from energy market users. The implementation of energy storage technology in the distribution grid constitutes an opportunity for the development of grid companies. This should increase the quality and reliability of energy supply, positively affect the reduction of balance difference volume, and improve the accuracy of forecast of the area's electricity demand. In the future, the stability of distribution grid operation and local system balancing will be guaranteed by the ability of DSOs to own and use energy storage in the form of voltage regulators installed inside transformer stations. The opportunity also lies in the DSOs' consistent implementation of investment plans and improved efficiency of grid investments.

On the other hand, a threat is posed by the volatility of market realities and regulatory uncertainty, the lack of transparency and simplicity of national laws, which do not serve the development of investment in the electricity sector and do not attract potential investors. Despite the many possible benefits of implementing smart metering, there are many risks from the technology used, and the cost of implementing smart metering is still very high. The growth of the electric car market could also be a threat to the proper operation of the grid. In general, therefore, grid companies need to adapt their operations to new developments both within the distribution sector and in its environment, such as the formation of energy clusters and cooperatives, energy storage or the development of electric vehicle charging infrastructure. All of the DSOs' adaptation activities have required modernization of grid assets, new investments and implementation of new smart grid technologies.

The organizational and legal changes taking place in the electricity industry are creating new challenges for grid companies. DSOs are required to adapt to the new energy market operating model. Adaptation tasks and meeting current and future requirements also face the selected unit of the grid company – the Lublin Branch.

Analysis of the balance difference volume in the Lublin Branch from 2015 to 2020 confirmed the rationale for upgrading the branch's grid assets. Its effect is to reduce grid losses. Due to the emergence of new and active participants in the balancing market, a new scope of duties and responsibilities for the branch was assigned. In order to ensure the

reliability of grid operation, the use of new technologies and systematic modernization of the grid are required, taking into account the variable nature of distributed sources. Incomplete implementation of smart grid solutions can further complicate the balancing process. It is necessary to expand the electricity infrastructure to increase the geographic balancing areas.

Analysis of the status of the Lublin Branch's distribution grid shows that the smart grid has not yet been fully implemented. The activities carried out in this direction are partial, focusing only on introduction of the selected solution, setting the direction of change rather than its final shape. The greater the capacity to use smart grids, the greater the reduction in future grid expansion costs. The current state of the Lublin Branch's distribution grid indicates a progressive ageing of the grid infrastructure. This is caused by the still insufficient pace of expansion and restoration of linear electricity infrastructure. This state of the grid in the future will lead to inability to fully realize the potential of investments implementing smart grids. Therefore, as a first step, it is imperative for the Lublin Branch to upgrade its grid infrastructure, directing funds to investments that implement smart grid functionality.

Analysis of the financial result in the Lublin Branch from 2017 to 2020 showed a stable financial situation of the branch. On the other hand, the faster rate of growth in operating expenses relative to the rate of growth in revenue from the sale of distribution services is of concern. As a result, it will become increasingly difficult to cover costs with revenues.

Although the cost analysis of the AMI system implementation carried out at the Bialystok Branch and the Łódź-City Branch confirmed the profitability of both projects, it is currently difficult to estimate the actual cost of a similar investment at the Lublin Branch on this basis, mainly due to the dynamically changing market environment and outdated equipment prices and installation costs.

In dynamically changing external and internal environment, the Lublin Branch as a part of the DSO undertakes various types of adaptation activities in order to maintain a proper strategic position in the electricity market. The strategic position of the Lublin Branch was analysed in light of the identified factors.

The PESTEL analysis showed that changes in the branch's external and internal environment due to political, technological and legal factors strongly affect the Lublin Branch's operations and force adaptation measures. It is extremely important for the branch to be prepared for any legal changes, including regulatory ones. The stalled development of the Lublin Branch's grid infrastructure caused by delays in the implementation of Poland's energy policy means that distribution grids are not fully prepared for the implementation of

modern technologies and solutions. In contrast, economic, social and environmental factors have a positive impact on the branch's operations. Economic growth, the affluence of the population and the geographical location are opportunities for the development of the Lublin Branch.

Analysis of the micro environment according to Porter's 5 forces method signalled that the greatest threats to the Lublin Branch come from substitutes, new competitors and the bargaining power of suppliers. The effect of increased demand for electricity will increase the profitability of the electricity sector and the risk of emergence of new competitors. On the other hand, the threat of substitutes and the bargaining power of suppliers depends on the pace of development of new technologies. Competition within the sector and the bargaining power of buyers seems to be of marginal importance for the Lublin Branch, however. Considering the energy market transformation process, it can be concluded that in the future there will be a change in the current balance of factor forces.

On the other hand, the SWOT analysis revealed numerous threats and weaknesses to the continued operation of the company under study, and identified potential opportunities and strengths of the Lublin Branch. The most concerning development among the branch's weaknesses is the rapid growth rate of operating expenses compared to the growth rate of the Lublin Branch's operating income. On the other hand, the biggest threats to the branch's development include the reform of the balancing market, which involves new responsibilities and tasks for the Lublin Branch in the electricity market, and the rapid and asymmetrical development of distributed sources. Most of the factors that negatively affect the branch are the result not only of regulatory policy itself, but also a consequence of PGE S.A. and PGE Dystrybucja S.A.'s conservative approach to implementing innovations.

For a correct assessment of the strategic position of the Lublin Branch and to determine further courses of action, the SWOT analysis was supplemented by an assessment of individual factors. Thus, a maxi-mini strategy was chosen as the most desirable course of action for the branch. In this strategy, the Lublin Branch should focus its activities on limiting the impact of risks and using the potential of its strengths, such as its stable financial position, the high volume of energy distributed, and financial resources for investment. This will allow the implementation of necessary investment projects and technological development. At the same time, the Lublin Branch must not limit itself to strengthening its own position as a monopolist in its area of operation, but should also strive to increase its power of influence through the use of solutions in the sub-area of smart grids and meet the expectations and needs of end users.

Theoretical considerations, an assessment of the functioning of distribution enterprises and a concrete analysis of the Lublin Branch as part of the DSO have made it possible to identify the conditions necessary for the further development of the DSO and the Lublin Branch. In particular, based on the assessment and analysis it may be assumed that it was proven that the progressing organizational, legal and regulatory transformations impose on grid companies a new role in the electricity system and tasks in the field of data management, implementation of new technologies determining the direction of transformation of the electricity sector (distributed generation, technologies supporting the development of RES, and in the longer term, energy storage and hydrogen economy) and financing the development of electricity grids. Meeting these challenges is a prerequisite for a well-functioning electricity market and ensuring energy security.

The considerations and analyses carried out allow to make several recommendations aimed at the development of the DSO and the Lublin Branch. It is therefore reasonable to work towards shaping such a DSO model in which:

- distribution grid includes developed smart grid elements,
- there is a stable financial situation, which translates into the implementation of investment projects,
- the development of new technologies is supported,
- detailed energy audits (grid losses, energy efficiency) are conducted,
- ongoing market and technological changes are monitored.

Meanwhile, the further development of the Lublin Branch should ensure the following:

- leveraging the potential of distribution grids,
- acquisition, processing, sharing and large-scale use of measurement data in operator activities and grid development planning,
- taking into account in the development plans of distributed sources and the possibility of using the energy potential of grid users,
- objective treatment of all grid users, allowing permitted activity in the use, generation and storage of energy,
- conducting dialogue with the community on local energy security.