FORUM FOR
ENERGY ANALYSIS

RISK OF A CAPACITY SHORTAGE IN THE POLISH ELECTRICITY SYSTEM UP TO 2020

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The aim of the Forum for Energy Anlysis is to conduct a dialogue focused on the power sector that is open to the diverse opinions of all stakeholders in Poland, based on analysis-orientated strategic thinking about the upcoming key challenges in the sector.

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1. KEY CONCLUSIONS

- There is no significant risk of a capacity deficit on the Polish power system up to 2020, as demonstrated by analysis of the level of available reserve capacity and an assessment of the power system.
- The need to decommission old power units, combined with increasing demand for power (1.3% annually) will lead to a decline in the level of reserve capacity required by PSE SA to 8% in 2018. In subsequent years the trend will reverse and reserve capacity will grow to 14% in 2020 as a result of the commissioning of new units, including coal-fired units in Kozienice (950 MW), Opole (1900 MW) and Jaworzno (950 MW).
- Taking into account the cold reserve contracted by PSE SA, reserve capacity will fall to 11% in 2018, and then rise to 16% in 2020. This is significantly higher than the reserve requirements in Italy or the United Kingdom (10%).
- After taking into account the cold reserve, LOLE (Loss of Load Expectation – the expected number of hours in a year in which available capacity is lower than electricity demand) does not exceed 0.2 hours, which is well above the goals set by other European countries (France and Great Britain – 3 h, Holland – 4h). This means that the estimated likelihood of a capacity deficit in the Polish electricity system is much lower than the standard accepted by France, Great Britain, or Holland.
- After 2013, Poland will import increasing amounts of electricity. If there are no delays in the completion of expected investment projects, Poland will return to being a net electricity exporter once the units in Opole (1900 MW) and Jaworzno (950 MW) are in operation in 2019-2020.

2. BACKGROUND OF THE STUDY

Based on data published by the Ministry of the Economy in 2013[1], in 2016 – 2017, power on the Polish electricity system may fall short of meeting demand by approx. 1100 MW in the winter and approx. 700 MW in the summer. The main reason for the power deficit is the expected decommissioning of the oldest power generation units for economic, technical and environmental reasons, as well as delays in the construction of new units due to regulatory and business uncertainty.

The risk of a capacity deficit has triggered a discussion in Poland on the condition of the electricity infrastructure, the need to modernise and build new power generation units, as well as on changes in the operation of the electricity market through the introduction of a "capacity" mechanism.

[1] "Sprawozdanie z wyników monitorowania bezpieczeństwa dostaw energii elektrycznej w latach 2011 – 2012" ("Monitoring Report on the Security of Supply for 2011-2012"), Ministry of the Economy, 2013.

The reliability of the National Electricity System is a priority and the starting point for planned changes to the electricity market. For this reason, DNV GL (an international company specializing in energy studies) was commissioned, in the context of the Forum Analiz Energetycznych (FAE) (Forum for Energy Analysis), to conduct an analysis of the risk of a capacity deficit on the Polish electricity system up to 2020. The completed study was then discussed by the FAE's Panel of Experts. The present document presents the key conclusions arising from the study, the methodological assumptions applied, and the key messages arising from the discussion with the Panel of Experts (described in more detail below).

3. EUROPEAN CONTEXT

As a result of decisions made at EU level on the establishment of a common energy market, resource adequacy has become the subject of a Europe-wide discussion. Activities are being pursued, both within the framework of ENTSO-E and in specific regional groups (e.g. the Pentalateral Energy Forum), to develop mechanisms of cooperation aimed at cross-border trade of energy and balancing resources. This discussion arises in the context of the continued development of intermittent sources of renewable energy, as well as in the context of the liberalisation of the electricity market, increasing competition and rising number of market actors. In recent years, the issue of resource adequacy and system reliability has been the subject of numerous analyses, including in the Pentalateral Energy Forum and the Nordic Grid. It is in Poland's interests to actively participate in the discussion on the adequacy of resources in the European context.

4. SCOPE AND TIMEFRAME OF THE STUDY

The Forum for Energy Analysis commissioned DNV GL to prepare an independent evaluation of resource adequacy and to assess the risk of a power deficit in the electricity system up to 2020. The study seeks to answer two key research questions:

1. What is the probability of a capacity deficit arising up to 2020, after accounting for implementation of PSE S.A.'s remedial measures (introduction of non-spinning reserve), and the European Commission's acceptance of Poland's transitional national plan for power installations under the Industrial Emissions Directive?
2. What will be the level of the capacity reserve on the National Electricity System?

The study was commissioned in April and conducted in May – June 2014.

5. STUDY METHODOLOGY

This policy paper has been prepared in three phases:

1. Commissioning an analysis by DNV GL - a company with experience in preparing similar studies in other countries, and therefore a proven model for EU energy markets, as well as knowledge about the methodology used by ENTSO-E for assessing resource adequacy.
2. Preparation of the study by DNV GL on the basis of the energy market model for European Union Member States (description below).
3. Discussion of the results of the study and designing recommendations in the framework of the "Panel of Experts" – 25 top-class power sector specialists. The Panel of Experts met at the end of June 2014.

Panel of Experts

The Forum for Energy Analysis distinguishes itself by the fact that it not only prepares studies, but it also discusses the results of the studies with an inter-disciplinary Panel of Experts before the publication of policy papers. The purpose of such an approach is to increase the transparency of the process of preparing analyses and formulating recommendations. The Panel of Experts is comprised of representatives of government ministries, energy companies, academic institutions, independent experts, and industry and non-governmental organizations.

It is, however, important to underscore that while that this text draws upon opinions from the Panel of Experts, it has not been jointly agreed upon with them.

5.1. DESCRIPTION OF THE MODEL

The study uses the standard model of the energy market for European Union Member States developed by DNV GL. In this study, the model was modified to accurately reflect the features of the electricity system in Poland.

The model of the European electricity market:

- Uses models of individual power generation units
- Is based on the principle of minimizing total production cost
- Accurately simulates the operation of the electricity system in hourly intervals

The core of the simulation is to determine how demand for electricity in Poland will be satisfied. The demand forecast is external (based on data from the Ministry of Economy). The model selects the power sources that are needed to satisfy demand based on the principle of minimizing total production costs.

A realistic scenario of future development of the Polish electricity market was prepared during the study. Reliance on a single scenario meant that conservative assumptions needed to be made as to the parameters.

The model generates a number of results characterizing the operation of the electricity system, such as the structure of fuel consumption, the marginal cost of production, the level of reserves, the level of cross-border trade and probability of emergency outages.

5.2. ASSUMPTIONS USED IN THE MODEL

The following assumptions have been made in the above model regarding the functioning of the electricity market up to 2020:

ASSUMPTIONS UP TO 2020	
Demand for electricity	
Annual increase (%)	1.3%
Real prices of energy carriers and CO_2	
Domestic coal	Increase in price of approx. 1% p.a.
Foreign coal	Stable prices
Domestic natural gas	Declining trend of 2-5% p.a.
Foreign natural gas	Declining trend of 2-5% p.a.
Prices of CO_2 emission allowances	
Rising trend	Approx. 2-11% p.a.
Demand side management	
Reduction in power consumption	95 MW
Generation capacity	
Increase in capacity of condensation units *(Capacity switched off at power plants and cogeneration plants: 3.3 GW, in non-spinning reserve: 1.5 GW, new: 4.7 GW)*	1.4 GW
Increase in the capacity from renewable energy sources (RES):	
Hydro	40 MW
Biomass	1000 MW
Wind	3400 MW
PV	4 MW
Increase in transmission capacity	
On the Lithuanian border	
Imports	500 MW
Exports	500 MW
On the German border	
Imports	500 MW
Exports	1500 MW

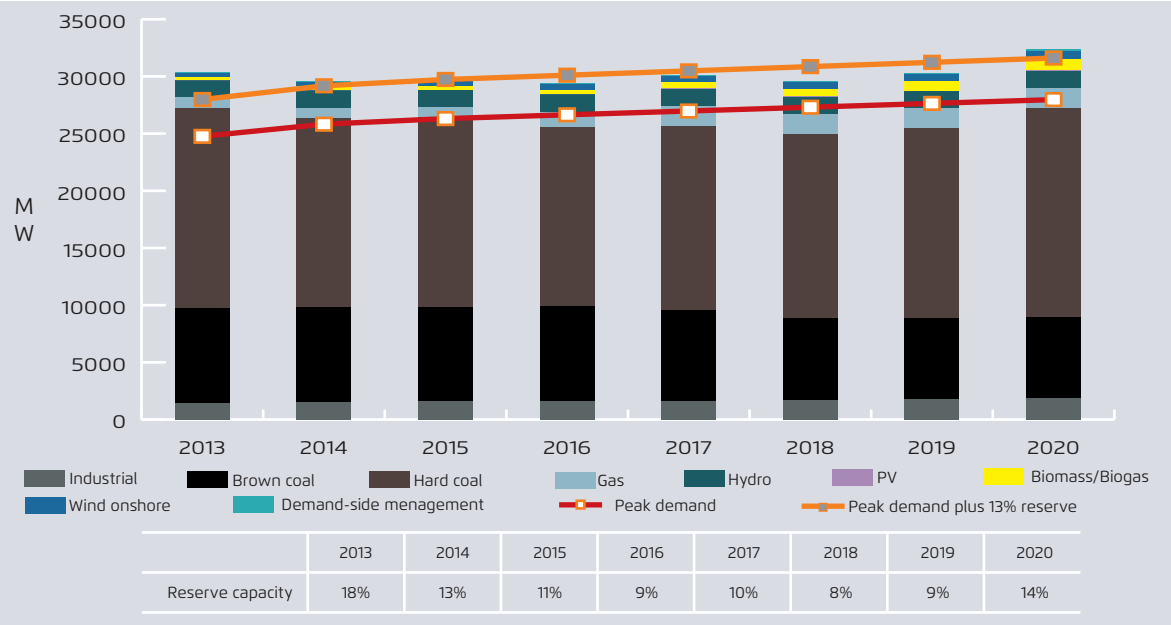
Improvements in energy efficiency are factored into the changes in demand for electricity – they have not been otherwise accounted for in the study. The capacity factors for generation capacity have been selected in accordance with accepted practice (e.g. for coal-fired units – 94%, for wind farms – 10%).

6. KEY RESULTS

Level of reserves in the National Electricity System

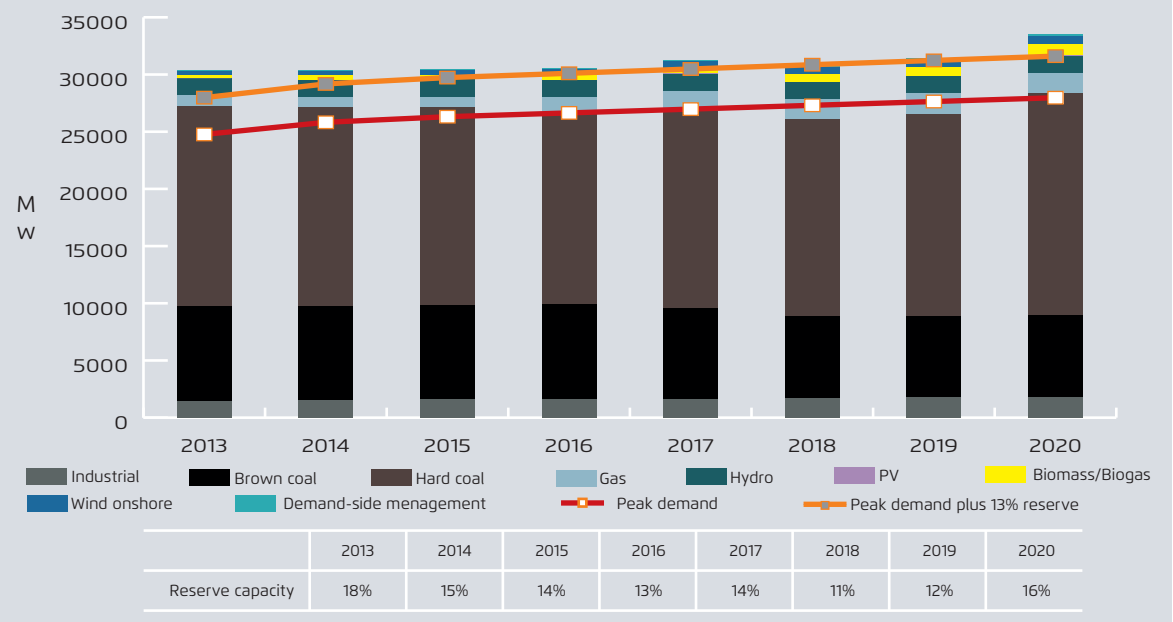
The resource adequacy standard used by the operator of the National Electricity System in Poland calls for a 13% capacity reserve margin. This means that in periods of peak power consumption during the year, available generation capacity should exceed the demand for power by 13%. (A lower level of reserves is required in some other European countries, e.g. in the United Kingdom and in Italy it is 10%). This indicator is currently at a conservative level of 13% excluding the non-spinning reserve (see Fig. 1a). Because of the need to decommission some older power generating units, the capacity reserves will decline to 8% in 2018, after which they will rise to 14% in 2020. This is the result of the commissioning of new units, in particular coal-fired units in Kozienice (950 MW), Jaworzno (950 MW) and Opole (1900 MW).

Fig. 1a Power balance on the National Electricity System up to 2020, not taking into account the cold reserve.



	2013	2014	2015	2016	2017	2018	2019	2020
Reserve capacity	18%	13%	11%	9%	10%	8%	9%	14%

Fig. 1b. Power balance on the National Electricity system up to 2020, taking into account the cold reserve.



	2013	2014	2015	2016	2017	2018	2019	2020
Reserve capacity	18%	15%	14%	13%	14%	11%	12%	16%

The decline in reserves is lower if the non-spinning reserve is taken into account. In that case, the level of reserves will decline to 11% in 2018, after which it will increase to 16% in 2020. This illustrates that, from the point of view of reliability of the National Electricity System, the decision made by PSE Operator S.A. to contract for a non-spinning reserve was effective, although keeping a higher reserve on the system is expensive.

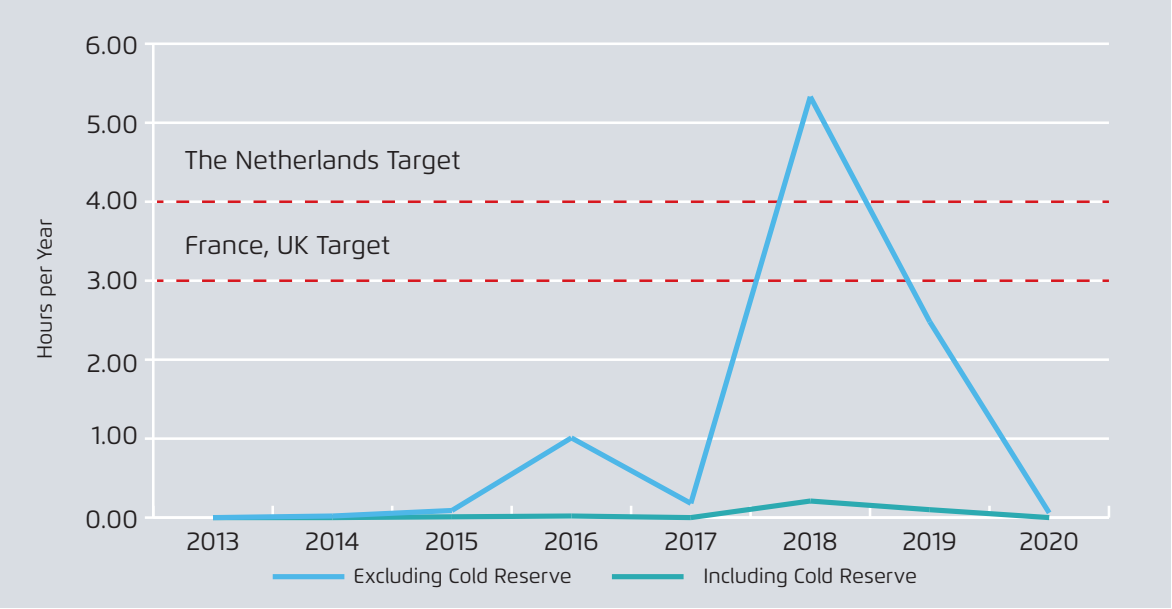
Risk of a power deficit up to 2020 according to the LOLE methodology

The current approach to the evaluation of resource adequacy in Poland and in several EU countries is based on the assumption that domestic demand for electricity is satisfied with domestic resources. As a result of the decision to integrate the energy markets, this trend is gradually changing and many countries are evaluating resource adequacy in a regional context, e.g. within the framework of the Pentalateral Energy Forum or the Nordic Grid. This recognizes that, in certain cases, a more effective solution is to cover the domestic power deficit from abroad instead of building new power generating capacity.

The probability that a resource deficit according to LOLE (Loss of Load Expectation) methodology will arise is a statistical measure, representing the expected number of hours in a year in which available capacity (excluding imports) is lower than electricity demand (see Figure 2). This results in an estimate of the risk of a capacity deficit.

- When the non-spinning reserve is not taken into account, in 2016, as well as in 2018 and 2019, the LOLE is calculated at 1.5, and 2 hours in a year. In 2020, the indicator drops to zero, after new units come online.
- When the non-spinning reserve is taken into account, LOLE drops to zero and domestic resources are estimated to fall short of domestic demand for just 12 minutes in 2018.

Fig. 2 Probability of a capacity deficit based on LOLE.



When comparing these results to standards adopted by France and the United Kingdom (LOLE of no higher than 3h/year) or the Netherlands (LOLE of no higher than 4h/year), it can be seen that when the non-spinning reserve is taken into account, the Polish electricity system meets these European standards with a high margin of security.

Power balance on the electricity system after 2020

Based on the discussion with the Panel of Experts, a number of trends are likely to affect the balance on the Polish power system after 2020:

- The implementation of the Industrial Emissions Directive is likely to result in the complete decommissioning of some of the older coal-fired units, while the upgraded units would operate at a higher marginal cost because of the use of expensive equipment and technologies to reduce toxic air emissions.
- Renewable energy will play an increasingly important role on the power system, diversifying the power mix and affecting the marginal unit in the merit order.
- The European Emission Trading System will enter into a new phase, which – with high probability – will reflect ambitious climate policy goals for 2020-30; the price of emission allowances will probably increase, and the allocation of free emission allowances among Polish energy producers may end. This will be a further cost factor, which is particularly severe for low-efficiency coal-fired units.
- Poland will continue along a path of increasing economic development, which will result in an increased demand for electricity, both from industry (which will manufacture more goods) and from households (which will be more affluent and, therefore, better equipped with household appliances and home electronics).

Key energy market parameters up to 2020

Over the coming years, Poland will import small amounts of electricity, but if the annual increase in demand for electricity is kept at a level of no more than 1.3 %, it will return to the position of a net electricity exporter after the units in Opole (1900 MW) and Jaworzno (950 MW) are commissioned in 2019-2020.

Wholesale prices of electricity will also stabilize at a level of EUR 36/MWh. This arises from the continuation of the trends in prior years, and assumes that there will be no structural incentives that would lead to rapid changes on the supply or demand side.

Recommendations

While there is no significant risk of a capacity shortfall on the Polish power system to 2020, a number of factors arising in the decade that follows will have an affect on the power system. Given the uncertainty over how these factors will influence resource adequacy, it would be prudent to:

1. Assess the influence of these factors on resource adequacy to 2030, and in particular:
   - Conduct studies on resource adequacy in the international (regional) context, taking into account interconnector capacity as a system resource
   - Apply economic indicators (e.g. the Value of Lost Load) to determine a level of system adequacy that balances the economic costs of increased outages with the cost of reducing the incidence of forced outages
2. Identify the most cost-effective mix of resources to meet system needs over time:
   - Create a full list of technically and economically available power resources (including those on the demand-side) and establish the timeframe for, and costs of, of activating these resources
   - Define the regulatory and financial incentives that are required to activate resource potential
   - Take into account the potential for demand side management. Even if the technical potential of DSM is not significant up to 2020, in the decade that follows DSM may be of key importance for minimizing the risk of a capacity deficit.

7. SUMMARY

Poland is facing the challenge of replacing old coal-fired units with new resources. This process will run smoothly up to 2020, as a result of investment projects in new coal-fired units in Kozienice, Opole and Jaworzno, gas-fired units in Stalowa Wola and Włocławek, and PSE S.A.'s contracts for non-spinning reserves and negawatts (settlements for voluntary curtailment). As a result, the risk of a power deficit arising up to 2020 is low.

After 2020, however, a number of factors are expected to impact the power system, including the continued ageing of the power infrastructure, the implementation of increasingly restrictive technical and environmental regulations, the increasing share of renewable resources (and in particular of wind) on the system, and increasing demand (including peak demand).

As a result of these developments, it is prudent to both carefully assess resource adequacy and system reliability (taking into account imports and the costs and benefits of different levels of reliability standards), and to identify a path to developing the lowest-cost mix of resources to meet system needs (including demand-side resources, which can be mobilized at lower cost and often more quickly than supply-side reserves).

These actions will be crucial to both properly assessing resource adequacy and system reliability, and to reducing the costs of load balancing.

The recommendations set forth in this document have been developed with the help of the Panel of Experts, who were invited to participate in the dialogue by the Forum for Energy Analysis. They do not, however, reflect the opinions of the Panel or of any of its individual members.

8. DEFINITIONS AND ABBREVIATIONS

ENTSO-E — European Network of Transmission System Operators for Electricity.

LOLE — Loss of Load Expectation. The expected number of hours in a year in which available capacity (excluding imports) is lower than electricity demand.

Merit Order — Dispatch of electrical generation in order from the least to the most expensive resource, based on the short-term marginal costs of production.

Nordic Grid — North Seas Countries' Offshore Grid Initiative. A regional initiative established by 10 countries with the goal of evaluating and facilitating coordinated development of a possible offshore grid that maximizes the efficient and economic use of renewable sources and infrastructure investments.

Pentalateral Energy Forum — A 5-country initiative involving Belgium, France, Holland, Luxembourg, and Germany, which has the objective of promoting collaboration on cross-border exchange of electricity.

Cold Reserve — Generating units that were planned to be decommissioned due to high operating costs, but as a result of contracts signed between PSE SA and energy companies, now constitute reserve capacity that can be activated by PSE SA in order to balance the electricity system.

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