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Power deficit in the Polish power system in August 2015 – comments of the Forum for Energy Analysis (Forum Analiz Energetycznych)

1. Description of the situation:

The heat wave which affected the whole country from the beginning of August, in combination with the hydrological conditions of the main rivers, resulted in deterioration of the operating conditions of power generation equipment and power networks in Poland. As a result, PSE SA (Polskie Sieci Elektroenergetyczne, the Transmission System Operator) imposed various levels of limitations of power supply for industrial consumers until the end of August. Such measures were taken for the first time in many years.

We present here a brief analysis of the situation, prepared by the Forum for Energy Analysis.

2. European context:

Extremely high temperatures have imposed pressure on domestic operators and on the power systems of most European countries. This pressure led to the need for additional balancing activities and generated additional costs, e.g. according to the calculations of the transmission system operator in Germany these costs amounted to 25 million EUR. The extent to which system operators have coped with the heat wave depended on 3 factors:

1) quality of cross-border interconnections and the ability to balance energy demand with energy supply from imports;
2) types of available energy sources – in most countries large thermal units faced the biggest problem;
3) quality of the transmission infrastructure.

Weather anomalies have been growing not only in Europe but also around the world, which is illustrated on the following chart. It can be reasonably assumed that the phenomena observed this summer will occur in the future as well.

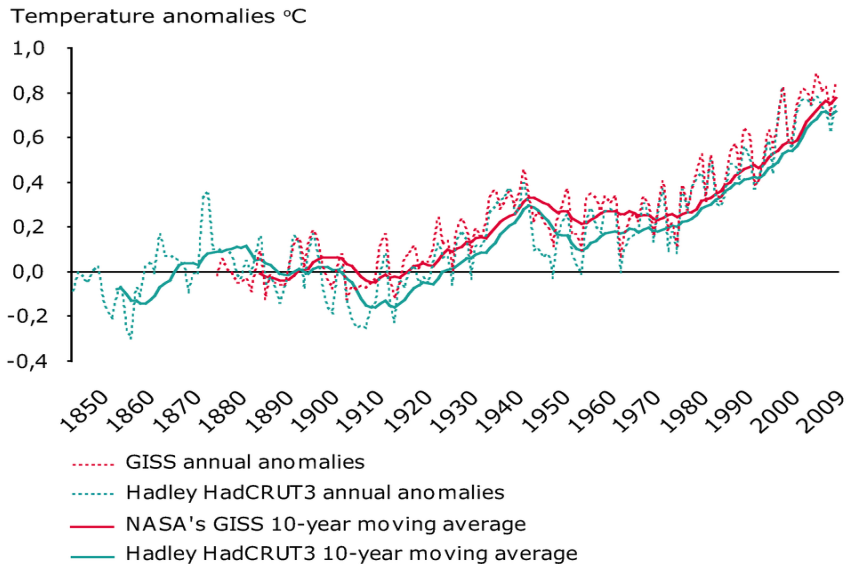

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Fig. 1. Average temperature deviations. Source: European Environmental Agency
http://www.eea.europa.eu/data-and-maps/indicators/global-and-european-temperature/global-and-european-temperature-assessment-3

3. Diagnosis of the situation in Poland

Energy demand:

a. The heat wave contributed to an increase in energy demand. In the summertime additional cooling equipment is put into operation in both industrial and retail facilities as well as in households. The power system load has increased to 22 GW and although this is less than the typical annual peak load, which occurs in wintertime (25-26 GW), it is more difficult to meet this peak demand due to smaller power resources available in the summer.
b. In the Polish power system the summer peak load occurs between 13:00 and 14:00 on working days. One of the reasons for increased electricity consumption during this period is the fact that multi-tiered tariffs for households (G12 and G12w) offer significantly reduced rates for energy distribution for about 15% of households between the hours of 13:00 and 15:00. This creates an incentive to increase consumption (e.g. by programming storage-type water heaters in single-family houses to automatically heat water).
c. PSE had at its disposal a little less than 200 MW of contracted emergency load shedding, i.e. demand management. This was only a fraction of what was really necessary and what was potentially available.

Energy supply:

d. In the Polish power system available capacity in summertime is always lower than in winter for the following reasons:
    i. combined heat and power plants are either shut down or operate at minimum load to provide domestic hot water;
    ii. approx. 30% of the power units are offline for maintenance and upgrades;
    iii. average wind speeds in summertime are lower than in wintertime, which results in lower capacity factors of wind farms in the summer as compared to the winter.
e. In conventional power plants with open-circuit cooling systems some power units had to be shut down or to operate at a reduced load due to cooling problems caused by low water levels in rivers and lakes and by high water temperatures. The primary cause of this phenomenon was the long-lasting heat wave and lack of precipitation.
f. At the crucial moment a failure occurred in the largest Polish power plant in Bełchatów, resulting in its disconnection from the power system. This was the direct cause of the limitations of power supply at 20th degree[1].
g. The operating power reserve did not help to bring the difficult situation in the

[1] Polish legislation foresee 10 degrees of limitations of power supplies to energy consumers, i.e. between 11 and 20, where 20th degree is the most restrictive, in particular:
11th degree determines that customer is allowed to consume power to the maximum amount of contracted power (i.e. power level contracted in agreement with distributor), which in practice means no limitations,
20th degree determines that customer is allowed to consume power to the amount of the agreed minimum enabling maintaining the human safety and preventing damaging or destroying technological facilities (http://www.pse.pl/index.php?dzid=32&did=2516).

power system under control. This fact was due to its structure –the operating reserve is composed of the residual or unused capacity of plants that are already in operation. The reduction in load factor caused by climatic and technical restrictions first and foremost manifested itself as a lack of capacity available to the system. The operating reserve did not contribute to making additional capacity available to the transmission system operator, but rather offered remuneration to resources that were already available to the system. There was no guarantee / commitment by the power generating entities that additional capacity would be reliably available in case of excessive load on the power system. In the year 2014 PSE spent 560 million PLN for the operating reserve, but did not obtain in exchange an improvement in the operating reliability of the power system when it was needed this year.

Cross-border networks and connections:

a. Poland has one of the most isolated power systems in the European Union and, as a result, can cover only 2% of its energy demand with imports.

Interconnection levels for electricity in 2014

Member State	
Member States above 10% interconnection	
AT	29%
BE	17%
BG	11%
CZ	17%
DE	10%
DK	44%
FI	30%
FR	10%
GR	11%
HR	69%
HU	29%
LU	245%
NL	17%
SI	65%
SE	26%
SK	61%
Member States below 10% interconnection	
IE	9%
IT	7%
RO	7%
PT	7%
EE[4]	4%
LT[4]	4%
LV[4]	4%
UK	6%
ES	3%
PL	2%
CY	0%
MT	0%

Source: ENTSO-E, Scenario Outlook and Adequacy Forecast 2014

b. Disturbances in energy flows in the region were caused by a failure in the large nuclear power plant in Temelin, Czech Republic. This resulted in the outflow of energy from the Polish power system to its southern neighbor.
c. At the same time, in Germany there was an energy surplus (owing to the operation of photovoltaic systems, which exceed 24 GW in installed capacity), but the existing cross-border connections with Germany were used to a very limited extent. Significant penetration of photovoltaic power would provide an automatic

safety buffer in the case of heat waves, which have an impact on the cooling systems of all thermal power plants (oil-, gas- and coal-fired, and nuclear).

d. High air temperatures heated power lines, which reduced their transmission capability due to higher resistance. Such factors make effective usage of power generating capacities more difficult, because energy transmission from regions with a power surplus to ones with a power deficit (e.g. to a large city centers) is more difficult.
e. The reactive power imbalance in the system, caused by putting many additional motors into operation (e.g. in air conditioning systems and air conditioners) makes supplying active energy more difficult.

Summary and conclusions:

The power deficit was caused by a combination of several factors: high temperatures, technical failures, cooling problems in coal-fired power plants and very limited possibilities for energy imports from abroad.

a. Preparing for high temperatures

As a result of global warming and successive temperature records one should expect that the problem of extremely high temperatures will become more and more serious. Therefore, changes to the power system should be initiated, aimed at cost-effective adaptations to face this challenge.

b. Diversifying generation

The risk to the power system is reduced, when the generation profile is diversified, and therefore has resources which are capable of providing power under various constraints. For example, PV provides the most energy in summer, especially when it is very hot.
In the case of heat waves, the development of thermal power plants is the least effective way to ensure reliable power supply to the Polish power system, which is already highly homogeneous. The failures of large power units in Bełchatów and in Temelin (Czech Republic) significantly deepened the crisis. In this context an increase in the share of distributed energy sources should be considered in order to avoid similar situations in the future.

c. Improved usage of cross-border interconnections

Inability to import energy from abroad – the only countries neighboring Poland with surplus power were Germany (from whom imports were not possible) and Scandinavia (with whom Poland fully used the 600 MW of available import capacity along the interconnector with Sweden). Due to the lack of coordination surrounding uncontrolled loop flows, Poland could not import energy across most interconnectors. Poland tried to import energy from the Czech Republic and Ukraine but there was no available surplus power at that time. Solving the problem of uncontrolled loop flows, improvement of energy trade with Germany, as well as improved interconnections with Scandinavia should be priority issues, especially in

view of the high share of PV power sources in Germany.

d. Introduction of a mechanism for "demand response" (DR)

Controlled load reduction through demand response is an effective measure which is underutilized in Poland. Other countries' experience shows that it is possible to reduce more than 10% of the peak energy demand in a controlled and effective manner by introduction of "demand response." For example, the transmission system operator can enroll - in advance – volunteers to participate in a demand resonse program in exchange for compensation for their readiness to reduce demand when called upon, selecting the lowest-cost offers. The costs of reduction of energy demand are not equal in the industrial sector and in the retail sector – some entities can reduce their power consumption at lower cost than others. For example, there is a difference in the cost of reducing operation of air conditioning systems or food chilling equipment.

e. **A more effective reserve**

Despite the high level of the reserves in Poland (amounting to approx. 13%) it turned out that not only the level of reserves is important, but first and foremost the operational capabilities of the reserves, that is, the ability to deploy within a short time.
The heat wave was forecast in advance. The system operator should have taken appropriate steps, based on these forecasts, to switch on additional power units in the system and to coordinate with neighboring system operators to improve cross-border exchanges.

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