Worry about Operating Reserves in Europe

"The day when electricity became scarce in Germany"

On 13 January 2019, the German newspaper, Frankfurter Algemeine Zeitung (FAZ), had a story about lack of electricity in Germany on 14 December 2018.


Frankfurter Allgemeine
Wirtschaft
F.A.Z.-INDEX 2.158,77 +0,05 % DAX 11.180,66 +0,07 % EUR/USD 1,1457 +0,09 % DOW JONES 25.063,89 -- ALLE KURSE
SOLAR- UND WINDKRAFT
Der Tag, an dem der Strom knapp wurde
VON ANDREAS MIHM , BERLIN - AKTUALISIERT AM 13.01.2019 - 20:16

Fig. 1 - "The day, when electricity became scarce"

The substance of the story was that 2500 MW production was missing, and that further import was impossible. Therefore, 1025 MW industrial consumption was curtailed in order to maintain operational reserves. The industrial consumers pay reduced rates in return for being part of the interruptible load. Therefore, this was not a real emergency, but just a normal dispatch of available resources. According to FAZ, such load curtailments affected the aluminium industry 78 times in 2018.

The frequency of load shedding annoys the industry.

FAZ explains the dilemma. The transmission system operators (TSOs) must mobilize necessary production reserves one day ahead. Reserve capacity is expensive. Therefore, it is important to have reliable forecasts. A lot of research has been made in forecasting demand, wind power and solar power, but the forecasts can have large errors.

Errors in solar power forecasts

German solar power output can be up to 8000 MW lower than expected on days with low stratus (German: Hochnebel). This seems not to be generally known. On the predictability of solar power, Fraunhofer concludes in a recent report[1]:

> *"Because PV power generation is decentralized, regional changes in cloud cover do not lead to serious fluctuations in PV power production throughout Germany as a whole."*

Tennet DE (one of four German system operators) has published expected and measured data[2] (fig. 2). Additional dispatchable reserves could have been ordered the previous day, but idle reserve capacity is more expensive than curtailing industrial load.

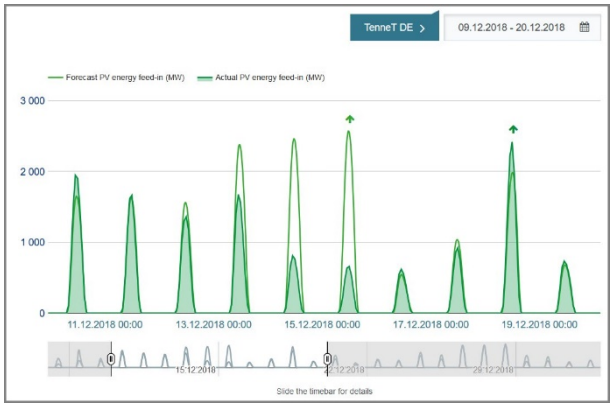

Fig. 2 - Overestimated solar power in December 2018

Industry representatives do not agree. The increasing number of curtailments has turned into a problem. The Association of German Industry (BDI) is concerned about the situation after 2022, when the last nuclear power plant has been shut down. The industrial losses are increasing and the compensations are far from sufficient. Therefore, BDI calls for a law reform.

[1] Recent Facts about Photovoltaics in Germany, Fraunhofer ISE, October 25, 2018
[2] https://www.tennet.eu/e-insights/energy-transition/day-ahead-generation-forecast-actuals-solar/

"Close to blackout, Germany (nearly) without power"

This headline was presented by EIKE (Europäisches Institut für Klima und Energie e.V.[3]) on its homepage on 22 January 2019. It refers to a drop in the continental frequency on 10 January 2019 at around 21.00. The source of the story was the Austrian newspaper Der Standard from 15 January 2019.

ENTSO-E (the European Network of Transmission System Operators for Electricity) confirms the frequency drop. The lowest frequency was 49.8 Hz. Most worrying is that nobody knows the causes of the drop. They are under investigation, says ENTSO-E and concludes:

> *"The frequency drop was sufficient to alert the TSOs but did not at any moment endanger security of supply."*

Missing nuclear production

In the autumn of 2018, six of seven nuclear reactors in Belgium were shut down for repair. The nuclear production was 40 TWh in 2017 and 27 TWh in 2018, and the load factor went down from 78% to 62%. Electricity supply depended heavily on import from France and Netherlands, and there was concern about electricity shortage[4]. In 2018, Belgium had to import 19 TWh or about 23% of the consumption.

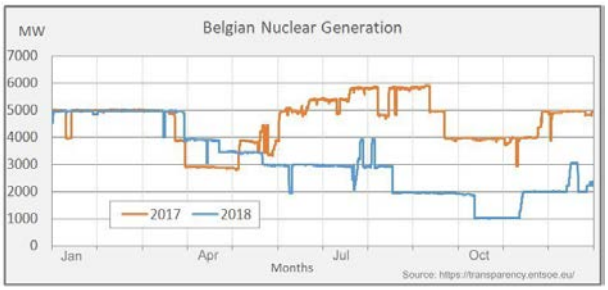

Fig. 3 – Shutdown of Belgian nuclear units in 2018

In the autumn of 2017, France had some reactors shut down. The difference between 2017 and 2018 was 14 TWh or the same magnitude as in Belgium. Due to the much larger French nuclear fleet, the load factor was practically the same (76% in 2017 and 77% in 2018).

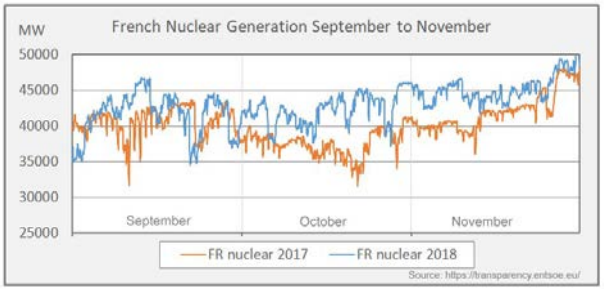

Fig. 4 - About 5 GW nuclear shutdown in France in 2017

Security concerns about nuclear facilities may lead to shutdown of a number of units in different countries at the same time. Such shutdowns could exhaust the European capacity reserves. The cases also demonstrate that small countries with large generators must rely on foreign reserves.

The end of Sweden's traditional self-sufficiency

The Swedish TSO, Svenska Kraftnät, expects an increasing capacity shortage for the annual peak hour for the coming years. A report from 2018[5] has some clear messages.

Extracts from the summary (my translation):

- *The analysis of upcoming winter shows that the capacity balance has deteriorated further compared to previous reports.*

[3] https://www.eike-klima-energie.eu/about-us/
[4] https://www.theguardian.com/world/2018/oct/30/belgium-energy-crisis-nuclear-reactors-shut-down-electricity
[5] Kraftbalansen på den svenska elmarknaden, Rapport 2018, Svenska Kraftnät, 2018-06-28

- *This implies that Sweden will be more dependent on import.*
- *However, Svenska Kraftnät recognizes a risk that flexible electricity production and flexible demand cannot be developed because the profitability of these measures still seems to be low.*

The power deficit during peak hours in a normal winter is expected to be 400 MW this winter and 2500 MW already in 2020/2021 (fig. 5).

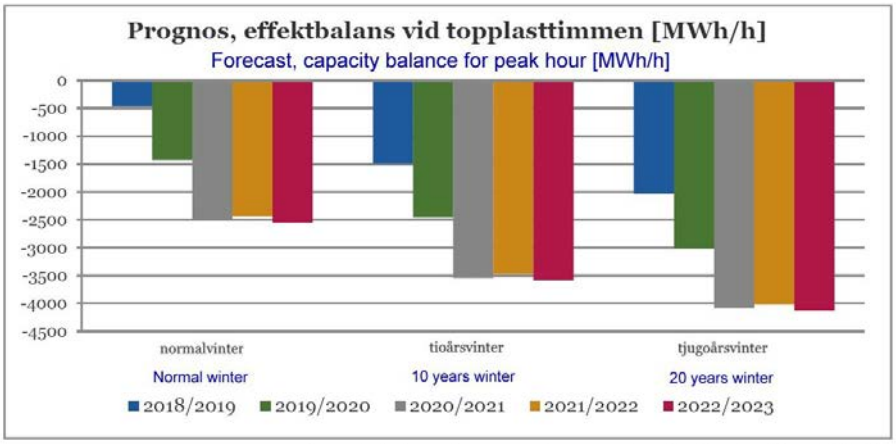

Fig. 5 - Expected peak hour capacity balances in Sweden 2018 to 2022

Sweden is interconnected with six neighbouring countries. The aggregated import capacity is 10.3 GW, but the available foreign support depends on excess production capacity in the neighbouring countries during the peak hour.

The full conclusion (my translation):
One of the most important conclusions in Svenska Kraftnät's long-term analyses is that there is still a risk that poor profitability will prevent the development of dispatchable electricity production. Electricity prices seem to remain low until the nuclear capacity has been closed down. This implies problems for the installation of other electricity production in time for replacement of the nuclear power. Analyses show that phasing out of nuclear power will cause a large number of hours with very high market prices and several hours, when it will be difficult to balance supply and demand. This demonstrates the need for additional dispatchable electricity production and demand flexibility.
Increasing shortage of capacity implies need for larger import. Therefore, it cannot be excluded that trading capacities must be increased. However, import can only contribute to preventing capacity shortage if neighbouring countries do not have their own deficits.

The concern about the future security of supply is increasingly reflected in public Swedish media such as newspapers and websites such as https://second-opinion.se/.

ENTSO-E's Mid-term Adequacy Forecast (MAF)

ENTSO-E is the European Network of Transmission System Operators for Electricity. ENTSO-E makes and publishes analyses of performances and perspectives for European power systems. The Mid-term Adequacy Forecast 2018[6] calculates for each country the risk of shortage of power in 2020 and 2025.

Advanced probabilistic methods are used for the calculation of LOLE (Loss of Load Expectation) in hours per year.

The results show satisfactory adequacy for all countries in 2020.

[6] https://www.entsoe.eu/outlooks/midterm/

For the base case 2025, a certain deterioration since 2020 is expected, but the level is not alarming.

A sensitivity test for 2025 assumes that power plants with high carbon emissions have been phased out before 2025. The case is called “Low carbon sensitivity 2025”.

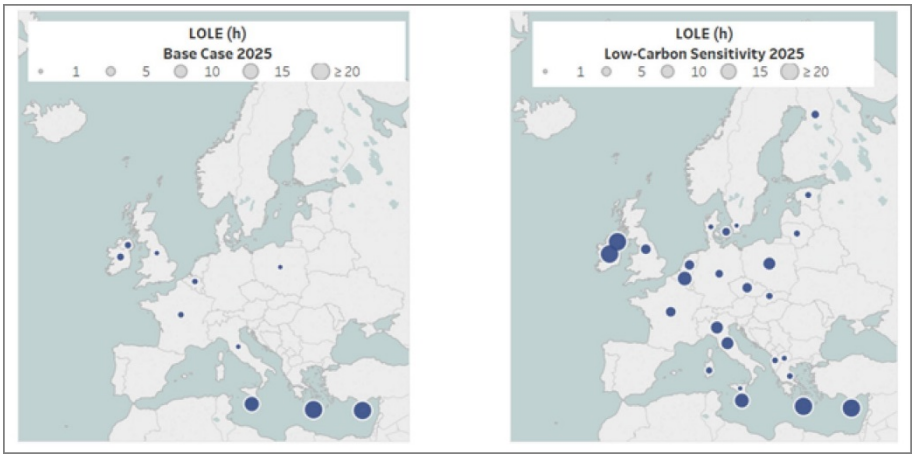

Fig. 6 - Phasing out 23 GW before 2025 will increase risk of power shortage

In fig. 6, bullet sizes illustrate LOLE (hours per year) in base case and low carbon sensitivity.

Calculations for island systems are sensitive to modelling assumptions and should be used with care. Some countries with high dependence on carbon-intensive electricity production will have an increased risk of power shortage in the low-carbon case.

In spite of the increasing LOLE from 2020 to 2025, the power adequacy still seems to be satisfactory for the interconnected European system. The condition is an efficient international coordination of electricity trade, transmission, system control and production.

In many cases, real cross-border capacities are much lower than the nominal capacities. It is important that realistic capacities be used in the calculations. Otherwise, the results can be misleading.

Is the worry justified?

There is no doubt that the reserve capacity in Europe will have a slightly decreasing trend from 2020 to 2025, but the risk level will still be satisfactory in 2025 according to ENTSO-E. The condition is a perfectly balanced development of trading systems, transmission systems, power system control and backup power.

Most European countries will be increasingly dependent on foreign support. A trustful international cooperation will be decisive. In some cases, system operators have limited exchange of power in order to protect national interests. If such measures prevail, the risk of power shortage in some countries can be much higher than estimated by ENTSO-E.