Germany will depend on imported gas for decades

European electricity supply has experienced two large transitions since the 1980s. The first one was the liberalization. The result was the European wholesale markets combined with local retail markets. The second transition is the ongoing reduction of greenhouse gas (GHG) emissions, the green transition.

The current price increases are results of both transitions. After the oil crises in the 1970s it was important for most electricity suppliers to exercise a fuel policy, which could smooth out fuel price variations. Stable prices were considered to be part of security of supply.

Nobody has such responsibility or intention after the liberalization of trade with electricity.

Wind and solar power have become main efforts in the green transition. Wind and solar power are fluctuating. They need additional measures such as backup capacity or energy storages to guarantee stable supplies for the electricity consumers.

The results are volatile wholesale prices in the electricity markets.

Germany sets electricity price levels in parts of Europe

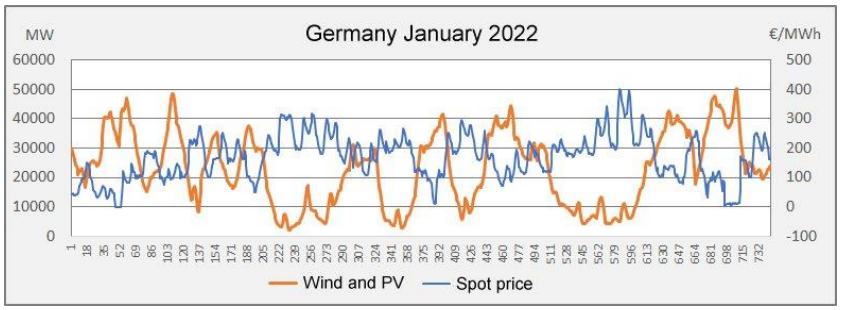

Fig. 1 – The spot price has both a daily cycle and a variation with wind and solar power.

Germany	
Wind and PV	Spot price
	Correlation
January 2022	-0,73
February 2022	-0,73
March 2022	-0,58
April 2022	-0,70
May 2022	-0,71
June 2022	-0,45
July 2022	-0,57
Total	-0,60

Table 1 – DE correlation coefficients

Market prices for electricity in Germany are oscillating in counterphase with wind and solar power (fig. 1). The correlation coefficients confirm the interdependence between the fluctuating production and the spot prices, month by month (table 1).

The covariation of wind/solar power and spot price can also be demonstrated graphically. Fig. 2 includes the first seven months of 2022.

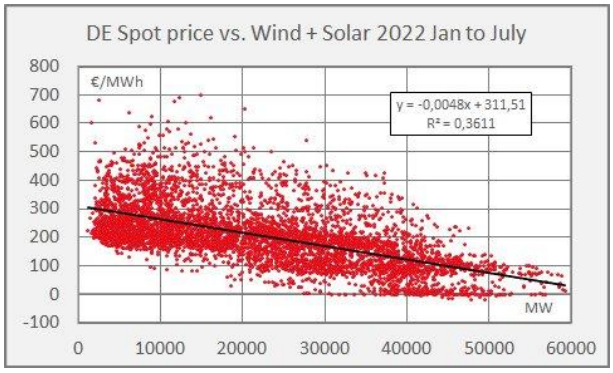

Fig. 2 – Market prices from below zero and up to 700 €/MWh have occurred in Germany in 2022

The month of July looks more confusing (fig. 3). However, counter variation of production

and price is still clear. The solar power output dominates the profile of wind plus solar output. The production in July was 7.2 TWh from wind power and 7.9 TWh from solar panels.

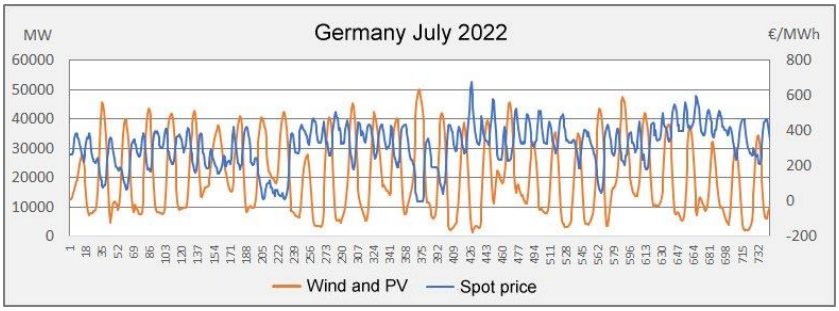

Fig. 3 - Both renewable production and spot prices have diurnal cycles

Market prices must have large variations to initiate balancing measures

The spot price is a marginal price, which is set by the most expensive supply bid. The German backup for low wind periods is changing from coal fired units to gas fired units. The booming prices of natural gas cause high spot prices during calm periods. The result is high price volatility in the wholesale markets.

Other balancing tools than gas fired power stations have been discussed for decades, such as batteries, pump storage, hot water storage and PTX. So far, none of these facilities are available in sufficient scale for a significant effect at European level.

The profitable operation of each of these technologies will depend on price variations. Large price variations will invite more investments in new balancing technologies and may reduce the dependence on Russian gas.

No matter what, the combined effect of the electricity market and the green transition will be a volatile spot electricity market with high average prices. Balancing fluctuating electricity production will be expensive for electricity consumers in the future.

Electricity production in Germany

In January to July 2017 the largest sources of electricity in Germany were distributed as shown in fig. 4.

Besides wind and solar, natural gas has increased its share of the production significantly.

In 2017, 78% of the electricity demand was covered by dispatchable power plants. In 2022, this value was reduced to 60%. The composition of this group of power stations will change. Germany has decided to phase out nuclear units, lignite units and coal units. Gas fired units will be the backbone of the necessary backup and balancing capacity.

7 months	2017	2022
lignite	26,5%	20,3%
wind	18,6%	26,4%
coal	13,8%	11,7%
nuclear	13,0%	6,4%
pv	8,6%	12,8%
biomass	8,0%	7,2%
gas	3,6%	10,3%

Fig. 4 – Share of German electricity production by fuel

A simulation has shown that **gas fired units will supply 27% of the electricity demand and be price setting in 72% of the hours in 2040**. The market price of natural

gas will set the market price of electricity in Germany and its neighbouring countries for decades.

Fig. 5 and 6 illustrate the increasing influence of wind and solar power on system operation from 2017 to 2022.

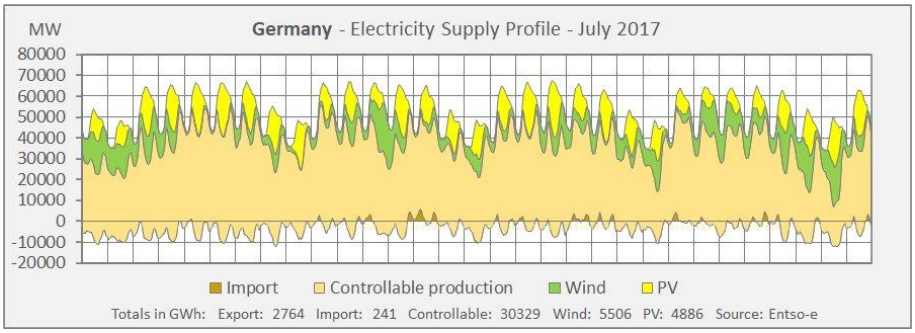

Fig. 5 - Dispatchable units made the balancing work in 2017

Fig. 6 demonstrates the magnitude of balancing work in Germany in July 2022. This group of units had to regulate production down and up by 20-30 GW within the same 24 hours.

Battery solutions and PTX[1] are supposed to contribute with regulating capacity. These solutions will adopt prices from the gas market or set their own higher prices. They will probably not be able to reduce the dominating role of natural gas or LNG within the next many years.

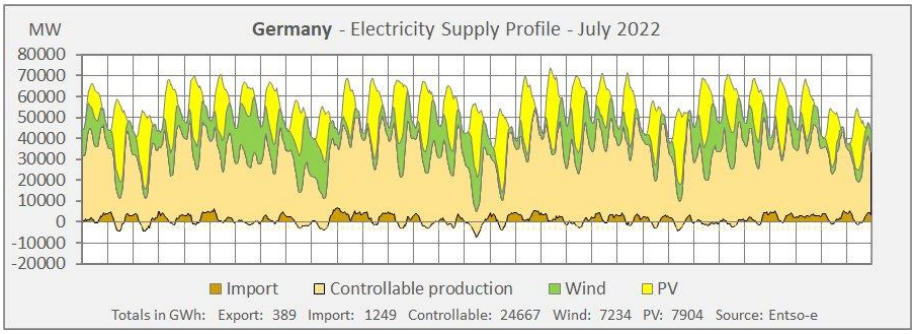

Fig. 6 - The balancing work has increased significantly since 2017

Gas fired units are well suited for flexible operations, but the dependence on such units will make the way to a fossil free future very long.

Spot prices and operating patterns in Denmark

Spot prices for West Denmark have the same pattern as in Germany. The variations are in counter phase with the wind power (fig. 7).This is confirmed by the correlation coefficients (fig. 8).

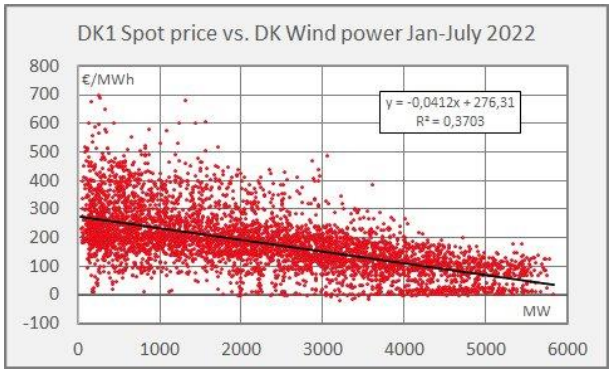

Fig. 7 - Danish spot prices are related to the German market

Denmark	
Wind power	Spot price
	Correlation
January 2022	-0,66
February 2022	-0,66
March 2022	-0,62
April 2022	-0,59
May 2022	-0,60
June 2022	-0,36
July 2022	-0,63
Total	-0,66

Fig. 8 - DK correlation coefficients

[1] PTX: Power to X

The share of wind power is larger in Denmark than in Germany. Therefore, the need for balancing capacity is relatively higher in Denmark. Most of the balancing capacity in Denmark is provided by exchange with neighbouring countries. Increasing problems in these countries may reduce this option and make it more expensive. Denmark is preparing the installation of special balancing facilities, called energy islands. The question is if these facilities will be operational in due time and with sufficient capacity.

In July 2022, Denmark imported up to 2.2 GW and exported up to 2.5 GW.

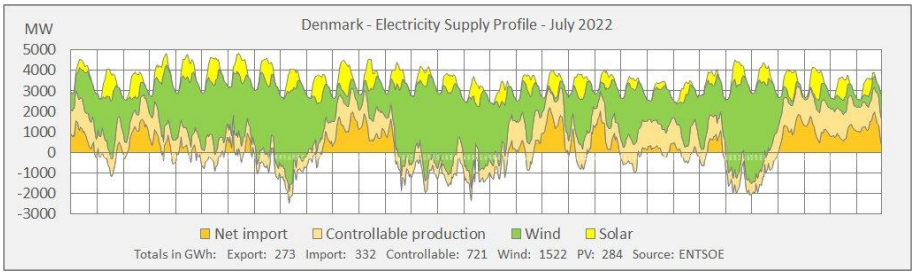

Fig. 9 - Danish controllable units perform only a minor share of the balancing work

The average market value of import was 241 €/MWh and for export only 104 €/MWh.

These values show that balancing by exchanging power with neighbouring countries is quite expensive (fig. 10).

Based on market values, 2.6 TWh were purchased abroad for mill. € 626, while 2.2 TWh were sold for only mill. € 226. The question is if new Danish balancing measures could do the same work for less than mill. € 400.

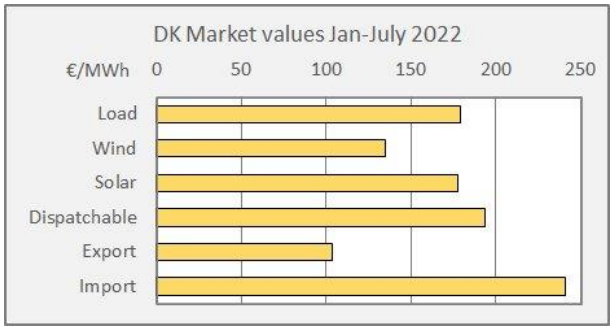

Fig. 10 - Dispatchable production has higher market value than wind and solar energy

Main conclusions

- The European fleet of wind and solar power plants needs a significant capacity of flexible facilities for balancing
- Dispatchable units in Germany are currently delivering an important part of the necessary balancing work.
- Denmark has so far covered most of its need for balancing services by import.
- The Danish balancing policy has been quite expensive in 2022.
- The need for balancing services will increase, while the capacity of dispatchable units is decreasing due to decommission of traditional power stations.
- After decommission of nuclear units and stop for use of coal and lignite, most of Germany's dispatchable capacity will be gas fired.
- Germany will depend on import of large quantities of gas in the foreseeable future.
- The future spot prices of electricity will be set by gas fired units in most hours.
- Additional wind and solar power plants will not reduce Europe's dependence on imported gas.
- The combined result of liberalization and green transition is that high prices of gas and electricity have come to stay.