Changed European power flows from 2019 to 2020

All European countries have large exchanges of electricity with their neighbouring countries. My report for 2019 demonstrated congestion problems all over Europe. A large number of tables presented the details.

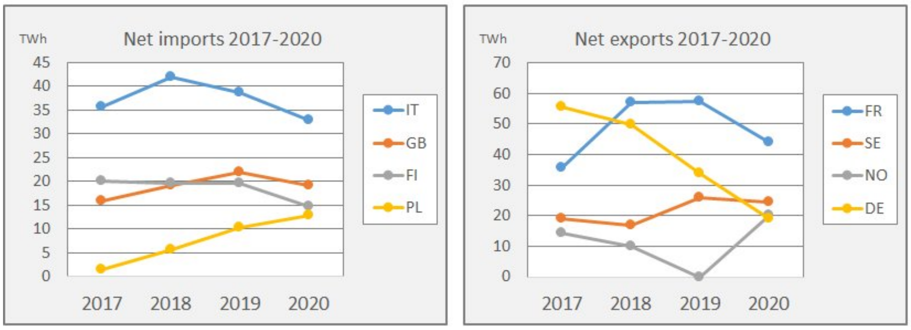

Fig. 1 - Net exchanges 2017-2020 for selected countries

This paper about 2020 will show the usual maps of European and Nordic net exchanges. The tables are replaced by duration curves to demonstrate the variation of hourly exchanges for some selected countries. Each country has a significant range from the year's maximum import to the year's maximum export.

Some countries such as Italy, Finland and Great Britain had considerable electricity imports throughout the years 2017 to 2020 (fig. 1). The electricity import to Poland for unknown reasons had a remarkable increasing trend.

Electricity export from France was high for the years concerned, while export from Germany was steadily decreasing. This trend is likely to continue due to the continued close down of Germen nuclear power plants.

Export from Norway varies from year to year, probably depending on inflow of water to the hydro systems.

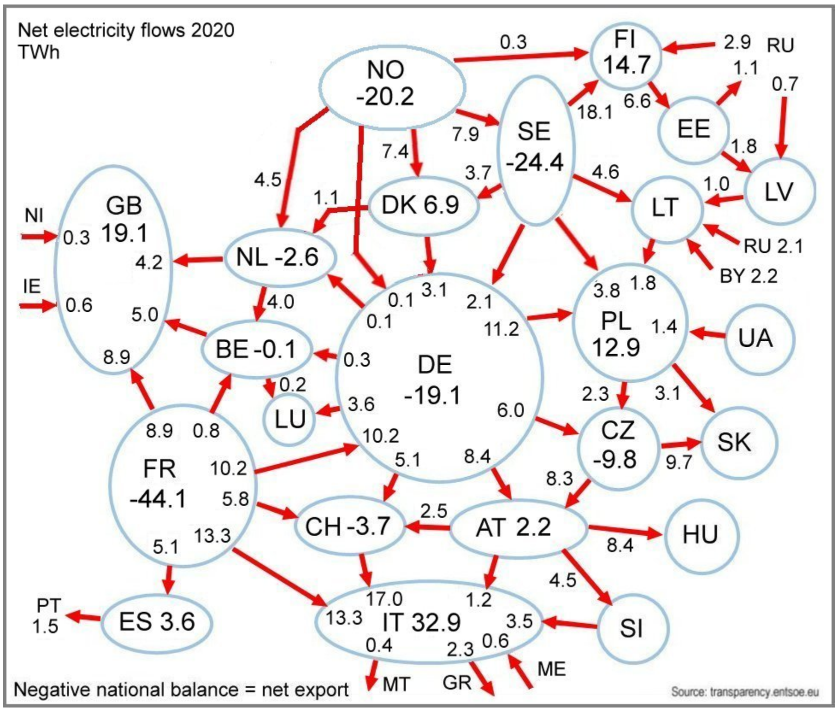

Fig. 2 - New interconnections have been added since 2019

Users of previous year's diagrams have rightly said that net flows do not show the full story. A zero-flow is not the same as poor utilisation of a line. However, fig. 2 is a compromise between clarity and complexity.

Total traffic across borders is much larger than the net exchanges

The duration curve for Germany's hourly net exchanges in 2020 (fig. 3) demonstrates visually that total exchanges can be much larger than net exchange. The net import area is above the axis. The larger export area is below the axis. The difference is the **19 TWh** net export in fig. 2. The 34 TWh import and 53 TWh export make an **87 TWh** total exchange or more than four times the net exchange.

The "range" or "variation" is the distance from top to bottom of the duration curve. For Germany, it was 30 GW in 2020. Transit has no influence on the range of exchanges.

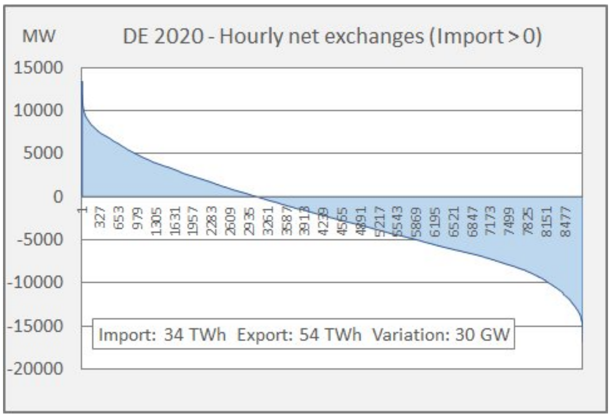

Fig. 3 - Duration curve for German exchanges in 2020

Fig. 4 to 11 show a selection of different duration curves.

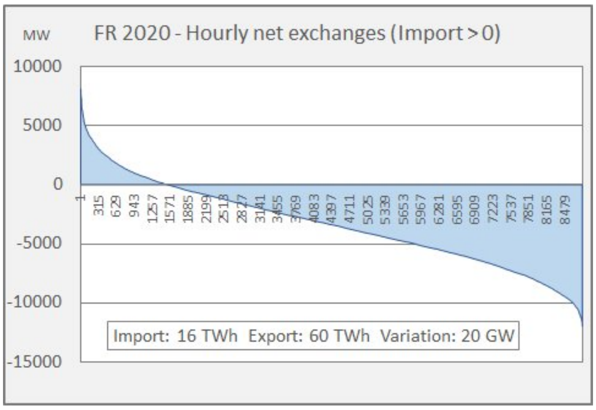

Fig. 4 - France had a large range from the extreme import to the extreme export (20 GW or 24%)

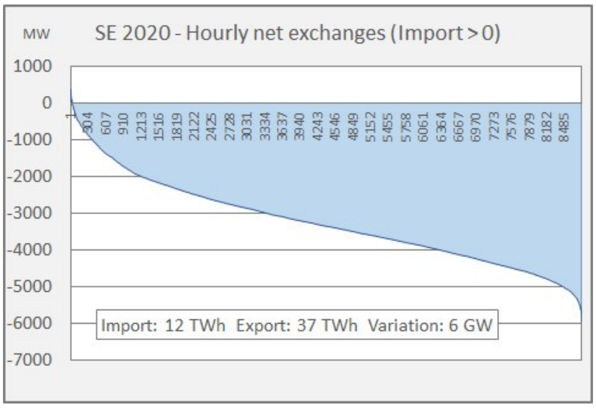

Fig. 5 - Sweden had practically no net import in 2020. The 12 TWh import was transit.

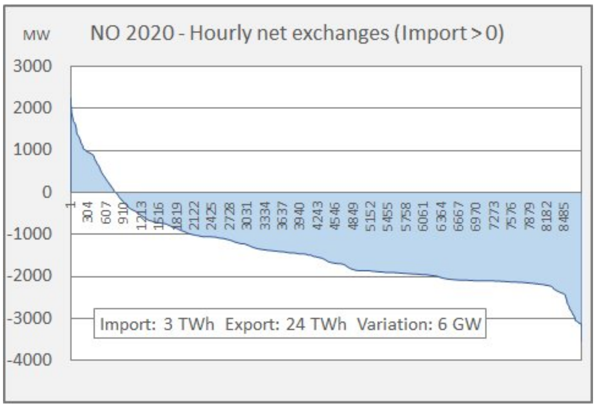

Fig. 6 - Norway

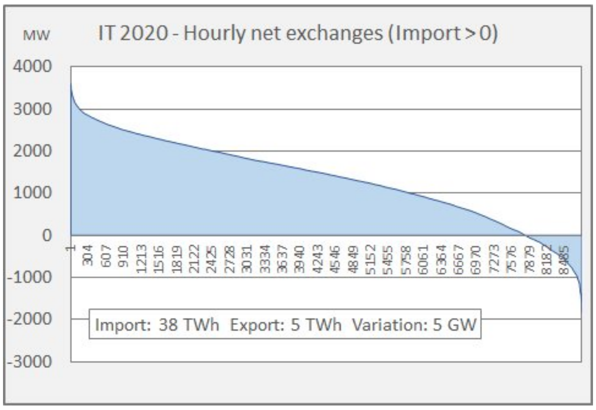

Fig. 7 – Italy – Europe's largest electricity importer

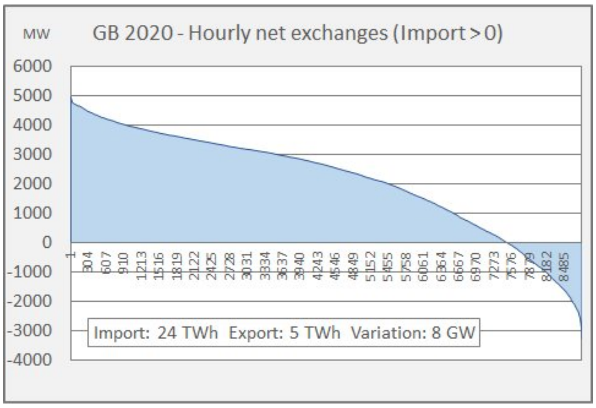

Fig. 8 - Great Britain

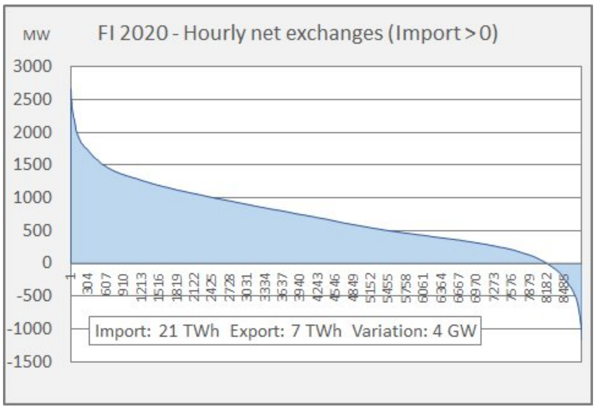

Fig. 9 - Finland

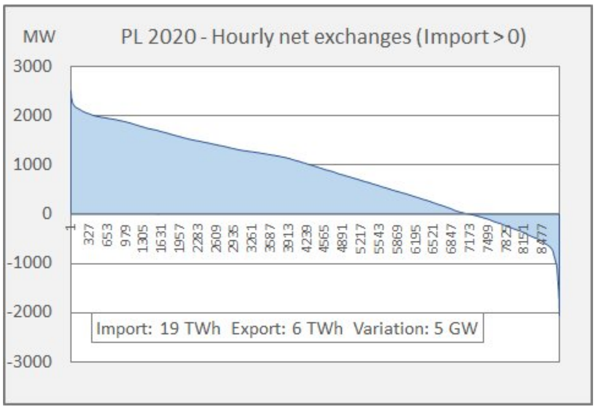

Fig. 10 - Poland

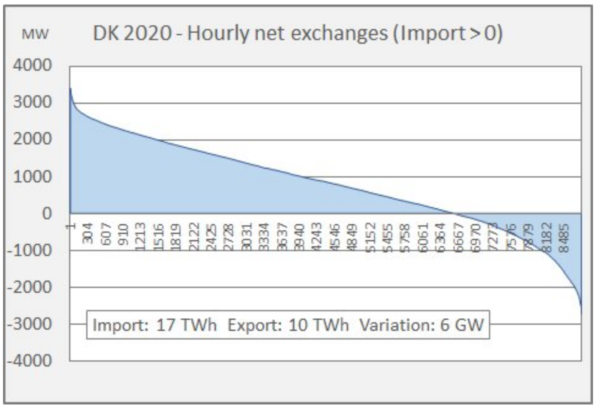

Fig. 11 – Denmark: Variation = 105% of max load

Denmark's electricity supply depends on foreign support

Each power system is a mixture of more or less flexible production units:

- Hydro units with water reservoirs are very flexible, even during emergencies
- Traditional thermal power stations are dispatchable and have good load-following properties
- Hydro units without reservoirs (run-of-river) have a steady production, but with limited flexibility
- Solar power fluctuates from zero to full production on a daily basis and quite predictable
- Wind power fluctuates randomly and with limited predictability

Electricity consumption varies on a daily basis. The production system must have some flexibility in order to meet the demand for electricity every second.

Fig. 12 shows the range of hourly net exchanges as percentage of the maximum demand for nine countries. For most countries, the magnitude of variations during 2020 was about 20%. Only Denmark had much larger variations.

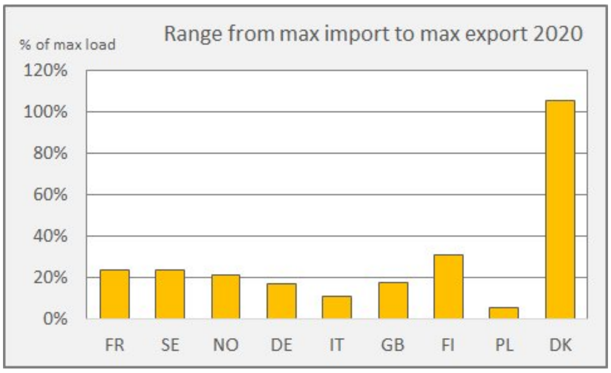

Fig. 12 - Relative ranges of net exchange variations

The electricity markets allocate electricity production including regulating power to the cheapest suppliers. The results can be large exchanges of power.

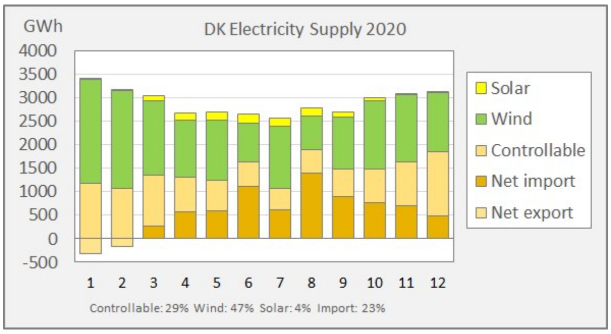

Fig. 13 - Denmark has a large net import of electricity, particularly during the summer season

Some main reasons for the large Danish variations are:

- A high share of fluctuating and non-dispatchable power production, primarily wind power, requires balancing resources to equalize the variations.
- Combined heat and power (CHP) systems have electricity production, which is cheap during the winter season. This production is replaced by import in the summer.
- Dispatchable power plants have been decommissioned. Denmark has no longer production capacity for covering its electricity demand under all circumstances.

Interconnectors to neighbouring counties are important resources for providing foreign balancing power, but only if such resources are available elsewhere, and the power grids have sufficient transfer capabilities.

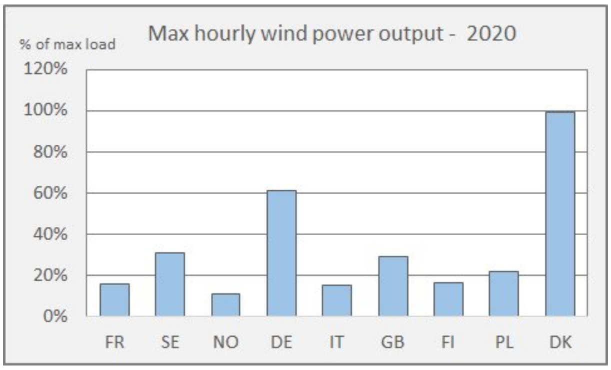

Fig. 14 - Relative maximum wind power output

The share of wind power is growing in most European countries. It takes additional grid capacity to utilize the wind power peaks and to fill the gaps during calm periods. There are already congestion problems in some countries.

Germany has the second largest share of wind power in fig. 14. This is not reflected in the range of net exchanges in fig. 12. Therefore, Germany seems to provide relatively more balancing work than Denmark.

Nordic grids stressed to capacity limits in 2020

The Nordic grids had an increased exchange of power from 2019 to 2020. Fig. 15 shows the exchanges between Nordpool price zones in 2019 and 2020.

The conditions in the summer of 2020 have been described in a previous note[1]. Among the results were extreme spot price differences and lack of reactive power. A combination of circumstances created the problems:

- A surplus of power in Norway due to higher inflow of water
- Cable faults on HVDC interconnectors
- Closedown of a Swedish nuclear unit, Ringhals 2
- Swedish expansion of wind power in the northern part of Sweden combined with a better “wind year” in 2020 than in 2019

[1] http://pfbach.dk/firma_pfb/references/pfb_challenging_summer_for_nordic_power_systems_2020_10_11.pdf

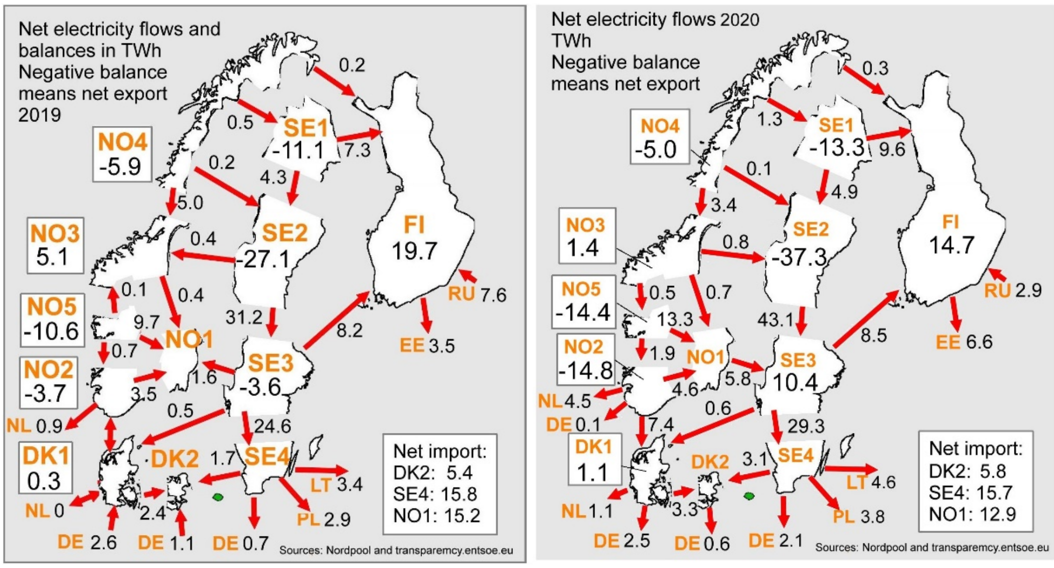

Fig. 15 - Remarkably increased exchanges from 2019 to 2020

This combination has apparently not been envisaged in the grid planning. Planners cannot predict all combinations. However, this is a poor excuse, because a resilient power system is supposed to be the result of a thorough planning process.

Wind power has a lower average utilization than controllable power. The consequence is that it takes more transmission capacity to move a GWh wind energy from the production sites to the demand centres. This fact seems to be ignored in the grid planning in several countries.

The construction of large power lines takes much more time than installing wind turbines. Therefore, it is working uphill to expand the power grids in order to catch up with the wind power expansion.