Nordpool Supply and Demand Curves

Textbooks on economy often explain their theories by simplified supply and demand curves (fig. 1). Real curves are useful for analyses of interesting cases.

Fig. 1 – Example from Nordpool's homepage

Nordpool's website has a page with System Price Curve Data:

https://www.nordpoolgroup.com/elspot-price-curves/

The curves represent supply and demand in the Nordic day-ahead electricity spot market, including Norway, Sweden, Finland, Denmark, Estonia, Latvia and Lithuania.

First step is to select a month. It is possible to choose any month since July 2014 (fig. 2).

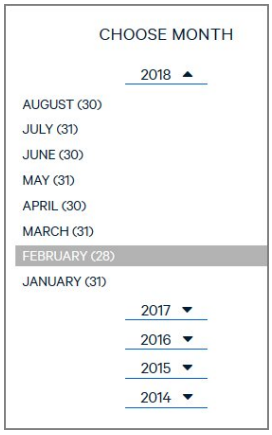

Fig. 2 - Selection of month

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Bid curve	14.02.201	Bid curve	14.02.201	Bid curve	14.02.201	Bid curve	14.02.201	Bid curve	14.02.201	Bid curve	14.02.201	Bid curve
2	Bid curve	EUR	Bid curve	EUR	Bid curve	EUR	Bid curve	EUR	Bid curve	EUR	Bid curve	EUR	Bid curve
3	Bid curve	SP1	Bid curve	SP1	Bid curve	SP1	Bid curve	SP1	Bid curve	SP1	Bid curve	SP1	Bid curve
4	Bid curve	285	Bid curve	285	Bid curve	285	Bid curve	285	Bid curve	285	Bid curve	285	Bid curve
5	Bid curve	2912,3	Bid curve	2912,3	Bid curve	2912,3	Bid curve	2914,1	Bid curve	2860,9	Bid curve	2928,4	Bid curve
6	Bid curve	-3862	Bid curve	-3892,1	Bid curve	-3732,7	Bid curve	-3893,9	Bid curve	-4490,8	Bid curve	-4710,9	Bid curve
14	Buy curve		Buy curve		Buy curve		Buy curve		Buy curve		Buy curve		Buy curve
15	Price valu	-500	Price valu	-500	Price valu	-500	Price valu	-500	Price valu	-500	Price valu	-500	Price valu
16	Volume va	48151,59	Volume va	47206,29	Volume va	46773,69	Volume va	46959,89	Volume va	47867,69	Volume va	50367,99	Volume va
17	Price valu	-499,9	Price valu	-499,9	Price valu	-499,9	Price valu	-499,9	Price valu	-499,9	Price valu	-499,9	Price valu
18	Volume va	48026,37	Volume va	47081,17	Volume va	46648,57	Volume va	46834,67	Volume va	47742,47	Volume va	50242,67	Volume va
19	Price valu	-499,8	Price valu	-499,8	Price valu	-499,8	Price valu	-499,8	Price valu	-499,8	Price valu	-499,8	Price valu
20	Volume va	48026,15	Volume va	47080,95	Volume va	46648,45	Volume va	46834,55	Volume va	47742,35	Volume va	50242,55	Volume va
21	Price valu	-499,1	Price valu	-499,1	Price valu	-499,1	Price valu	-499,1	Price valu	-499,1	Price valu	-499,1	Price valu
22	Volume va	48024,64	Volume va	47079,45	Volume va	46646,96	Volume va	46833,06	Volume va	47740,85	Volume va	50241,02	Volume va
23	Price valu	-499	Price valu	-499	Price valu	-499	Price valu	-499	Price valu	-499	Price valu	-499	Price valu
24	Volume va	48024,42	Volume va	47079,24	Volume va	46646,74	Volume va	46832,84	Volume va	47740,63	Volume va	50240,8	Volume va
25	Price valu	-497,139	Price valu	-497,125	Price valu	-497,125	Price valu	-497,122	Price valu	-497,122	Price valu	-497,111	Price valu
26	Volume va	48020,39	Volume va	47075,22	Volume va	46642,73	Volume va	46828,82	Volume va	47736,59	Volume va	50236,65	Volume va
27	Price valu	-481,471	Price valu	-481,471	Price valu	-481,471	Price valu	-481,471	Price valu	-481,471	Price valu	-481,471	Price valu
28	Volume va	47989,77	Volume va	47044,9	Volume va	46612,5	Volume va	46798,59	Volume va	47706,19	Volume va	50205,56	Volume va
29	Price valu	-402,749	Price valu	-402,749	Price valu	-402,749	Price valu	-402,749	Price valu	-402,749	Price valu	-402,749	Price valu
30	Volume va	47844,81	Volume va	46901,38	Volume va	46469,4	Volume va	46655,45	Volume va	47562,2	Volume va	50058,01	Volume va

Fig. 3 - A corner of the table for 14 February 2018

The supply and demand curves for each day are available as tables (fig. 3). Each table has 48 columns, two for each hour. The demand bids ("Buy curve") starts in row 14. Each bid takes two rows, one with price and one with accumulated volume.

In order to create a better overview, I made a tool for converting the table into 24 charts, one for each hour of the day (fig. 4).

The data cover a range from -500 €/MWh to 3000 €/MWh. It is possible to specify a range for the chart. In fig. 4, a range from -50 €/MWh to 100 €/MWh has been selected.

The bid curves can give an impression of the properties of the market during the hour.

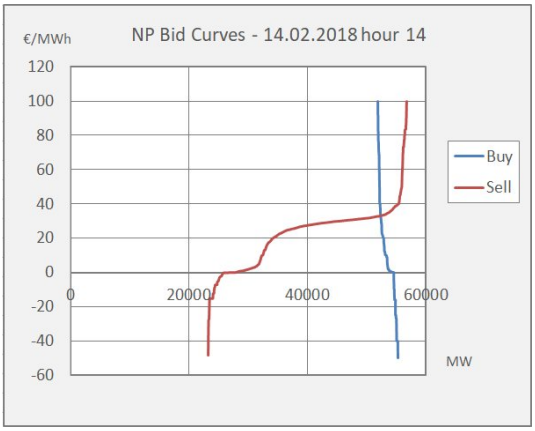

Fig. 4 - Bid curves for the hour from 14:00 to 15:00 on 14 February 2018

One important characteristic is that there is only little elasticity in the demand curves. The demand side of the day-ahead spot market does not yet respond significantly to price variations.

The supply side has a minimum value (21,364 MW), probably due to nuclear power and run-of-river hydro systems. The main flexibility seems to be in the price range between 0 and 40 €/MWh. There is a well-defined intersection at 52,376 MW and 31.60 €/MWh.

The intersection does not define the final system price. The reason is that the system price can be adjusted after the daily "market coupling" with the continental electricity markets.

Extreme cases in 2018

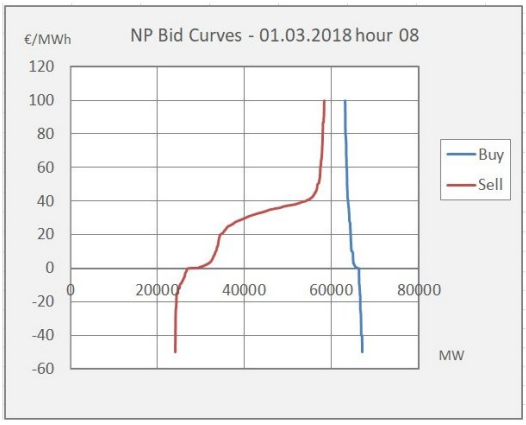

Fig. 5 - The final system price was 198.29 €/MWh

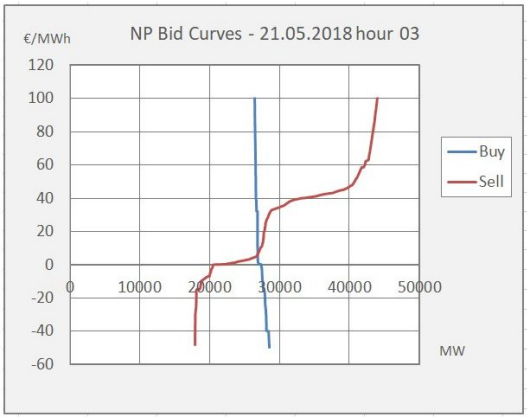

Fig. 6 - The final system price was 4.35 €/MWh

On March 1st, 2018 hour 8 (from 08:00 to 09:00), the demand exceeded 60 GW, and supply seems to have been insufficient (fig. 5). The two curves meet at 3000 €/MWh. The final system price was 198.29 €/MWh. The corresponding EEX spot price in Germany was 39.75 €/MWh. The import from Germany during that hour was 1335 MW and from Russia 633 MW. Norway exported 730 MW and Germany 2010 MW to the Netherlands during the same hour.

The import from Germany and export to the Netherlands may seem inconsistent. The cause was bottlenecks in Norway and Denmark. They divided the Nordpool system and created two large price zones (fig. 7).

	Hours	SYS	SE1	SE2	SE3	SE4	FI	DK1	DK2	Oslo	Kr.sand	Bergen	Molde	Tr.heim	Tromsø	EE	LV	LT
01-03-2018	08 - 09	198,29	255,02	255,02	255,02	255,02	255,02	42,04	255,02	255,02	42,04	42,04	255,02	255,02	255,02	255,02	255,02	255,02

Fig. 7 - Nordpool system price and zonal prices 1 March 2018 08-09 (Source: Nordpool)

Sweden and Finland had one price, while Denmark and Norway were divided. The spot price was 42.04 €/MWh in western Denmark (DK1) and southwestern Norway and 252.02 €/MWh for the other zones.

On May 21st, 2018 hour 3, the demand was less than 30 GW, and supply was plentiful. The two curves meet at 6.70 €/MWh, and the final system price was 4.35 €/MWh. The German EEX spot price was -9.21 €/MWh. The net import from Germany to the Nordpool area was 1525 MW. The export from the Nordpool area to the Netherlands was 731 MW and to Russia 119 MW. Germany exported 3253 MW to the Netherlands.

German influence on Nordic markets

Large export from Germany was characteristic for both cases. The conditions were normal in Germany. May 21st was a Monday. The daily solar power peak was about 30 GW in May. Onshore wind power output reached about 15 GW, which is less than half the peak values for offshore wind.

If the German grid had been a copperplate without bottlenecks, balancing the system might have been technically possible without negative spot prices and unwelcome export to neighbouring countries (fig. 8).

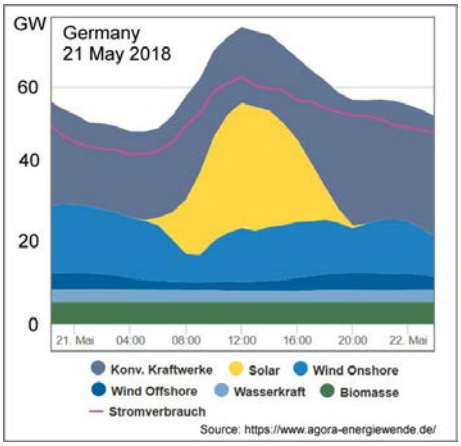

Fig. 8 - Up to 31.7 GW solar power

For the hour 03-04, the German spot price was -9.21 €/MWh, the export was 6.0 GW, and the conventional production was 21.9 GW. A reduction of the conventional production by the 6 GW does not look unrealistic.

A reduction of the Nordpool supply curves by the import from Germany (1525 MW) would change the system price for the hour 03-04 from 6.70 €/MWh to 29.16 €/MWh (fig. 9). The price sensitivity to rather small changes in volume is high in this particular case.

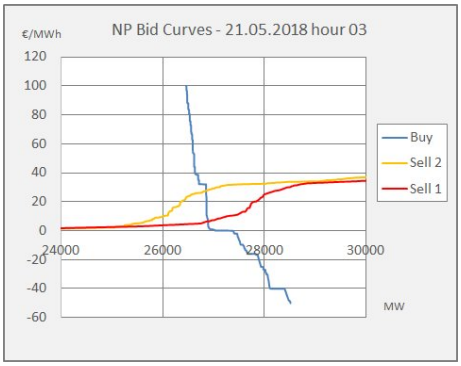

Fig. 9 - 1525 MW more or less can change the NP system price completely

It is a useful quality of the market that a country, which cannot balance its national power system, can solve the problem by exchanges with its neighbours.

However, export of balancing problems may also export price volatility. Increasing shares of wind and solar power will require increasing balancing resources somewhere. It will be an advantage for the robustness of the international markets if each nation as a main rule is able to balance its own non-dispatchable resources.

Grid reinforcements are under construction in Germany but completion of the projects will take several years. In the meantime, an improved market design with at least two price zones could provide some relief.

For want of both, the expansion of wind and solar power seems for the time being to have gone too far, particularly in northern Germany.