Wind and solar energy are cannibalizing themselves

Wind energy worth 30% less than dispatchable energy in 2023

Declining market value of wind and solar energy

In the Danish energy debate, it was established approximately 10 years ago that wind power was now the cheapest form of electricity production. At the time, the price of oil was unusually high, but the statement has not really been challenged since.

The year 2023 has shown that you can no longer use the average cost per kWh in the comparison between different forms of production. Market prices vary more and more from hour to hour, so the value of electricity production depends on the time of production.

When there is a lot of wind, the market price for electricity is low, and the commercial value of the wind energy correspondingly lower. Therefore, it is necessary to calculate the value of the wind energy in relation to the market price hour by hour in order to find a average market value of the energy produced.

The result has long been that the value of wind energy per kWh has been lower than the corresponding value of electricity consumption.

For solar energy, the market value has until now been close to the market value of electricity consumption, because the solar cells' production is highest in the middle of the day, when the energy is needed, but in the summer of 2023 the production of solar energy in Denmark had become so high that the spot price dipped in the middle of the day, and solar energy thereby became less valuable.

In this way, 2023 looks like a turning point, when wind and solar power start to cannibalize themselves by driving down the value of their output.

Very turbulent market prices

Denmark now has so much wind and solar power, that random fluctuations in production affect prices in the spot market. This results in high prices when it is necessary to import power, and very low prices when there is a production surplus in Denmark.

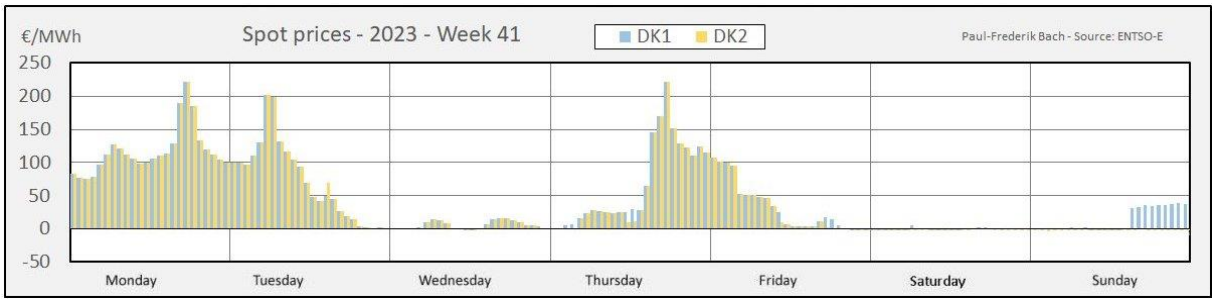

Fig. 1 - Example of a week with large spot price variations in Denmark

The reason for the unstable prices in fig. 1 is that uncontrollable production has grown faster than flexible consumption, which is necessary to create a reasonable balance between supply and demand. There are several PTX plants for hydrogen production on the drawing board, but so far, they are birds in the bush.

The hours with low prices affect the average electricity price. This is good for the electricity consumers, but less good for the producers.

There have also been large fluctuations in the spot prices from year to year (Fig. 2). The price increases associated with Europe's gas supply in 2022 led to inflation that was not to the benefit of electricity consumers.

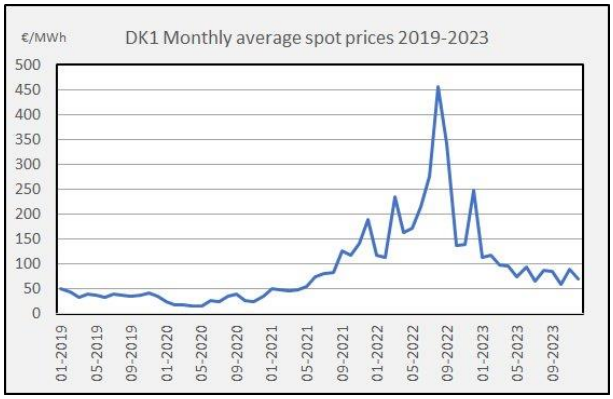

Fig. 2 - Spot prices in 2022 reflect problems with Europe's gas supply

Calculation of the market value for each production type is done by determining the value of each hour's production as price times quantity. The period's values are added together and divided by the total quantity.

Clear trends

Because of the price variations, it gives a messy graphic to show a longer period of development of market values for several production types. Therefore, the value of electricity consumption is set to 100%, so that the value of productions and exchanges is shown as a % of the value of consumption.

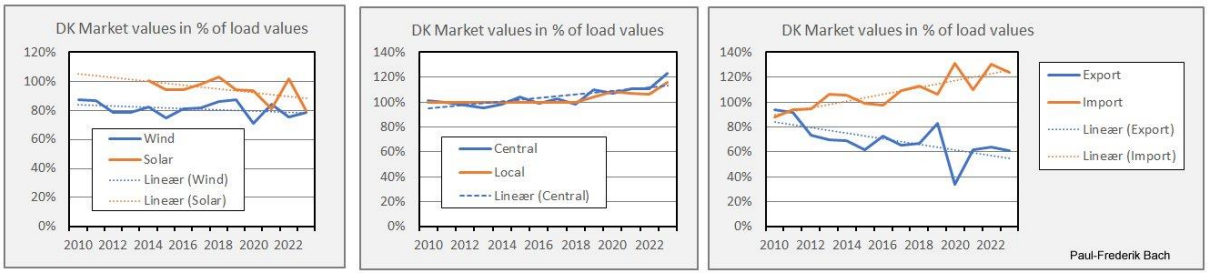

Fig. 3 - Clear trends 2010 to 2023. Solar power data not available before 2014.

The method shows clear trends over a number of years (Fig. 3).

The value of wind energy has always been around 80% of the value of electricity consumption, but with a slightly decreasing trend. This effect should have always been taken into account in assessments of the profitability of wind energy.

Solar energy has had roughly the same value as electricity consumption, but with significant decreases in 2021 and 2023. Since solar energy now affects spot prices in the middle of the day, there is reason to expect that the value will be close to the value of wind energy in the future.

The value of dispatchable production (Central & Local) has long been close to 100%, but with a significant increase from 2019. Thus, the dispatchable production approaches 120%, while the non-dispatchable production gathers around 80%.

Most striking are the trends for the value of exchanges. The value of imports has increased to around 120%, while the value of exports is falling to below 60%. This may mean that Denmark does not have dispatchable resources that are competitive with the prices offered from neighbouring countries.

The price differences increased in 2023

Fig. 4 shows how the price differences sharpen from 2022 to 2023.

The value of wind energy is around 80% both years, the onshore turbines slightly lower than the offshore turbines.

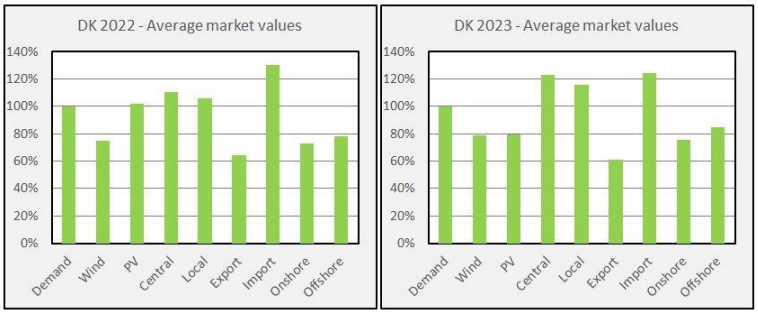

Fig. 4 - The market values of the production types in 2022 and 2023

Solar energy (PV) decreased significantly from 2022 to 2023.
This is consistent with the increased amount of solar energy and the price dips that occurred in the middle of the day in the summer of 2023.

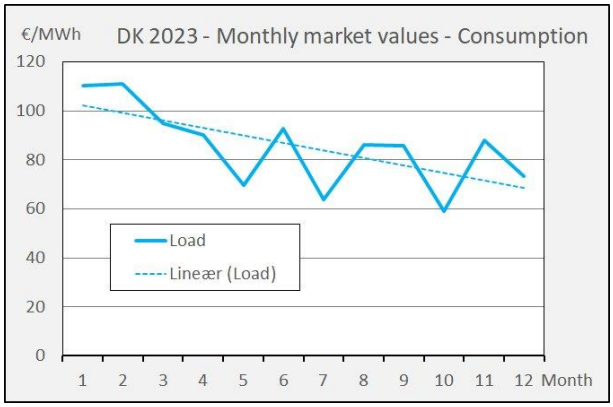

Fig. 5 - Steadily decreasing prices during 2023

The value of dispatchable production (Central & Local) increased significantly from 2022 to 2023, while the gap between export and import prices was almost unchanged from approx. 60% to approx. 120%.

The price development for the value of electricity consumption during 2023 (Fig. 5) can be seen as part of the path to normalization of the spot price level after the crisis in 2022 (Fig. 2).

Price differences in Europe put pressure on the networks

Table 1 shows the average spot prices in Europe in 2023.

Nordpool's price zones are referred to by abbreviations.

Average prices vary from €29.95 per MWh in northernmost Norway (NO4) at € 107.23 per MWh in Switzerland. For central Italy, the average price was €128.45 per MWh.

It is also worth noting that negative spot prices have become somewhat normal for all countries with up to 467 hours in Finland.

The price differences are signs of bottlenecks in the transmission networks. The big price differences are seen in the Nordpool

	Avg. spot price	Standard deviation	Neg.	Max	Min
EUC	€/MWh	€/MWh	hours	€/MWh	€/MWh
Belgium	97,04	46,03	227	330,36	-120,00
France	96,63	45,69	152	276,12	-134,94
Germany-LU	94,96	47,71	306	524,27	-500,00
Netherlands	95,61	49,17	321	463,77	-500,00
Poland	111,56	37,67	43	216,47	-13,81
Czech Rep.	100,56	44,06	136	444,02	-68,54
Slovakia	104,49	45,97	90	444,02	-24,37
Austria	101,91	44,56	113	437,47	-500,00
Switzerland	107,23	40,67	76	268,80	-142,88
Hungary	106,58	48,28	74	437,47	-500,00
	Avg. spot price	Standard deviation	Neg.	Max	Min
EUN	€/MWh	€/MWh	hours	€/MWh	€/MWh
DK1	86,68	48,85	285	524,27	-440,10
DK2	81,14	50,11	231	524,27	-60,04
NO1	66,90	44,64	381	332,00	-61,84
NO2	79,36	36,29	174	261,85	-61,84
NO3	38,56	32,76	401	332,00	-10,06
NO4	29,95	26,18	375	332,00	-10,06
NO5	67,02	43,35	374	261,85	-6,62
SE1	39,97	34,13	434	332,00	-60,04
SE2	39,98	34,12	434	332,00	-60,04
SE3	51,67	45,27	429	332,00	-60,04
SE4	64,81	50,59	368	332,00	-60,04
FI	56,44	56,65	467	777,18	-500,00
EE	90,66	55,78	129	777,18	-60,04
LV	93,76	54,54	100	777,18	-56,55
LT	94,31	54,86	100	777,18	-56,55

Table 1 - Average spot prices 2023 in north and central EU

area, where the southern zones assume prices from the central EU. This applies to Denmark (DK1 & DK2), Norway (NO2), Sweden (SE4) and the Baltic countries.

There are also bottlenecks in Germany, but since Germany only has one price zone, Germany cannot contribute to a more even distribution of the price differences.

Market values have been calculated for Germany (table 2). The results are similar to the corresponding Danish ones. Therefore, the large difference between the value of fluctuating and dispatchable production probably applies to the whole of Northern Europe, where the share of wind power is high.

Market values		
DE 2023	€/MWh	% of Load
Load	98,29	100,0%
Import	116,30	118,3%
Export	54,37	55,3%
Dispatchable	108,35	110,2%
Wind	79,83	81,2%
Solar	72,30	73,6%

Table 2 - German market values 2023

The downsides of the success story

Danish electricity production's conversion to wind and solar energy is massively marketed as a success story. It weakens awareness of possible unwanted effects that could be countered by timely course changes.

An increased production of wind and solar energy provides a theoretical improvement in the global climate, but not necessarily an improved Danish climate account. This is because exported electricity benefits another country's climate account. This is one of the reasons why the increased electricity production should, as far as possible, be utilized in Denmark.

Added to this are the effects in the electricity market, where fluctuating production can depress its own value and thereby cannibalize itself. The widening gap between import and export prices impairs the economics of foreign trade.

The media have reported on difficult times for the European wind industry. It has not been mentioned whether this is related to the fact that the commercial value of wind energy is only about 70% of the value of dispatchable production, but it is an obvious conclusion.

Therefore, the political decision-makers should take an interest in how the decline in the relative value of wind and solar energy can be stopped. For many years, flexible consumption and especially hydrogen production with PTX plants have been marketed as the solution to the imbalances. However, far too little has happened. Flexibility on the demand side should be prioritized over new wind turbines for a number of years, until the unfortunate development is reversed.