Danish Wind Power Jan-June 2017

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Conclusion

The Danish data for variation in wind power, export and import for the months January to June 2017have been investigated. It has been found that the wind power part of the Danish electricity consumption is 344 W/kW or 34 % and not as generally assumed 440 W/kW, due to the simple fact that a lot of the wind power is exported when it blows.

It has been shown too that the Danish wind success had not been possible without back up from the Scandinavian hydro power capacities. And that this is a unique situation, so that other countries will depend on thermal back-up capacities, since no other back up capacity of any importance has been invented so far.

It has been shown that the German system can't give an essential back up for the Danish wind turbines. Roughly speaking the wind in Denmark and Germany is present and not present at the same times. And Germany has already problems enough to transfer wind power from the windy north to south, where the weather is more pleasant.

Foreword

The author is a retired chemical engineer with a broad experience from the chemical industry and has no personal interest in any of the treated questions.

The authors personal views are written in italics. They may be discussed of course, whereas it is the authors hope that the figures and diagrams are indisputable. All the data are based on the sources mentioned here under. All Energinet.dk's data are given every hour.

The capacity data on page 7 are taken from Energistyrelsens Stamdata.

Units

The author thinks that numbers normally are not very interesting unless you can relate them to something known or understandable. For instance it not very interesting to tell that the wind power at a certain time was 5000 MW, but it may be interesting that it vas 1,25 times the load at a certain time. Then the interested reader may wonder: "What do we do with all that electricity?"

Nor does it make much sense, to tell that we imported say 3000 MW at a time and exported 2500 MW at another time. But if the figures are shown as part of the consumption they give meaningful information.

However it is practical to express these figures not in "%" but in W/kW.

The author has during his career had to make long and complicated calculations including many constants and variables. It is much easier and safer only to use units defined in "Systeme Internationale".

So instead of writing that the export was 75% of the load we write that the export was 750W/kW Load. A little longer may be, but precise and clear.

Sources

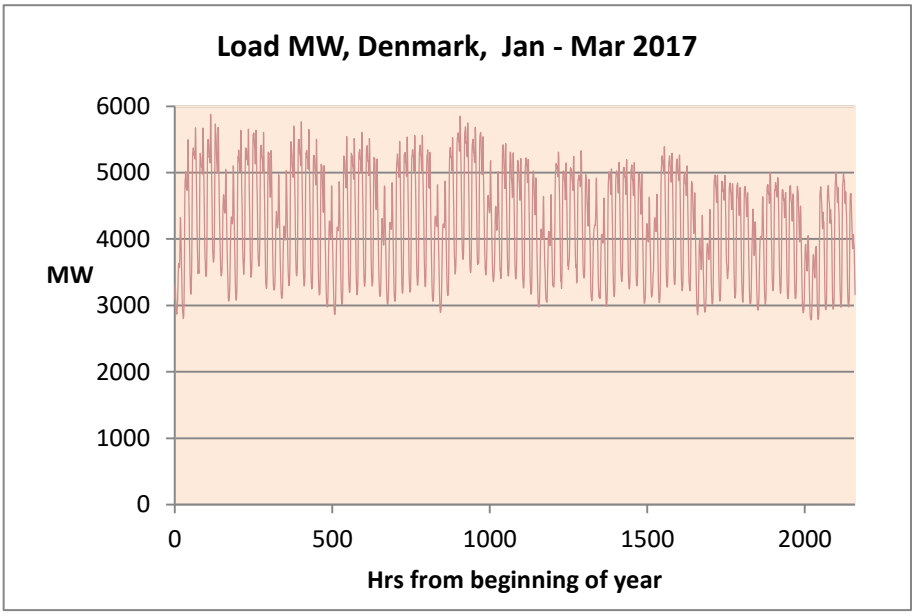
Alle the data used in this report are taken from

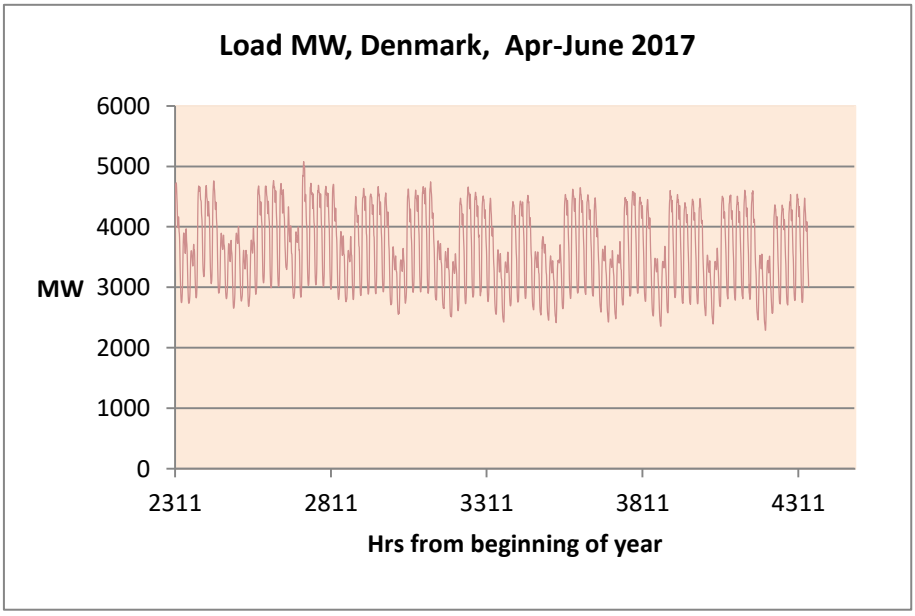
http://osp.energinet.dk/_layouts/Markedsdata/framework/integrations/markedsdatatemplate.aspx?language=en

https://ens.dk/service/statistik-data-noegletal-og-kort/data-oversigt-over-energisektoren

The Danish Electric Load

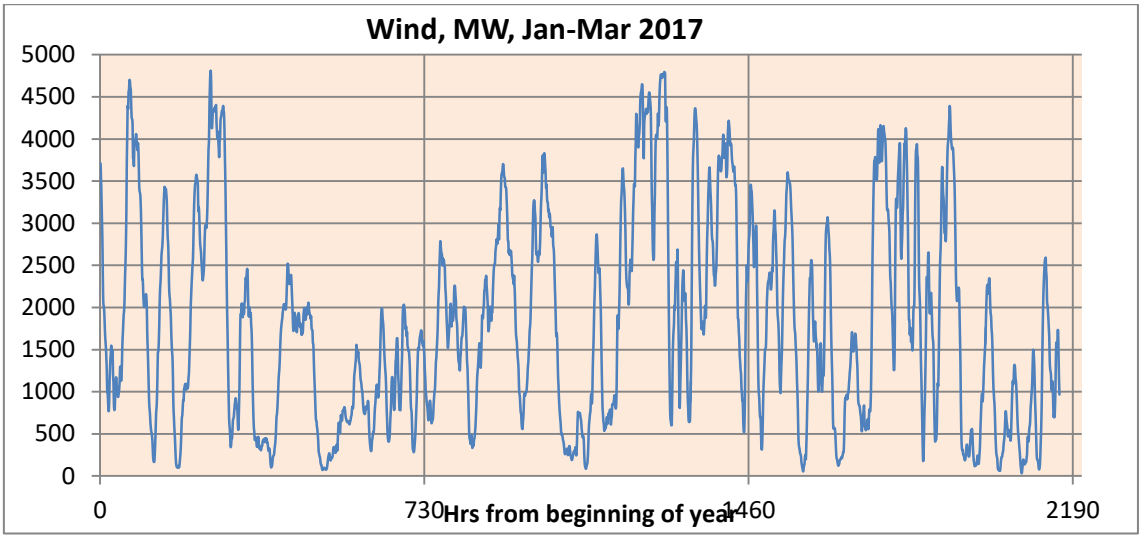
Load, MW. Jan-Jun 2017			
	Jan-Mar	Apr-Jun	Jan-Jun
Average	4234	3628	3930
Max	5905	5081	5905
Min	2784	2359	2359
Stddev	764	637	765
Observations	2160	2184	4344
GWh	**9143**	**7912**	**17055**

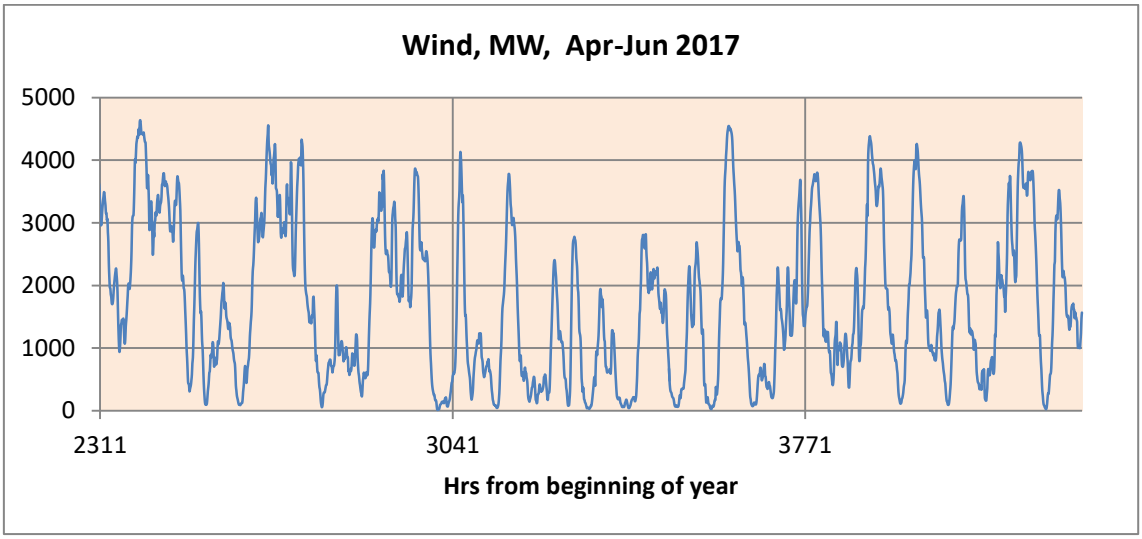




Windpower

Wind Power, MW. Jan-Jun 2017				
	Jan-Mar	Apr-Jun	Jan-Jun	Jan-Jun% of capacity
Average	1800	1678	1739	32
Max	4812	4639	4812	89
Min	31	12	12	0,2
Stddev	1236	1253	1246	
Observations	2160	2184	4344	
GWh	**3888**	**3665**	**7553**	
Installed capacity end of June 2017, MW				**5393**



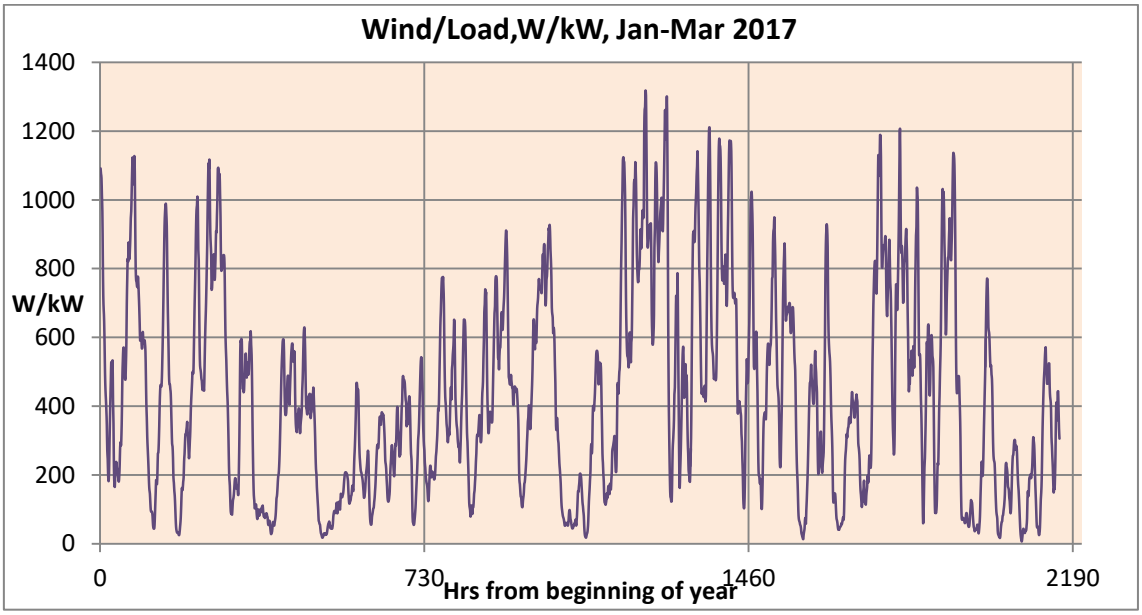


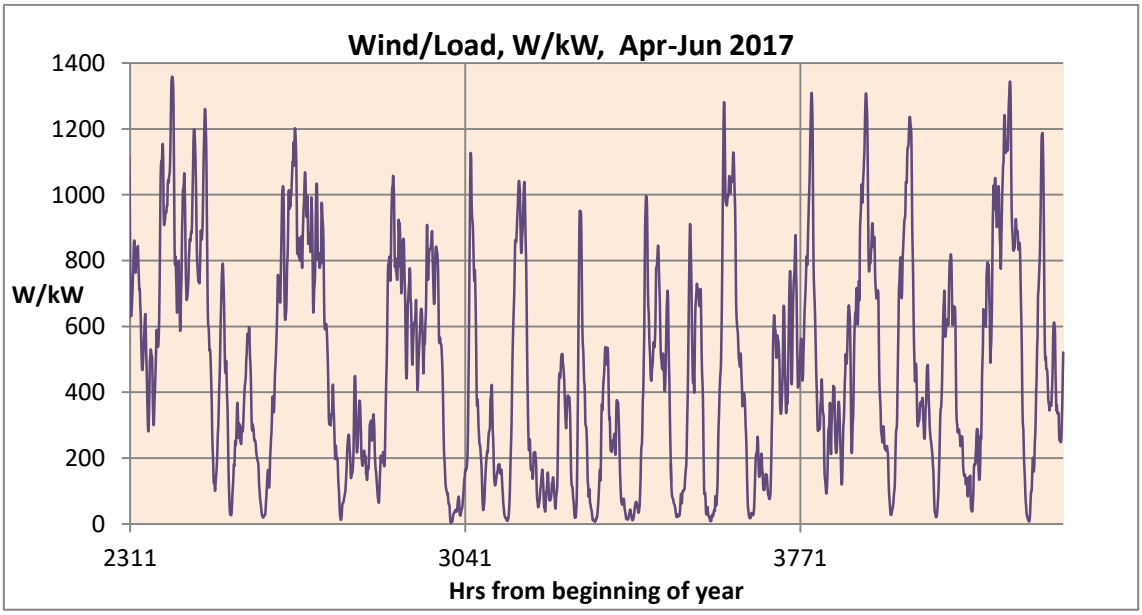
The wind industry likes very much to tell that wind power from on shore turbines is the cheapest form for energy. Howeveer, it forgets to tell that the wind energy must have a 100% back up capacity, and that this costs somewhat.

Relation between wind power and load

This is shown in the graphs below. The unit is W/kW. Thus 100 W/kW corresponds to 10%.

Wind/Load W/kW, Spring 2017			
	Jan-mar	Apr-Jun	Jan-Jun
Average	432	466	449
Max	1318	1359	1359
Min	6	3	3
Stddev	299	340	321
Observations	*2160*	*2184*	*4344*





The average load in the first half of 2017 was 3930 MW, and the average wind power was 1739 MW, i.e. 44,2%, or as we prefer to express it 442 W/kW. However, since the wind power sometimes surpasses the load, i.e. when the wind/load>1000W/kW it is evident that this can't be the whole truth.

It might be an interesting experiment to make the wind industry responsible for the total electricity supply. The result might be less wind in the system if the decisions were based on economic calculations. Even after a reasonable carbon dioxide tax.
Alas, the people, or at least the elected representatives have decided that saving the climate is holy and thus indisputable duty.
In an article in Jyllands Posten on September 03.2017, the author – correctly – writes that we can't save our country and freedom unless our own soldiers have boots on.
He forgot to tell, that there will be no boots and no uniforms and no steel to produce weapons either unless several Asian nations permit it, because the European politicians in there endeavour to save the climate and the World have forced a large part of our energy intensive industries to transfer the production to Asia.

Useful Wind Power.

In fact 44,2% is very far from the whole truth. If you any time subtract the net export from the wind power you get a realistic idea of how much the wind power contributes to the actual load. We call this remaining wind power

Useful Wind Power

Useful Wind Jan-Jun. 2016 and2017			
		2016	**2017**
Load average	MW	3933	3930
Windpower average	MW	1398	1739
Wind Power/Load	**W/kW**	**356**	**442**
Useful Wind Power	MW	1190	1363
Proportion useful Wind Power	**W/kW**	**935**	**784**
Rectified Wind Power/load	**W/kW**	**303**	**347**
Observations		*4368*	*4344*

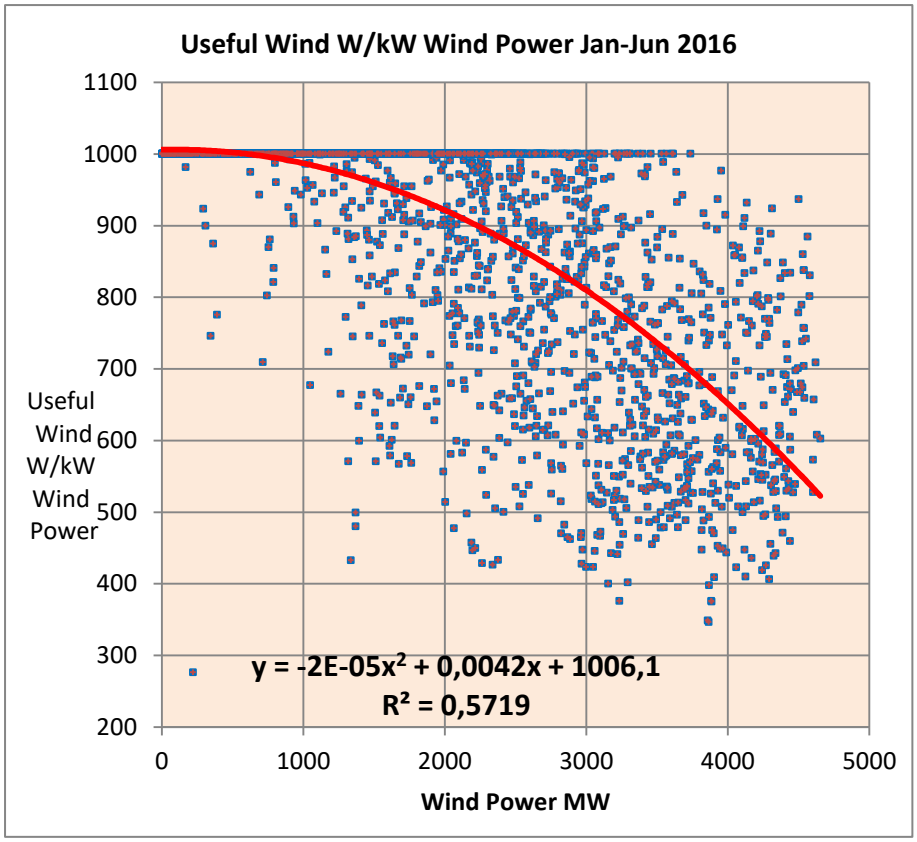
We find that of the 1739 MW wind power produced Jan-Jun 2017 on average only 1363 MW remains as **useful wind power** after the net export has been subtracted. Thus the wind power proportion of the load is reduced from **44,9% to 34,7%** or **347 W Wind/kW Load.**

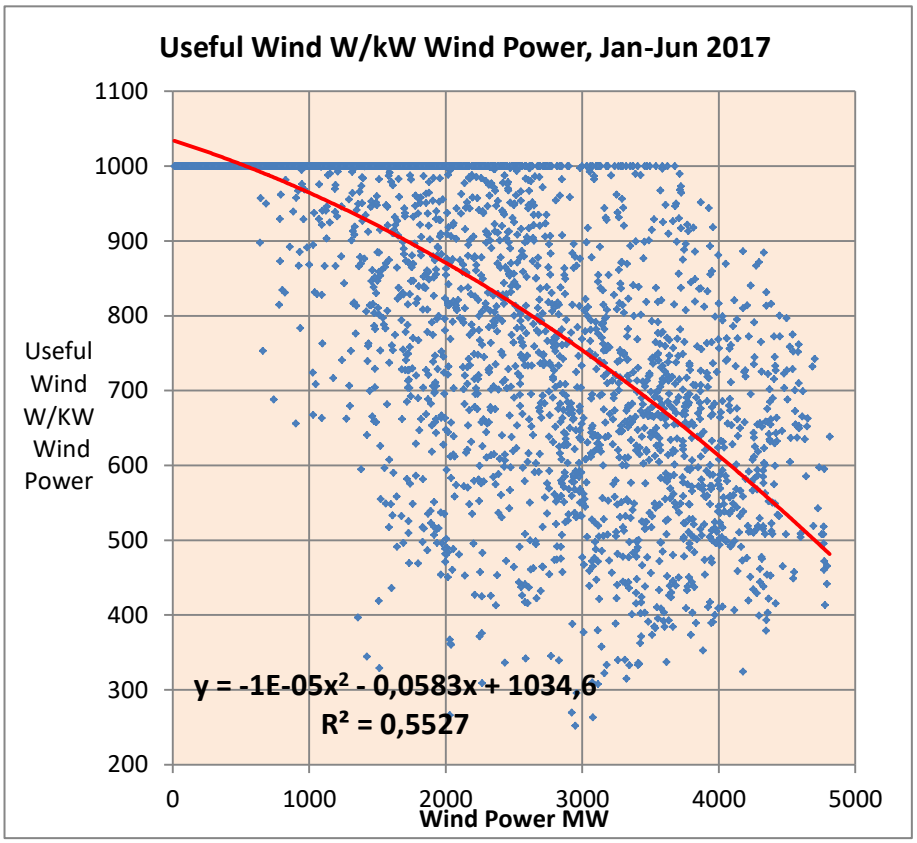
The data for Jan-Jun 2016 are shown too. The average wind power in 2016 was considerably lower than in 2016 than in 2017, which can't be ascribed to increased wind power capacity. The wind power in the first half of 2017 was 24 % higher than in 2016 The capacities on June 30, 2017 were, and the capacities only 3% higher than a year before.

Wind Power generating Capacities June 30		
Year	2016	2017
Off shore	1271	1266
On Shore	3849	4027
Sum	5120	5293

The wind industry has not informed the public how to cope with an electricity supply, with a variation of 24 % from year to year.

Useful Wind Power and Wind Power





The graphs to the left illustrate how the useful part of the wind power depends on the produced wind power effect.

In the ideal case the points would make a straight line, where Y= 1000, indicating that for each kW wind power produced 1000 watts would be used in the Danish system..
It can be seen, that nearly all the wind produced by an effect lower than 1000 MW is useful.
When the production reaches 2000 MW only about 900 W/kW wind power is useful – a little higher in 2016 than in 2017 simply because less wind was produced in 2016.

By a wind power effect of 4000 MW te corresponding figures for useful wind/wind power are about 650 and 610 W useful Wind/kW Wind.

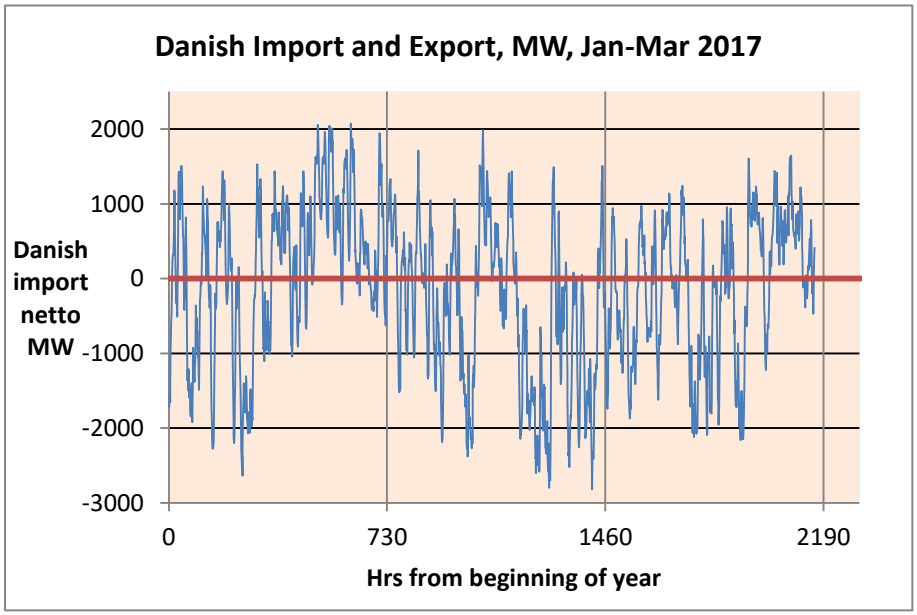
So it is very well justified to ask if it makes sense to expand the production capacity.

Import and export of electricity.

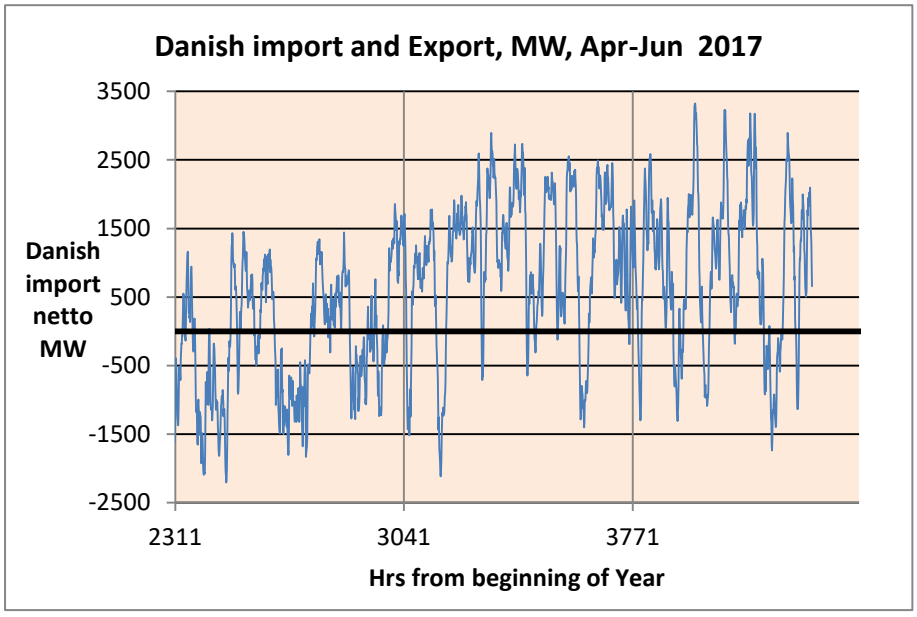
Import and export of electricity relative to the load is described above. However the load is variable so the absolute figures and the corresponding graphs are shown in the following. (*Import is positive, and export negative)*

Danish Import, Export and Load,MW, Jan-Jun 2017				
	Jan - Mar	Apr-Jun	Jan-June	Load Jan-June
Average	-149	586	221	3930
Max	2073	3326	3326	5905
Min	-2823	-2207	-2823	2359
Stddev	1042	1145	1155	765
Observations	2160	2184	4344	4344

It is remarkable, that the import can reach a level at 3326 MW, where the average load is 3930 MW.
It is unthinkable that you could reach a similar level in for instance Germany and France.



The large fluctuation in im- and export is no big surprise.
But it might be a good idea for UK, Germany and France to ask how to handle a wind power generation corresponding to 44 % of the load!



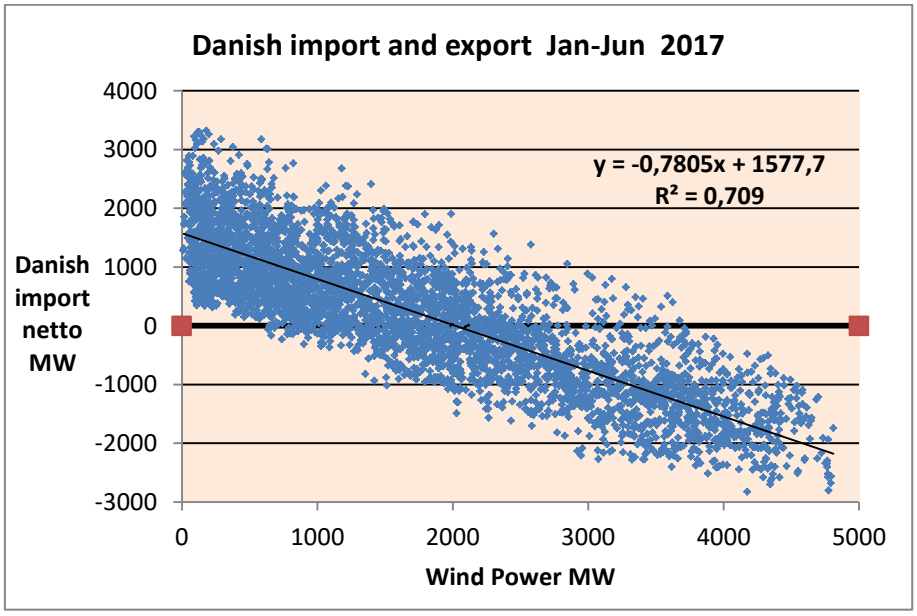
The average German load is about 55 GW. Operating under the same conditions as Denmark, Germany should then be able to import 46 GW, and to export 40 GW.

Furthermore, "Die Energiewende" must necessarily imply a considerable increase in the use of electricity. The above mentioned report from The Frauenhofer Institute proposes to increase the German wind power by a factor 8.

Correlation between wind power, import and export.

Export and import of electricitty Jan-June 2017				
		Norway + Sweden	Germany	Total
Average	MW	234	-14	221
Max	MW	3180	2076	3326
Min	MW	-2706	-1747	-2823
Stddev	MW	996	432	1155
Observations		4344	4344	4344
	GWh	1017	-59	958

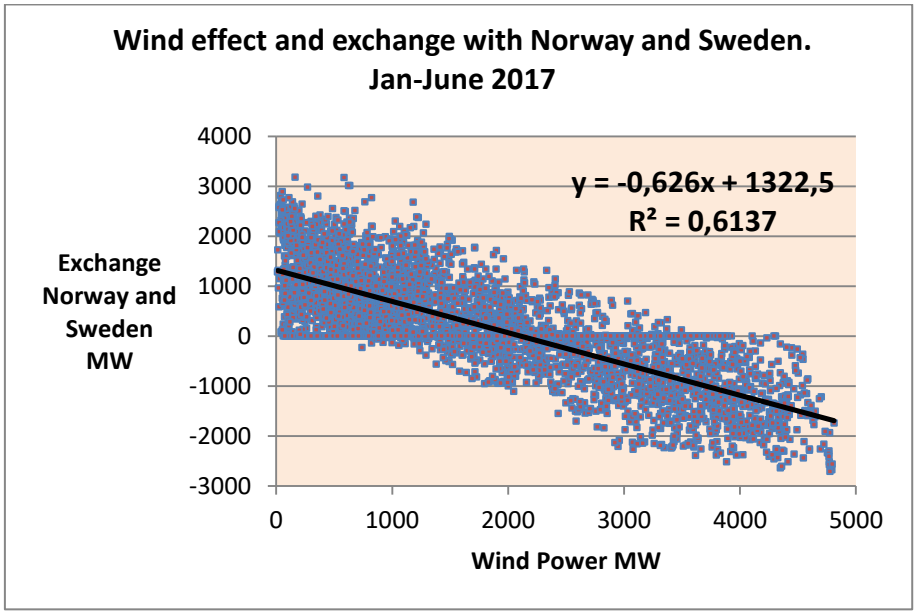
The figures for trade with Norway and Sweden and Germany are rectified for the transfers through Denmark.

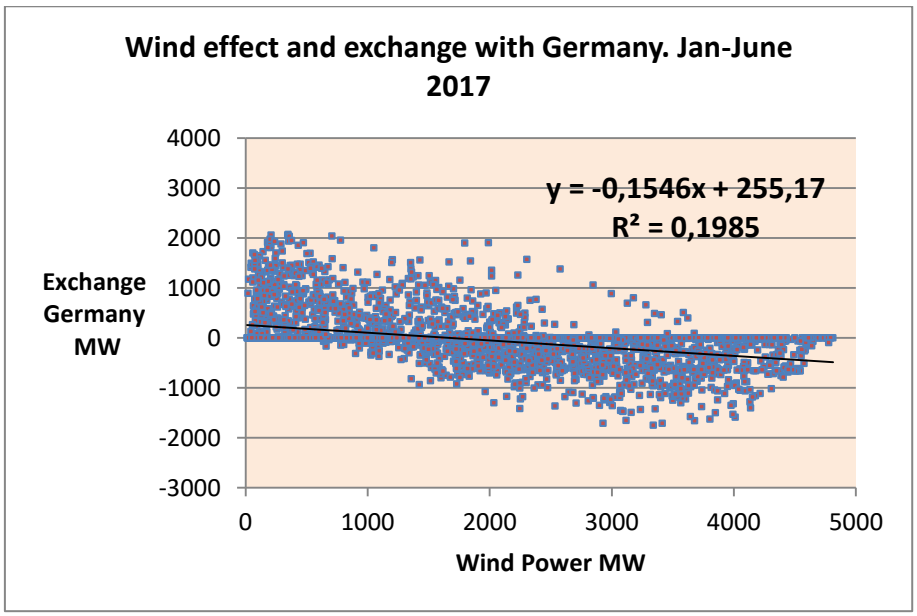


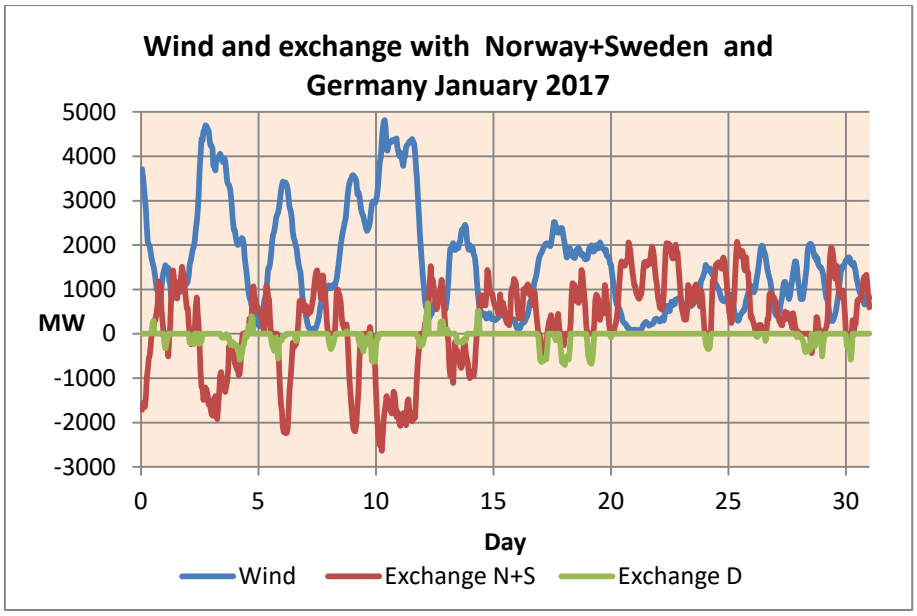
(Import is positive and export negative).

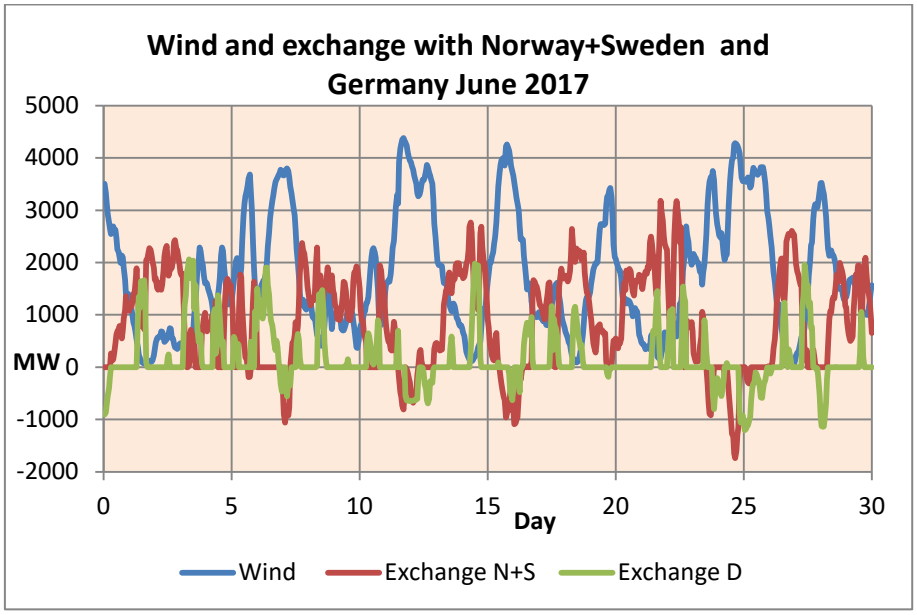
The need for **back up** is convincingly illustrated by the graph above. Denmark gets mainly the back up from Swedish and Norwegian hydro power, and to a lower degree from the large German system.
We exported on average 14 MW to Germany and imported 234 MW from Norway and Sweden in the first hal of 2017.

The trade with Norway+Sweden and Germany is shown hereunder.


Wind effect and exchange with Norway and Sweden. Jan-June 2017
y = -0,626x + 1322,5
R² = 0,6137
Exchange Norway and Sweden MW
4000
3000
2000
1000
0
-1000
-2000
-3000
0
1000
2000
3000
4000
5000
Wind Power MW


Wind effect and exchange with Germany. Jan-June 2017
y = -0,1546x + 255,17
R² = 0,1985
Exchange Germany MW
4000
3000
2000
1000
0
-1000
-2000
-3000
0
1000
2000
3000
4000
5000
Wind Power MW


Wind and exchange with Norway+Sweden and Germany January 2017
MW
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
0
5
10
15
20
25
30
Day
Wind
Exchange N+S
Exchange D



It is easy to see that the exchange with Norway and Sweden is much larger than the exchange with Germany. Especially in the winter. So it can be concluded, that wind power can't be back up for wind power in a neighbouring country.

You need hydropower or thermal power. The Scandinavian hydro power capacity is far from large enough to deliver back up to Western Europe. The Scandinavian hydro capacity is roughly 50 % of the entire Western European capacity.

So the hydro capacity is insufficient, and "green energy" and "Energie Wende" remains a fata morgana.

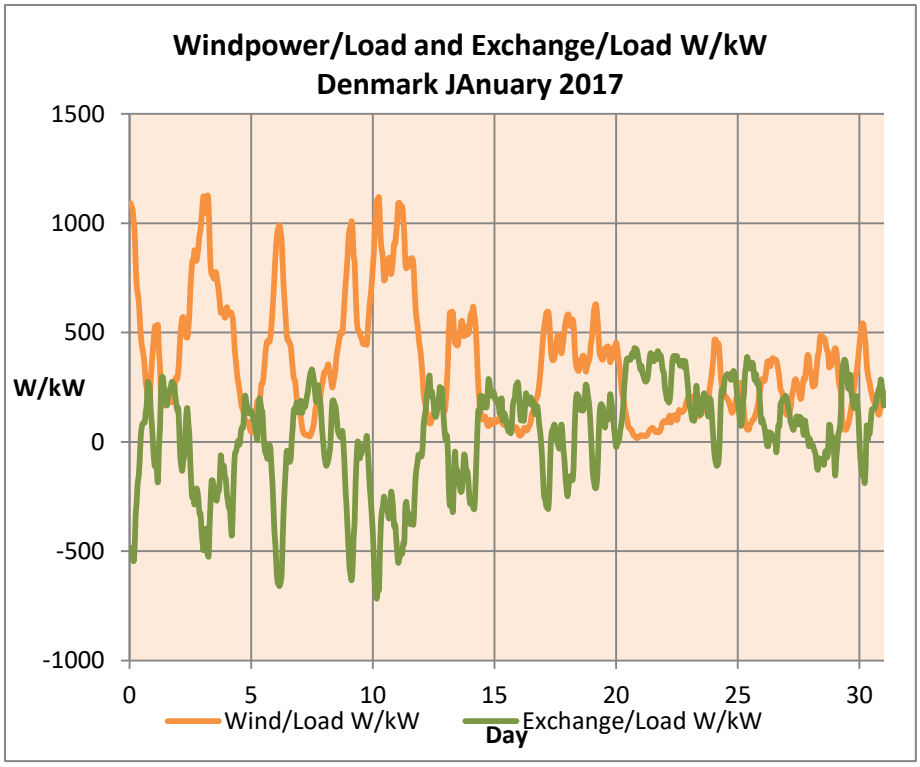
Wind Power, Load and Foreign Exchange.

This is shown in some detail on the following graphs. The graphs may need a little explanation.

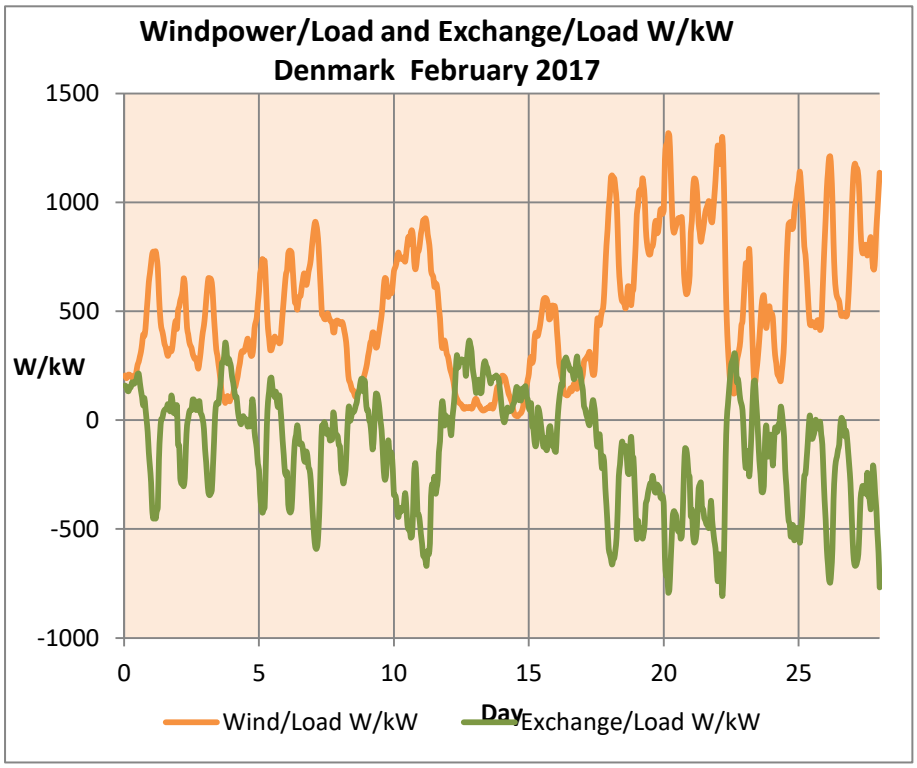
Two values are shown.

1. Wind/Load in the unit W/kW.
   If the wind power at a given time is 2000 MW and the load is 4000 MW, then result will be 500 W/kW.
2. Exchange/load in the unit W/kW.
   If the import at a given time is 1000 MW and the load is 4000 MW, then the result will be 250 W/kW

Wind/Load and Exchange/Load, 2017				
	Wind/Load W/kW		Exchange/Load W/kW	
	Jan	Feb	Jan	Feb
Average	364	519	30	-134
Max	1128	1318	429	366
Min	18	17	-716	-808
Stddev	269	312	238	264



Please note, that on January 10, the wind power reached 1000 watt/kW Load, and that the export reached a value of 700 W/kW load.

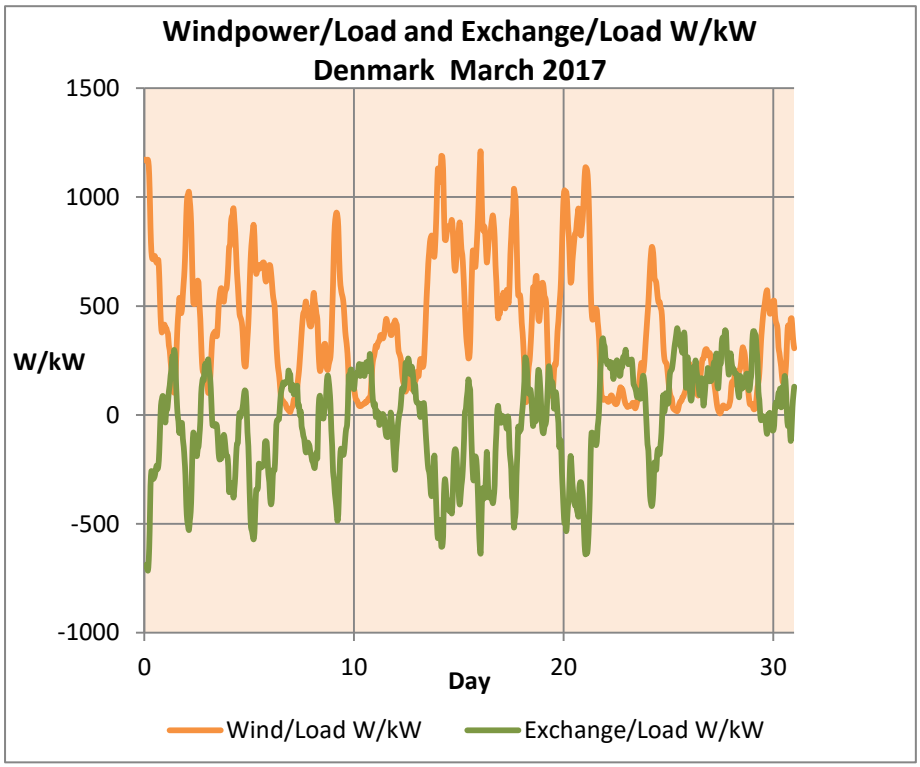


On February 20 the wind power reached 13 W/kW load and the export was 800 W/kW load.

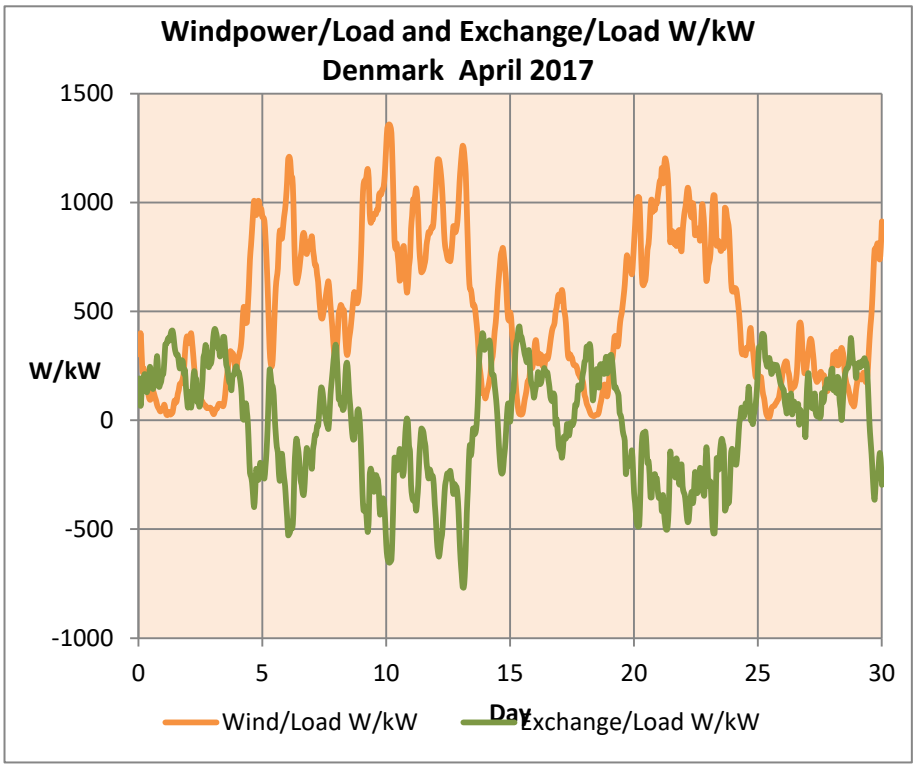
On 21-23 January the imports were about 400 W/kW load.

February was very windy, so on average the export was about 134 W/kW load.

Wind/Load and Exchange/Load, 2017				
	Wind/Load W/kW		Exchange/Load W/kW	
	Mar	Apr	M;ar	Apr
Average	419	513	-39	-21
Max	1207	1359	398	431
Min	6	12	-716	-768
Stddev	298	350	238	261



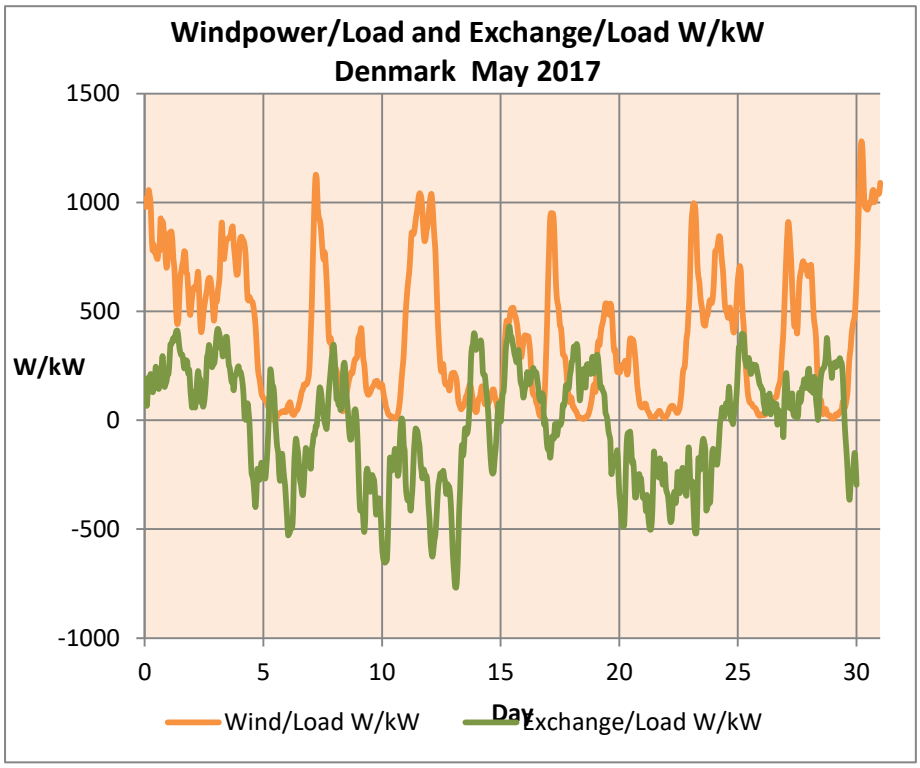
The export/load reaches 768 W/kW on April 13, and the import/load reaches 431 W/kW on April 15 at 9 o'clock
The export/load reaches 768 W/kW on April 13, and the import/load reaches 431 W/kW on April 15 at 9 o'clock.

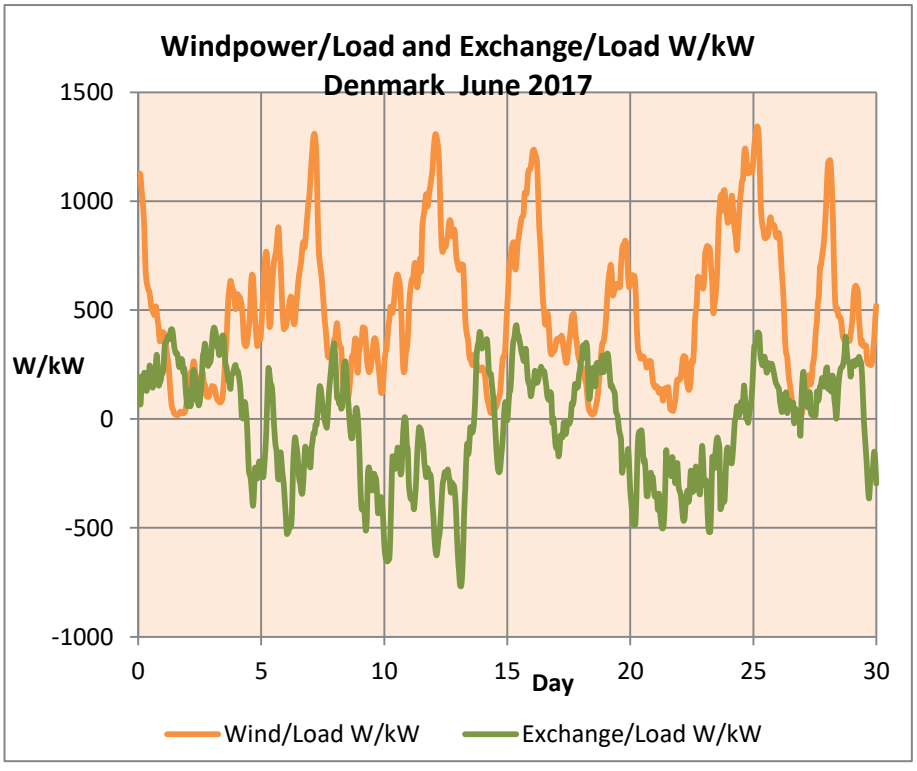


Denmark is generally considered a fore runner in windpower.

That has been possible because the Danish electricity load is only about 5% of our neighbours', and because Norway and Sweden have a hydro power capacity about ten times the Danish average load.

Wind/Load and Exchange/Load, 2017				
	Wind/Load W/kW		**Exchange/Load W/kW**	
	May	Jun	May	Jun
Average	383	504	240	275
Max	1281	1344	799	775
Min	3	8	-586	-519
Stddev	323	331	311	304





In May and June the import reached a maximum of 799 W/kW load and the export 586 W/kW load.

The German load is about 55 GW, so if the German wind power capacity was relatively as large as the Danish, Germany should be able to import 44 GW, and export more than 30 GW.

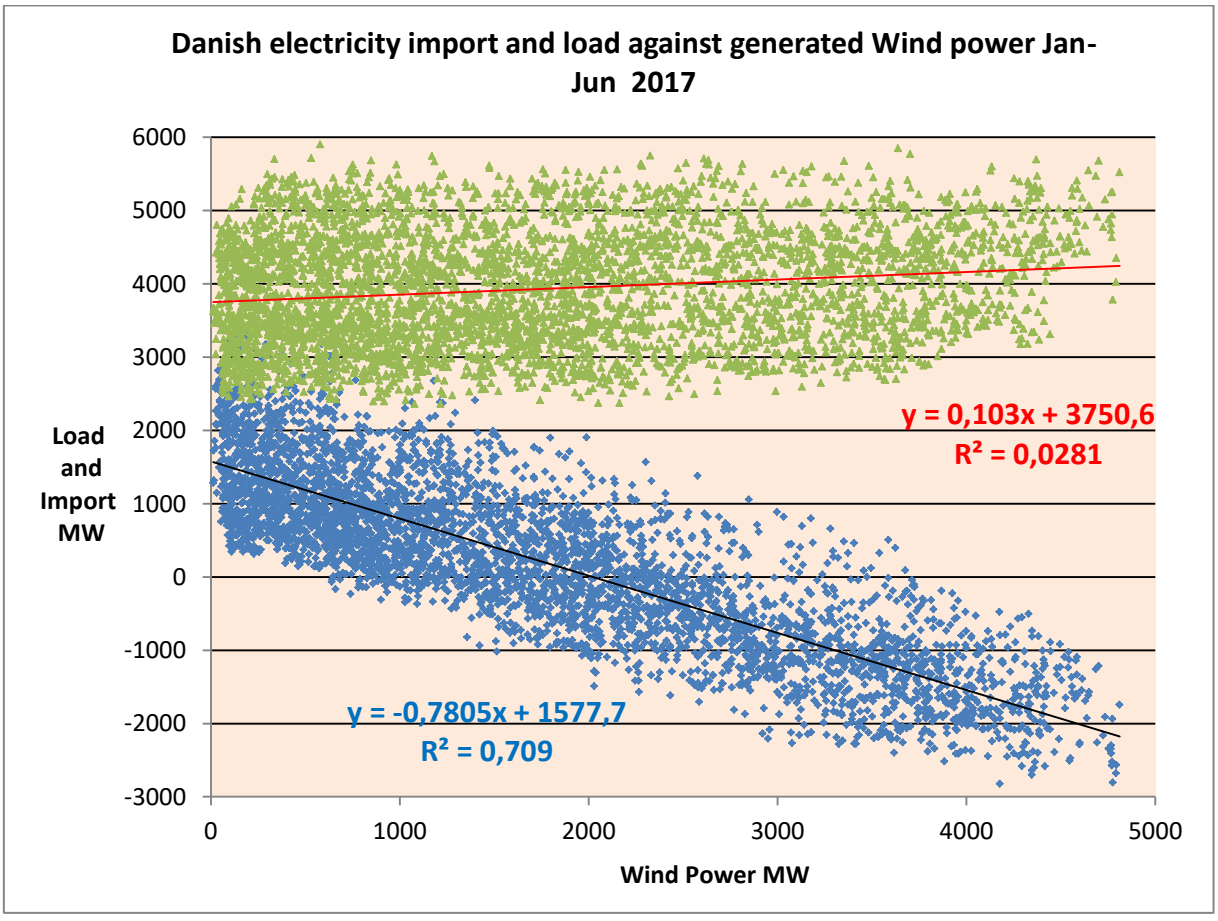
Alternatively be able to send 30 GW into the storage system, and hours later receive 44 GW back from this storage system.
An interesting per-spective described in the below mentioned report form The Frauenhofer Institute.

https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/studie-100-erneuerbare-energien-fuer-strom-und-waerme-in-deutschland.pdf

This report describes a system where wind power among other is used to produce hydrogen, which together with carbon monoxide and carbon dioxide obtained from burning of straw should be used to produce methanol, which admittedly can be stored.

The author is an experienced chemical engineer and considers this report to be absolute nonsense with only one purpose: To supply some researchers with tax payers' money.

Wind energy and load



It is no surprise that the import of electricity is high, when the wind power is low and vice versa. The correlation is expressed by the equation
Y = -0,7805X + 1580, where Y is the import and X the wind power. The correlation coefficient R^2 = 0,71 i.e. R= 0,84.

Intelligent Systems

There has been much talk about an intelligent electric system, where more electricity is used when it blows. It is observed that such a system does not exist even though we have had wind power in the grid in 35 years. There is hardly any correlation between wind power and load. But it blows more in the dark and cold January than in June. So it is evident that we use more electricity when it blows. Although with a very low correlation coefficient.

An intelligent electric system presupposes political skill and large investments. May be, however, the non existent correlation between wind power and load, is due to the circumstance that the politicians after all are intelligent enough not pursue such an intelligent system?

The Danish Wind Turbine industry will surely not like the conclusion: A high proportion of wind power in a system implies that the system is small compared to the neighbouring countries, and that these have a large and easily controllable hydro power capacity. Or that they are willing to have back up in form of lignite and Russian gas.

Hardly what the Germans thought when their chancellor decided to make an "Energiewende"

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