Bad wind, lower wind power, exploding costs!

Abstract:

1. Average wind speed is on decline at meteoLCD, and probably also at large parts of neighboring countries
2. As a consequence German and Luxembourg wind-energy production is hampered by declining capacity factors
3. Nevertheless, the huge windpower capacity installed, together with an inadequate grid and nearly nonexistent storage facilities, makes that the cost for downing wind parks rises exponentially in Germany.

1. Declining wind speed

In a previous blog I commented on the declining capacity factor of the Irish Eirgrid's wind turbines, taken as a whole. The same holds for Germany and Luxembourg, at least from 2007/8 on. The German wind power association recently acknowledged that despite more than 1000 supplementary wind turbines being installed in 2012, the total energy output was less than that of the previous year (45.9 versus 46.5 TWh). The culprit is declining wind speed.
I checked this wind speed trend on the meteoLCD data, starting in 2002 because since that date all equipment was the same and did not move.

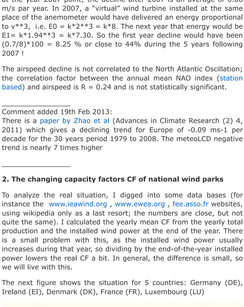

fig. 1 Trends in mean yearly air speed at meteoLCD, Diekirch

The data points represent the yearly mean air speed measured by a cup anemometer. There clearly is a first period of positive trend, with a decline starting in 2007. I fitted two regression lines forced to meet at the year 2007 point; the decline after 2007 is an average of 0.06 m/s par year. In 2007, a "virtual" wind turbine installed at the same place of the anemometer would have delivered an energy proportional to v**3, i.e. E0 = k*2**3 = k*8. The next year that energy would be E1= k*1.94**3 = k*7.30. So the first year decline would have been (0.7/8)*100 = 8.25 % or close to 44% during the 5 years following 2007 !

The airspeed decline is not correlated to the North Atlantic Oscillation; the correlation factor between the annual mean NAO index (station based) and airspeed is R = 0.24 and is not statistically significant.

Comment added 19th Feb 2013:
There is a paper by Zhao et al (Advances in Climate Research (2) 4, 2011) which gives a declining trend for Europe of -0.09 ms-1 per decade for the 30 years period 1979 to 2008. The meteoLCD negative trend is nearly 7 times higher

2. The changing capacity factors CF of national wind parks

To analyze the real situation, I digged into some data bases (for instance the www.leawind.org , www.ewea.org , fee-asso.fr websites, using wikipedia only as a last resort; the numbers are close, but not quite the same). I calculated the yearly mean CF from the yearly total production and the installed wind power at the end of the year. There is a small problem with this, as the installed wind power usually increases during that year, so dividing by the end-of-the-year installed power lowers the real CF a bit. In general, the difference is small, so we will live with this.

The next figure shows the situation for 5 countries: Germany (DE), Ireland (EI), Denmark (DK), France (FR), Luxembourg (LU)

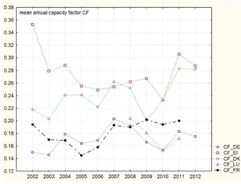

fig.2: Annual mean capacity factors of national wind parks

Clearly the German CF's (blue circles) and the Luxembourg CF's (pink triangles) are declining since 2007. The next figure computes the regression lines starting in 2007.

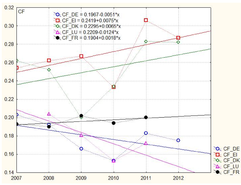

fig.3. Linear trends of annual mean capacity factors

Both Germany and Luxembourg show visible declining trends: Germany's CF declines by 0.0051 per year, i.e. by 2.5% with respect to 2007, or a total (derived from the trend) of **-12.6%**. Luxembourg's decline is even more spectacular (the 2012 data are not yet available): CF declines by 0.0124 per year i.e. by approx. 6% per year (w.r. to 2008) or **-24%** for the whole period.
Neither of these countries had by the end of 2011 a big offshore contribution (percentages of offshore installed power: DE = 0.3, DK =0.1, EI = 1.5, all others 0%). Nevertheless it is clear that relative flat countries close to the sea as Denmark and Ireland fare much better than the "more continental" ones..

3. The German "Abregelung"

Despite declining capacity factor and energy production from wind turbines, the yearly total of wind energy that has to be destroyed in Germany rises in a spectacular manner. The German word for this destruction is a harmless sounding "Abregelung", translated to "down-regulation". In fact, this word corresponds to the power that must not be produced to avoid a breakdown of the electrical grid. The grid operators as Eon or Tennet must pay the wind park owners for this, and these sums end up inflating the final consumer price. Here are the numbers as found in the Ecofys report " Abschätzung der Bedeutung des Einspeisemanagements "

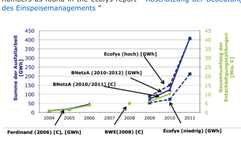

fig.3. German wind generated electrical energy destroyed and compensations paid.

Taking the solid blue triangle data points from the Bundesnetzagentur (BNetzA) one can see that the costs rise from about 6 million to 40 million Euro in the 3 years 2009 to 2011; this is an exponential increase that will continue as long as the deficient grid can not cope with increasing high wind production when local demand is low:

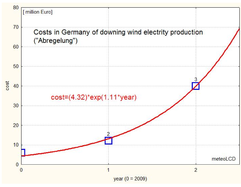

fig.4. Annual costs in million Euro for downing wind production in Germany

The real costs for the customer are still higher, as a not negligible part of the energy produced has to be sold at zero or negative prices. For instance during 2012, electricity prices became negative 15 times at the Leipzig EEX exchange, **reaching an eye watering ~473 Eur/MWh** at Christmas day 2012 in the morning. The total cost for the 2 successive days 25/26 Dec 2012 with negative price balance is approx. **75 million Euro.** So it does not come as a surprise that German electricity is among the most expensive in the EU for the normal household paying the full tariff (about 29 cent/kWh in 2013, to be compared to the French tariff of 15.6 cent/kWh).

Without being a tenacious opponent to wind power, one has to ask the question how a nation of excellent engineers and scientists became so enthralled in "green" energy that they forgot two essentials in their rush for new wind parks: grid adequacy and storage facilities.

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One Response to "Bad wind, lower wind power, exploding costs!"

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September 19, 2013 at 09:06 | Reply

[…] two previous comments (here and here) I wrote about declining wind power and declining capacity factors of installed wind turbines in […]

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