Wind Report Germany 2013

(This blog has now been updated and finished. 25 Sep 2014))

The Fraunhofer Institut IWES has published a slick **report** on the state of wind energy in Germany, with statistics going from 2000 to 2013. Sure, the IWES people are addicted to renewable energy, so do not expect deep going musings on intermittency and power net stability. Nevertheless the report is well done and the time to read is well spent.

1. The crux with the capacity factor

Since 2000, the installed wind capacity (i.e. total theoretical power installed) increased dramatically, and the newest turbines are giants of 3-4 MW (and more to come). The following tables will be our start point to calculate the yearly capacity factor from the combined ON- and OFFshore systems. Offshore still is negligible, delivering in 2013 only about 0.9 TWh from a total of 47 TWh produced.

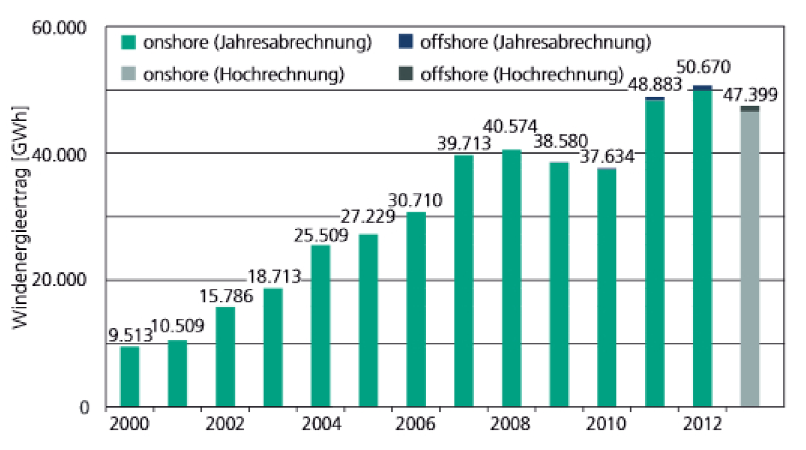


Abbildung 7: Entwicklung der Windstromerträge in Deutschland, Datenquellen: EEG-Jahresabrechnungen [21], AGEE [1, 2], Hochrechnungsdaten der ÜNB [22–25]. Aufgrund unterschiedlicher Datenquellen kommt es zu Abweichungen zu anderen in diesem Report dargestellten Zahlen.

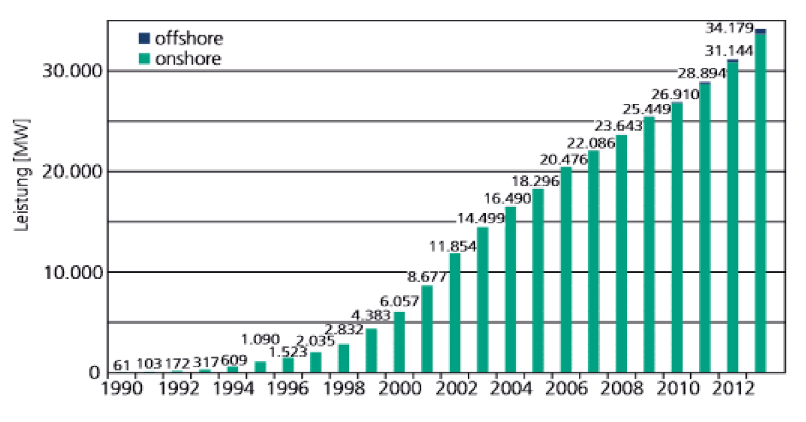
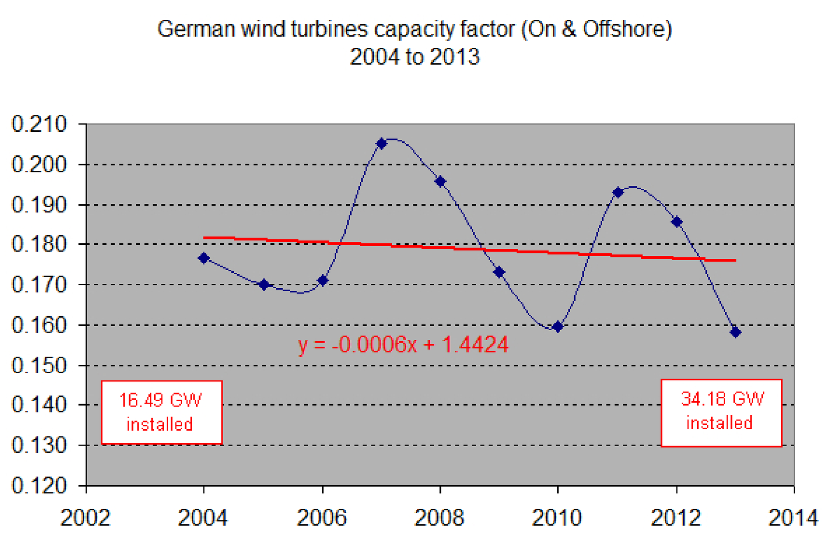


Abbildung 8: Zeitliche Entwicklung der installierten on- und offshore Windleistung in Deutschland, Datenquellen: IWET [27], Fraunhofer IWES

Let us take the last decade 2003 to 2013 and calculate the capacity factor using both data series:



In 2004 the total installed power was about 16.5 GW and more than double ten years after. One has to keep in mind that some of this new power came from repowering, i.e. replacing old wind turbines by more modern ones, and as a general rule the technical sophistication of the turbines increased continuously during that decade. As a consequence one should have expected increasing capacity factors (CF's). Alas, the data show a visible negative trend and a great amplitude between 0.160 and 0.205. This decade suggests a periodicity of about 4 years and a possible ongoing down trend (largely caused by lower windspeed).

The conclusion is that increasing even by a vast amount the number of onshore wind turbines and making an agressive repowering will not increase the CF (here the decadal mean is 0.179). Even a very optimistic fan of wind power should not expect more than 0.20 for onshore wind parks. Shall I recall that classic power stations (fossil, nuclear…) have CF's between 0.80 and 0.90 !

Offshore wind parks surely are much better, but the available numbers in Germany are still small.

The next figure from the report gives the "Volllaststunden" of offshore wind parks for the decade 2002 to 2011; to get the CF divide this number by 8760 (Germans mostly use the "Volllaststunden" which correspond to the virtual yearly working hours with an output equal to the name-plate capacity).

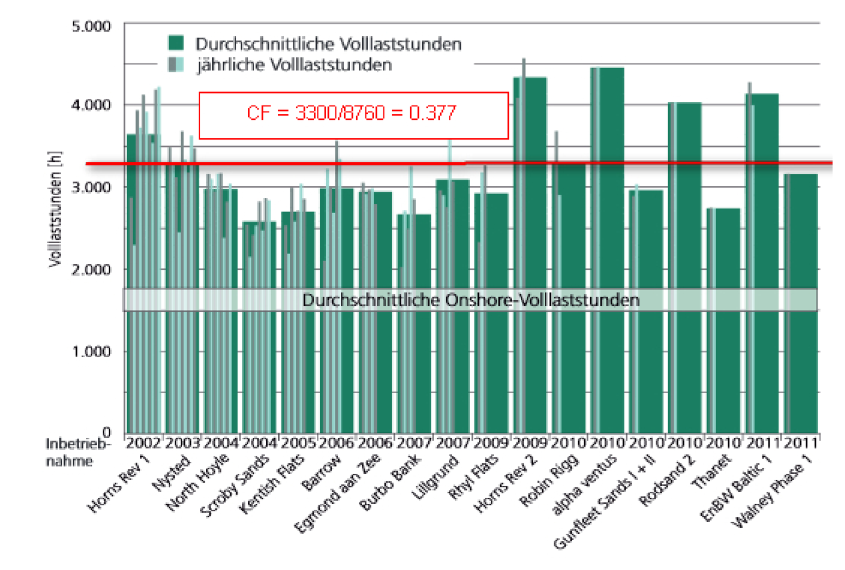


Abbildung 65: Offshore-Volllaststunden verschiedener Windparks ab einer Leistung von 45 MW, Datenquellen: Windparkbetreiber [118–123]

The red line is the estimated average (by eye balling) of ~3300 hours, which gives a CF = 0.377, about two times that of the onshore parks. Note the big differences between the wind parks during the last years!

Conclusion: should the onshore turbines be scrapped and only offshore installations be installed? One big unknown is the reliability of the offshore turbines, which work in much harsher conditions, might have life spans much shorter than the usual 20 years assumed for the land based turbines and possible need much more expensive maintenance.

2. The recycling problem

The report has an interesting chapter on what to do with the big structures when end of life is reached. Steel, concrete and copper cabling do not pose great problems, but nobody knows how to recycle the fiberglass rotors or recuperate the rare earths used in the magnets. For the moment, there is no valid information what happened to the turbines which have been dismounted.. It is suggested that the fiberglass rotors be burned in cement factories. The authors write that "zu den Fragen (Aufgaben, Verantworlichkeiten…) halten sich die Betreiber im Moment noch bedeckt".

3. Running future offshore wind parks.

Offshore wind parks have a big number of wind turbines; it is known that wind turbines work less efficiently in more turbulent air. This means that the second, third etc. turbines in a row (or a matrix) suffer from the turbulence and air velocity reduction created by up-wind located systems. IWES found that slowing down the first turbines touched by the wind increases remarkably overall performance, as shown in the next graph:

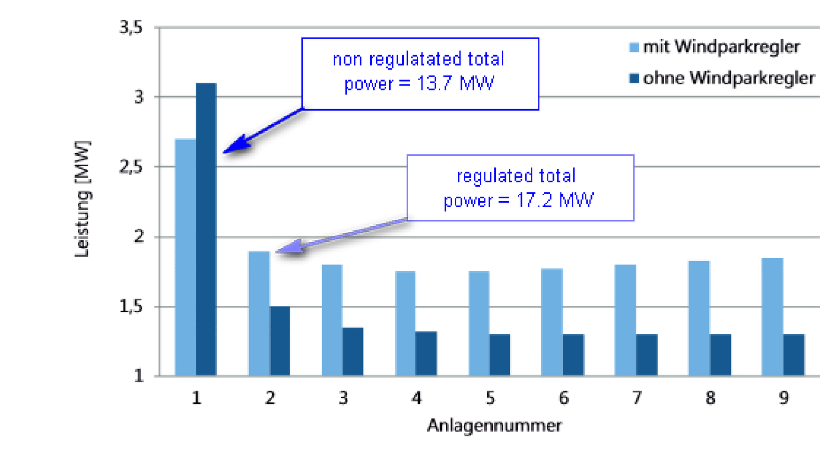
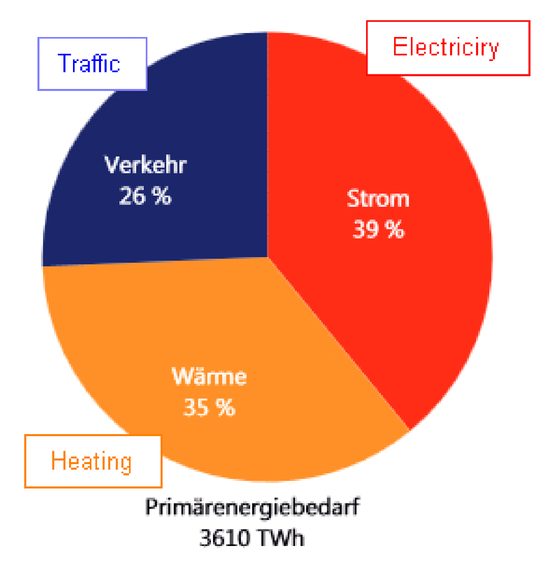


Abbildung 4: Leistung an neun hintereinander stehenden Windenergieanlagen mit und ohne zentralen Windparkregler (WPR). Wird die vorderste Anlage gedrosselt gefahren, erhöht dies die Gesamtproduktion.

Putting a restriction on the first of 9 turbines in a row increases total power by about 25%. This shows that an intelligent regulation system is mandatory for offshore wind parks.

4. "All electric" future.

The IWES sees the German energy future as a total electric one, with electricity produced exclusively from "renewable" fuels: hydro, biomass (biogas), wind, solar and geothermal. Note that CO2-free nuclear power is completely absent in this scenario. Fossil sources like oil will practically only be permitted as a feedstock for chemistry. The next figure, probably from a simulation run (text boxes added by me), gives the total yearly energy consumed in 2013 for different parts of activity and life:



In 2011 Germany used 3772 -285 = 3487 TWh energy for these 3 activities; the 285 TWh were needed for other activities. If the future is "all-electric" and "renewable", this is the total which must be delivered by hydro, wind, biomass, solar and possibly for a very small fraction, geothermal sources. In 2013, these renewables delivered about 147 TWh, which means that without major savings through increased efficiency the renewables must be upped by a **factor of 25** ! Let us make a very, very optimistic hypothesis that heating requirements will be half of what they are today and that better efficiency of electrical cars and transportation systems will down the traffic (=transportation) requirements also by 50% . This still leaves about 2509 TWh to be produced by renewables. In 2013 wind energy delivered about 47 TWh, biomass ~29 TWh, solar PV ~19 TWh and hydro ~ 14 TWh. Hydro power is nearly at its maximum; biomass also can not be upped tremendously, as no supplementary soil can be used for growing energy plants. This means that wind and solar PV will have to take the burden to deliver at least 2400 TWh. Without any revolution in electricity storage, and even with smart grid technology, at least 2 times of these 2400 TWh must be installed, to be sure that a minimum baseload is always available. These numbers make me dizzy, and I wonder where the surfaces to install the new systems will be found.

Now let us assume that by a twist of German public mood nuclear power would make a come back. A modern nuclear facility of say 4000 MW has an efficiency of about 80%, so it will deliver a baseload of 28 TWh per year. Dividing 3610 by 28 gives 129 nuclear installations, each needing about 2-3 km2, which gives a total of less than 400 km2 occupied land or sea surface. A report from the NREL gives the needed permanent area for wind parks as 0.3 hectar/MW, probably a non-realistic low number as new environmental restrictions ("10H Regel") impose larger and larger distances from dwellings.. Now let us assume that 1200 TWh must be delivered by wind (the other half coming from solar PV on roofs or other sources which minimum land area usage). Assuming an overall capacity factor of 0.3 (which would correspond to a huge increase on offshore installations), the needed name-plate power will be (1200*1E6/8760)/0.3 = 456620 MW, and the occupied land/sea area ~137000 hectar = 1370 km2. The same energy delivered by nuclear facilities would need less than 200 km2, more than 6 times less, and would be non-intermittent and reliable.

IWES assumes that the all-electricity scenario will need only 1000 TWh, (with big electrical lorries using a system of trolley overhead feeding!). In my opinion, a future with more and more energy restrictions will not be tolerated by the public (and rightly so!). Progress which will turn us back to a permanent type of post WWII rationing might be palatable to the Greens who hold political power today, but not to their children and children's children.

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