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Is there an upper limit for wind and solar grid penetration?

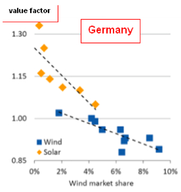
1. Germany's negative electricity prices.

We often read in the press that German wind and solar electricity exceeds the demand, and must be exported at very low or even negative prices. Agora Energiewende writes in June 2014 that the situation of negative prices becomes more frequent, as the conventional fossil and nuclear producers can not diminish their minimum production (the "spinning reserve") below 20 to 25 GW (often also called the "must run minimum production"). If all things remain as they are, Agora predicts more than 1000 hours per year of negative electricity prices for 2022 ! But they also say that up until know, renewables never were able to produce more than 65% of the demand, even during peak production periods. The excess in production leading to negative prices is caused by the impossibility of intermittent renewables to guarantee the needed electrical power at every moment of the year. Conclusion: wind and solar (the main renewables) are unsteady (and often unpredictable) producers which absolutely need spinning reserve to have year round electricity availability.

2. Is there an upper limit for renewable producers in a stable electrical grid?

This question has been researched by Jesse Jenkins (MIT) and Alex Trembath (from the Breakthrough Institute). They came to a very easy to memorize rule of thumb: "**When wind and solar work without subsidies** (as do other producers)**, the maximum amount of their part in the total power production of the grid is equal to their capacity factor".**

They give the following graph from another publication showing the decline in the value factor of Wind and Solar electricity with increasing market share in Germany (boxes added by me):



The value factor = (market price from wind&solar generation)/(average market price). The negative trend for the solar electricity is especially sobering.

Conclusion: Economics, and not so much technology impose an upper limit for the integration of wind & solar electricity.

Let me give two examples:

A. Rheinland-Pfalz (the German Land bordering on Luxembourg) , 2013 (see link):

Production from wind and solar: 3041916 MWh and 1369808 MWh

Capacity factors: 0.151 for wind and 0.092 for solar

Fraction of the total power produced: 0.203 for wind and 0.091 for solar

Conclusion: Wind production exceeds the limit given by the rule of thumb, and solar power has reached its maximum.

B. Luxembourg, 2013 (see link1 and link2):

Production from wind and solar: 83027 MWh and 73738 MWh

Capacity factors: 0.162 for wind and 0.089 for solar

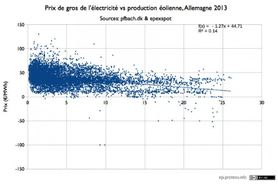
Fraction of total power produced: 0.029 for wind and 0.026 for solar

Conclusion: Wind and solar productions are both well below the rule of thumb limit.

3. Two other papers/comments on this problem

Proteos writes in his French blog: "Les subventions à l'éolienne et au solaire sont parties pour durer":

He writes that wind and solar have a marginal zero price (as wind and solar energy has no price), so on average they get a price which is lower than the average market price, and with increased renewable penetration, this price is falling (picture shows German situation):

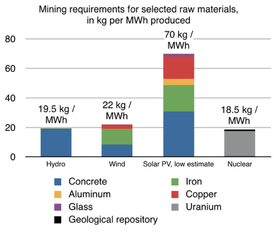


Without subsidies, these renewable producers will go out of business, as will the conventional producers which deliver the base-load and spinning reserve. Finally all power producers must be subsidized to have a working electrical infrastructure and power.

JM. Korhonen writes in his blog: About 20% of wind and 74% of solar production are worthless, and under a free market, the renewables revolution will stop dead on its tracks once peak production reaches demand. He also is skeptic of the much touted "demand site management" (to be introduced with the smart meters), which will not avoid PV hitting a wall.

4. A limit imposed by material requirements.

Korhonen cites a 2013 paper by Vidal et al. published in Nature Geoscience with estimates of the extraordinary huge amounts of concrete, aluminium, copper and glass needed by wind and solar, if 25000 TWh world production would be reached in 2050. From 2035 on these requirements would outstrip the year 2010 **total** world production. The next figure is self-explaining:



Note that despite all the hulla-bahoo about uranium mining nuclear power comes out best!

5. Overall conclusion

Let me give this in the words of Korhonen:

"In conclusion, we may very well have too much of a good thing. And this is something that bears remembering the next time someone tells you that renewable overproduction is not a problem, or that renewables are reducing electricity prices and making existing plants uncompetitive. Or applauds, when 50% (or some other figure) of daily electricity production is met from renewable sources."

As so often, reality bites harder than the teeth of naive greenies!

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