Wind and Solar: Intermittency, storage and backup (part 1).

A couple of recent papers/studies make a thorough analysis of the German Energiewende and the new problems caused by relying more and more on intermittent producers. The first paper is by Friedrich Wagner from the Max-Planck Institut für Plasmaphysik. Titled "**Surplus from and storage of electricity generated by intermittent sources**" it was published in December 2016 in the European Physical Journal Plus (link). The second is part 1 of a two part study published by VGB Powertech in June 2017. The authors are Thomas Linnemann and Guido S. Vallana, and the title is "**Windenergie in Deutschland. Teil 1: Entwicklungen in Deutschland seit dem Jahr 2010**" (link) .The link points to the original version in German, but an English translation will be available soon.

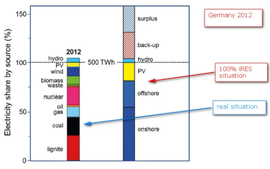
I wrote a comment on this last paper titled "**Vom Winde verweht**", adding some reflections concerning the situation in Luxembourg; this has been published in the Saturday 5th August 2017 edition of the Luxemburger Wort, Luxembourg's largest newspaper.

1. **A switch from demand orientated to supply driven.**

One of the most important aspects in the rush to decarbonize the electricity sector is that a fundamental change is planned to enable the functioning of intermittent suppliers like wind and solar. The traditional electricity market is demand driven: the client has a certain maximum intensity hardwired in his counter or inbox (say 32 A or 64 A per phase, usually there are 3 phases); he can rely on this maximum which will be available at all time (but possibly at a different price according to a predefined peak or low demand period per day); the electricity supplier must do his best that the power asked for will be delivered at the correct voltage and frequency.
The new planned situation will see a swapping of the roles: the supplier decides what electrical energy he will deliver and at what price, and the consumer must accept. Smart meters allow very fine-grained changes of the tariff, which can be modified for very short time-segments; the maximum power can be throttled down if needed. All this is called DSM (demand side management), and practically robs the consumer of its freedom of lifestyle or consumption pattern. All this because the extremely variable iRES (intermittent Renewable Energy Sources) can not guaranty a previously defined standard base-load. This supply driven "market" may recall to the older of us memories of the life in the former east-European communist states (like the DDR), where complicated 5 year state plans ruled the economy; it seems like an irony that such a life-style will be hyped as progressive by the iRES lobbyists.

2. Unavoidable surplus and huge backup

F. Wagner's paper gives some very interesting numbers, concerning an electricity market based on wind and solar alone. He assumes that fuels from biomass will be used for aviation, heavy machinery and big lorry transport, so biomass is not included among the future zero-carbon electricity market. Neither is hydroelectricity, which has practically reached a limit in Germany. He assumes that the future electricity consumption will be 500 TWh per year, which is a rather conservative (low) number if one thinks of the political push for electrical cars. A first conclusion is that in the wind/solar mix, solar PV electricity must not exceed about 20-25%, so there will be no equal sharing between wind and solar. The next figure (fig.2 of report added text-boxes) shows how this scenario, if it had been applied, would have worked out in 2012:



To guarantee supply, a huge backup infrastructure of 131 TWh must be installed (which corresponds to 73 GW installed capacity), and on top a yearly 131 TWh surplus energy will be unavoidable. The calculation show that when iRES sources contribute less than 25%, no surplus will be generated. In the 100% scenario, the unavoidable and strongly variable surplus which will quickly become a liability as there will be no consumer available to pay for it (note that negative price periods are becoming more and more frequent at the EEX exchange); **this means that onshore wind turbines must be shutdown every year for a total period of about one month!**

Speaking of surplus, the first answer of iRES advocates is electricity storage (in batteries, hydro or through chemical transformations). Wagner analysis covers short time day-storage solutions and long-time seasonal storage, which both will be needed. In winter, surplus is strong both during day- and nighttime, so a one day storage will not be enough. In spring, a daily storage solution would show a capacity factor (=efficiency) of 3%, which is ridiculously low. A seasonal storage solution which would avoid any backup infrastructure would demand an enormous capacity of at least 100 GW. Nothing similar does exist, and no technological miracle solution for such a storage is in the pipe-line.

The **conclusions** of F. Wagner's report:

- a 100% iRES electricity production must install a capacity 4 times greater than the demand
- if storage capacity will be delivered by pumped water storage, it must be increased by at least 70 times
- the integral capacity factor of the iRES system will be 18%, and a backup system of about 89% of peak load must be installed
- to nominally replace 20 GW nuclear power, 100 GW iRES power will be needed
- an extremely oversized power supply system must be created
- the Energiewende can not reach its coal of CO2 avoidance (*"there is a clear conflict between political goal and applied method… overproduction by iRES may not be the right way to go"*)

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to be followed by part 2 which discusses the PWG paper

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