

Wind and PV Variations in German Export

On the 15th and 16th April 2013 the German newspaper Handelsblatt had a story about alarming conditions of the German high voltage grid in March. Now the German Federal Grid Agency (Bundesnetzagentur) has issued a report on the supply situation for electricity and gas during the winter season 2012/13¹. The report confirms the critical conditions during the last days of March. The following chart from the report makes a connection between export of electricity and injection of renewable energy.

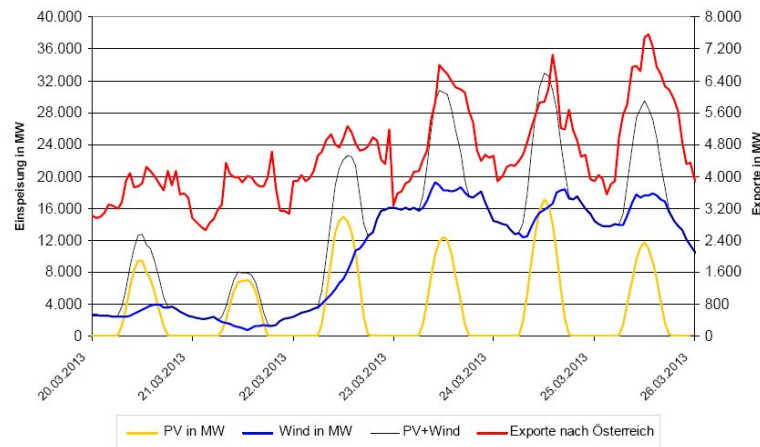
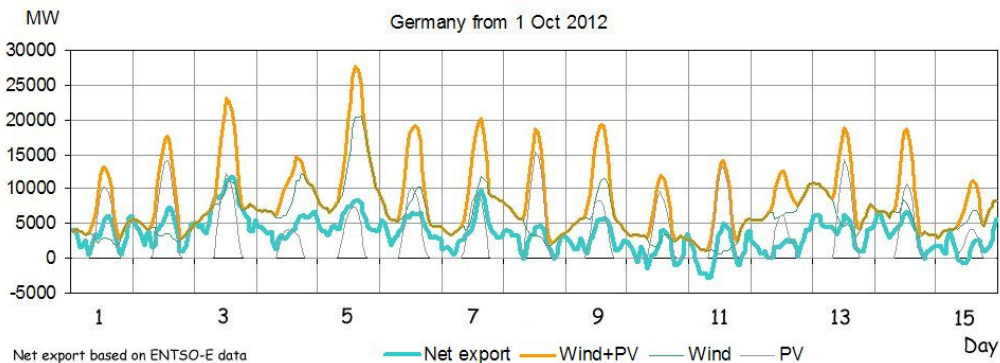


Abbildung 8: Abhängigkeit der Exporte nach Österreich von Photovoltaik- und Windenergieeinspeisung im Zeitraum vom 20. bis 26.3.2013. Quelle: BNetzA

The German export of electricity is increasing in spite of the recent closure of seven nuclear units. In this chart the attention is drawn to the export to Austria.

A more general observation for the winter 2012/13 can be made: German electricity export clearly reflects the variations of wind power and PV. The chart below concerns the first 15 days of October 2012. Any other period would give a similar image.



Germany seems to absorb a considerable part of the variations internally because the export variations are smaller than the RE variations. Nevertheless the dependence on export is a hint that Germany (and Denmark) should put more emphasis on the efficient utilisation of variable energy sources than on the production itself in order to prevent increasing balancing problems in the future.

¹ Bericht zum Zustand der leitungsgebundenen Energieversorgung im Winter 2012/13, Bundesnetzagentur, 20 Juni 2013

In 2009 similar observations were made for Denmark² but local energy experts fiercely denied any connection between wind power and electricity export. By then the Danish production of wind energy was about 20% of the electricity demand. In 2012 the German penetration of renewables in electricity was 8% wind energy and 5% solar energy.

Less strained winter than in 2011/12 but some violations of the n-1 criteria

From the summary of the report (my translation):

- Generally the winter 2012/13 was less strained than the winter 2011/12. Nevertheless, some days occurred with load conditions which could be controlled by partly comprehensive interventions from the transmission grid operators.
- For some hours of the winter it was not possible to operate the transmission grid with n-1 security in spite of comprehensive interventions from the transmission grid operators.

German grid events in the winter 2012/13

- On 4th October 2012 a tornado caused severe damage on several pylons of the double circuit 380 kV line between Pulgar and Vieselbach in the 50Hertz control area. One circuit was ready for provisional operation from 19th October. Both circuits were fully repaired on the 21st February 2013. No violation of the n-1 criteria occurred but the lignite fired power plant Lippendorf was prevented from using its full capacity.
- A local 110 kV supply grid in the 50Hertz control area which was supplied by a single line was disconnected on the 27th October 2012 due to galloping conductors³ of the 220 kV double circuit line Röhrsdorf-Weida. The supply was restored after 30 minutes. The 220 kV line was back in normal operation after 45 minutes.
- On the 25th and 26th March 2013 the grid conditions were particularly strained and during some hours there was no n-1 security for the lines Remptendorf-Redwitz and Mecklar-Dipperz. The reason was a combination of high injection of wind and PV power in the north and low availability of conventional power plants in the south. The preventive re-dispatch was 550 MW, the curative re-dispatch was up to 2620 MW and the wind power curtailment was up to 1390 MW. Reserve capacity was called for in Austria but the call was too late. Therefore the export to Austria attracted special attention.

Voltage problems

The closure of seven nuclear units has removed essential reactive resources from the grid and made it more difficult to keep the grid voltage within permitted limits. Different replacements are being installed. In 2012 the conversion of the generator of the nuclear unit Biblis A into a synchronous compensator was completed and a new 380 kV line was commissioned.

Nevertheless, on 9th and 10th November 2012 critical system conditions occurred in the TenneT grid with voltages above the upper limit. Three 380 kV circuits were disconnected in order to bring the voltages closer to the acceptable limits. For security reasons it was not possible to disconnect more lines.

The commissioning of new inductors at the end of 2012 and at the beginning of 2013 has improved the voltage control. Further improvements are expected from the future new HVDC facilities.

² Wind Energy - The Case of Denmark, CEPOS, 15 Sep 2009

³ See for instance http://en.wikipedia.org/wiki/Conductor_gallop

Re-dispatch measures

The German legislation has paved the way for market interventions in case of grid security problems.

The total duration of re-dispatch measures was 3700 hours for the winter 2012/13 or the same magnitude as in the previous winter.

Six grid elements were exposed to overload for more than 50 hours. The duration and the amount of re-dispatched energy are lower than for the previous winter.

Overloaded Grid element	Duration Hours	Amount MWh
Lehrte-Mehrum	1,565	120,064
Remptendorf - Redwitz	983	521,958
Pulgar-Vieselbach	346	160,610
UW Conneforde	214	29,245
Vierraden - Krajnik (PL)	157	69,194
Wolmirstedt - Helmstedt	121	46,336

Voltage problems in the TenneT control area caused re-dispatch in 720 hours. The amount of re-dispatched energy was 76,860 MWh.

Curtailment of renewable power was necessary for 42 days of which 18 days concerned the 50Hertz control area, 1 day concerned the TenneT control area and 23 days concerned both control areas. The total duration of curtailment of renewables was 724 hours.

Small production reserves in southern Germany

The increased production capacity since the end of 2011 explains the increasing export of electricity.

Capacity in MW	31.12.2011	31.12.2012	Change
Not renewable	98,704	99,613	909
Renewable	65,264	74,625	9,361
Total	163,968	174,238	10,269

German power plant owners have announced intentions to close conventional power plants. Bundesnetzagentur is particularly concerned that power plant closures in the southern part of Germany would bring the security of supply in danger.

A new § 13a of the German Energy Industry Act (EnWG) obliges power plant owners to give at least a 12 months notice before a preliminary or final closure of a power plant.

After having mentioned some specific cases the report says (my translation): "Due to the general shortage of production capacity in the southern Germany and based on current knowledge it can be assumed that no closure of production plants could be permitted within the foreseeable future. It is not expected to be possible to close conventional production units before grid reinforcements have taken place and the nuclear exit is complete."

Spot price variations from north to south

In the winter 2012/13 Sweden and Denmark had slightly lower average day-ahead spot prices than Germany according to table 10 of the report. In Germany's neighbouring countries to the west and the south the spot prices were considerably higher than in Germany.

The table seems to reflect the frequent surplus of production in countries with a considerable share of volatile generation.

Country	Average spot price €/MWh
Germany	41,82
The Netherlands	53,22
France	50,21
Switzerland	52,64
Sweden	39,83
Denmark West	38,40
Denmark East	39,28