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Sunny or Cloudy weather: which impact on electricity from wind and solar?

A guest article by French expert Bernard Chabot

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"You can cut all the flowers but you cannot keep spring from coming" (Pablo Neruda)

From January to May 2013, Germany weather was very different from other years, mainly with less sun than average. To assess if those exceptional conditions had an important impact on electricity production from renewables, we will analyze power production from solar, wind and combined [Wind + PV] in Germany. Results shows that related monthly productivity Nh (expressed in averaged Wh/W.day each month) was less than in the same five first months of 2012, without a dramatic difference if we consider the combination of wind and solar PV production and the total production during the five first months of 2013. In remaining 2013 months, the differences in productivity from wind and solar compared to 2012 could be compensated, and the increase in wind and PV installed power will also contribute to lower the differences in total production in 2013 compared to 2012 or even increase it.

Figure 1 shows on the left the monthly PV production in Germany for the complete 2012 year and for the five first months of 2013. On the right are shown the related mean PV daily productivity ratios ***Nh*** (expressed in Wh/W.day, or equivalent mean hours of operation per day at rated power during the month)**,** defined as the ratio between the mean daily production during the month and the total PV installed power at the start of the month

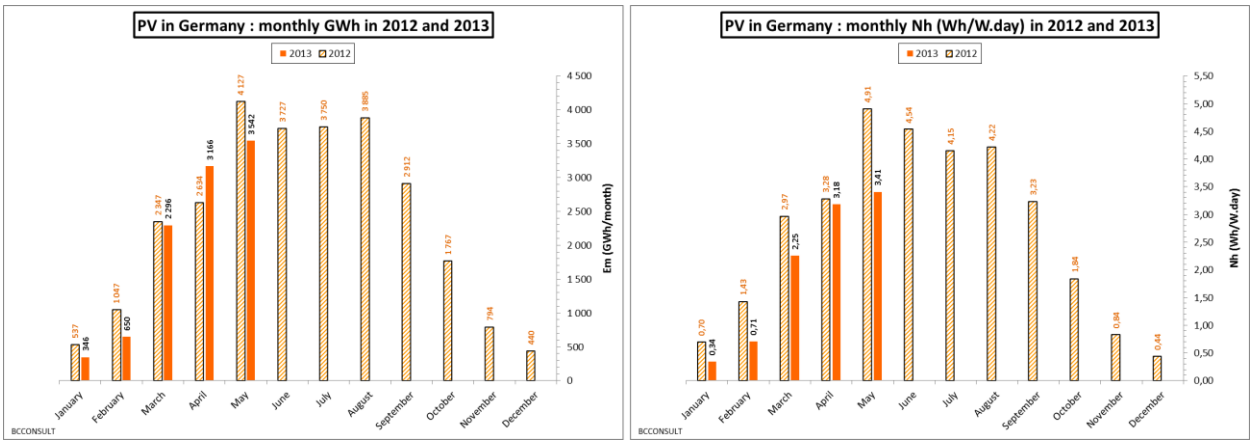

Figure 1: Monthly PV production and mean daily productivity in Germany from January 2012 to May 2013

Same results are shown for wind power in figure 2:

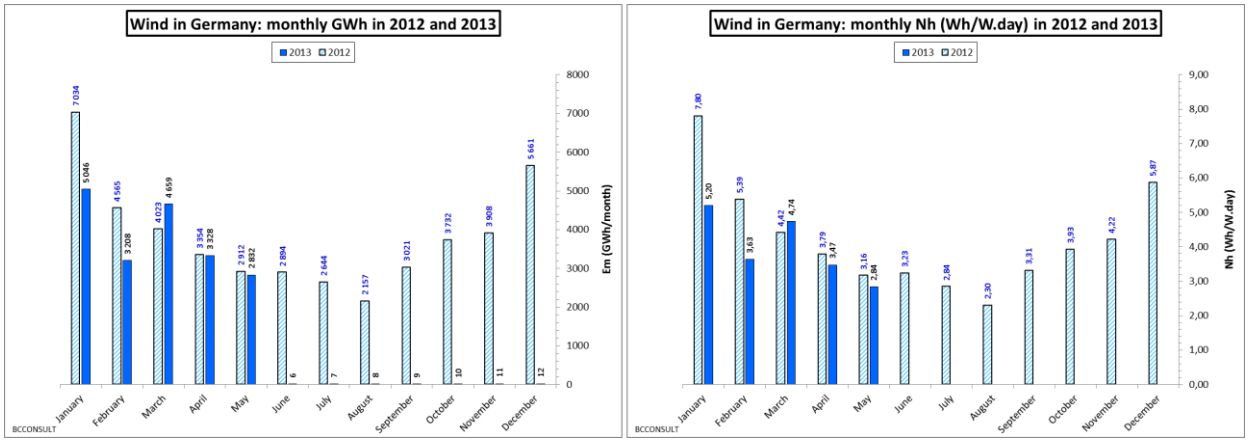

Figure 2: Wind power production and productivity in Germany from January 2012 to May 2013

One can see that the wind and PV production and productivity profiles are complementary during the year. As a consequence, the [wind + PV] production and productivity during the year is more "stable" than the two individual productions, as shown in figure 3:

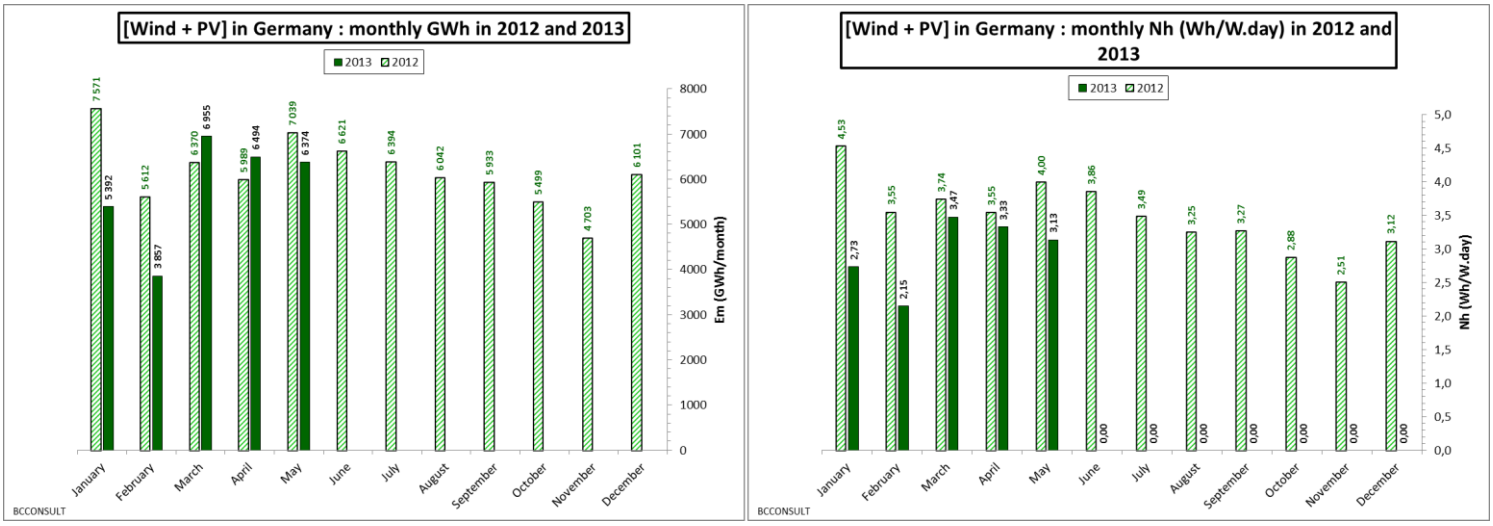

Figure 3: Combined [Wind+PV] power production and productivity in Germany from January 2012 to May 2013

Detailed values for monthly electricity production and productivity ratio are summarized in table 1:

Table 1: monthly electricity production Em (GWh/month) and productivity ratio Nh (averaged h/d)

Em GWh/month	2013			2012		
	PV	Wind	[Wind+PV]	PV	Wind	[Wind+PV]
May	3 542	2 832	6 374	4 127	2 912	7 039
April	3 166	3 328	6 494	2 634	3 354	5 989
March	2 296	4 659	6 955	2 347	4 023	6 370
February	650	3 208	3 857	1 047	4 565	5 612
January	346	5 046	5 392	537	7 034	7 571
January-May	**10 000**	**19 072**	**29 072**	**10 692**	**21 888**	**32 581**

Nh Hour/day	2013			2012		
	PV	Wind	[Wind+PV]	PV	Wind	[Wind+PV]
May	3,41	2,85	3,13	4,91	3,16	4,00
April	3,18	3,48	3,33	3,28	3,79	3,55
March	2,25	4,74	3,47	2,97	4,42	3,74
February	0,71	3,64	2,15	1,43	5,39	3,55
January	0,34	5,20	2,73	0,70	7,80	4,53

The relative changes of those parameters from January to May in 2012 and in 2013 are shown in table 2:

Table 2: Relative changes from 2012 to 2013 of monthly production **Em** and productivity ratio **Nh**:

Changes in monthly production Em (GWh)			
2013/2012	**PV**	**Wind**	**[Wind+PV]**
May	-14,2%	-2,8%	-9,4%
April	20,2%	-0,8%	8,4%
March	-2,2%	15,8%	9,2%
February	-37,9%	-29,7%	-31,3%
January	-35,6%	-28,3%	-28,8%
January-May	**-6,5%**	**-12,9%**	**-10,8%**

Changes in mean daily productivity Nh (h/d)			
2013/2012	**PV**	**Wind**	**[Wind+PV]**
May	-30,6%	-9,9%	-21,6%
April	-3,0%	-8,1%	-6,1%
March	-24,0%	7,4%	-7,1%
February	-50,2%	-32,5%	-39,5%
January	-50,7%	-33,4%	-39,8%

The relative change for solar PV production during the five first months of 2013 versus the same months of 2012 was -6.5 %, compared to a higher value of -12.9 % for wind power (but the January 2012 wind power production was exceptionally high). This may appear "counterintuitive" as a change in sun hours is more evident for us than a change in wind speeds which are more difficult to assess without scientific measurements.

What is interesting is that the change in combined [Wind + PV] production is between those two values at -10.8 %. **So combining wind and PV (with around the same installed base as at present in Germany) "soften" the extreme changes due to weather conditions**.

The maximum monthly relative change in electricity production was in February 2013, both for wind, PV and their combined production, around one third less in 2013 than in 2012.

Changes in averaged daily productivity ratio **Nh** along the five first months of 2013 compared to 2012 (see table 2) are higher than for electricity production, as new wind and solar capacities are added each month. Corresponding maximum values are more than -50% for solar PV in January and February, around -33 % for wind power the same months and around 40 % for their combined production. **Here also, the "softening effect" by combining wind and PV production is noticeable and interesting**.

Figure 4 summarizes the monthly production from wind, PV and conventional power plant larger than 100 MW, with data from reference [1].

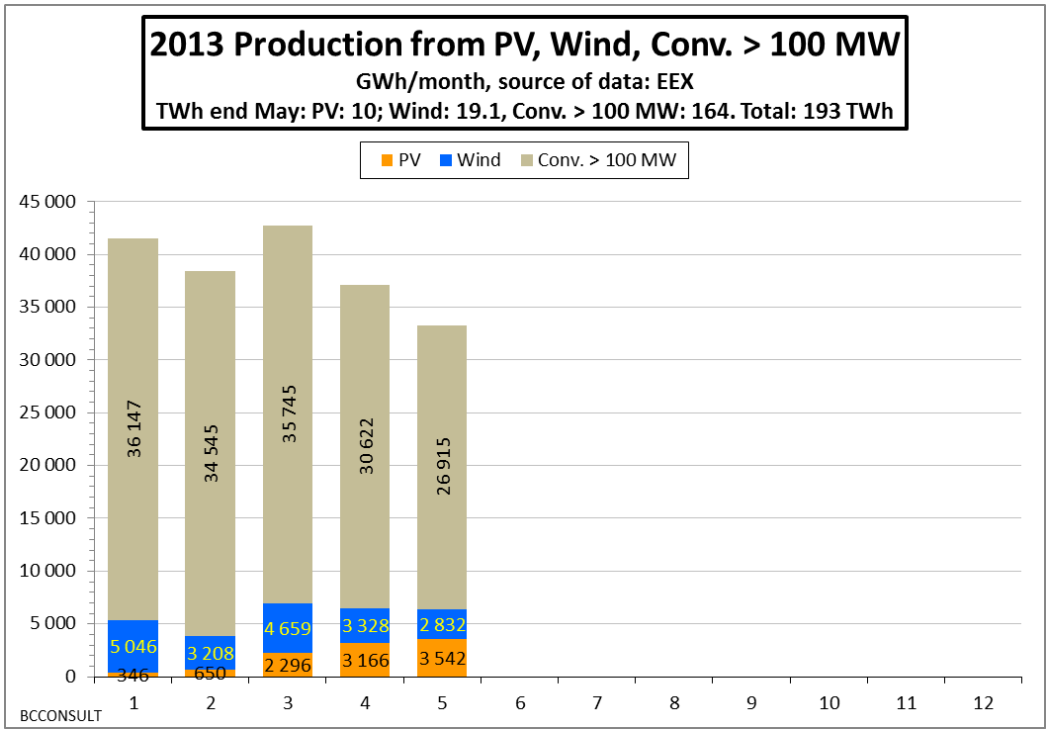

Figure 4: electricity production from wind, PV and conventional large power plants in 2013

The relative corresponding contributions are shown in figure 5. The total [Wind + PV] contribution was minimum in February with 10 %.

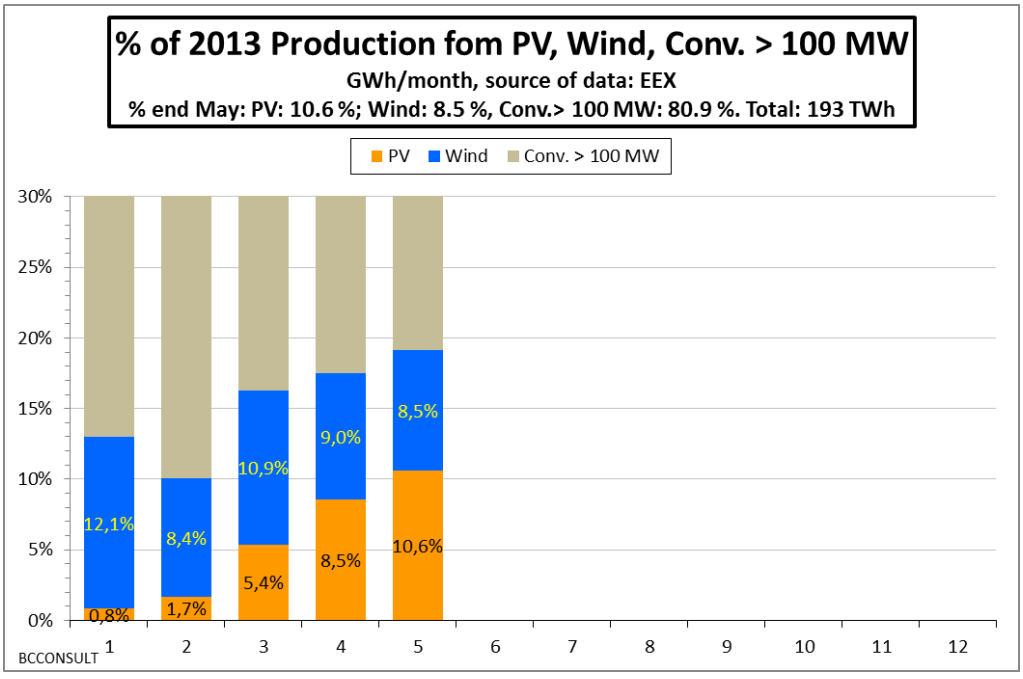

Figure 5: % of production from PV, Wind and large conventional power plants in 2013

The cumulative wind, PV and [Wind + PV] production is shown in figure 6.

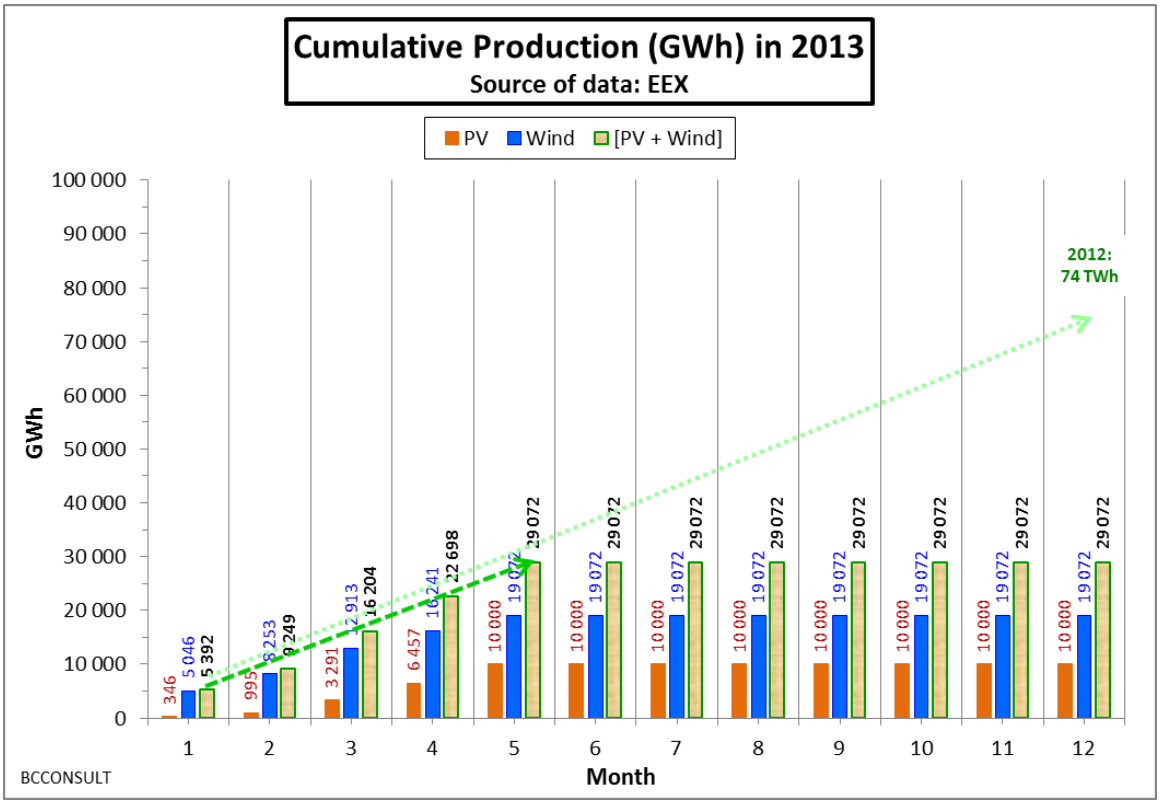

Figure 6: cumulative wind, PV and [Wind + PV] production up to May 2013 and comparison with 2012 trend.

One can see that the 2013 trend is slightly lower than the 2012 one. But the difference is small and could be compensated by an increase of wind and PV production in the remaining months of 2013, resulting from both better meteorological conditions and from additional production of new PV and wind power capacities added from June to December 2013.

In conclusion, once again the advantages of combining solar and wind production are put in evidence, here in case of harsh meteorological condition. And as such conditions could be more frequent in the future due to climate change, this qualitative result should be taken into account within energy and climate policies.

A specific conclusion for wind power is that its larger variability than PV and its relative low productivity ratio experienced in recent years and months would advocate for a fast increase of use of new wind turbines providing higher annual averaged capacity factors in light wind condition (IEC class III conditions), as described in reference [2]

REFERENCES:

[1] EEX web site for PV and wind production:
http://www.transparency.eex.com/en/Statutory%20Publication%20Requirements%20of%20the%20Transmission%20System%20Operators/Power%20generation/Actual%20solar%20power%20generation

[2] Bernard CHABOT "Wind Power Silent Revolution: New Wind Turbines for Light Wind Sites", online May 6, 2013 and downloadable as pdf at the bottom of the web page: http://www.renewablesinternational.net/turbines-in-low-wind-areas/150/505/62498/
