2017

DEUTSCHE WINDGUARD

STATUS OF LAND-BASED WIND ENERGY DEVELOPMENT IN GERMANY

On behalf of:

BWE German Wind Energy Association

VDMA Power Systems

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STATUS OF LAND-BASED WIND ENERGY DEVELOPMENT IN GERMANY

This factsheet provides the most current overview of land-based wind energy development in Germany. Particular attention is paid to the level of new construction in 2017. In addition, the average system configuration and regional distribution, as well as the tendering rounds for land-based wind energy for 2017 are examined.

NET AND GROSS ADDITION

In 2017, the gross addition of land-based wind turbine generators (WTG) in Germany came to 5,334 MW, generated by 1,792 newly erected WTG. This is equivalent to an increase of 15% compared to the previous year. This made 2017 the year with the highest capacity additions since the beginning of wind energy development in Germany. Generating 952 MW, 315 of these WTG were identified as repowering machines that replaced dismantled old WTG. It was found that a total of 387 WTG had been dismantled that together produced 467 MW. The net addition in 2017 came to 4,866 MW. As a result, at the closing of 2017, the cumulative WTG portfolio increased to 28,675 WTG with a cumulative capacity of 50,777 MW. This equates to an increase of the cumulative capacity of 11% compared to the preceding year. Table 1 shows the overall status as of December 31st, 2017 and depicted in Figure 1 is the development of land-based wind energy over time.

Table 1: Status of Land-based Wind Energy Development (2017-12-31)

	Status of Land-based Wind Energy Development	Capacity [MW]	Number of WTG
Development 2017	Gross addition during 2017	5,333.53	1,792
	Repowering share (not binding)	951.77	315
	Dismantling in 2017 (incl. subsequent registration) (not binding)	467.27	387
	Net addition during 2017	4,866.26	1,405
Cumulative 2017-12-31	Cumulative WTG portfolio Status: December 31, 2017 (not binding)	50,776.93	28,675

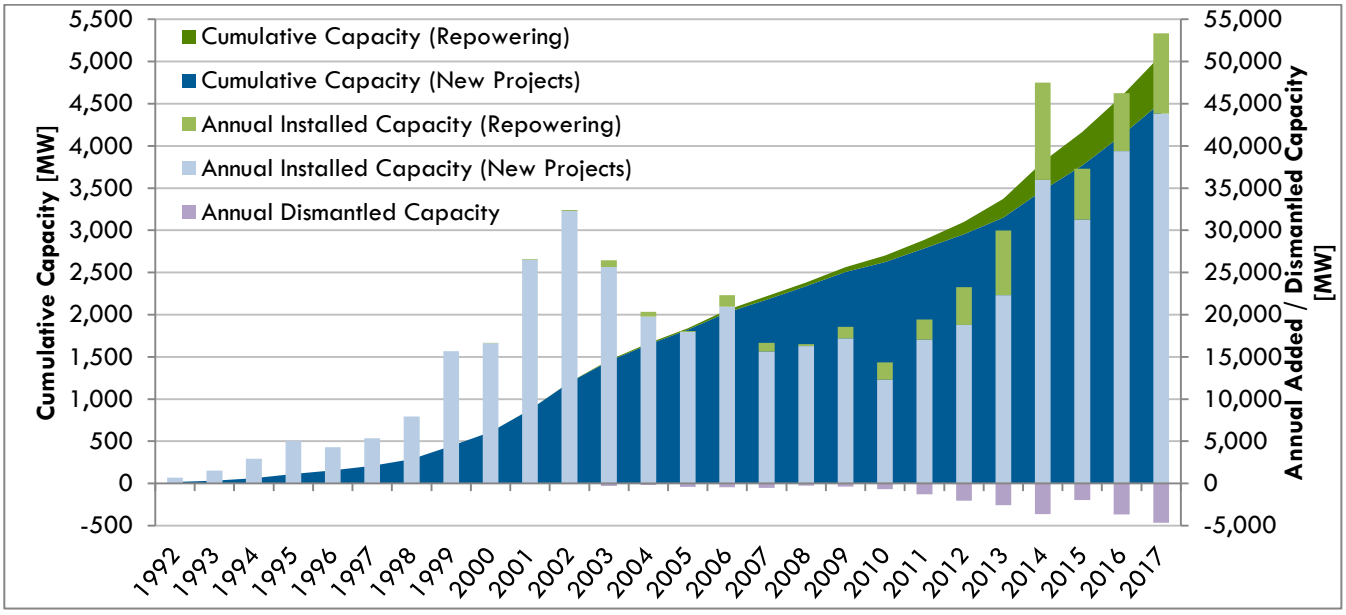

Figure 1: Development of the annual installed and cumulative Capacity (MW) of Land-based Wind Energy in Germany incl. Repowering and Dismantling, as of 2017-12-31

From 2012 onward, data was determined using industry player questionnaires and additional research. Database 1992 – 2011: DEWI.
The figures contain partly rounded values. There may be slight deviations in their addition.

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DISMANTLING AND REPOWERING

For 2017, 387 WTG with a capacity of 467 MW were identified as having been dismantled. This takes reconciliation of decommissionings logged in the WTG register, as well as late registrations for the previous year into consideration. The average capacity of a WTG dismantled in 2017 was 1,207 kW. There are various reasons for decommissioning a WTG. Mainly, turbines are decommissioned if their operation is no longer economically feasible, their technological condition prohibits continued operation or there is high pressure to free up the space occupied by the WTG for new projects, where the old turbines are replaced in a repowering effort. All WTG currently in operation receive at least the base remuneration according to the Renewable Energy Act (EEG) of 2000, as WTG installed prior to 2000 were guaranteed to be eligible for this remuneration until the end of 2020.

As part of the data collection for 2017, out of a total of 1,792 newly erected WTG 315 of them could be identified as repowering WTG. This is equivalent to an identified capacity of 952 MW, which constitutes a share of 18% of the gross additions. The repowering WTG have an average capacity of 3,021 kW.

Shown in Figure 2 is the identified annual newly-added repowering capacity, the dismantled capacity, as well as the share of the capacity of repowering turbines in the annual gross additions over time. The repowering capacity that notably declined following the cancellation of the repowering bonus with the EEG 2014, increased again in 2017 and reached its second highest value since 2014.

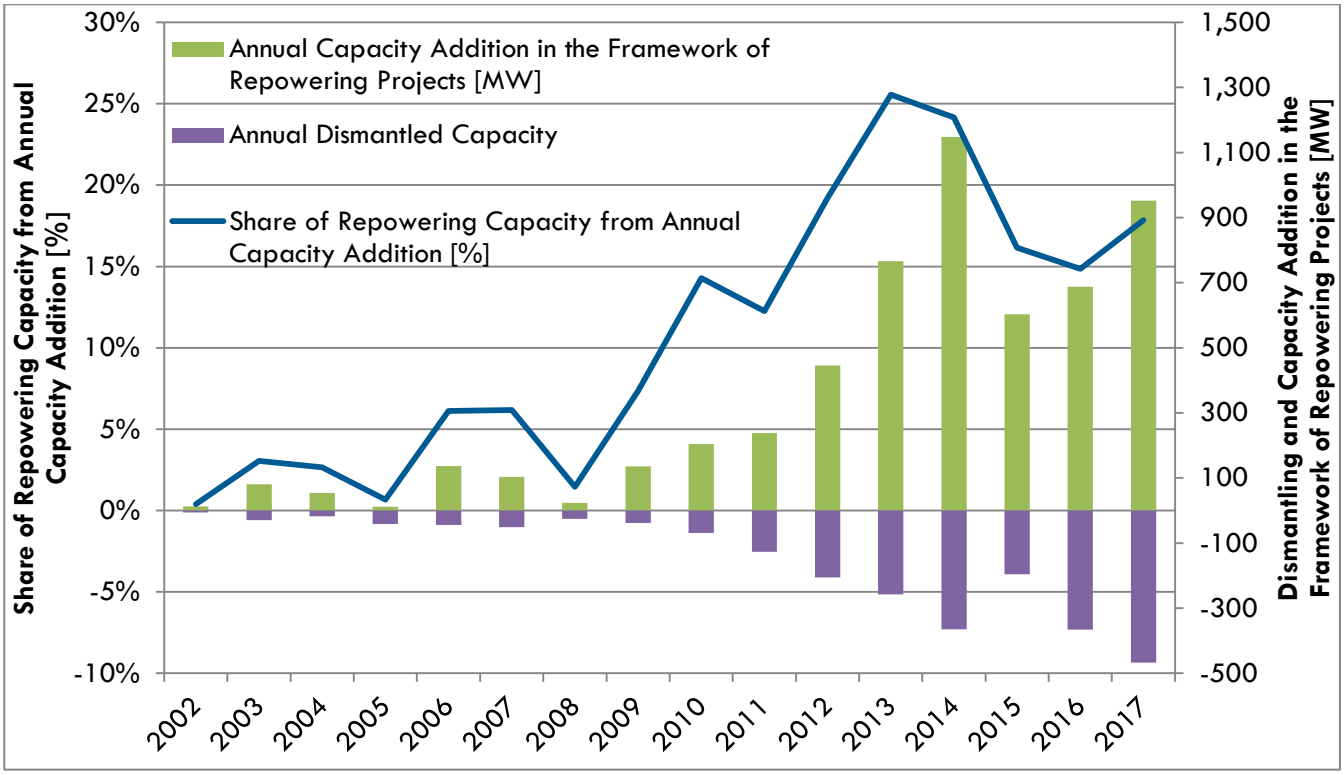

Figure 2: Development of the annual installed, dismantled and cumulative Capacity of Repowering Projects, as of 2017-12-31

From 2012 onward, data was determined using industry player questionnaires and additional research. Database 1992 – 2011: DEWI.
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AVERAGE WIND TURBINE GENERATOR CONFIGURATION

The average WTG configuration as erected in 2017 is summarized in Table 2. When compared to the preceding year, the average nameplate capacity increased by 5% to 2,976 kW and the average rotor diameter of new WTG increased by 3% to 113 meters. Resulting from increasing capacity and rotor area, the specific power of 309 W/m² for 2017 decreased by 2% from that of 2016. The average hub height remained unchanged at 128 m. Hence, the total height of WTG increased by only 1% on average. The development of the average capacity of WTG erected in a particular year and the cumulative portfolio over time is shown in Figure 3. At the end of 2017, the average capacity of each WTG in the total portfolio amounted to 1,771 kW, which denotes an increase of 5% compared to the previous year.

Table 2: Average Configuration of WTG erected in 2017 as of 2017-12-31

	Average Land-based Turbine Configuration, Erected in 2017	
2017	Average Capacity	2,976 kW
	Average Rotor Diameter	113 m
	Average Hub Height	128 m
	Average Specific Power	309 W/m²

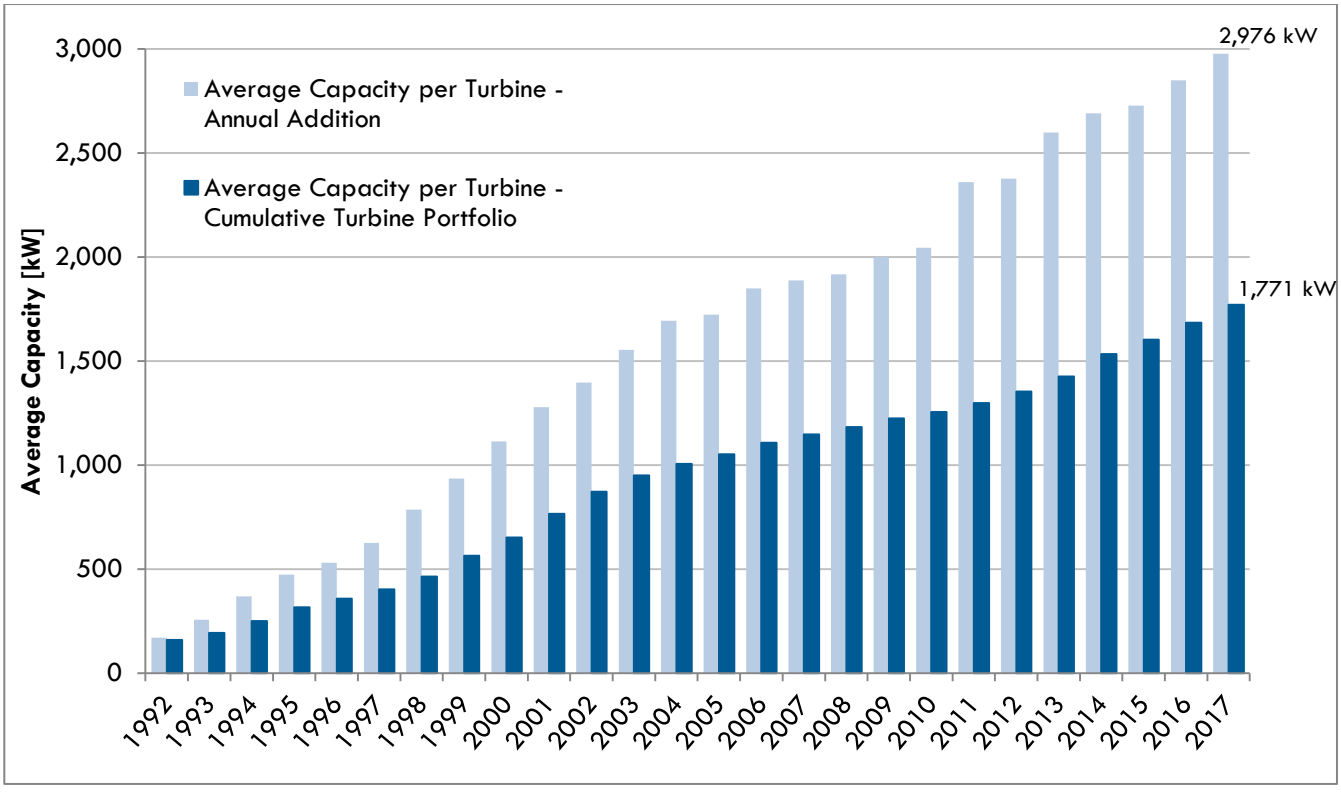

Figure 3: Average Capacity Development of Land-based WTG Newly Installed and Cumulatively Present in the German Turbine Portfolio as of 2017-12-31

From 2012 onward, data was determined using industry player questionnaires and additional research. Database 1992 – 2011: DEWI.
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REGIONAL DISTRIBUTION OF WIND ENERGY ADDITIONS

In comparison to all other federal states, the largest increase in overall new capacity for 2017 occurred in the state of Lower Saxony at 27% and a capacity of 1,436 MW. Lower Saxony is clearly ahead of second-place holder North Rhine-Westphalia at 16% and 870 MW capacity. Schleswig-Holstein (552 MW) and Brandenburg (535 MW) each add about 10% to the Germany-wide wind energy development. Unchanged from 2016, Baden-Wuerttemberg comes in fifth place with an installed capacity of 401 MW and a share of 8%. The remaining federal states combine 1,540 MW (29% of the total additions). In the regional comparison of additions, the northern German states claim 42%, the central states 39% and the southern states 19% of the gross additions.

Table 3: Addition (gross) to Wind Energy in the German States in 2017 as of 2017-12-31

		Gross Additions in 2017			Average Turbine Configuration			
Rank	State	Gross Capacity Addition [MW]	Gross-Number of Added WTG	Share in the Gross Capacity Addition	Average WTG Capacity [kW]	Average Rotor Diameter [m]	Average Hub Height [m]	Average Specific Power [W/m²]
1	Lower Saxony	1,435.92	485	26.9%	2,961	108	124	338
2	North Rhine-Westphalia	869.67	307	16.3%	2,833	112	128	299
3	Schleswig-Holstein	551.82	180	10.3%	3,066	106	96	354
4	Brandenburg	535.25	171	10.0%	3,130	117	138	296
5	Baden-Wuerttemberg	401.20	128	7.5%	3,134	123	145	264
6	Hesse	280.00	94	5.2%	2,979	120	143	264
7	Bavaria	260.70	92	4.9%	2,834	119	138	256
8	Rhineland-Palatinate	244.70	82	4.6%	2,984	112	142	308
9	Saxony-Anhalt	227.20	76	4.3%	2,989	116	130	287
10	Mecklenburg-Western Pomerania	170.95	58	3.2%	2,947	104	123	350
11	Thuringia	138.82	45	2.6%	3,085	118	140	281
12	Saarland	106.85	36	2.0%	2,968	118	138	275
13	Hamburg	49.80	20	0.9%	2,490	111	113	255
14	Saxony	49.25	16	0.9%	3,078	109	122	346
15	Bremen	11.40	2	0.2%	5,700	147	117	324
16	Berlin	0.00	0	0.0%	-	-	-	-
	Total	**5,333.53**	**1,792**	**100%**	**2,976**	**113**	**128**	**309**

Trailing Bremen only due to the installation of a large offshore prototype there in 2017, the on average largest WTG were installed in Baden-Wuerttemberg. With an average nominal capacity of 3,134 kW, 123 meter rotor diameter and 145 meter hub height, these WTG surpass all others. Turbines with the least amount of nominal capacity were installed in North Rhine-Westphalia (2,833 kW), the on average smallest rotor diameter is found in Mecklenburg-Western Pomerania (104 meters) and, just like in previous years, the lowest hub height by far is located in Schleswig-Holstein (96 meters). The WTG with the on average lowest specific area capacities were erected in Hamburg (255 W/m²) and Bavaria (256 W/m²). The largest specific area capacity is found with WTG in Schleswig-Holstein with an average of 354 W/m². Table 3 shows the gross additions, as well as the average turbine configuration according to the German federal states.

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REGIONAL DISTRIBUTION OF THE CUMULATIVE TOTAL PORTFOLIO

Table 4 provides an overview of the cumulative capacity and number of WTG in the individual German federal states. Lower Saxony still leads the state comparison with a cumulative total portfolio of 10,582 MW (6,197 WEA). Along with Schleswig-Holstein, Mecklenburg-Western Pomerania, as well as the city-states of Bremen and Hamburg, it is part of the North Region and accounts for 41.4% of the total capacity portfolio of that Region. Lower Saxony is followed by Schleswig-Holstein with 6,863 MW and Brandenburg with 6,794 MW. The states in Central Region of Germany account for 43.4% of the overall capacity portfolio. Significant growth occurred in North Rhine-Westphalia, pushing Saxony-Anhalt (in the previous year still in second place in the Central Region) to third place. The South Region had a share of 15.3% of the overall capacity installed in Germany. Compared to the preceding year, the internal ranking of the southern federal states remained unchanged. Overall, the share of the cumulative portfolio in the North and Central Regions each decreased by about 0.3% when compared to 2016. The share of the South Region continued its upward trend in 2017 and increased by about 0.6%. Depicted in Figure 4 is the cumulative capacity distribution across the three Regions over time.

Table 4: Cumulative Capacity and Number of WTG in the German Federal States as of 2017-12-31

	Region / State	Cumulative Capacity Status: 2017-12-31 [MW]	Cumulative Number Status: 2017-12-31 [WTG]
North	Lower Saxony	10,582	6,197
	Schleswig-Holstein	6,863	3,658
	Mecklenburg-Western Pomerania	3,253	1,889
	Bremen	185	87
	Hamburg	117	63
Central	Brandenburg	6,794	3,734
	North Rhine-Westphalia	5,449	3,630
	Saxony-Anhalt	5,118	2,863
	Hesse	1,983	1,092
	Thuringia	1,470	837
	Saxony	1,199	891
	Berlin	12	5
South	Rhineland-Palatinate	3,400	1,690
	Bavaria	2,493	1,153
	Baden-Wuerttemberg	1,442	700
	Saarland	416	186
	Total	**50,777**	**28,675**

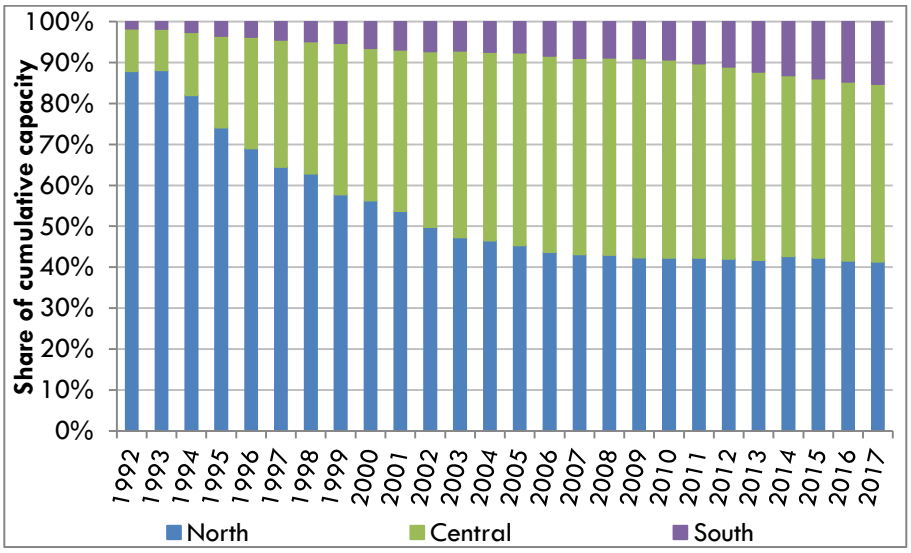

Figure 4: Germany-wide Installed Cumulative Capacity Distribution across the Regions as of 2017-12-31

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PROJECTION OF MONTHLY POWER GENERATION FROM WIND ENERGY

Shown in Figure 5 is the preliminary extrapolation of power generated by land-based wind energy as provided by grid transmission operators. According to this extrapolation, wind turbine generators fed 85.2 TWh of electricity into the German grid in 2017. Compared to 2016, the energy yield increased by 31%. This is partly due to the low-wind situation of the previous year and partly due to the continuously increasing number of turbines and the subsequent capacity feeding into the grid.

A share of 37% of the overall annual electricity production could be claimed in the 4th quarter of the year. The three months of the quarter are those with the highest generation throughout the year, where December truly stands out with regard to land-based generation with more than 12 TWh. As was to be expected, the summer months saw the lowest generation levels. Even though a higher yield was achieved in June, when compared to the previous year, the month from May to September show with on average 4.9 TWh the lowest share of power generation.

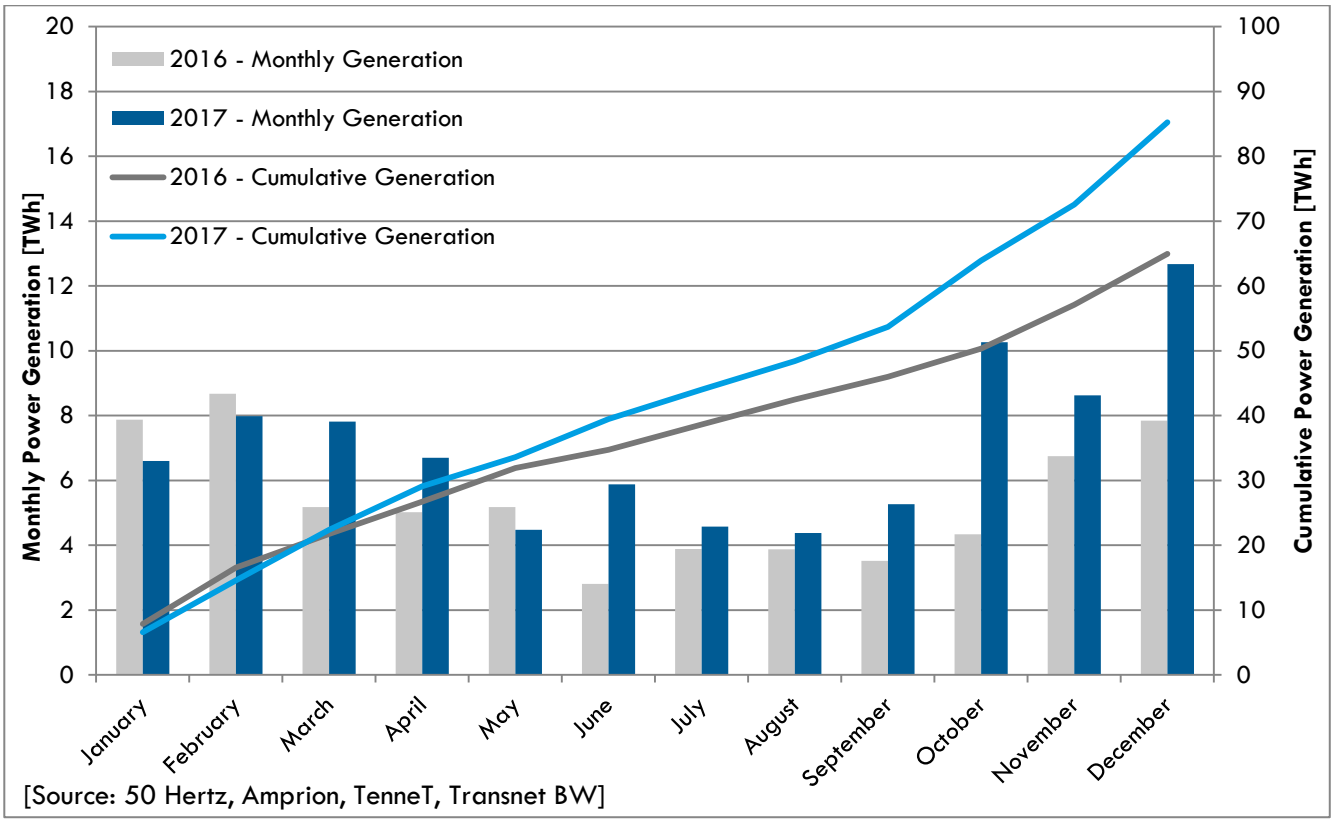

Figure 5: TSO Projection of Electricity Production by Land-based WTG of the Cumulative Portfolio for First Half of 2017 and Previous Year

Offshore wind turbine generators added 17.4 TWh to the annual yield. As a result, the total electricity generated by wind energy in 2017 reached 102.6 TWh, exceeding the generation level of the previous year by 34%. The share of electricity generated by wind from the net power generation is thus anticipated to be nearly 19%. [Source: Fraunhofer ISE].

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WIND TURBINES GENERATORS IN THE TRANSITIONAL SYSTEM

In the EEG 2017, WTG that had received a permit in accordance with the Federal Emissions Control Act (BImSchG) and that had been registered in the turbine register of the German Federal Network Agency (BNetzA) on time, were granted a transitional period. Should these WTG be commissioned prior to the end of 2018, then they would receive remuneration according to the old system and did not have to participate in the tendering system. By the end of 2017, half of this period had already passed. According to the turbine register as of November 2017, about 3,000 WTG having a capacity of 9.1 GW may opt into using this transitional regulation. For 475 MW, this possibility was declined voluntarily and participation in the tendering system was declared. Consequently, the remaining 8.6 GW can be commissioned in 2017 and 2018 according to the transitional regulations. At an overall capacity of 5.3 GW, the WTG installed in 2017 comprise 59% of the capacity that is allowed to be commissioned according to the transitional regulations. This leaves about 3.3 GW that are allowed to be installed and commissioned according to these regulations during 2018. Figure 6 depicts the implementation status of WTG subject to the transitional regulations. A deviation from the data recorded in the turbine register is possible due to various survey methodologies.

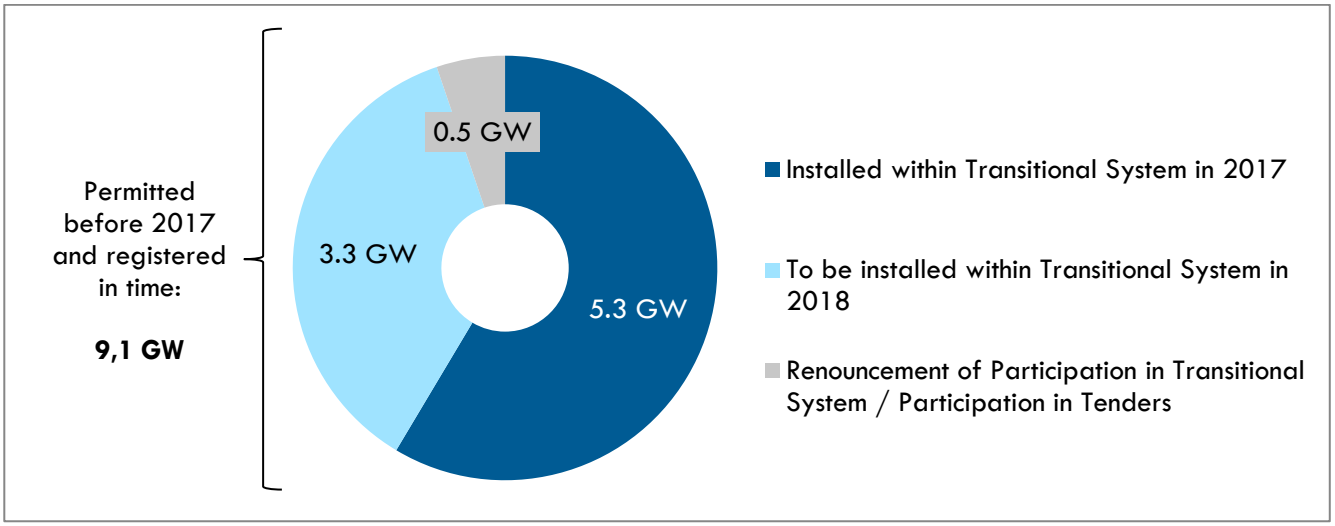

Figure 6: Implementation Status of WTG Transitional System. Registrations in Installations Register as of November 2017

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TENDER FOR LAND-BASED WIND ENERGY IN 2017

The first three tendering rounds for land-based wind energy in Germany were conducted in 2017. The first round consisted of a tendered 800 MW, the subsequent rounds consisted of 1,000 MW each. Bids for 2,820 MW in total were accepted. Of these projects, 94% have not yet received a BImSchG-permit. With bids totaling about 7,655 GW, on average, tenders were oversubscribed to by a factor of 2.7. Figure 7 shows the capacity of the submitted tenders and the granted acceptances for the three tendering rounds of 2017. The distribution of acceptances across the German federal states can be taken from Figure 8. Bids for 814 MW were accepted from Brandenburg and were particularly successful in the second round of tendering. In total, 29% of the accepted capacity is found in this state. Following in second place is Lower Saxony with 576 MW, which is equivalent to 20% of the tendered volume. Projects from North Rhine-Westphalia were particularly successful in the third round of tendering and secured an overall capacity of 368 MW. With Mecklenburg-Western Pomerania (357 MW) and Schleswig-Holstein (214 MW) all three coastal federal states placed in the Top 5. Additional acceptances were given to WTG in Hesse, Thuringia, Saxony-Anhalt, Rhineland-Palatinate, Bavaria and Saxony, that together won 17% of the tendered volume. Projects from Baden-Wuerttemberg were unsuccessful in the first tendering round, while no bids came from Saarland, Berlin, Bremen and Hamburg.

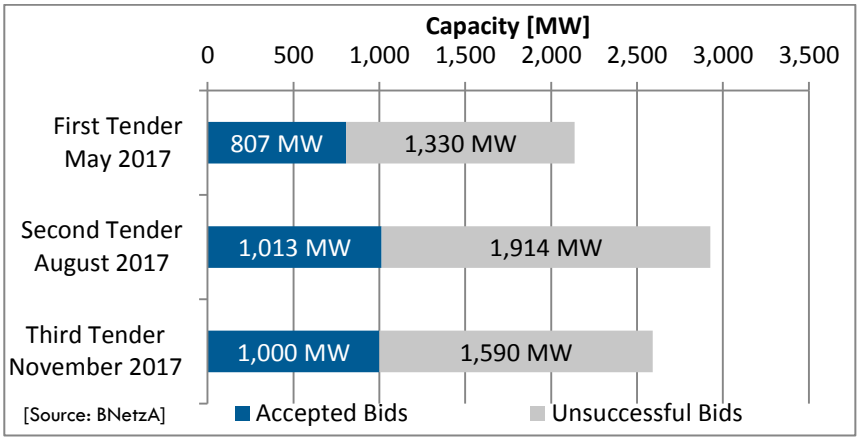

Figure 7: Awards and Bids per Tender for Land-based Wind Energy in the year 2017

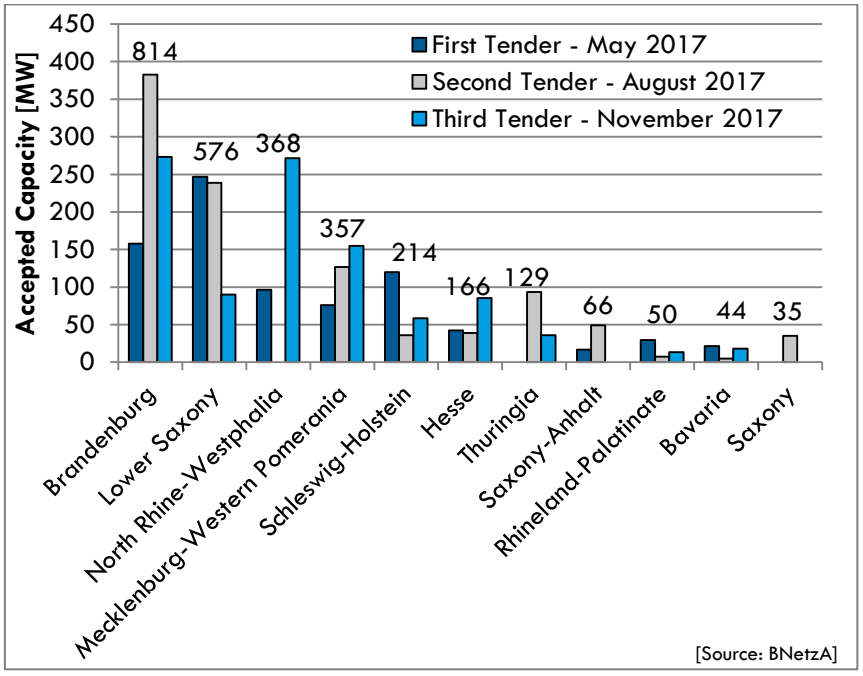

Figure 8: Regional Distribution of per Tender for Land-based Wind Energy in 2017

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TENDER FOR LAND-BASED WIND ENERGY IN 2018 - OUTLOOK

A total of 700 MW of land-based wind energy is anticipated to be tendered in each of the four rounds in 2018. The first two tendering rounds of 2018, scheduled to occur in February and May, are only open to projects that have already received BImSchG permission. According to the BNetzA, permissions totaling 1,697 MW have been registered that are qualified to partake in the first round of 2018. This includes turbines that have foregone participation in the transitional system, those that were registered after the deadline to be considered for the transitional system, as well as WTG that received permits after 2016 and were registered with the BNetzA.

Aside from tenders for capacities solely for wind energy, Germany will see its first tender to allow photovoltaic systems to compete with land-based WTG in 2018. The overall 400 MW that will be tendered to both technologies in April and November 2018 will be deducted from the 2019 tender volume of each individual technology-specific call for tenders. Land-based wind energy tendering volume could thus be reduced by up to 400 MW in 2019, should WTG win against PV systems in the cross-technology tendering process.

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