

**1st Half
2017**

DEUTSCHE
WINDGUARD

STATUS OF LAND-BASED WIND ENERGY DEVELOPMENT IN GERMANY

On behalf of:



Power Systems

STATUS OF LAND-BASED WIND ENERGY DEVELOPMENT IN GERMANY

This statistic analyses the status of land-based wind energy development in Germany as of June 30, 2017. It provides a detailed overview of the additions in the first half of 2017 as well as the total portfolio, including average turbine configuration and regional distribution.

NET AND GROSS ADDITION

In Germany, 790 land-based wind turbine generators (WTG) were installed in the first half of 2017 with a total capacity of 2 281 MW (gross). Compared to the first half of the previous year, this equals an increase of 11% in capacity installations. The dismantling of 146 WTG with a capacity of 167 MW was also identified. This results in a net addition of 644 WTG with 2 114 MW during the first half of 2017. Among the installed turbines, there are 151 repowering WTG with a capacity of 450 MW which replace dismantled turbines.

As of June 30, 2017, the cumulative turbine portfolio increased to 27 914 WTG with a total of 48 024 MW. This corresponds to a 5% increase in

the cumulative installed capacity compared to the portfolio six months earlier. Figure 1 shows the development of land-based wind energy in the course of time, based on the annually installed, dismantled and cumulative capacity.

Table 1: Status of Land-based Wind Energy Development (2017-06-30)

	Status of Land-based Wind Wnergy Development	Capacity [MW]	Number of WTG
Development 1 st Half 2017	Net addition during first half of 2017	2 113.78	644
	Gross addition during first half of 2017	2 280.70	790
	Repowering share	449.75	151
	Dismantling in first half of 2017 (incl. subsequent registration)	166.92	146
Cumulative 2017-06-30	Cumulative WTG portfolio Status: June 30, 2017	48 024.45	27 914

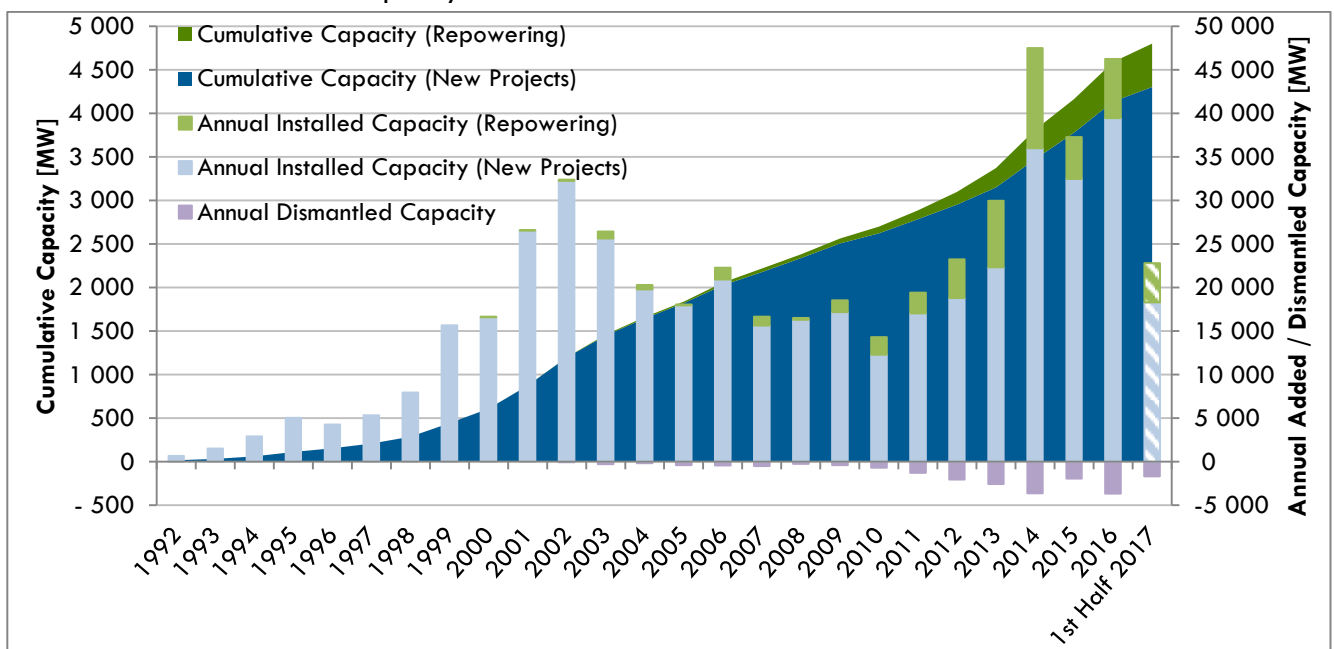


Figure 1: Development of the annual installed and cumulative Capacity (MW) of Land-based Wind Energy in Germany incl. Repowering and Dismantling, as of 2017-06-30

DISMANTLING

In the first half of 2017, a total of 146 dismantled WTG were identified by research, by comparison with the installations register of the Bundesnetzagentur (BNetzA) as well as by consideration of late notifications from the previous year. With the decommissioning of these turbines, a capacity of 167 MW was removed. The average turbine capacity of the WTG dismantled therefore is 1 143 kW while the average dismantling age in the first half of 2017 was 16 years.

One of the reasons to dismantle a WTG is repowering. Due to the limited availability of area suitable for wind energy use, repowering is also carried out without an incentive by EEG bonuses. A lack of license for continued operation or a lack of economic viability can also be decisive for decommissioning. Even old WTG, which were commissioned more than 20 years ago, still are entitled to EEG remuneration. This was ensured to all existing facilities until the end of 2020 when first EEG came into force in 2000.

REPOWERING

151 of the 790 WTG newly installed in the first half-year 2017, were identified as repowering turbines which replace dismantled WTG. In total repowering turbines in the first half of 2017 have a capacity of 450 MW. This equals a 20% repowering share within the gross capacity addition.

Since the repowering bonus has been suspended with the amendment of the EEG in 2014, the definition of a repowering turbine has become more stringent. Previously, a WTG could be classified as a repowering turbine entitled to the bonus, if an old turbine in the same or adjacent county was dismantled. Without the bonus, WTG are regarded as repowering turbines if a new, modern WTG is replaced at the same location. As a result, WTG are no longer regarded as repowering turbines, if the dismantling of old turbines takes place spatially independently, for example, in a neighboring county.

CUMULATIVE PORTFOLIO

As of June 30, 2017, a total of 27 914 wind turbines with a capacity of 48 024 MW were installed in Germany. Compared to the portfolio by the end of the previous year, a capacity increase of about 5% was achieved. Due to a probable underestimation of the dismantling in the years prior to the introduction of the installations register, the cumulative values recorded may deviate from the actual turbine portfolio.

Since August 2014, the BNetzA installations register has provided a better data base, particularly for repowering and dismantling. The reduction was not recorded retroactive for the years before. With the publication of the market master data register (Marktstammdatenregister), which is expected to take place in the autumn of 2017, the data situation can also improve with regard to the accumulated stock. In connection with further data sources, it should be pointed out that the present statistics on the status of the wind energy expansion record the installation of wind turbines reported by the turbine manufacturers. This can be slightly different from the commissioning date, which is recorded in the installations register as well as in the future market master data register.

AVERAGE WIND TURBINE GENERATOR CONFIGURATION

The average turbine generator configuration of the land-based turbines installed in the first half of 2017 in Germany only changed slightly compared to the previous year's installations. The average capacity of the newly constructed wind turbines amounts to 2 887 kW, which is an increase of 1% compared to the previous year. The average rotor diameter is 111 m, which equates to an increase

Table 2: Average Configuration of WTG erected in 2016 as of 2017-06-30

Average Land-based Turbine Configuration, Erected in the First Half of 2017		
1 st Half of 2017	Average WTG Capacity	2 887 kW
	Average Rotor Diameter	111 m
	Average Hub Height	127 m
	Average Specific Power	310 W/m ²

of 1% compared to 2016. And the average hub height decreased by 1% to 127 m. The average total height is thus almost unchanged. The average specific power, which represents the ratio of turbine capacity and swiped rotor area, decreased by 1% to 310 W/m².

The development of the average capacity of the turbines erected in the respective year is drafted in figure 2. The figure also shows the increase in the average capacity in relation to the cumulative portfolio of wind energy turbines in Germany. At 1 728 kW in the first half-year of 2017, the average performance in the cumulative portfolio continued to rise. The increase compared to the end of 2016 is 2%.

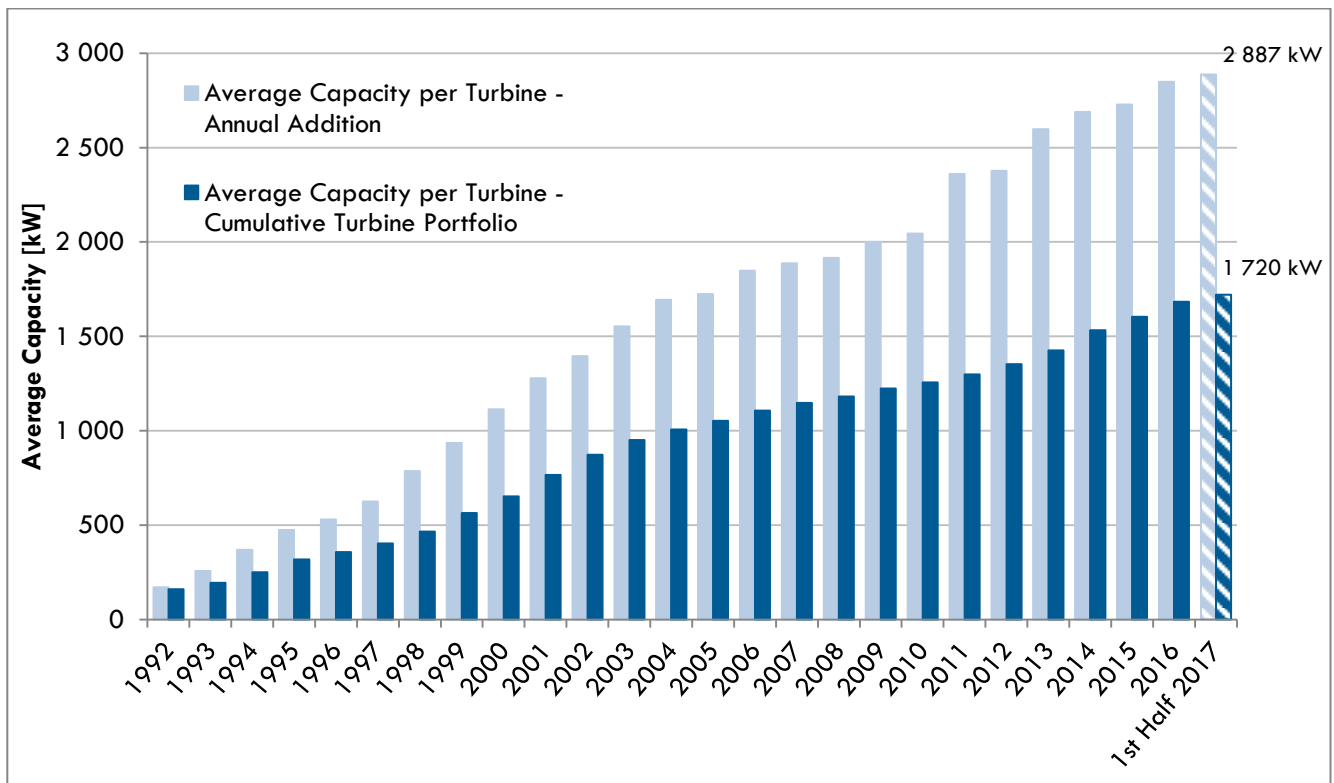


Figure 2: Average Capacity Development of Land-based WTG Newly Installed and Cumulatively Present in the German Turbine Portfolio as of 2017-06-30

From 2012 onward, data was determined using industry player questionnaires and additional research.

Database 1992 – 2011: DEWI

These figures contain partly rounded values. There may be slight deviations in their addition.

REGIONAL DISTRIBUTION OF WIND ENERGY ADDITIONS

As in the previous year, Lower Saxony is at the top of the comparison with the federal states and, with 203 WTG and 577 MW respectively, represents a quarter of the total capacity additions. Second place stands North Rhine-Westphalia at just under 14% of the newly installed capacity. 114 WTG with 314 MW were erected there. Brandenburg is third with 78 WTG and 238 MW respectively. This corresponds to a good 10% of the capacity installed in Germany in the first half of 2017. Nearly 10% and thus ranked fourth is Schleswig-Holstein with 73 WTG and 218 MW. In the regional comparison, the federal states in the north account for 40%, in the center 38% and in the south 22% of the capacity additions.

Table 3: Addition (gross) to Wind Energy in the German States in 2017 as of 2017-06-30

Rank	State	Gross Additions in the First Half of 2017			Average Turbine Configuration			
		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/m ²]
1	Lower Saxony	576.65	203	25.3%	2 841	105	120	348
2	North Rhine-Westphalia	313.50	114	13.7%	2 750	111	126	292
3	Brandenburg	238.15	78	10.4%	3 053	113	136	310
4	Schleswig-Holstein	217.90	73	9.6%	2 985	104	92	364
5	Bavaria	181.90	66	8.0%	2 756	118	138	253
6	Rhineland-Palatinate	141.50	47	6.2%	3 011	114	142	302
7	Hesse	128.30	45	5.6%	2 851	119	140	257
8	Baden-Wuerttemberg	120.10	41	5.3%	2 929	119	143	266
9	Mecklenburg-Western Pomerania	99.35	33	4.4%	3 011	106	124	346
10	Saxony-Anhalt	94.05	31	4.1%	3 034	116	135	293
11	Thuringia	65.65	23	2.9%	2 854	113	137	285
12	Saarland	53.80	19	2.4%	2 832	119	138	257
13	Saxony	31.25	10	1.4%	3 125	109	119	347
14	Hamburg	18.60	7	0.8%	2 657	115	130	256
15	Berlin	0.00	0	0.0%	-	-	-	-
15	Bremen	0.00	0	0.0%	-	-	-	-
	Total	2 280.70	790	100%	2 887	111	127	310

In the first half of 2017, the most powerful generators were installed in Saxony with an average turbine capacity of 3 255 kW. In Hamburg, the smallest average capacity turbine type was used with 2 657 kW. The average rotor diameters were between 104 m and 119 m, the smallest of these was installed in Schleswig-Holstein and the largest in Hesse, Baden-Wuerttemberg and Saarland.

With an average hub height of 92 m, Schleswig-Holstein remains clearly below the average hub height in other federal states, which reached at least an average hub height of 119 m. The highest turbines with an average hub height of 143 m were built in Baden-Wuerttemberg. The specific power, which averaged between 253 W/m² and 364 W/m², is the lowest in Bavaria and the highest in Schleswig-Holstein.

REGIONAL DISTRIBUTION OF THE CUMULATIVE TOTAL PORTFOLIO

With 6 015 WTG and 9 855 MW, the largest share of the turbine portfolio is located in Lower Saxony. Schleswig-Holstein is second with 3 628 WTG and 6 630 MW. Brandenburg with 3 669 WTG and 6 531 MW has the largest cumulative capacity of states in the center of Germany or respectively the third-largest share of all states. In the south, most turbines with the highest cumulative capacity are installed in Rhineland-Palatinate with 1 659 WTG and 3 300 MW.

By the end of the first half year, 41% of the nationwide installed power accounted for the federal states in the north, 43% for the states in

Table 4: Cumulative Capacity and Number of WTG in the German Federal States as of 2017-06-30

Region / State		Cumulative Capacity Status: 2017-06-30 [MW]	Cumulative Number Status: 2017-06-30 [WTG]
North	Lower Saxony	9 855	6 015
	Schleswig-Holstein	6 630	3 628
	Mecklenburg-Western Pomerania	3 186	1 873
	Bremen	174	85
	Hamburg	88	53
Central	Brandenburg	6 531	3 669
	Saxony-Anhalt	4 987	2 821
	North Rhine-Westphalia	4 906	3 447
	Hesse	1 832	1 043
	Thuringia	1 399	816
	Saxony	1 185	889
	Berlin	12	5
	Rhineland-Palatinate	3 300	1 659
South	Bavaria	2 414	1 127
	Baden-Wuerttemberg	1 161	613
	Saarland	363	171
	Total	48 024	27 914

central Germany and another 15% for the southern federal states. Table 4 summarizes the cumulative capacity and the number of turbines by federal states. Compared to the previous year, the cumulative capacity of the northern states as well as the states in the center slightly decreased. In the southern states, the proportion of cumulated capacity increases a little. Figure 3 shows the development of the cumulative capacity distribution over the regions over time.

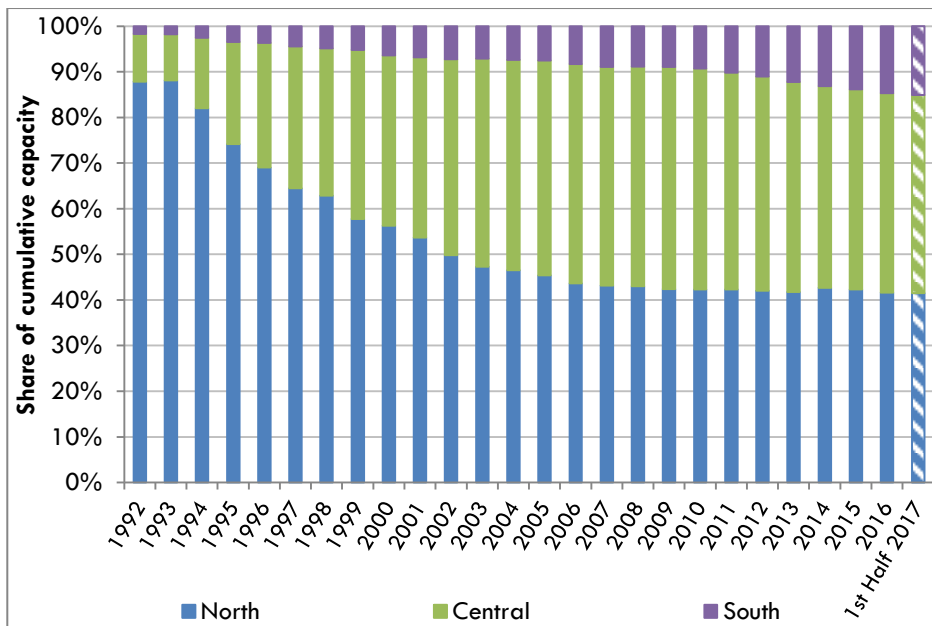


Figure 3: Germany-wide Installed Cumulative Capacity Distribution across the Regions as of 2017-06-30

From 2012 onward, data was determined using industry player questionnaires and additional research.

Database 1992 – 2011: DEWI

These figures contain partly rounded values. There may be slight deviations in their addition.

PROJECTION OF MONTHLY POWER GENERATION FROM WIND ENERGY

A first overview of the expected monthly distribution of wind power generation in the first half of 2017 is provided by the Transmission System Operators (TSO). The data is determined on the basis of measured reference turbines and is extrapolated to the total portfolio. Thus, an estimate of the approximate power generation from wind energy is made. The actual production data will be published in the course of the following year. For a better comparability, additional to the 2017 power generation the extrapolated data for the year 2016 is also presented in figure 4.

According to the extrapolation, a quantity of about 39 TWh of land-based wind power generation was fed into the grid in the first half of 2017. This corresponds to a share of gross electricity consumption of about 13%. Compared to the calculation for the first half of the previous year, an increase in production of 14% can be observed. February was the strongest month in the first half of 2017 with an electricity generation from wind energy of about 8 TWh. At a yield of 4.5 TWh, May was the weakest month of the year.

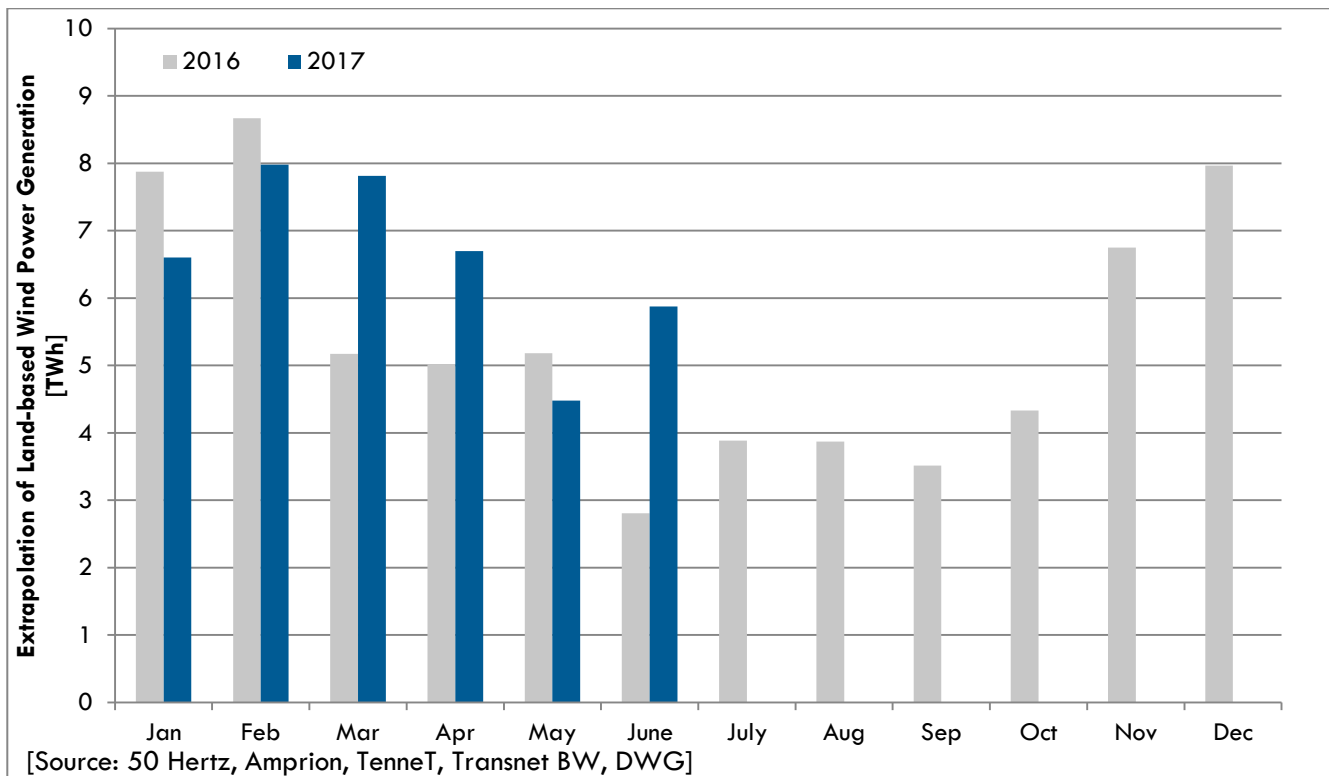
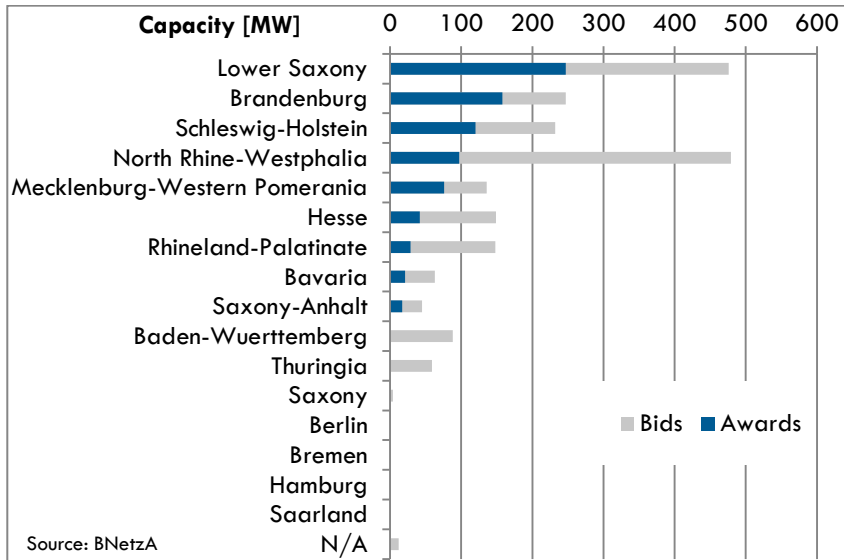


Figure 4: TSO Projection of Electricity Production by Land-based WTG of the Cumulative Portfolio for First Half of 2017 and Previous Year

FIRST TENDER FOR LAND-BASED WIND ENERGY

In May 2017 the first tender for land-based wind energy took place in Germany. In total, in the year 2017 2.8 GW are to be tendered within three rounds. In the first round a capacity of 800 MW was advertised for bids. The awarded projects were published by BNetzA on May 19, 2017. 256 bids with a total capacity of 2 137 MW were received. Thus, the tender was 2.6 times oversubscribed.



70 bids with 224 WTG respectively 807 MW were awarded. Citizen-owned wind farms, as defined in the renewable energy act dominated with 65 accepted bids equaling 96% of the awarded capacity. The capacity allowed for the grid expansion area was exhausted at 258 MW. The accepted bids were between 4.20 and 5.78 ct/kWh. After the adjustment of the bid for the citizen-owned wind farms to the highest accepted bid, the average capacity-weighted award is 5.71 ct/kWh with regard to the

Figure 5: Regional Distribution of Bids and Awards in the First Tender for Land-based Wind Energy

100% reference yield site. The regional distribution of bids and awards is represented in figure 5. Bids were submitted by projects in twelve federal states. The awards are allocated to nine federal states. In the city states and in Saarland, no bids were submitted. None of the bids issued in Baden-Wuerttemberg, Thuringia and Saxony were awarded. With 247 MW, the projects in Lower Saxony were awarded the highest capacity. The success rate (ratio of bids to awards) was 52%. Brandenburg, Schleswig-Holstein, North Rhine-Westphalia and Mecklenburg-Western Pomerania also scored with a high success rate (over 50%). With a comparatively poor success rate of only 20%, North Rhine-Westphalia was awarded only 97 MW despite a high bid volume. The success rate in the federal states is shown in figure 6.

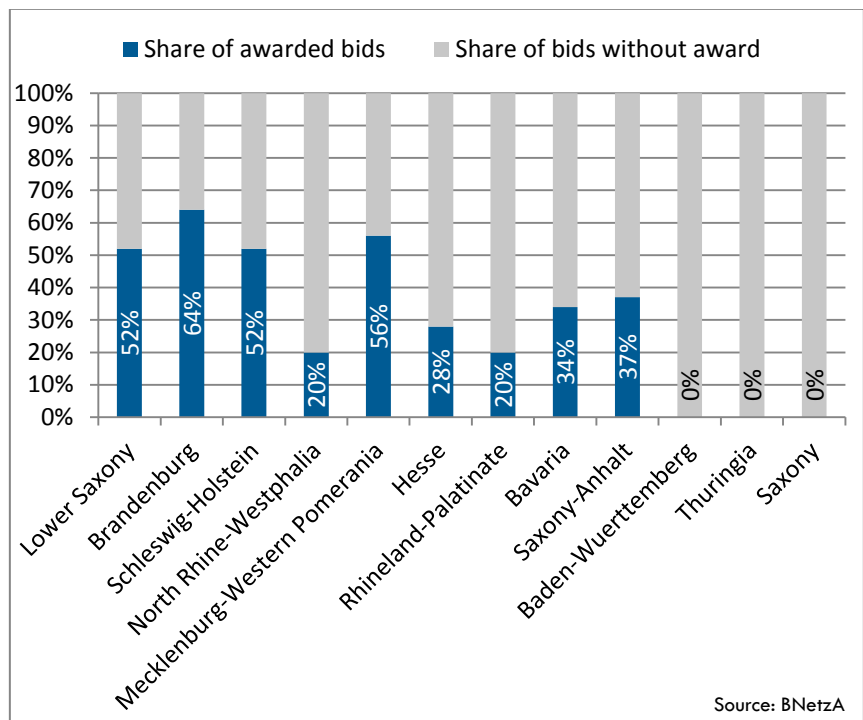


Figure 6: Success Rate in the First Tender by Federal States

From 2012 onward, data was determined using industry player questionnaires and additional research.

Database 1992 – 2011: DEWI

These figures contain partly rounded values. There may be slight deviations in their addition.

WIND TURBINES GENERATOR IN TRANSITION SYSTEM

Wind energy installations which have been approved by the Federal Immission Control Act (BImSchG) by December 31, 2016 and have been reported to BNetzA installations register in time, may be installed under the previous remuneration system and do not have to participate in the tender, if they achieve commissioning by the end of 2018. According to the installations register (reports as of 05/17) 3 039 WTG with 9 107 MW fulfill this requirement. Of this capacity, 475 MW voluntarily renounced the transitional arrangements and thus decided for the participation in the tendering system. This leaves 8 632 MW, which may be installed in 2017 and 2018 under the transitional regulations. According to the installations register (05/17), commissioning was already reported for 607 of these turbines with a capacity of 1 747 MW by end of May. This leaves about 6 886 MW which have not been reported yet and must be put into operation between May 2017 and the end of 2018 in order to remain in the transitional system.

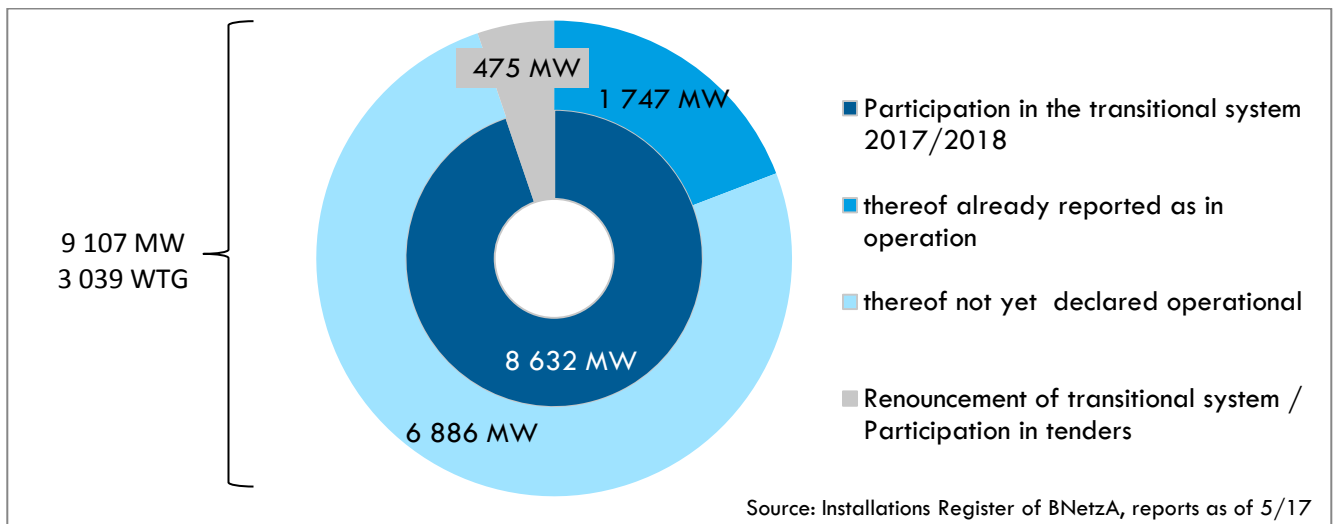


Figure 7: Implementation Status of WTG Transition System. Registrations in Installations Register as of 5/17

SECOND TENDER FOR LAND-BASED WIND ENERGY

The second round of tender for land-based wind energy will take place in August 2017. The tender volume is 1 000 MW. 322 MW of this capacity may be awarded in the grid expansion area. According to BNetzA, permitted wind turbines with a total capacity of 1 225 MW are approved for participation. This includes projects, which waived their participation in the transitional system, which were reported late and therefore may not install within the transitional system as well as projects which were approved in 2017 and reported to the register in time. In addition, projects may participate without a BImSchG-permit, if they are organized as a citizen-owned wind energy project as defined in the EEG 2017. Such projects provided a significant capacity in the first tender and are likely to do so again in further 2017 tenders, as they will not be accepted during the first two rounds of tender in 2018.

Data Collection and Preparation:

Deutsche WindGuard GmbH

Silke Lüers
Dr.-Ing. Knud Rehfeldt
Anna-Kathrin Wallasch
Kerstin Vogelsang

www.windguard.com