1st Half 2018

DEUTSCHE WINDGUARD

STATUS OF LAND-BASED WIND ENERGY DEVELOPMENT IN GERMANY

On Behalf of:

BWE Bundesverband WindEnergie

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STATUS OF LAND-BASED WIND ENERGY DEVELOPMENT IN GERMANY

This factsheet analyzes the most current status of land-based wind energy development in Germany as of June 30th, 2018. Along with the development of new construction, the average wind turbine generator (WTG) configuration, regional distribution for land-based wind energy and the results of the related tendering rounds conducted during the first half of 2018 are examined.

NET AND GROSS ADDITION

In the first half of 2018, a total of 497 WTGs were newly erected in Germany. This is equivalent to a gross addition of 1,626 MW and a decrease of 20% compared to the gross additions of the first half of 2017. New construction contained 88 repowered WTGs, having a total capacity of 297 MW and replaced dismantled WTGs. Having generated a capacity of 121 MW, 101 WTGs were dismantled in the first half of 2018 resulting in a net addition of 1,505 MW. By June 30th, 2018 the captured cumulative WTG portfolio had increased to 29,071 WTGs with a cumulative overall capacity of 52,282 MW. Table 1 shows the overall status of land-based wind energy development and Figure 1 depicts the annually installed, dismantled and cumulative capacity over time.

Table 1: Status of Land-based Wind Energy (2018-06-30)

	Status of Land-based Wind Energy Development	Capacity [MW]	Number of WTG
Development 1st Half 2018	**Gross addition during the first half of 2018**	1,626.05	497
	Repowering share (not binding)	296.50	88
	Dismantling in the first half of 2018 (incl. subsequent registration) (not binding)	120.69	101
	Net addition during the first half of 2018	1,505.36	396
Cumulative 2018-06-30	Cumulative WTG portfolio Status: June 30, 2017 (not binding)	52,282.30	29,071

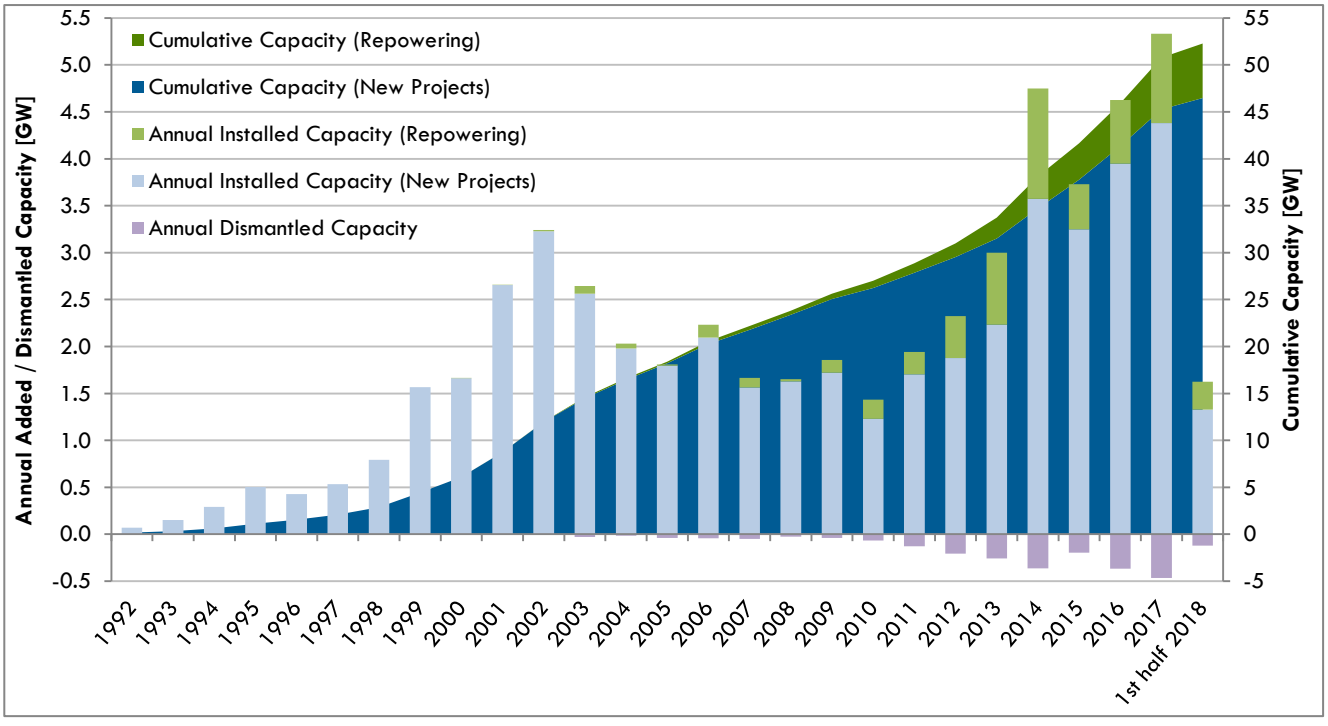

Figure 1: Development of the annual installed and cumulative Capacity (MW) of Land-based Wind Energy in Germany incl. Repowering and Dismantling, as of 2018-06-30

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.

Im Auftrag von: BWE Bundesverband WindEnergie, VDMA Power Systems

AVERAGE WIND TURBINE GENERATOR CONFIGURATION

WTGs erected during the first half of 2018 exhibited an average turbine configuration that diverged from WTGs erected in 2017. Table 2 provides an overview of the average configuration of those WTGs erected in the first half of 2018. The average nominal capacity of 3,272 kW for these WTGs surpassed 3 MW for the first time ever and equates to about a 10% increase compared to the previous year. Compared to 2017, the values of average rotor diameters increased by 5% and average hub heights increased by 7%. The average rotor diameter went from 113 meters in 2017 to 119 meters in the first half of 2018, the average hub height from 128 meters to 137 meters.

Table 2: Average Configuration of WTG installed in the First Half of 2018, as of 2018-06-30

	Average Land-based Turbine Configuration	
1st Half 2018	Average Capacity	3,272 kW
	Average Rotor Diameter	119 m
	Average Hub Height	137 m
	Average Specific Power	299 W/m²

The average specific power, reflecting the relationship between turbine capacity and rotor-sweep area, dropped again (-3%) during the first six months of 2018 to a current value of 299 W/m². The box plots in Figure 2 show the spectrum of the individual characteristic values of WTGs erected in the first half of 2018. The nominal capacity of individual WTGs ranges from 0.8 to 4.2 MW. Most turbines (depicted by the quartiles), however, have capacities of 3.0 to 3.45 MW. The rotor diameter of WTGs erected in the first half of the year is at least 53 meters and at most 141 meters. Minimum and maximum hub heights used during the first half of 2018 is 59 meters and 164 meters, respectively. With regard to rotor diameters, as well as hub heights, the configuration of the majority of turbines is found in the upper area of the spectrum. The average specific power of the turbines erected in the first six months of 2018 falls between 196 und 598 W/m², though more than half of the turbines had a specific power between 274 and 321 W/m².

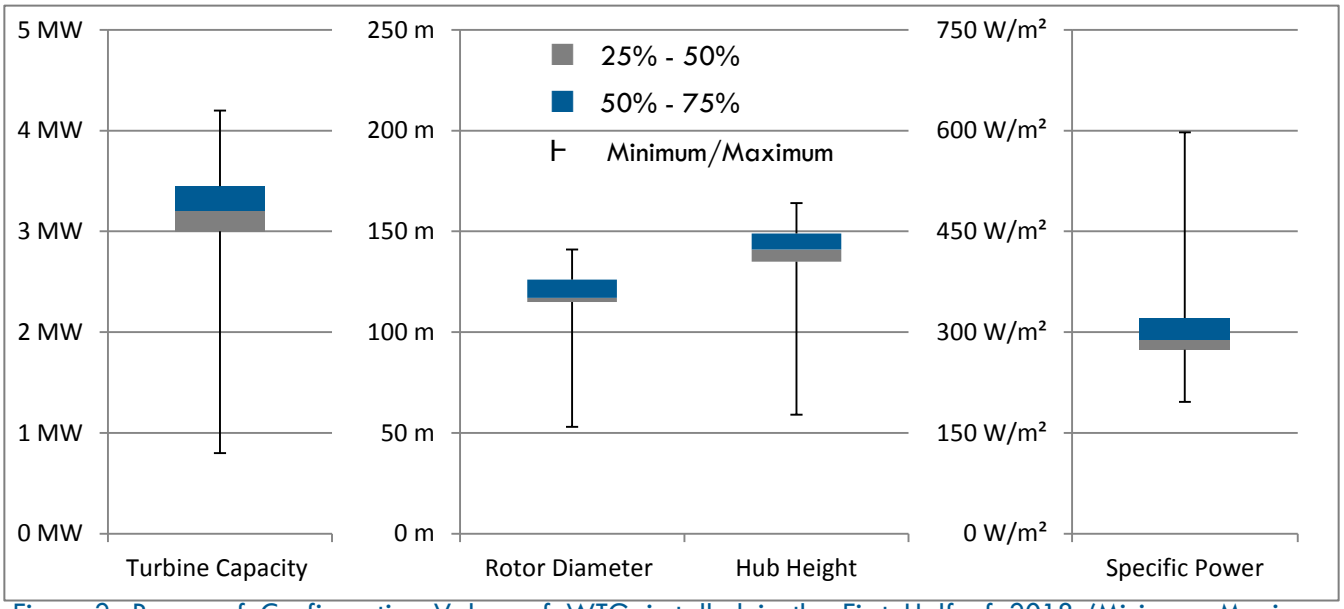

Figure 2: Range of Configuration Values of WTG installed in the First Half of 2018 (Minimum, Maximum, Median, 25% and 75% Quartile), as of 2018-06-30

From 2012 onward, data was determined using industry player questionnaires and additional research. Database 1992 – 2011: DEWI.
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DISMANTLING AND REPOWERING

The decommissioning of WTGs can occur due to various reasons. These include turbines reaching the end of their technical service life, lack of economic profitability or high pressure to free up space for new projects, where the old machines are replaced in a repowering effort. All WTGs currently in operation receive at least the base remuneration, for with the advent of the EEG of the year 2000 WTGs installed prior to 2000 were guaranteed to be eligible for a renewable energy sources act (EEG) remuneration until 2020.

In the first half of 2018, the dismantling of 101 WTGs with an overall capacity of 121 MW was captured. This takes late decommissioning registrations of the previous year, as well as decommissionings published in the German Federal Network Agency (BNetzA) Renewable Energy Core data Register into consideration. The identification of WTGs dismantled in the past is subject to a higher level of uncertainty and is anticipated to remain incomplete regardless of the capture of late registrations.

A certain number of old WTGs were decommissioned as a result of repowering. In the first half of 2018, 88 repowering WTGs with a cumulative capacity of 297 MW were identified, which is equivalent to 18% of the gross addition. Figure 3 shows the overall dismantled capacity, the capacity of annually erected repowering WTGs, as well as the share of repowering capacity compared to the annual gross addition over time. It is obvious that the share of the gross addition is currently increasing following an initial 2015 recession in repowering activities due to the elimination of the repowering bonus (EEG 2014).

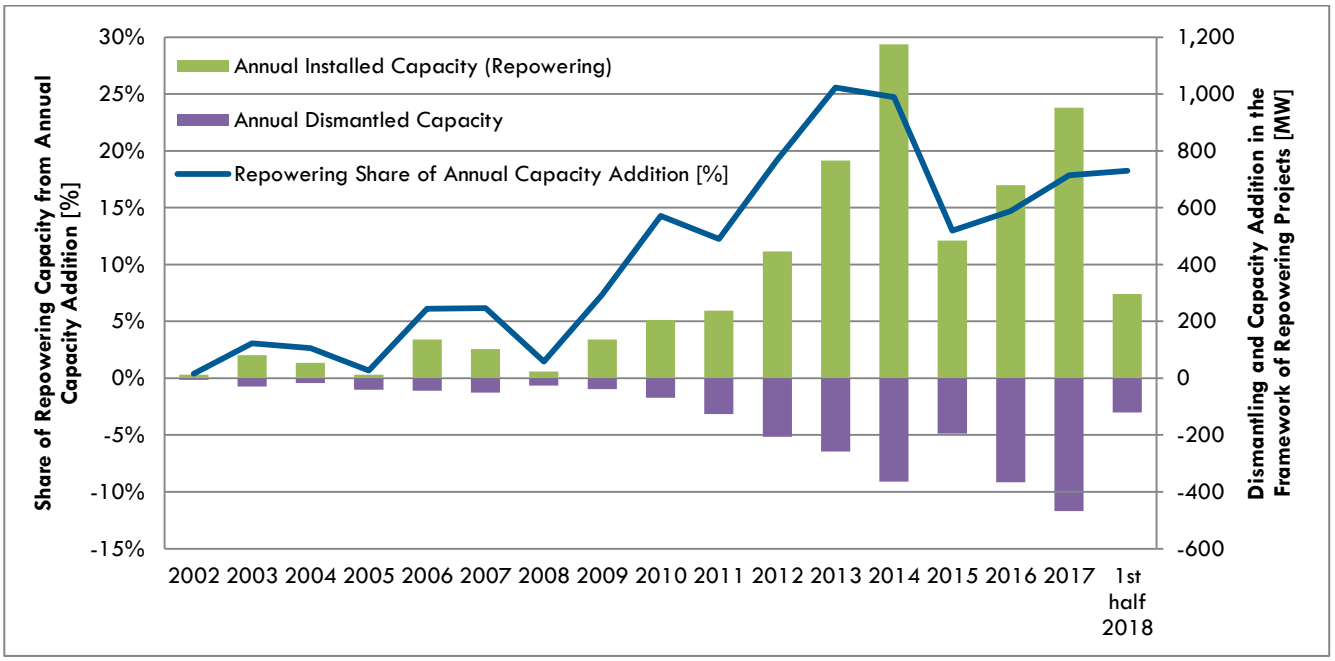

Figure 3: Development of the annual installed, dismantled and cumulative Capacity of Repowering Projects, as of 2018-06-30

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

As was the case in the previous year, for the first half of 2018 Lower Saxony led the comparison of German federal states with regard to gross additions. A total of 130 WTGs with an overall capacity of 465 MW were erected over the course of the first six months of 2018. That puts 29% of the gross additions within the coastal state, followed in second place by North Rhine-Westphalia with a significantly smaller share of 16% of the total gross additions with 83 WTGs and 259 MW. Third place is occupied by Brandenburg with nearly 12% of the capacity addition. Here, 57 WTGs with an overall capacity of 189 MW were erected. Hesse, coming in fourth place, had erected 52 WTGs with a capacity of 162 MW and a 10% share of the overall additions. A share of about 9% placed Rhineland-Palatinate in fifth place with a gross addition of 50 WTGs and 153 MW. The remaining share of about 24% (397 MW) of the Germany-wide addition to wind energy for the first half of 2018 is distributed among the remaining federal states, excluding Berlin where no new WTG erections were recorded. In the regional comparison of gross additions, about 38% occurred in the northern, nearly 45% in the central and about 17% in the southern federal states.

Table 3: Addition (gross) to Wind Energy in the German Federal States in the First Half of 2018

		Gross Additions in First Half of 2018			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	465.25	130	28.6%	3,579	121	137	318
2	North Rhine-Westphalia	258.65	83	15.9%	3,116	117	142	293
3	Brandenburg	188.95	57	11.6%	3,315	122	139	283
4	Hesse	162.40	52	10.0%	3,123	119	145	287
5	Rhineland-Palatinate	153.40	50	9.4%	3,068	118	145	283
6	Thuringia	112.35	33	6.9%	3,405	121	132	300
7	Mecklenburg-Western Pomerania	72.20	22	4.4%	3,282	119	127	297
8	Baden-Wuerttemberg	65.45	19	4.0%	3,445	124	147	286
9	Schleswig-Holstein	62.60	22	3.8%	2,845	104	96	343
10	Saarland	33.00	12	2.0%	2,750	114	137	271
11	Bavaria	17.15	6	1.1%	2,858	121	145	254
12	Bremen	12.80	4	0.8%	3,200	113	104	319
13	Saxony-Anhalt	8.20	3	0.5%	2,733	110	128	286
14	Saxony	7.05	2	0.4%	3,525	128	111	274
15	Hamburg	6.60	2	0.4%	3,300	117	92	307
16	Berlin	0.00	0	0.0%				
	Germany	**1.626.05**	**497**		**3,272**	**119**	**137**	**299**

WTGs with the on average highest nominal capacity of 3,579 MW were erected in Lower Saxony in the first half of 2018. Turbines with the lowest median nominal capacity of 2,733 MW were installed in Saxony-Anhalt. The largest average rotor diameter of 128 meters was chosen in Saxony, the smallest diameter of 104 meters in Schleswig-Holstein. The highest average hub height of 147 meters for new WTGs was found in Baden-Wuerttemberg. An average hub height of less than 100 meters was chosen in Hamburg (92 meters) and Schleswig-Holstein (96 meters). The values for average specific area power lie between 343 W/m² in Schleswig-Holstein and 254 W/m² in Bavaria. The detailed gross addition and average WTG configuration values according to the German federal states are listed in Table 3.

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REGIONAL DISTRIBUTION OF THE CUMULATIVE TOTAL PORTFOLIO

The regional distribution of cumulative capacity and number of WTGs is shown in Table 4. Due to the incomplete capture of dismantling, the cumulative numbers are subject to a higher level of uncertainty.

The largest share of about 11 GW of the overall capacity portfolio is located in Lower Saxony. With nearly 7 GW in capacity, Brandenburg comes in second and Schleswig-Holstein in third place with 6.9 GW. A capacity portfolio of notably above 5 GW was captured in North Rhine-Westphalia and Saxony-Anhalt.

The coastal federal states and the two city states Bremen and Hamburg together combine at about 21.5 GW or 41% of the overall capacity in Germany. The federal states of central Germany have the largest portfolio of 22.7 GW and provide 43% of the overall capacity, the southern states provide the lowest share of the overall capacity with about 8 GW and 15%, respectively. The distribution of the cumulative capacity across the three regions is represented by the outside ring depicted in Figure 4, with the inside ring representing shares according to the regions in the additions of the first half of 2018. Compared to the previous year, the share of the cumulative capacity in the north decreased while the middle and south of the country showed a slight increase.

Table 4: Cumulative Capacity and Number of WTG in the German Federal States, as of 2018-06-30

	Region / State	Cumulative Capacity Status: 2018-06-30 [MW]	Cumulative Number Status: 2018-06-30 [WTG]
North	Lower Saxony	10,981	6,277
	Schleswig-Holstein	6,894	3,653
	Mecklenburg-Western Pomerania	3,325	1,911
	Bremen	198	91
	Hamburg	123	63
Central	Brandenburg	6,983	3,791
	North Rhine-Westphalia	5,703	3,708
	Saxony-Anhalt	5,121	2,861
	Hesse	2,144	1,141
	Thuringia	1,573	863
	Saxony	1,205	892
	Berlin	12	5
South	Rheinland-Pfalz	3,553	1,739
	Bavaria	2,510	1,159
	Baden-Wuerttemberg	1,507	719
	Saarland	449	198
		52,282	**29,071**

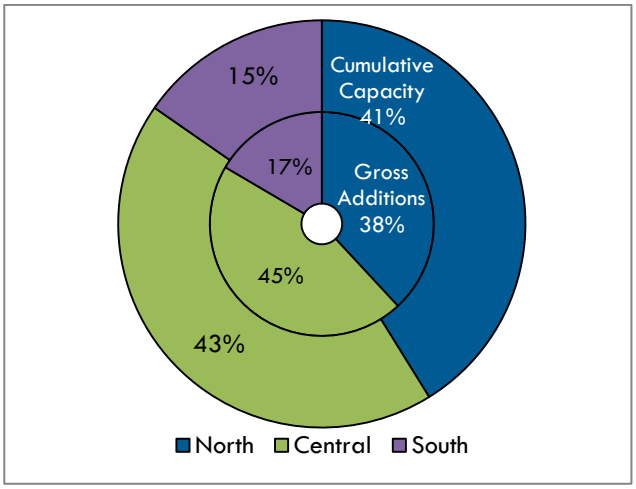

Figure 4: Distribution of the Cumulative Capacity and Gross Addition across the Regions in the First Half of 2018, as of 2018-06-30

From 2012 onward, data was determined using industry player questionnaires and additional research. Database 1992 – 2011: DEWI.
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TENDER FOR LAND-BASED WIND ENERGY IN THE FIRST HALF OF 2018

In the first half of 2018, capacity for land-based WTGs was granted in two tendering rounds in which a total of 1,313 MW was awarded. The February 2018 tendering round, during which 709 MW was awarded, was oversold by a factor of 1.4. In comparison, the May 2018 tendering round had all of its valid tenders awarded, since this round undersold with submitted tenders for 604 MW. In an additional cross-technology tendering round, in which wind energy competed with photovoltaic systems, WTGs did not receive any bid acceptance. The WTGs that had received acceptance in the first half of 2018 all had permits according to the Federal Emissions Control Act (BImSchG) and should be realized within 30 months by August and November 2020, respectively.

REGIONAL DISTRIBUTION OF THE AWARDED BIDS

The distribution across the federal states of the award volume for both tendering rounds conducted in the first half of 2018 can be seen in Figure 5. With an applied capacity of 210 MW, projects in Lower Saxony were awarded the largest volume in the first six months of 2018. Projects in North Rhine-Westphalia received awards for 201 MW, Brandenburg received 194 MW, and 174 MW went to Rhineland-Palatinate during that same time. Projects in nine additional federal states received at least one bid acceptance. Projects in Berlin, Hamburg and Saarland did not participate in the two tendering rounds.

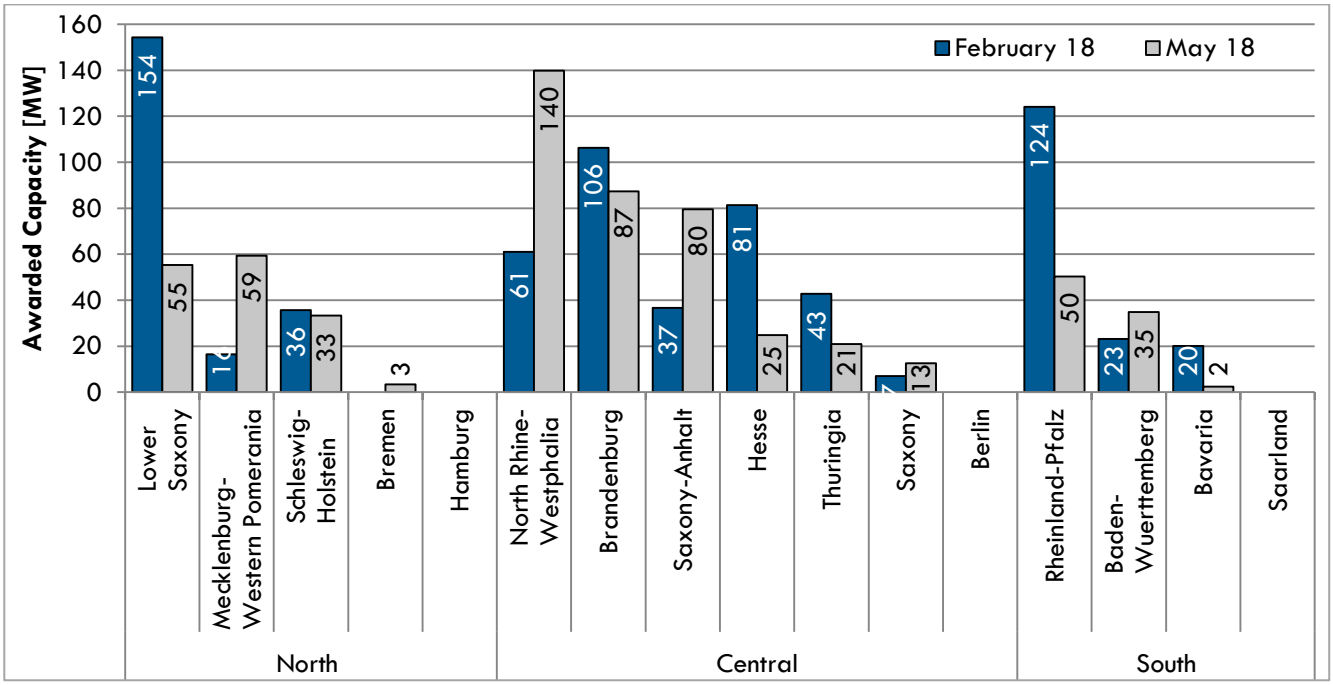

Figure 5: Regional Distribution of Awarded Capacity across the German Federal States in the First Half of 2018 (Source: BNetzA)

Subsequently, 358 MW went to the northern federal states, which equate to 27% of the overall awarded capacity from the tendering rounds of the first half of 2018. In 2017, 41% of the entire award volume went to the northern states. With 700 MW, an equivalent of 53% of the award volume, the central German states received a similar share compared to the 56% of 2017. The southern German states were awarded 255 MW of the applied volume, which represents a significant volume increase from 3% in the first half of 2017 to 19% in 2018.

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BIDS AND AWARDED BIDS

The bid acceptance values for all tendering rounds for land-based wind energy in Germany across the entire range, as well as by the average weighted acceptance value are depicted in Figure 6. The projects whose bids were primarily accepted during the tendering rounds of 2017 were citizens' energy projects. These projects were allowed to bid without BImSchG permits and their acceptance values had been determined by uniform pricing. A few projects that had their bids accepted in the tendering rounds of 2017 and all WTGs with accepted bids from the 2018 rounds each have BImSchG permits and were awarded according to the pay as bid system. This is characterized in the larger bandwidths of the acceptance values of the two 2018 rounds.

As a result of the high competitive pressure and the long realization timeframes of the 2017 tendering rounds, the acceptance values dropped markedly. The average weighted acceptance values noticeably increased again to 4.73 € cents/kWh in 2018 due to the BImSchG permitting requirement and the resulting shorter implementation deadlines. Yet another increase to a median 5.73 € cents/kWh resulted from a lack of competition (under sale) of the May 2018 round.

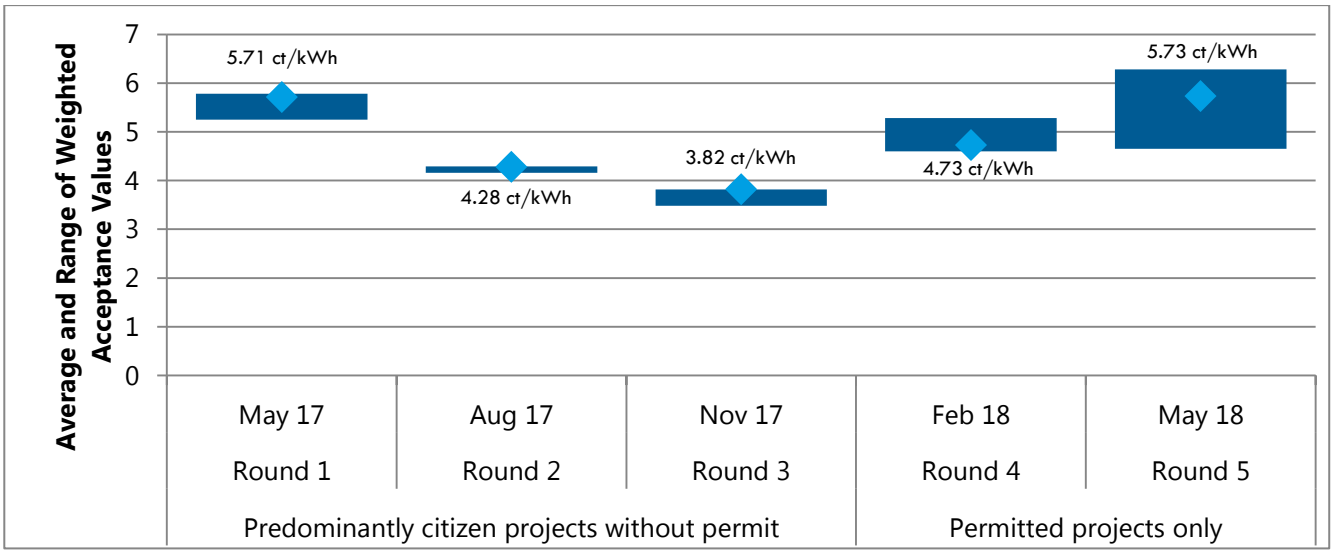

Figure 6: Awarded Bids of all Tender Rounds for Land-based Wind Energy in Germany (Source: BNetzA)

TENDER FOR LAND-BASED WIND ENERGY IN 2018 - OUTLOOK

Two additional tendering rounds for land-based wind energy will be conducted during the remainder of 2018 where a capacity of about 670 MW each is anticipated to be awarded. This is equivalent to the legally designated volume minus the capacity of pilot WTGs that became operational in the previous year. The two tendering rounds to occur in August and November 2018 are only accessible to projects for which BImSchG permits had already been granted. According to the German Federal Network Agency (BNetzA), permits for 1,288 MW have been registered that qualify for the third round of 2018. This includes WTGs that waived participation in the transitional system or turbines that were registered late in the WTG Register with regard to the qualification for the transitional system, as well as WTGs with 2017 and 2018 permits, registered with BNetzA and not yet awarded or assigned to an award.

IMPLEMENTATION STATUS OF CAPACITIES WITHIN TRANSITIONAL SYSTEM AND CAPACITIES WITH PERMIT

With the introduction of the Renewable Energy Law (EEG) 2017, the subsidized wind energy development is limited through fixed capacities. Subsidized are WTGs within the transitional system, meaning those turbines that received permits according to the Federal Emissions Control Act by December 31st, 2016 and had been reported to the BNetzA Core Data Register on time. If the WTGs can be commissioned by the end of 2018, their remuneration is based on the old system and they do not need to participate in the tendering system. According to the BNetzA Core Data as of May 2018, about 9 GW are subject to the transitional system, of which 6.6 GW had already been in operation by the end of that month. Additional turbines with about 0.5 GW have voluntarily waived their claim to remuneration according to the transitional system. Hence, about 1.9 GW remain with a claim to the transitional remuneration that has to be operational by the end of December 2018 to actually receive their claim. Of the voluntary waivers, currently about 0.2 GW were able to secure a subsidy claim in the tender. By May 2018, 0.3 GW of WTGs with pre-2017 permits have thus not received acceptance and subsequently cannot claim a subsidy according to the EEG.

All turbines that received their permits starting in 2017 are required to participate in the tender process to receive a remuneration claim. According to the BNetzA Core Data Register, in 2017 permits were granted for 1.4 GW. By the end of May 2018, an additional 0.5 GW received permits according to the BImSchG. In the tendering rounds up to now, 0.9 GW of WTGs with 2017 permits and 0.4 GW with 2018 (Jan – May) permits already received bid acceptance.

Depicted in Figure 7 is the implementation status of WTGs in the transitional system, as well as permits from 2017 onward according to the BNetzA Core Data Register as of May 2018. A shift compared to the WTGs erected by the end of the first half of 2018 according to manufacturer information exists due to the capture status and the definition. Furthermore some of the recently permitted WTGs could already be associated with a 2017 bid acceptance for wind turbine generators without BImSchG permit.

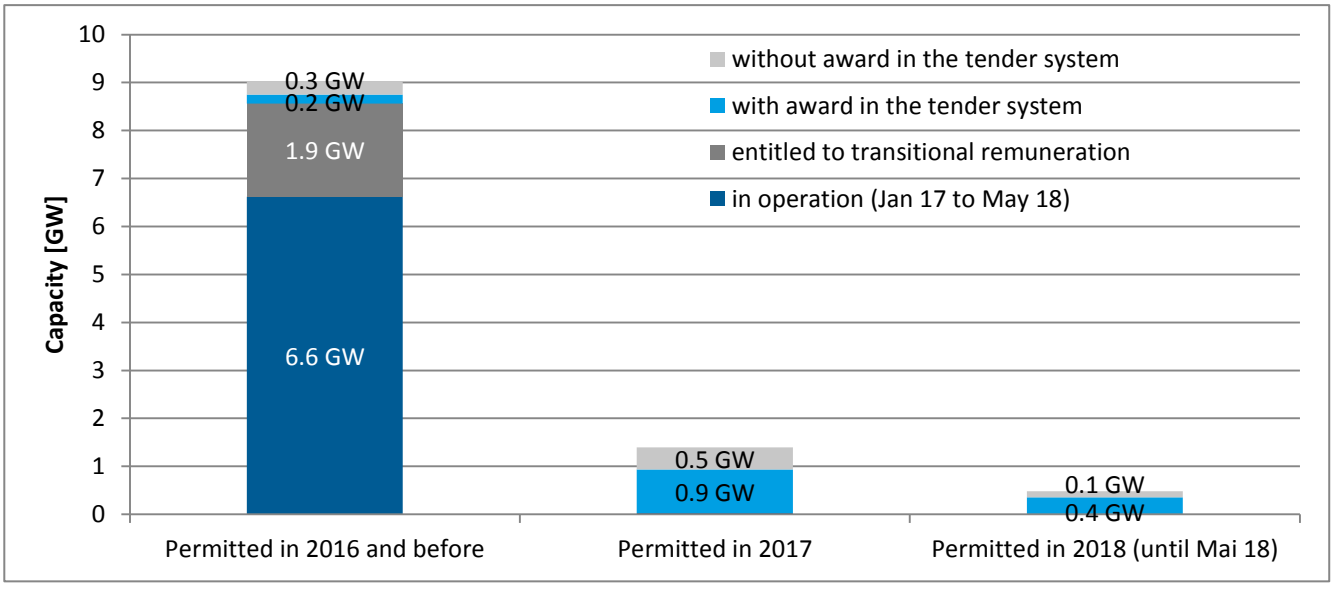

Figure 7: Implementation Status of Capacities within Transitional System and Capacities with Permit until May 2018 (Database: BNetzA Core Data, as of May 2018)

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PROJECTION OF MONTHLY POWER PRODUCTION FROM WIND ENERGY

The preliminary projection of monthly power production from land-based wind energy based on data from transmission grid operators (German: Übertragungsnetzbetreiber or ÜNB) is shown in Figure 8. Along with the monthly feed-in of the first half of 2018 are the values of the previous year. In the first six months of 2018, land-based WTGs fed 45.9 TWh into the German grid. Compared to the first half of 2017, during which 39.5 TWh were fed into the grid, the energy yield increased by 16%. The pivotal reason for this increase, aside from the overall increased number of WTGs, is the particularly production-rich month of January 2018. As already noted in December 2017, power production of land-based WTGs in January 2018 was noticeably above 12 TWh. This also adds to the fact that the first quarter of 2018 with 28.0 TWh was much stronger than the second quarter with about 17.8 TWh.
According to the German Association of Energy and Water Industries (German: Bundesverband der Energie- und Wasserwirtschaft or BDEW) the share of power produced in Germany by land-based WTGs in the first half of 2018 was 14.7% of the gross power production. This is equivalent to an increase of 2.2 percentage points compared to the first half of the previous year (Source: BDEW).

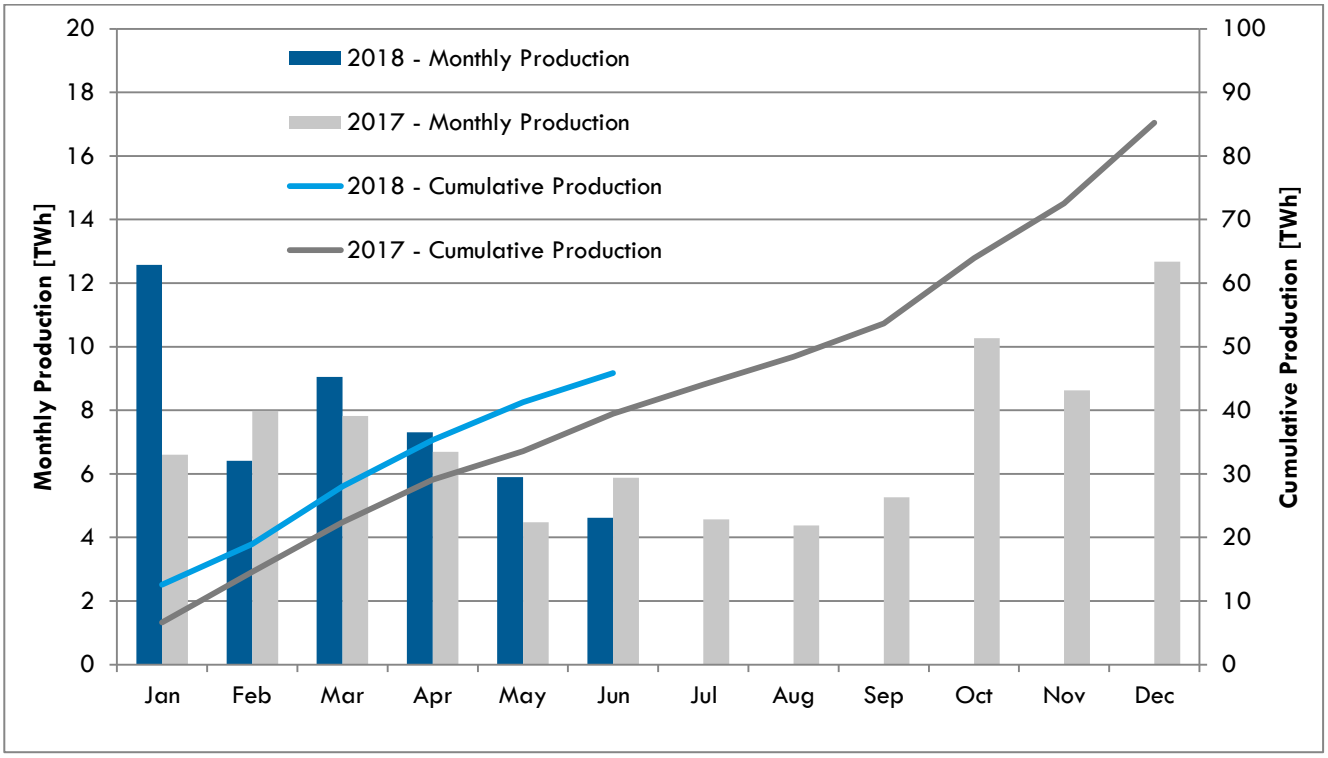

Figure 8: TSO Projection of Electricity Production by Land-based WTG of the Cumulative Portfolio for First Half of 2018 and Previous Year (Database: 50Hertz, Amprion, TenneT, TransnetBW)

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