DEUTSCHE WINDGUARD

Status of Onshore Wind Energy Development in Germany

First Half of 2019

On behalf of

BWE Bundesverband WindEnergie

VDMA Power Systems

Contents

Notes

The data from 2012 onward was obtained through surveys with industry representatives, as well as additional research. The basis of the data for the years 1992 – 2011 are analyses of the DEWI.

The information provided within the text and the figures partially includes rounded values. Thus, when added, there is a possibility of deviations from the overall values. The cumulative data may be overestimated due to the incomplete capture of dismantling.

Analyses that rely on deviating data bases (i.e. Core Energy Market Data Register) exhibit a deviating data inventory.

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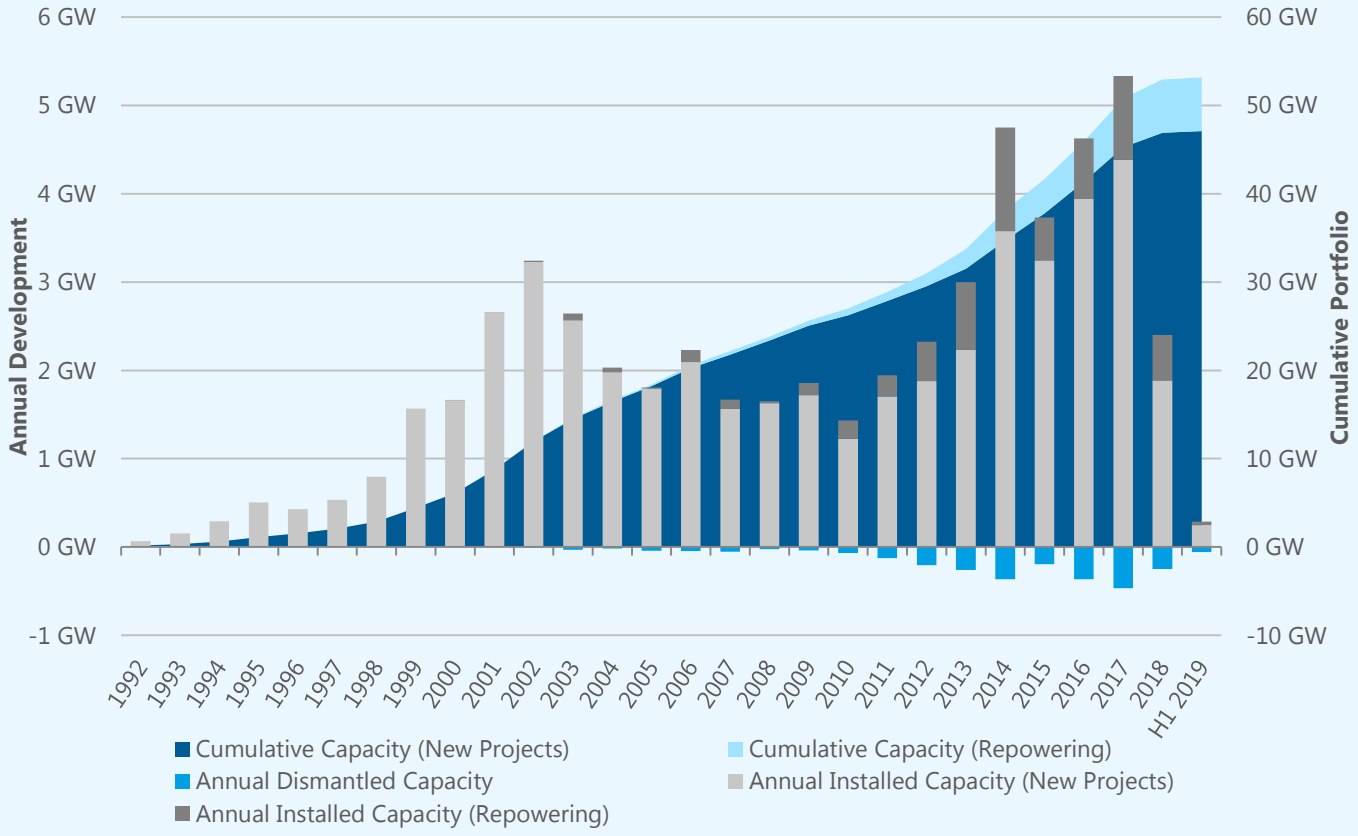
Net and Gross Wind Energy Additions

Onshore wind energy in Germany saw an addition of 86 wind turbine generators (WTG) in the first half of 2019. This equates to a gross addition of 287 MW and represents the lowest level within a six-month period since the introduction of the Renewable Energy Sources Act (German: Erneuerbare-Energien-Gesetz or EEG) in the year 2000. This reduction that started to become evident last year clearly continues, following the record years of 2014 to 2017. When compared to the first six months of 2018, this year's development reduction amounts to 82%.

Taking the dismantling of 51 WTG with a cumulative capacity of 56 MW into account, the net addition in the first half of 2019 came to 231 MW. The cumulative WTG portfolio as of June 30th, 2019 increased to 29,248 WTG with an overall capacity of 53,161 MW.

Status of Onshore Wind Energy Development

		Capacity	Number
Development H1 2019	Gross additions	287 MW	86 WTG
	Repowering share	41 MW	12 WTG
	Dismantling (incl. subsequent registration) (non-binding)	56 MW	51 WTG
	Net additions	231 MW	35 WTG
Cumulative 2019-06-30	Cumulative WTG portfolio (non-binding)	53,161 MW	29,248 WTG



Annual Development Onshore Wind Energy in Germany

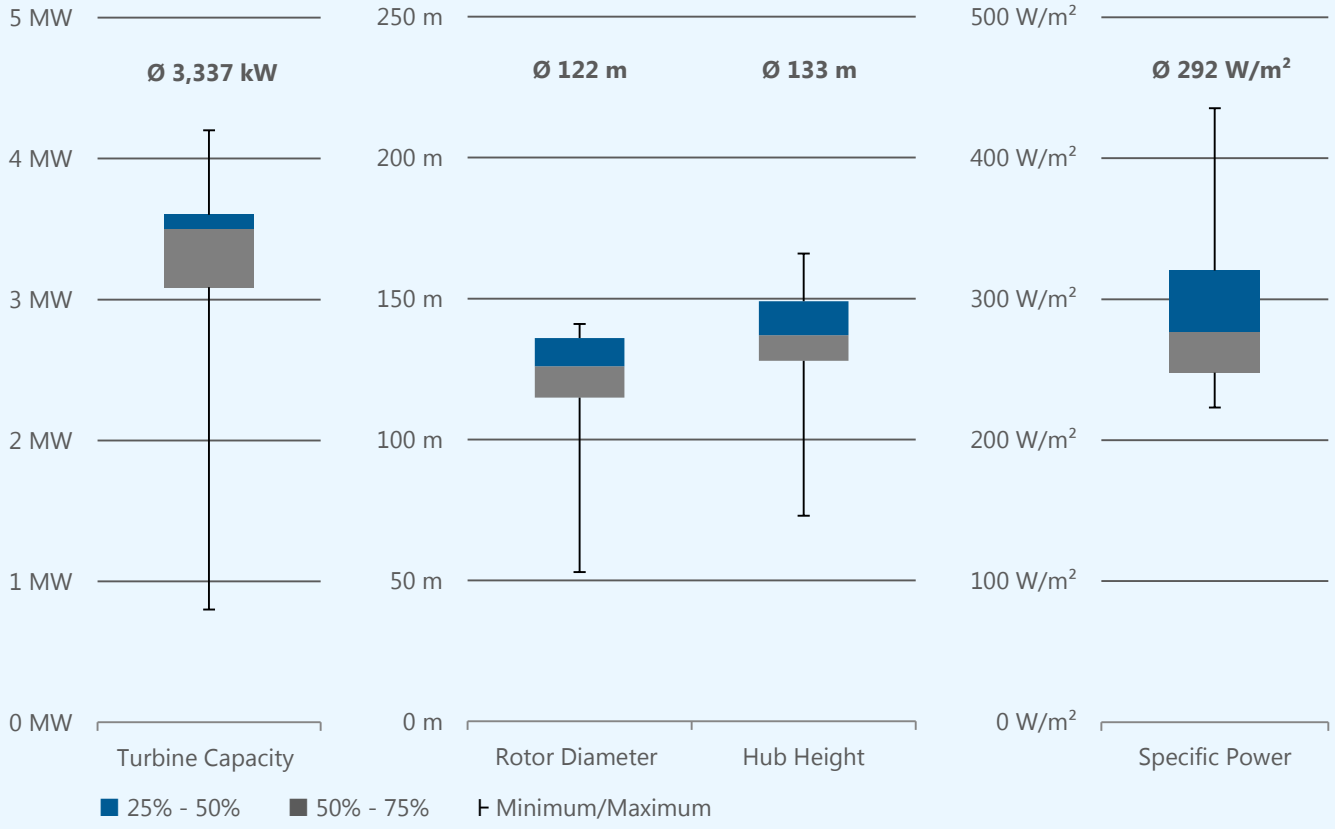
Average Wind Turbine Generator Configuration

The average configuration of newly installed wind turbine generators is described by the following parameters: nominal turbine capacity, rotor diameter, hub height and specific area power. The latter results from the relation of the nominal turbine capacity to the area swept by the rotor.
Compared to 2018, there was a 3% increase in the average values of WTG capacity and rotor diameter. The change to the median hub height is negligible.
The on average decline of specific power is because the increase in rotor areas is larger than the increase in nominal turbine capacity.

The range of turbine configurations used in Germany is very large. The diagram below shows the maximum and minimum values as well as the quartiles.

Average Wind Turbine Generator Configuration

Average Configuration	Addition H1 2019	Changes compared to prior year
Turbine Capacity	3,337 kW	3%
Rotor Diameter	122 m	3%
Hub Height	133 m	0%
Specific Power	292 W/m²	-4%



Range of Configuration Values of newly installed WTG

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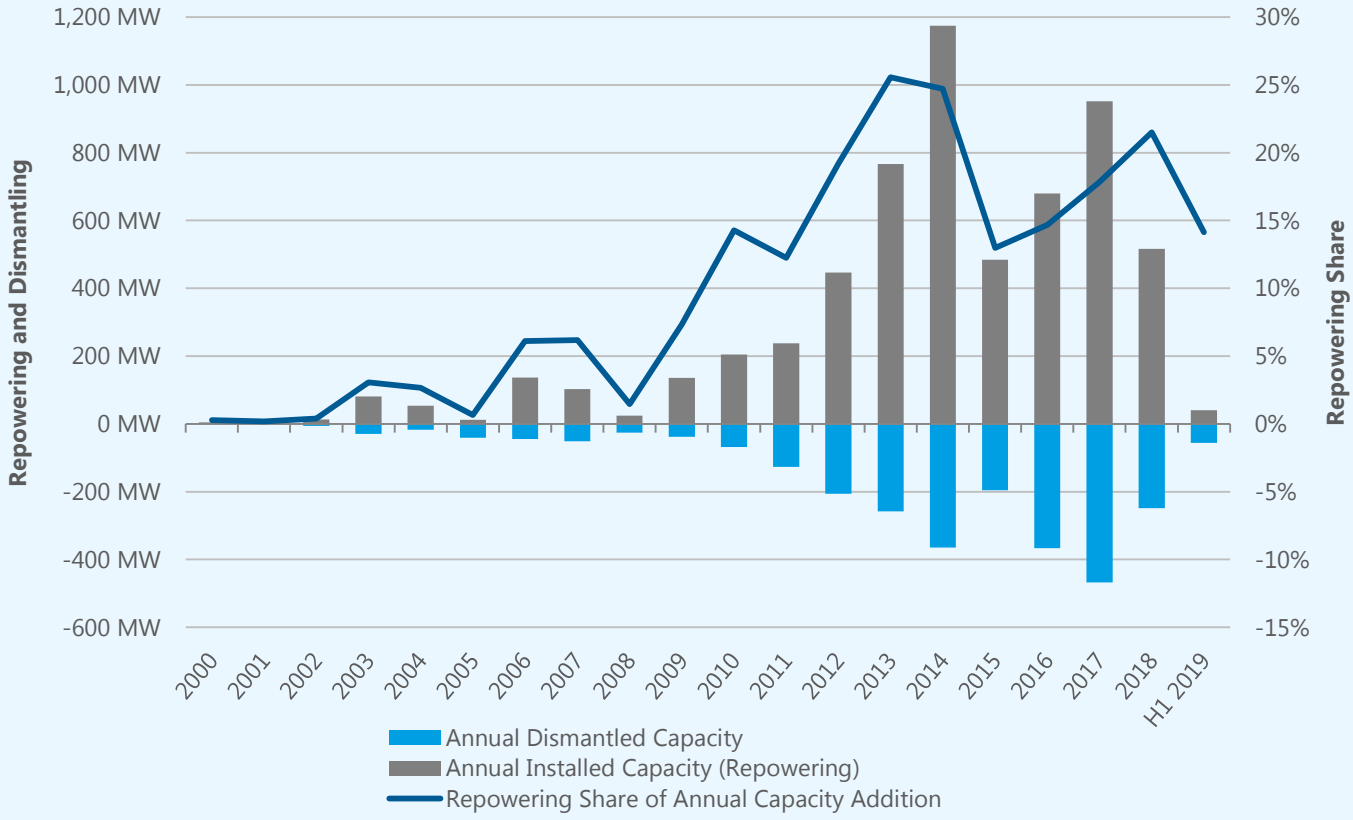
Dismantling and Repowering

The dismantling of 51 WTG with a cumulative capacity of 56 MW was captured during the first half of 2019. While a part of these WTG is dismantled permanently, others are replaced by new turbines within the framework of repowering. The twelve repowering WTG erected in the first half of 2019 have a combined capacity of 41 MW. Although the newly installed repowering capacity has declined notably, the share of repowering in gross addition remains rather stable compared to recent years.

In repowering projects it is common that a large number of small and low-capacity turbines are replaced by a lesser number of state-of-the-art turbines, because the latter WTG with higher hub heights and larger rotor diameters require more space than the WTG they replace. Nonetheless, the energy yield of repowering WTG is higher than the yield of the old, dismantled WTG.

Late decommissioning registrations from the previous year, as well as decommissioning listed in the registers of the German Federal Network Agency (German: Bundesnetzagentur or BNetzA) were factored into the capture of the dismantling. Identification of WTG dismantled in the past is subject to an increased level of uncertainty and remains incomplete, regardless of the capture of late registrations.



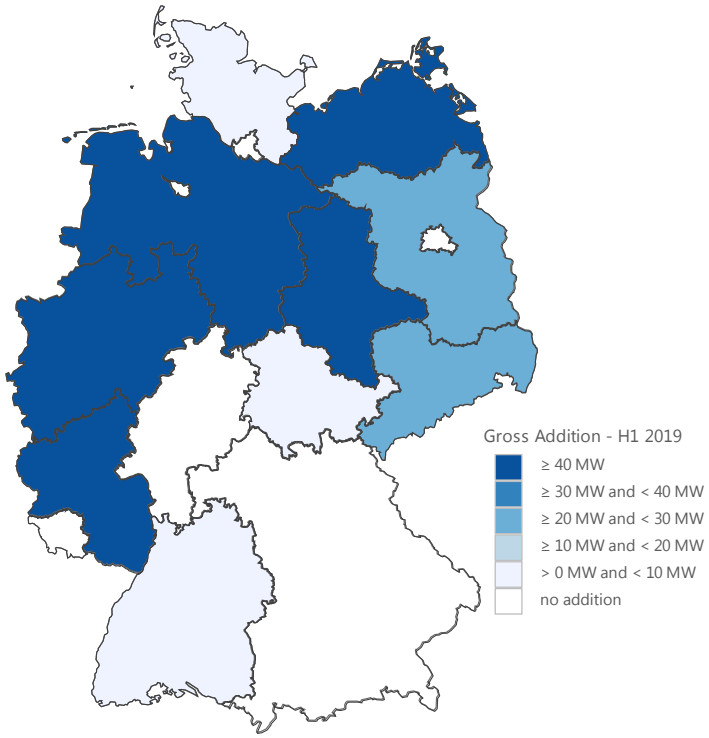
Repowering Share, annual installed Repowering Capacity and dismantled Capacity

Regional Distribution of Wind Energy Additions

In Germany, site quality-dependent remuneration elements allowed for wind energy additions to reach far inland. Dependent on various factors (e.g. land availability, local political decisions) the additions in each German federal state are not steady.

Over the course of the first six months of 2019, none of the states took a clear lead in adding to their portfolio. Only Rhineland-Palatinate, Lower Saxony, Saxony-Anhalt, North-Rhine Westphalia and Mecklenburg-Western Pomerania saw the erection of more than ten WTG, reflecting an overall low level of additions.

As a result of the low number of WTG, the average turbine configuration across the German states is influenced heavily by individual projects, subsequently providing little to draw conclusions regarding regional technological developments.



Regional Distribution of Gross Capacity Additions

Addition (gross) and Average Configuration of newly installed WTG in the German Federal States

Position	State	Gross Additions in First Half of 2019			Average Configuration of newly added WTG			
		Capacity Addition	Number of Added WTG	Share in the Gross Capacity Addition	WTG Capacity	Rotor Diameter	Hub Height	Specific Power
1	Rhineland-Palatinate	49 MW	15 WTG	16.9%	3,237 kW	120 m	139 m	292 W/m²
2	Lower Saxony	47 MW	14 WTG	16.2%	3,325 kW	120 m	136 m	296 W/m²
3	Saxony-Anhalt	43 MW	12 WTG	15.1%	3,615 kW	137 m	130 m	247 W/m²
4	North Rhine-Westphalia	42 MW	14 WTG	14.7%	3,018 kW	110 m	128 m	324 W/m²
5	Mecklenburg-Western Pomerania	42 MW	11 WTG	14.5%	3,773 kW	121 m	139 m	333 W/m²
6	Saxony	28 MW	8 WTG	9.8%	3,525 kW	128 m	135 m	273 W/m²
7	Brandenburg	25 MW	8 WTG	8.6%	3,103 kW	120 m	122 m	277 W/m²
8	Schleswig-Holstein	5 MW	2 WTG	1.7%	2,500 kW	108 m	96 m	272 W/m²
9	Thuringia	3 MW	1 WTG	1.2%	3,450 kW	136 m	166 m	237 W/m²
10	Baden-Württemberg	3 MW	1 WTG	1.1%	3,300 kW	126 m	137 m	265 W/m²
	Bavaria	0 MW	0 WTG	0.0%				
	Hesse	0 MW	0 WTG	0.0%				
	Saarland	0 MW	0 WTG	0.0%				
	Bremen	0 MW	0 WTG	0.0%				
	Hamburg	0 MW	0 WTG	0.0%				
	Berlin	0 MW	0 WTG	0.0%				
	Germany	**287 MW**	**86 WTG**		**3,337 kW**	**122 m**	**133 m**	**292 W/m²**

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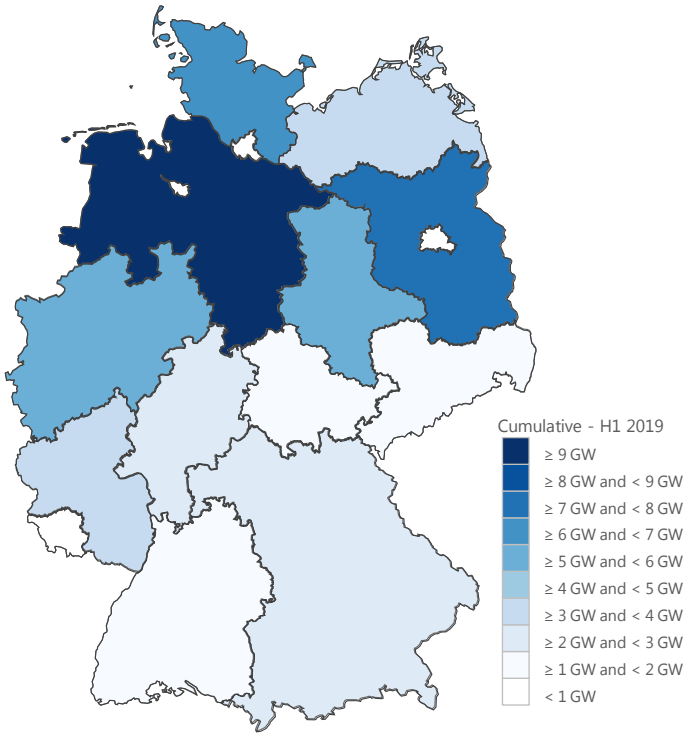
Regional Distribution of the Cumulative Portfolio

The cumulative wind turbine generator portfolio is distributed across all German states and regions. Lower Saxony has by far the largest number of WTG and the highest installed capacity. Schleswig-Holstein's portfolio, however, is largest when the surface area of the state is taken into consideration. About 41% of the cumulative capacity is installed in the coastal states of Northern Germany. The central states combine about 43% of the capacity and the remainder of the cumulative capacity of about 15% is located in the southern states.

As a result of the presumably incomplete capture of dismantling, as well as varying definition and counting systems, the data captured by this statistic differs from other publications. In the long run, the statistics survey will be synchronized with the Core Energy Market Data Register (German: Marktstammdatenregister or MaStR).



Regional Distribution of the Cumulative Capacity

Cumulative Capacity and Number of WTG in the German Federal States

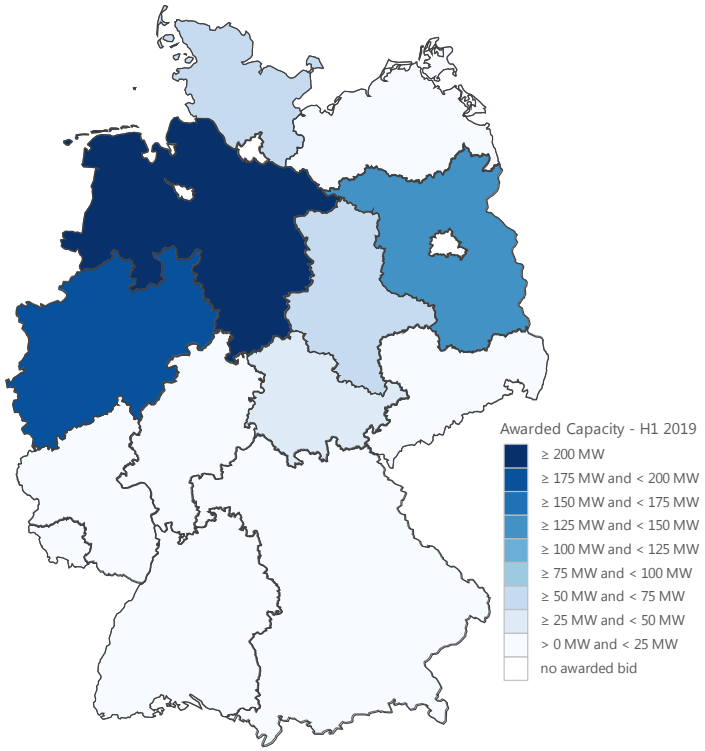
		Cumulative Portfolio (2019-06-30)					
		Cumulative Capacity			Cumulative Number		
Region	State	Statistics	MaStR*	State Data**	Statistics	MaStR*	State Data**
North	Lower Saxony	11,205 MW	11,179 MW		6,311 WTG	6,135 WTG	
	Schleswig-Holstein	6,967 MW	6,751 MW	6,564 MW	3,661 WTG	3,296 WTG	2,966 WTG
	Mecklenburg-Western Pomerania	3,404 MW	3,312 MW		1,924 WTG	1,842 WTG	
	Bremen	198 MW	201 MW		91 WTG	92 WTG	
	Hamburg	128 MW	122 MW		65 WTG	71 WTG	
Central	Brandenburg	7,105 MW	7,049 MW		3,825 WTG	3,799 WTG	
	North Rhine-Westphalia	5,814 MW	5,747 MW		3,738 WTG	3,400 WTG	
	Saxony-Anhalt	5,163 MW	5,162 MW		2,863 WTG	2,872 WTG	
	Hesse	2,197 MW	2,120 MW		1,155 WTG	956 WTG	
	Thuringia	1,570 MW	1,646 MW		859 WTG	910 WTG	
	Saxony	1,254 MW	1,225 MW		904 WTG	943 WTG	
	Berlin	12 MW	12 MW		4 WTG	10 WTG	
South	Rhineland-Palatinate	3,628 MW	3,560 MW		1,758 WTG	1,673 WTG	
	Bavaria	2,514 MW	2,525 MW		1,160 WTG	1,219 WTG	
	Baden-Württemberg	1,528 MW	1,585 MW		723 WTG	752 WTG	
	Saarland	476 MW	488 MW		207 WTG	202 WTG	
		53,161 MW	**52,685 MW**		**29,248 WTG**	**28,172 WTG**	

* Turbine Portfolio according to statistically relevant WTG in Operation as in the Core Energy Market Data Register (MaStR)
** Turbine Portfolio subject to approval according to LLUR Schleswig-Holstein

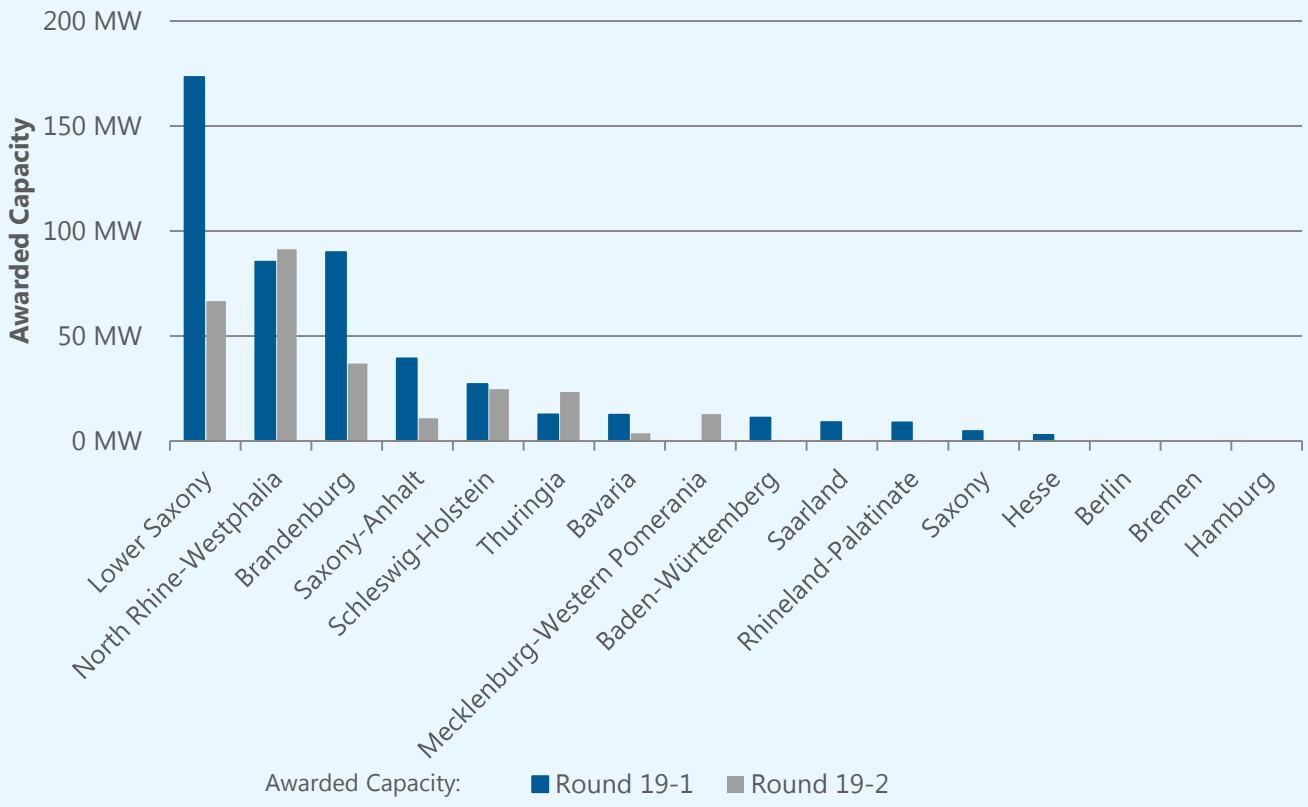
Regional Distribution of Awarded Bids

Two tendering rounds for onshore wind energy and one combined tender for wind and photovoltaics (PV) were conducted in the first half of 2019. The tender volume in the technology-specific tendering rounds in the first six months of 2019 was not fully exhausted. Hence, for the available capacity of 1,350 MW from those two rounds, there are only 746 MW of awarded bids. No wind energy project was awarded in the combined tendering round.

Within the current rounds of 2019, the largest capacity was awarded to projects in Lower Saxony. Bidders from North-Rhine Westphalia and Brandenburg were also successful with an awarded capacity in the triple-digit-MW range. With the exception of bidders from the city states, at least one bid from each state participated successfully.



Regional Distribution of Awarded Capacity (Database: BNetzA)



Regional Distribution of Awarded Capacity across the German Federal States (Database: BNetzA)

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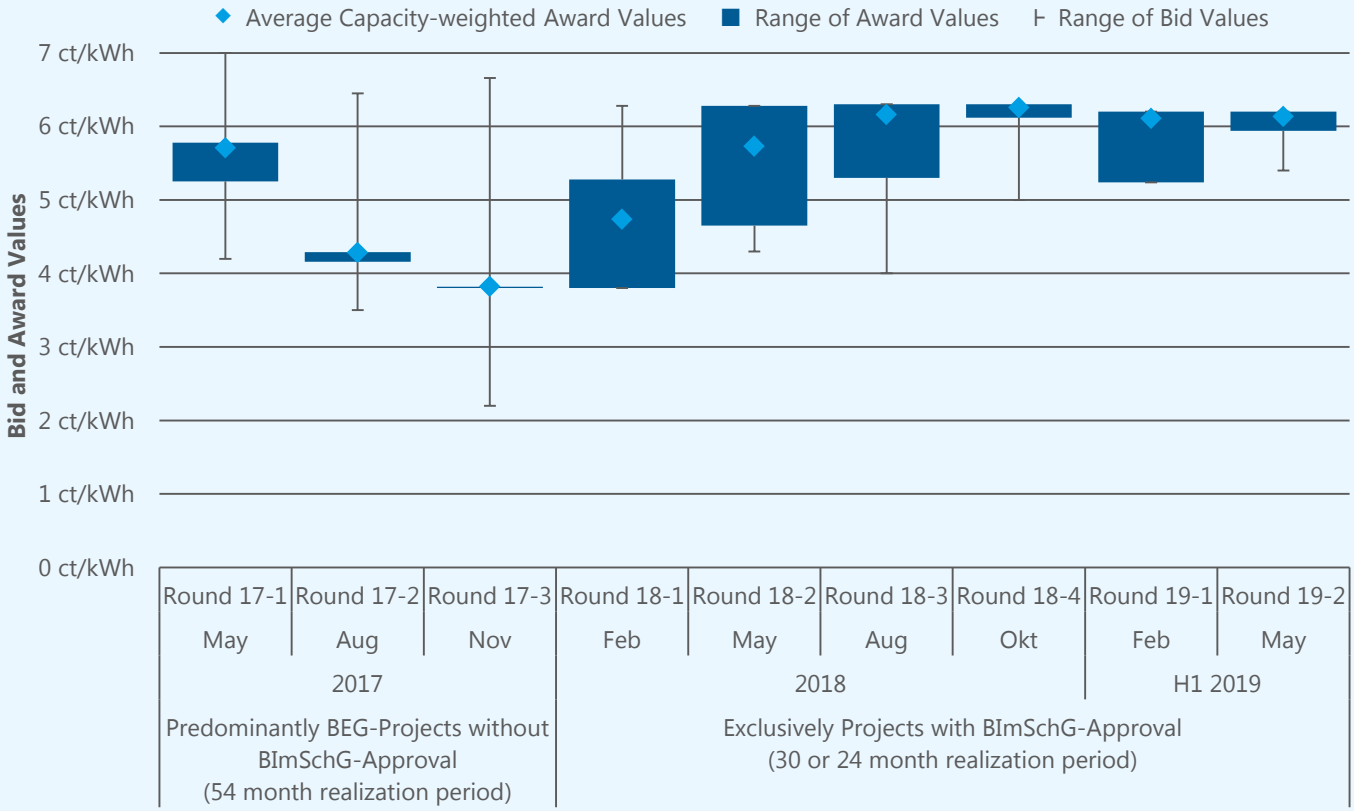
Bid and Award Values of the Tenders

To receive an award in the tenders for onshore wind energy, bidders have to submit the lowest bid for a project at the (theoretical) reference location. In case the winning bid was placed by a project with citizens participation as defined by the Renewable Energy Sources Act (German: Bürgerenergiegesellschaft or BEG), the bid value is corrected according to the uniform pricing process and the attributable award value is equivalent to the highest respective awarded bid value. For regular projects without the participation of citizens according to the EEG, the bid value is equivalent to the award value. Possible bid values are limited by a maximum value as stipulated for that year by the BNetzA. The maximum for the year 2019 is 6.2 € Cents/kWh.

Since 2018, participation requires permission according to the Federal Emissions Control Act (German: Bundesimmissionsschutzgesetz or BImSchG), thus shortening implementation deadlines and considerably reducing the number of eligible WTG. The average-weighted award values of the first two tendering rounds of 2019 are 6.11 and 6.13 € Cents/kWh, respectively, and thus each is just below the maximum allowed value. This indicates that due to the lack of competition, bidders were able to closely align their bids with the limiting maximum value.

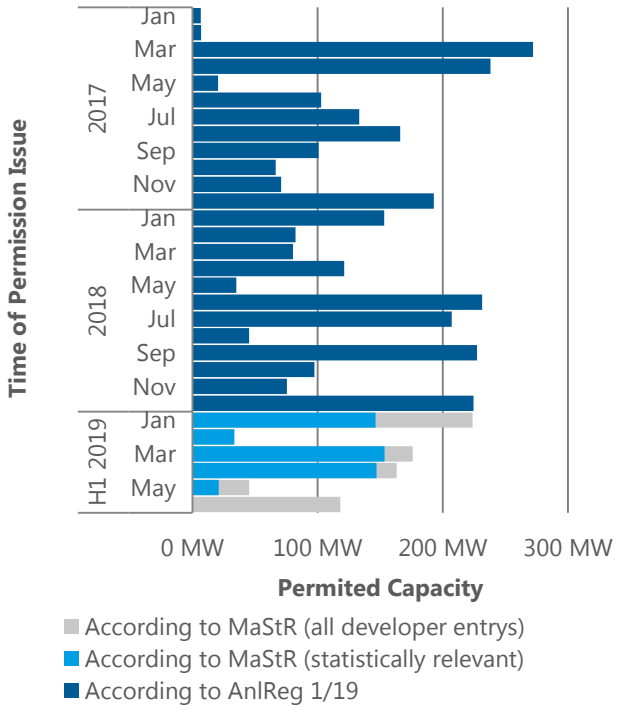
The values that are decisive for the expected revenues per kilowatt hour of the awarded WTG result from adaptations to the award values with the help of site-specific correction factors. In this context, should the energy yield of the project be higher than the reference yield, the award value will be corrected downward; in the opposite case, the award value will be corrected upward.



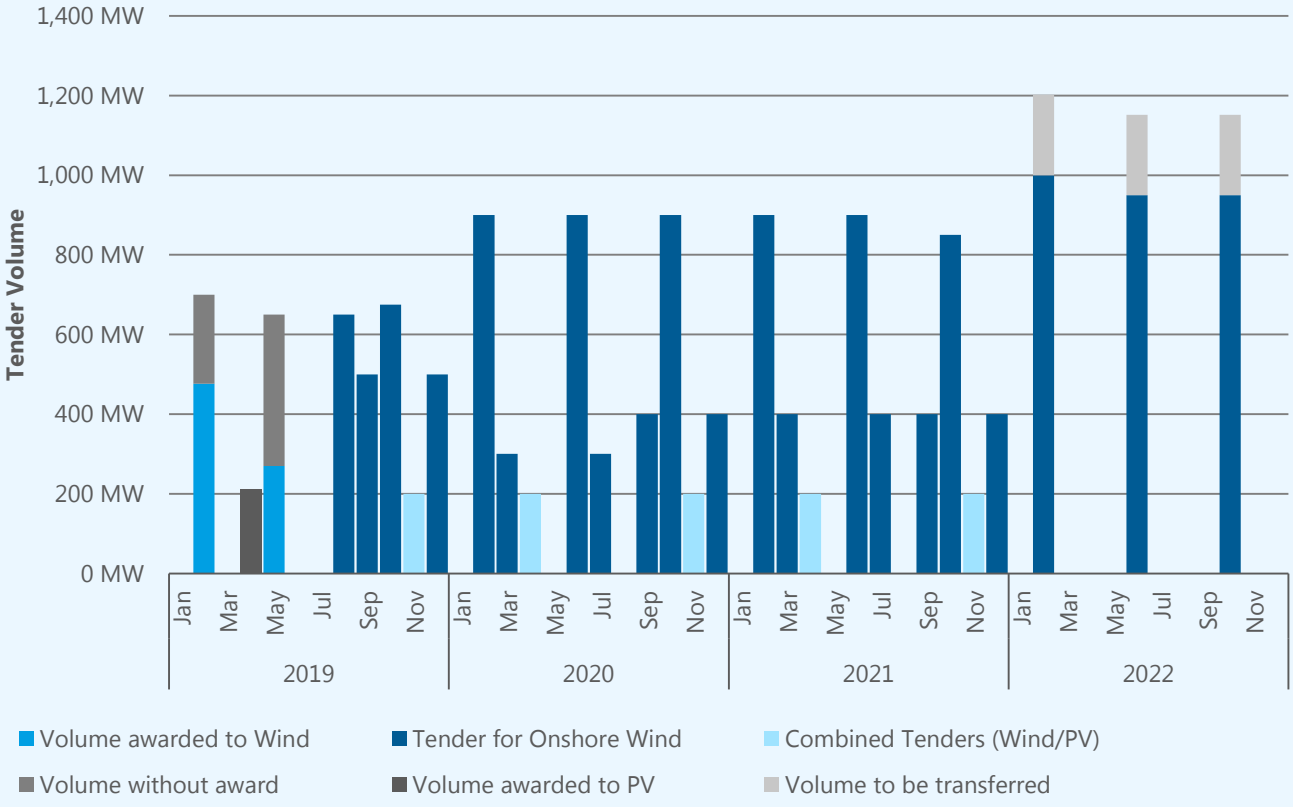
Development of Awarded Bids of Tender Rounds for Onshore Wind Energy (Database: BNetzA)

Permitted Capacity and Future Tender Rounds

Following the establishment of additional tenders in 2018, volumes for onshore wind energy for the years 2019 to 2021 were markedly increased. Ongoing at the same time are tenders combined with PV, in which WTG did not manage to receive any bid awards so far. Furthermore, due to lack of participants the capacity in the technology-specific tendering rounds in the first half of 2019 has not been fully awarded. Similar to the situation in 2017 and 2018, the number of permits in the first half of 2019 issued was low. So far permits of 759 MW were reported by project operators to the register. Hitherto, the BNetzA labeled 502 MW of the currently reported permits as statistically relevant, others may still include duplicates. Since many of the recently permitted WTG already received awards, future tendering rounds could possibly suffer from too few participants again. Volumes from 2019 that were not awarded will be transferred to the year 2022.



Monthly Permitted Capacity since 2017



Tender Volume 2019 to 2022 (according to the EEG)

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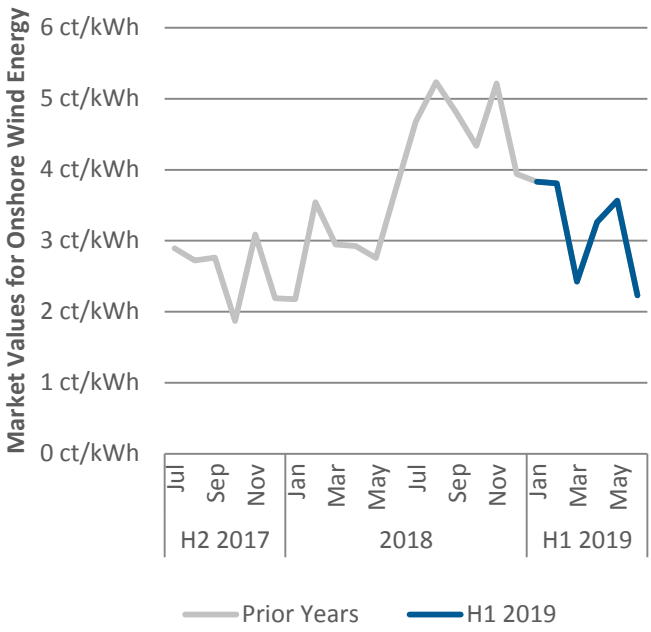
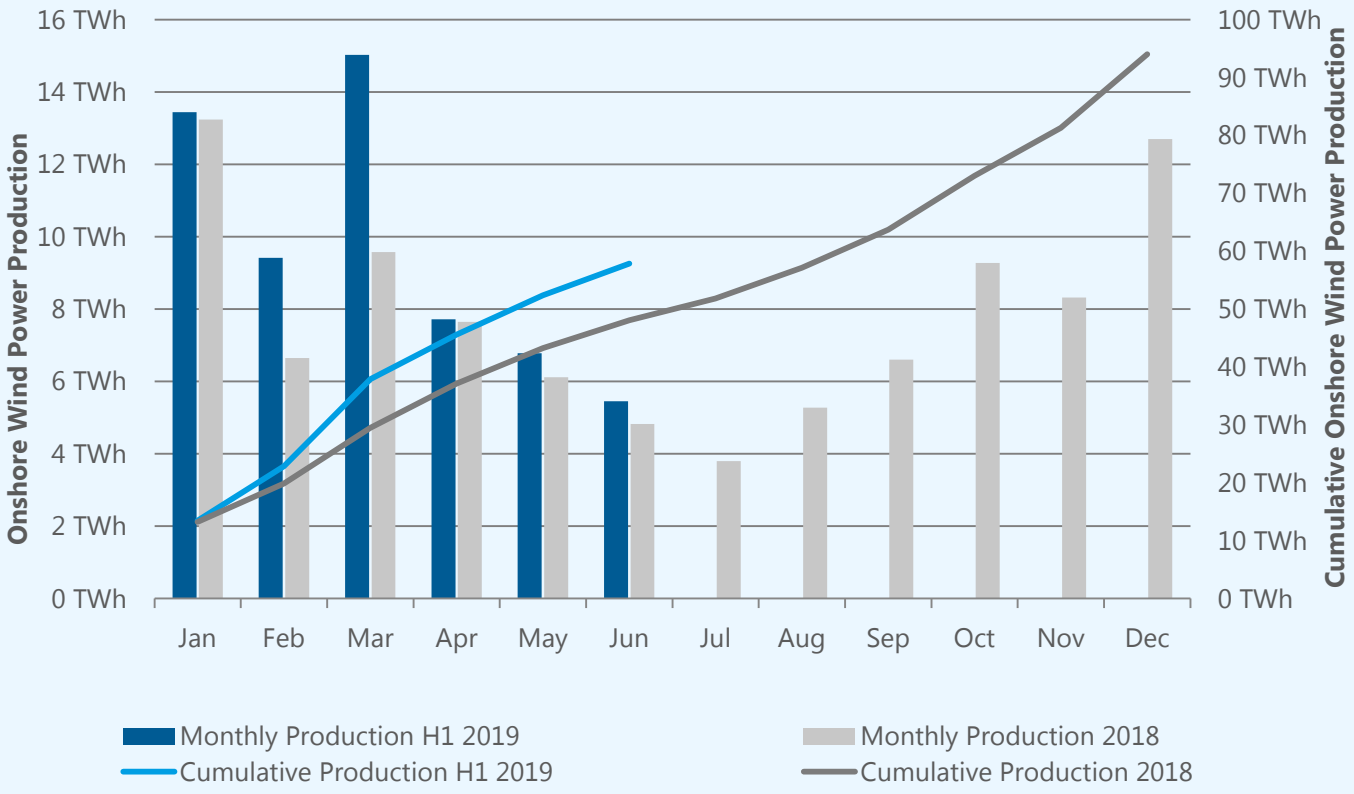
Monthly Power Production and Market Values

According to the projection data of Transmission System Operators (German: Übertragungs-netzbetreiber or ÜNB), onshore wind energy in Germany produced 57.8 TWh of power in the first half of 2019. Thus, the current 6-month production level is 20% higher than the power production at the same time in the previous year. This is particularly a result of the favorable wind conditions in February and March 2019 compared to 2018. During that time, significantly more power was fed into the grid compared to the same timeframe of the year before.

The average power market revenues per kilowatt hour for onshore wind energy (monthly market values) varied between 3.8 € Cents/kWh in January and 2.2 € Cents/kWh in June. Compared to the previous year, the average volume-weighted market value fell 14% from 3.7 € Cents/kWh to 3.2 € Cents/kWh in the first half of 2019.



Monthly Market Values for Onshore Wind Energy (Database: Netztransparenz)



Projection of Power Production by Onshore WTG (Database: Netztransparenz: Projection Data)

About Deutsche WindGuard

In a complex energy market WindGuard is committed to providing extensive scientific, technical, and operational services which are unbiased and manufacturer-independent. Over 40 services lead to extraordinary synergistic effects between departments. Whether due diligence, market analysis, contract & tenders or feasibility studies: every single one of them contains the expertise and knowhow of the whole WindGuard Group. WindGuard has been publishing the semi-annual statistics on wind energy development since 2012.

About Bundesverband Windenergie e.V. (BWE)

With 20,000 members, BWE, a member of Bundesverband Erneuerbare Energie [German Renewable Energy Federation (BEE)], represents the entire industry. Members of BWE include the mechanical engineering industry's suppliers and manufacturers; project developers; specialist jurists; the financial sector; companies from the fields of logistics, construction, service/maintenance and storage technology; electricity traders; network operators; and energy suppliers. As a result, BWE is the primary contact for politics and business, science and the media.

About VDMA Power Systems

VDMA Power Systems is a division of the non-profit German Engineering Federation (VDMA). The association represents the interests of manufacturers of wind turbines and hydroelectric plants, fuel cells, gas/steam turbines and plants and engine systems at home and abroad. VDMA Power Systems serves them all as an information and communication platform for all industry issues, such as energy policy, energy policy, legislation, market analyses, trade fairs, standardization, and press and public relations.