DEUTSCHE WINDGUARD

Status of Onshore Wind Energy Development in Germany

Year 2019

On behalf of

BWE Bundesverband WindEnergie

VDMA Power Systems

Contents

Notes

The data from 2012 onward was obtained through surveys with manufacturers and other 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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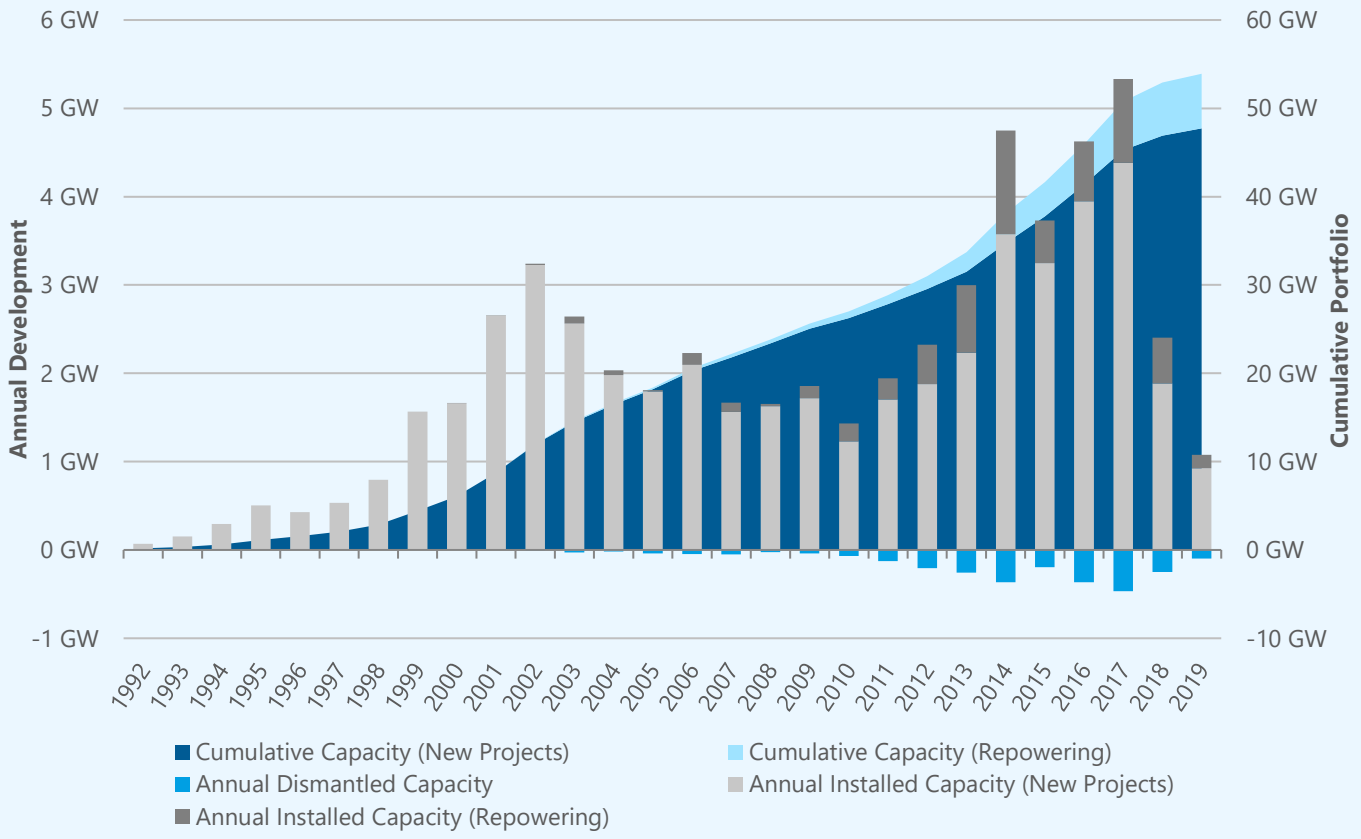
Net and Gross Wind Energy Additions

In 2019, a total of 325 onshore wind turbine generators (WTG) with a capacity of 1,078 MW were erected in Germany. Considering that 82 WTG with a capacity of 97 MW were dismantled, the net addition results in 243 WTG with 981 MW. In the second half of the year installation activities increased compared to the first half, nevertheless 2019 will be the year with the lowest level of additions in over 20 years. The capacity installed in 2019 is 55% below that of the previous year and 80% below that of the record year 2017. In the past ten years (2009-2018), an average annual addition of around 3.1 GW was achieved. The additions in 2019 also stay significantly below this average.

In total, as of December 31, 2019, the recorded cumulative WTG portfolio increased to 29,456 WTG with a total capacity of 53,912 MW. As a result, the capacity of the cumulative portfolio only grew by 2% over the course of the year.

Status of Onshore Wind Energy Development

		Capacity	Number
Development Year 2019	Gross additions	1,078 MW	325 WTG
	Repowering share	155 MW	50 WTG
	Dismantling (incl. subsequent registration) (non-binding)	97 MW	82 WTG
	Net additions	981 MW	243 WTG
Cumulative 2019-12-31	Cumulative WTG portfolio (non-binding)	53,912 MW	29,456 WTG



Annual Development Onshore Wind Energy in Germany

Average Wind Turbine Generator Configuration

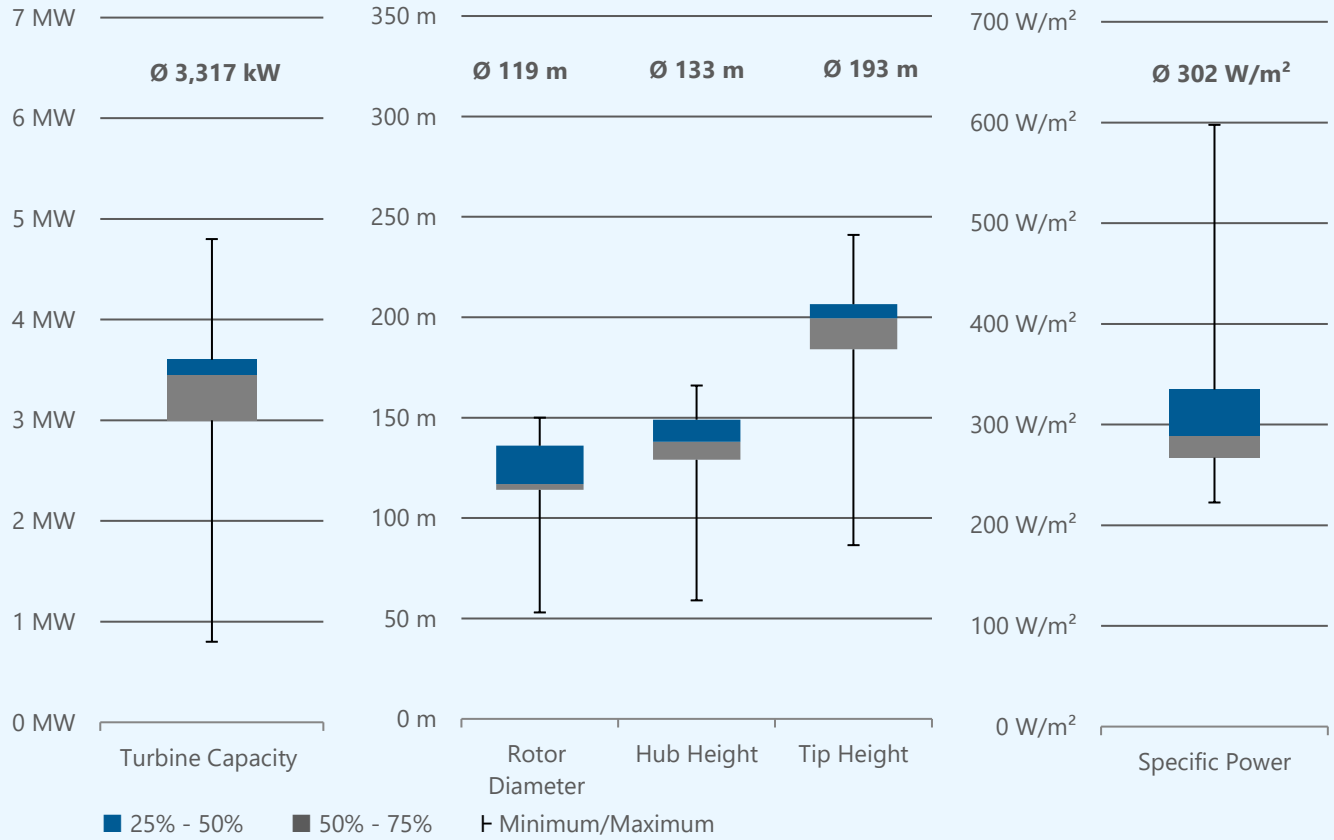
The average configuration of wind turbines generators is described by the nominal turbine capacity, the rotor diameter and the hub height. The nominal capacity in relation to the area swept by the rotor of a WTG results in its specific area power, which also serves as a parameter for the description of a WTG.

Over the course of 2019, turbines with an average output of 3.3 MW were installed in Germany. Compared to the previous year, this represents an increase of 3%. The rotor diameter and hub height have also increased compared to the previous year. With an average rotor diameter of 119 meters and a hub height of 133 meters, this results in an average total tip height of 193 meters.

At 302 W/m², the specific area power remains mostly unchanged in comparison to the previous year.

Average Wind Turbine Generator Configuration

Average Configuration	Addition Year 2019	Changes compared to prior year
Turbine Capacity	3,317 kW	+3%
Rotor Diameter	119 m	+2%
Hub Height	133 m	+1%
Tip Height	193 m	+1%
Specific Power	302 W/m²	0%



Range of Configuration Values of newly installed WTG

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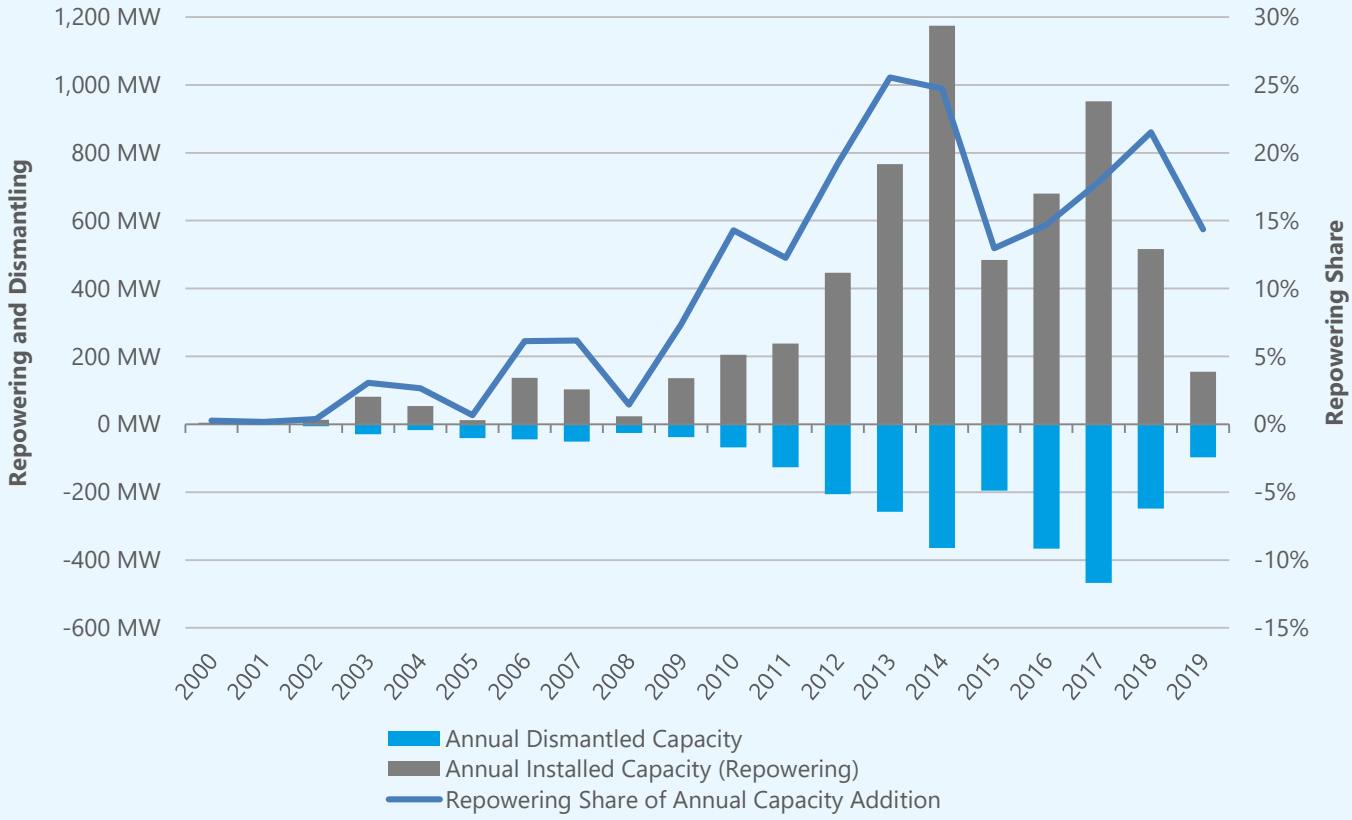
Dismantling and Repowering

The dismantling recorded in 2019 amounts to 82 WTG with a cumulative capacity of 97 MW. Not all dismantled turbines can be replaced by new ones as part of repowering measures. If new turbines cannot be approved on project sites, old turbines that have reached the end of their technical or economic life are subsequently dismantled without being replaced. With the expiration of the remuneration by the Renewable Energy Sources Act (German: Erneuerbare-Energien-Gesetz or EEG) at the end of 2020 for turbines commissioned in or before the year 2000, the economic pressure on older turbines will increase significantly. Dismantling for economic reasons could therefore increase considerably in 2020.

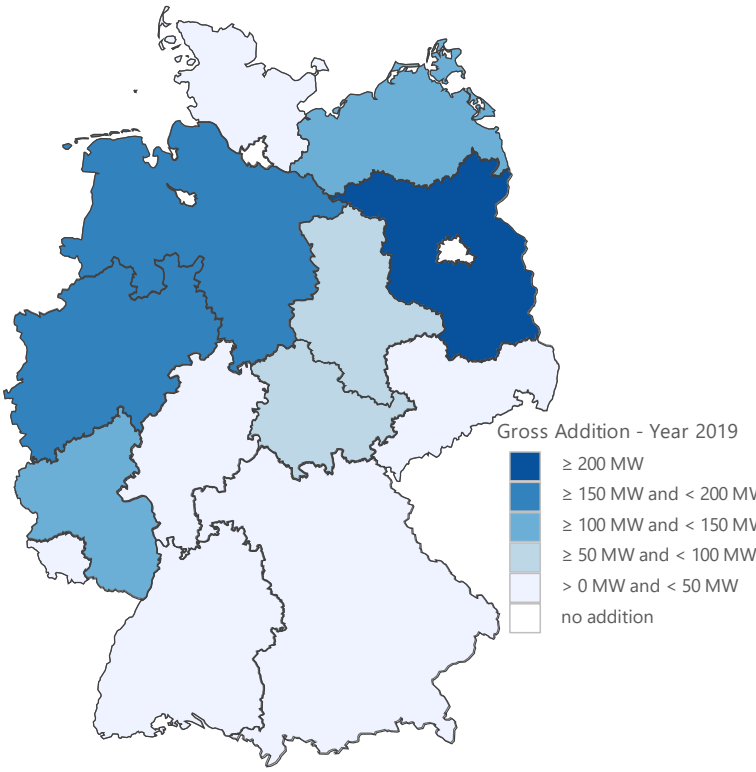
In 2019, 50 WTG with a capacity of 155 MW could be identified as repowering turbines replacing old turbines. The share of repowering in gross additions is thus comparable to that of previous years, but the absolute figures - just like the overall additions - have dropped significantly. The space requirements of new turbines, which are usually much higher and have larger rotor diameters, are greater than those of the old turbines. As a result, in repowering projects a large number of small and low-power turbines is often replaced by a smaller number of modern state-of-the-art turbines. Nevertheless, repowering WTG can usually achieve higher energy yields than the old, dismantled WTG.



Repowering Share, Annual Installed Repowering Capacity and Dismantled Capacity

Regional Distribution of Wind Energy Additions

In Germany, site-dependent remuneration elements are to enable construction of WTG at locations with less wind, too. However, the additions depend on various factors (e.g. political decisions by the federal states, approval procedures) which influence the regional distribution among the federal states. In 2019, the largest share in gross capacity addition of 22% was realized in Brandenburg. Lower Saxony and North Rhine-Westphalia follow in second and third place, respectively. Furthermore, only Mecklenburg-Western Pomerania and Rhineland-Palatinate were able to achieve additions beyond 100 MW. Saxony-Anhalt and Thuringia surpassed the 50 MW mark. Due to the low number of newly installed WTG in some federal states, the average configuration is sometimes strongly influenced by individual projects. However, there is still a tendency for WTG with the lowest height and highest specific area power to be built in coastal states.



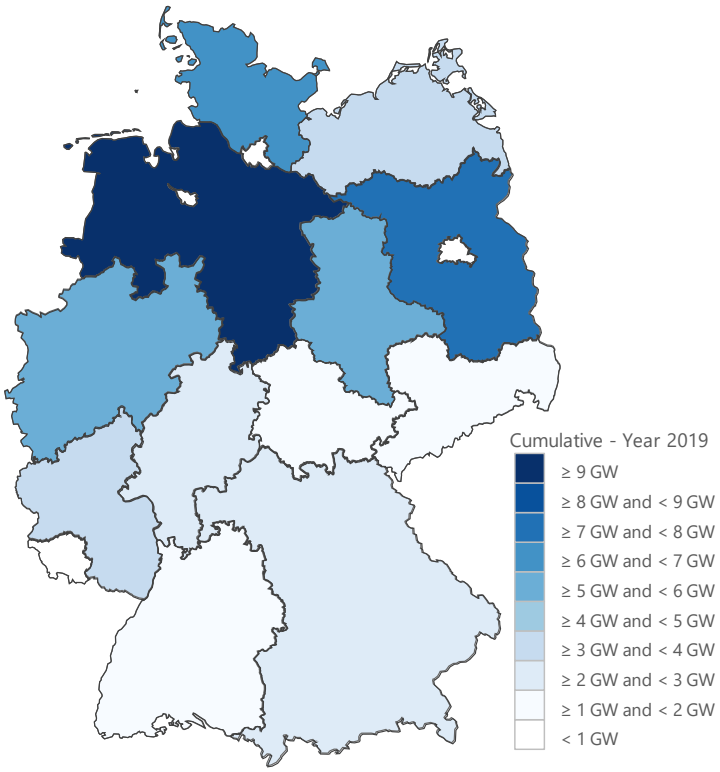
Regional Distribution of Gross Capacity Additions

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

Position	State	Gross Additions in Year 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	Brandenburg	240 MW	73 WTG	22.3%	3,292 kW	120 m	138 m	299 W/m²
2	Lower Saxony	170 MW	51 WTG	15.8%	3,335 kW	118 m	130 m	308 W/m²
3	North Rhine-Westphalia	151 MW	45 WTG	14.0%	3,359 kW	120 m	135 m	302 W/m²
4	Mecklenburg-Western Pomerania	126 MW	40 WTG	11.7%	3,150 kW	106 m	124 m	361 W/m²
5	Rhineland-Palatinate	114 MW	33 WTG	10.6%	3,447 kW	126 m	146 m	280 W/m²
6	Saxony-Anhalt	73 MW	23 WTG	6.8%	3,167 kW	120 m	123 m	287 W/m²
7	Thuringia	57 MW	15 WTG	5.3%	3,803 kW	138 m	145 m	255 W/m²
8	Saxony	42 MW	12 WTG	3.9%	3,500 kW	127 m	141 m	275 W/m²
9	Schleswig-Holstein	35 MW	11 WTG	3.2%	3,173 kW	113 m	98 m	326 W/m²
10	Baden-Württemberg	25 MW	8 WTG	2.4%	3,175 kW	120 m	136 m	283 W/m²
11	Hesse	20 MW	6 WTG	1.9%	3,400 kW	128 m	140 m	266 W/m²
12	Bavaria	17 MW	6 WTG	1.6%	2,883 kW	116 m	128 m	272 W/m²
13	Saarland	7 MW	2 WTG	0.6%	3,450 kW	136 m	166 m	237 W/m²
	Bremen	0 MW	0 WTG	0.0%				
	Hamburg	0 MW	0 WTG	0.0%				
	Berlin	0 MW	0 WTG	0.0%				
	Germany	**1,078 MW**	**325 WTG**		**3,317 kW**	**119 m**	**133 m**	**302 W/m²**

Regional Distribution of the Cumulative Portfolio

In the past, the construction of WTG has taken place in all federal states and regions of Germany with varying intensity. Coastal states account for about 41% of cumulative capacity by the end of 2019. The federal states in central Germany account for about 44% and in the south for about 15% of the cumulative capacity. Different data are available on the actual cumulative WTG portfolio. Due to dissimilar definition and counting systematics the sources differ from each other. The Core Energy Market Data Register (German: Marktstammdatenregister or MaStR), in which operators must register their turbines, is still under development and is to be filled with all existing turbines by the end of January 2021. Until then, the sources (DWG Statistics, MaStR and in some cases federal state data) will be maintained in parallel.



Regional Distribution of the Cumulative Capacity

Cumulative Capacity and Number of WTG in the German Federal States

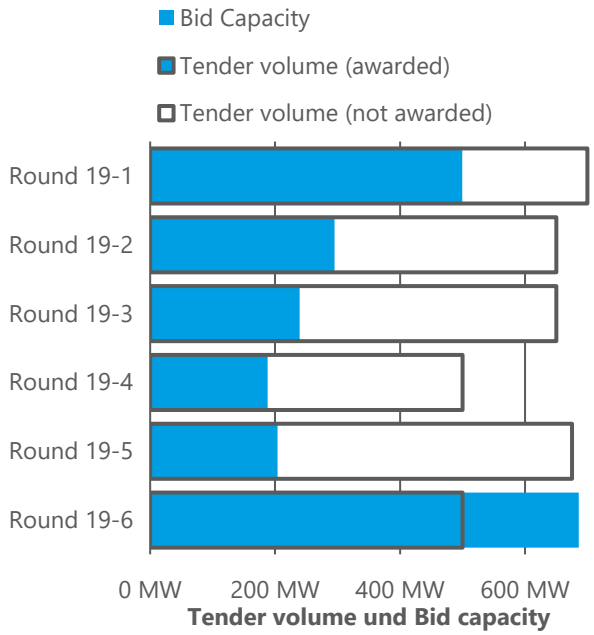
		Cumulative Portfolio (2019-12-31)					
		Cumulative Capacity			Cumulative Number		
Region	State	DWG Statistics	MaStR*	State Data**	DWG Statistics	MaStR*	State Data**
North	Lower Saxony	11,325 MW	11,184 MW		6,342 WTG	6,170 WTG	
	Schleswig-Holstein	6,996 MW	6,809 MW	6,561 MW	3,669 WTG	3,319 WTG	2,959 WTG
	Mecklenburg-Western Pomerania	3,473 MW	3,368 MW		1,942 WTG	1,856 WTG	
	Bremen	198 MW	204 MW		91 WTG	93 WTG	
	Hamburg	128 MW	122 MW		65 WTG	71 WTG	
Central	Brandenburg	7,320 MW	7,297 MW		3,890 WTG	3,871 WTG	
	North Rhine-Westphalia	5,920 MW	5,896 MW		3,767 WTG	3,445 WTG	
	Saxony-Anhalt	5,193 MW	5,172 MW		2,874 WTG	2,875 WTG	
	Hesse	2,217 MW	2,161 MW		1,161 WTG	969 WTG	
	Thuringia	1,613 MW	1,696 MW		866 WTG	925 WTG	
	Saxony	1,267 MW	1,288 MW		908 WTG	965 WTG	
	Berlin	12 MW	12 MW		4 WTG	10 WTG	
South	Rheinland-Pfalz	3,685 MW	3,651 MW		1,772 WTG	1,701 WTG	
	Bavaria	2,531 MW	2,538 MW		1,166 WTG	1,227 WTG	
	Baden-Württemberg	1,550 MW	1,607 MW		730 WTG	762 WTG	
	Saarland	483 MW	506 MW		209 WTG	208 WTG	
	Germany	**53,912 MW**	**53,512 MW**		**29,456 WTG**	**28,467 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 as of December, 2 2019

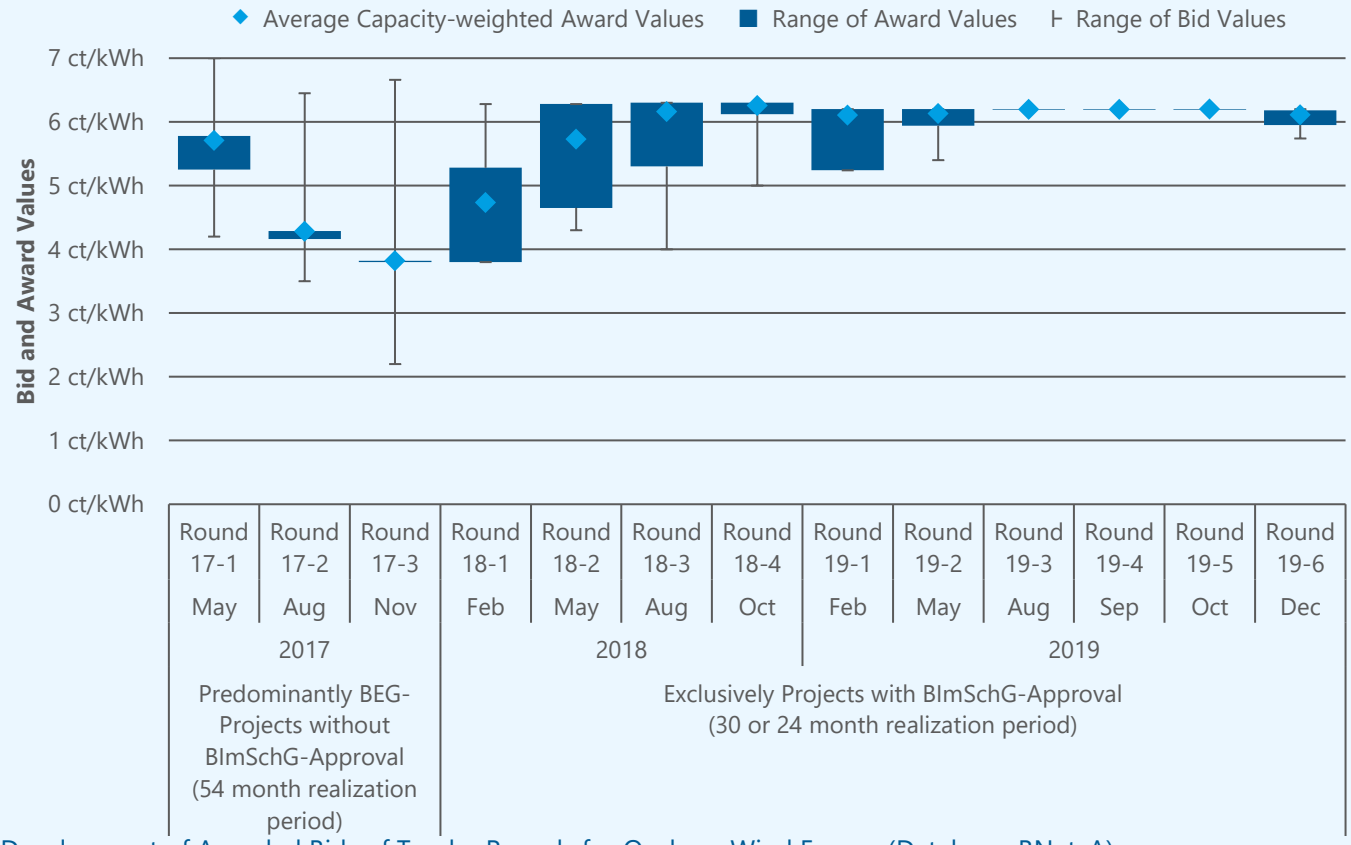
Competitive Situation in Tender System

The tender year 2019 for onshore wind energy was characterized by a lack of competition. After the tendered volume was not covered by the volume of bids in the first five rounds, the last round in December (round 19-6) finally saw competition again. Overall, however, the volume awarded in tenders 2019 was significantly lower than the volume envisioned in the expansion path.

Despite the volume of 3,675 MW tendered in 2019, only wind energy projects with a capacity of 1,847 MW were awarded. The low level of competition is also reflected in the award values, which over the course of 2019 have approached the maximum permissible value of 6.2 € ct/kWh. In the sixth tendering round of the year for onshore wind, the award value fell slightly again due to the higher competition.



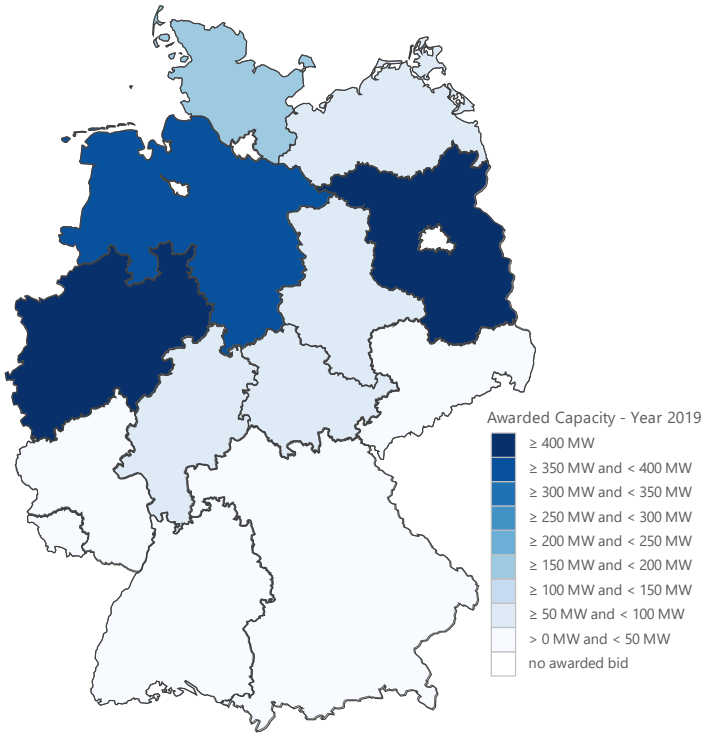
Competitive Situation in Tender System for Onshore Wind Energy (Database: BNetzA)



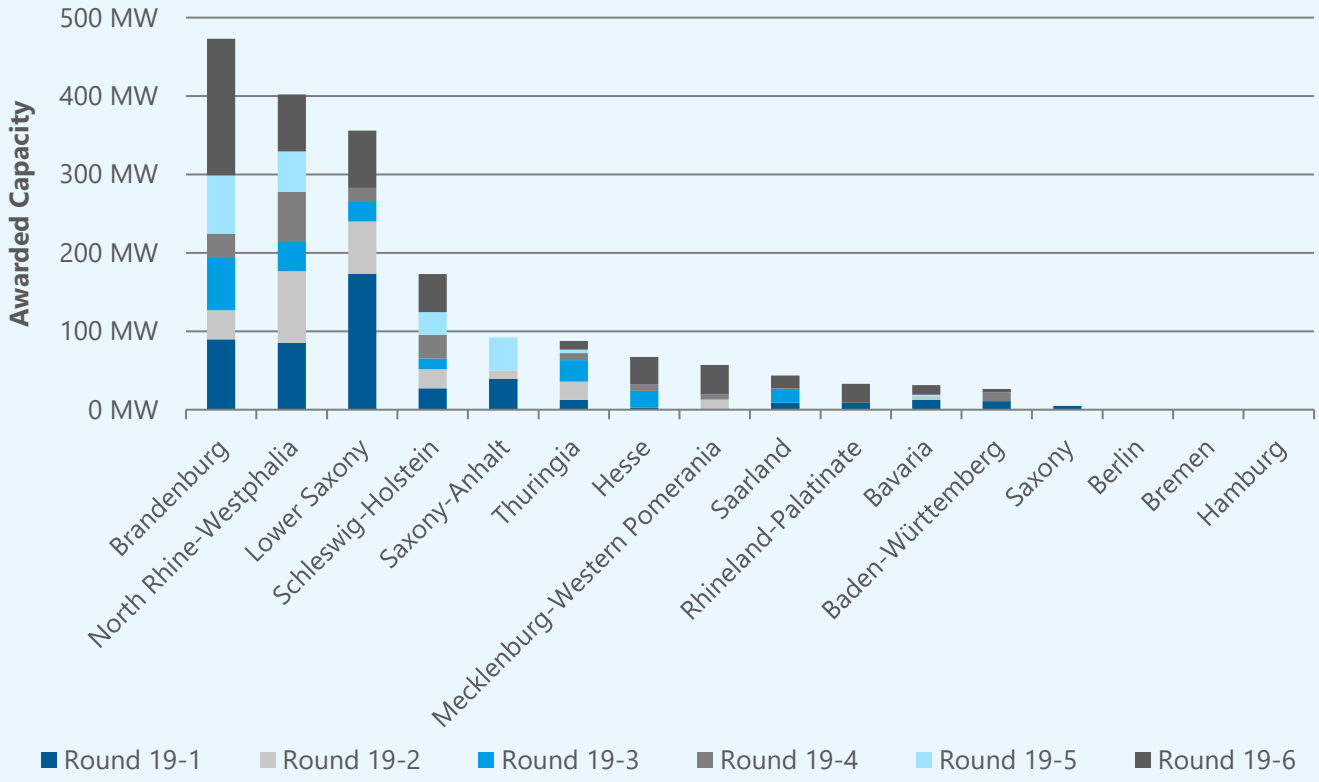
Development of Awarded Bids of Tender Rounds for Onshore Wind Energy (Database: BNetzA)

Regional Distribution of Awarded Bids

The regional distribution of awards in 2019 shows a clear concentration on the federal states of Brandenburg, North Rhine-Westphalia and Lower Saxony. Together they account for two thirds of the awarded capacity. Particularly few bids and awards were received from Saxony and the federal states in the south of Germany (Baden-Württemberg, Bavaria, Rhineland-Palatinate and Saarland). This means that the distribution of the awards is similar to the 2019 additions - the development takes place in the north and the center and activities in the south lag behind. This is mainly due to the lack of permits, which is reflected in the low level of participation in the tender rounds.



Regional Distribution of Awarded Capacity (Database: BNetzA)

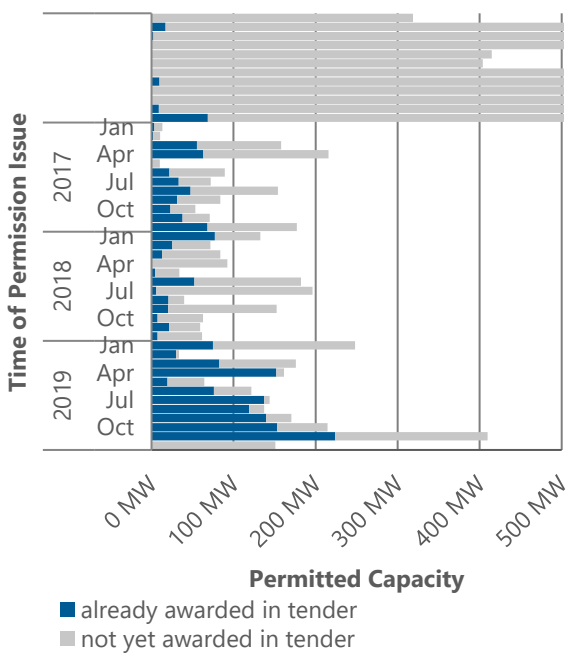


Regional Distribution of Awarded Capacity across the German Federal States (Database: BNetzA)

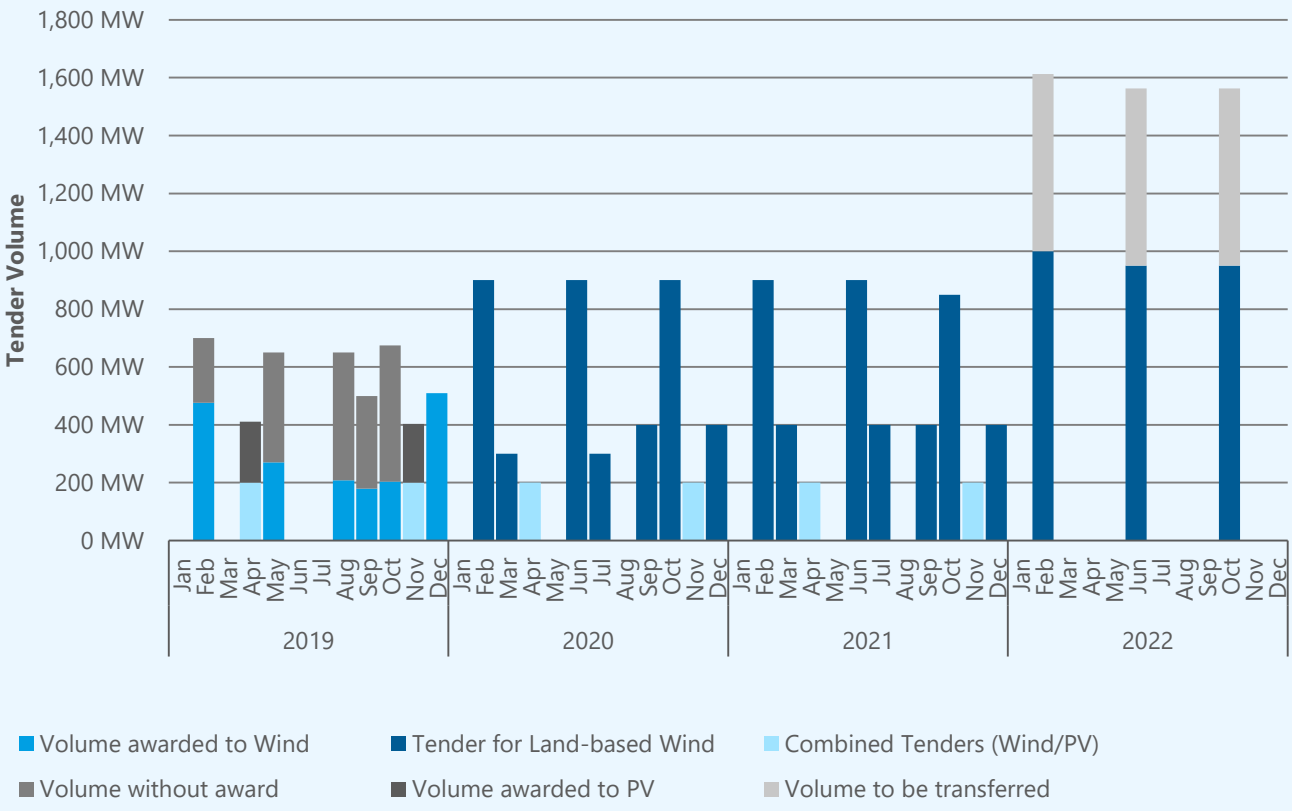
Permitted Capacity and Future Tender Rounds

At the time of evaluation, the MaStR reported approximately 2.0 GW of permits for the year 2019. This represents a recovery from the very low approval levels of 2017 (+48%) and 2018 (+29%). However, the number of permits remains well below the level achieved in the years before the introduction of the tender system. The permits granted are a prerequisite for participation in the coming tender rounds. For the year 2020 tenders for 4.1 GW of onshore wind energy are planned. The total number of permits registered in the MaStR to date and not yet awarded (approx. 2.1 GW) is still not sufficient to meet the tender targets for 2020.

The volumes of the technology-specific tenders that were not awarded in 2019 will be added to the tender volume in 2022. Accordingly, quantities that cannot be awarded in 2020 are carried forward to 2023.



Monthly Permitted Capacity



Tender Volume 2019 to 2022 (according to the EEG)

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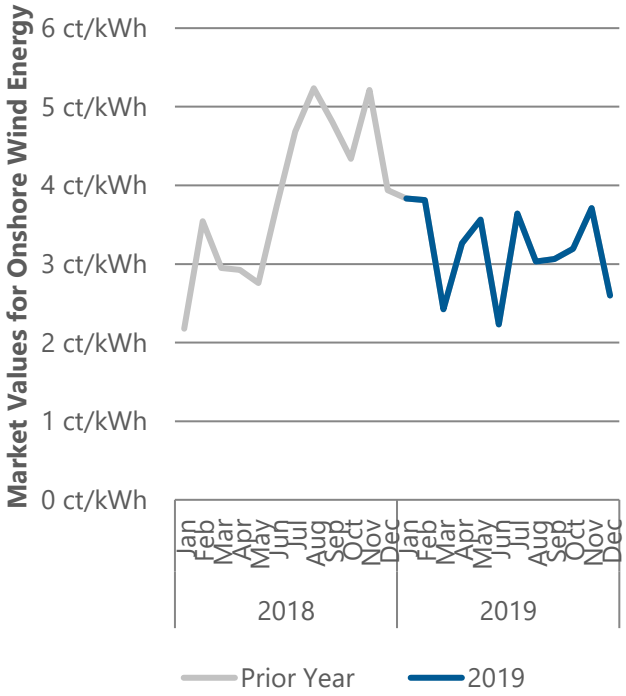
Monthly Power Production and Market Values

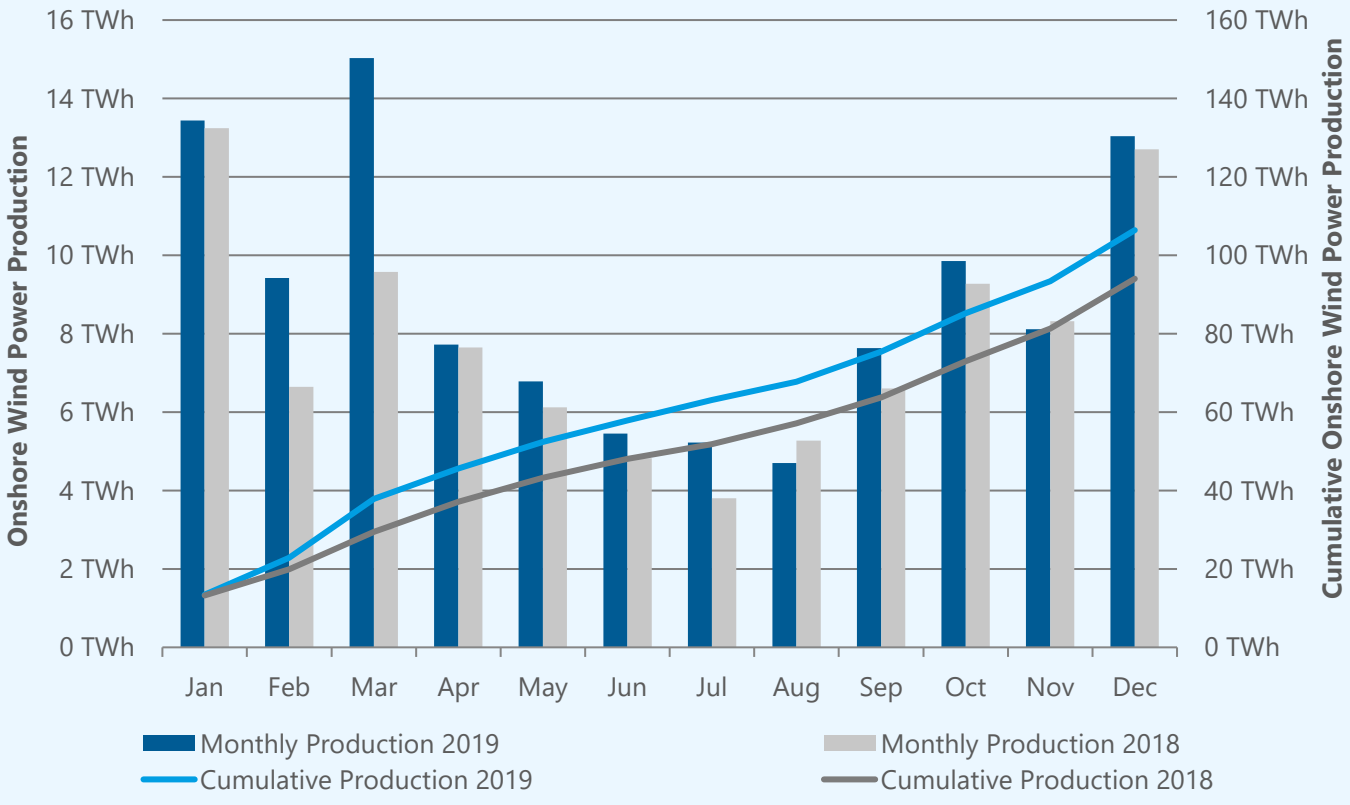
According to the projection data of the Transmission System Operators (TSO), the electricity generated by onshore wind turbines in Germany has increased to 106 TWh in 2019. Despite the low level of new installations, the previous year's data was thus exceeded by 13%.

The market values that could be called up on the electricity exchange for electricity from onshore wind turbines fell significantly again in 2019 compared with the above-average values at the end of 2018.

The monthly average values over the course of 2019 ranged between 2.2 € ct/kWh and 3.8 € ct/kWh, resulting in a volume-weighted average market value of 3.2 € ct/kWh over the year. Compared to 2018, this corresponds to a market value reduction of 14%.



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)

BWE, a member of Bundesverband Erneuerbare Energie [German Renewable Energy Federation (BEE)] with more than 20,000 members, 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.