

Status of Onshore Wind Energy Development in Germany

First Half of 2021



On behalf of



Power Systems

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Notes

The data from 2012 onwards was obtained through surveys with manufacturers and other industry representatives, as well as through additional research. Analyses of the DEWI serve as the data basis for the years 1992-2011. Data corrections based on the Core Energy Market Data Register (German: Marktstammdatenregister or MaStR) were made. The MaStR and the publications of the awards by the BNetzA serve as a data basis for the analysis of the permit situation and the tender results.

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. MaStR) exhibit a deviating data inventory.

Photo on Title Page

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Gross and Net Wind Energy Additions

In the first half of 2021, 240 new onshore wind turbine generators (WTG) with a total capacity of 971 MW were installed in Germany. Compared to the first six months of the previous year, this represents an increase of 62%. Within the same period, the dismantling of 135 WTG with a capacity of 140 MW was recorded.

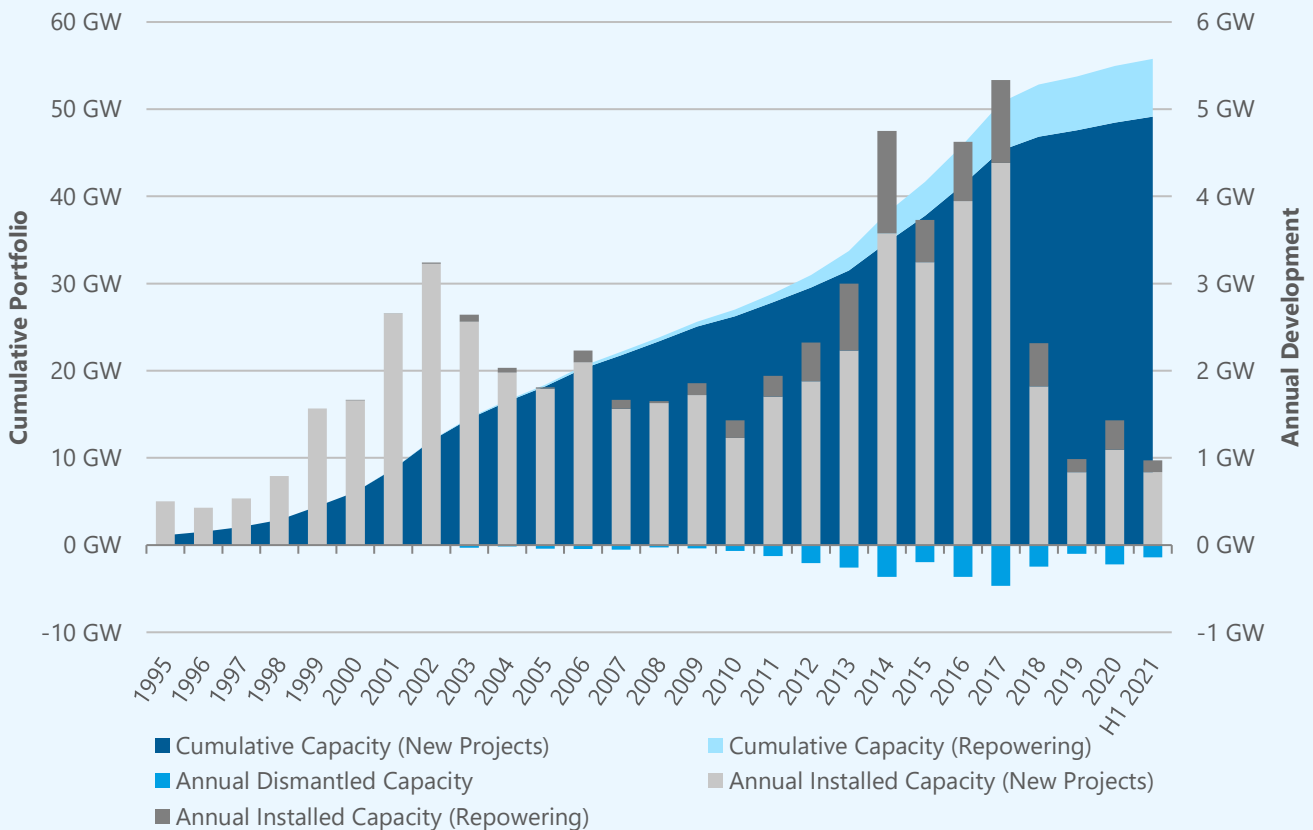
Status of Onshore Wind Energy Development

		Capacity	Number
Development H1 2020	Gross additions	971 MW	240 WTG
	Repowering share	134 MW	35 WTG
	Dismantling (incl. subsequent registration) (non-binding)	140 MW	135 WTG
	Net additions	831 MW	105 WTG
Cumulative 2021-06-30	Cumulative WTG portfolio (non-binding)	55,772 MW	29,715 WTG

Expansion Target for Onshore Wind Energy

	Year	Cumulative Capacity
Target according to EEG 2021	2022	57,000 MW
	2024	62,000 MW
	2026	65,000 MW
	2028	68,000 MW
	2030	71,000 MW

The net increase in capacity in the first half of 2021 amounts to 831 MW. The cumulative onshore wind turbine generator portfolio thus increases by 1.5% to 55,772 MW as of June 30, 2021. A total of 29,716 onshore wind turbine generators are installed in Germany, providing this capacity. To achieve the expansion target for 2022, a further net increase of about 1.2 GW is therefore required. The expansion targets were set in the Renewable Energy Sources Act 2021 (German: Erneuerbare-Energien-Gesetz or EEG) and have not yet been adjusted to the expected increase in electricity demand by 2030.

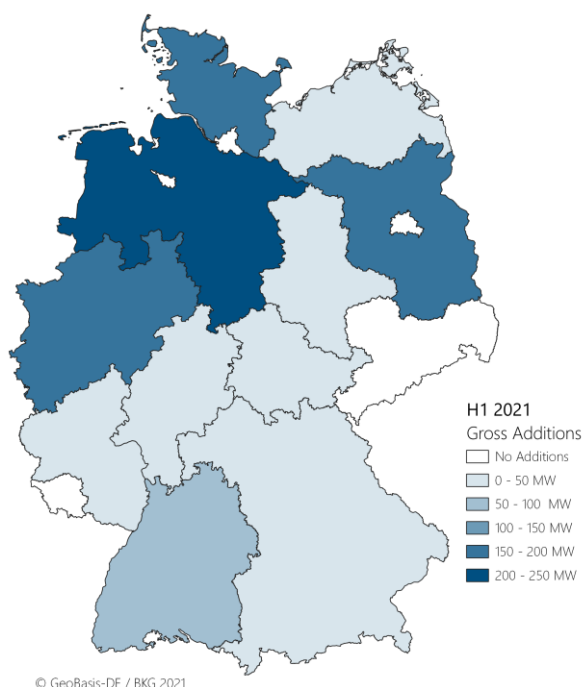


Annual Development Onshore Wind Energy Capacity in Germany

Regional Distribution of Wind Energy Additions

With a share of 22% in current gross additions, Lower Saxony is narrowly leading the federal state ranking in the first half of the year. Brandenburg, North Rhine-Westphalia, and Schleswig-Holstein follow with 16% to 17% of gross capacity additions. In the south of the country, Baden-Württemberg stands out with a 9% share of new capacity additions. In the three city states as well as in Saarland and Saxony, no new wind turbines were commissioned in the first half of the year. For Saxony, this means that due to the decommissioning of some wind turbines in the first half of 2021, negative net additions are recorded.

Most repowering turbines were installed in Schleswig-Holstein. The repowering share in gross additions is also highest with 34%. Brandenburg, Saxony-Anhalt, and Thuringia also have a high repowering share.



Regional Distribution of Gross Capacity Additions

Gross Additions, Dismantling, Net Additions and Repowering in German Federal States

Position	H1 2021 State	Gross Additions			Dismantling and Net Additions			Repowering		
		Capacity Addition	Number Added WTG	Share*	Capacity Dismantling	Number Dismantled WTG	Net Additions	Capacity Repowering	Number Repowering WTG	Repowering-Share**
1	Lower Saxony	211 MW	48 WTG	22%	20 MW	21 WTG	191 MW	8 MW	2 WTG	4%
2	Brandenburg	166 MW	40 WTG	17%	6 MW	6 WTG	159 MW	49 MW	12 WTG	29%
3	North Rhine-Westphalia	154 MW	40 WTG	16%	12 MW	13 WTG	142 MW	4 MW	1 WTG	3%
4	Schleswig-Holstein	152 MW	39 WTG	16%	44 MW	35 WTG	108 MW	51 MW	14 WTG	34%
5	Baden-Württemberg	85 MW	21 WTG	9%	4 MW	4 WTG	81 MW	0 MW	0 WTG	0%
6	Saxony-Anhalt	49 MW	12 WTG	5%	24 MW	21 WTG	25 MW	14 MW	4 WTG	28%
7	Rhineland-Palatinate	39 MW	10 WTG	4%	7 MW	7 WTG	32 MW	0 MW	0 WTG	0%
8	Thuringia	33 MW	7 WTG	3%	9 MW	5 WTG	24 MW	8 MW	2 WTG	26%
9	Hesse	32 MW	9 WTG	3%	2 MW	3 WTG	30 MW	0 MW	0 WTG	0%
10	Mecklenburg-Western Pomerania	28 MW	7 WTG	3%	5 MW	7 WTG	23 MW	0 MW	0 WTG	0%
11	Bavaria	23 MW	7 WTG	2%	1 MW	1 WTG	23 MW	0 MW	0 WTG	0%
12	Berlin	0 MW	0 WTG	0%	0 MW	0 WTG	0 MW	0 MW	0 WTG	-
	Bremen	0 MW	0 WTG	0%	0 MW	0 WTG	0 MW	0 MW	0 WTG	-
	Hamburg	0 MW	0 WTG	0%	0 MW	0 WTG	0 MW	0 MW	0 WTG	-
	Saarland	0 MW	0 WTG	0%	0 MW	0 WTG	0 MW	0 MW	0 WTG	-
	Saxony	0 MW	0 WTG	0%	6 MW	12 WTG	-6 MW	0 MW	0 WTG	-
	Germany	971 MW	240 WTG		140 MW	135 WTG	831 MW	134 MW	35 WTG	14%

* Share of gross capacity additions per federal state in total gross capacity additions

** Share of repowering capacity per federal state in gross capacity addition per federal state

Average Wind Turbine Generator Configuration

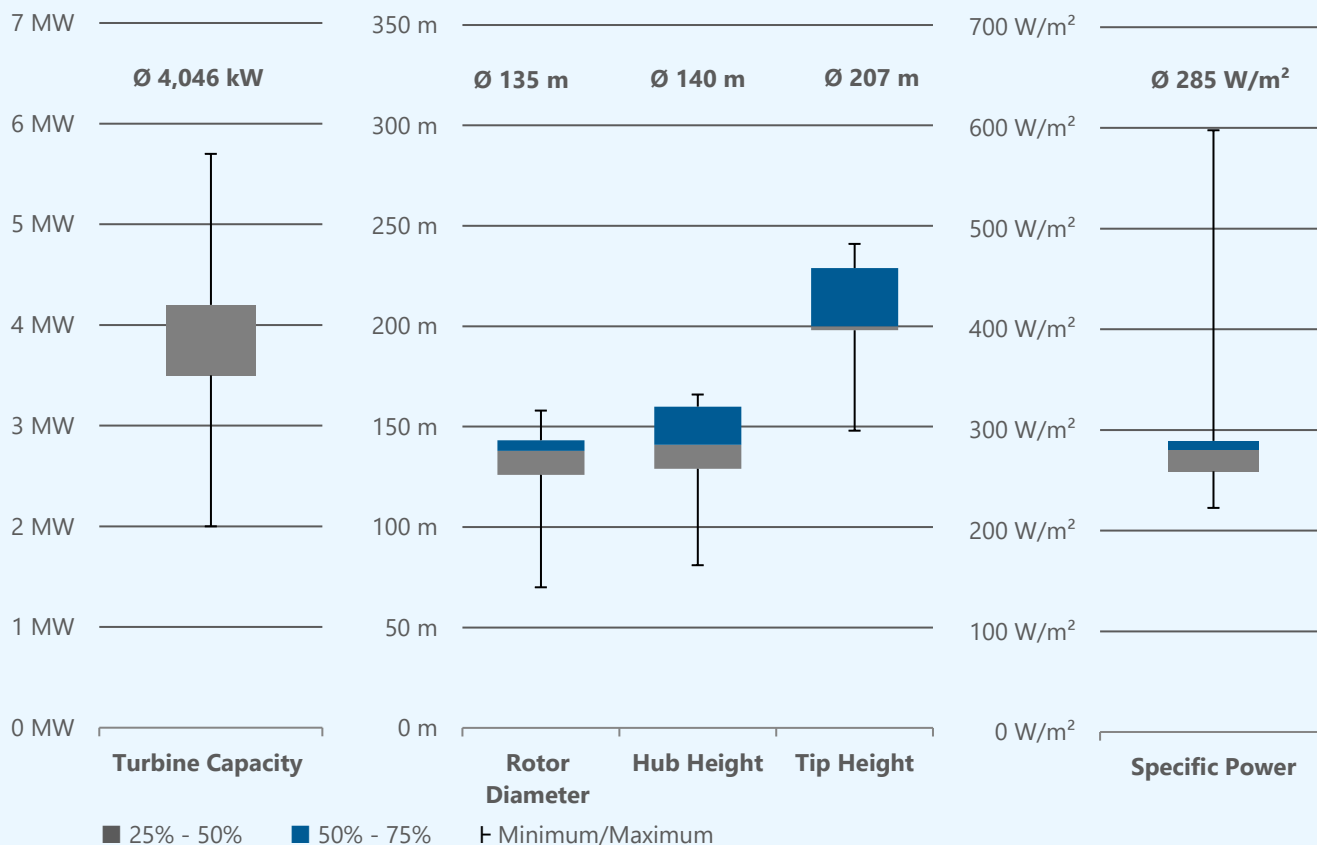
Regarding the average wind turbine generator configuration, the transition to the turbine classes of 4 MW and above is clearly evident in the new installations in the first half of 2021. More than half of the newly installed turbines belong to this class. As a result, the average capacity has increased by 19% compared to the previous year and now amounts to 4,046 kW. The most powerful turbines installed in the first half of the year have a rated capacity of 5,700 kW.

The average rotor diameter of 135 m and the average hub height of 140 m were also significantly greater compared to the previous year. The average total height of turbines installed in the first half of 2021 amounts to 207 m.

In contrast, the specific power slightly drops to 285 W/m² compared to the previous year.

Average Wind Turbine Generator Configuration

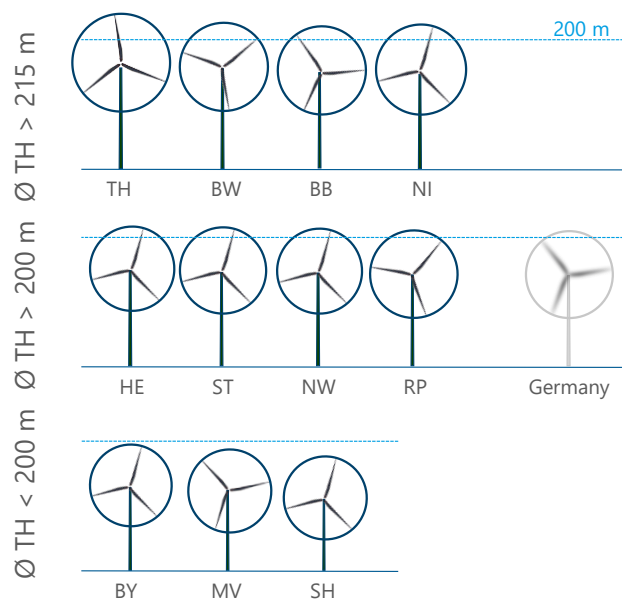
Average Configuration	Additions H1 2021	Changes compared to prior year
Turbine Capacity	4,046 kW	19%
Rotor Diameter	135 m	11%
Hub Height	140 m	4%
Tip Height	207 m	6%
Specific Power	285 W/m ²	-4%



Range of Configuration Values of newly installed WTG

Regional Differences in Wind Turbine Generator Configuration

The largest and most powerful wind turbine generators were installed in Thuringia in the first half of 2021. With an average capacity of 4,657 kW and a total height of 232 m, the Thuringian turbines surpass the new installations from Lower Saxony and Baden-Württemberg, which follow in second place in terms of capacity and total height. In contrast, onshore wind turbine generators installed in Schleswig-Holstein in the first half of 2021 are significantly lower on average and reach a total height of 175 m. At 302 W/m², new turbines in Schleswig-Holstein have the highest specific power. The lowest average specific power of 256 W/m² characterises the new wind turbine generators in Thuringia.



Turbine Configuration of newly installed WTG in German Federal States

Average Installed Turbine Configuration in German Federal States

Additions H1 2021	State	Average Configuration of newly installed WTG					
		WTG-Number	Turbine Capacity	Rotor Diameter	Hub Height	Specific Power	Tip Height
	Lower Saxony	48 WTG	4,397 kW	140 m	146 m	287 W/m ²	216 m
	Brandenburg	40 WTG	4,140 kW	137 m	148 m	281 W/m ²	217 m
	North Rhine-Westphalia	40 WTG	3,848 kW	132 m	144 m	290 W/m ²	210 m
	Schleswig-Holstein	39 WTG	3,909 kW	129 m	110 m	302 W/m ²	175 m
	Baden-Württemberg	21 WTG	4,043 kW	137 m	155 m	275 W/m ²	223 m
	Saxony-Anhalt	12 WTG	4,096 kW	134 m	145 m	288 W/m ²	212 m
	Rhineland-Palatinate	10 WTG	3,870 kW	136 m	141 m	264 W/m ²	209 m
	Thuringia	7 WTG	4,657 kW	152 m	156 m	256 W/m ²	232 m
	Hesse	9 WTG	3,550 kW	131 m	148 m	265 W/m ²	213 m
	Mecklenburg-Western Pomerania	7 WTG	3,929 kW	129 m	124 m	296 W/m ²	189 m
	Bavaria	7 WTG	3,333 kW	127 m	128 m	261 W/m ²	192 m
	Berlin	0 WTG					
	Bremen	0 WTG					
	Hamburg	0 WTG					
	Saarland	0 WTG					
	Saxony	0 WTG					
Germany	240 WTG	4,046 kW	135 m	140 m	285 W/m²	207 m	

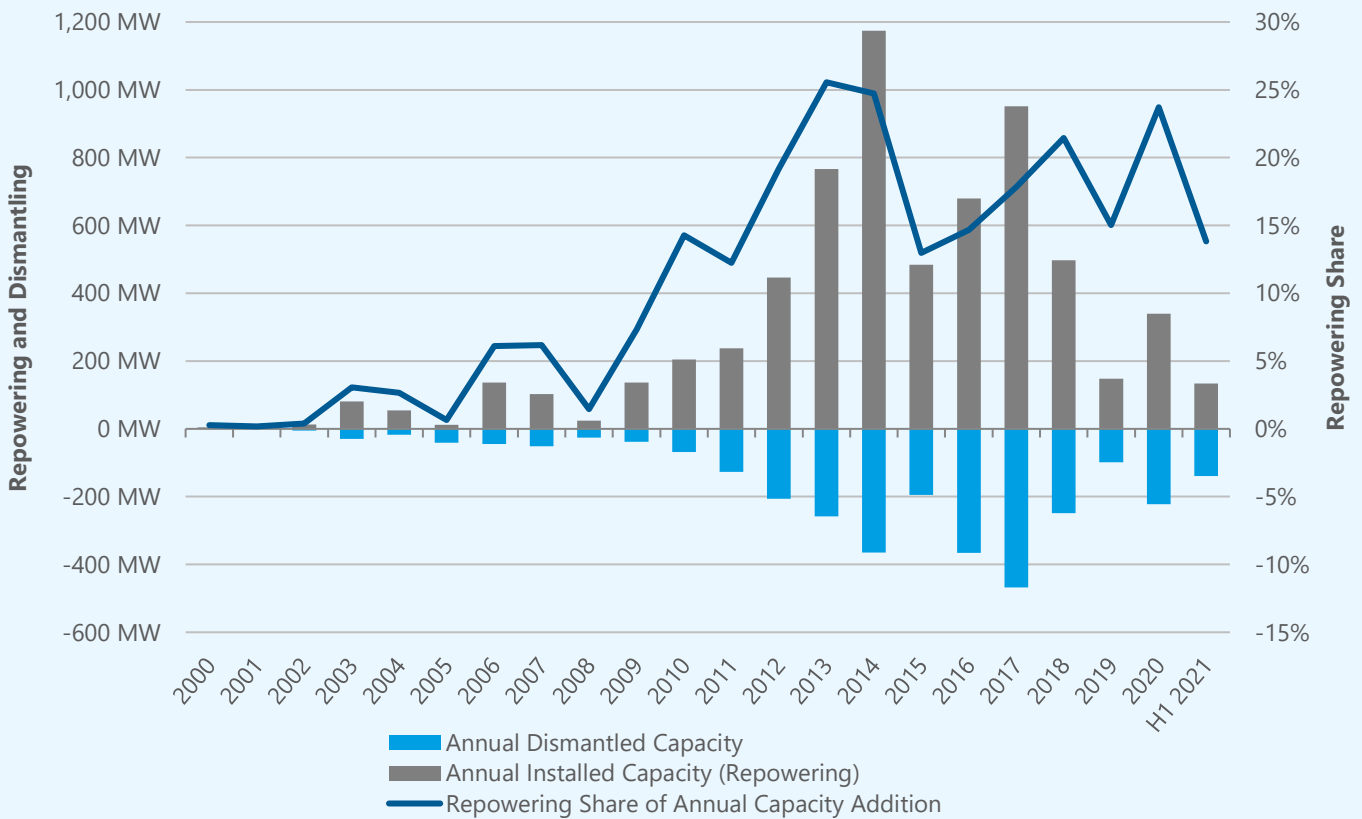
Dismantling and Repowering

In the first half of 2021, 35 of the newly installed wind turbine generators with a total of 134 MW were classified as repowering wind turbine generators. The repowering share of gross capacity additions is therefore around 14%. Not all of the 135 identified decommissioned turbines with a combined capacity of 140 MW were replaced by a new turbine as part of repowering activities. Some turbines have been dismantled without replacement, while the replacement of others is still planned for the coming months. In future, repowering is to be facilitated by an amendment to the Federal Immissions Control Act (German: Bundes-Immissionsschutzgesetz or BImSchG). This amendment stipulates that prior

impacts from existing turbines to be decommissioned on areas that will be repowered can be taken into account in the approval process.

Around three quarter of the decommissioned capacity belonged to turbines whose regular EEG remuneration entitlement expired at the beginning of 2021. Turbines commissioned before January 1, 2001, no longer receive regular EEG subsidies as of January 1, 2021. The electricity can be sold by means of unsubsidised sales contracts or remunerated until the end of the year via subsidised market value transfer.

In relation to the total number of turbines for which the EEG subsidy has expired, the proportion of decommissioned turbines is very low.



Development of Annual Dismantled Capacity, Annual Installed Repowering Capacity and Repowering Share

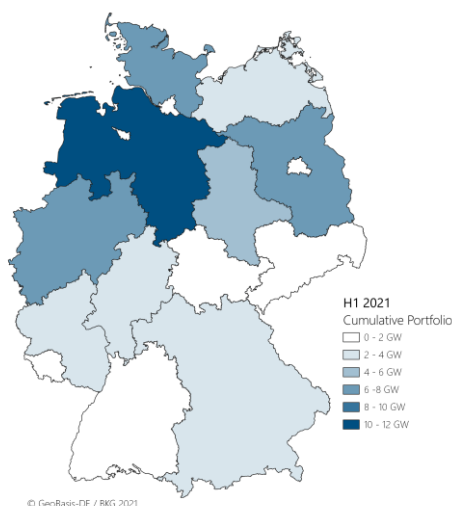
Regional Distribution of the Cumulative Portfolio

The regional distribution of the total number of wind turbine generators in Germany shows a clear north-south divide. Although the remuneration system provides stronger support for the areas with less wind, which occur more frequently in the south, their share of cumulative capacity is the lowest at 15%. In the tenders from 2022 onwards, the south should therefore be supported by an award quota. Accordingly, projects in a defined southern region are to receive preferred awards up to a fixed share of the award volume (15% in 2022/2023 and 20% from 2024).

In mid-2021, the coastal states accounted for about 41% of the cumulative installed capacity, and the federal states in central Germany for about 44%.

Different data are available on the actual cumulative installed capacity. Due to different definition and counting systems, the sources differ from each other. All operators had to register their

installations in the Core Energy Market Data Register (German: Marktstamm-daten-register or MaStR) by the end of January 2021. The verification of the reported data by the respective grid operators is still ongoing and has so far been completed for 81% of the reported capacity.



Regional Distribution of the Cumulative Capacity

Cumulative Capacity and Number of WTG in the German Federal States

		Cumulative Portfolio (2021-06-30)					
Region	State	Cumulative Capacity			Cumulative Number		
		DWG Statistics	MaStR*	State Data**	DWG Statistics	MaStR*	State Data**
North	Lower Saxony	11,621 MW	11,619 MW		6,379 WTG	6,243 WTG	
	Schleswig-Holstein	7,175 MW	6,976 MW	6,839 MW	3,678 WTG	3,305 WTG	3,011 WTG
	Mecklenburg-Western Pomerania	3,573 MW	3,550 MW		1,964 WTG	1,868 WTG	
	Bremen	198 MW	201 MW		91 WTG	93 WTG	
	Hamburg	128 MW	118 MW		65 WTG	65 WTG	
	Central	Brandenburg	7,638 MW	7,629 MW		3,934 WTG	3,887 WTG
North Rhine-Westphalia		6,317 MW	6,238 MW		3,845 WTG	3,606 WTG	
Saxony-Anhalt		5,305 MW	5,323 MW		2,861 WTG	2,877 WTG	
Hesse		2,325 MW	2,271 MW		1,185 WTG	1,118 WTG	
Thuringia		1,680 MW	1,706 MW		872 WTG	891 WTG	
Saxony		1,267 MW	1,277 MW		895 WTG	918 WTG	
Berlin		12 MW	19 MW		4 WTG	11 WTG	
South	Rhineland-Palatinate	3,789 MW	3,770 MW		1,794 WTG	1,750 WTG	
	Bavaria	2,581 MW	2,583 MW		1,178 WTG	1,283 WTG	
	Baden-Württemberg	1,653 MW	1,733 MW		752 WTG	842 WTG	
	Saarland	510 MW	524 MW		218 WTG	221 WTG	
Germany	55,772 MW	55,537 MW		29,715 WTG	28,978 WTG		

* Turbine Portfolio (incl. small turbines) based on WTG reported as in operation according to MaStR

** Turbine Portfolio subject to permit according to LLUR Schleswig-Holstein as of June 30, 2021

Results of Tender Rounds

In the first half of 2021, two tender rounds for onshore wind energy in Germany were held. A total volume of around 2,743 MW was put out to tender. Despite a reduction of the tender volume in the tender round in May (WIN21-2) to around 1,243 MW, both tender rounds remained without sufficient participation and the submitted bid volume did not meet the tendered volume.

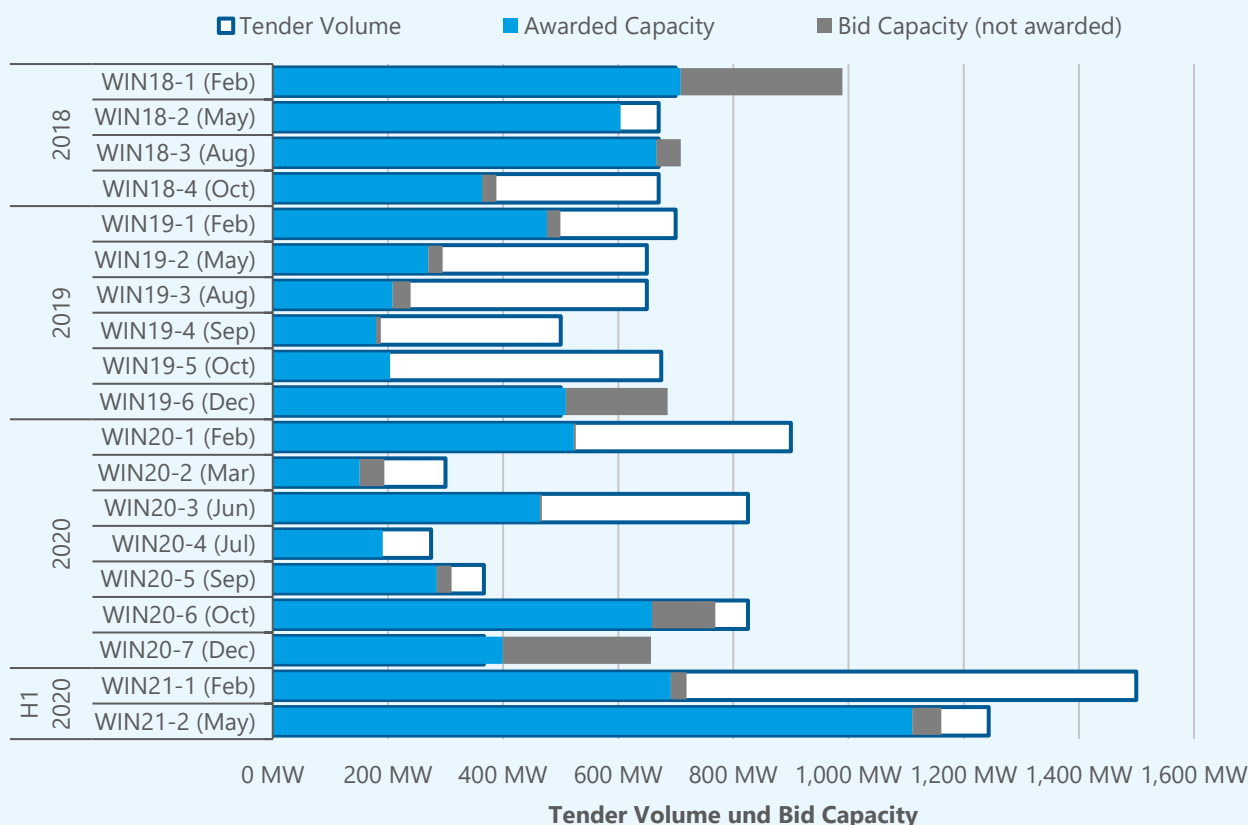
After the exclusion of some bids, a capacity of 1,802 MW was awarded in the first half of 2021. In addition to newly approved turbines that successfully participated in the tender for the first time in 2021, several turbines whose original awards from 2018 have been lapsed were also awarded. Furthermore, additional awards were issued for some turbines to increase their previously awarded capacity.

The upper limit for bid values in 2021 tender rounds is 6.0 ct/kWh. The bid values submitted

continue to be strongly oriented towards this maximum value. Thus, the average volume-weighted award value for the first half of 2021 is 5.94 ct/kWh.

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

	Year	Bid Limit	Capacity-weighted award value
Year of Tender	2017	7.0 ct/kWh	4.53 ct/kWh
	2018	6.3 ct/kWh	5.63 ct/kWh
	2019	6.2 ct/kWh	6.14 ct/kWh
	2020	6.2 ct/kWh	6.11 ct/kWh
	H1 2021	6.0 ct/kWh	5.94 ct/kWh

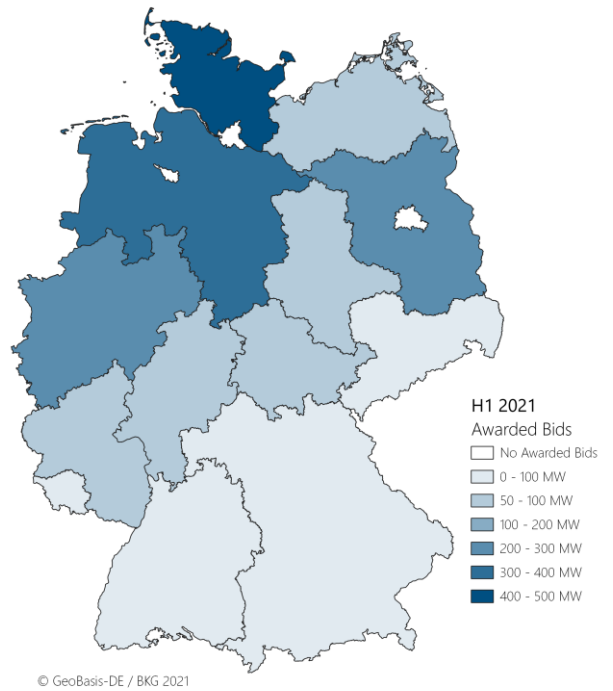


Competitive Situation in Tender System for Onshore Wind Energy (Database: BNetzA)

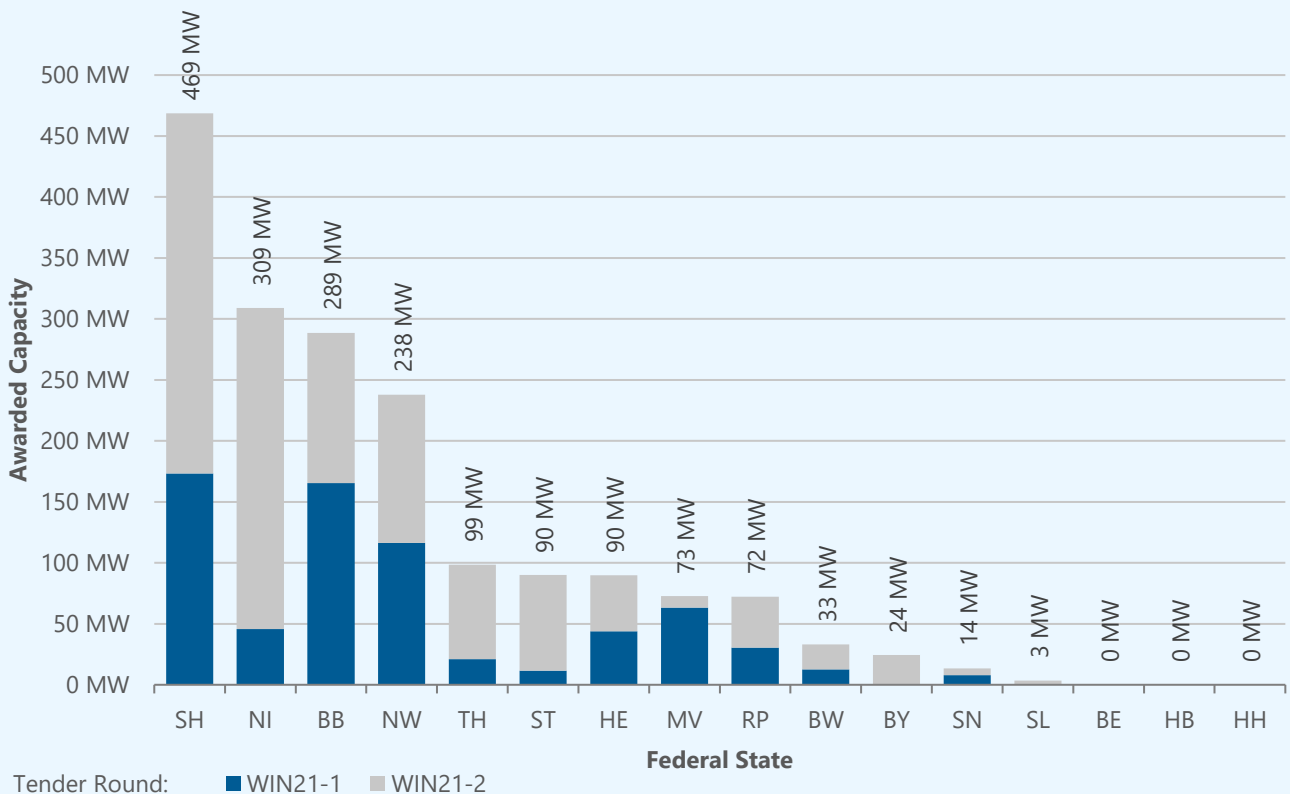
Regional Distribution of Awarded Bids

Schleswig-Holstein accounted for the largest award volume in the first half of the year, with about 26% of the awarded volume. Particularly in consideration of the relatively small area of the state, Schleswig-Holstein is the clear frontrunner in the current tender rounds. The following ranks are taken by Lower Saxony (17% of the award volume), Brandenburg (16%) and North Rhine-Westphalia (13%). In the previous year, onshore wind turbine generators from these four federal states also accounted for the largest awarded capacity.

The remaining federal states, except for the city states, were able to successfully place at least one bid in the tender rounds of the first half of 2021 and achieved shares of up to 5% each. Overall, a North-South divide remained visible regarding participation in the tender rounds.



Regional Distribution of Awarded Capacity (Database: BNetzA)



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

Development Status of Awarded Turbines

Wind turbine generators that have secured their EEG remuneration entitlement by successfully participating in a tender generally have to be commissioned within 30 months (24 months penalty-free) to avoid forfeiting the award. In certain tender rounds, however, different deadlines apply (e.g. extension for BEG projects without permit and for tender rounds affected by COVID-19, shortening for some special tender rounds). Furthermore, project-specific extensions can be applied for, e.g. in case of a legal action against the turbine’s permit.

The implementation period for awards from the first two bidding rounds in 2018 has already expired. It is expected that award quantities (375 MW) from these rounds that have not yet been realised* will probably not be implemented. This does not include turbines that may still be

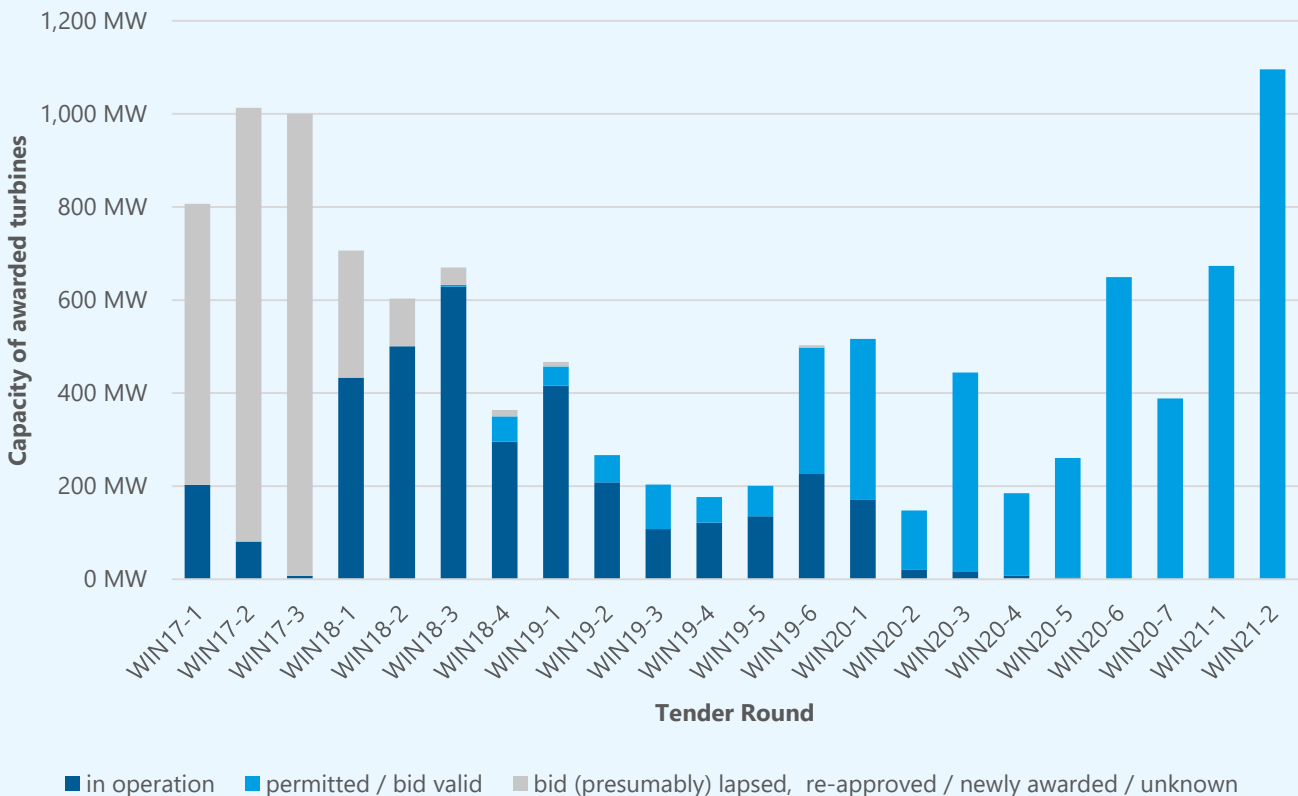
implemented in the short term within the scope of an individual deadline extension. A further realisation of the awards for not permitted turbines from 2017 (2.5 GW) is uncertain.

At the end of the first half of the year, the realisation rate of the 2018 awards was around 79% and 65% of the volume from 2019 has already been realised. In total, the realisation of 4.8 GW of awarded turbines with permit is still pending.

Realized Capacity of Tenders for Onshore Wind Energy in Germany

	Year	Realized Capacity	Realization Rate
Year of Tender	2017	291 MW	10%
	2018	1,859 MW	79%
	2019	1,215 MW	66%
	2020	221 MW	8%
	H1 2021	1 MW	0%

* The evaluations represent an assessment of the development status based on an analysis of the MaStR and the awards issued by BNetzA. Deviations from actually allocated awards are possible. It was assumed that the award volume corresponds to the permitted/installed capacity.



Development Status* of Awarded Capacity (Database: BNetzA, MaStR, own research and assumptions)

Permitted Capacity and Future Tender Rounds

In the first half of 2021, wind turbine generators with a capacity of 1,535 MW were permitted. Compared to the first half of 2020, this corresponds to an increase of 10%, but compared to the second half of 2020, the permit volume is lower. About half of the permits were issued in March 2021, while below-average permit volumes were achieved in the other months.

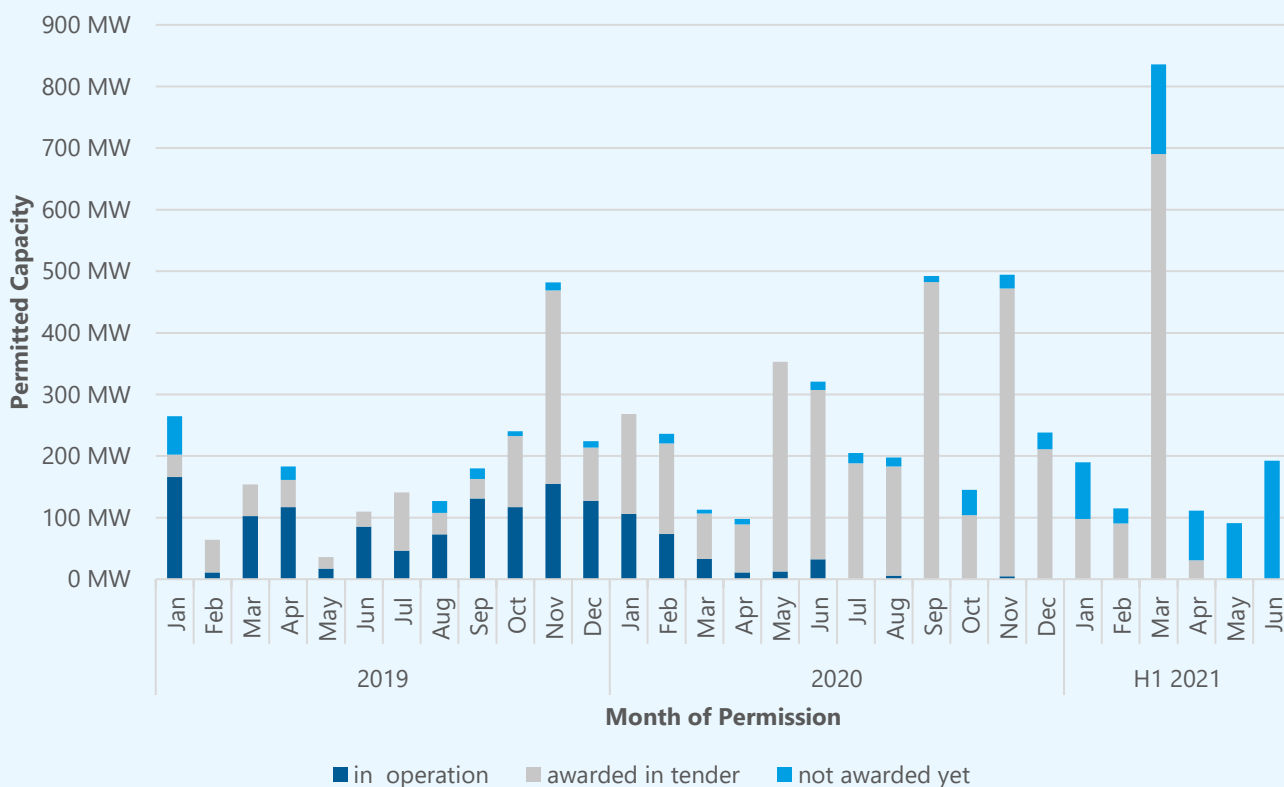
Turbines that received permit by April 6, 2021 and were registered in MaStR were able to participate in the tender round in May 2021 and a large share of them have already been awarded. The permit and registration period for the third tender round in 2021 for onshore wind energy in September ends on August 4, 2021. If competition is expected, up to 1,492 MW might be tendered in this round.

In 2022, according to a recent amendment to the Renewable Energy Sources Act (German:

Erneuerbare-Energien-Gesetz or EEG), the tender volume of the first three tender rounds will be increased to a total of 4,000 MW. In addition, there will be a fourth round, in which the capacity not awarded in the previous year will be put out to tender again.

Tender volume 2021 to 2028 (according to EEG)

Year	Events	Tender Volume
2021	3	4,500 MW
2022	3+1	4,000 MW + rerun volume from 2021
2023	3+1	3,000 MW + rerun volume from 2022
2024	3	3,100 MW
2025	3	3,200 MW
2026	3	4,000 MW + rerun volume from 2023
2027	3	4,800 MW + rerun volume from 2024
2028	3	5,800 MW + rerun volume from 2025



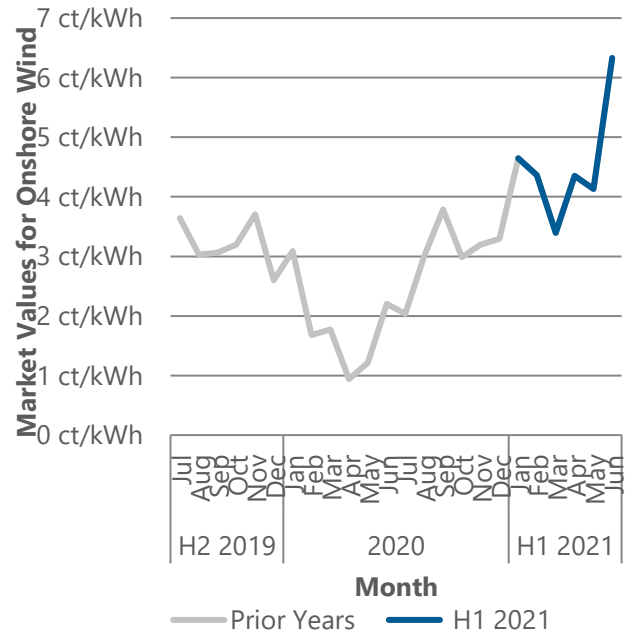
* Permits with an updated permit date have been dated back to the date of the first registration in MaStR.

Monthly Permitted Capacity including Status

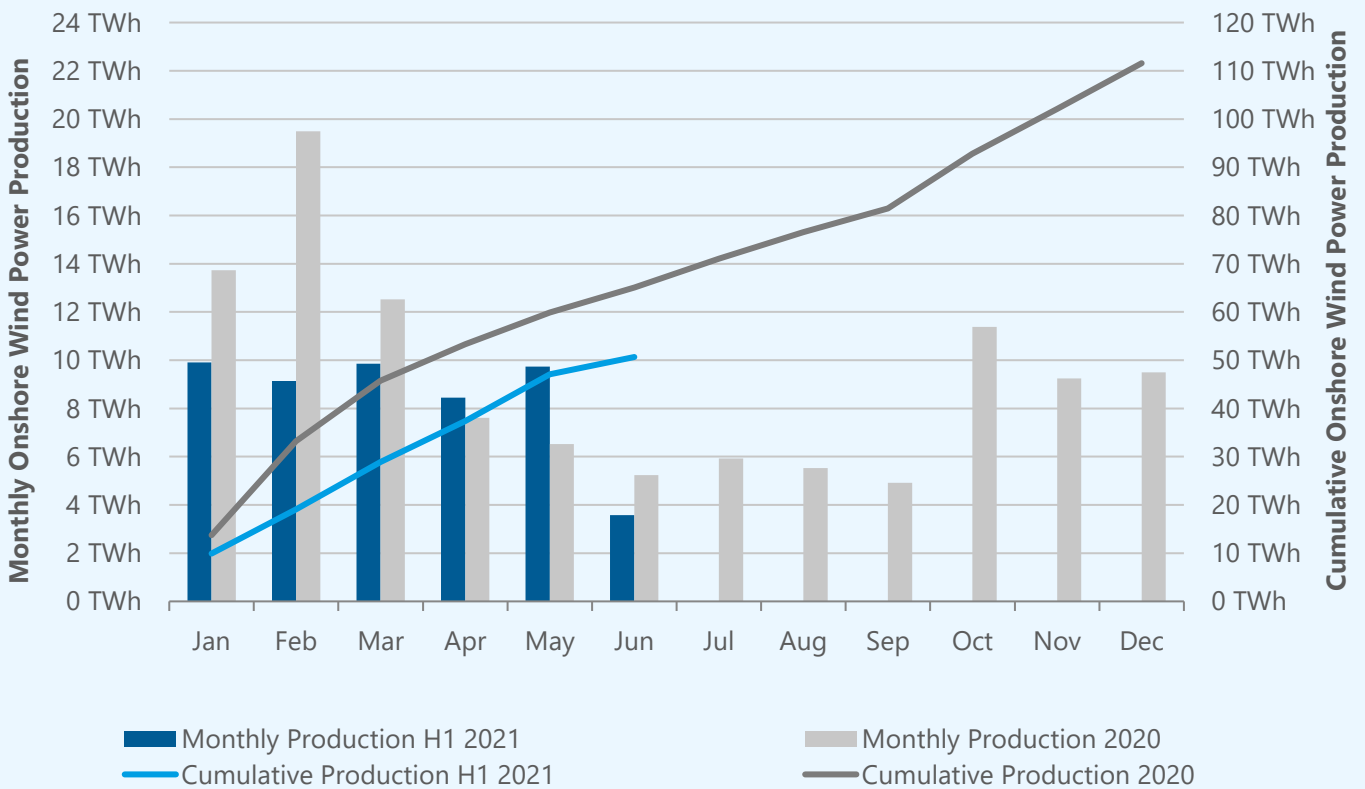
Monthly Power Production and Market Values

The production of electricity from onshore wind energy in the first half of 2021 is around 51 TWh and thus remains significantly below the generation volume of the first half of 2020. This is particularly due to the first quarter, which was characterised by above-average feed-in in 2020, whereas it was characterised by comparatively low feed-in this year.

The monthly market values for onshore wind energy on the electricity exchange have fully recovered after the sharp drop in values associated with the effects of the COVID-19 pandemic in spring 2020. In June 2021, the monthly market value of 6.33 ct/kWh surpassed the previous maximum value from 2018. The volume-weighted average market value for the first half of 2021 is 4.32 ct/kWh, which is 81% above the previous year's average.



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



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

About Deutsche WindGuard

In the complex energy market, Deutsche WindGuard is committed to providing independent, manufacturer-neutral consulting and comprehensive scientific, technical and operational services. The wide range of services creates extensive synergy effects. Whether due diligence, market analysis, contract consulting or feasibility studies: each of them contains the expertise and know-how of the entire WindGuard group. Deutsche WindGuard has been publishing the semi-annual statistics on wind energy development since 2012.

About Bundesverband Windenergie e.V. [German Wind Energy Association (BWE)]

BWE, a member of Bundesverband Erneuerbare Energie [German Renewable Energy Federation (BEE)] with more than 20,000 members, represents the entire wind industry in Germany. Members of BWE range from industry suppliers in the fields of mechanical engineering and manufacturing over project developers to legal experts, the financial sector, electricity traders, network operators, energy suppliers, and companies specialized in logistics, construction, service/maintenance, and storage technologies. Its broad membership makes of BWE the primary point of contact for politics, business, science, and the media in all matters linked to wind energy.

About VDMA Power Systems

VDMA Power Systems is a trade association of the German Engineering Federation VDMA e.V. The trade association represents the interests of manufacturers of wind energy and hydropower plants, fuel cells, thermal plants and storage systems in Germany and abroad. For them, VDMA Power Systems serves as an information and communication platform for all industry topics such as energy policy, legislation, market analyses, trade fairs, standardisation and press and public relations.