DEUTSCHE WINDGUARD

Status of Onshore Wind Energy Development in Germany

Year 2021

On behalf of

BWE Bundesverband WindEnergie

VDMA Power Systems

Contents

Notes

The analysis within the scope of the Status of Onshore Wind Energy Development is based on the data of the core energy market data register (German: Marktstammdatenregister or MaStR) of the Federal Network Agency (German: Bundesnetzagentur or BNetzA) as well as on the announcements of the BNetzA regarding the tenders for onshore wind energy. The data was partially validated and corrected with regard to various details and supplemented with unrecorded dismantling and repowering properties of projects. The publication of the Status of Onshore Wind Energy Development takes place before the end of the reporting deadline for commissioning in 2021. Further reports that increase the added capacity are possible. Furthermore, changes or subsequent reporting of existing turbines to the MaStR may result in deviations from the portfolio shown.

Some of the figures in the text and illustrations are rounded values. Their addition may therefore result in slight deviations from the total values.

Photo on Title Page

Repowering project in North Friesland

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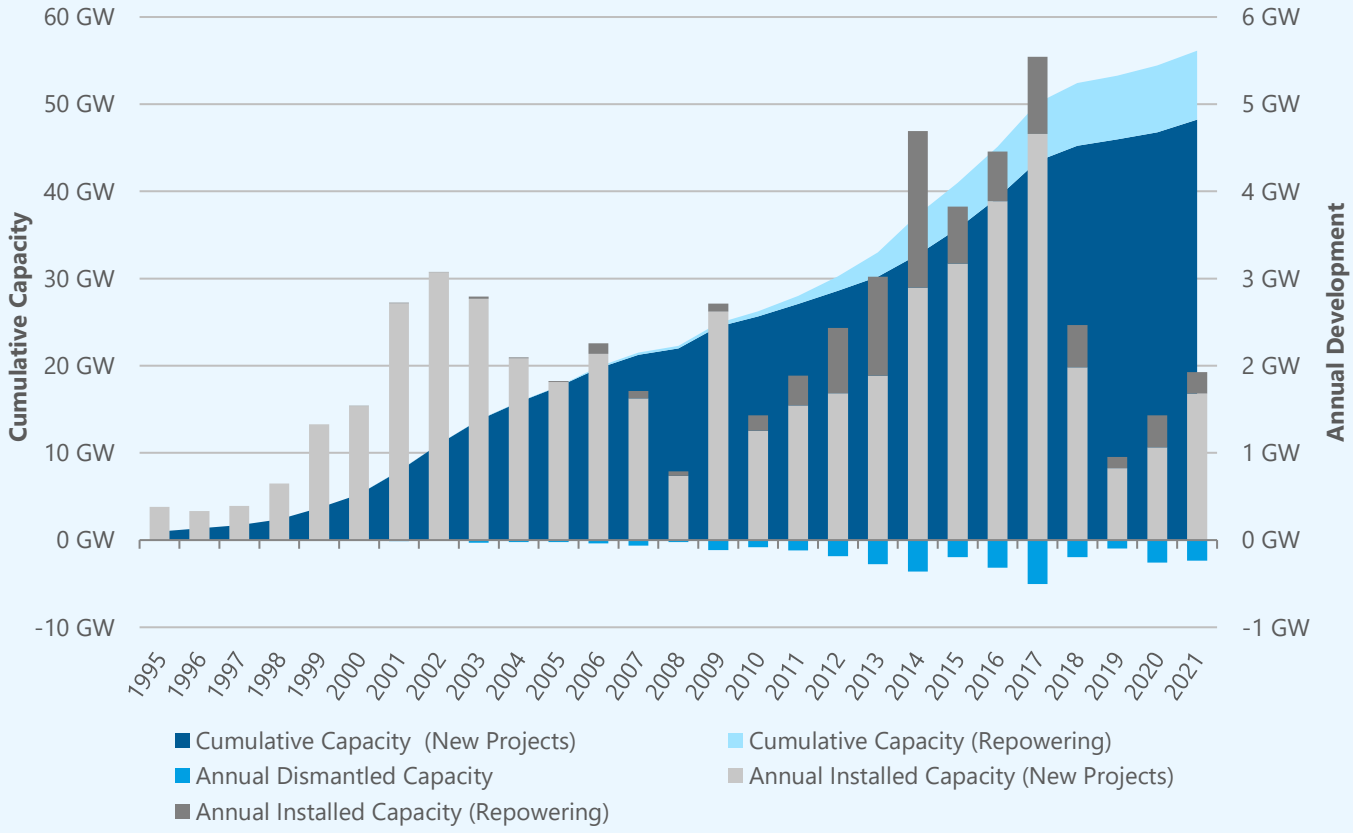
Gross and Net Wind Energy Additions

In 2021, XXX new onshore wind turbines (WTG) were installed in Germany. Together, the new installations have a capacity of X,XXX MW. This is offset by the decommissioning of XXX wind turbines with a capacity of XXX MW. Thus, a net addition of X,XXX MW could be achieved in 2021. Gross new installations are still at a low level but are slowly recovering for the second year in a row from the drop in new installations in 2019 and are XX% above the gross new additions of the previous year.

At the end of 2021, the total portfolio of onshore wind turbines in Germany amounts to XX,XXX WTG with a total installed capacity of XX,XXX MW.

Status of Onshore Wind Energy Development

		Capacity	Number
Development 2021	Gross additions	1,925 MW	484 WTG
	Repowering share	244 MW	64 WTG
	Decommissioning	234 MW	231 WTG
	Net additions	1,691 MW	253 WTG
Cumulative 2021-12-31	Cumulative Portfolio	56,138 MW	28,235 WTG

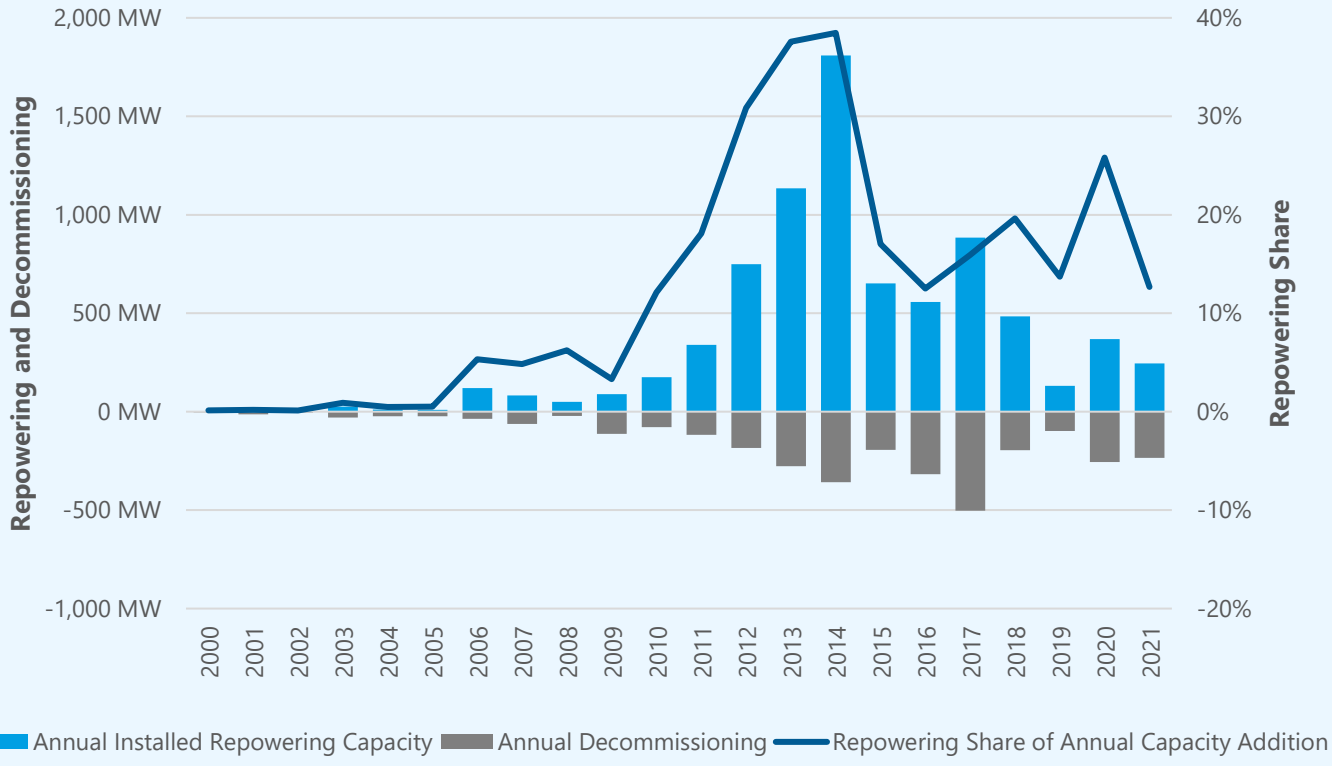


Annual Development Onshore Wind Energy Capacity in Germany

Decommissioning and Repowering

In 2021, XXX wind turbines with a total capacity of XXX MW were decommissioned. XXX of the wind turbines decommissioned in 2021 started operations more than 20 years ago. Nevertheless, there has not yet been a major wave of decommissioning due to the end of subsidies under the Renewable Energy Sources Act 2021 (German: Erneuerbare-Energien-Gesetz or EEG) for old turbines. XXX WTG with XXX MW installed in 2000 or before are still in operation at the end of 2021. Not least due to the high market prices in 2021, many of the old turbines can continue to be operated if they are not decommissioned due to technical defects, expiring certificates of continued operation or in the course of a repowering project. At the end of 2021, the EEG subsidy entitlement ended for a further year of installations. XXX WTG with XXX MW, which were commissioned in 2001, are facing the decision to switch to unsubsidized continued operations or to stop operating.

Repowering is not on option at every site. In 2021, XX wind turbines with XXX MW were newly installed as part of repowering projects. In terms of gross new additions, this corresponds to a repowering share of XX%. Significantly higher repowering shares were achieved between 2012 and 2014 before the repowering bonus expired - however, repowering at the same site was not necessary to obtain this bonus, the dismantling of an old turbine in a surrounding district was sufficient. Today, repowering is no longer financially supported by a bonus in the EEG; the preservation of sites for wind energy use and the increase in the amount of electricity that can be generated on the sites through new types of turbines are the main drivers for repowering projects.



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

Regional Distribution of Wind Energy Additions

With XX% of the newly installed capacity, the majority of the gross new capacity was ~~also~~ realized in the states of Lower Saxony, Brandenburg, North Rhine-Westphalia and Schleswig-Holstein in 2021. While Lower Saxony is the leading state in absolute figures, Schleswig-Holstein leads the field in terms of new installations in relation to the state's area.
The states of Baden-Württemberg, Saxony-Anhalt, Mecklenburg-Western Pomerania, Rhineland-Palatinate, Thuringia and Hesse are in the middle of the field with a share of X to X%. The smallest additions - apart from the city states - took place in Bavaria, Saarland and Saxony.
Wind energy turbines were decommissioned in almost all the German federal states. Most were decommissioned in Schleswig-Holstein, Saxony-Anhalt and North Rhine-Westphalia. Saxony-Anhalt, Schleswig-Holstein and Thuringia stand out with particularly high repowering shares.

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Regional Distribution of Gross Capacity Additions

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

Year 2021		Gross Additions			Dismantling and Net Additions			Repowering		
Position	State	Capacity Addition	Number Added WTG	Share*	Capacity Dis-mantling	Number Dismantled WTG	Net Additions	Capacity Repo-wering	Number Repo-wering WTG	Repo-wering-Share**
1	Lower Saxony	421 MW	104 WTG	22%	18 MW	18 WTG	403 MW	44 MW	12 WTG	10%
2	Brandenburg	412 MW	104 WTG	21%	17 MW	16 WTG	395 MW	57 MW	14 WTG	14%
3	North Rhine-Westphalia	331 MW	83 WTG	17%	32 MW	33 WTG	299 MW	12 MW	3 WTG	4%
4	Schleswig-Holstein	269 MW	67 WTG	14%	88 MW	77 WTG	181 MW	71 MW	19 WTG	27%
5	Baden-Württemberg	114 MW	28 WTG	6%	5 MW	4 WTG	110 MW	0 MW	0 WTG	0%
6	Saxony-Anhalt	71 MW	18 WTG	4%	33 MW	30 WTG	38 MW	43 MW	12 WTG	61%
7	Mecklenburg-Western Pomerania	70 MW	19 WTG	4%	9 MW	18 WTG	61 MW	0 MW	0 WTG	0%
8	Rhineland-Palatinate	69 MW	16 WTG	4%	9 MW	9 WTG	60 MW	0 MW	0 WTG	0%
9	Thuringia	65 MW	14 WTG	3%	11 MW	7 WTG	54 MW	17 MW	4 WTG	26%
10	Hesse	62 MW	18 WTG	3%	3 MW	6 WTG	58 MW	0 MW	0 WTG	0%
11	Bavaria	27 MW	8 WTG	1%	2 MW	2 WTG	25 MW	0 MW	0 WTG	0%
12	Saarland	10 MW	3 WTG	0%	0 MW	0 WTG	10 MW	0 MW	0 WTG	0%
13	Berlin	4 MW	1 WTG	0%	0 MW	0 WTG	4 MW	0 MW	0 WTG	0%
14	Saxony	1 MW	1 WTG	0%	8 MW	11 WTG	-7 MW	0 MW	0 WTG	0%
	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	-
	Germany	**1,925 MW**	**484 WTG**		**234 MW**	**231 WTG**	**1,691 MW**	**244 MW**	**64 WTG**	**13%**

* 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 Turbine Configuration and Regional Differences

Installed turbine technology is constantly developing – with new turbine types being constantly introduced to the market. On average, a wind turbine installed in 2021 has a nominal capacity of XXXX kW – XX% more than in the previous year. This allows a greater increase in capacity to be achieved through a smaller number of turbines.

The size of the turbines has also increased again. On average, a wind turbine installed in 2021 has a rotor diameter of 133 m and a hub height of 140 m. At an average of 206 m, the total height is 6% above the previous year's average.

Depending on the site conditions and existing restrictions, a suitable turbine is selected for each project, resulting in regional differences in terms of configuration.

Usually, the lowest turbines are found in Schleswig-Holstein. In 2021, however, Saxony undercuts the northern state with the installation of a single small turbine. The most powerful turbines were installed in Thuringia in 2021.

Average Wind Turbine Generator Configuration

Average Configuration	Additions Year 2021	Changes compared to prior year
Turbine Capacity	3,978 kW	+17%
Rotor Diameter	133 m	+10%
Hub Height	140 m	+4%
Tip Height	206 m	+6%

Average Turbine Configuration of newly installed WTG in German Federal States

Additions Year 2021		Average Configuration of newly installed WTG			
State	**Number of WTG**	**Turbine Capacity**	**Rotor Diameter**	**Hub Height**	**Tip Height**
Lower Saxony	104 WTG	4,049 kW	133 m	141 m	207 m
Brandenburg	104 WTG	3,964 kW	136 m	149 m	217 m
North Rhine-Westphalia	83 WTG	3,991 kW	134 m	142 m	209 m
Schleswig-Holstein	67 WTG	4,015 kW	131 m	108 m	173 m
Baden-Württemberg	28 WTG	4,082 kW	137 m	156 m	224 m
Saxony-Anhalt	18 WTG	3,933 kW	133 m	144 m	210 m
Mecklenburg-Western Pomerania	19 WTG	3,689 kW	121 m	131 m	191 m
Rhineland-Palatinate	16 WTG	4,288 kW	141 m	146 m	216 m
Thuringia	14 WTG	4,629 kW	151 m	161 m	237 m
Hesse	18 WTG	3,429 kW	120 m	150 m	210 m
Bavaria	8 WTG	3,366 kW	128 m	131 m	195 m
Saarland	3 WTG	3,200 kW	126 m	159 m	222 m
Berlin	1 WTG	4,200 kW	138 m	160 m	229 m
Saxony	1 WTG	800 kW	53 m	73 m	100 m
Bremen	0 WTG	-	-	-	-
Hamburg	0 WTG	-	-	-	-
Germany	**484 WTG**	**3,978 kW**	**133 m**	**140 m**	**206 m**

Regional Distribution of the Cumulative Portfolio

At the end of 2021, onshore wind turbines with about 56 GW are installed in Germany. At XX%, the largest share of installed capacity is in Lower Saxony. Schleswig-Holstein has by far the highest capacity density among the states with a large surface area. Brandenburg, North Rhine-Westphalia and Saxony-Anhalt also make a large contribution to the total portfolio in both absolute and relative terms.

Despite location-specific support, there is still a clear North-South divide in terms of capacity density. Berlin, Bavaria, Baden-Württemberg and Saxony make the smallest contribution to the total capacity with less than 100 kW/km² - these states have a share of 35% of the federal territory but provide only 10% of the total installed wind energy capacity.

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Regional Distribution of the Cumulative Capacity

Cumulative Capacity and Number of WTG in the German Federal States

Cumulative Portfolio* (2021-12-31)					
State	**Cumulative Capacity**	**Cumulative Number**	**Share**	**Capacity per km²**	**WTG per km²**
Lower Saxony	11,688 MW	6,120 WTG	21%	245 kW/km²	0.13 WTG/km²
Brandenburg	7,866 MW	3,930 WTG	14%	265 kW/km²	0.13 WTG/km²
Schleswig-Holstein	7,018 MW	3,048 WTG	13%	444 kW/km²	0.19 WTG/km²
North Rhine-Westphalia	6,388 MW	3,545 WTG	11%	187 kW/km²	0.10 WTG/km²
Saxony-Anhalt	5,318 MW	2,849 WTG	9%	260 kW/km²	0.14 WTG/km²
Rhineland-Palatinate	3,813 MW	1,746 WTG	7%	192 kW/km²	0.09 WTG/km²
	3,567 MW	1,850 WTG	6%	153 kW/km²	0.08 WTG/km²
Bavaria	2,567 MW	1,129 WTG	5%	36 kW/km²	0.02 WTG/km²
Hesse	2,304 MW	1,115 WTG	4%	109 kW/km²	0.05 WTG/km²
Thuringia	1,737 MW	870 WTG	3%	107 kW/km²	0.05 WTG/km²
Baden-Württemberg	1,730 MW	781 WTG	3%	48 kW/km²	0.02 WTG/km²
Saxony	1,264 MW	869 WTG	2%	69 kW/km²	0.05 WTG/km²
Saarland	531 MW	221 WTG	1%	207 kW/km²	0.09 WTG/km²
Bremen	201 MW	87 WTG	0%	479 kW/km²	0.21 WTG/km²
Hamburg	119 MW	65 WTG	0%	157 kW/km²	0.09 WTG/km²
Berlin	23 MW	8 WTG	0%	26 kW/km²	0.01 WTG/km²
Germany	**56,134 MW**	**28,233 WTG**		**157 kW/km²**	**0.08 WTG/km²**

* with a minimum turbine capacity of 100 kW

Results of Tender Rounds

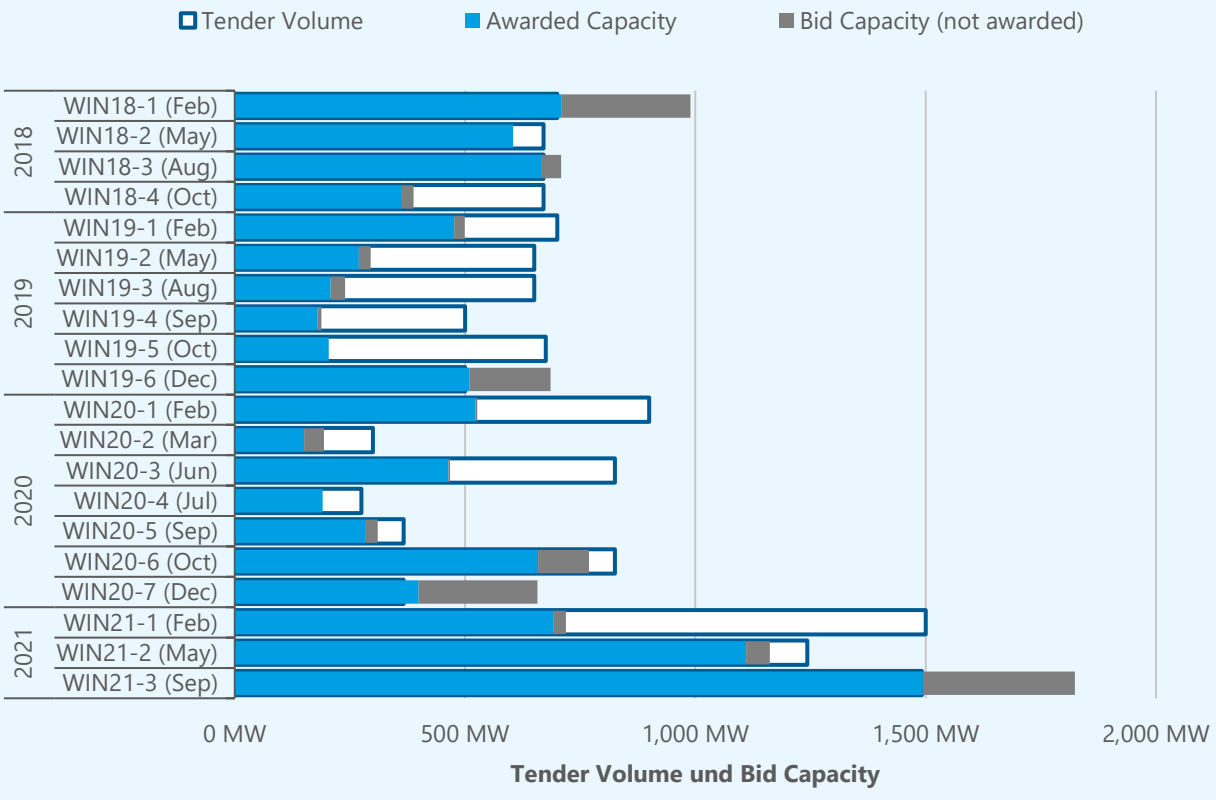
The German Federal Network Agency (German: Bundesnetzagentur or BNetzA) carried out three tender rounds for onshore wind energy in 2021. A total of 4,235 MW was put out to tender, and 3,704 MW was awarded. According to the EEG 2021, quantities not awarded can be put out to tender in an additional tender round in December 2022.

In the two tender rounds in February and May 2021 the bid volume was below tender volume, although the tender volume in the second tender round had already been reduced by the BNetzA. In the September tender round, however, competition prevailed and bids with XXX MW could not be awarded. Even in tender rounds without competition, there were small quantities of bids that were not awarded; these were due to bid exclusions.

The maximum value for bids in the 2021 tender rounds was 6.0 ct/kWh. The average volume-weighted award value of 5.88 ct/kWh is only slightly lower.

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
	2021	6.0 ct/kWh	5.88 ct/kWh



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

Regional Distribution of Awarded Bids

In the 2021 tender rounds, most of the awards were won by the federal state of Schleswig-Holstein. With 870 MW awarded, projects from the northernmost German state secured 26% of the total volume awarded. This is followed by Lower Saxony, North Rhine-Westphalia and Brandenburg. Together, the four states account for about three-quarters of the awarded capacity in 2021 for the third year in a row.

The other federal states, apart from the city states of Berlin and Hamburg, each successfully placed at least one bid in the 2021 tender rounds. In relation to the state area, Bavaria, Baden-Württemberg and Saxony had the lowest tender participation. Saarland is also one of the federal states with a low area-related award volume due to a lower award quota.

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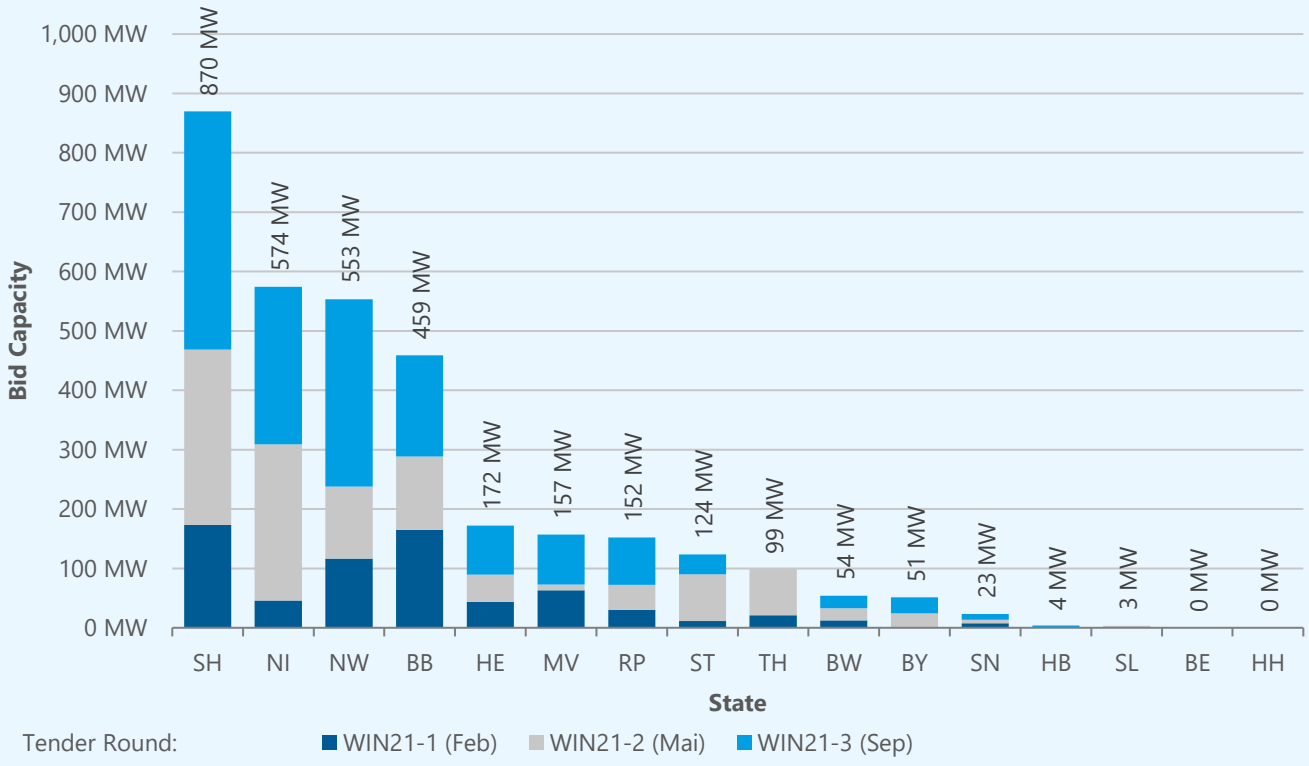
Regional Distribution of Awarded Capacity (Database: BNetzA)



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

Development Status of Awarded Turbines

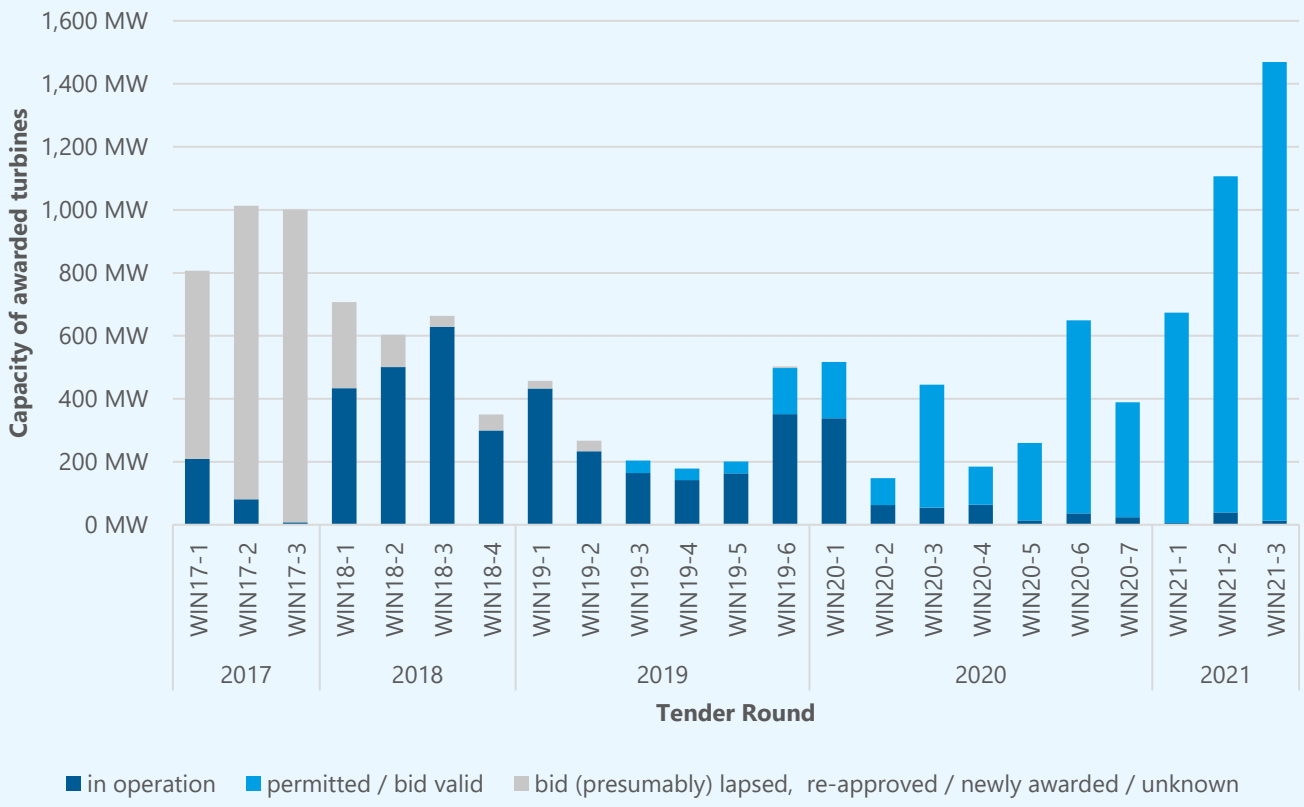
Since the introduction of tenders for onshore wind energy, XXXX MW have been awarded. By the end of 2021, XXXX MW had been successfully realized. There are deadlines for the installation of the awarded turbines after which the awards will expire. Generally, turbines that have been awarded must be commissioned within 30 months (24 months without penalty fees). The deadline has been extended, for example, for citizens' energy communities without a project permit and for some tender rounds affected by the COVID 19 pandemic. Shortened deadlines apply to some special tender rounds. Furthermore, project-specific extensions can be applied for, e.g. in the event of a lawsuit against the permit. The deadlines for the tender rounds up to mid-2019 have already expired. Award quantities* from these rounds that have not yet been realized will presumably not be realized.

The realization rate for the 2018 awards is therefore around 79%. 80% of the volume from 2019 and 20% from 2020 ~~has~~ already been installed.

Realized Capacity of Tenders for Onshore Wind Energy in Germany

	Year	Realized Capacity	Realization Rate
Year of Tender	2017	297 MW	11%
	2018	1,862 MW	79%
	2019	1,486 MW	80%
	2020	593 MW	22%
	2021	58 MW	3%

* 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.

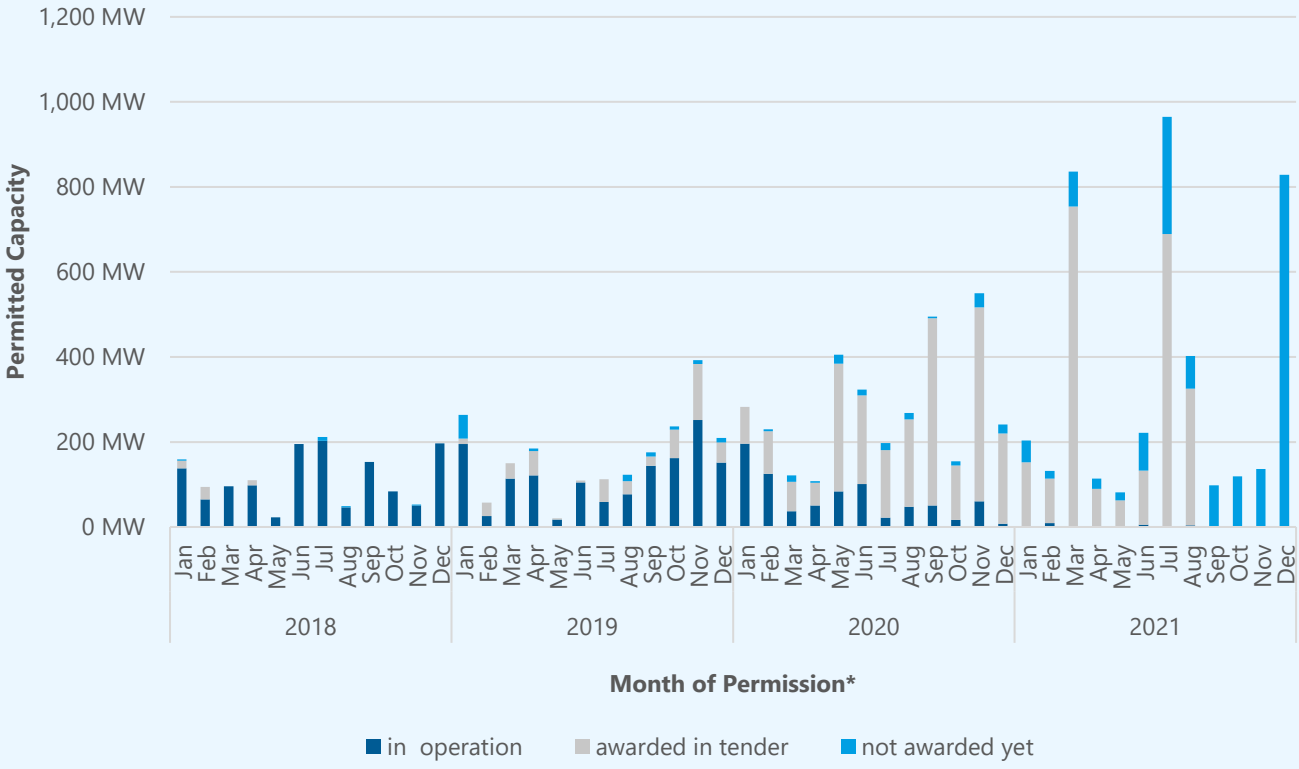


Development Status* of Awarded Capacity (Database: BNetzA, MaStR, own research and assumptions)

Permitted Capacity and Future Tender Rounds

In 2021, permits were issued for XXX wind turbines with a capacity of X.XXX MW. The permit situation has thus improved by XX% compared to the previous year. XX% of the turbines permitted in 2021 have already been awarded in a tender round. XXX turbines with XXX MW as well as single still open permits from previous years can participate in future tender rounds and secure an EEG subsidy entitlement in case of an award.
Most of the permits were issued in March, July and December – in each case in time to meet the deadline for participation in the tender rounds in May and September 2021 and for the upcoming tender in February 2022.

In 2022, in accordance with the EEG 2021, the tender volume for the three regular tender rounds in February, May and September 2022 was increased to a total of 4,000 MW. In addition, there will be a fourth additional round in December, in which the capacity not awarded in the previous year will be put out to tender again. Adjustments to the tender volumes in the individual rounds, for example due to expected low participation or due to the allocation of capacity to pilot turbines, can be made by the BNetzA.



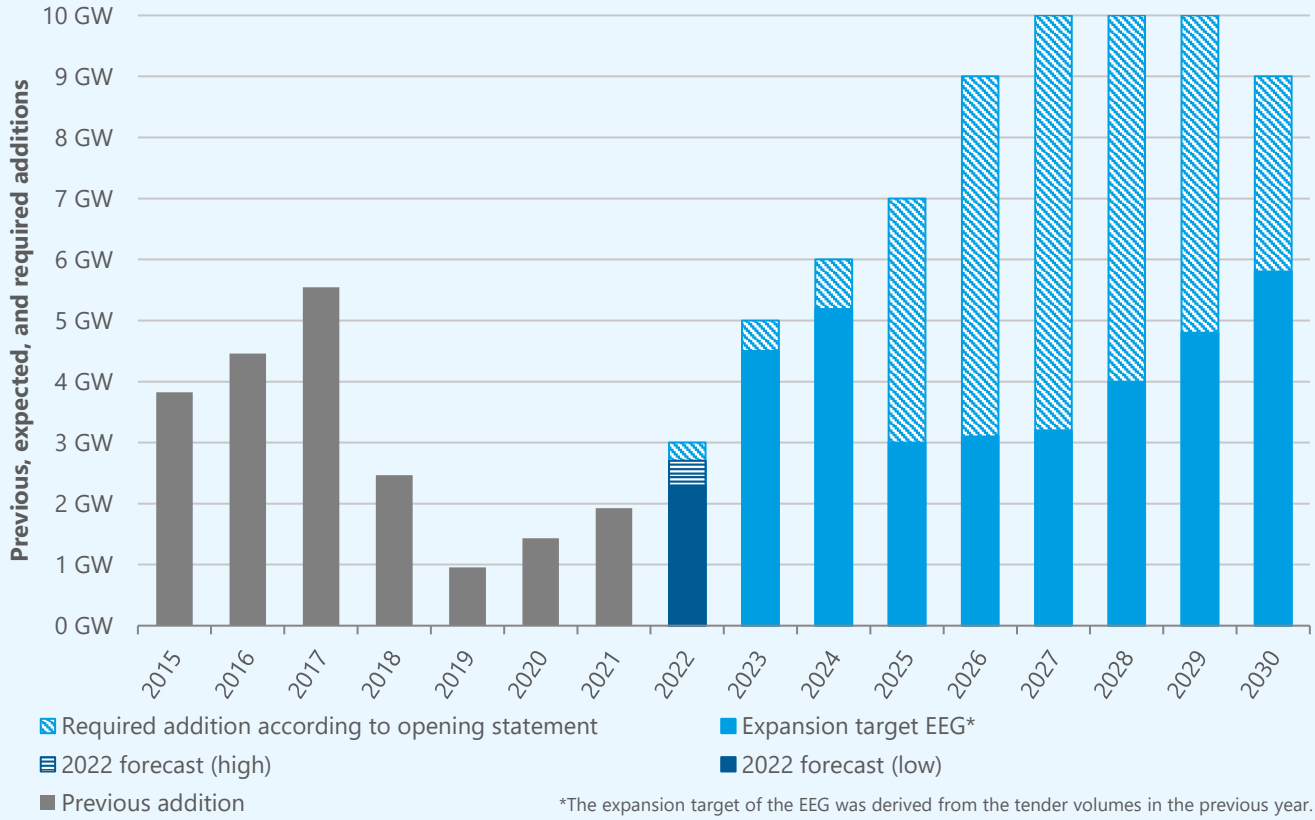
*Permits with an updated permit date have been dated back to the date of the first registration in MaStR.

Monthly Permitted Capacity including Status

Expected Development and Political Target

The wind turbines installed by the end of 2021 took an average of 20 months from the date of the award notice to commissioning. This corresponds roughly to the implementation time after the award notice required for the wind turbines installed in 2020. On the basis of this implementation time and the number of turbines that have already been awarded and have not yet been installed, it is possible to calculate the expected number of new installations. For the year 2022, if the time of implementation remains unchanged, this results in an expected addition of 2.3 GW to 2.7 GW. The addition of new capacity in subsequent years will be significantly influenced by the wind turbines that will be awarded from 2022 onwards.

Currently, the tender volumes defined in the EEG 2021 have set a path for the further expansion of wind energy. However, the coalition agreement of the new government from December 2021 already announces a necessary adjustment of the tender volumes with high targets for renewable electricity generation. The figures presented in the "Opening statement on climate protection" of the Federal Ministry of Economics and Climate Protection (German: Bundesministerium für Wirtschaft und Klimaschutz) provide an outlook on the gross additional capacity required for onshore wind energy in the coming years. The ambitious targets can only be achieved if a correspondingly large number of projects are ready for realization.

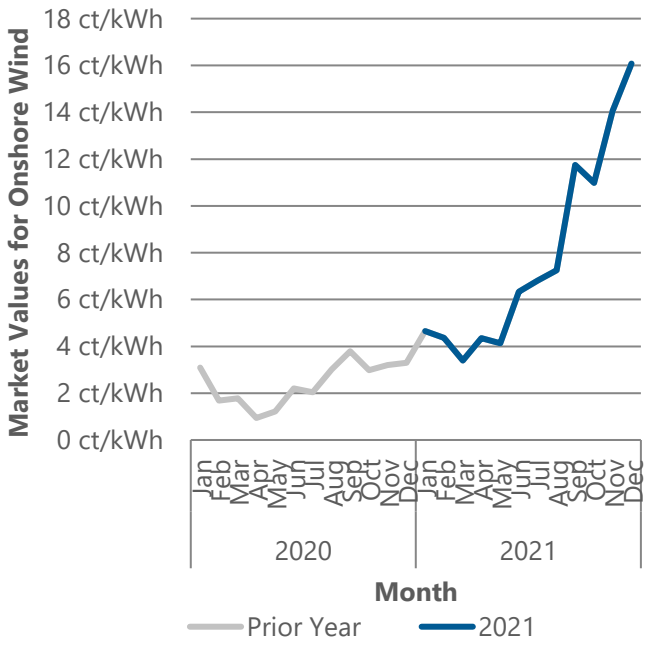


Expected expansion in 2022 and expansion targets according to EEG 2021

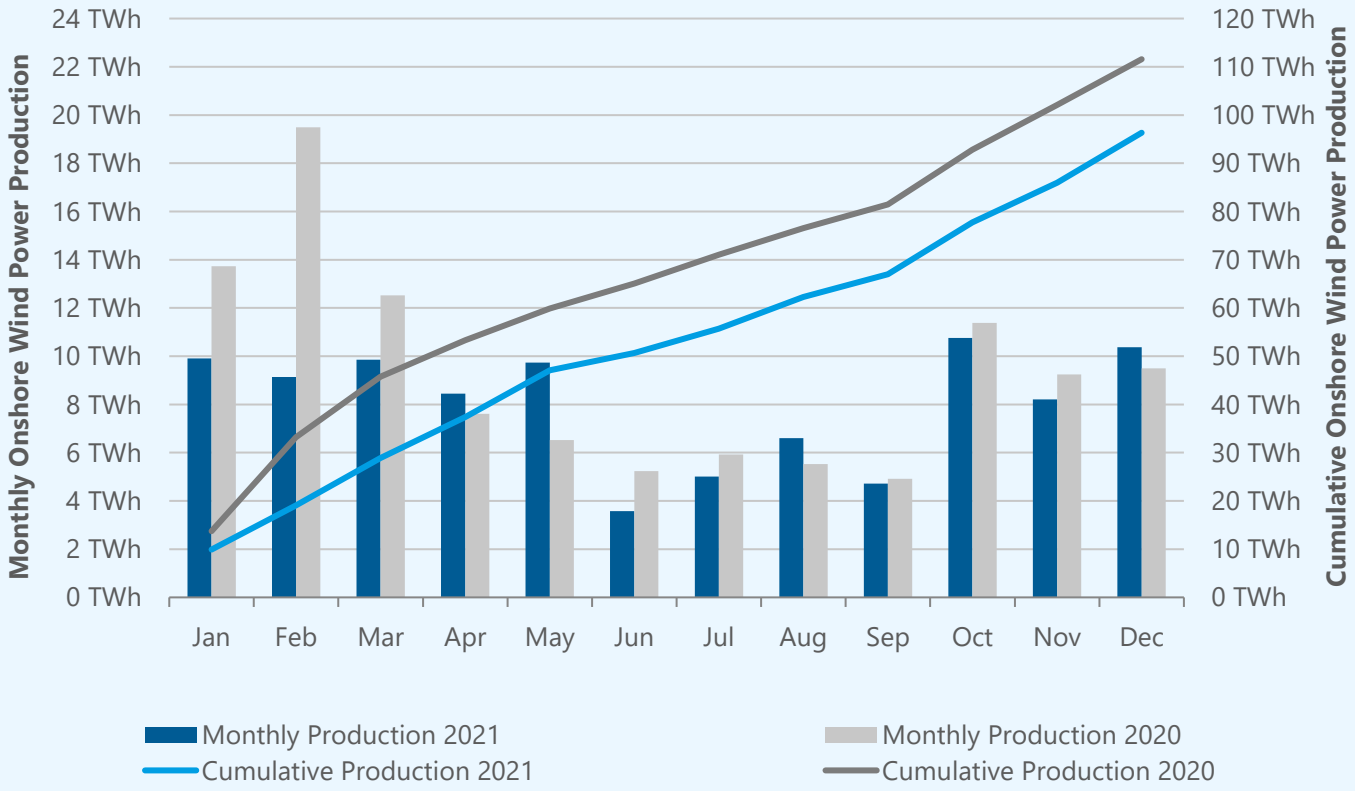
Monthly Power Production and Market Values

In the course of 2021, onshore wind energy produced approximately 96.3 TWh of electricity. According to the projection data, electricity production in 2021 is thus 14% lower than in 2020. The first quarter of 2021 in particular is characterized by significantly lower production compared to 2020.

Monthly onshore wind market values on the power exchange stabilized in the first half of 2021 following the sharp drop associated with the COVID 19 pandemic in 2020. This was followed by an enormous increase in the second half of the year to an unprecedented price level with a record value of 16 ct/kWh in December 2021. The volume-weighted average monthly market value for 2021 is correspondingly high at 7.85 ct/kWh, 229% 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.