

Status of Onshore Wind Energy Development in Germany

First Half of 2022



On behalf of



Contents

Wind Energy Development and Status.....	3
Decommissioning, Continued Operation and Repowering	4
Regional Distribution of Wind Energy Installation	5
Average Turbine Configuration and Regional Differences.....	6
Regional Distribution of the Cumulative Portfolio	7
Results of Tender Rounds	8
Regional Distribution of Awarded Bids.....	9
Development Status of Awarded Turbines.....	10
Permitted Capacity and Future Tender Rounds.....	11
Expected Development and Political Target.....	12
Power Generation and Market Values.....	13

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 takes place before the reporting deadline for commissioning in the first half of 2022. Further reports increasing the amount added and withdrawn as well as permits are possible. Further reports that increase the installed 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

© Nordex

Contact

Deutsche WindGuard GmbH

Oldenburger Straße 65

26316 Varel, Germany

Phone +49 (4451) 9515-0

Fax +49 (4451) 9515-29

Email info@windguard.de

URL <http://www.windguard.com/>

Wind Energy Development and Status

In the first half of 2022, 238 new onshore wind turbines (WTG) with a combined capacity of 977 MW were installed in Germany. The addition of new wind turbines in the first six months of the year is thus at about the same level as in the previous year.

In contrast, 82 wind turbines with a total capacity of 99 MW were dismantled in the same period. The net addition in the first half of 2022 is therefore 878 MW.

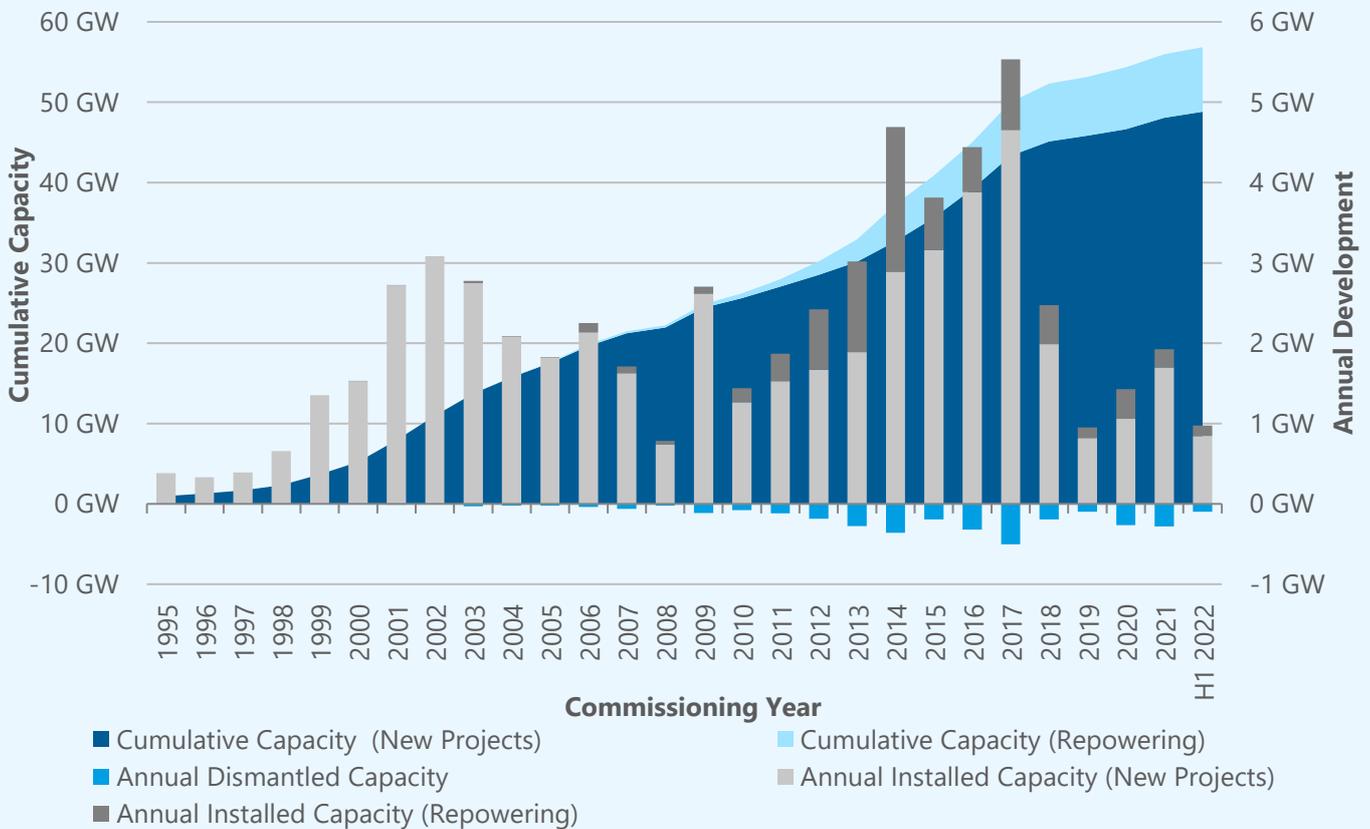
In the first half of 2022, 35 wind turbines with 133 MW were newly erected as part of repowering projects. In relation to the gross new construction, this corresponds to a repowering share of 14%.

The active total portfolio of onshore wind energy in Germany as of June 30, 2022 amounts to 28,287 wind turbines with a combined installed capacity of 56,848 MW. In the course of the first

half of the year, the cumulative capacity increased by 1.7%.

Status of Onshore Wind Energy Development

		Capacity	Number
Development	H1 2022		
	Gross installations	977 MW	238 WTG
	Repowering share	133 MW	35 WTG
	Decommissioning	99 MW	82 WTG
	Net installations	878 MW	156 WTG
Cumulative	2022-06-30		
	Cumulative	56,848 MW	28,287 WTG



Annual Development Onshore Wind Energy Capacity in Germany

Decommissioning, Continued Operation and Repowering

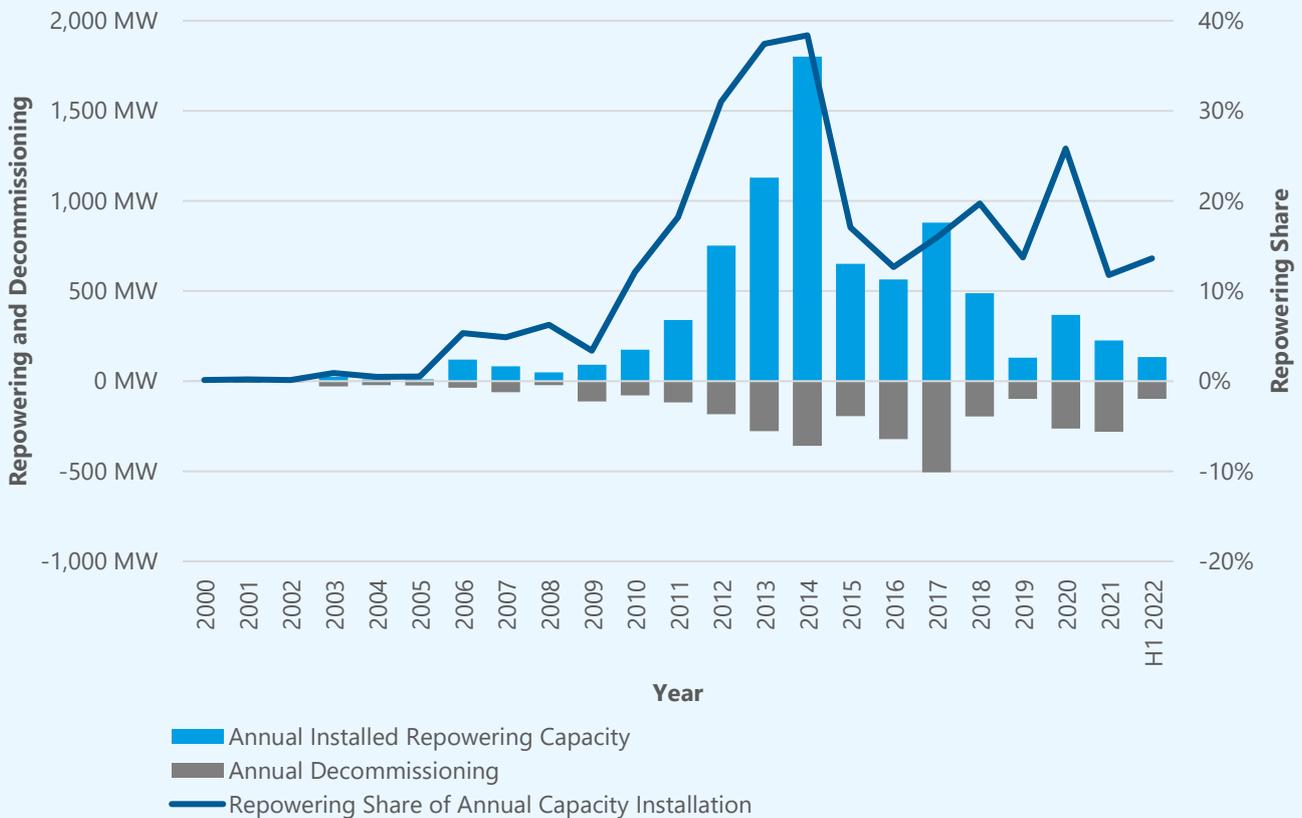
In the first half of 2022, 82 wind turbines with a combined capacity of 99 MW were decommissioned. 39 of these turbines with a total capacity of 38 MW were commissioned before 2002 and are no longer entitled to feed-in subsidies according to the EEG. 6,084 further wind turbines with a combined capacity of about 5.5 GW, which have reached the end of their subsidy period, continued to be in operation by mid-2022. Not least due to the currently very high market prices, the old turbines can continue to be operated if they do not have to be decommissioned due to technical defects or expiring certificates of continued operation or are replaced by new turbines in the repowering process.

The share of repowering capacity in new installations has increased somewhat compared to last year, but most projects continue to be realized

on new sites or as park expansions. If the dismantling of old WTG increases, the pressure to continue using the old areas will rise.

Age of dismantled and existing WTG

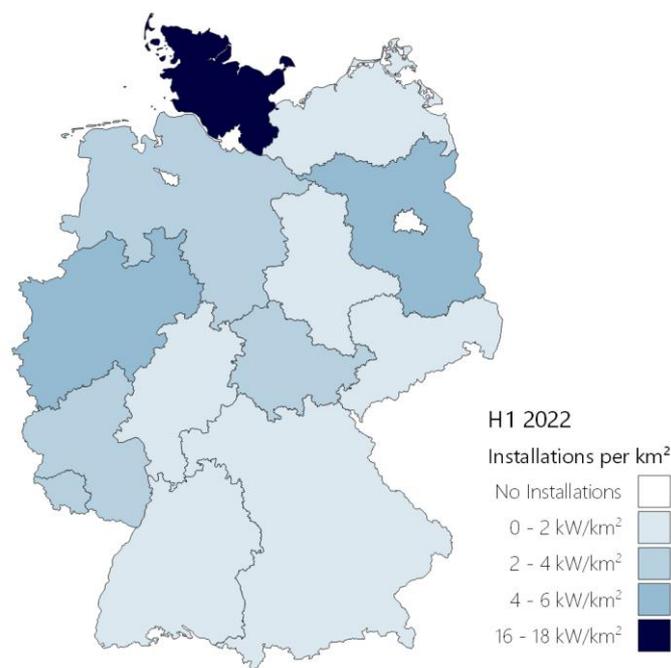
Age	Decommissioned H1 2022		In Operation 2022-06-30	
	Capacity	Number	Capacity	Number
>20 Years, no funding claim (COD ≤ 2001)	38 MW	39 WTG	5,540 MW	6,084 WTG
15 - 20 Years (COD 2002 - 2006)	45 MW	35 WTG	11,273 MW	7,058 WTG
10 - 15 Years (COD 2007 - 2011)	16 MW	8 WTG	8,374 MW	4,218 WTG
5 - 10 Years (COD 2012 - 2016)	0 MW	0 WTG	18,374 MW	6,877 WTG
0 - 5 Years (COD 2017 - 2022)	0 MW	0 WTG	13,287 MW	4,050 WTG



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

Regional Distribution of Wind Energy Installation

Schleswig-Holstein is the front-runner in the regional distribution of new installations in the first half of 2022. With a share of 29% of gross additions and an addition of more than 17 kW/km² of the state's area, the state in the north surpasses all other federal states. The states of North Rhine-Westphalia, Brandenburg and Lower Saxony follow in second to fourth place and also installed relevant shares. In total, 80% of the total additions in the first half of 2022 were achieved by the four states with the highest additions. The shares of all other federal states are correspondingly low. In relation to the respective state area, Bavaria, Hesse, Saxony and Baden-Württemberg stand out with an addition of less than 1 kW/km². In the city states, no new turbines were commissioned in the first half of the year.



Base map: © GeoBasis-DE / BKG 2022

Regional Distribution of Gross Capacity Installation

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

H1 2022		Gross Installations			Dismantling and Net Installation			Repowering		
Position	Federal State	Capacity	Number	Share*	Capacity	Number	Net Instal-	Capacity	Number	Repo-
		Instal-	New		Dis-	Dismantled		lantation	Repo-	
		lation	WTG		mantling	WTG		owering	owering	Share**
1	Schleswig-Holstein	280 MW	72 WTG	29%	47 MW	33 WTG	233 MW	71 MW	20 WTG	25%
2	North Rhine-Westphalia	187 MW	47 WTG	19%	11 MW	14 WTG	177 MW	17 MW	4 WTG	9%
3	Brandenburg	172 MW	38 WTG	18%	3 MW	3 WTG	169 MW	21 MW	4 WTG	12%
4	Lower Saxony	142 MW	30 WTG	15%	6 MW	8 WTG	136 MW	0 MW	0 WTG	0%
5	Rhineland-Palatinate	42 MW	11 WTG	4%	1 MW	1 WTG	41 MW	8 MW	2 WTG	20%
6	Thuringia	38 MW	9 WTG	4%	2 MW	1 WTG	36 MW	0 MW	0 WTG	0%
7	Saxony-Anhalt	34 MW	9 WTG	3%	28 MW	21 WTG	6 MW	17 MW	5 WTG	49%
8	Mecklenburg-Western Pomerania	30 MW	8 WTG	3%	0 MW	0 WTG	30 MW	0 MW	0 WTG	0%
9	Baden-Württemberg	21 MW	5 WTG	2%	0 MW	0 WTG	21 MW	0 MW	0 WTG	0%
10	Bavaria	9 MW	3 WTG	1%	0 MW	0 WTG	9 MW	0 MW	0 WTG	0%
11	Saarland	8 MW	2 WTG	1%	0 MW	0 WTG	8 MW	0 MW	0 WTG	0%
12	Hesse	8 MW	2 WTG	1%	0 MW	0 WTG	8 MW	0 MW	0 WTG	0%
13	Saxony	7 MW	2 WTG	1%	1 MW	1 WTG	6 MW	0 MW	0 WTG	0%
	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	-
	Germany	977 MW	238 WTG		99 MW	82 WTG	878 MW	133 MW	35 WTG	14%

* Share of gross capacity Installations per federal state in total gross capacity installation

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

Average Turbine Configuration and Regional Differences

The installed turbine technology continues to develop steadily - for example, the average rated capacity of wind turbines installed in the first half of 2022 increased to 4,103 kW - 3% more than in the previous year.

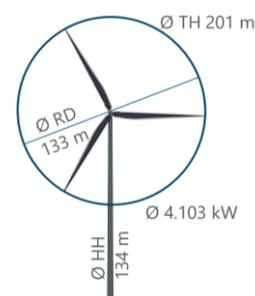
The average total height of the newly installed turbines, on the other hand, has decreased slightly. With a rotor diameter of 133 m and a hub height of 134 m, the average wind turbine of the first half of the year has a total height of 201 m - 3% less than in 2021. Nevertheless, the development of rotor diameters has not stagnated - turbine types with a rotor diameter of over 170 m have already been announced. The fact that no increases are currently being recorded is due, among other reasons, to the higher proportion of installations in Schleswig-Holstein, where the turbines are generally smaller in height than in the

rest of the country. In addition to Schleswig-Holstein, installations in Mecklenburg-Western Pomerania also remained below the 200 m mark on average in the first half of the year.

The most powerful turbines on average were erected in Lower Saxony in the first half of 2022, the highest on average in Saarland.

Average Wind Turbine Generator Configuration

Installations H1 2022	Change compared to prior year
Turbine Capacity	+3%
Rotor Diameter	+0%
Hub Height	-4%
Tip Height	-3%



Average Turbine Configuration of newly installed WTG in German Federal States

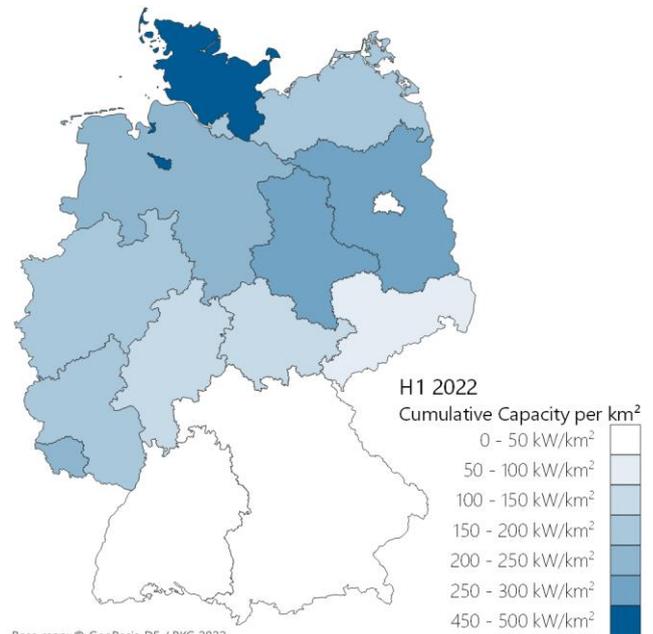
Installations H1 2022	State	Average Configuration of newly installed WTG				
		Number of WTG	Turbine Capacity	Rotor Diameter	Hub Height	Tip Height
	Schleswig-Holstein	72 WTG	3,887 kW	126 m	103 m	166 m
	North Rhine-Westphalia	47 WTG	3,987 kW	133 m	144 m	211 m
	Brandenburg	38 WTG	4,524 kW	141 m	147 m	218 m
	Lower Saxony	30 WTG	4,724 kW	146 m	152 m	225 m
	Rhineland-Palatinate	11 WTG	3,777 kW	135 m	144 m	211 m
	Thuringia	9 WTG	4,222 kW	146 m	158 m	231 m
	Saxony-Anhalt	9 WTG	3,756 kW	132 m	162 m	229 m
	Mecklenburg-Western Pomerania	8 WTG	3,700 kW	110 m	137 m	192 m
	Baden-Württemberg	5 WTG	4,140 kW	140 m	133 m	203 m
	Bavaria	3 WTG	3,000 kW	115 m	149 m	207 m
	Saarland	2 WTG	4,200 kW	150 m	166 m	241 m
	Hesse	2 WTG	3,750 kW	132 m	148 m	214 m
	Saxony	2 WTG	3,600 kW	136 m	166 m	234 m
	Berlin	0 WTG	-	-	-	-
	Bremen	0 WTG	-	-	-	-
	Hamburg	0 WTG	-	-	-	-
Germany		238 WTG	4,103 kW	133 m	134 m	201 m

Regional Distribution of the Cumulative Portfolio

At the end of the first half of 2022, the total number of onshore wind turbines in Germany reached 56.8 GW. At 11.8 GW, Lower Saxony accounts for more than one-fifth of the total capacity. Brandenburg, Schleswig-Holstein and North Rhine-Westphalia each have more than 10% of the total capacity.

In relation to their respective areas, Schleswig-Holstein and Bremen have the highest power density with more than 450 kW/km². The state in the north and the Hanseatic city represent 5% of the federal area and have 13% of the total power. The states of Brandenburg, Saxony-Anhalt, Lower Saxony, Saarland, Rhineland-Palatinate, North Rhine-Westphalia, Hamburg, Mecklenburg-Western Pomerania, Hesse and Thuringia in the midfield with 100 to 300 kW/km² account for 60% of the federal area and 77% of the installed capacity. Saxony, Baden-Württemberg, Bavaria and Berlin are at the bottom of the list (each with

less than 100 kW/km²). Together they have 35% of the federal area and 10% of the installed capacity.



Regional Distribution of the Cumulative Capacity

Cumulative Capacity and Number of WTG in the German Federal States

Cumulative Portfolio* (2022-06-30)					
Federal State	Cumulative Capacity	Cumulative Number	Share	Capacity per km ²	WTG per km ²
Lower Saxony	11,785 MW	6,101 WTG	21%	247 kW/km ²	0.13 WTG/km ²
Brandenburg	8,067 MW	3,984 WTG	14%	272 kW/km ²	0.13 WTG/km ²
Schleswig-Holstein	7,215 MW	3,067 WTG	13%	456 kW/km ²	0.19 WTG/km ²
North Rhine-Westphalia	6,548 MW	3,573 WTG	12%	192 kW/km ²	0.10 WTG/km ²
Saxony-Anhalt	5,309 MW	2,830 WTG	9%	259 kW/km ²	0.14 WTG/km ²
Rhineland-Palatinate	3,862 MW	1,758 WTG	7%	194 kW/km ²	0.09 WTG/km ²
Mecklenburg-Western Pomerania	3,556 MW	1,837 WTG	6%	153 kW/km ²	0.08 WTG/km ²
Bavaria	2,575 MW	1,132 WTG	5%	37 kW/km ²	0.02 WTG/km ²
Hesse	2,337 MW	1,139 WTG	4%	111 kW/km ²	0.05 WTG/km ²
Thuringia	1,733 MW	850 WTG	3%	107 kW/km ²	0.05 WTG/km ²
Baden-Württemberg	1,729 MW	772 WTG	3%	48 kW/km ²	0.02 WTG/km ²
Saxony	1,273 MW	871 WTG	2%	69 kW/km ²	0.05 WTG/km ²
Saarland	520 MW	213 WTG	1%	202 kW/km ²	0.08 WTG/km ²
Bremen	201 MW	87 WTG	0%	479 kW/km ²	0.21 WTG/km ²
Hamburg	122 MW	67 WTG	0%	161 kW/km ²	0.09 WTG/km ²
Berlin	17 MW	6 WTG	0%	19 kW/km ²	0.01 WTG/km ²
Germany	56,848 MW	28,287 WTG		159 kW/km²	0.08 WTG/km²

* with a minimum turbine capacity of > 100 kW

Results of Tender Rounds

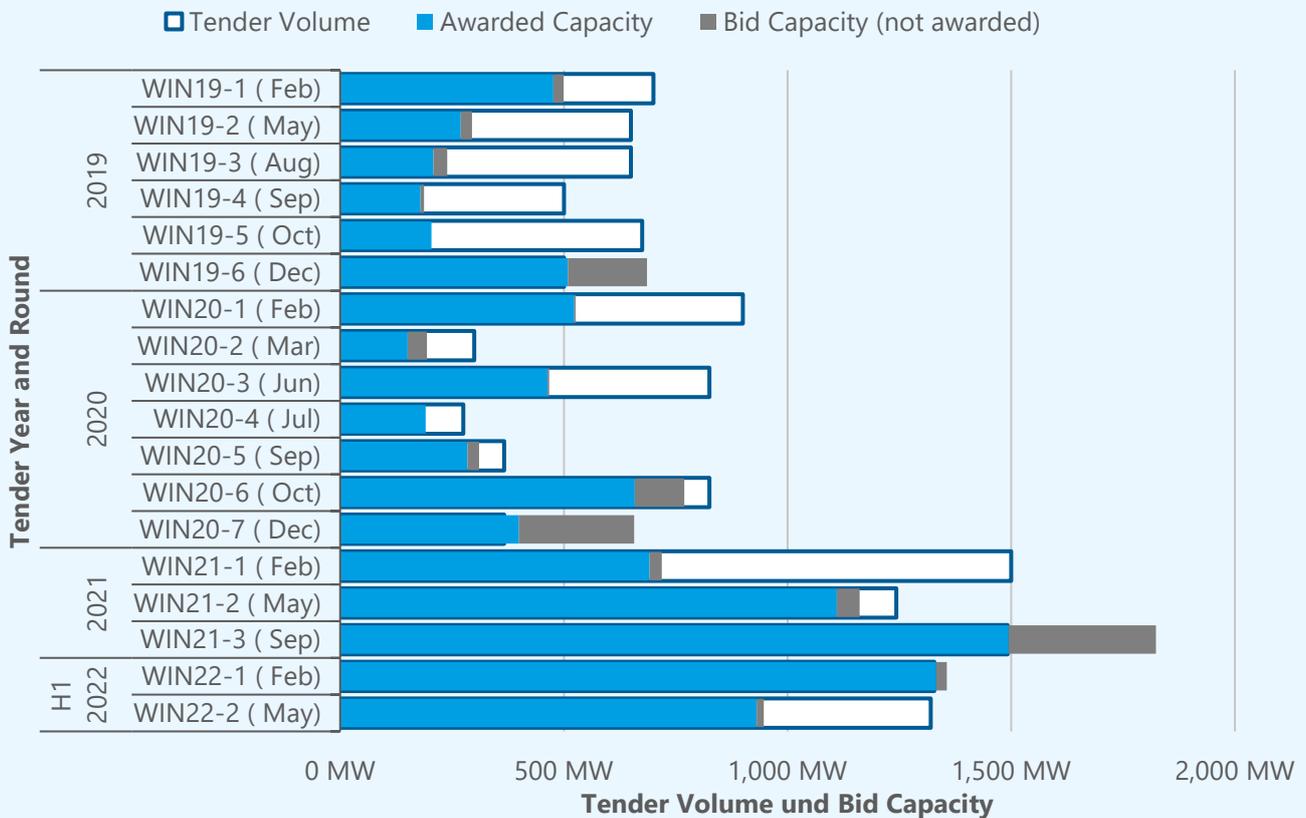
In the first half of 2022, the German Federal Network Agency (BNetzA) held two rounds of tenders for onshore wind energy. A total of 2,648 MW were put out to tender, and 2,263 MW were awarded. While enough valid bids were received in the February tender round to fill the entire tender volume, the May tender round was undersubscribed. With awards amounting to 931 MW, only 71% of the tendered volume could be awarded. The consequence of the lack of competition may be a reduction in planned tender volumes in the next round in September, when another lack of competition is expected.

The maximum permissible value for bids in the 2022 bidding rounds is set at 5.88 ct/kWh. As in the past, the average volume-weighted award

value of the rounds in the first half of the year is just slightly below this at 5.79 ct/kWh.

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

	Year	Maximum Permissible Value	Average capacity-weighted Award Value
Tender Year	2019	6.20 ct/kWh	6.14 ct/kWh
	2020	6.20 ct/kWh	6.11 ct/kWh
	2021	6.00 ct/kWh	5.88 ct/kWh
	H1 2022	5.88 ct/kWh	5.79 ct/kWh

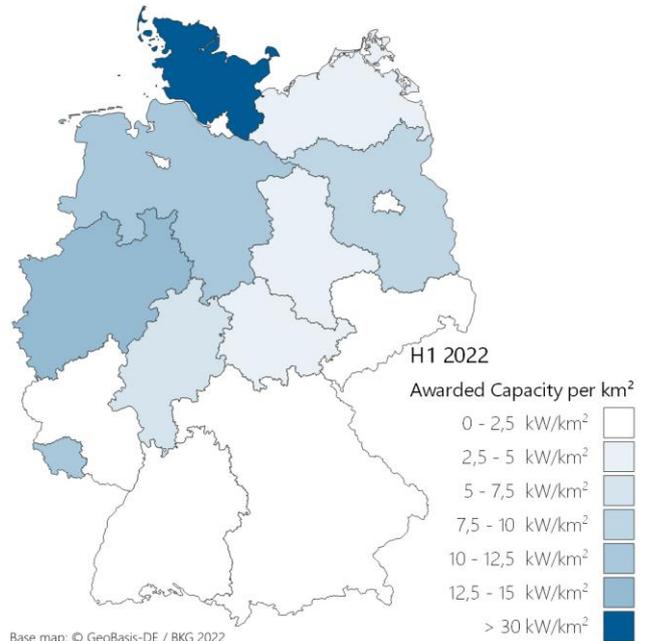


Competitive Situation in Tender System for Onshore Wind Energy (Database: BNetzA)

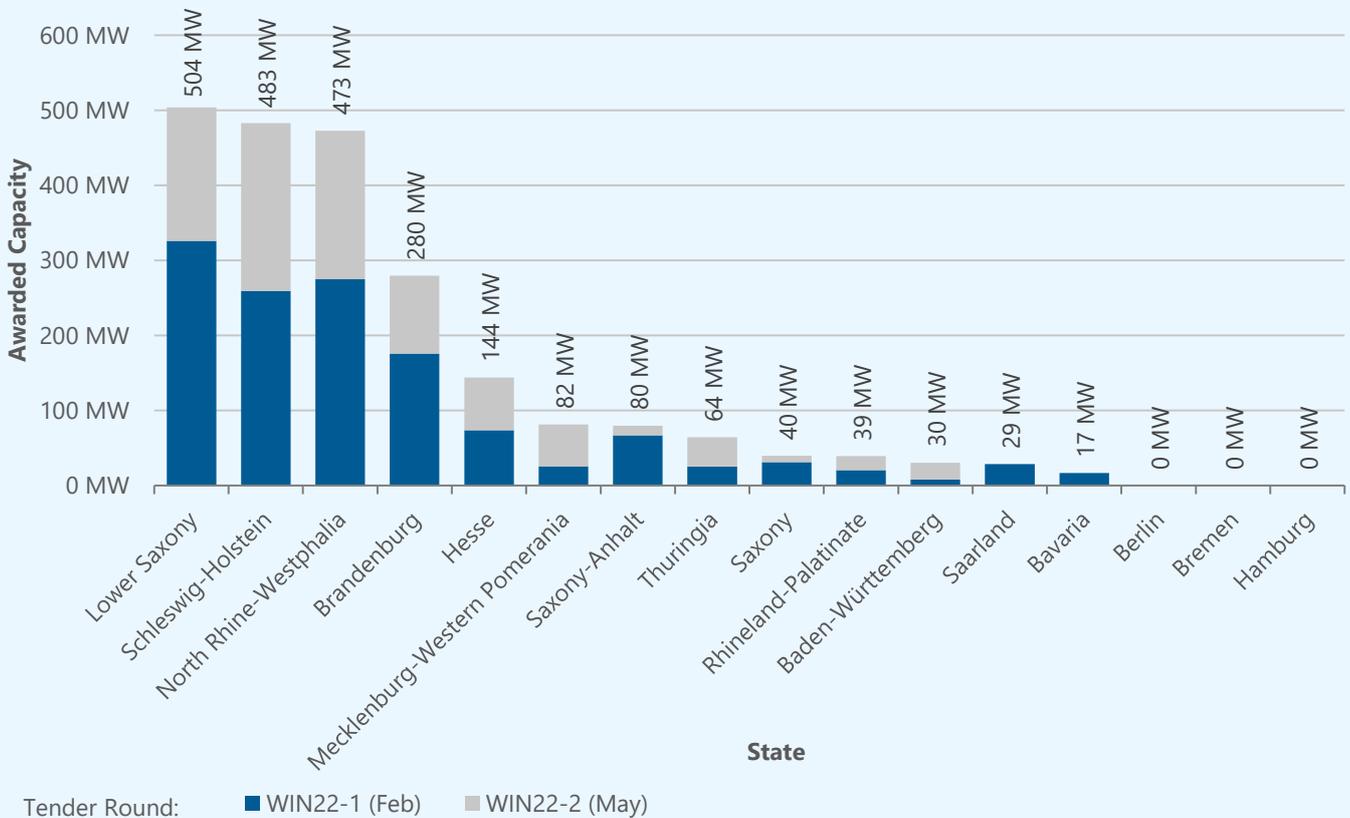
Regional Distribution of Awarded Bids

Lower Saxony, Schleswig-Holstein and North Rhine-Westphalia achieved the largest award volumes in the two bidding rounds in the first half of 2022, with a small difference between them. Together, the three states account for 64% of the award volume. Brandenburg and Hesse follow with 280 MW and 144 MW, respectively. All other states achieved less than 100 MW of the awarded capacity each. Berlin, Bremen and Hamburg did not participate in the two tender rounds.

In terms of the respective state area, Schleswig-Holstein has by far the greatest success in the tender rounds in the first half of 2022 (>30 kW/km²). North Rhine-Westphalia, in second place, achieved less than half as much capacity per km², with Saarland and Lower Saxony slightly below. Saxony, Rhineland-Palatinate, Baden-Württemberg and Bavaria achieve the lowest award volume in relation to the state area.



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 2017, approximately 15.2 GW have been awarded in the tenders for onshore wind energy. By the end of the first half of 2022, 5.4 GW had been successfully implemented. There are deadlines of usually 30 months (24 months penalty-free) for the implementation of the awarded wind turbines, after which the awards expire. Longer deadlines apply, for example, to citizens' energy companies (BEGs) that have been awarded without a permit, to some tender rounds affected by the pandemic, or in the event of a lawsuit against the permit. Previously unrealized awarded capacities from the tender rounds up to the middle of 2019 are not expected to be implemented anymore. Thus, the awards from 2019, with a realization rate of 92%, are the most successful so far. The implementation deadlines for the turbines awarded in 2020 do not end until the first half of 2023, so the implementation rate

of 49% today will still increase. The winners of the tender rounds from 2021 are slowly beginning with the first commissioning and no turbine awarded in 2022 has yet been implemented.

Realized Capacity* of Tenders for Onshore Wind Energy in Germany

	Year	Realized Capacity	Realization Rate
Year of Tender	2017	309 MW	11%
	2018	1,881 MW	80%
	2019	1,708 MW	92%
	2020	1,321 MW	49%
	2021	219 MW	7%
	H1 2022	0 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

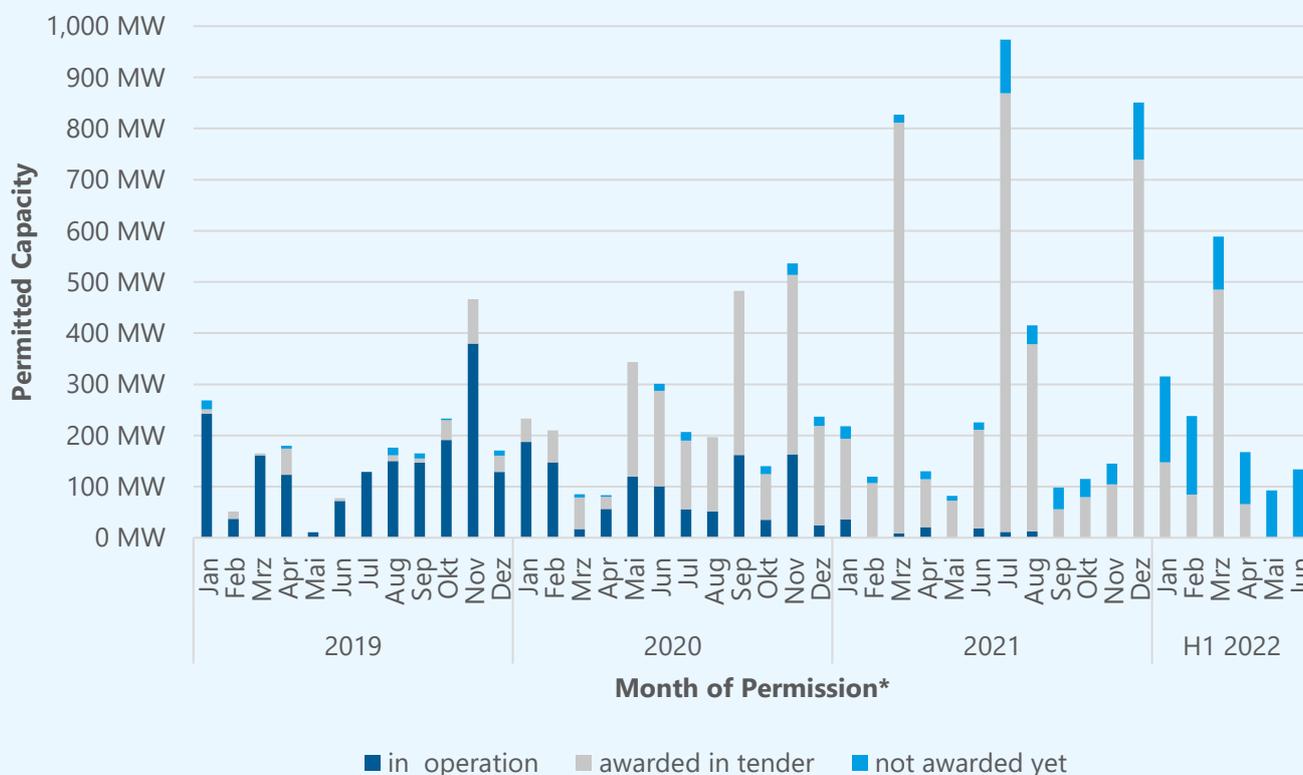
In the first half of 2022, permits were issued for 306 new wind turbines with a combined capacity of 1,536 MW. Thus, too little new capacity has been approved so far to continue the upward trend of the past years - the permit volumes have reached approximately the level of the first half of 2021. 51% of the newly approved capacity has already been awarded in the tenders.

In the second half of 2022, another regular tendering date will be held in September in accordance with the EEG 2021. The maximum tender volume for this round is 1,333 MW. In addition, a fourth, so-called "catch-up tender" will take place in December, in which the capacity not awarded in the previous year will be put out to tender again. A tender volume of 1,190 MW is expected. Adjustments to the tender volumes in the individual rounds, e.g. due to expected lack of

competition or due to the allocation of capacities to pilot turbines, can be made by the BNetzA. Most approvals are granted in time to meet the participation deadline two months before an upcoming tender date (e.g., in March 2022). Thus, increased permit volumes can also be expected for July and October 2022.

Annual Permitted Capacity

	Year	Permitted Capacity	Number WTG
Year of Permission	2019	2,092 MW	526 WTG
	2020	3,055 MW	691 WTG
	2021	4,199 MW	890 WTG
	H1 2022	1,536 MW	306 WTG



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

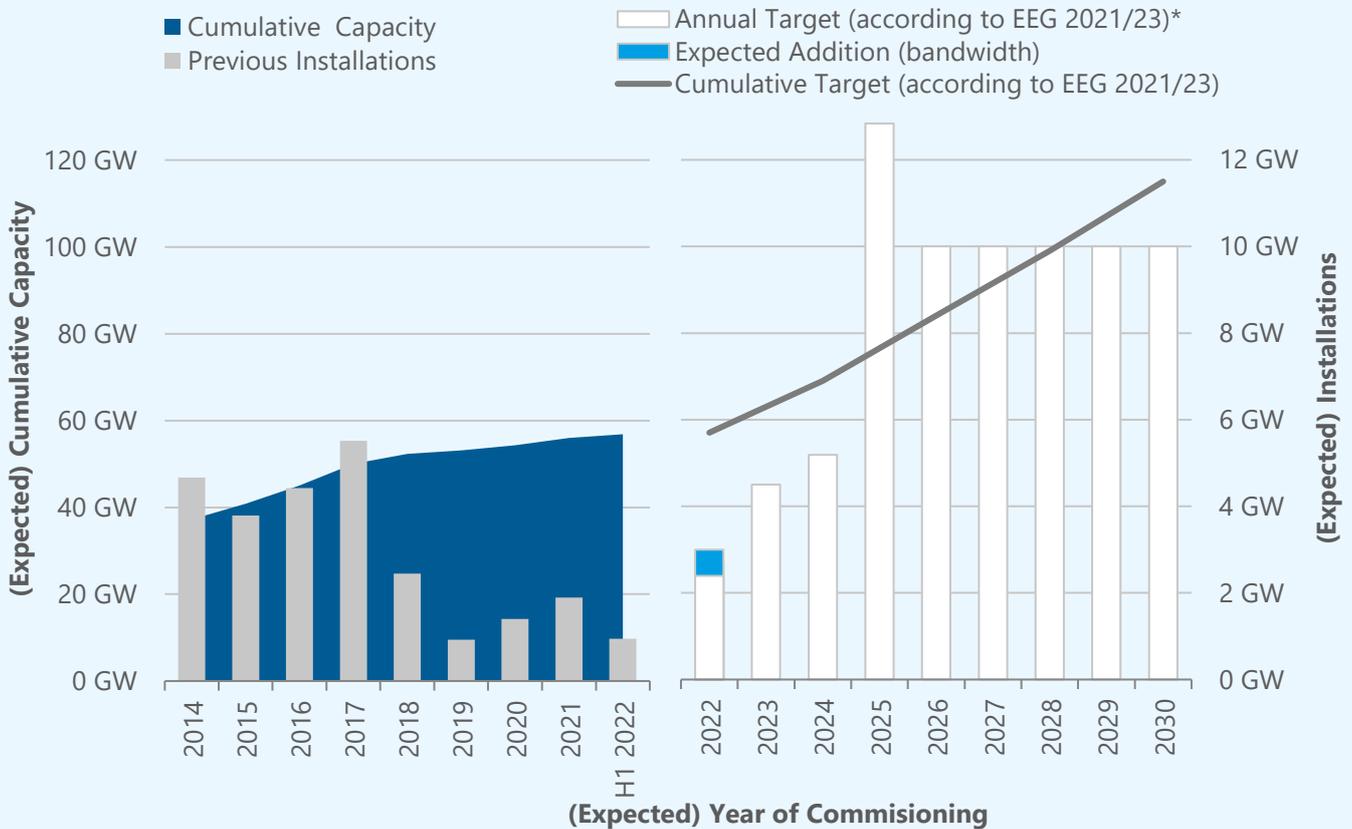
Monthly Permitted Capacity including Status

Expected Development and Political Target

The wind turbines installed in the first half of 2022 took an average of around 20 months from the date of the award notice to commissioning. This is about the same as the time required for the wind turbines installed in 2021 after being awarded. On the basis of this previous realization speed and the number of turbines already awarded and not yet realized, the expected future installation can be determined. For the further course of 2022, an unchanged implementation speed results in an expected addition of 2.4 GW to 3.0 GW. In 2023, the target* (4.5 GW) set by the tender volumes in the EEG 2021 will probably not be achieved, as in the past in several tender rounds tender volume was not fully awarded.

In the future, the EEG 2023 will determine the tender quantities and thus also indicate the politically targeted expansion path. In 2023, the tender volume will initially increase to 12.8 GW, and from 2024 onwards, 10 GW will probably be tendered annually. This means that the desired annual addition from 2025 onwards will be around twice as high as the addition in the previous record year of 2017. These ambitious targets can only be achieved if a correspondingly large number of projects are approved and the processes and supply chains required for implementation function.

*The expansion target of the EEG was derived from the planned tender volumes in the year before the previous year.

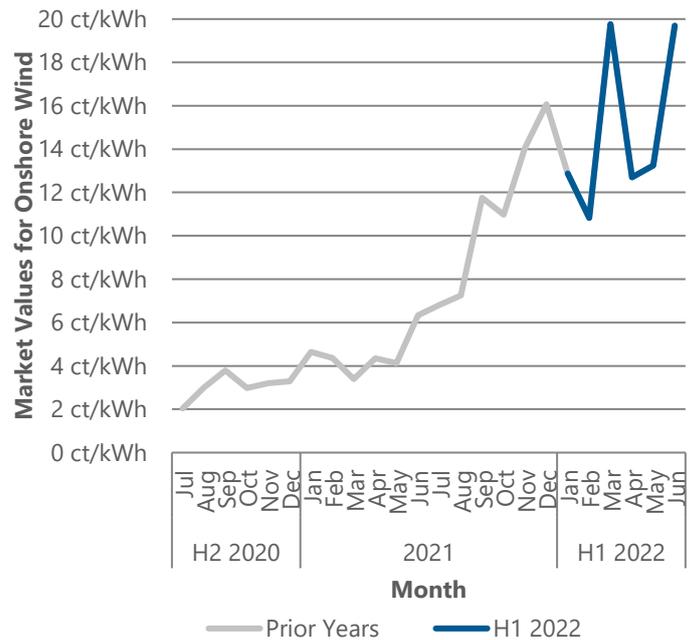


Expected expansion in 2022 and expansion targets according to EEG 2021/23

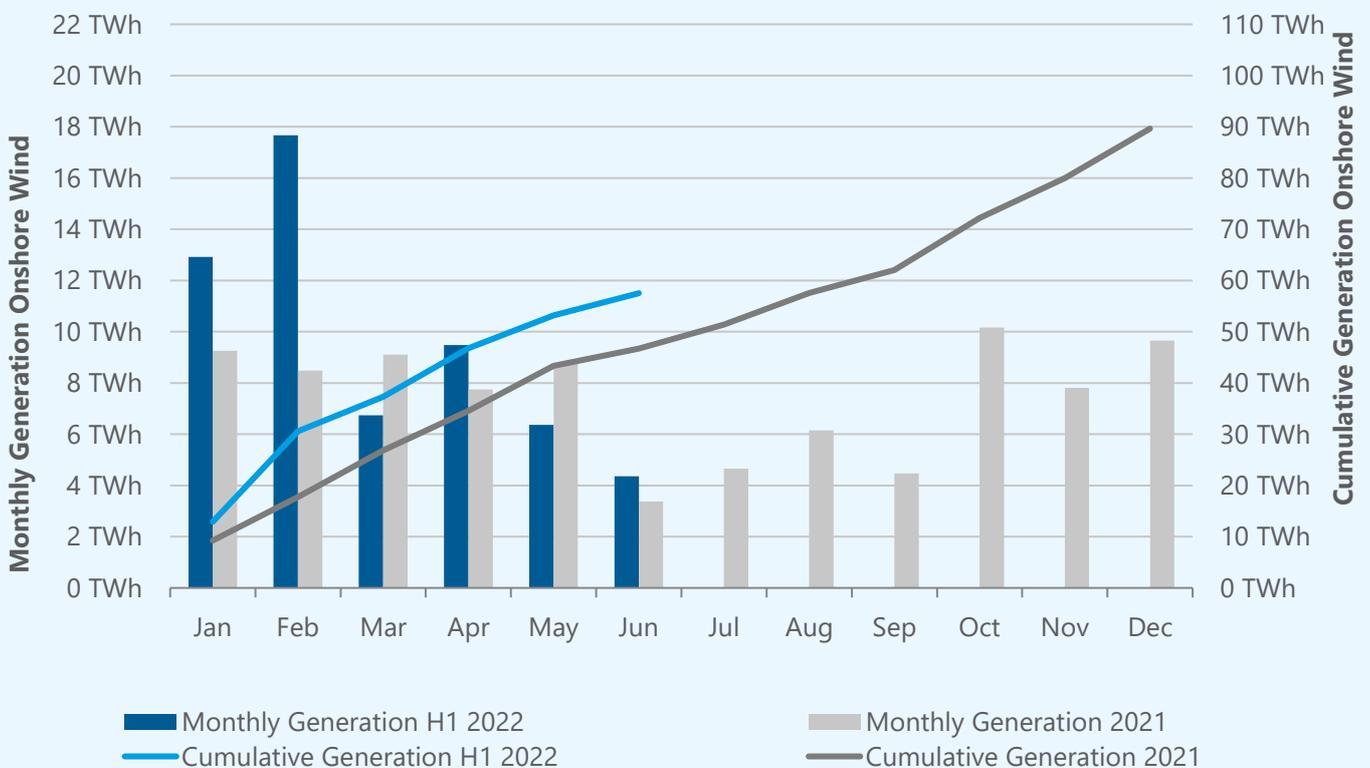
Power Generation and Market Values

In the first half of 2022, German onshore wind energy contributed around 57.5 TWh to the energy supply. Compared to the first six months of the previous year, this corresponds to an increase of 23%. In terms of feed-in, January and February 2022 significantly exceeded the rather weak winter months from 2021. At 22%, onshore wind energy makes a significant contribution to Germany's power generation.

In March and June 2022, the market value for onshore wind energy reached almost 20 ct/kWh and remained at the high level already reached in the summer of 2021 in the first half of 2022. Accordingly, the volume-weighted average market value for onshore wind energy for the first half of 2022 increased to 14.74 ct/kWh compared to the previous year's average (+72%).



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



Power Generation Onshore Wind (Database: Bundesnetzagentur | SMARD.de)

About Deutsche WindGuard

In the complex energy market, Deutsche WindGuard is committed to providing unbiased, manufacturer-independent consulting and comprehensive scientific, technical and operational services. The broad portfolio creates extensive synergy effects: Whether due diligence, market analysis, contract consulting or feasibility studies – each of them contains 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.