FACHAGENTUR
WIND UND SOLAR

Status of Onshore Wind Energy Development in Germany

Year 2024

On behalf of

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Year 2024

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Preliminary remarks

The analysis is based on the data of the market data registry (German: Marktstammdatenregister or MaStR) of the Federal Network Agency (German: Bundesnetzagentur or BNetzA), on publications of the BNetzA regarding the tenders for onshore wind energy as well as on own research. The data was checked for plausibility, supplemented in some cases and corrected in others. Findings on repowering are largely based on own researches and interviews with stakeholders. Turbine decommissioning was added in isolated cases where reports provided evidence of this, but where the final decommissioning has not (yet) been registered.

The time allocation of approvals is based on the initial approval date. A later modification date, due to modifications to the ap-proved wind turbine, does not change the chronological allocation of the approval. The analysis also includes turbines approved in 2024, which have not yet been registered, but for which the author has the official notice of approval. Only wind turbines with a minimum capacity of 100 kilowatt (kW) are included in the analysis. Decommissioned wind turbines with a generator output of 80 kW are considered.[1]

The publication of this paper takes place before the reporting deadline[2] for registration. Further reports increasing the quantity of permits, additions and decommissions are possible. Furthermore, late registrations and subsequent changes to register entries can also lead to discrepancies in the situation presented here for the 2024 calendar year.

[1] Small wind turbines only play a minor role in Germany. According to data in the MaStR, 97 wind turbines with a capacity of just 443 kW (0.4 MW) were commissioned in 2024. At the beginning of 2025, 964 small wind turbines (up to 75 kW generator power) with a total capacity of 8.9 MW were registered as “in operation” across Germany.

[2] Art. 5 MaStR stipulates that registration must take place within one month of commissioning. The one-month period also applies to provisional and final decommissioning as well as “approvals” in accordance with the Federal Immission Control Act (German: Bundes-Immissionsschutzgesetz).

Summary

The year 2024 was characterized by an unprecedented development in the number of approvals for new wind turbines. Approximately, 2,400 turbines with a good 14,000 megawatts (MW) of capacity were newly approved by the authorities across Germany. Compared to the previous year this corresponds to an increase of 85 per cent. Almost 30 per cent of the approved capacity comes from North Rhine-Westphalia (4,044 MW), making the state the clear leader in the state rankings. By comparison, in second-placed Lower Saxony around half as much capacity (2,061 MW) was approved. Despite the unique abundance of permits, the processing times in the vast majority of states fell significantly. On average, permitting procedures took 23 months - 10 percent less than in 2023.

The high number of new approvals also had an impact on last year's tender dates. The Federal Network Agency was able to allocate 90 percent of the 2024 auction volume by awarding bids for 11 gigawatts (GW) of wind energy capacity. This corresponds to an increase of a good 70 percent compared to the volume awarded in the previous year.

Last year, 635 new turbines with an output of 3,251 megawatts (MW) were commissioned. Here, too, North Rhine-Westphalia leads the federal state statistics with 748 MW gross additions, followed by Lower Saxony (673 MW) and Schleswig-Holstein (574 MW). Compared to the 2023 expansion year, current commissioning was nine percent lower. On the other hand, the repowering share of gross additions increased. 37 percent of the capacity installed in 2024 was realized as a replacement for old turbines. Accordingly, the decommissioning figures also reached a new high: 553 old turbines with 703 MW have so far been registered as finally decommissioned in 2024. Based on experience, this figure is likely to increase slightly in the coming weeks due to late registrations.

After deducting decommissioning, the net increase in wind energy capacity amounted to 2,545 MW last year. The total number of wind turbines grew by only 80.

At the end of 2024, the total nationwide portfolio comprised around 28,700 turbines with a capacity of 63.5 GW. 11.7 GW of the installed capacity has no longer been entitled to remuneration under the Renewable Energies Act (EEG) since January 1, 2025. The average age of the German wind turbine fleet is 15.2 years. Wind turbines in the Free State of Saxony have the highest operating age (Ø 20.1 years). Saarland has the youngest wind turbine fleet with an average of 10.8 years of operation.

In 2024, almost 112 billion kilowatt hours (kWh) of electricity were generated by onshore wind turbines. With a share of more than a quarter, onshore wind energy was thus the most important source of energy for electricity generation in Germany.

Table 1: Status of onshore wind energy development

Year 2024	Wind turbines	Capacity [MW]
Permits	2,405	14,056
Gross installations	635	3,251
Repowering share	224	1,191
Decommissioning	555	706
Net installations	80	2,545
Total installation December 31, 2024	28,766	63,461

1 Wind Energy Installation

In 2024, 635 onshore wind turbines with a total electrical output of 3,251 MW were commissioned in Germany. Over a third (37 %) of the newly installed wind energy capacity was realized as repowering. In terms of installed capacity, the gross additions are nine percent below the previous year's figure (3,581 MW). The associations explain the lack of a ramp-up in new installations to date with the lower tender and award volumes two years ago, as well as continuing delays in project implementation due to delayed grid connections and grid component deliveries, as well as the ongoing lack of planning and infrastructure for large and heavy load transports.

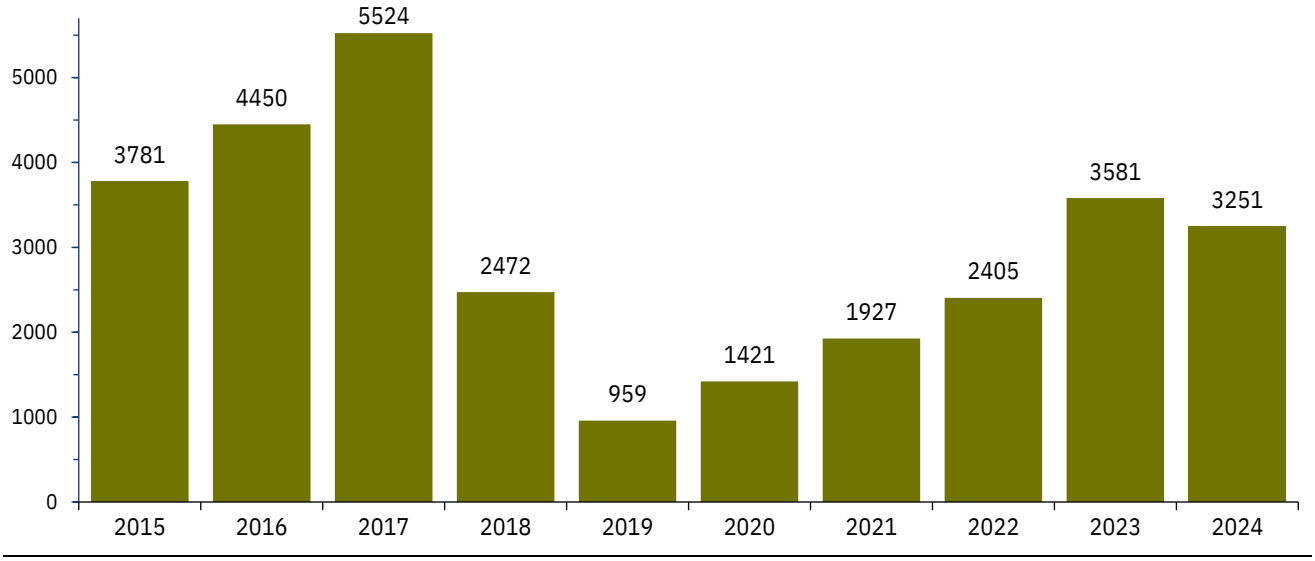

Figure 1: Onshore wind energy capacity commissioned annually (gross additions)
Data: MaStR; values in megawatts

After deducting the decommissioning reported last year (555 wind turbines, 706 MW), the net increase amounted to 2,545 MW or 80 turbines.

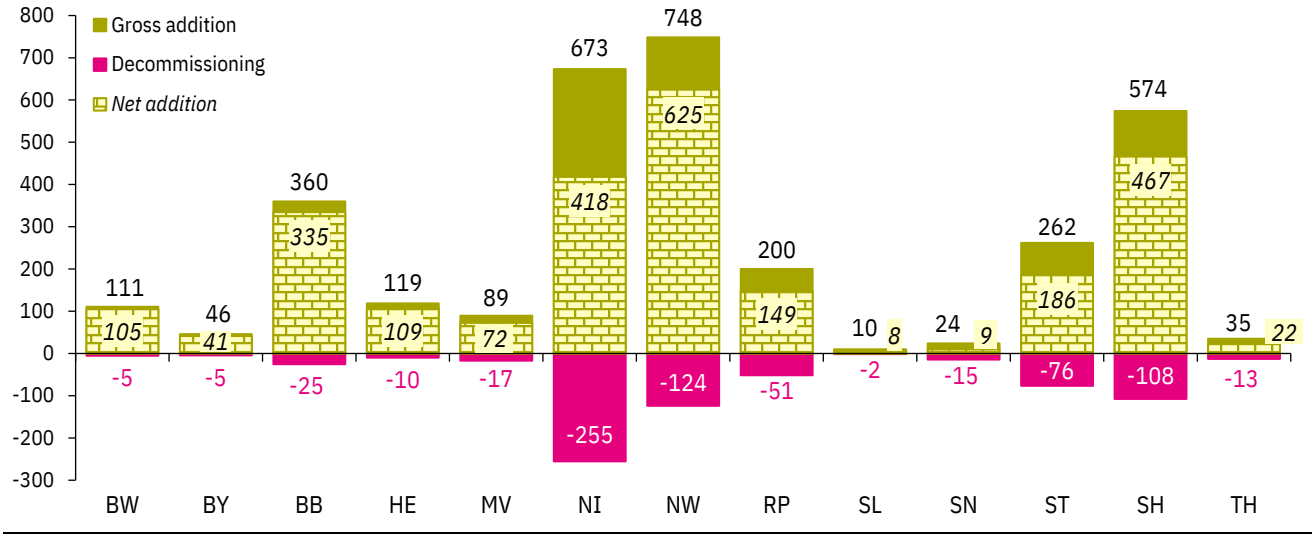

Figure 2: Gross/ net addition of wind energy capacity in 2024 in the federal states
Data: MaStR; values in megawatts; for the abbreviations of federal states, see table 2

1.1 Regional Distribution of Commissioning

Almost every fourth megawatt installed in wind turbines in 2024 is located in North Rhine-Westphalia (748 MW). It is followed by Lower Saxony with 673 MW of new turbine capacity. In third place is Schleswig-Holstein, where wind turbines with 574 MW went into operation. Only eight wind turbines were commissioned in Bavaria, five in Saxony and two in Saarland. There was no expansion in the three city states.

The decline in new installations compared to 2023 was not the same in all federal states. Individual regions recorded a significant increase in output compared to the previous year: In Saxony-Anhalt, annual capacity growth has tripled. In Baden-Wuerttemberg and Bavaria, growth was in the upper double-digit percentage range. North Rhine-Westphalia and Rhineland-Palatinate also recorded a significant increase in gross new additions of over 40 percent each.

Table 2: Commissioning of new wind turbines / capacity in 2024; data: MaStR

Federal state	Wind turbines	Capacity [MW]	Share of total additions [MW]	Change compared to 2023 [MW]	Ø Hub height [m]	Ø Rotor diameter [m]	Ø Wind turbine capacity [MW]
Baden-Wuerttemberg [BW]	24	110.8	3.4%	+89%	156	141	4.62
Bavaria [BY]	8	45.7	1.4%	+79%	167	158	5.71
Brandenburg [BB]	69	360.1	11.1%	-16%	162	151	5.22
Hesse [HE]	22	118.7	3.7%	-26%	165	153	5.40
Mecklenburg-Western Pomerania [MV]	16	89.3	2.7%	-51%	148	152	5.58
Lower Saxony [NI]	127	673.2	20.7%	+5%	148	150	5.30
North Rhine-Westphalia [NW]	154	748.3	23.0%	+41%	140	145	4.86
Rhineland-Palatinate [RP]	41	200.3	6.2%	+44%	151	142	4.88
Saarland [SL]	2	9.8	0.3%	-63%	163	144	4.90
Saxony [SN]	5	23.9	0.7%	-48%	154	145	4.77
Saxony-Anhalt [ST]	48	261.9	8.1%	+200%	159	152	5.46
Schleswig-Holstein [SH]	113	574.1	17.7%	-53%	109	139	5.08
Thuringia [TH]	6	34.9	1.1%	+8%	164	156	6.14
Germany	635	3,250.8	100%	-9%	143	146	5.12

In the southern region (Südregion[3]), 65 new turbines with an output of 333 MW were connected to the grid, most of them in the Rhineland-Palatinate region (155 MW) and in Baden-Wuerttemberg (111 MW). The southern region's share of total new installations reached ten percent, which means that gross new additions there improved in absolute and percentage terms (+223 MW; +6 %) compared to the previous year.

1.2 Turbine Configuration

For some years now, there has been a high level of dynamism in the development of the generator output of new wind turbines, which is now also reflected in the number of turbines commissioned. While the average generator output of turbines commissioned in 2015 was still 2.7 MW, this value exceeded the five-megawatt threshold for new turbines for the first time in 2024. The average generator output of newly installed turbines has risen by 90 percent in the last ten years. A good half of the new turbines in 2024 have a

[3] The geographical scope covers Baden-Wuerttemberg and Saarland in their entirety. Bavaria and Rhineland-Palatinate are also largely covered by the area, with the exception of a few districts in the far north. In Hesse, five rural districts (below the Main line) and the independent city of Darmstadt are included in the southern region; cf. section 3 no. 43c in conjunction with Annex 5 EEG.

generator output of more than 5.5 MW. In contrast, turbines with a capacity of up to 3.5 MW only account for five percent of gross new installations.

Rotor blade lengths have also increased by 40 percent over the last decade. Hub heights have increased accordingly over the same period - in this case by almost a fifth (17%).

This trend in turbine configurations will continue in the coming years, as the average generator output has already reached 5.8 MW with the most recently approved but not yet realized wind turbines. Both the average hub height and the rotor diameter have exceeded the 155-metre mark (see section 5.3).

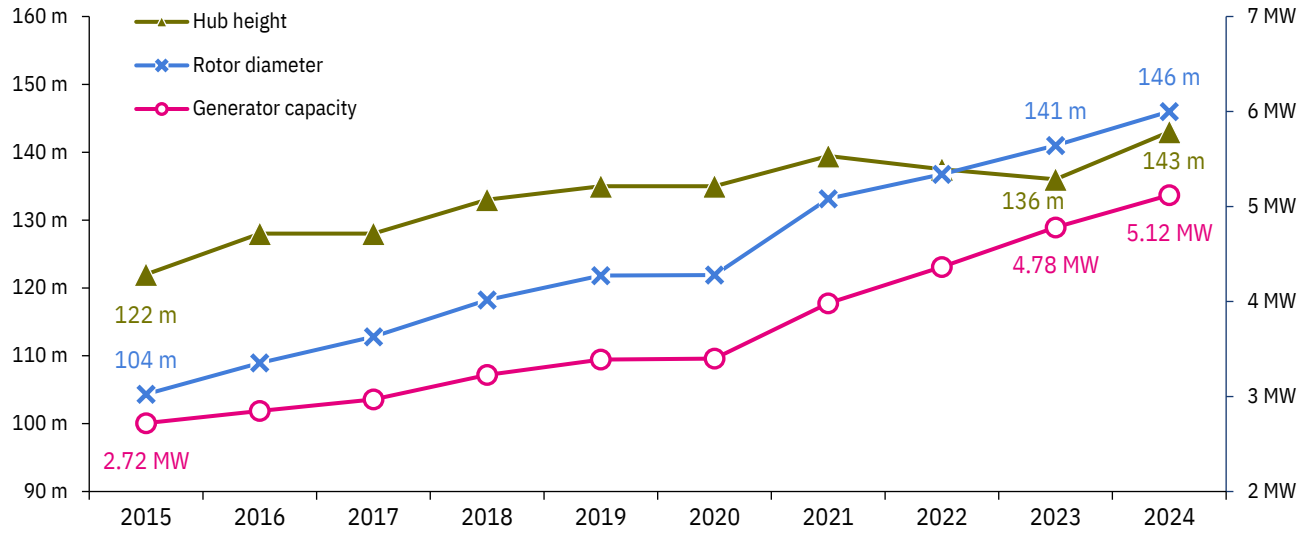

Figure 3: Configuration of wind turbines commissioned each year
Data: MaStR, own research; values in megawatts or metres

1.3 Realization Period

The period from the granting of (initial) permit to the commissioning of wind turbines, referred to here as the implementation period, has increased continuously in recent years. While in the years 2011 to 2017[4] it typically took just under a year to connect a turbine to the grid after it had been approved, this step recently took more than twice as long. In 2024, plant implementation took an average of 26.7 months and was therefore only slightly shorter than in the two previous years, when the implementation period reached its highest level to date at more than 27 months. The shortest realization time in 2024 was just over five months, while the longest time span was almost eight years (95 months).

The significant increase in implementation times in recent years is partly due to the tendering process, as it takes an average of five months[5] from the (initial) permit to the award of the bit. Once last year's new wind turbines were awarded, it took an average of 20 months before they went into operation. In addition, a considerable number of turbines have their original permit amended again - either because the output has been increased or because a change of type has been made, sometimes in conjunction with a change of manufacturer. Such subsequent changes to the originally approved situation can be identified in a quarter of the 2024 commissioning projects, which ultimately resulted in 15 percent more capacity (+125 MW) being realized than initially approved. Protracted legal proceedings against the permit can also bring the realization process to a standstill. All of these circumstances have an impact on the realization time, because by definition, all time spent after the initial permit is granted is included in the realization phase.

[4] More detailed information on this period: FA Wind (2023), Typische Verfahrenslaufzeiten von Windenergieprojekten - Empirische Datenanalyse für den Zeitraum 2011 bis 2022.
[5] Data basis: 6,245 wind turbines which were awarded a contract in the tender years 2018 to 2024.

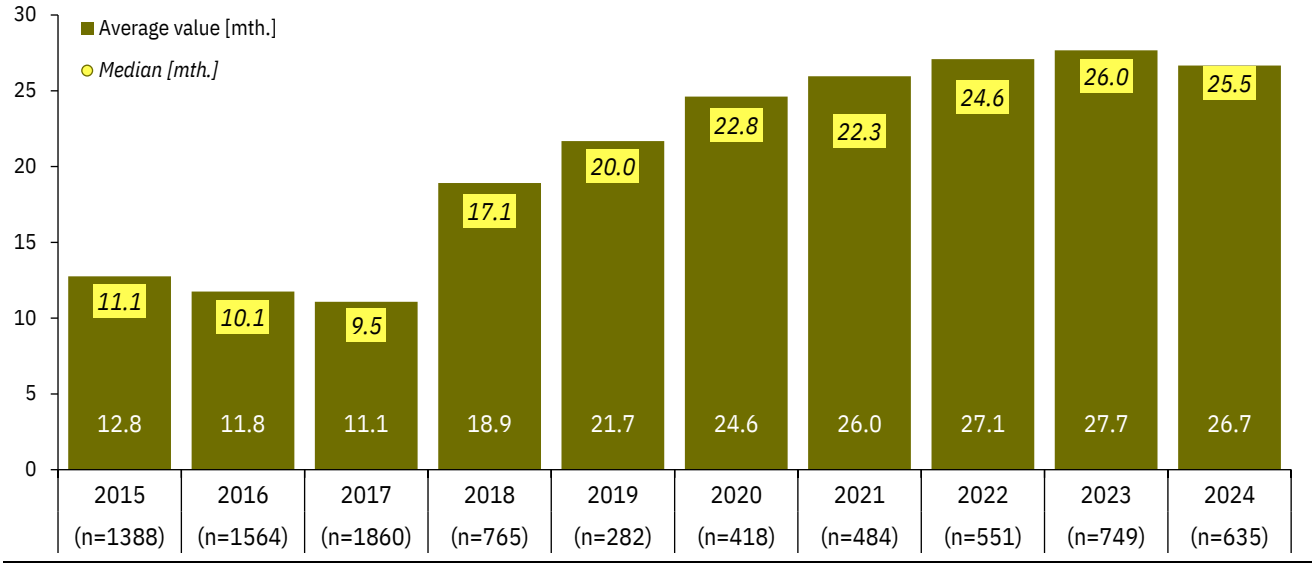

Figure 4: Realization period (permit to commissioning) of wind turbines commissioned annually
Data: MaStR, own research; values in months

2 Repowering and Decommissioning

More than half of Germany's wind turbines have been in operation for at least 15 years. Around 10,800 wind turbines are already more than 20 years old. With increasing age, the question arises as to whether the existing turbine location can continue to be used with modern, more powerful machines (repowering) or whether the old turbines will be removed without replacement at the end of their technical operating life.

2.1 Repowering

224 wind turbines with a capacity of 1,191 MW were put into operation in 2024 as part of a repowering project. In terms of installed capacity, the repowering rate thus reached 37 percent - the highest value since 2015.

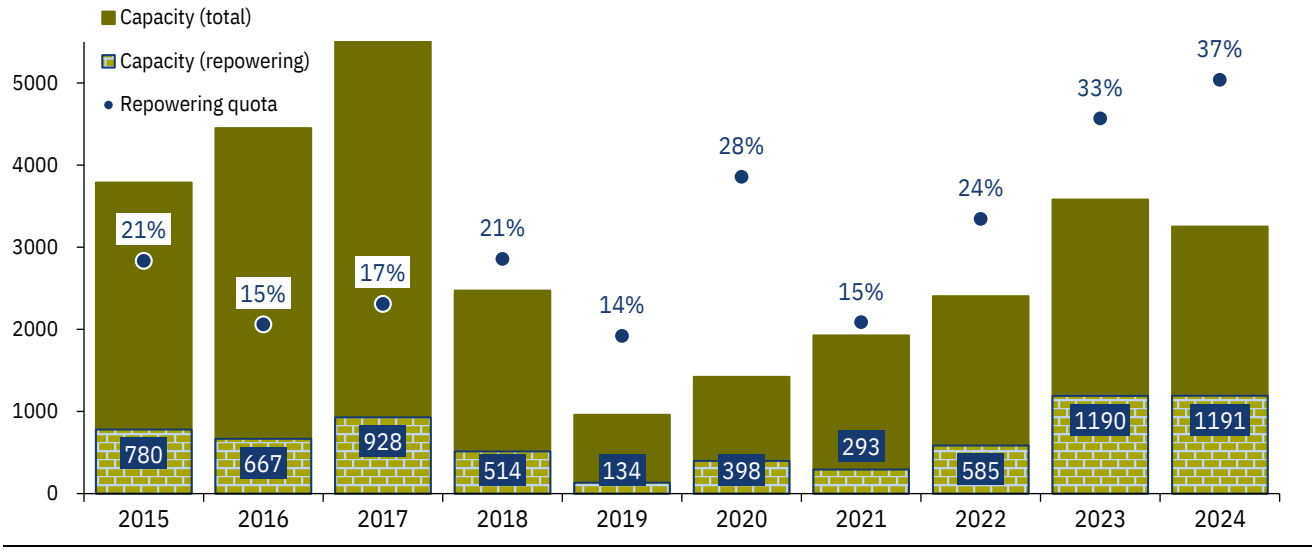

Figure 5: Share of repowering capacity in annual commissioning
Data: MaStR, AnlReg, own research; values in megawatts

Repowering projects were realised in 12 federal states. A third of the capacity realized is located in Lower Saxony (387 MW). Just under a fifth of the repowered capacity was connected to the grid in Schleswig-Holstein (225 MW) and North Rhine-Westphalia (218 MW).

14 percent of the new repowering capacity was realized in Saxony-Anhalt (161 MW). At 62%, Saxony-Anhalt also recorded the highest repowering rate, followed by Lower Saxony and Saxony, each with a share of over 50% of the state-specific gross additions.

Table 3: Regional distribution of repowering in 2024; data: MaStR, own research

Federal state	Wind turbines	Capacity [MW]	Share of total additions [MW]
Baden-Wuerttemberg	4	21.0	20.6%
Brandenburg	11	61.1	17.0%
Hesse	4	26.4	22.2%
Mecklenburg-Western Pomerania	4	21.0	23.5%
Lower Saxony	72	387.3	57.5%
North Rhine-Westphalia	43	218.4	29.2%
Rhineland-Palatinate	6	36.5	18.2%
Saarland	1	4.2	42.9%
Saxony	3	12.6	52.8%
Saxony-Anhalt	31	161.0	61.5%
Schleswig-Holstein	42	224.7	39.1%
Thuringia	3	17.1	49.0%
Germany	224	1,191.2	36.6%

2.2 Decommissioning

In 2024, 555 wind turbines with a total capacity of 706 MW were reported to the market master data register as finally decommissioned. Compared to 2023, this is an increase of 19 percent in terms of decommissioned capacity. Even though the decommissioning figures have recently increased significantly, there is still no serious wave of decommissioning that could have occurred as a result of the almost 10,000 existing turbines that have now been decommissioned. Rather, the number of turbines decommissioned in recent years correlates with the development of repowering and leads to the conclusion that old turbines were mainly decommissioned to replace new wind turbines.

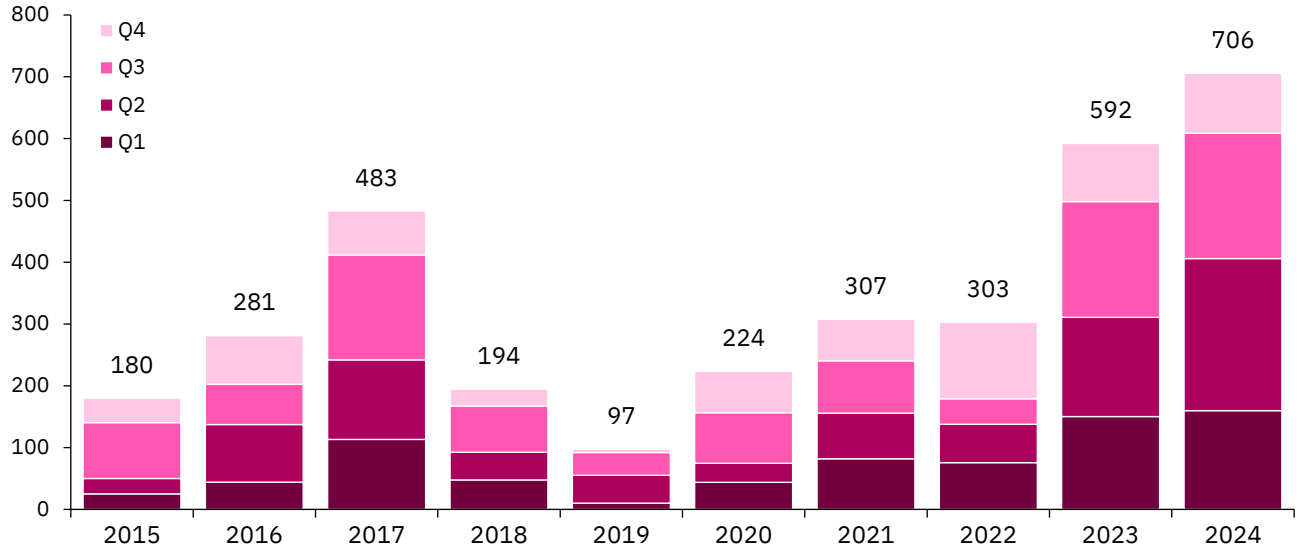

Figure 6: Wind energy capacity decommissioned annually
Data: MaStR, AnlReg; values in megawatts

The average age of the wind turbines decommissioned in 2024 was 22.6 years of operation. The shortest operating phase lasted just under nine years, while the longest period was 33 years. A good half of last year's decommissioned turbines had a generator capacity of between 1 and 2 MW. Most decommissioning took place in Lower Saxony (171 wind turbines, 255 MW), followed by North Rhine-Westphalia (119 wind turbines, 124 MW) and Schleswig-Holstein (70 wind turbines, 108 MW).

Table 4: Regional distribution of decommissioned wind turbines in 2024; data: MaStR

Federal state	Wind turbines	Capacity [MW]	Operation age [years]
Baden-Wuerttemberg	3	5.4	22.2
Bavaria	4	4.5	23.3
Brandenburg	18	25.5	22.1
Hesse	18	9.8	27.0
Mecklenburg-Western Pomerania	25	17.1	24.4
Lower Saxony	171	255.4	22.5
North Rhine-Westphalia	119	123.7	23.1
Rhineland-Palatinate	39	51.4	20.6
Saarland	1	1.5	21.7
Saxony	18	14.6	23.0
Saxony-Anhalt	60	76.4	22.2
Schleswig-Holstein	70	107.6	21.6
Thuringia	9	13.0	21.8
Germany	555	705.7	22.6

In the past decade, around 2,850 wind turbines with a capacity of 3.4 GW were decommissioned. During this time, most of the wind energy capacity was permanently decommissioned in Lower Saxony (1,069 MW), followed by Schleswig-Holstein (797 MW) and North Rhine-Westphalia (435 MW).

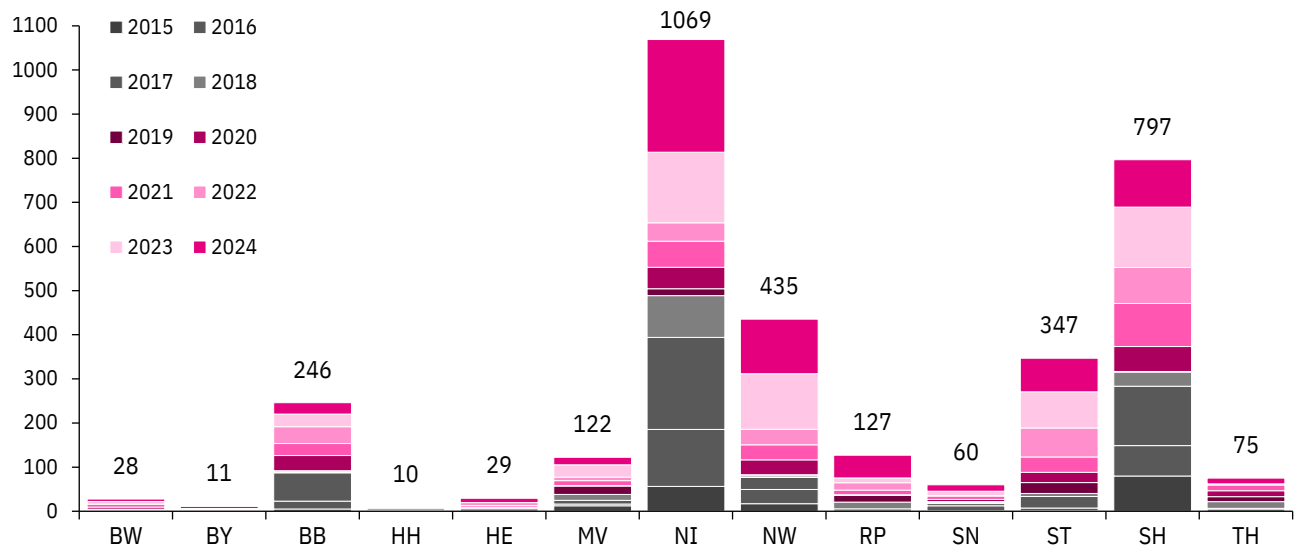

Figure 7: Decommissioned wind energy capacity in the period 2015 to 2024 in the federal states
Data: MaStR, AnlReg; values in megawatts

3 Total Installations of Onshore Wind Energy

According to data in the core energy market data register, 28,766 wind turbines with a capacity of 63.5 GW were in operation at the end of 2024.

The ratio of installed wind energy capacity to state area (installation density) shows that Bavaria, by far the largest state in terms of area, has by far the lowest installation density - apart from Berlin. At just 38 kilowatts per square kilometre (kW/km²) of land area, Bavaria's specific value is six times lower than that of the much more densely populated state of North Rhine-Westphalia. Among the coastal states, Mecklenburg-Western Pomerania stands out. Despite comparable wind conditions, the installation density of 163 kW/km² in the second largest coastal state is considerably lower than in Lower Saxony. Compared to Schleswig-Holstein, Mecklenburg-Western Pomerania is three times behind its neighbour. Even the densely populated city state of Hamburg ranks ahead of Mecklenburg-Western Pomerania in this indicator. Schleswig-Holstein has the highest area-specific installation value at 568 kW/km², followed by Bremen and Brandenburg. The nationwide installation density at the end of 2024 was 177 kW/km².

3.1 Regional Distribution of Installed Onshore Wind Turbines

Most wind energy capacity is installed in Lower Saxony (12.9 GW), followed by Brandenburg (9.0 GW), Schleswig-Holstein (9.0 GW) and North Rhine-Westphalia (7.8 GW). The average generator output of existing turbines is 2.21 MW - i.e. less than half of current-day new turbines. The average total height of existing turbines is 144 metres, while the wind turbines installed in 2024 have an average total height of 216 metres.

At the end of 2024, wind turbines were in operation in 271 (out of 294) districts nationwide. There were also wind turbines in 43 district-free cities. In terms of installation density per district area, Dithmarschen in Schleswig-Holstein leads the nationwide comparison with 1,640 kW/km². In second place is the Schleswig-Holstein district of Nordfriesland with an installation density of 1,183 kW/km². Although more wind energy capacity is connected to the grid there than in the neighbouring district, the district area is significantly larger, which is why the installation density is behind Dithmarschen. The district of Paderborn in North Rhine-Westphalia ranks third, followed with almost equal values by the district of Aurich in Lower Saxony (833 kW/km²) and the district of Lippe in North Rhine-Westphalia (830 kW/km²).

Table 5: Regional Distribution of Wind Turbines as of December 31, 2024; data: MaStR, own research

Federal state	Wind turbines	Capacity [MW]	Share of total additions [MW]	Installation density [kW/km²]
Baden-Wuerttemberg	800	1,889	3.0%	53
Bavaria	1,155	2,675	4.2%	38
Berlin	6	17	0.03%	19
Brandenburg	4,082	8,997	14.2%	303
Bremen	85	202	0.3%	481
Hamburg	68	125	0.2%	166
Hesse	1,181	2,639	4.2%	125
Mecklenburg-Western Pomerania	1,845	3,797	6.0%	163
Lower Saxony	6,156	12,950	20.4%	271
North Rhine-Westphalia	3,670	7,778	12.3%	228
Rhineland-Palatinate	1,783	4,151	6.5%	209
Saarland	219	553	0.9%	215
Saxony	852	1,361	2.1%	74
Saxony-Anhalt	2,730	5,503	8.7%	269
Schleswig-Holstein	3,267	8,973	14.1%	568
Thuringia	867	1,853	2.9%	114
Germany	28,766	63,461	100%	177

13 percent of Germany's wind turbines have a generator output of up to 750 kW. However, these systems only account for three percent of electricity generation capacity. One third of the existing turbines are in the 1 to 2 MW power class. This segment accounts for 27 percent of the total installed capacity. Almost a quarter of existing turbines are equipped with a generator capacity of 2 to 3 MW. Just under a quarter of the wind turbines in operation were installed with more than three megawatts. The high operating age of approximately 15,000 existing turbines with a generator capacity of up to 2 MW shows the great repowering potential that can be tapped in the coming years.

Table 6: Power classes of the installed wind turbines as of December 31, 2024; data: MaStR

Power classes	Wind turbines	Capacity [MW]	Share of total turbine additions	Share of total additions [MW]	Operation age [years]
P ≤ 750 kW	3,748	1,959	13.0%	3.1%	26.4
750 < P ≤ 1,000 kW	1,873	1,658	6.5%	2.6%	19.3
1,000 < P ≤ 2,000 kW	9,671	17,193	33.6%	27.1%	19.5
2,000 < P ≤ 3,000 kW	6,622	16,439	23.0%	25.9%	10.6
3,000 < P ≤ 4,000 kW	4,699	15,438	16.3%	24.4%	8.1
P > 4,000 kW	2,153	10,773	7.5%	17.0%	2.6

3.2 Age Structure of Onshore Wind Turbines

At the end of 2024, the turbines connected to the grid had a calculated average age of 15.2 years. Figure 8 breaks down the installed wind energy capacity by year of commissioning. Of the wind energy capacity installed before the turn of the millennium, just under 1.9 GW was still in operation at the end of last year. Together with the capacity that was installed between 2000 and 2004 and is still connected to the grid, the wind energy capacity that no longer receives subsidies under the Renewable Energies Act (EEG) since the beginning of 2025 amounts to 11.5 GW (magenta-coloured bars, Figure 8).

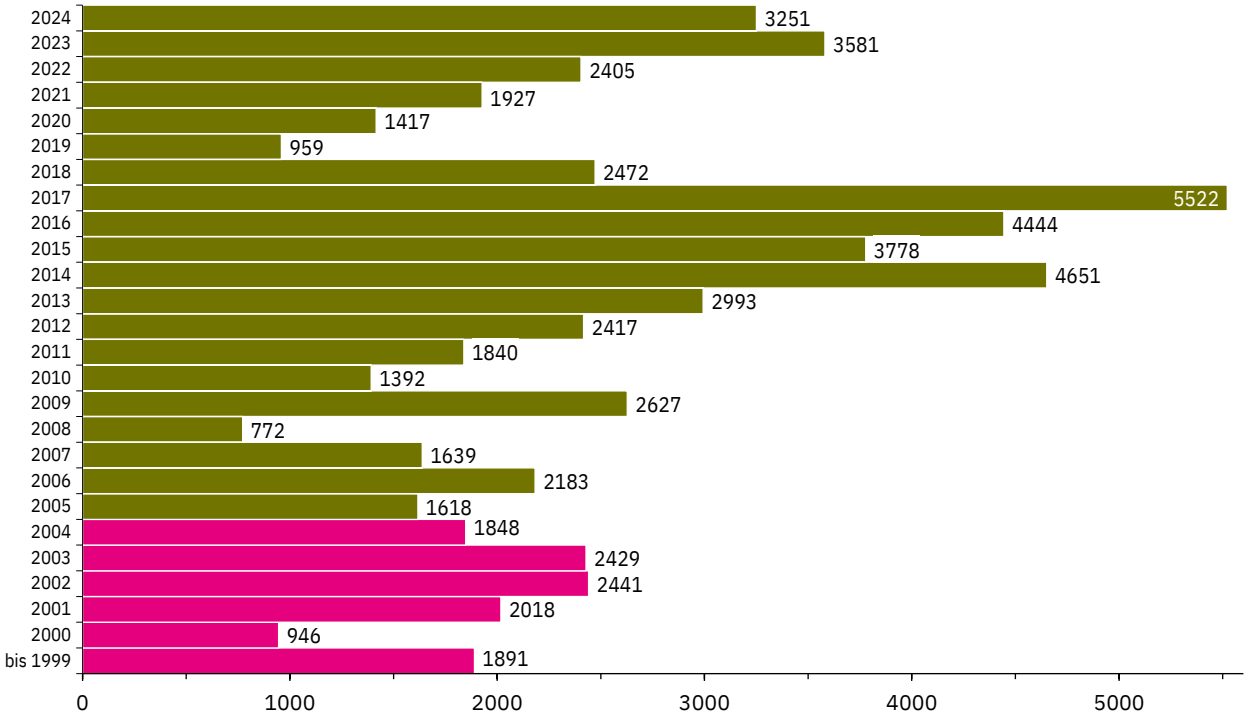

Figure 8: Onshore wind energy installation by year of commissioning (magenta = no subsidies)
Data: MaStR; values in megawatts

Of the wind energy capacity installed at the end of 2024, 18 percent has now exited the subsidy regime of the Renewable Energies Act. A further 14 percent have already been connected to the grid for 15 to 20 years. A fifth of the nationwide capacity has bee n generating electricity from wind energy for 10 to 15 years. Almost half (47 %) of the installed generation capacity has been in operation for up to ten years.

The age structure of the turbine fleet varies greatly from state to state. In Saxony, for example, the proportion of wind energy capacity that no longer receives EEG-subsidies (44 %) is more than twice as high as the national average (18 %). At 20.1 years, the Saxon turbine fleet also has the highest average age in a state comparison. In Brandenburg, Mecklenburg-Western Pomerania, Lower Saxony, Saxony-Anhalt and Thuringia, the respective share of wind energy capacity no longer being subsidized is also above the national average. Of the capacity in the commissioning period 2005 to 2009, which will fall out of the EEG subsidy regime in the next five years, Brandenburg, Lower Saxony, Saxony and Saxony-Anhalt have above-average shares in the portfolio. In Saxony, 60 percent of the installed capacity will lose its entitlement to remuneration under the EEG by the end of 2029. In Saxony-Anhalt, more than half (53 %) will reach the end of the subsidy period by then.

Apart from Berlin[6], the Saarland (Ø 10.8 years) and Bavaria (Ø 12.7 years) have the youngest wind turbine parks. Only eleven percent (Saarland) resp. 15 percent (Bavaria) of wind turbine capacity there has been in operation for more than 15 years. In most states, the largest share of capacity was connected to the grid between 2015 and 2019. During this period, Baden-Wuerttemberg and Saarland each installed more than half of their current wind energy capacity and are therefore well above the national average (27 %).

[6] The six wind turbines connected to the grid there have been in operation for an average of 9.3 years.

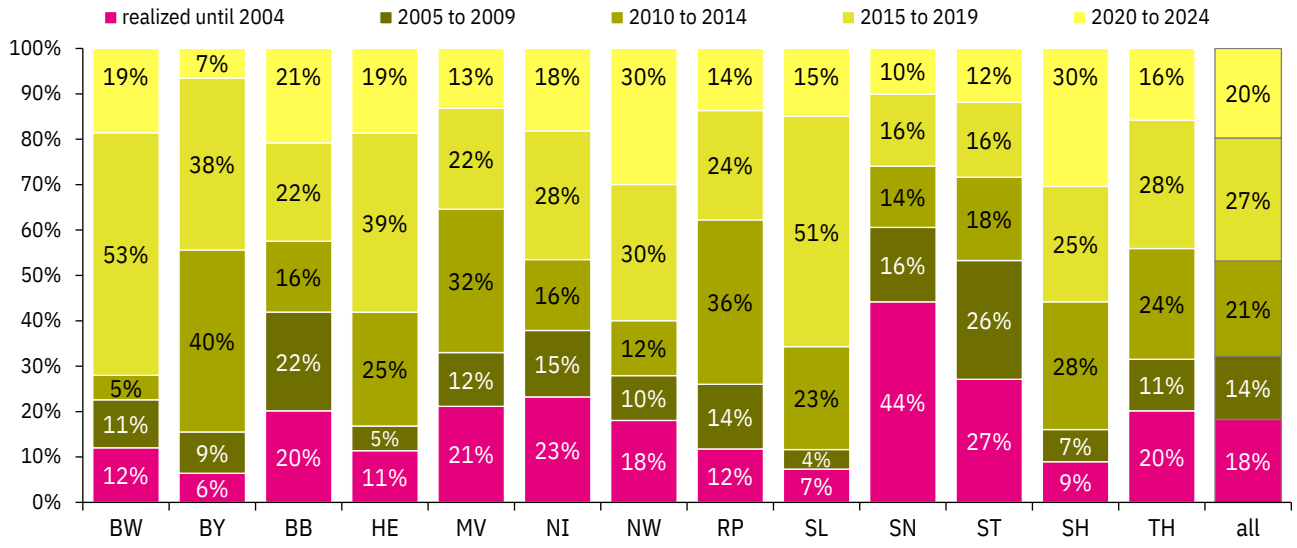

Figure 9: Age structure of installed wind energy capacity by year of commissioning
Data: BNetzA

4 Results of Tender Rounds

In 2024, the Federal Network Agency held four tender rounds for onshore wind turbines. The tenders in February and May were undersubscribed. The auction volume in August was slightly oversubscribed and in November two gigawatts more were bid than were tendered. Of the total tender volume of 12,084 MW, the Federal Network Agency was able to award 10,996 MW. Originally, a tender volume of 14,793 MW[7] was planned, which was reduced by the authority in the run-up to the auctions in May and August due to an expected lack of competition.[8] Nevertheless, never before has so much wind energy capacity been awarded in one year as in 2024. Compared to the previous year (6,377 MW), the volume awarded increased by a good 70 percent.

The average award value across all tender rounds in 2024 amounts to 7.26 Euro cent per kilowatt hour (ct/kWh). It is therefore slightly below the average value of the previous year (7.33 ct/kWh). In December 2024, the Federal Network Agency announced that the maximum value for 2025 will be set at 7.35 ct/kWh.[9] The value thus remains unchanged for the third year in a row.

Table 7: Development of awarded values for onshore wind energy; data: BNetzA

Year	Permissible maximum value [ct/kWh]	Quantity-weighted awarded values [ct/kWh]
2019	6.20	6.14
2020	6.20	6.11
2021	6.00	5.88
2022	5.88	5.81
2023	7.35	7.33
2024	7.35	7.26

Volumes that have been tendered, awarded or bid but not awarded since 2019 are shown in Figure 10.

[7] Art. 28 para. 1 EEG provided a volume of 10,000 MW for 2024, plus unallocated volumes from 2023 (6,463 MW). A quarter of this was allocated to each of the bidding dates in May, August and November 2024. The remaining quarter was allocated to the bid date of February 1, 2025.
[8] Art. 28 para. 6 EEG provides for a volume reduction in the run-up to a bidding date if there is a "threat" of underbidding.
[9] Cf. BNetzA Festlegungsentscheidung (Az: 4.08.01.01/1#36) v. 17.12.2024.

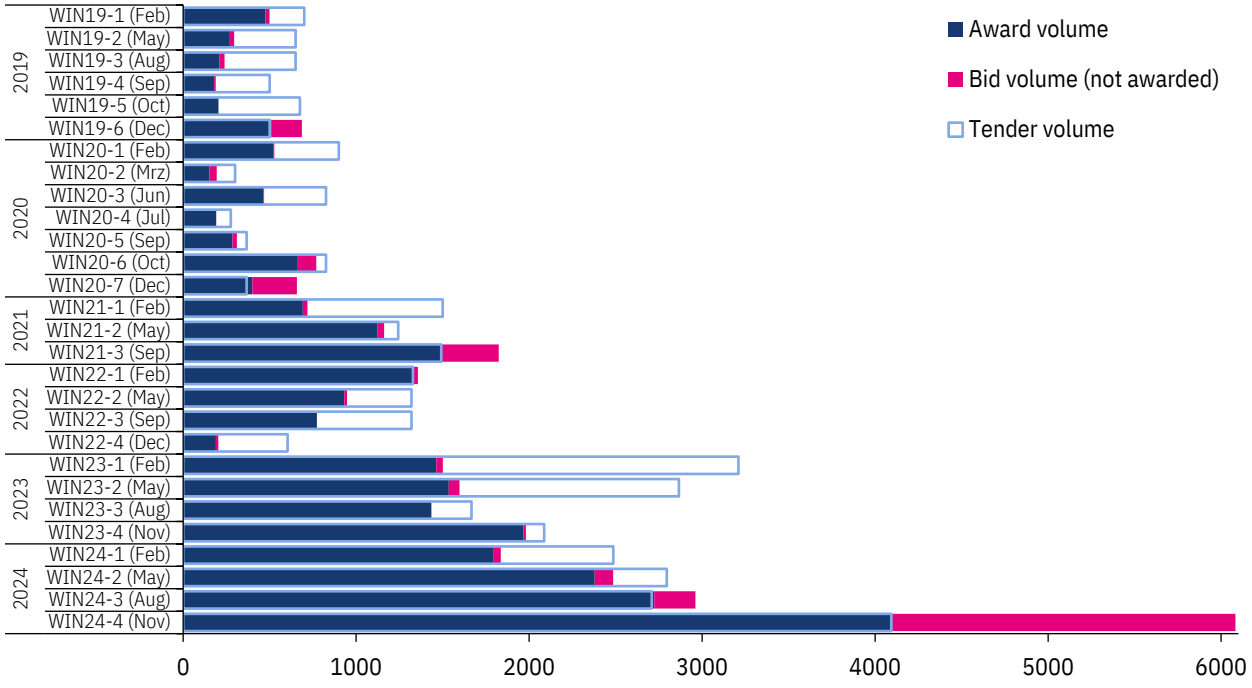

Figure 10: Tender and award volumes of the individual tender rounds since 2019
Data: BNetzA

4.1 Regional Distribution of Awarded Bids

The largest share of the award volume in 2024 went to North Rhine-Westphalia (28 %), Lower Saxony (14 %) and Brandenburg (10 %). More wind energy capacity was awarded in these three states (5,849 MW) than in all other states combined (5,147 MW). In almost all federal states, with the exception of Baden-Wuerttemberg and Schleswig-Holstein, the quantities awarded increased compared to the previous year. Above-average increases were recorded in Bavaria, Brandenburg, Hesse, Mecklenburg-Western Pomerania, North Rhine-Westphalia, Saarland, Saxony, Saxony-Anhalt and Thuringia.

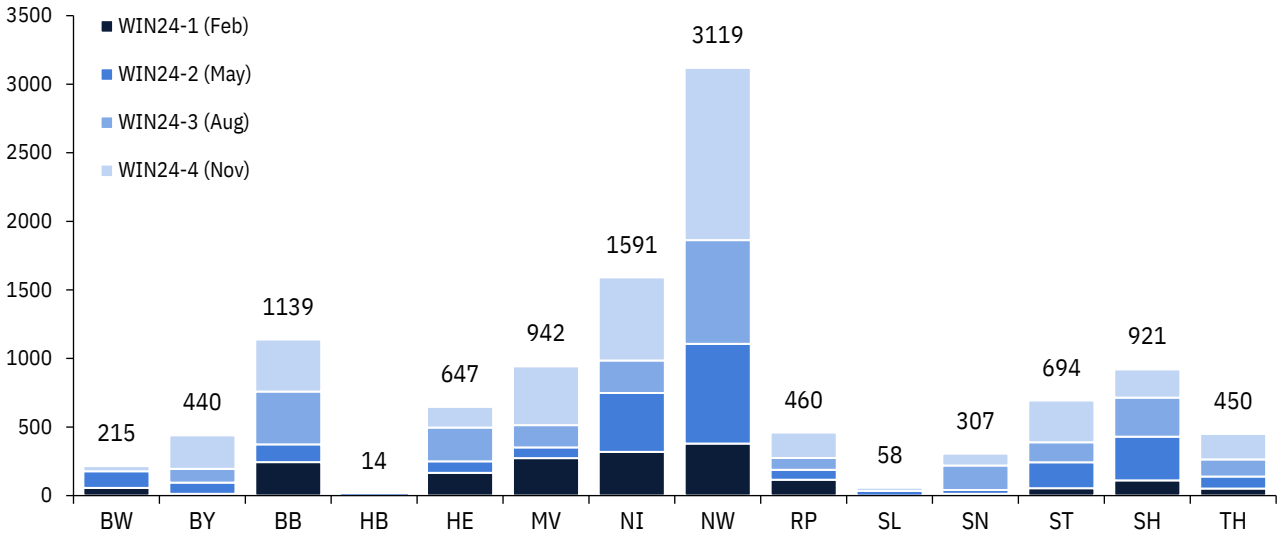

Figure 11: Distribution of awarded volumes in the 2024 tenders to federal states
Data: BNetzA; values in megawatts

The area-related award volumes are below the national average (30.7 kW/km²) in Baden-Wuerttemberg, Bavaria, Hesse, Rhineland-Palatinate, Saarland and Thuringia. North Rhine-Westphalia leads the state ranking by a clear margin in terms of absolute and area-related award volumes.

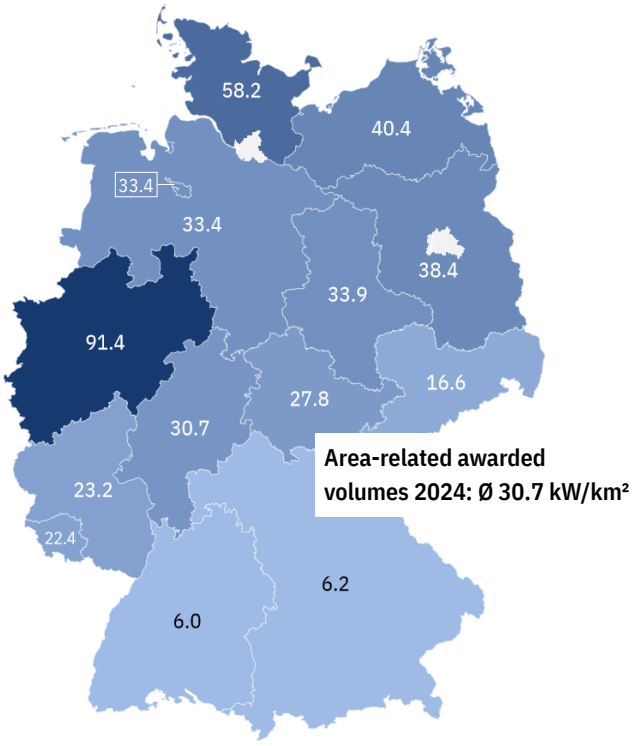

Figure 12: Area-related awarded volumes in the 2024 tenders
Data: BNetzA, Destatis; values in kilowatts per square kilometre; map: FA Wind und Solar based on © GeoNames, Microsoft, TomTom

4.2 Realization Status of the Awarded Wind Energy Capacity

Of the 33.6 GW of wind energy capacity awarded since the introduction of the tendering regime, 13.7 GW have been realized to date. The regular realization period for awards of 13 GW from the tender rounds, which were carried out until 2021 has now expired.

In 2017, a year characterized by awards for unapproved turbines, the realization rate was only 12 percent. This can be attributed to the initial uncertainty caused by the switch of the funding regime to tenders. Since then, the rate has risen significantly. 81 percent of the volumes awarded in 2018 were realized. The realization rate of the volumes awarded in 2019 and 2020 each reached more than 90 percent. Almost 90 percent of the 2021 awards were realized. The deadlines for the realization of the 2022 awards are still ongoing - here the rate at the end of the year 2024 was 80 percent. Almost a quarter (23 %) of the volumes awarded in 2023 have been realized to date. The first wind turbines from last year's tender rounds have already been put into operation.

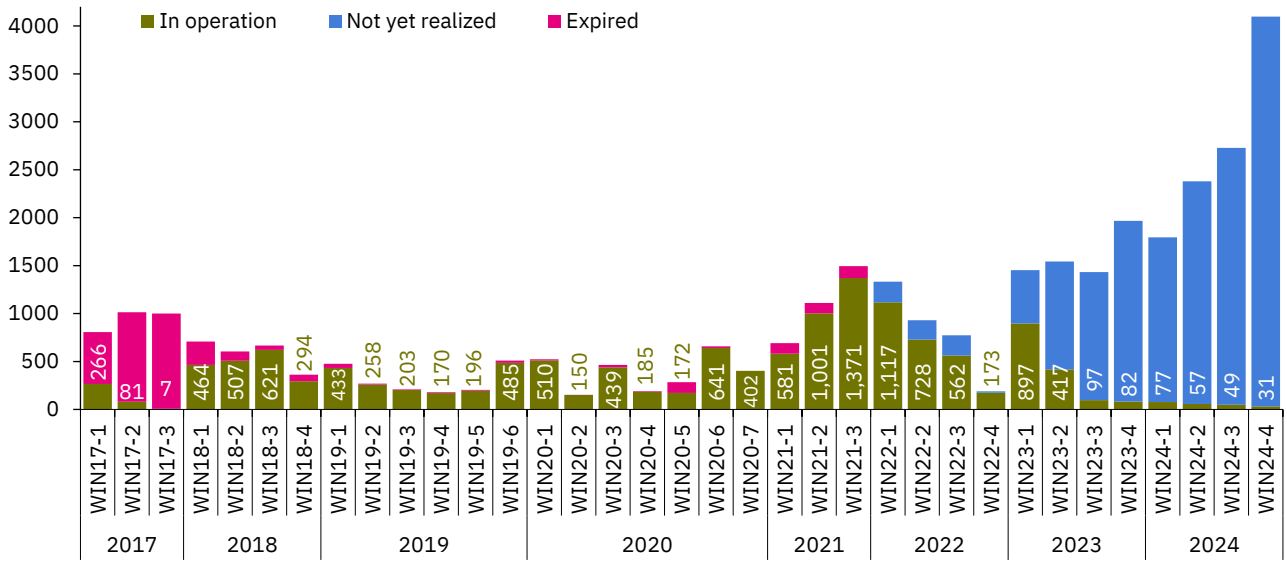

Figure 13: Wind energy capacity awarded and realized in the individual tender rounds
Data: BNetzA, MaStR, own research; values in megawatts

Of the volumes awarded since 2018,[10] a good 43 percent had been realized by the end of 2024. At least two gigawatts each were connected to the grid in Brandenburg, Lower Saxony, North Rhine-Westphalia and Schleswig-Holstein. More than 500 MW of awarded capacity has now been taken into operation in Hesse, Mecklenburg-Western Pomerania, Rhineland-Palatinate and Saxony-Anhalt.

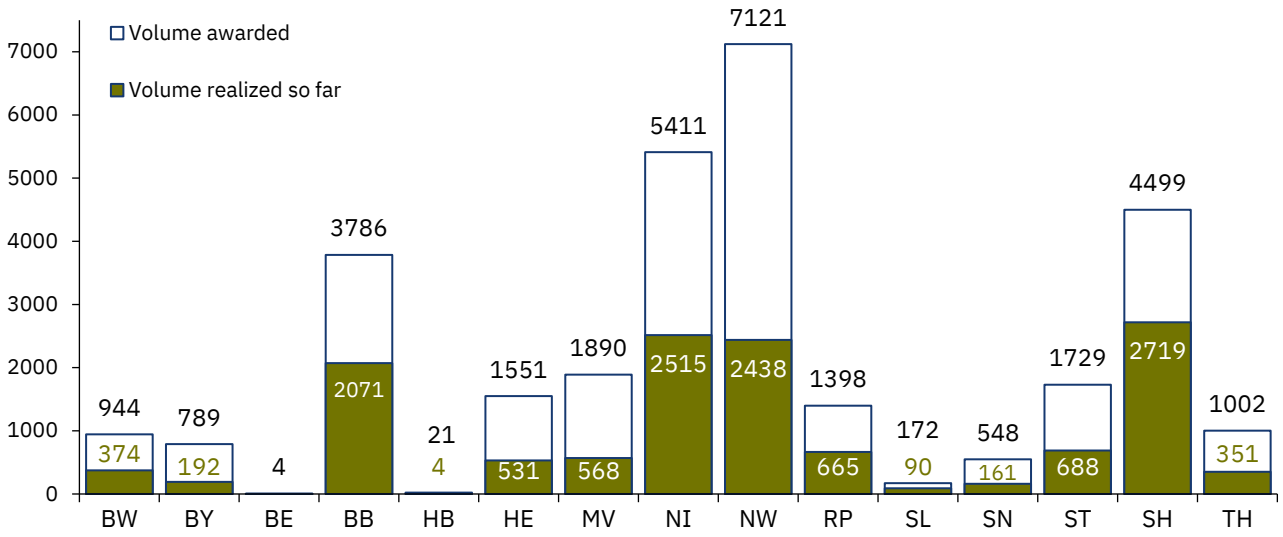

Figure 14: Wind energy capacity awarded and realized in the federal states – without tender year 2017
Data: BNetzA, MaStR; values in megawatts

5 Permits for New Wind Turbines

In 2024, new permits[11] were issued for 2,405 wind turbines with a total capacity of 14,056 MW. This is by far the highest volume of permits to date in the history of wind energy expansion in Germany.

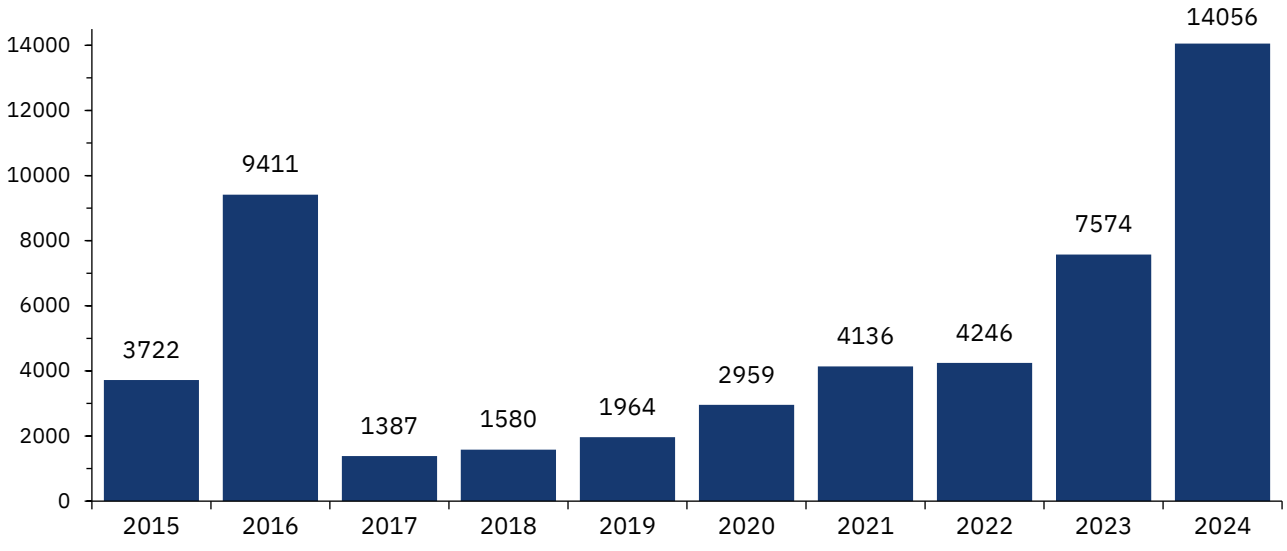

Figure 15: Annual newly approved wind energy capacity in Germany
Data: MaStR, own research; values in megawatts

At the beginning of 2025, the market data registry recorded around 4,400 wind turbines with a total capacity of 24.9 GW that had been permitted but not yet put into operation. Of these, around 2,870 wind turbines (16.2 GW) had a valid award from the tender. A good half of the turbines currently recorded in the register were approved in 2024.

[10] Of the tender volumes in 2017, which was characterized by unapproved projects, only 13% were realized. Due to this low rate, this tender year is not included here.
[11] Only wind turbines for which a permit was issued for the first time in 2024 are included. Changes to existing approvals that were granted in 2024 are not included in the 2024 statistics, as their (initial) approval was already recorded at an earlier date.

5.1 Regional Distribution of Permitted Wind Energy Capacity

In the state ranking, North Rhine-Westphalia leads by a clear margin with 4,044 MW of newly approved capacity in 2024 (677 wind turbines), followed by Lower Saxony with 2,061 MW and Brandenburg with 1,502 MW of newly approved capacity. No permits were registered for Berlin and Bremen last year. Only one turbine received a permit in Hamburg.

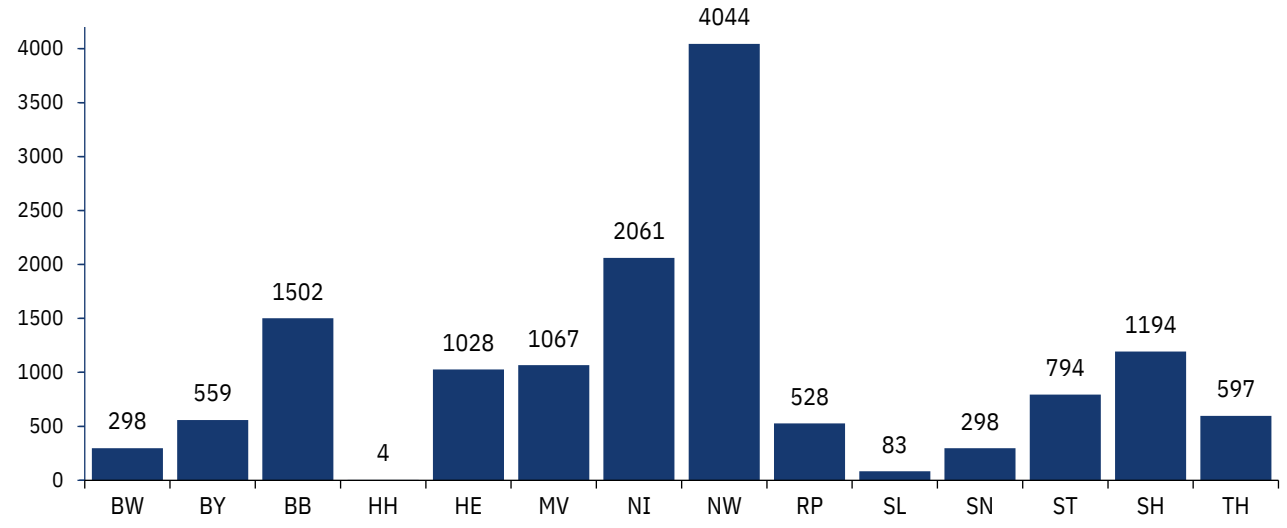

Figure 16: Newly permitted wind energy capacity in 2024 at the federal states
Data: MaStR, own research; values in megawatts

Ten percent of the wind energy capacity approved in 2024 is attributable to the southern region (“Südregion”). 232 turbines with a capacity of 1,388 MW received permits there. Districts in the Bavarian (504 MW) and Rhineland-Palatinate (420 MW) parts of this region account for the largest shares.

5.2 Permit Period

Despite the unprecedented number of new approvals, the average time required for obtaining a permit decreased in the majority of federal states in 2024. On a national average, the approval procedures took 23 months (median 17 months) and were thus completed ten percent faster than in the previous year (average 26 months). Figure 17 shows the average duration of the procedure in relation to the years in which the permit notices (initial decision) were issued. This clearly shows that the duration of the procedure has increased almost without exception and with a growing scope since 2017. A trend reversal occurred in the past year.

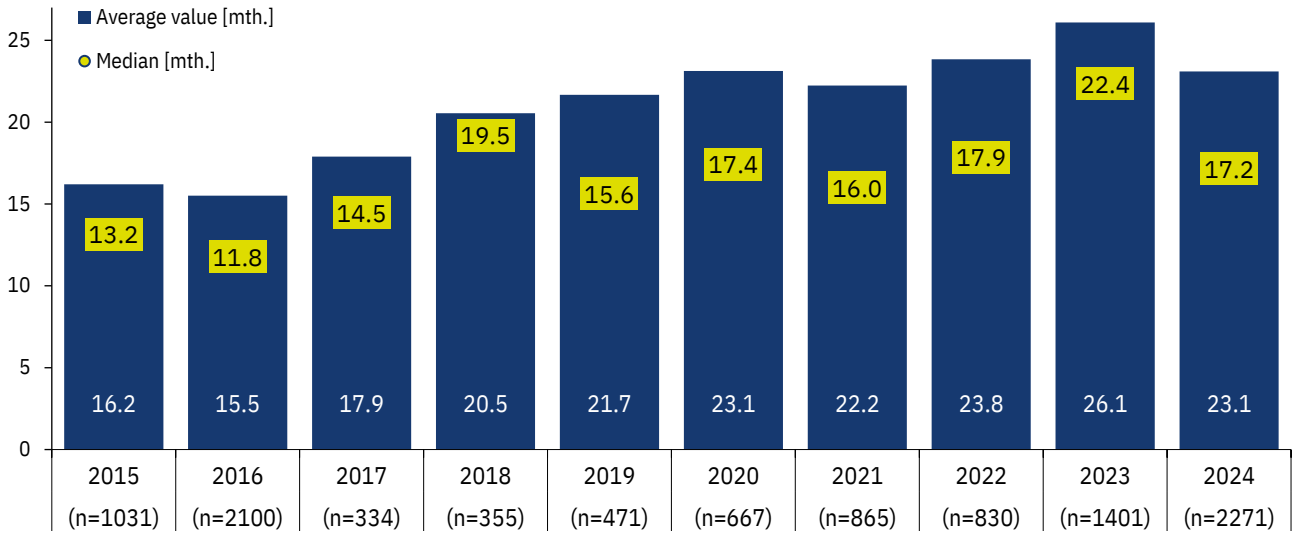

Figure 17: Duration of permit procedures in a year-on-year comparison
Data: MaStR, UVP-Portal, own research; values in months

There are significant differences in the duration of the procedure in the federal states in 2024, ranging from ten months (Bavaria) to 53 months (Mecklenburg-Western Pomerania). Long durations, such as in Mecklenburg-Western Pomerania, are also due to the fact that the numerous legislative changes introduced by the incumbent government are now leading to the completion of approval procedures that had previously been running for years without results.

The change in procedure times compared to the approval year 2023 also varies greatly from state to state: While the approval duration almost halved in Baden-Wuerttemberg, the average duration of the procedure increased by 50 percent in Mecklenburg-Western Pomerania. North Rhine-Westphalia is noteworthy in this context, as the average duration of permit procedures there fell by a third despite the unusually high number of permits in 2024.

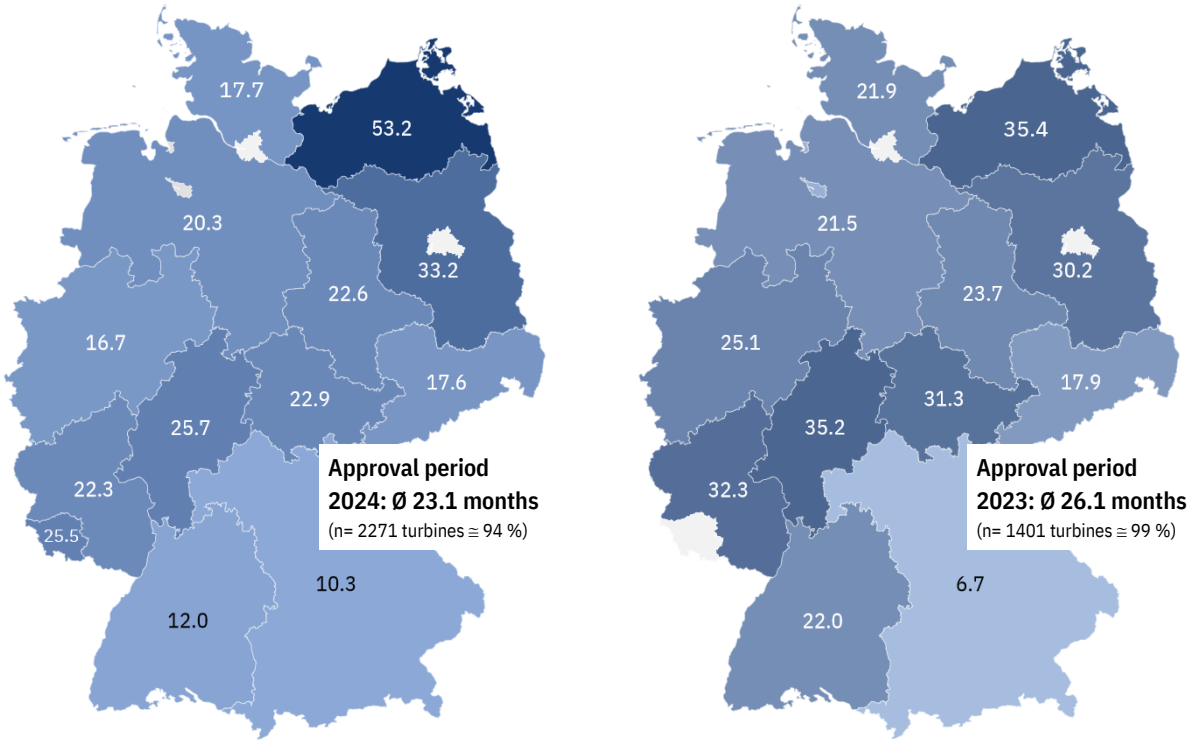

Figure 18: Duration of the approval procedures completed in the federal states in 2024 and 2023
Data: MaStR, UVP-Portal, own research; values in months; maps: FA Wind und Solar based on © GeoNames, Microsoft, TomTom

5.3 Turbine Configuration

In the past decade, the generator capacity of newly approved turbines has recorded continuous annual growth rates of between six and ten percent. In the meantime, the average generator capacity of approved turbines has reached 5.8 MW.

Over three quarters of the wind turbines approved last year have a generator capacity of more than 5.5 MW. A good quarter of the turbines were even approved with a capacity of more than 6.5 MW. There is no end in sight to this trend, as all major turbine manufacturers already have model series in the 7 MW class in their product ranges.

Table 8: Power classes of the wind turbines permitted in 2024; data: MaStR

Power classes	Wind turbines	Capacity [MW]	Share of turbines
P ≤ 3,500 kW	52	154.0	2.2%
3,500 < P ≤ 4,500 kW	321	1,350.4	13.3%
4,500 < P ≤ 5,500 kW	171	896.4	7.1%
5,500 < P ≤ 6,500 kW	1.214	7,102.5	50.5%
P > 6,500 kW	647	4,552.8	26.9%

A new milestone has also been set for hub heights, as 64 wind turbines with a hub height of 199 metres have been permitted in 2024. If implemented, these turbines will reach a new height record with a total height of 285 metres.

6 Expected Development and Political Target

The Renewable Energies Act (EEG 2023) outlines a capacity-related expansion path[12] for individual energy sources, including onshore wind. According to this, “69 gigawatts by 2024” should be installed in the onshore wind energy sector. The political target was clearly missed with 63.5 GW achieved by the end of the year. For 2026, the EEG envisages an installed wind energy capacity of 86 gigawatts. To achieve this, 22.5 GW net would have to be installed in the next two years. Even though there is currently around 25 GW of approved capacity, reaching the 2026 target is likely to be very ambitious from today's perspective.

Based on experience,[13] this year's installations will mainly be fed by the volumes awarded in 2023 as well as unrealized residual volumes from the 2022 tender year. If the current implementation rate continues and the failure rates remain as low as in previous years, gross additions are expected to reach a capacity of 4.8 to 5.3 gigawatts by the end of 2025.

The extraordinarily high award volumes in the past year suggest that the expansion will reach the necessary expansion path in 2026.

7 Monthly Power Generation and Market Values

The German onshore windfarms generated 111.9 terawatt hours [TWh] of electricity in 2024. Compared to the previous year, feed-in fell by 5.8 percent, which was also due to the fact that 2023 was an exceptionally good wind year,[14] while both 2024 and 2022 were below average.[15]

With a share of 25.9 percent, onshore wind energy was the most important source of energy for electricity generation in Germany in 2024 - as in the previous year.[16] The share of renewable energies in national electricity generation rose to 59 percent last year.

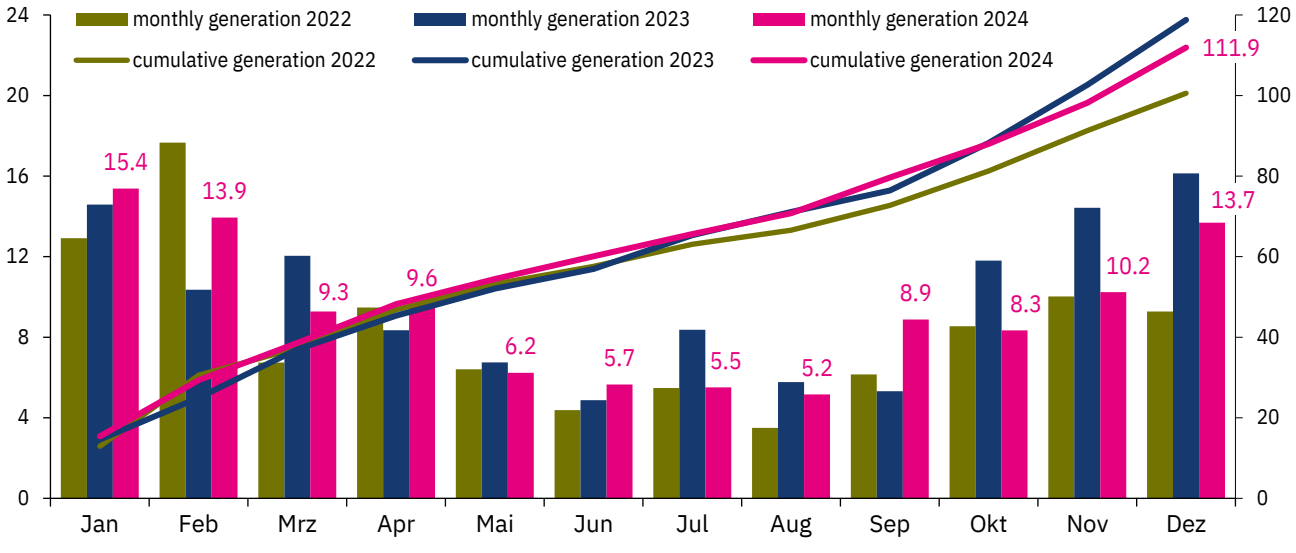

Figure 19: Electricity generation from onshore wind turbines in Germany
Data: BNetzA | SMARD.de; values in terawatt hours

The monthly market values[17] for electricity from onshore wind energy continued to fall in 2024. After record values in 2022 - in which the annual market value for onshore wind power reached 19.32 ct/kWh - the market values fell continuously from the beginning of 2023. At 7.62 ct/kWh, the annual market value has more than halved in 2023 compared to 2022. The price decline continued in 2024. Here, the annual market value for onshore wind is 6.29 ct/kWh - the lowest it has been in four years.

[12] Cf. Art. 4 No. 1 EEG.
[13] For the 3,000 wind turbines that have been realized to date with an award, it took an average of 20 months from the announcement of the award to the commissioning of the turbine.
[14] According to anemos Wind- und Ertragsindex Report 2023 was “the windiest year in Germany for over 20 years”. The wind index for Germany in 2023 was “significantly above the level of previous years”.
[15] Cf. Erneuerbare Energien, Windkraft verfehlt Rekordernte knapp, erzeugte aber konstanter Strom, online article v. 2.1.2025.
[16] Cf. SMARD.de, Der Strommarkt im Jahr 2024, online article v. 2.1.2025.
[17] Netztransparenz.de, Monthly market values in accordance with Annex 1 (to Section 23a EEG) No. 5.2.

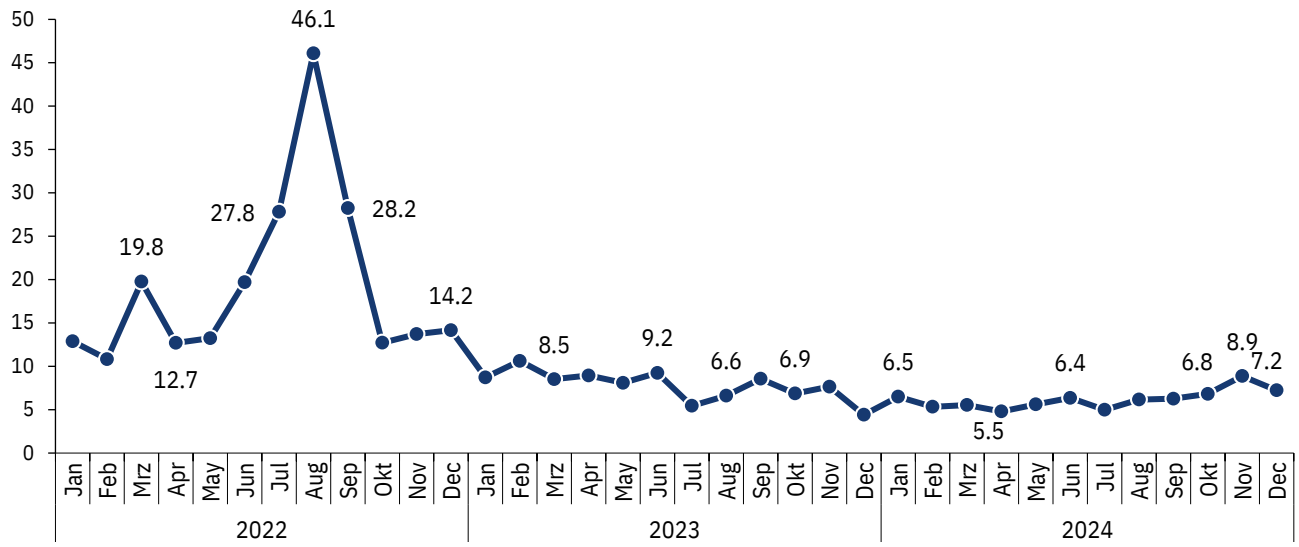

Figure 20: Monthly market values for electricity from onshore wind turbines
Data: German transmission system operators | Netztransparenz.de; values in Euro cent per kilowatt hour [ct/kWh]

About Bundesverband WindEnergie e.V. [German Wind Energy Association (BWE)]
BWE, a member of Bundesverband Erneuerbare Energie [German Renewable Energy Federation (BEE)] with approximately 17,000 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 the association for power plant construction. It represents the interests of manufacturers and suppliers of power and heat generation systems in Germany and abroad. These include wind energy, photovoltaic and hydropower plants, engines and thermal power plants as well as storage and sector coupling technologies. VDMA Power Systems serves as a cross-technology information and communication platform for them, focussing on energy and industrial policy, innovations and technology, markets and trade fairs as well as press and public relations work. VDMA Power Systems is a trade association within the German Engineering Federation VDMA e.V.

About Fachagentur Wind und Solar
Fachagentur Wind und Solar is a non-profit association. Its members are the federal government, the federal states, municipal umbrella organisations, business and nature conservation associations and companies. The organisation supports the environmentally friendly use of onshore wind energy and solar energy in Germany. Among other things, it produces analyses, information collections and expert reports. Its work is based on the climate and energy policy goals of the European Union. The association works on the basis of facts, case law and science.

FACHAGENTUR
WIND UND SOLAR

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