

Status of Offshore Wind Energy Development in Germany

Year 2021



On behalf of



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Notes

The data was obtained through surveys with industry representatives as well as through additional research (sources e.g. BNetzA and BSH). Retroactive adjustments to the data are done based on corrected notifications if required.

The installed capacity of offshore wind energy projects is not always equal to the grid connection capacity. Future offshore wind energy projects are assigned with their total capacity to the respective expected year of commissioning.

The information provided within the text and figures partially includes rounded values. Thus, when added, there is a possibility of deviations from the overall values.

Photo on Title Page

Inspections at OWP Global Tech I

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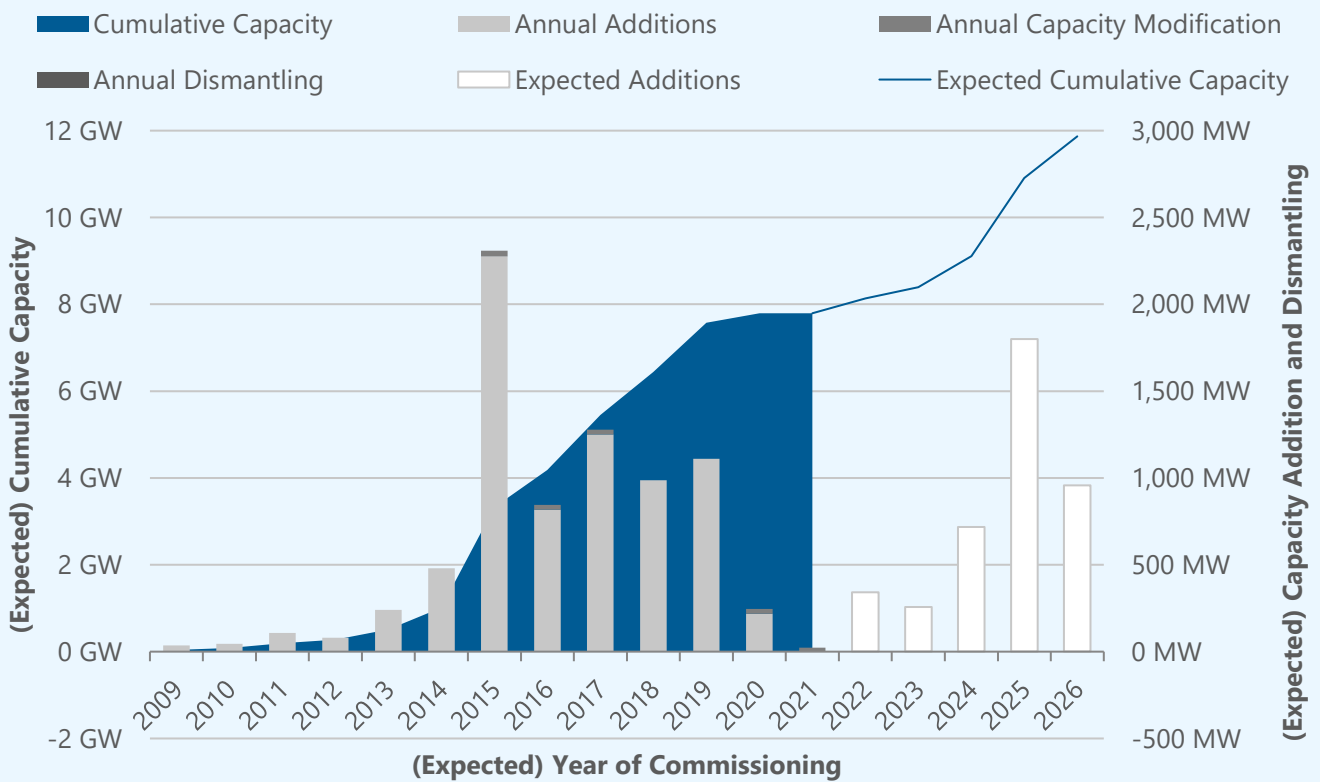
Offshore Wind Energy Development

As of December 31, 2021, 1,501 offshore wind turbines (OWT) with a capacity of 7.8 GW were in operation in Germany. In the course of 2021, neither new turbines nor foundations were installed, but 132 existing turbines received a capacity upgrade. This increases the total installed capacity by 24 MW at the end of 2021.

From 2022 onwards, the offshore wind projects (OWP) that were awarded in the tender rounds in the transitional system in 2017 and 2018 will be installed and commissioned by 2025. In the 2021 tender round, additional capacity was awarded to be commissioned in 2026. If all awarded projects are fully realised, the installed capacity will be increased to almost 12 GW by the end of 2026.

Status of the Offshore Wind Energy Development

		Capacity	Number
Modification Year 2021	Capacity Modifications of existing OWT	24 MW	132 OWT
	OWT (feeding in)	7,794 MW	1,501 OWT
Cumulative 2021-12-31	Installed OWT (no feed-in)	0 MW	0 OWT
	Foundations w/o OWT		No Foundations



(Expected) Development of the Offshore Wind Energy in Germany
(Database: own surveys, MaStR, BNetzA)

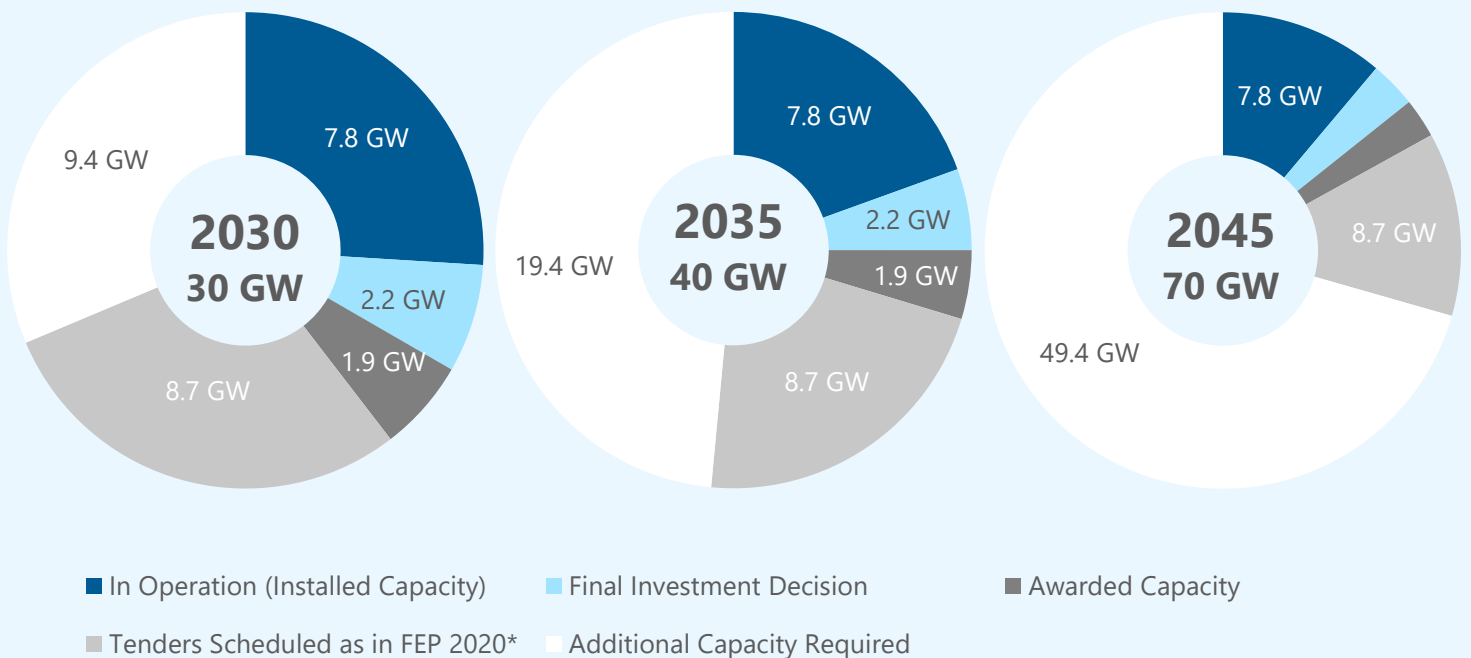
Expansion Targets Offshore Wind Energy

The coalition agreement signed by the new German government in December 2021 sets ambitious targets for offshore wind energy. They significantly exceed the expansion path defined in the Offshore Wind Energy Act (German: Windenergie-auf-See-Gesetz) and last adjusted at the end of 2020. The new expansion target scheduled for 2030 rises from 20 GW to 30 GW, 40 GW of offshore wind energy is now envisaged by 2035, and a further increase in offshore wind energy capacity to 70 GW is planned by 2045.

The offshore wind energy capacity in operation at the end of 2021 is 7.8 GW. In addition, an investment decision has already been made for 2.2 GW and a grid connection commitment has been awarded for a further 1.9 GW by tender. In the Site Development Plan 2020 (German: Flächenentwicklungsplan or FEP) of the Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie

or BSH) further tenders have already been scheduled for a capacity of 8.7 GW, which should be installed by 2030. With the planning presented in the FEP 2020, the new targets of the coalition agreement cannot yet be achieved; an additional 9.4 GW are required by 2030.

The preliminary draft for updating the FEP 2020 published at the end of 2021 already presents adjustments to be discussed for this purpose and takes into account the expansion targets of the coalition agreement. The pre-draft is based on the priority and reservation areas for offshore wind energy shown in the Maritime Spatial Plan (German: Raumordnungsplan) for the German exclusive economic zone (EEZ), which came into force in 2021. While sufficient areas are available to achieve the targets for 2030 and 2035 under the assumptions of the preliminary draft, additional areas would have to be developed in order to realise 70 GW by 2045.



* revision already initiated in the preliminary draft of the FEP update

Development Status of Offshore Capacity with Expansion Targets by 2030, 2035 and 2045 (Database: own surveys, MaStR, BNetzA, FEP 2020)

Activities in Offshore Wind Energy Projects

In Germany, 27 offshore wind energy projects are in operation by the end of 2021. These projects had received grid connection commitments before the change to the tender system and were installed by 2020. Activities in 2021 were limited to capacity upgrades in two existing projects. Future development will be dominated by tendering projects. For the Kaskasi and Arcadis Ost 1 projects, which were awarded in the transitional system, a final investment decision has been made and construction is expected to start in 2022. Investment decisions have also already been made for Baltic Eagle, Gode Wind 3 and Borkum Riffgrund 3. The OWP Nordsee Two, Windanker and the project on site N-3.7, which were awarded in the first central tender round in 2021, are still in the early stages of project development. Furthermore, in the coastal waters of the Baltic Sea, two projects OWP Gennaker (900 MW) and the test

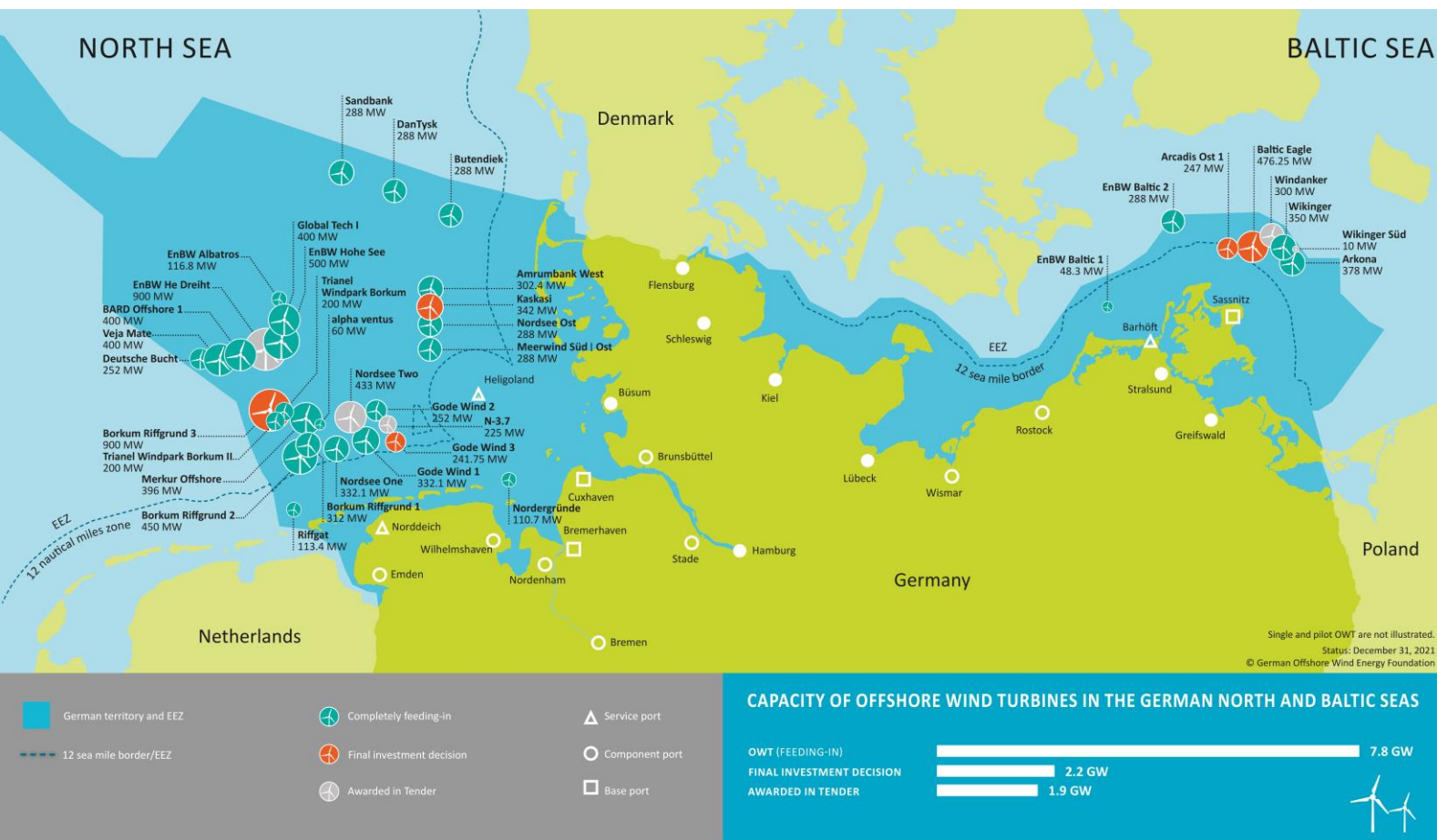
field near Warnemünde are planned. These projects are not subject to the tender system.

Overview of awarded projects

OWP	Status	Expected Commissioning	Capacity [MW]**
Kaskasi*	FID	2022	342
Arcadis Ost 1	FID	2023	247
Wikinger Süd	Awarded	2023	10
Baltic Eagle	FID	2024	476.25
Gode Wind 3	FID	2024	241.75
Borkum Riffgrund 3	FID	2025	900
EnBW He Dreih	Awarded	2025	900
N-3.7	Awarded	2026	225
Nordsee Two	Awarded	2026	433
Windanker	Awarded	2026	300

* incl. pilot OWT

** grid connection capacity



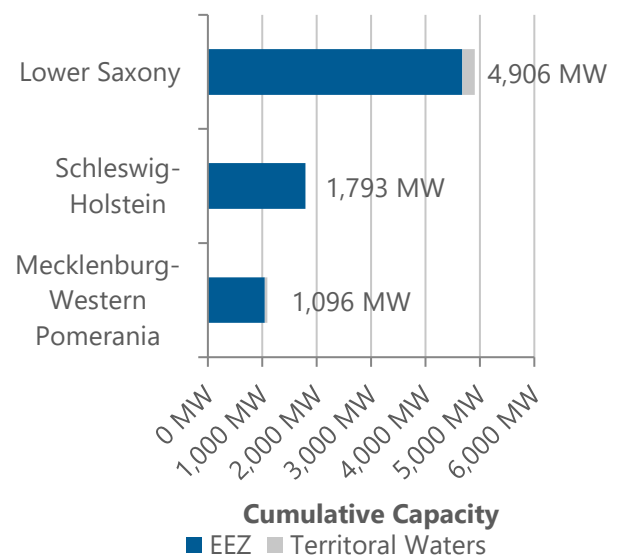
Overview Map of Offshore Wind Energy in Germany (© German Offshore Wind Energy Foundation)

Distribution across Federal States and North and Baltic Seas

Based on the location of the respective grid connection point in Lower Saxony, Schleswig-Holstein and Mecklenburg-Western Pomerania, the installed capacity at sea can be allocated to the federal states. Most of the 6.7 GW of installed offshore wind capacity in the North Sea (4.9 GW) is connected to Lower Saxony, while the remaining 1.8 GW can be allocated to Schleswig-Holstein. The 1.1 GW of installed capacity in the Baltic Sea is entirely allocated to Mecklenburg-Western Pomerania.

Around 3 GW of the capacity awarded in the 2017/2018 and 2021 tender rounds is allocated to the North Sea and 1 GW to the Baltic Sea. The capacities to be tendered from 2022 according to the Site Development Plan 2020, with a total of 8.7 GW, are located entirely in the North Sea. In the Baltic Sea, no further tenders are planned until

2025 according to the Site Development Plan 2020.



Distribution of Cumulative Capacity of OWT (feeding in) across the Federal States and Maritime Areas

Distribution across the North and Baltic Seas

		North Sea		Baltic Sea	
		Capacity	Number	Capacity	Number
Additions Year 2021	OWT (feeding in)	0 MW	0 OWT	0 MW	0 OWT
	Capacity Modifications of existing OWT	0 MW	0 OWT	24 MW	132 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT	0 MW	0 OWT
	Foundations w/o OWT	No Foundations		No Foundations	
Cumulative 2021-12-31	OWT (feeding in)	6,698 MW	1,269 OWT	1,096 MW	232 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT	0 MW	0 OWT
	Foundations w/o OWT	No Foundations		No Foundations	
Future Additions	Already awarded capacity* (Commissioning by 2026)	3,042 MW		1,033 MW	
	Capacity to be tendered until 2025 (Commissioning by 2030)**	8,730 MW		0 MW	

* incl. pilot OWT

** according to FEP 2020, revision already initiated in the preliminary draft of the FEP update

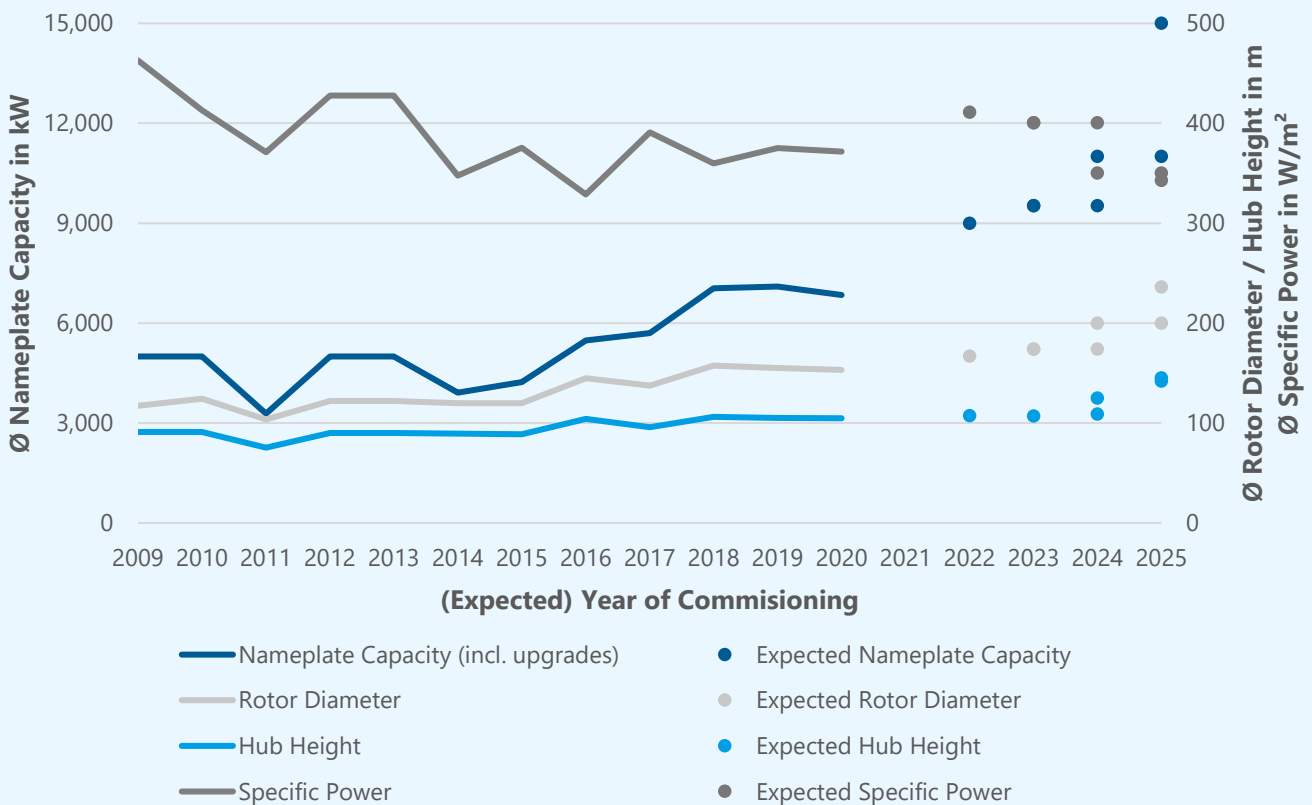
Turbine Configuration

On average, the offshore wind turbines installed in Germany at the end of 2021 have a ~~nameplate capacity~~ nameplate capacity of just under 5.2 MW. In recent years, increasingly larger turbines have been installed. The trend towards ever higher nominal capacities is particularly evident when considering the future projects. In the projects of the coming development phase (with commissioning until 2025), turbines with a nominal capacity up to 15 MW are planned. Compared to the existing turbines, the turbine capacity will thus increase by 115% to more than 11 MW on average. According to current plans, the rotor diameter and hub height will also be increased to 167 m to 236 m rotor diameter and approx. 100 m to 145 m hub height, depending on the specific project.

Due to the expected capacity increases, however, the specific power remains at a level comparable to previous years and is between 340 W/m² and 410 W/m² in the planned projects until 2025.

Average Turbine Configuration

Average Configuration	Cumulative 2021-12-31	Expected additions until 2025
Nameplate Capacity (incl. upgrades)	5,192 kW	11,177 kW
Rotor Diameter	133 m	196 m
Hub Height	95 m	127 m
Specific Power	372 W/m ²	370 W/m ²



(Expected) Turbine Configuration over Course of Time

Water Depth and Distance to Shore

The offshore wind turbines installed in Germany are subject to different conditions in terms of water depth and distance to the shore. Only a few turbines are in shallow waters close to the coast; the majority are located at least 40 km from the shore in water depths of 20 m and more. The turbines furthest from the coast are located at a distance of more than 120 km off the coast and in water depths of up to 44 m. On average, the offshore wind turbines installed by the end of 2021 have a water depth of 30 m and a distance to shore of 74 km.

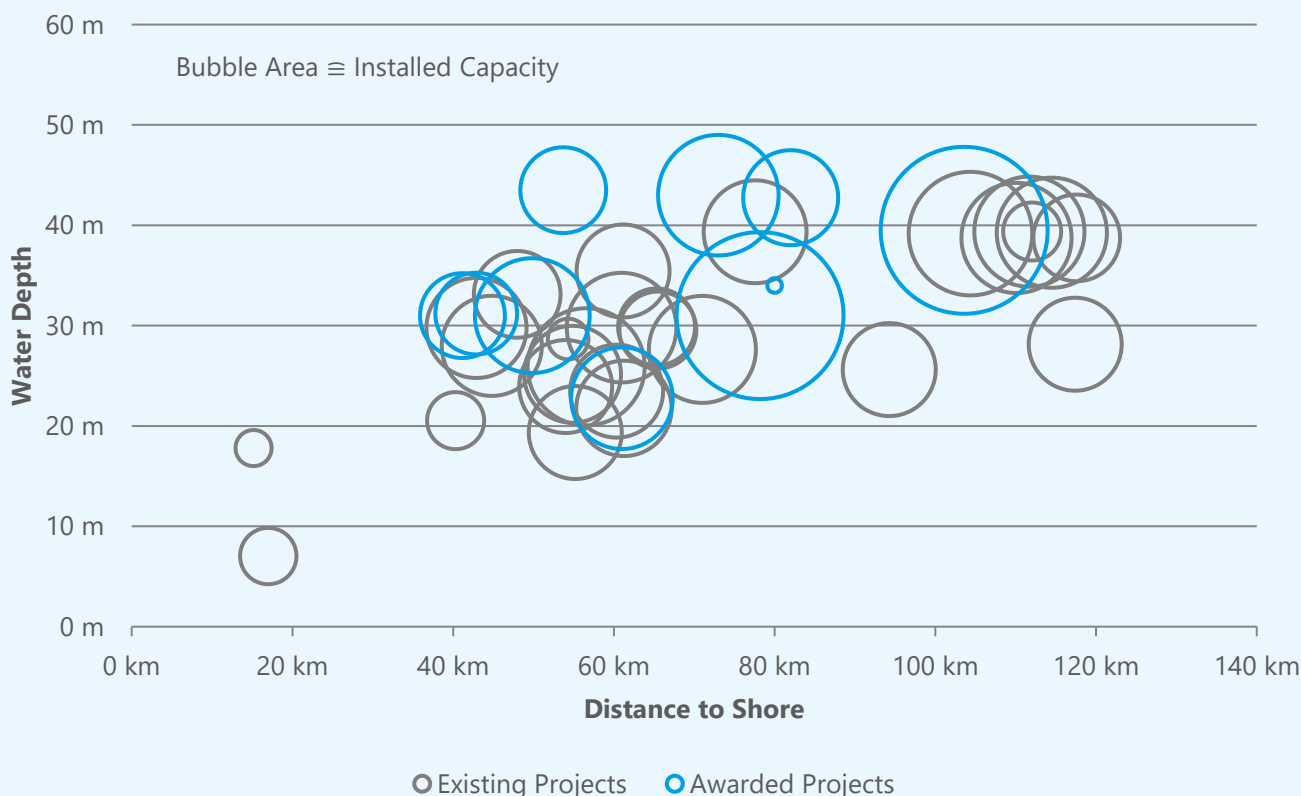
The turbines to be installed in the coming years up to 2025 are also distributed over different water depths and distances from the coast. On average, however, their water depth and distance to the

shore do not differ much from those of the existing turbines.

With regard to the type of foundation, the monopile foundation has become the most commonly used type in Germany. Monopile foundations are going to be used for all offshore wind turbines to be installed by 2025.

Average water depth and distance to shore of OWT

Average Location	Cumulative 2021-12-31	Expected additions until 2025
Water Depth	30 m	35 m
Distance to Shore	74 km	76 km



Water Depth and Distance to Shore of Existing Projects and Awarded Projects

Offshore Tenders in Central Model

The first tender round for offshore wind energy in the central model took place on September 1, 2021. Bids could be submitted for the areas N-3.7, N-3.8 and O-1.3 with a total capacity of 958 MW. The BSH had previously investigated these areas and determined their suitability.

Bids of 0 ct/kWh were awarded for all three areas. For two areas (N-3.8 and O-1.3), several zero-cent bids were submitted, so the lottery procedure provided for by law was applied.

In the case of the awards for the areas N-3.8 and O-1.3, the project developers who had originally planned projects there had rights of entry. In both cases, the holders used their right of entry to take over the award. Accordingly, the award for site N-3.8 was given to Northland Power and RWE Renewables, who are jointly realising the OWP Nordsee Two there, and Iberdrola is developing

the OWP Windanker on site O-1.3. The project on site N-3.7 is being implemented by RWE Renewables. The commissioning of these three projects is planned for 2026.

The suitability assessment is currently progressing on sites N-7.2, N-3.5 and N-3.6 for the tenders in 2022 and 2023 as defined in the FEP 2020. This is still to be done for other areas. At present, the plans for the provision of areas for offshore wind energy are being revised as part of the update of the Site Development Plan.

In addition to the tenders in the central model, an award procedure for the areas for other offshore energy production is to be carried out for the first time in 2022. The corresponding award criteria (including energy quantity, energy efficiency, technology maturity) were defined in a regulation in 2021.

Envisioned Offshore Sites for Tender from 2021 onwards (Database: FEP 2020)

Area	Tender Round	Expected Commissioning	Expected Capacity	Status	Size of Area	Company
N-3.7	2021	2026	225 MW	Awarded	ca. 17 km ²	RWE Renewables
Nordsee Two (N-3.8)	2021	2026	433 MW	Awarded	ca. 23 km ²	Northland Power (85%) and RWE Renewables (15%)
Windanker (O-1.3)	2021	2026	300 MW	Awarded	ca. 25 km ²	Iberdrola
N-7.2	2022	2027	930 MW	Planned	ca. 58 km ²	
N-3.5	2023	2028	420 MW	Planned	ca. 29 km ²	
N-3.6	2023	2028	480 MW	Planned	ca. 33 km ²	
N-6.6	2024	2029	630 MW	Planned	ca. 44 km ²	
N-6.7	2024	2029	270 MW	Planned	ca. 16 km ²	
N-9.1*	2024	2029	1,000 MW	Planned	ca. 100 km ²	
N-9.2*	2024	2029	1,000 MW	Planned	ca. 104 km ²	
N-10.1*	2025	2030	1,000 MW	Planned	ca. 95 km ²	
N-10.2*	2025	2030	1,000 MW	Planned	ca. 93 km ²	
N-9.3*	2025	2030	1,000 MW	Planned	ca. 105 km ²	
N-9.4*	2025	2030	1,000 MW	Planned	ca. 99 km ²	
N-11.1/N-11.2*	after 2025	after 2030	2,000 MW	Presented for information purposes		
N-12.1/N-12.2*	after 2025	after 2030	2,000 MW	Presented for information purposes		
N-12.3/N-12.4*	after 2025	after 2030	2,000 MW	Presented for information purposes		
N-13.1/N-13.2*	after 2025	after 2030	2,000 MW	Presented for information purposes		
ggf. N-11.3/ N-12.5/N-13.3*	after 2025	after 2030	ggf. 2,000 MW	Presented for information purposes		
SEN-1				Planned	ca. 28 km ²	
SEO-1				Planned	ca. 8 km ²	

* according to FEP 2020, revision already initiated in the preliminary draft of the FEP update

Overview of Grid Connection Capacities

At the end of 2021, grid connections for offshore wind energy with a capacity of 8.2 GW are in operation in Germany. The majority of the connection capacity is already being used by the OWP feeding into the grid. Further capacities are under construction or in planning stage, or have

been identified by the responsible transmission system operators; confirmation by the Federal Network Agency is still pending. However, in order to achieve the goals of the coalition agreement, further capacities and an adjustment of the previously planned timeline are necessary.

Installed and Planned Grid Connections (to Converter Station or Bundling Point) in the North and Baltic Seas (Database: FEP 2020, 2nd draft of NEP 2035 version 2021, TSOs, additional research)

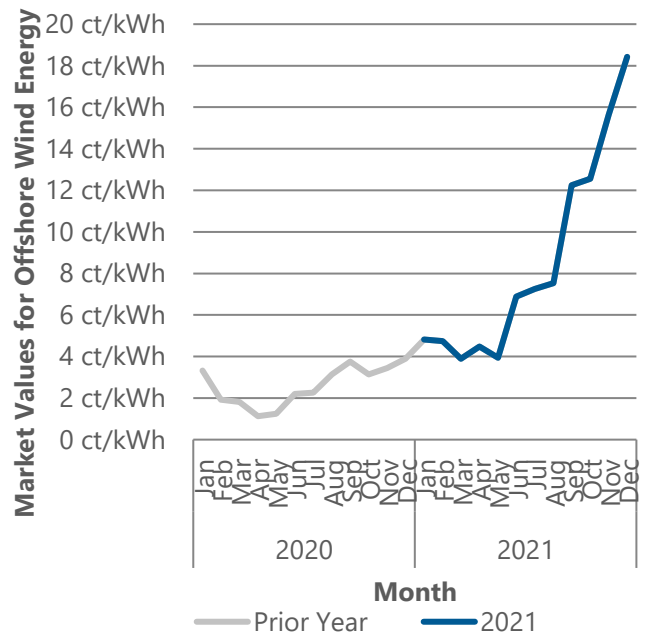
Grid Connection System	Status	(Expect.) Commissioning	(Expect.) Capacity	(Preliminary) Assigned Offshore Wind Energy Projects and Areas
North Sea				
NOR-2-1 (Alpha Ventus)	In Operation	2009	62 MW	alpha ventus
NOR-6-1 (BorWin1)	In Operation	2010	400 MW	BARD Offshore 1
NOR-0-1 (Riffgat)	In Operation	2014	113 MW	Riffgat
NOR-2-2 (DoWin1)	In Operation	2015	800 MW	Borkum Riffgrund 1, Trianel Windpark Borkum, Trianel Windpark Borkum II
NOR-4-1 (HelWin1)	In Operation	2015	576 MW	Meerwind Süd Ost, Nordsee Ost
NOR-4-2 (HelWin2)	In Operation	2015	690 MW	Amrumbank West, Kaskasi incl. Pilot OWT
NOR-5-1 (SylWin1)	In Operation	2015	864 MW	Butendiek, DanTysk, Sandbank
NOR-6-2 (BorWin2)	In Operation	2015	800 MW	Deutsche Bucht, EnBW Albatros, Veja Mate
NOR-3-1 (DoWin2)	In Operation	2016	916 MW	Gode Wind 1, Gode Wind 2, Nordsee One
NOR-0-2 (Nordergründe)	In Operation	2017	111 MW	Nordergründe
NOR-2-3 (DoWin3)	In Operation	2018	900 MW	Borkum Riffgrund 2, Merkur Offshore
NOR-8-1 (BorWin3)	In Operation	2019	900 MW	EnBW Hohe See, Global Tech I
NOR-3-3 (DoWin6)	Under Construction	2023	900 MW	Gode Wind 3, N-3.7, Nordsee Two
NOR-1-1 (DoWin5)	Under Construction	2024	900 MW	Borkum Riffgrund 3
NOR-7-1 (BorWin5)	Under Construction	2025	900 MW	EnBW He Dreiht
NOR-7-2 (BorWin6)	Procurement Procedure	2027	930 MW	N-7.2
NOR-3-2 (DoWin4)	Permitting Procedure	2028	900 MW	N-3.5, N-3.6
NOR-6-3 (BorWin4)	Permitting Procedure	2029	900 MW	N-6.6, N-6.7
NOR-9-1 (BalWin1)	Preparation of planning and permitting procedures	2029	2,000 MW	N-9.1, N-9.2*
NOR-10-1 (BalWin2)	Preparation of planning and permitting procedures	2030	2,000 MW	N-10.1, N-10.2*
NOR-9-2 (BalWin3)	Preparation of planning and permitting procedures	2030	2,000 MW	N-9.3, N-9.4
NOR-11-2 (LanWin4)	Conditionally confirmed	2031	2,000 MW	ggf. N-11.3, N-12.5, N-13.3*
NOR-13-1 (LanWin5)	Conditionally confirmed	2032	2,000 MW	N-13.1, N-13.2*
NOR-11-1 (LanWin3)	Conditionally confirmed	2033	2,000 MW	N-11.1, N-11.2*
NOR-12-2 (LanWin2)	Identified	2034	2,000 MW	N-12.3, N-12.4*
NOR-12-1 (LanWin1)	Conditionally confirmed, need for adjustment identified	2035	2,000 MW	N-12.1, N-12.2*
NOR-x-1 (Zone 4)	Identified	2036	2,000 MW	
NOR-x-2 (Zone 4)	Identified	2037	2,000 MW	
NOR-x-3 (Zone 4)	Identified	2038	2,000 MW	
NOR-x-4 (Zone 4)	Identified	2039	2,000 MW	
NOR-x-5 (Zone 4)	Identified	2040	2,000 MW	
Baltic Sea				
OST-3-1 (Baltic 1)	In Operation	2011	51 MW	EnBW Baltic 1, GICON-SOF
OST-3-2 (Baltic 2)	In Operation	2015	288 MW	EnBW Baltic 2
OST-1-1 (Ostwind 1)	In Operation	2018	250 MW	Wikinger
OST-1-2 (Ostwind 1)	In Operation	2019	250 MW	Arkona
OST-1-3 (Ostwind 1)	In Operation	2019	250 MW	Arkona, Wikinger, Wikinger Süd
OST-2-1 (Ostwind 2)	Under Construction	2023	250 MW	Arcadis Ost 1
OST-2-2 (Ostwind 2)	Under Construction	2023	250 MW	Baltic Eagle
OST-2-3 (Ostwind 2)	Under Construction	2024	250 MW	Baltic Eagle
OST-1-4 (Ostwind 3)	Preparation of planning and permitting procedures	2026	300 MW	Windanker
OST-6-1 ("Gennaker")	Realisation planned according to § 17d para. 6 ff EnWG			
OST-T-1 (Testfeld)	Conditionally confirmed by NEP			

* according to FEP 2020, revision already initiated in the preliminary draft of the FEP update

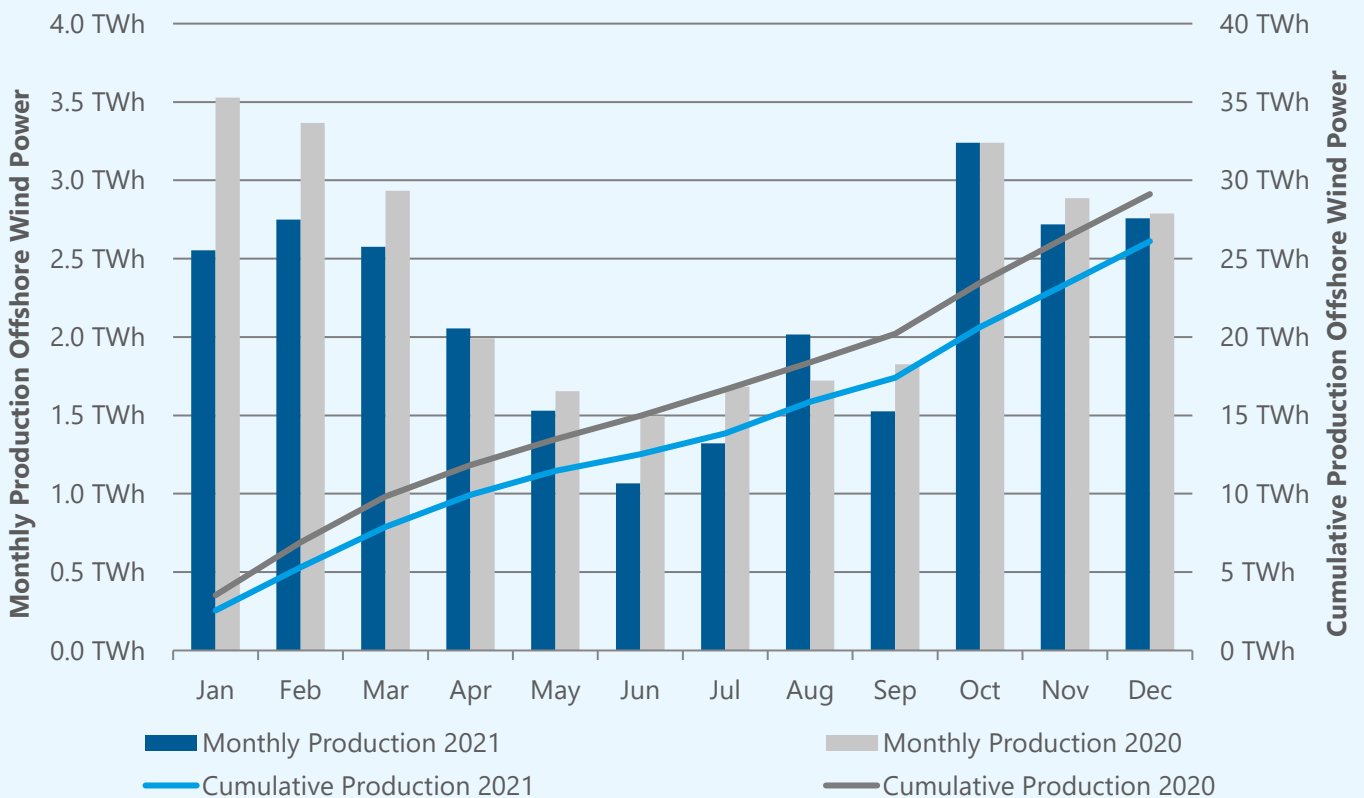
Monthly Power Production and Market Values

The market values for electricity from offshore wind energy reached record levels in 2021. In December 2021, the highest value to date was achieved with 18.4 ct/kWh - this is several times higher than the all-time low of 1.1 ct/kWh recorded in April 2020. On an annual average, the volume-weighted monthly market value of 9.02 ct/kWh in 2021 is 236% higher than the previous annual average.

In contrast, electricity production in 2021 remained below previous year's values. Due to weaker wind conditions, the production level of 2020 could only be exceeded in a couple of months. According to the projection data of the transmission system operators, 26.1 TWh of electricity from offshore wind energy was produced in Germany in 2021. Compared to 2020, this is a decline of 10%.



Monthly Market Values for Offshore Wind Power (Database: Netztransparenz)



Power Production from Offshore Wind Turbine Generators (Database: Projection by TSO (Netztransparenz))

About Deutsche WindGuard

In a complex energy market WindGuard is committed to providing extensive scientific, technical, and operational services which are unbiased and manufacturer-independent. WindGuard has been publishing the semi-annual development statistics since 2012.

About the German Windenergy Association (BWE)

The German Windenergy Association (BWE) is partner to over 3,000 companies in the wind energy industry and represents the interests of about 20,000 members. The entire know-how of a multifaceted industry is pooled through BWE.

About Bundesverband der Windparkbetreiber Offshore e.V. (BWO)

The association of German offshore wind farm operators (BWO) represents all companies that plan, construct and operate offshore wind farms in Germany. The BWO is the central contact on all questions concerning offshore wind energy.

About Stiftung OFFSHORE-WINDENERGIE

The aim of the foundation is to consolidate the role of offshore wind energy and promote its expansion in the interest of environmental and climate protection. It has established itself as a non-partisan, supra-regional and independent communication platform for the entire offshore wind energy sector.

About VDMA Power Systems

The trade association VDMA Power Systems and its working groups represent the interests of manufacturers and suppliers of power and heat generation plants.

About WAB e.V.

Bremerhaven-based WAB is the nationwide contact partner for the offshore wind industry in Germany and the leading business network for onshore wind energy in the north-west region. The association fosters the production of "green" hydrogen from wind energy. It comprises some 250 SMEs as well as institutes from all sectors of the wind and maritime industry as well as research.