

Status of Offshore Wind Energy Development in Germany

Year 2020



On behalf of



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Notes

The data was obtained through surveys with industry representatives as well as through additional research (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 final 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

Offshore converter station BorWin gamma (BorWin3)

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Offshore Wind Energy Development

At the end of 2020, 1,501 offshore wind turbines (OWT) with a capacity of 7,770 MW were in operation. In a European comparison, this puts Germany in second place behind the United Kingdom.

The current expansion stage was completed with the commissioning of 32 OWT with 219 MW during 2020. The only other development of the year 2020 was power upgrades to a number of existing turbines.

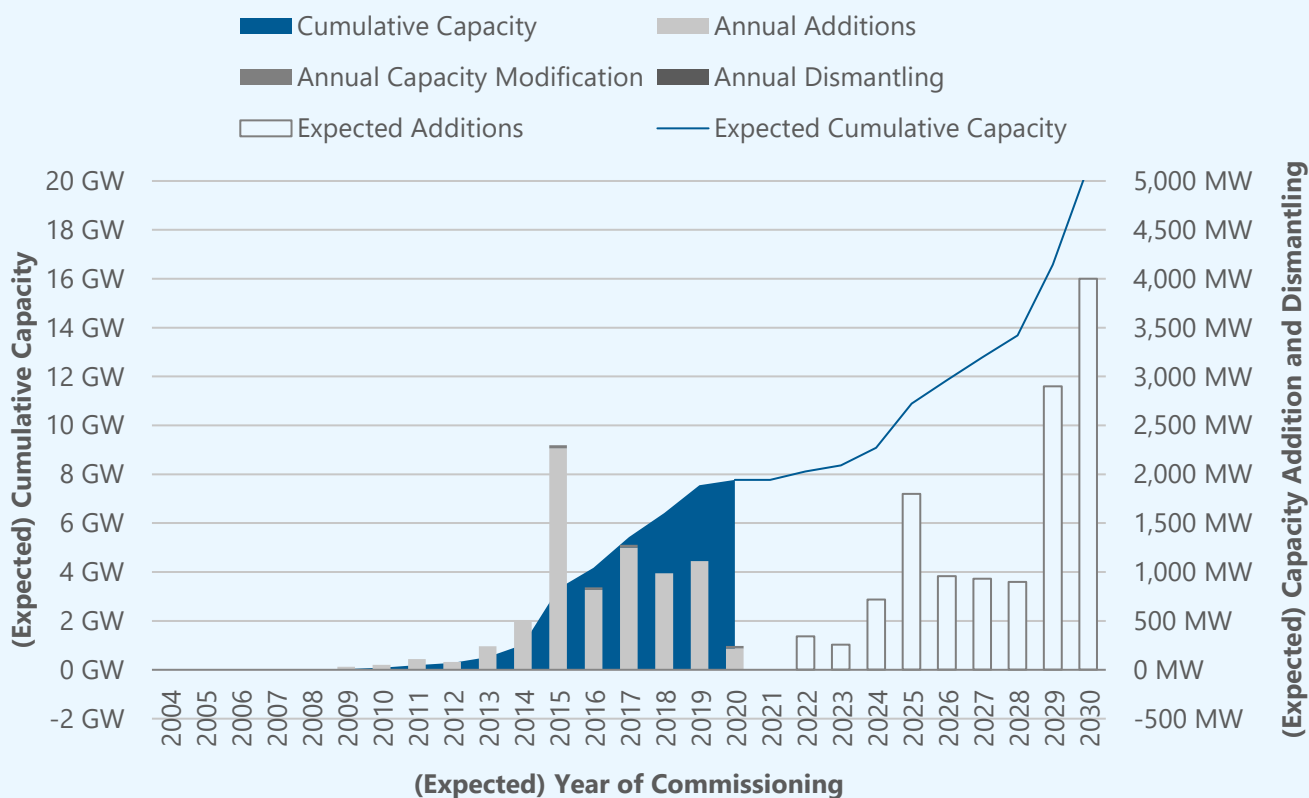
There are no new offshore wind energy projects (OWP) under construction, thus no capacity additions are expected for the upcoming year 2021. From 2022, the OWP awarded in the 2017/2018 tender rounds are to be commissioned. These OWP will successively increase the cumulative capacity to 10.8 GW by 2025.

In order to achieve the new expansion target of 20 GW in 2030, which was raised at the end of 2020, project areas will be put out to tender

starting in 2021 and are scheduled to be commissioned in 2026 and onward.

Status of the Offshore Wind Energy Development

		Capacity	Number
Additions	Year 2020		
	OWT (feeding in)	219 MW	32 OWT
	Capacity Modifications of existing OWT	26 MW	79 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT
			No Foundations
Cumulative	2020-12-31		
	OWT (feeding in)	7,770 MW	1,501 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT



(Expected) Development of the Offshore Wind Energy in Germany (Database: own surveys, MaStR, FEP 2020)

Expansion Targets Offshore Wind Energy

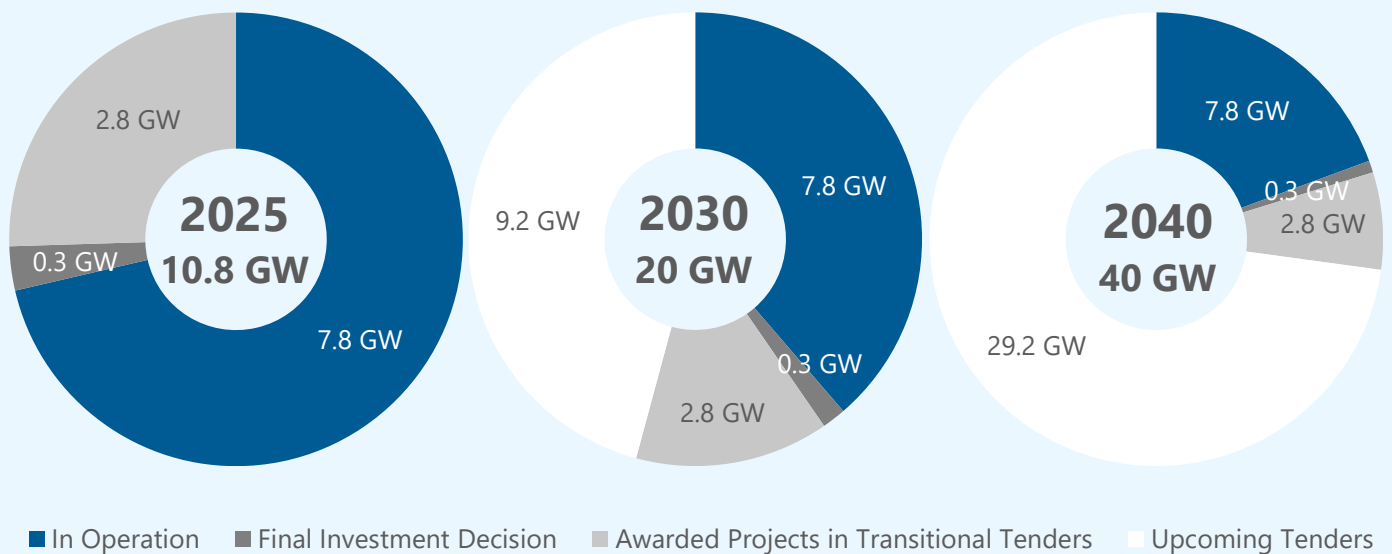
The amendment to the Offshore Wind Energy Act (German: Windenergie-auf-See-Gesetz or WindSeeG) that came into effect on December 10, 2020, set new expansion targets for offshore wind energy in Germany. The previous expansion target was increased from 15 GW to 20 GW of installed capacity by 2030 and supplemented by a target of 40 GW of installed capacity by 2040.

In addition, in November 2020, the European Commission proposed in its EU Strategy for Offshore Renewable Energy to expand Europe's offshore wind energy capacity to at least 60 GW by 2030 and 300 GW by 2050.

At the end of 2020, turbines with a cumulative capacity of nearly 7.8 GW were feeding into the German grid. Together with the turbines that were awarded in the two tender rounds 2017/2018 and whose implementation is currently being prepared, the installed capacity is expected to increase to a total of 10.8 GW by 2025. Over the

course of 2020, a final investment decision was made for the OWP Kaskasi that, including some pilot turbines, has a capacity of 342 MW. For the remaining 2.8 GW of awarded capacity a final investment decision had not been made by the end of 2020.

To achieve the new expansion target of 20 GW by 2030, in the tenders from 2021 a volume of 9.2 GW must be tendered, awarded and realized. The project areas specified for this purpose in the 2020 Site Development Plan (German: Flächenentwicklungsplan or FEP) are more than sufficient. For the realization of 40 GW by 2040, an additional 20 GW is required. Priority and reservation areas have already been defined for the German Exclusive Economic Zone (EEZ; German: Ausschließliche Wirtschaftszone or AWZ) in the draft of the maritime spatial plan of the Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie or BSH).



Development Status of Offshore Capacity with expected Commissioning by 2025, 2030 and 2040

Activities in Offshore Wind Energy Projects

Over the course of 2020, two offshore wind energy power projects (OWP) in Germany were commissioned. Furthermore, all turbines in the OWP EnBW Hohe See and several turbines in the Wiking project received a capacity upgrade in 2020.

With the commissioning of the OWP EnBW Albatros at the beginning of 2020 and the OWP Trianel Windpark Borkum II midyear, the last turbines of the old system (until EEG 2014) have been connected to the grid. A total of 27 projects in the North Sea and Baltic Sea are in operation as of December 31, 2020. The expansion phase of the projects that were implemented before the introduction of the tender system has thus been completed.

The next OWP to be implemented in Germany are the projects that were awarded in the transitional tenders rounds of 2017/2018. Seven projects are

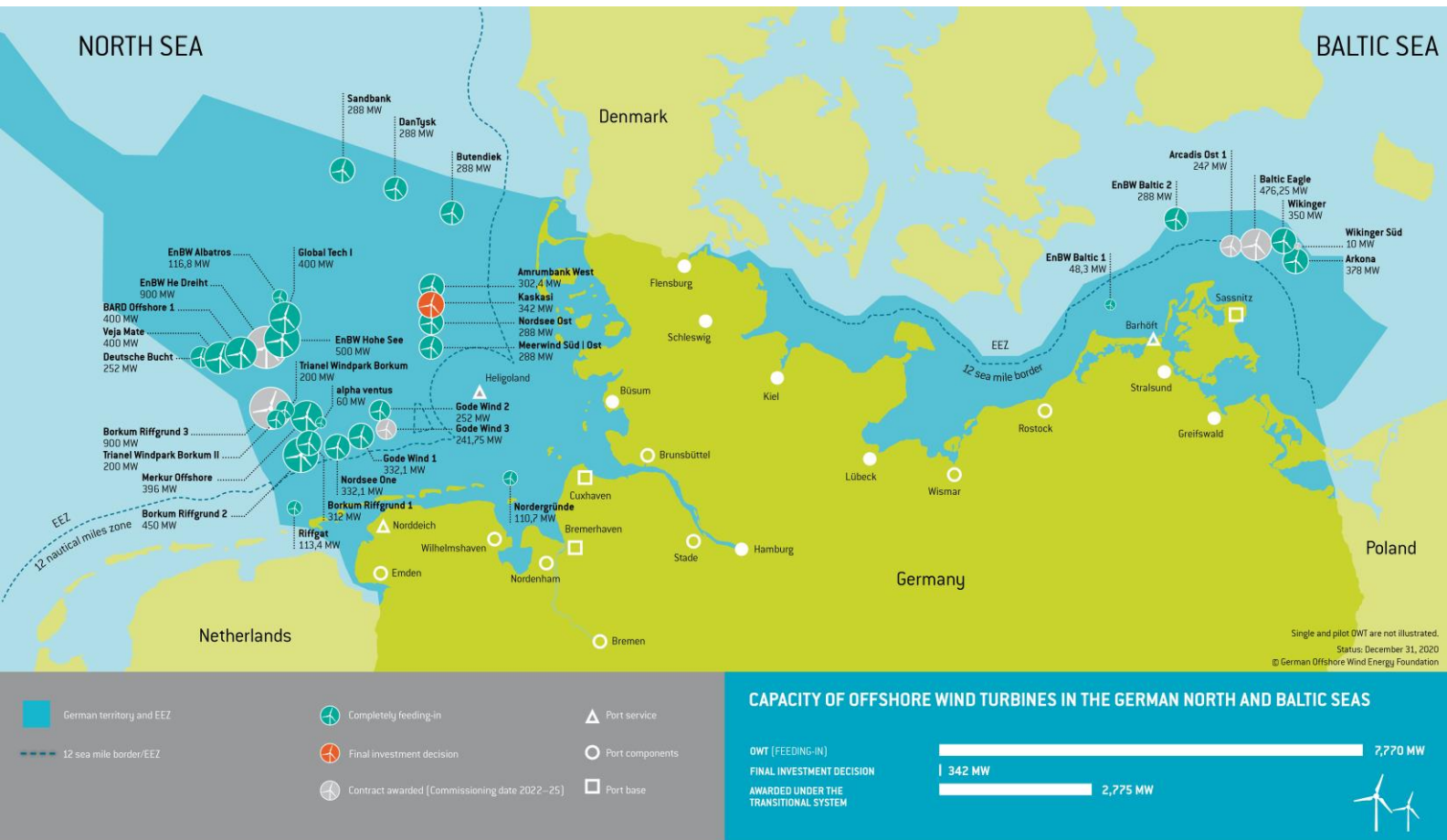
scheduled to be commissioned successively from 2022 to 2025. An investment decision has already been made for the OWP Kaskasi, which is the first project to be commissioned. Planning and preparations are underway for the remaining OWP.

Overview of awarded projects (tenders 2017/2018)

OWP	Status	Expected Commissioning	Capacity [MW]**
Kaskasi*	FID	2022	342
Wiking Süd	Awarded	2023	10
Arcadis Ost 1	Awarded	2023	247
Baltic Eagle	Awarded	2024	476.25
Gode Wind 3	Awarded	2024	241.75
Borkum Riffgrund 3	Awarded	2025	900
EnBW He Dreiht	Awarded	2025	900

* incl. pilot OWT

** grid connection capacity



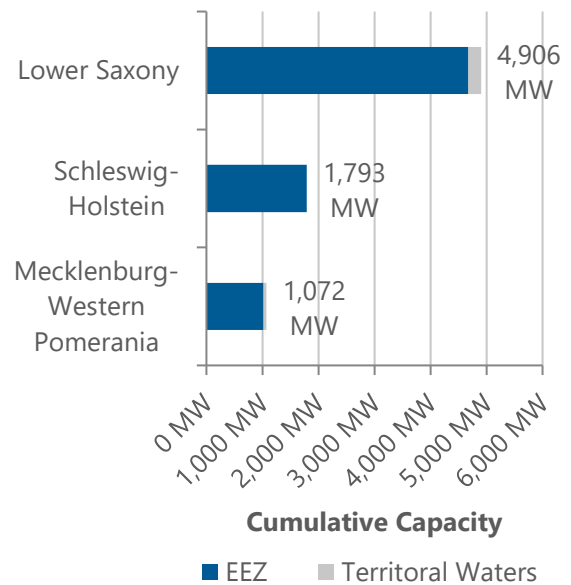
Overview Map of Offshore Wind Energy in Germany (© German Offshore Wind Energy Foundation)

Distribution across Federal States and North and Baltic Seas

The capacity installed in the North and Baltic Seas at the end of 2020 can be allocated to the federal states of Lower Saxony, Schleswig-Holstein and Mecklenburg-Western Pomerania on the basis of the location of the respective grid connection point. Of the 6.7 GW of installed capacity in the North Sea, 4.9 GW is located in Lower Saxony, while Schleswig-Holstein accounts for the remaining 1.8 GW. The 1.1 GW of installed capacity in the Baltic Sea is entirely allocated to Mecklenburg-Western Pomerania. In all three German states, the share of turbines installed in the territorial waters is significantly lower than the share of turbines installed in the German Exclusive Economic Zone (EEZ; German: Ausschließliche Wirtschaftszone or AWZ).

The capacity awarded in the 2017/2018 tender rounds is mainly located in the North Sea (2.4 GW) and only 0.7 GW are located in the Baltic Sea. The capacities to be tendered from 2021 with a total

of almost 9.7 GW are also mainly located in the North Sea (9.4 GW). There is only one area with a capacity of 0.3 GW in the Baltic Sea.



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 2020	OWT (feeding in)	219 MW	32 OWT	0 MW	0 OWT
	Capacity Modifications of existing OWT	25 MW	71 OWT	1 MW	8 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT	0 MW	0 OWT
	Foundations w/o OWT	No Foundations		No Foundations	
Cumulative 2020-12-31	OWT (feeding in)	6,698 MW	1,269 OWT	1,072 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	Awarded in 2017/2018* (Commissioning until 2025)	2,384 MW		733 MW	
	Tenders in 2021-2025 (Commissioning until 2030)	9,388 MW		300 MW	

* incl. pilot OWT

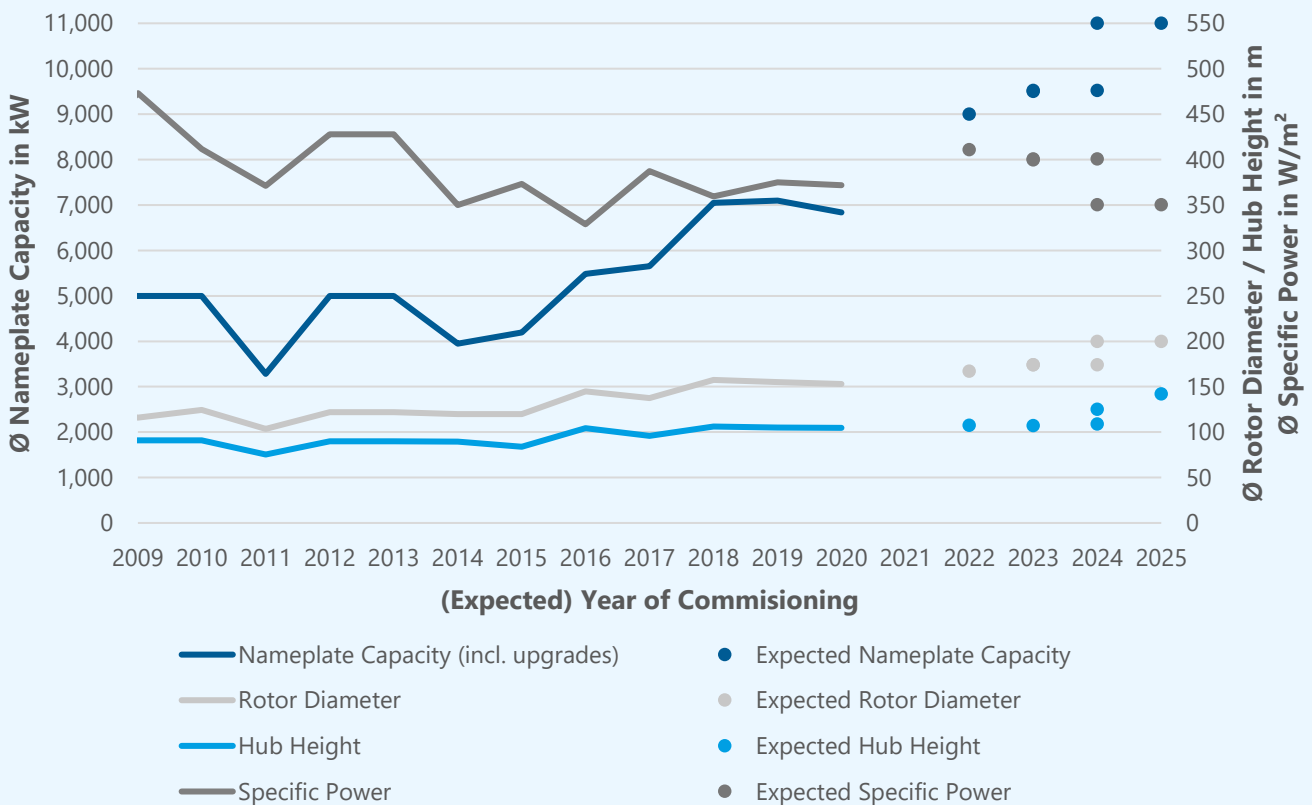
Turbine Configuration

In 2020, two different types of turbines were commissioned. Their average configuration changed only slightly compared to the previous year. The turbines commissioned in 2020 have an average turbine capacity of 6.84 MW, a rotor diameter of 153 m and a hub height of 105 m. The ratio of turbine capacity to rotor area results in the so-called specific power of 372 W/m² on average. The development of the turbine configuration over time is subject to project-related leaps. Nevertheless, a trend towards increasing turbine capacity can be observed, which will be continued in the projects of the next expansion phase (commissioning until 2025) with planned turbine capacities of up to 11 MW. According to current plans, rotor diameter and hub height are also being increased up to 200 m and 125 m,

respectively, in the upcoming projects until 2025. However, due to the expected increases in nameplate capacity, the specific power will remain at levels comparable to that of previous years.

Average Turbine Configuration of OWT Feeding into the Grid

Average Configuration	Additions Year 2020	Cumulative 2020-12-31
Nameplate Capacity (incl. upgrades)	6,840 kW	5,177 kW
Rotor Diameter	153 m	133 m
Hub Height	105 m	95 m
Specific Power	372 W/m ²	371 W/m ²



(Expected) Turbine Configuration over Course of Time

Water Depth and Distance to Shore

From nearshore turbines in shallow water right off the coast to those in the EEZ that are installed in water depths of up to 44 m and distances of over 120 km from the coast, turbines are subject to different conditions. Across the total portfolio of OWT the average water depth is 30 m, and the average distance to shore is 74 km.

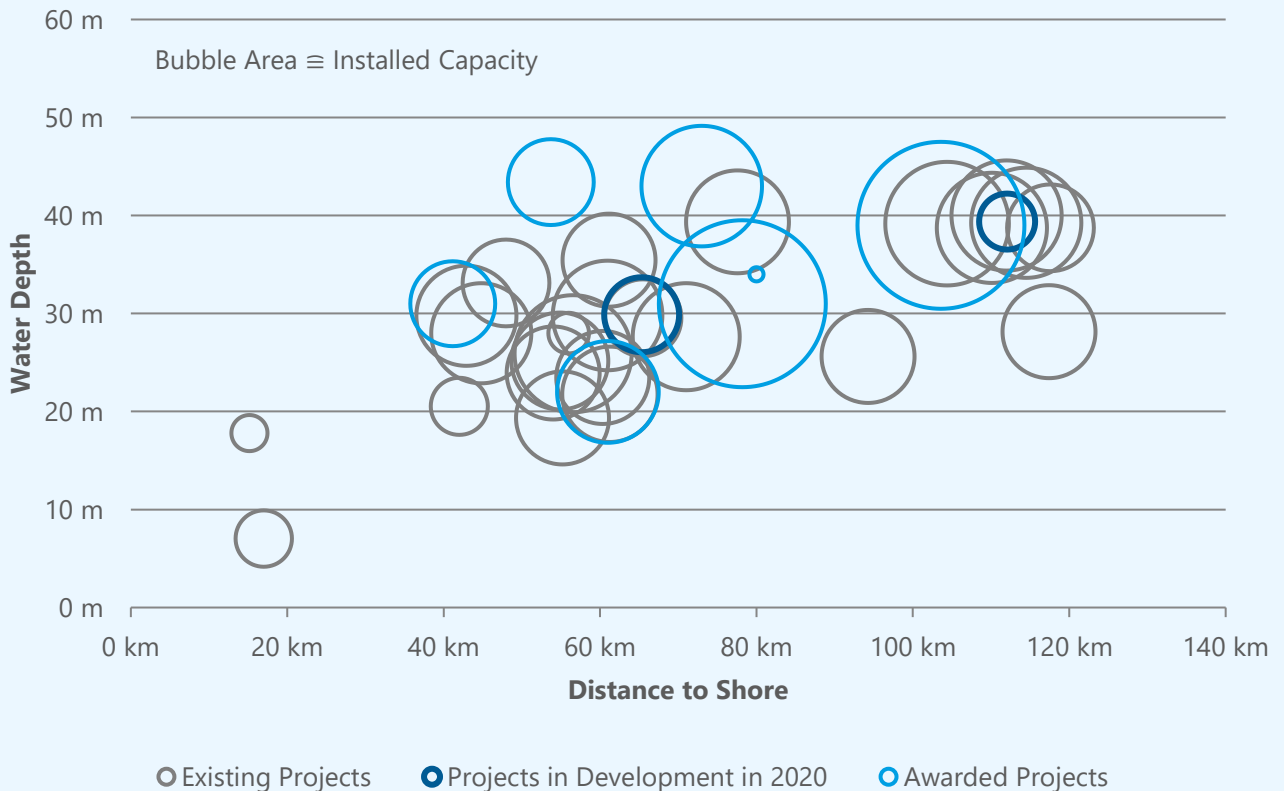
On average, OWT commissioned in 2020 were installed in water depths of 34 m and at 89 km to shore. The turbines that will be realized in the upcoming years are also spread over a wide range of different water depths and distances from shore.

The decision for a certain type of foundation is not only based on water depth, but also on other factors such as soil properties. Monopiles are by far the most frequently used foundation type in Germany. All OWT commissioned in 2020 used monopiles, and monopiles are also planned for

the projects in the transitional system. The monopiles are continuously being developed further and upcoming installations can be used to test new installation methods (e.g. vibration method) and innovative structural designs (e.g. collared monopiles or self-expanding piles/shoes). Further planned pilot installations with other new foundation types (mono bucket or floating foundation) could not successfully be realized in Germany so far.

Average Location of OWT Feeding into the Grid

Average Location	Additions Year 2020	Cumulative 2020-12-31
Water Depth	34 m	30 m
Distance to Shore	89 m	74 m



Water Depth and Distance to Shore of Existing Projects, Projects in Development and Awarded Projects

Offshore Tenders from 2021 onwards

After the transitional phase (tenders of 2017/2018), the tenders will henceforth take place in the so-called central model. The amendment to the Offshore Wind Energy Act (German: Windenergie-auf-See-Gesetz or WindSeeG) provide for annual tender rounds on September 1, starting in 2021. The Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie or BSH) defines the areas to be put out to tender and their respective tender dates in the Site Development Plan (German: Flächenentwicklungsplan or FEP) and carries out the preliminary investigation of these areas.

In the tenders, the award for the construction of an offshore wind energy project on a pre-investigated area is awarded to the bidder with the lowest bid value. If several bidders submit zero-cent bids for the same area, the amended WindSeeG provides for a lottery procedure for the

award. This means that the second bidding component, which was still provided for in the draft law for these situations with several zero-cent bids, is no longer included. The lottery procedure is to be reviewed in 2022 to determine whether any adjustments are required.

In 2019, the BSH has already defined areas in the FEP for tenders starting in 2021. To meet the increase in the offshore target to 20 GW by 2030, the BSH has made adjustments to the FEP 2020. Furthermore, the FEP 2020 defines two areas for possible alternative energy generation at sea without grid connection, for which tenders are to be issued according to an ordinance authorization in the WindSeeG. In addition, the FEP 2020 presents further possible areas for long-term development after 2030, the development of which should enable to achieve the target of around 30 GW by 2035 (according to the 2021-2035 scenario framework).

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

Area	Tender Round	Expected Commissioning	Expected Capacity	Location	Size of Area	Expected Grid Connection
N-3.7	2021	2026	225 MW	North Sea	ca. 17 km ²	NOR-3-3
N-3.8	2021	2026	433 MW	North Sea	ca. 23 km ²	NOR-3-3
O-1.3	2021	2026	300 MW	Baltic Sea	ca. 25 km ²	OST-1-4
N-7.2	2022	2027	930 MW	North Sea	ca. 58 km ²	NOR-7-2
N-3.5	2023	2028	420 MW	North Sea	ca. 29 km ²	NOR-3-2
N-3.6	2023	2028	480 MW	North Sea	ca. 33 km ²	NOR-3-2
N-6.6	2024	2029	630 MW	North Sea	ca. 16 km ²	NOR-6-3
N-6.7	2024	2029	270 MW	North Sea	ca. 45 km ²	NOR-6-3
N-9.1	2024	2029	1,000 MW	North Sea	ca. 100 km ²	NOR-9-1
N-9.2	2024	2029	1,000 MW	North Sea	ca. 104 km ²	NOR-9-1
N-10.1	2025	2030	1,000 MW	North Sea	ca. 95 km ²	NOR-10-1
N-10.2	2025	2030	1,000 MW	North Sea	ca. 93 km ²	NOR-10-1
N-9.3	2025	2030	1,000 MW	North Sea	ca. 105 km ²	NOR-9-2
N-9.4	2025	2030	1,000 MW	North Sea	ca. 99 km ²	NOR-9-2
SEN-1	not defined			North Sea	ca. 28 km ²	none
SEO-1	not defined			Baltic Sea	ca. 8 km ²	none
N-11.1/N-11.2*	after 2025	after 2030	2,000 MW	North Sea		NOR-11-1
N-12.1/N-12.2*	after 2025	after 2030	2,000 MW	North Sea		NOR-12-1
N-12.3/N-12.4*	after 2025	after 2030	2,000 MW	North Sea		NOR-12-2
N-13.1/N-13.2*	after 2025	after 2030	2,000 MW	North Sea		NOR-13-1
ggf. N-11.3/N-12.5/N-13.3*	after 2025	after 2030	ggf. 2,000 MW	North Sea		ggf. NOR-11-2

* only presented as possible areas in the FEP 2020 for information purposes

Overview of Grid Connection Capacities

As of December 31, 2020, a total offshore grid connection capacity of 8.2 GW was in operation in Germany. The majority of this capacity is already being used by the existing offshore wind energy projects feeding into the grid. Additional capacity

that needs to be built to meet the 2030 target has already been confirmed in the 2030 Grid Development Plan (German: Netzentwicklungsplan or NEP) or identified in the 2020 Site Development Plan (German: Flächenentwicklungsplan or FEP).

Installed and Planned Grid Connections (to Converter Station or Bundling Point) in the North and Baltic Seas (Database: FEP 2020, NEP 2030 Version 2019 Confirmation, TSO, additional research)

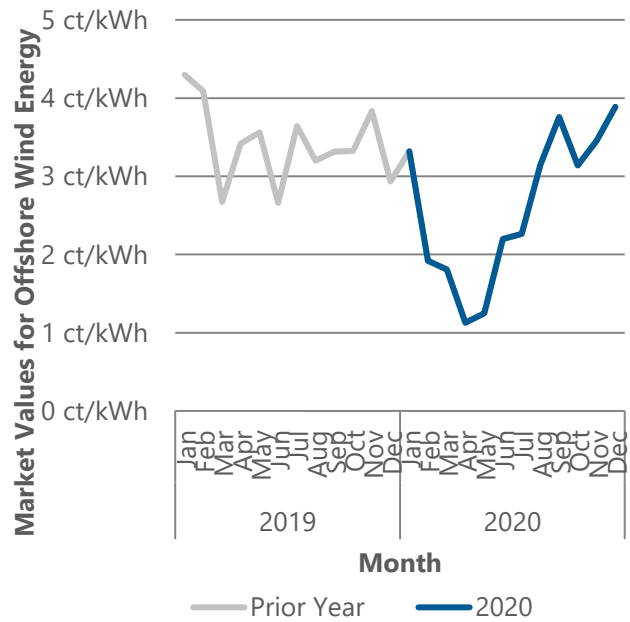
Grid Connection System	Status	(Expect.) Commissioning	(Expect.) Capacity	(Preliminary) Assigned Offshore Wind Energy Projects and Areas
North Sea				
NOR-2-1 (Alpha Ventus)	In Operation	2009	62 MW	alpha ventus
NOR-6-1 (BorWin1)	In Operation	2010	400 MW	BARD Offshore 1
NOR-0-1 (Riffgat)	In Operation	2014	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, N-3.8
NOR-1-1 (DoWin5)	Under Construction	2024	900 MW	Borkum Riffgrund 3
NOR-7-1 (BorWin5)	Under Construction	2025	900 MW	EnBW He Dreihit
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 the Permitting Procedures	2029	2,000 MW	N-9.1, N-9.2
NOR-10-1 (BalWin2)	Conditionally confirmed in NEP, adjusted in FEP 2020	2030	2,000 MW	N-10.1, N-10.2
NOR-9-2 (BalWin3)	Not confirmed in NEP, identified in FEP 2020	2030	2,000 MW	N-9.3, N-9.4
NOR-11-1	Conditionally confirmed in NEP, presented for information purposes in FEP 2020	after 2030	2,000 MW	N-11.1, N-11.2*
NOR-11-2	Conditionally confirmed in NEP, presented for information purposes in FEP 2020	after 2030	ggf. 2,000 MW	ggf. N-11.3/N-12.5/N-13.3*
NOR-12-1	Conditionally confirmed in NEP, adjusted and presented for information purposes in FEP 2020	after 2030	2,000 MW	N-12.1, N-12.2*
NOR-12-2	Not confirmed in NEP, presented for information purposes in FEP 2020	after 2030	2,000 MW	N-12.3, N-12.4*
NOR-13-1	Conditionally confirmed in NEP, presented for information purposes in FEP 2020	after 2030	2,000 MW	N-13.1/N-13.2*
Baltic Sea				
OST-3-1 (Baltic 1)	In Operation	2011	51 MW	EnBW Baltic1, 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)	Partially under Construction	2023	250 MW	Arcadis Ost 1
OST-2-2 (Ostwind 2)	Partially under Construction	2023	250 MW	Baltic Eagle
OST-2-3 (Ostwind 2)	Partially under Construction	2024	250 MW	Baltic Eagle
OST-1-4	Confirmed in NEP, adopted in FEP 2020	2026	300 MW	O-1.3
OST-7-1 („Testfeldanbindung“)	Conditionally confirmed in NEP, not yet specified in FEP 2020			
OST-6-1 („Gennaker“)	No need identified in FEP, therefore not confirmed by the NEP			

* only presented as possible areas in the FEP 2020 for information purposes

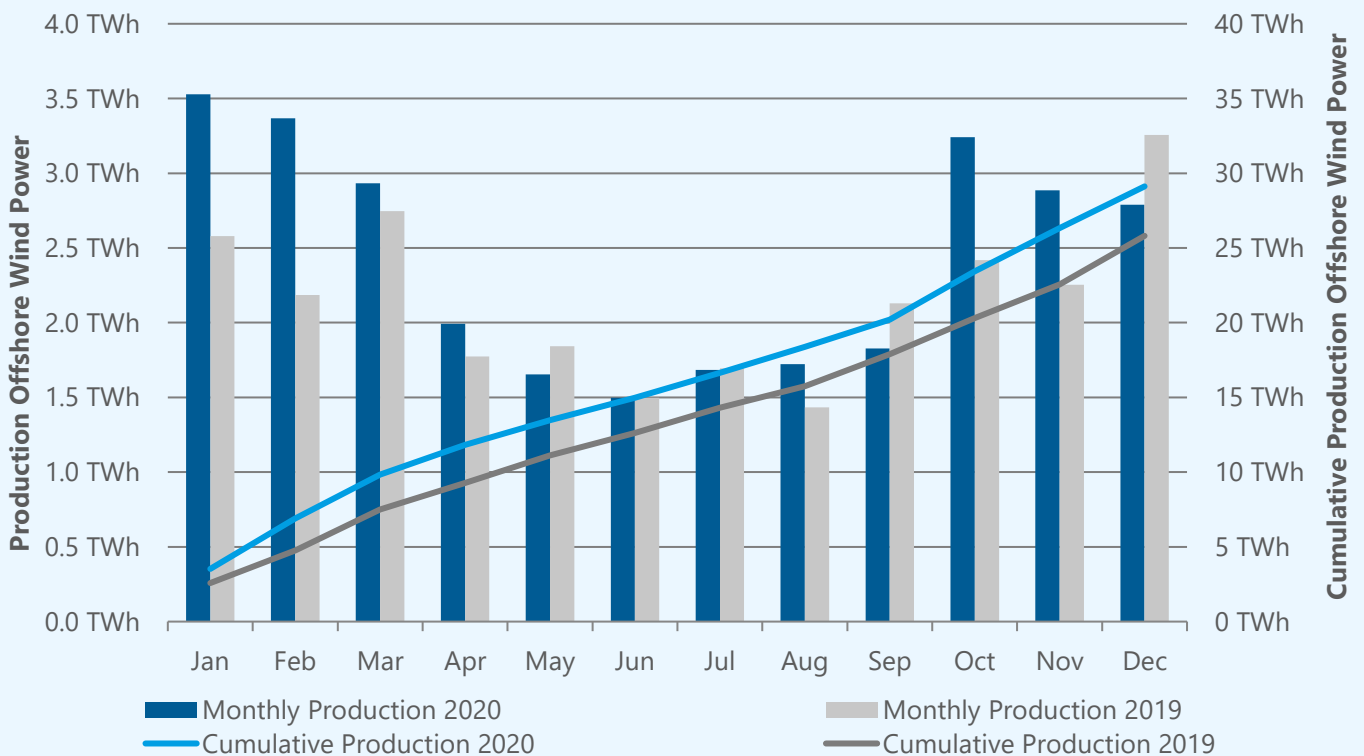
Monthly Power Production and Market Values

Monthly market values for offshore wind energy dropped at the beginning of 2020 due to the COVID-19 pandemic, reaching a low of 1.1 ct/kWh in April 2020. Since August 2020, the market value for electricity from offshore wind energy has again reached at a level comparable to the previous year. The price drop in the first half of the year is also reflected in the volume-weighted average of 2.7 ct/kWh in 2020 – 21% below the previous year's average of 3.4 ct/kWh.

According to the projection data of the transmission system operators (TSO), the power production of the German offshore wind energy projects amounted to 29.1 TWh in 2020. Especially in the months of January, February, October and November, the feed-in was significantly higher than in the previous year. Overall, 13% more electricity was fed into the grid from offshore wind energy in 2020 compared to the projection from 2019.



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 Bundesverband WindEnergie e.V. (BWE)

The Bundesverband WindEnergie e.V. (BWE) is a partner of over 3,000 wind energy industry companies and represents 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.