

Status of Offshore Wind Energy Development in Germany

Year 2019



On behalf of



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Notes

The data was obtained through surveys with industry representatives, as well as additional research (e.g. BNetzA and BSH).

Retroactive adjustments to the data were done based on data corrections by the project developer.

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.

The installed capacity of offshore wind projects is not always equal to the grid connection capacity.

Photo on Title Page

Wind Farm Deutsche Bucht (2019)

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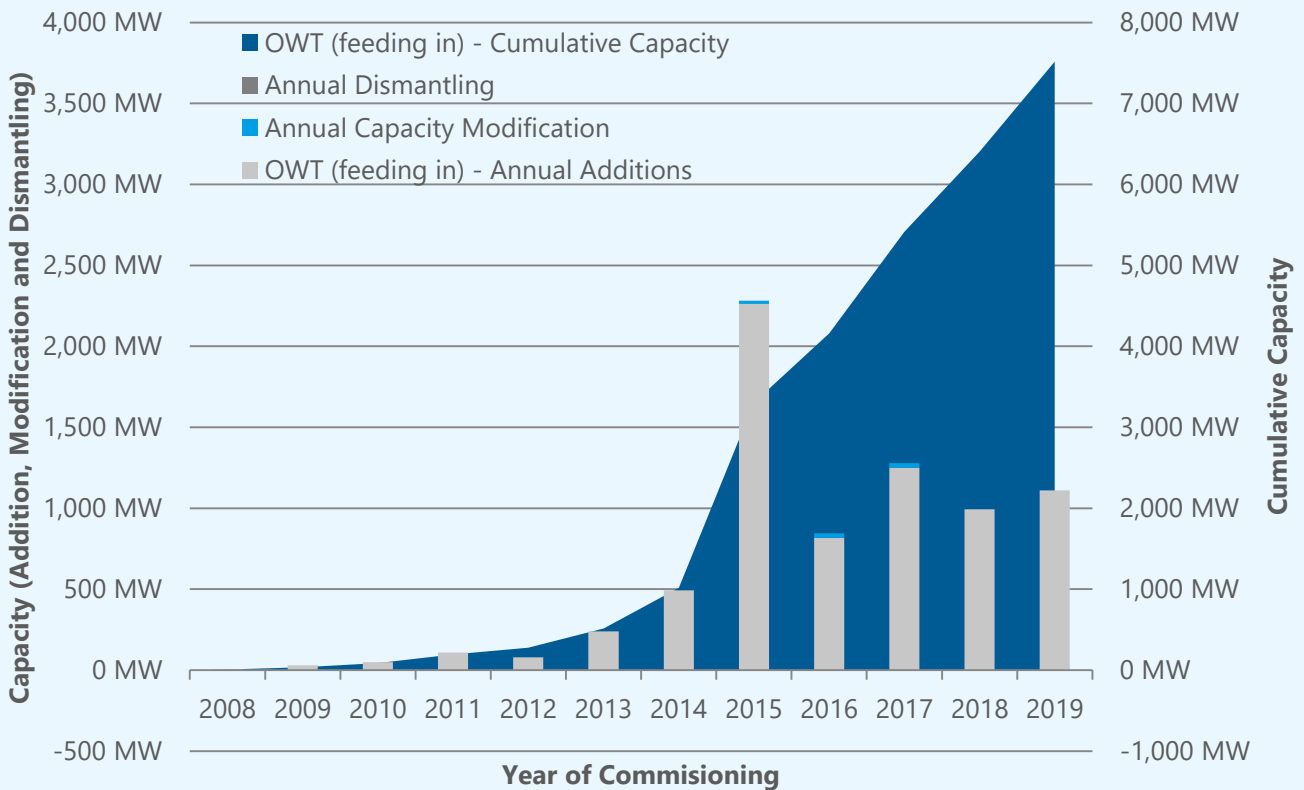
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Offshore Wind Energy Development

Over the course of 2019, 160 offshore wind turbine generators (OWT) with an installed capacity of 1,111 MW were feeding into the grid for the first time in Germany. About three quarters of these initial feed-ins occurred during the second half of the year. As of December 31, 2019, a total of 1,469 OWT with a cumulative installed capacity of 7,516 MW were in operation. On top of the existing, fully operational OWT, the installation of 16 additional OWT with 112 MW was completed during 2019. However, none of these had fed into the grid by the end of the year. There are also 16 foundations that had been erected in the German Exclusive Economic Zone (EEZ; German: Ausschließliche Wirtschaftszone or AWZ) in 2018 but are still void of their respective OWT.

Status of the Offshore Wind Energy Development

		Capacity	Number
Additions Year 2019	OWT (feeding in)	1,111 MW	160 OWT
	Installed OWT (no feed-in)	112 MW	16 OWT
	Foundations w/o OWT		No Foundations
Cumulative 2019-12-31	OWT (feeding in)	7,516 MW	1,469 OWT
	Installed OWT (no feed-in)	112 MW	16 OWT
	Foundations w/o OWT		16 Foundations



Development of the Offshore Wind Energy in Germany (Capacity of OWT Feeding into the Grid)

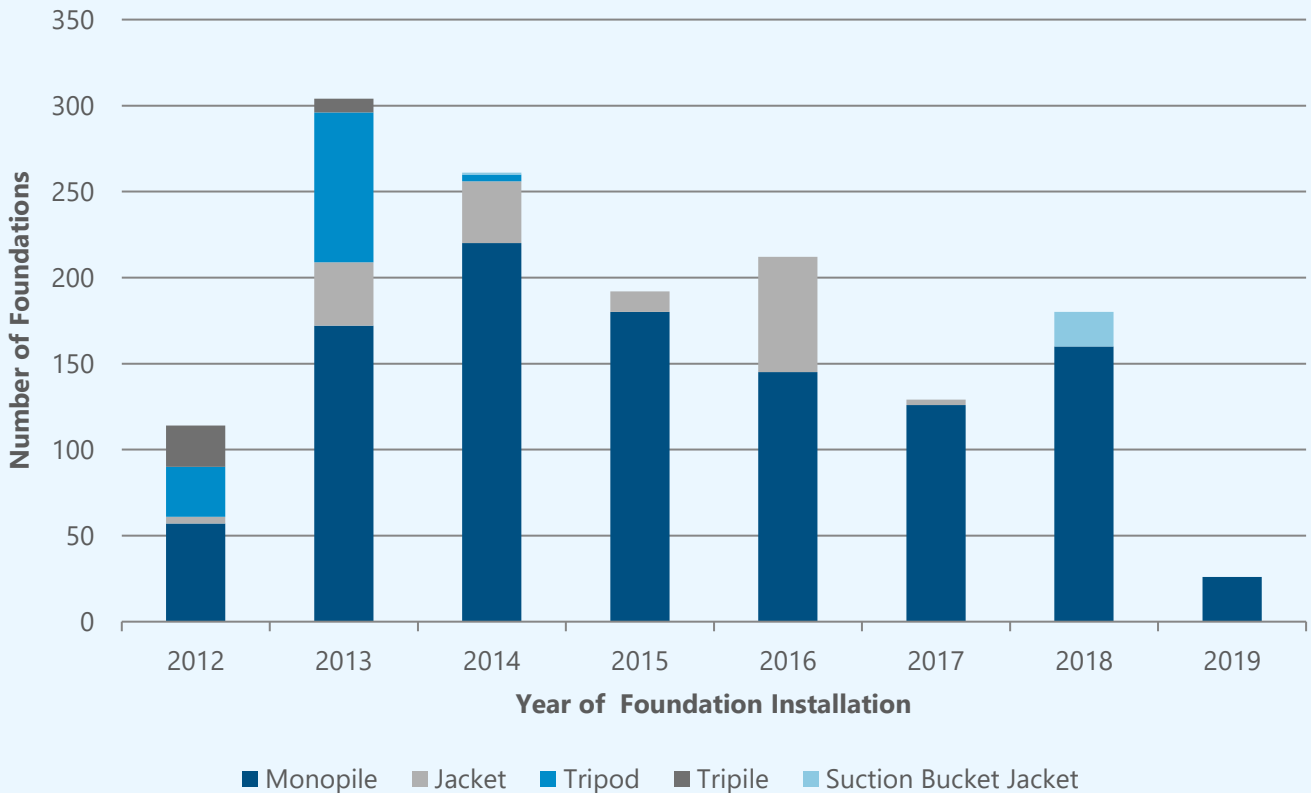
Turbine Configuration and Foundation Types

The capacity of OWT placed into operation in 2019 ranges from 6 to 8.4 MW, resulting in an average turbine capacity of 6.9 MW. The averaged rotor diameters and hub heights are 155 meters and 104 meters, respectively. Compared to the previous year, the average turbine is about 2% smaller with regard to capacity, rotor diameter and hub height. When averaged, the ratio of the nominal capacity to rotor area has actually increased slightly, with an average specific power of 367 W/m². Each and every foundation installed successfully in 2019 was a monopile, all of which were erected in the first six months of that year.

With about three quarters of all OWT in Germany sitting atop a monopile, this foundation type retains its lead undefeated.

Average Turbine Configuration of OWT Feeding into the Grid

Average Configuration	Additions Year 2019	Cumulative 2019-12-31
Nameplate Capacity (incl. upgrades)	6,942 kW	5,117 kW
Rotor Diameter	155 m	132 m
Hub Height	104 m	95 m
Specific Power	367 W/m ²	369 W/m ²



Foundation Types over Course of Time

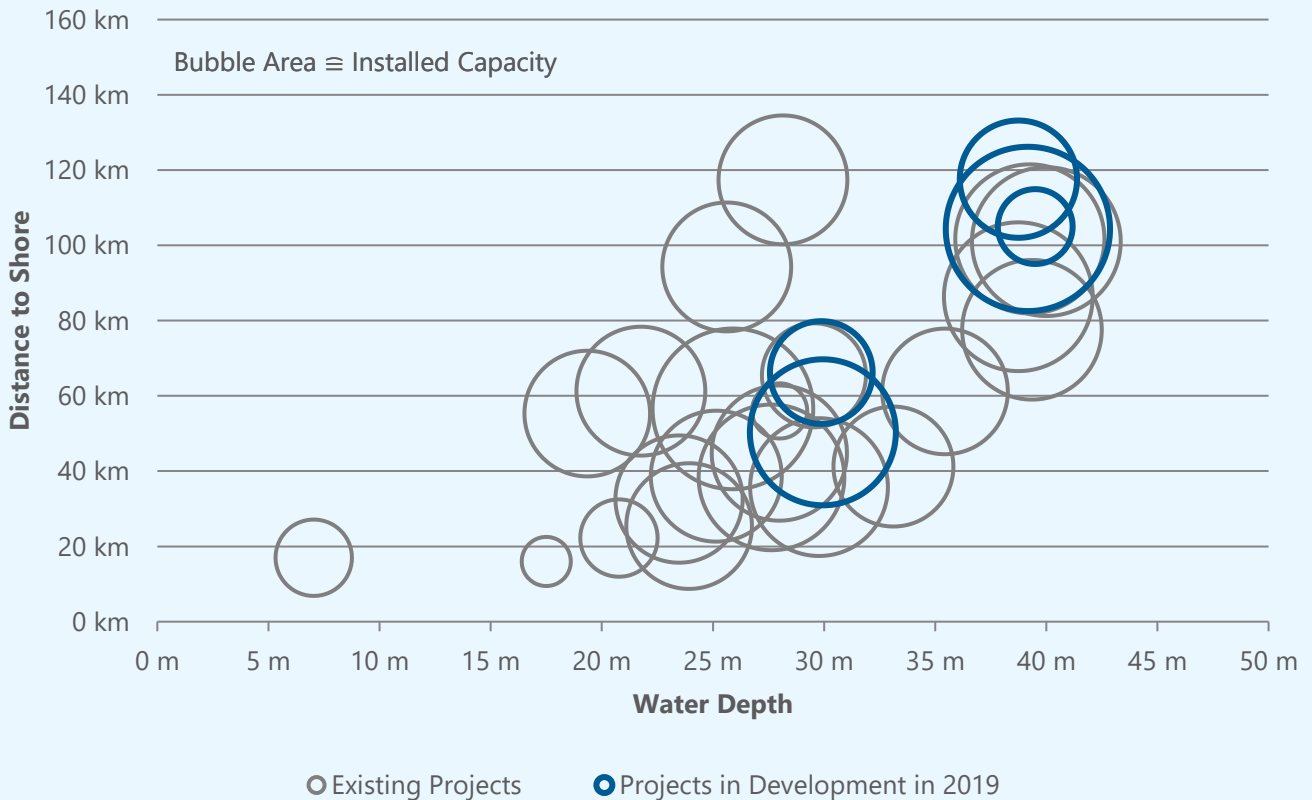
Water Depth and Distance to Shore

All turbines placed into operation in 2019 are, on average, located in water depths of 36 meters and at a distance of 88 kilometers from the shore. Compared to turbines realized in the previous year, the water depth increased by about 33% and current-year OWT are about 1.8 times further away from the mainland.

A closer look at the various offshore wind energy projects (OWP) implemented during the year reveals that the areas in which the different projects are located vary. Work on projects in Cluster 6 and 8 are conducted in great water depths and distance from shore, while projects under way in Cluster 2 during 2019 are found mid-range regarding these two criteria.

Average Location of OWT Feeding into the Grid

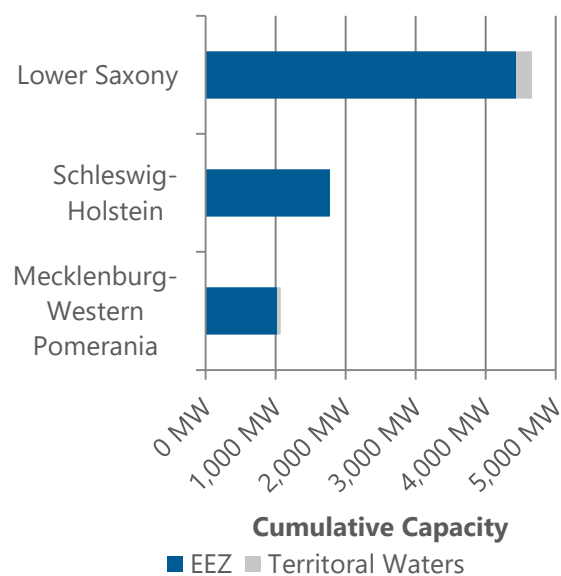
Average Location	Additions Year 2019	Cumulative 2019-12-31
Water Depth	36.0 m	29.7 m
Distance to Shore	88 km	65 km



Water Depth and Distance to Shore

Distribution across Federal States and North and Baltic Seas

OWT and foundation installations, as well as commissioning of turbines over the course of 2019 occurred exclusively in the North Sea. By the end of the year, there were no OWT under construction in the Baltic Sea. As of December 31, 2019, the overall feed-in capacity was 6,440 MW in the North and 1,076 MW in the Baltic Sea. With the regional distribution of capacities being dependent on their respective connection point location, the vast majority of 4,662 MW is located in Lower Saxony. A further 1,778 MW are connected in Schleswig Holstein and 1,076 MW in Mecklenburg-Western Pomerania. The share of turbines erected in territorial waters is small compared to that of turbines in the EEZ.



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

Distribution across the North and Baltic Seas

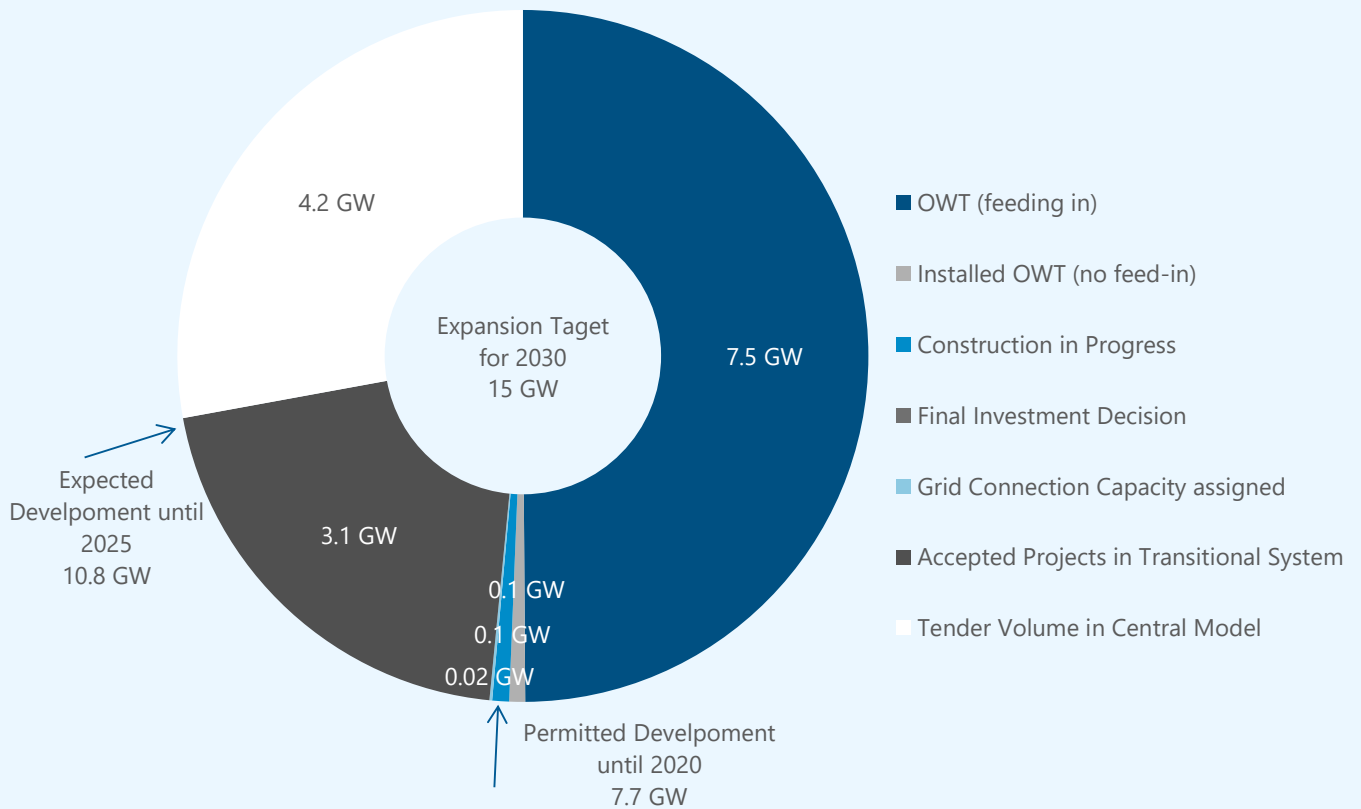
		North Sea		Baltic Sea	
		Capacity	Number	Capacity	Number
Additions Year 2019	OWT (feeding in)	1,111 MW	160 OWT	0 MW	0 OWT
	Installed OWT (no feed-in)	112 MW	16 OWT	0 MW	0 OWT
	Foundations w/o OWT		No Foundations		No Foundations
Cumulative 2019-12-31	OWT (feeding in)	6,440 MW	1,237 OWT	1,076 MW	232 OWT
	Installed OWT (no feed-in)	112 MW	16 OWT	0 MW	0 OWT
	Foundations w/o OWT		16 Foundations		No Foundations

Expansion Target and Allocated Grid Connection Capacity

As currently defined in the German Renewable Energy Sources Act (German: Erneuerbare-Energien-Gesetz or EEG), the goal of offshore wind energy capacity to be installed by 2020 is 6.5 GW. The German Energy Industry Act (German: Energiewirtschaftsgesetz or EnWG) defines a development curtailment by 2020 through the maximum assignable overall capacity of 7.7 GW. At the end of 2019, this capacity had not been exhausted since projects have still been under construction or have not yet been feeding into the grid.

Also, construction of pilot turbines with 16.8 MW had not yet been completed by the end of 2019. Grid connection confirmations of 19.3 MW were present for additional pilot turbines.

The April 2017 and April 2018 tendering rounds of the transitional system according to the Offshore Wind Energy Act (German: Windenergie-auf-See-Gesetz or WindSeeG) awarded a future additional overall capacity of 3.1 GW to projects planned to be realized between 2021 and 2025. The planning and permitting proceedings for these projects are ongoing. Assuming these projects are pushed ahead successfully, the end of 2025 could potentially see a cumulative capacity of 10.8 GW. By the end of 2019 the offshore goal set by the German legislature still remained at 15 GW until 2030. The remaining 4.2 GW will be awarded through tendering rounds according to the central model starting in 2021.



Development Status of Offshore Capacity with expected Commissioning by 2030

Offshore Development until 2030

As of today, offshore wind energy projects in both the North and Baltic Sea slated to be realized by the end of 2025 had been previously specified in the 2017 and 2018 tendering rounds. A total of 3,100 MW was awarded in the two tendering rounds of the transitional system, with 733 MW located in the Baltic Sea and 2,367 MW to be constructed in the North Sea. The volume-weighted, average awarded bid value of the two currently concluded tendering rounds was 2.6 € cents/kWh.

In 2019 it was announced that the Gode Wind 3 and Gode Wind 4 projects would be developed together under the name of Gode Wind 3. Likewise, the projects Borkum Riffgrund West 1, Borkum Riffgrund West 2 and OWP West will be combined into the project Borkum Riffgrund 3.

For the further development of offshore wind energy, the Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie or BSH) has determined nine (partial) areas in the Site Development Plan (German: Flächenentwicklungsplan or FEP). Development of projects in these areas will be tendered in the central model from 2021 to 2026. The overall capacity of 4,200 MW, scheduled for grid connection starting in 2026 until 2030, will be awarded successively in order to achieve the current development goal of 15 GW. Of this capacity, 3,900 MW will be located in the North and 300 MW in the Baltic Sea.

Scheduled Offshore Projects in the North und Baltic Sea until 2030 (Database: BNetzA, BSH, Additional Research)

Project / Area	Tender Round	Location	Developer	Capacity	Expected Year of Commissioning	Awarded Bid (average)
Concluded Tenders within the Transitional System				3,100.00 MW		
Kaskasi	2018	North Sea	Innogy	325.00 MW	2022	unknown
Baltic Eagle	2018	Baltic Sea	Iberdrola	476.25 MW	2023	6.46 ct/kWh
Wikinger Süd	2018	Baltic Sea	Iberdrola	10.00 MW	2023	0.00 ct/kWh
Arcadis Ost 1	2018	Baltic Sea	Parkwind	247.00 MW	2023	unknown
Gode Wind 3 (formerly Gode Wind 3, Gode Wind 4)	2017/18	North Sea	Ørsted	241.75 MW	2024	8.09 ct/kWh
Borkum Riffgrund 3 (formerly Borkum Riffgrund West 1, Borkum Riffgrund West 2, OWP West)	2017/18	North Sea	Ørsted	900.00 MW	2025	0.00 ct/kWh
EnBW He Dreiht	2017	North Sea	EnBW	900.00 MW	2025	0.00 ct/kWh
Upcoming Tenders within the Central System (as in FEP 2019)				4,200.00 MW		
N-3.7	2021	North Sea		225.00 MW	2026	
N-3.8	2021	North Sea		375.00 MW	2026	
O-1.3	2021	Baltic Sea		300.00 MW	2026	
N-7.2	2022	North Sea		900.00 MW	2027	
N-3.5	2023	North Sea		420.00 MW	2028	
N-3.6	2023	North Sea		480.00 MW	2028	
N-6.6	2024	North Sea		630.00 MW	2029	
N-6.7	2024	North Sea		270.00 MW	2029	
N-9.1 TF 1	2025	North Sea		600.00 MW	2030	

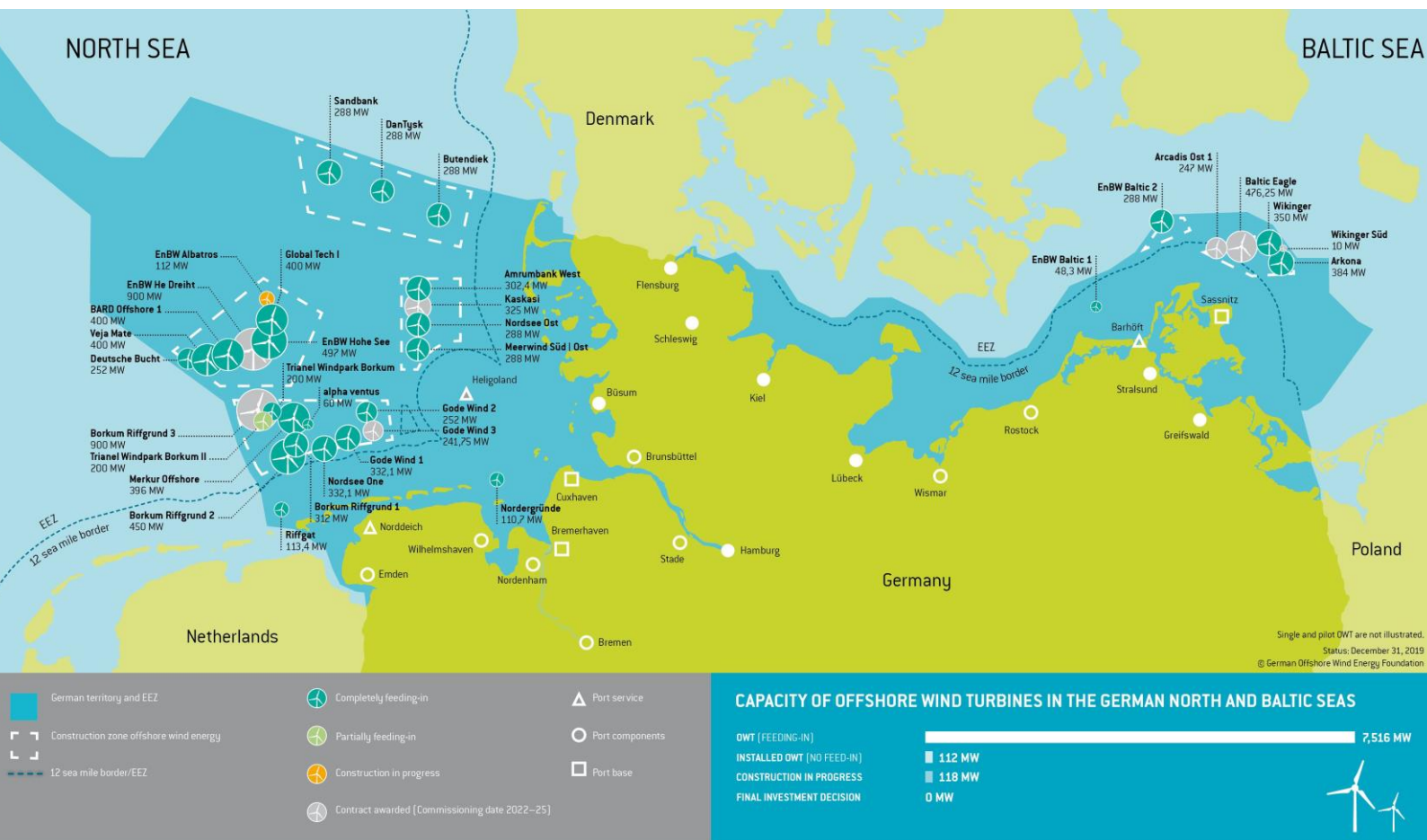
Activities in Offshore Wind Energy Projects

By the end of 2019, Germany counted 25 fully operational offshore wind energy projects. Included in this number are the Merkur Offshore, EnBW Hohe See and Deutsche Bucht projects, where all associated OWT were connected to the grid over the course of the year. Furthermore, half of the turbines of OWP Trianel Windpark Borkum II started feeding into the grid. Erection and commissioning work on the project continue in 2020. All turbines of the OWP EnBW Albatros were erected in 2019, but none had started feeding into the grid by the last day of 2019. The pilot turbines realized in connection with the Deutsche Bucht project are still under

construction, but installation work was paused by the end of the year.

Although grid connection confirmations were granted for several pilot turbines within OWP Kaskasi and EnBW Baltic II, final investment decisions for them have yet to be made.

Ten awards for seven OWP were issued in the two tendering rounds of 2017 and 2018. While they have secured their grid connection capacity claim and are to be realized by 2025, none of these projects have existing final investment decisions.



Overview Map of Offshore Wind Energy in Germany Year 2019 (© German Offshore Wind Energy Foundation)

Overview of Grid Connection Capacities

At the end of 2019, Germany had an offshore grid connection capacity of 8.2 GW in operation. A large portion of this capacity is either in use by fully operational OWT or slated towards projects currently under construction and awarded projects. Additional capacities are scheduled for projects in the central system.

Remaining capacities on existing connections can be engaged by pilot wind turbine generators. Further grid connections needed for offshore wind energy development in the future were conditionally confirmed within the Grid Development Plan (German: Netzentwicklungsplan or NEP) at the end of 2019.

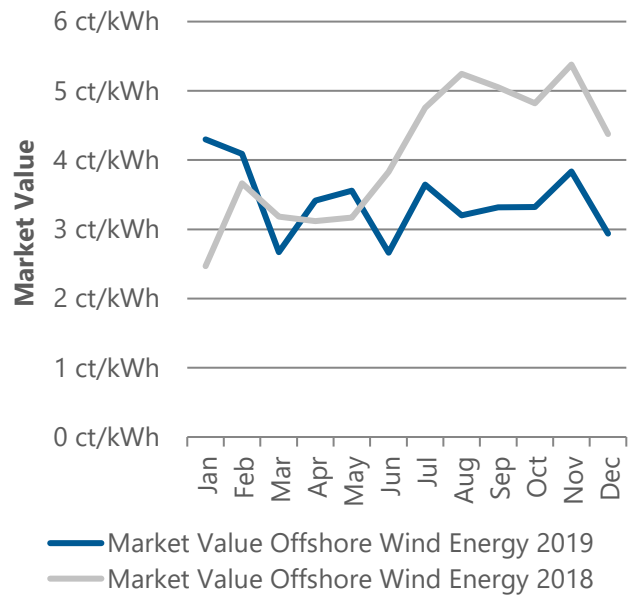
Installed and Planned Grid Connections (to Converter Station or Bundling Point) in the North and Baltic Seas (Database: NEP 2030 Version 2019 Second Draft and Confirmation, FEP 2019, TSO, Additional Research)

Grid Connection System	Status	(Expect.) Commissioning	(Plan.) Capacity	Assigned Offshore Wind Energy Projects until 2030
North Sea				
Nearshore Emden	In Operation	2004	4.5 MW	Single OWT Nearshore
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, 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, Pilot OWT
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 Test Operation	2019	900 MW	EnBW Hohe See, Global Tech I
NOR-3-3 (DoWin6)	Unter Construction	2023	900 MW	Gode Wind 3, N-3.7, N-3.8
NOR-1-1 (DoWin5)	Unter Construction	2024	900 MW	Borkum Riffgrund 3
NOR-7-1 (BorWin5)	Preparation of the Permitting Procedures	2025	900 MW	EnBW He Dreiht
NOR-7-2 (BorWin6)	Preparation of the Permitting Procedures	2027	930 MW	N-7.2
NOR-3-2 (DoWin4)	Preparation of the Planning and Permitting Procedures	2028	900 MW	N-3.5, N-3.6
NOR-6-3 (BorWin4)	Preparation of the Planning and Permitting Procedures	2029	900 MW	N-6.6, N-6.7
NOR-9-1 (BalWin1)	Confirmed in NEP	2029	2,000 MW	N-9.1 TF 1
NOR-10-1 (BalWin2)	Conditionally confirmed in NEP	2030	1,700 MW	No tender dates set
NOR-12-1 (LanWin1)	Conditionally confirmed in NEP	2030	2,000 MW	No tender dates set
NOR-11-1	Conditionally confirmed in NEP	after 2030	2,000 MW	No tender dates set
NOR-11-2	Conditionally confirmed in NEP	after 2030	2,000 MW	No tender dates set
NOR-13-1 (SylWin3)	Conditionally confirmed in NEP	after 2030	2,000 MW	No tender dates set
Baltic Sea				
Nearshore Rostock	In Operation	2006	2.5 MW	Singel OWT Nearshore
OST-3-1 (Baltic1)	In Operation	2011	51 MW	EnBW Baltic 1, GICON-SOF
OST-3-2 (Baltic2)	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)	Procurement, Permit still pending	2021	250 MW	Arcadis Ost 1
OST-2-2 (Ostwind 2)	Procurement, Permit still pending	2022	250 MW	Baltic Eagle
OST-2-3 (Ostwind 2)	Procurement, Permit still pending	2022	250 MW	Baltic Eagle
OST-7-1 (nördlich Warnemünde)	Conditionally confirmed in NEP	2024	300 MW	Offshore-Test Field (conditional: O-7) No tender dates set
OST-1-4	Confirmed in NEP	2026	300 MW	O-1.3
OST-6-1 ("Gennaker")	No need identified in FEP 2019, therefore not confirmed by the NEP			

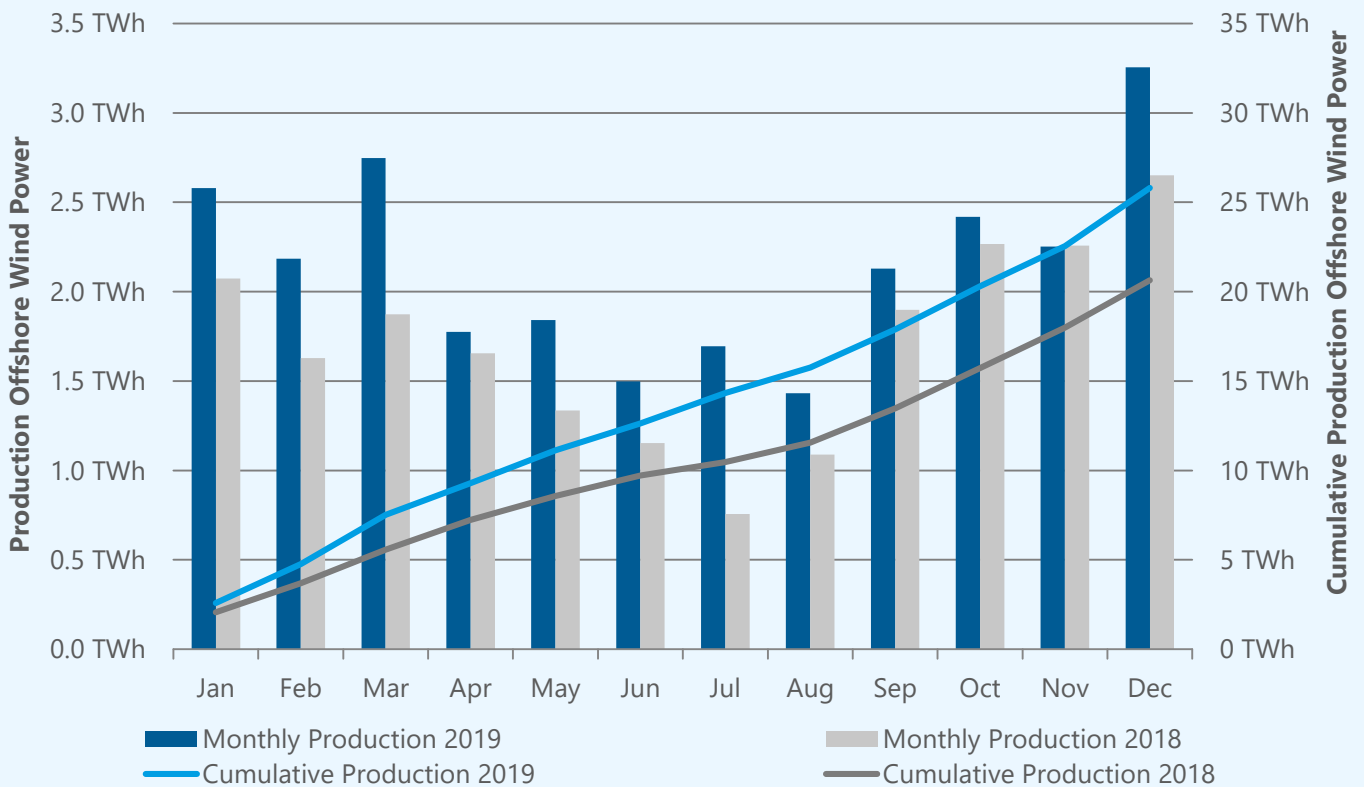
Monthly Power Production and Market Values

German OWP fed 25.8 TWh of power into the grid in 2019 according to the projection data provided by Transmission System Operators (German: Übertragungsnetzbetreiber or ÜNB). This equates to an increase of roughly 25% compared to the projection of the previous year. Following the considerable increase of monthly market values for offshore wind energy in the second half of 2018, these values decreased notably in 2019. The 4 € Cents/kWh mark was exceeded for the last time in February of 2019. Since then the average market values fluctuated between 2.7 and 3.8 € Cents/kWh.

Averaged over a 12-month period, the value-weighted market value is 3.4 € Cents/kWh, almost 0.7 € Cents/kWh below the value of the preceding year.



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 German Offshore Wind Energy Foundation was founded in 2005 on the initiative of the Federal Ministry of Environment. Also participating were the coastal states and all economic sectors engaged in offshore wind energy.

About VDMA Power Systems

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

About WAB e.V.

WAB is the voice of Germany's offshore wind industry and the onshore wind energy network in the Northwest region. WAB represents some 250 businesses and institutes active in all value-creation stages of the onshore and offshore wind energy sectors.