

Status of Offshore Wind Energy Development in Germany

Year 2018



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 the BNetzA turbine portfolio and the master data of transmission grid operators (TSO, German: Übertragungsnetzbetreiber or ÜNB).

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 Wind Farm Borkum Riffgrund 2 (2018)

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Contact

Deutsche WindGuard GmbH

Oldenburger Strasse 65

26316 Varel, Germany

Phone +49-4451 9515 0

Fax +49-4451 9515 29

Email info@windguard.de

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

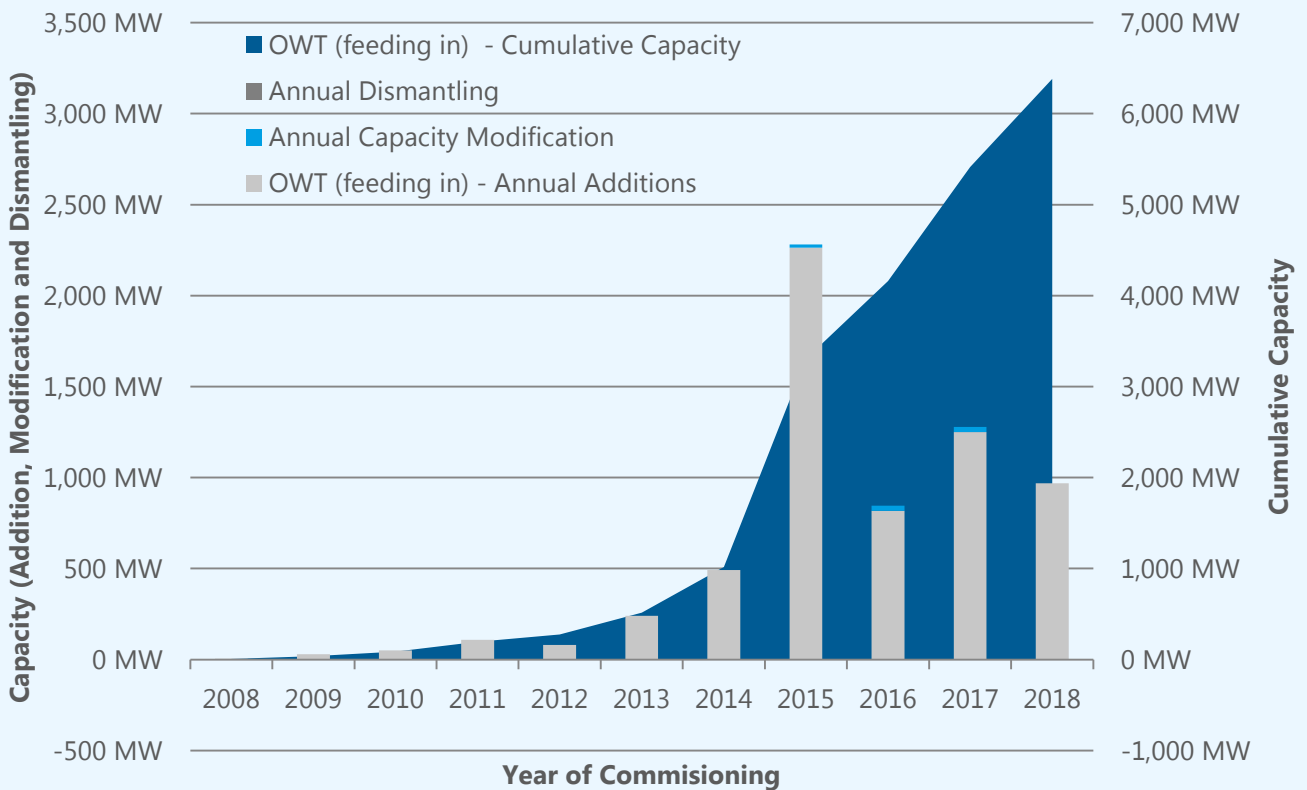
Offshore Wind Energy Development

In Germany in 2018, 136 new offshore wind turbine generators (OWT) producing an installed capacity of 969 MW started feeding into the grid. The cumulative capacity of all 1,305 OWT feeding into the grid in Germany by December 31st, 2018 was 6,382 MW. Compared to the previous year, this equates to a 23% decrease in annual additions.

In addition to the OWT already feeding into the grid, over the course of the year 46 additional OWT with 276 MW had been fully erected but were not feeding into the grid by December 31st, 2018. By the end of the year, a further 124 foundations had been prepared to receive their respective OWT.

Status of the Offshore Wind Energy Development

		Capacity	Number
Additions Year 2018	OWT (feeding in)	969 MW	136 OWT
	Installed OWT (no feed-in)	276 MW	46 OWT
	Foundations w/o OWT		124 Foundations
Cumulative 2018-12-31	OWT (feeding in)	6,382 MW	1,305 OWT
	Installed OWT (no feed-in)	276 MW	46 OWT
	Foundations w/o OWT		124 Foundations



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

Turbine Configuration and Foundation Types

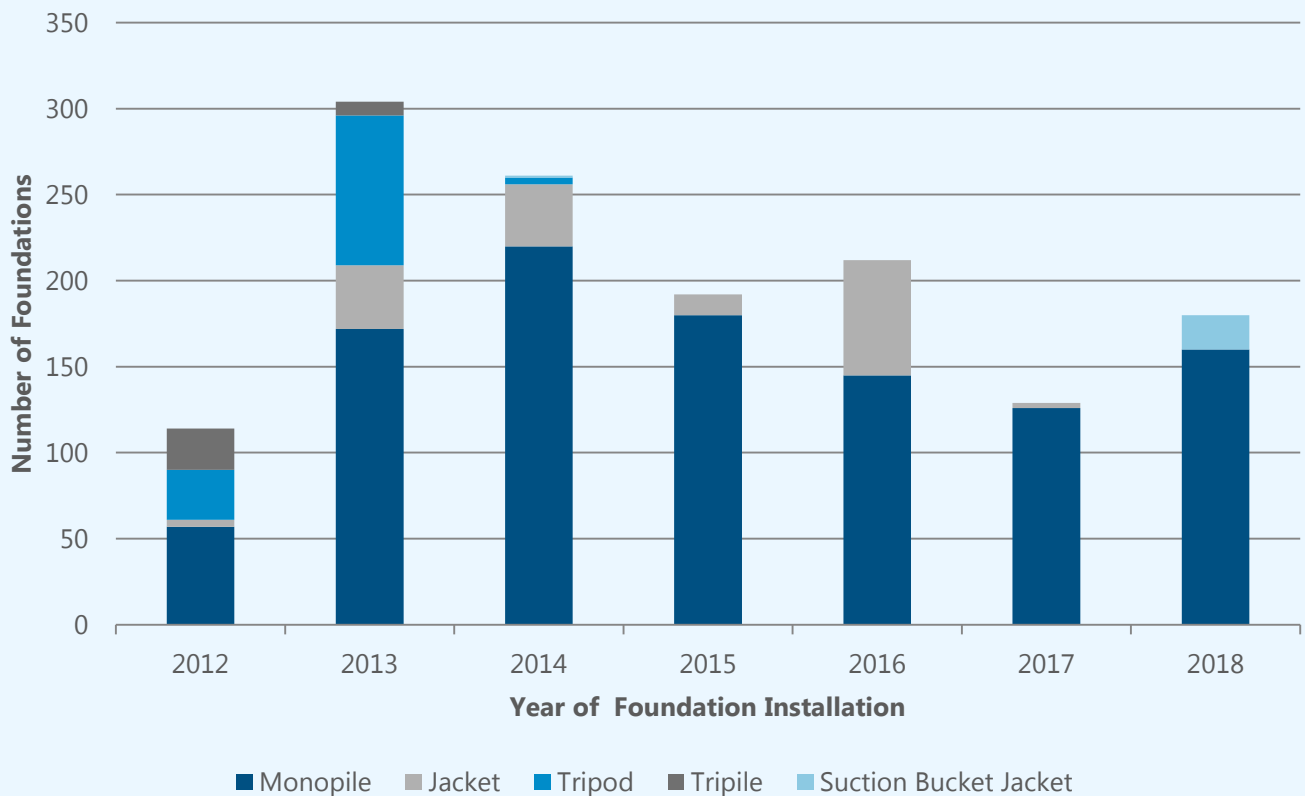
The additions of 2018 are characterized by a notable increase in size of offshore wind turbine generators. The OWT placed into service in 2018 had an average nominal capacity of over 7 MW. Compared to the installations of the previous year, rotor diameter and hub height also increased. The average specific area power decreased slightly compared to 2017.

Monopiles were used for most of the OWT foundations installed in 2018, corresponding to the trend of previous years. The second foundation technology employed in 2018, so-called suction bucket jackets, is being used in larger numbers for the first time in a German project.

Looking at the total portfolio, monopiles by far are the most implemented technology. In second and third place are jackets and tripods, which do not affect the current new construction.

Average Turbine Configuration of OWT Feeding into the Grid

Average Configuration	Additions Year 2018	Cumulative 2018-12-31
Nameplate Capacity (incl. upgrades)	7,124 kW	4,890 kW
Rotor Diameter	158 m	129 m
Hub Height	106 m	93 m
Specific Power	363 W/m ²	369 W/m ²



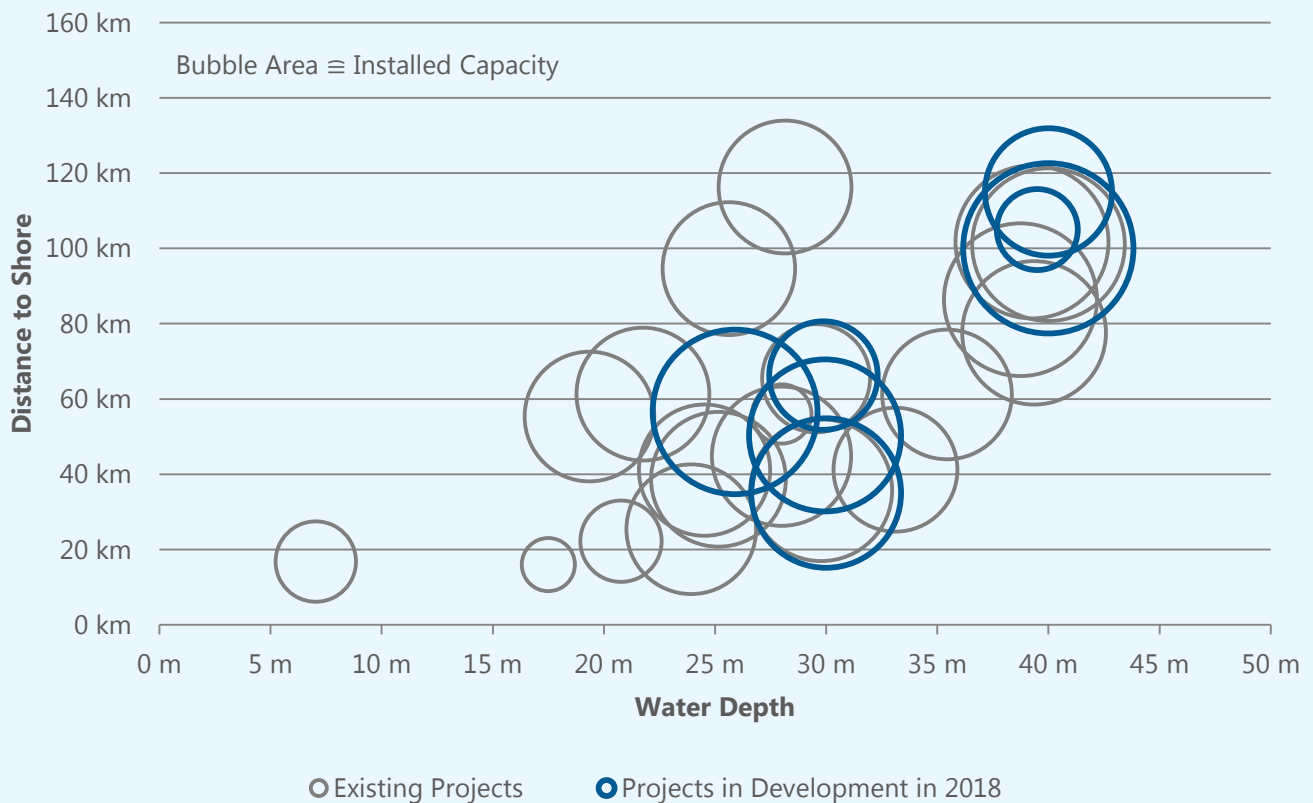
Foundation Types over Course of Time

Water Depth and Distance to Shore

There are notable variances in water depth and distance to shore of offshore wind energy projects in Germany. Some projects are barely 20 km off the mainland coast, while projects in the clusters of Zone 2 are clearly more than 100 km away from the mainland. Water depths differ accordingly.

A number of projects currently in development or realized during 2018, respectively, are found in

the center field of portfolio projects with regard to water depth and distance to shore. In particular, these are the North Sea-Cluster 2, as well as Baltic Sea projects. Projects realized in North Sea-Clusters 6 and 8 exhibit far larger distances to shore and water depths. They belong to projects furthest from the mainland in water depths of about 40 meters.



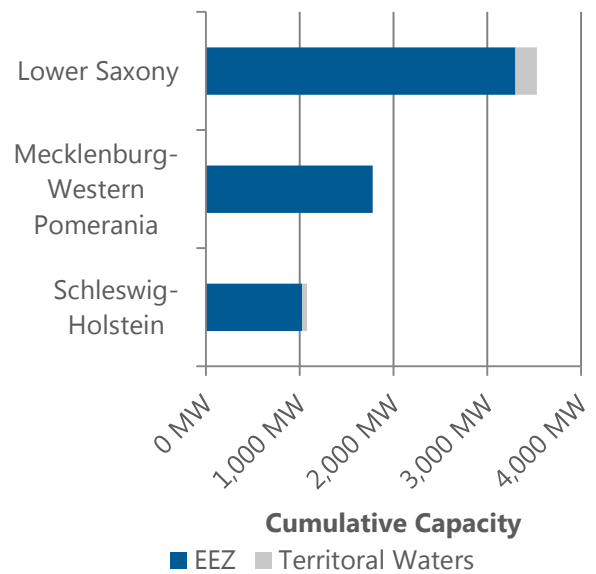
Water Depth and Distance to Shore

Distribution across Federal States and North and Baltic Seas

Over the course of 2018, OWT were placed into service both in the North and Baltic Seas. There are currently no further OWT under construction in the Baltic Sea. In comparison, at the end of 2018 in the North Sea there existed not only non-grid feeding OWT, but also foundations ready to be outfitted with OWT and OWT locations awaiting work to be done to them.

In total, by year's end the capacity feeding into the grid amounted to 5,306 MW in the North Sea and 1,076 MW in the Baltic Sea.

With regard to the distribution across the German federal states (allocation according to the location of the grid connection point) the vast majority of installed capacity is allocated to Lower Saxony. The share of OWT erected in territorial waters is small compared to OWT located in the exclusive economic zone (EEZ, German: Ausschließliche Wirtschaftszone or AWZ).



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

Distribution across the North and Baltic Seas

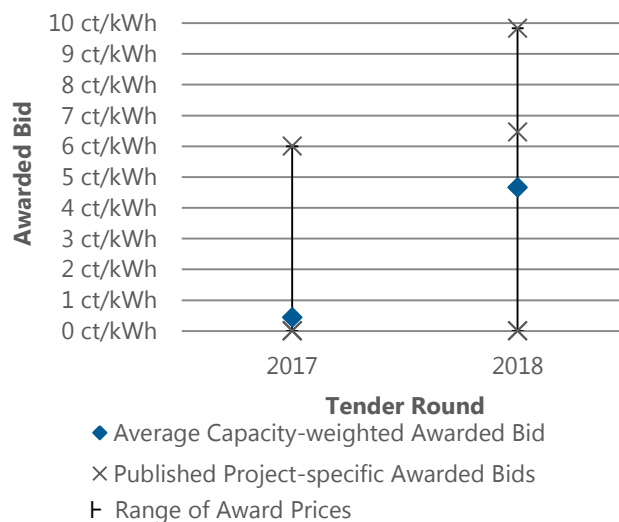
		North Sea		Baltic Sea	
		Capacity	Number	Capacity	Number
Additions Year 2018	OWT (feeding in)	585 MW	76 OWT	384 MW	60 OWT
	Installed OWT (no feed-in)	276 MW	46 OWT	0 MW	0 OWT
	Foundations w/o OWT		124 Foundations		0 Foundations
Cumulative 2018-12-31	OWT (feeding in)	5,306 MW	1,073 OWT	1,076 MW	232 OWT
	Installed OWT (no feed-in)	276 MW	46 OWT	0 MW	0 OWT
	Foundations w/o OWT		124 Foundations		0 Foundations

Tender Results within the Transitional System

A total of 3.1 GW of the grid connection capacity available up to 2025 was awarded in two tendering rounds in April 2017 and April 2018. Participation in these tendering rounds was only permitted for projects within territorial waters, as well as in Zones 1 and 2 that had either been approved or discussed prior to August 1st, 2016. The projects with the lowest per-kWh-cost were awarded winning bids. These projects are scheduled to become operational starting in 2021 and until 2025. The respective commissioning dates as planned by the individual stakeholders align with the corresponding grid connection availability.

The bid values of the awarded projects of both tendering rounds range from 0 € cents/kWh to 9.83 € cents/kWh. On a capacity weighted average, the award level of 0.44 € cents/kWh from the 2017 round is significantly lower than the 4.66 € cents/kWh from 2018.

Based on the current legislative environment, the next tendering round for offshore wind energy will not occur until September of 2021 within the framework of the so-called central model.



Range of Awarded Bids in Tender Rounds of the Transitional System (Database: BNetzA)

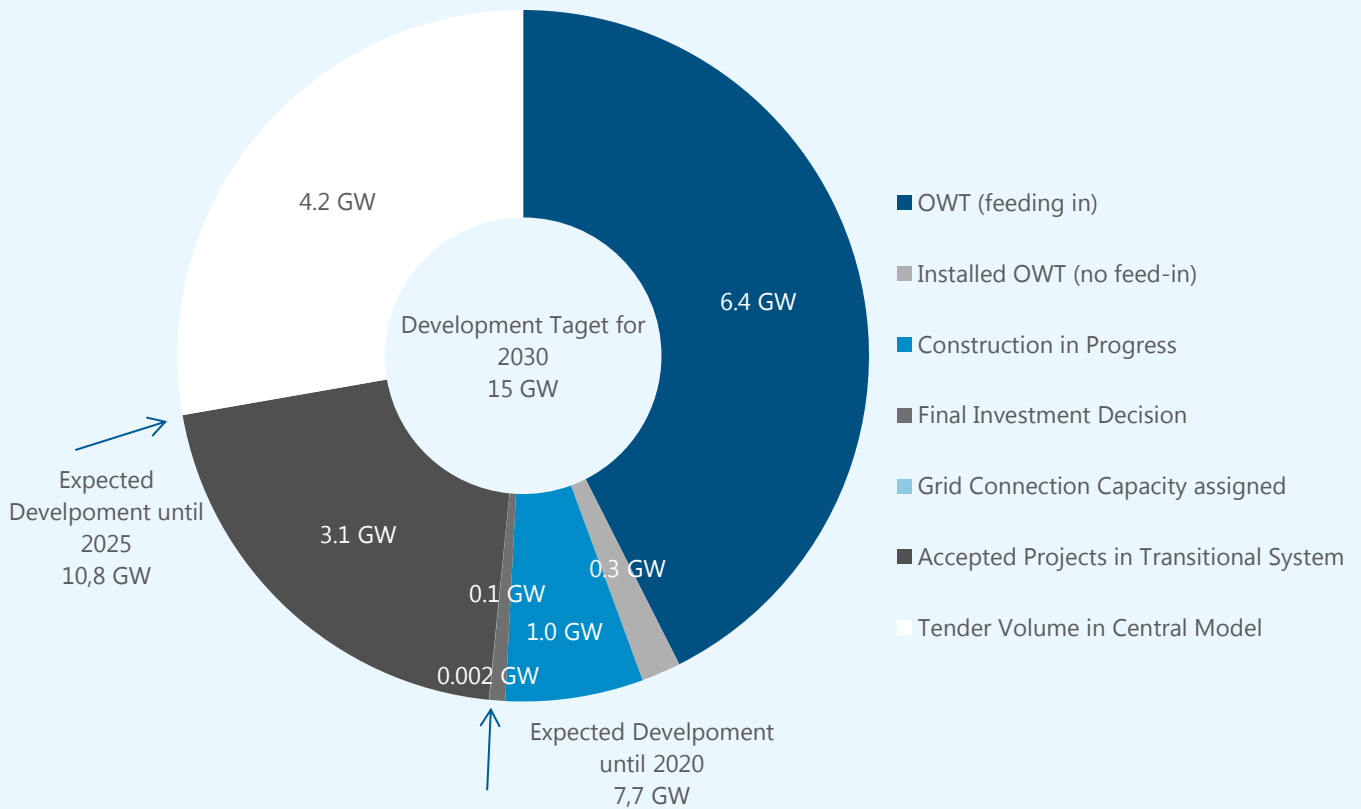
Awarded Offshore Projects in the North und Baltic Sea (Database: BNetzA, BSH, Additional Research)

Project	Tender Round	Developer/Owner	Accepted Capacity	Expected Year of Commissioning	Awarded Bids
North Sea					
Kaskasi II	2018	Innogy	325.00 MW	2022	unknown
OWP West	2017	Ørsted	240.00 MW	2024	0.00 € ct/kWh
Borkum Riffgrund West 2	2017	Ørsted	240.00 MW	2024	0.00 € ct/kWh
Gode Wind 3	2017	Ørsted	110.00 MW	2024	6.00 € ct/kWh
Borkum Riffgrund West 1	2018	Ørsted	420.00 MW	2024/25	0.00 € ct/kWh
Gode Wind 4	2018	Ørsted	131.75 MW	2024/25	9.83 € ct/kWh
EnBW He Dreiht	2017	EnBW	900.00 MW	2025	0.00 € ct/kWh
Baltic Sea					
Arcadis Ost 1	2018	Parkwind NV	247.25 MW	2021	unknown
Wikinger Süd	2018	Iberdrola	10.00 MW	2022	0.00 € ct/kWh
Baltic Eagle	2018	Iberdrola	476.00 MW	2022/23	6.46 € ct/kWh

Expansion Target and Allocated Grid Connection Capacity

Currently, the German Renewable Energy Sources Act (German: Erneuerbare-Energien-Gesetz or EEG) defines as development target an increase of installed offshore wind energy capacity to 6.5 GW for 2020 and 15 GW for 2030. The goal defined for 2020 has almost been reached as of today. A curtailment of development up to 2020 is set through the maximum allotted total capacity of 7.7 GW as defined by the Energy Industry Act (German: Energiewirtschaftsgesetz). This capacity has been exhausted by projects that received grid connection confirmation prior to the onset of the tendering system.

In addition, during the April 2017 and April 2018 tendering rounds of the transitional system following the Offshore Wind Energy Act (German: Windenergie-auf-See-Gesetz), projects with a capacity of 3.1 GW scheduled to become operational between 2021 and 2025 have been assigned. As a result, the overall cumulative capacity of 10.8 GW will be achieved by 2025. To reach the 2030 goal defined by the EEG, another 4.2 GW are needed. This capacity is to be awarded in tendering rounds according to the central model starting in 2021.

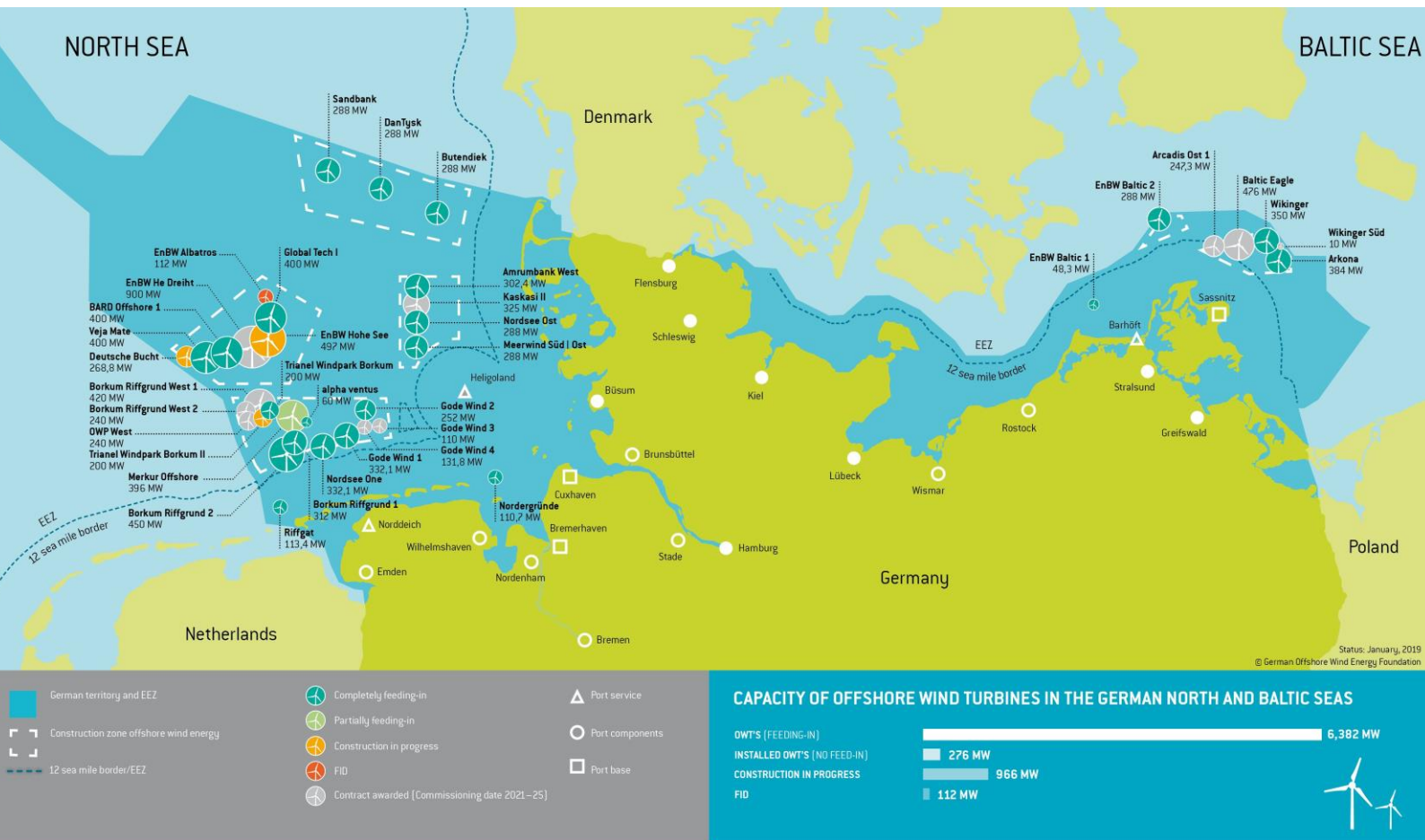


Development Status of Offshore Capacity with expected Commissioning by 2030

Activities in Offshore Wind Energy Projects

By December 31st, 2018, 22 offshore wind energy projects (OWP) are operational in Germany. Included are the projects Arkona and Borkum Riffgrund 2, in which all OWT started feeding into the grid during the course of 2018. Added to these are four additional OWP that were in the construction phase by the end of 2018 and one project with an existing investment decision. OWT installation within the OWP Merkur Offshore was completed and a number of OWT were placed into service. Over the course of 2018, foundations were installed in the projects Trianel Windpark Borkum II, EnBW Hohe See and Deutsche Bucht.

A final investment decision is available for project EnBW Albatros, which will be realized along with EnBW Hohe See. An investment decision was also made in 2018 for two pilot OWT in the North Sea, which will henceforth be attributed to the project Deutsche Bucht. The OWT GICON-SOF has secured its grid connection confirmation, but has not yet received a final investment decision. A total of 10 OWP were awarded during the tendering rounds of 2017 and 2018. They have hence secured their grid connection capacity and are to be realized by 2025.



Overview Map of Offshore Wind Energy in Germany 2018 (©Map: German Offshore Wind Energy Foundation)

Overview of Grid Connection Capacities

By the end of 2018, in the German North and Baltic Seas a grid connection capacity of about 6.8 GW was available for offshore wind projects. By 2020, further grid connection systems of 1.4 GW overall are scheduled to be operational. Additional capacities of 3.45 GW are budgeted by 2025.

For OWP that will be realized in the central system starting in 2026, offshore connection line

requirements will be based on the area development plan (German: Flächenentwicklungsplan or FEP) developed by the Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie or BSH). The FEP is currently only available in draft and should be finalized by June 2019.

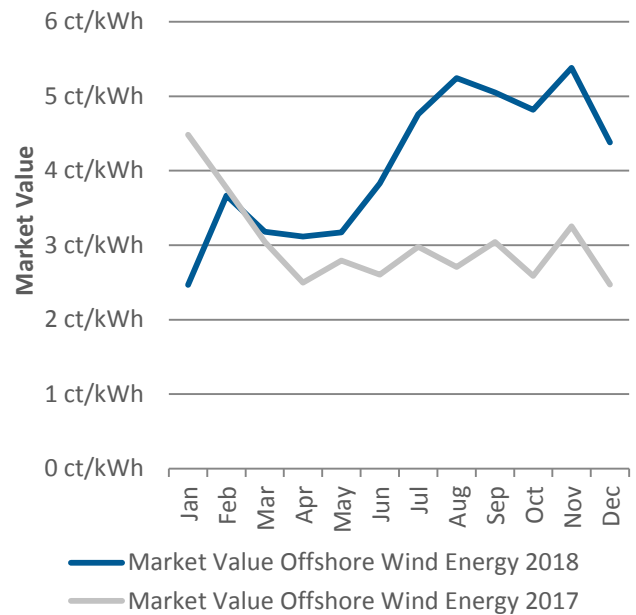
Installed and Planned Grid Connections (to Converter Station or Bundling Point) in the North and Baltic Seas (Database: Draft FEP, O-NEP 2030 (2nd Draft, Confirmation and Implementation Report, Additional Research)

Grid Connection System	Status	(Expect.) Commissioning	(Plan.) Capacity	Assigned Offshore Wind Energy Projects
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 (DoIWin1)	In Operation	2015	800 MW	Borkum Riffgrund 1, Trianel Windpark Borkum
NOR-4-1 (HelWin1)	In Operation	2015	576 MW	Meerwind Süd Ost, Nordsee Ost
NOR-5-1 (SylWin1)	In Operation	2015	864 MW	Butendiek, DanTysk, Sandbank
NOR-4-2 (HelWin2)	In Operation	2015	690 MW	Amrumbank West, Kaskasi II
NOR-6-2 (BorWin2)	In Operation	2015	800 MW	EnBW Albatros, Deutsche Bucht, Veja Mate
NOR-3-1 (DoIWin2)	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 (DoIWin3)	In Operation	2018	900 MW	Borkum Riffgrund 2, Merkur Offshore
NOR-8-1 (BorWin3)	Under Construction	2019	900 MW	EnBW Hohe See, Global Tech I
NOR-3-3 (DoIWin6)	Construction Preparations Under Way	2023	900 MW	Gode Wind 3, Gode Wind 4
NOR-1-1 (DoIWin5)	In the Permitting Procedure, Award Process in Preparation	2024	900 MW	Borkum Riffgrund West 2, OWP West, Borkum Riffgrund West 1
NOR-7-1 (BorWin5)	In the Permitting Procedure	2025	900 MW	EnBW He Dreih
NOR-7-2 (BorWin6)	Preparation of the Planning and Permitting Procedures	2027	900 MW	
NOR-3-2 (DoIWin4)	Preparation of the Planning and Permitting Procedures	2028	900 MW	
NOR-6-3 (BorWin4)	Preparation of the Planning and permitting Procedures	2029	979 MW	
NOR-9-1	Named in the FEP draft	n.a.	1,000 MW	
Baltic Sea				
Nearshore Rostock	In Operation	2006	3 MW	Single OWT Nearshore
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)	Under Construction	2019	250 MW	Arkona
OST-1-3 (Ostwind 1)	Under Construction	2019	250 MW	Arkona, Wikinger, Wikinger Süd
OST-2-1 (Ostwind 2)	In the Permitting and Award Procedure	2021	250 MW	Arcadis Ost 1
OST-2-2 (Ostwind 2)	In the Permitting and Award Procedure	2021	250 MW	Baltic Eagle
OST-2-3 (Ostwind 2)	In the Permitting and Award Procedure	2022	250 MW	Baltic Eagle
OST-1-4 (or OST-2-4)	Named in the FEP draft	2026	300 MW	
OST-7-1	Named in the FEP draft	2027	n.a.	

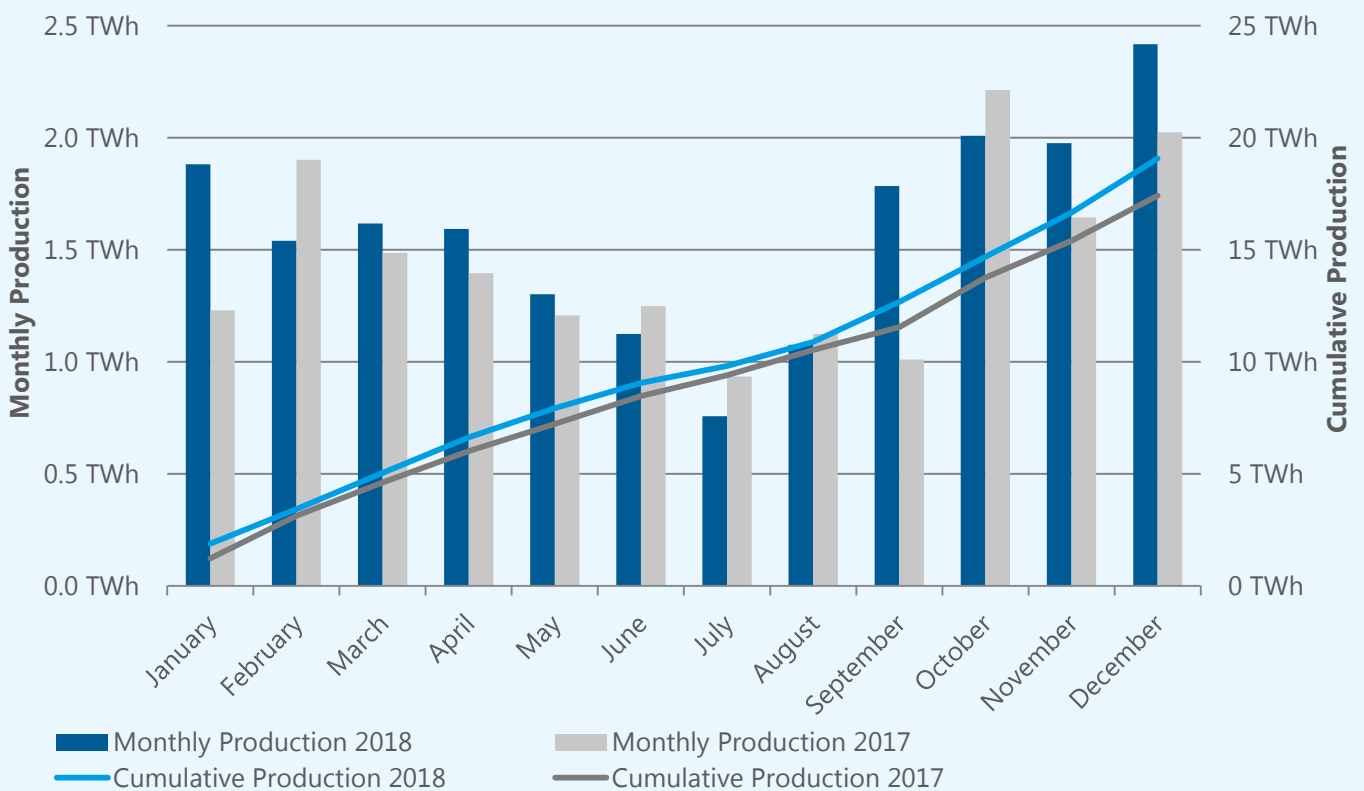
Monthly Power Production and Market Values

According to calculations of the Fraunhofer ISE, German OWP fed 18.8 TWh of electricity into the grid in 2018. This is equivalent to an increase in feed-in of offshore energy of 8% compared to the previous year, giving offshore wind energy a share of about 3.5% of the public power supply in 2018. The production data forecasted by Transmission System Operators (TSO, German: Übertragungsnetzbetreiber or ÜNB) is slightly higher.

The average, volume-weighted power market revenues per kilowatt hour for offshore OWT (monthly market values) increased notably over the course of the year compared to the level of the previous year. The average volume-weighted market value increased from 3.0 € cents/kWh in 2017 by 37% to 4.1 € cents/kWh in 2018. Where in January 2018 the value was still at 2.5 € cents/kWh, in November the maximum market value of the year of 5.4 € cents/kWh was reached.



Monthly Market Values for Offshore Wind Energy (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 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)

BWO represents all businesses that develop, construct and operate offshore wind farms in the German North and Baltic Seas. This allows BWO to combine forces to achieve a successful energy transition in Germany and Europe.

About Stiftung OFFSHORE-WINDENERGIE

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

About VDMA Power Systems

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

About the WAB e.V.

WAB is the network of the onshore wind energy in Germany's northwest region and serves as a nationwide contact for the offshore wind industry. Since 2002, more than 350 German companies and institutes have become members of WAB.