

Status of Offshore Wind Energy Development in Germany

First Half of 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

Offshore Wind Farm Merkur Offshore (2019)

© Merkur Offshore GmbH | picture by van der Kloet

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Offshore Wind Energy Development

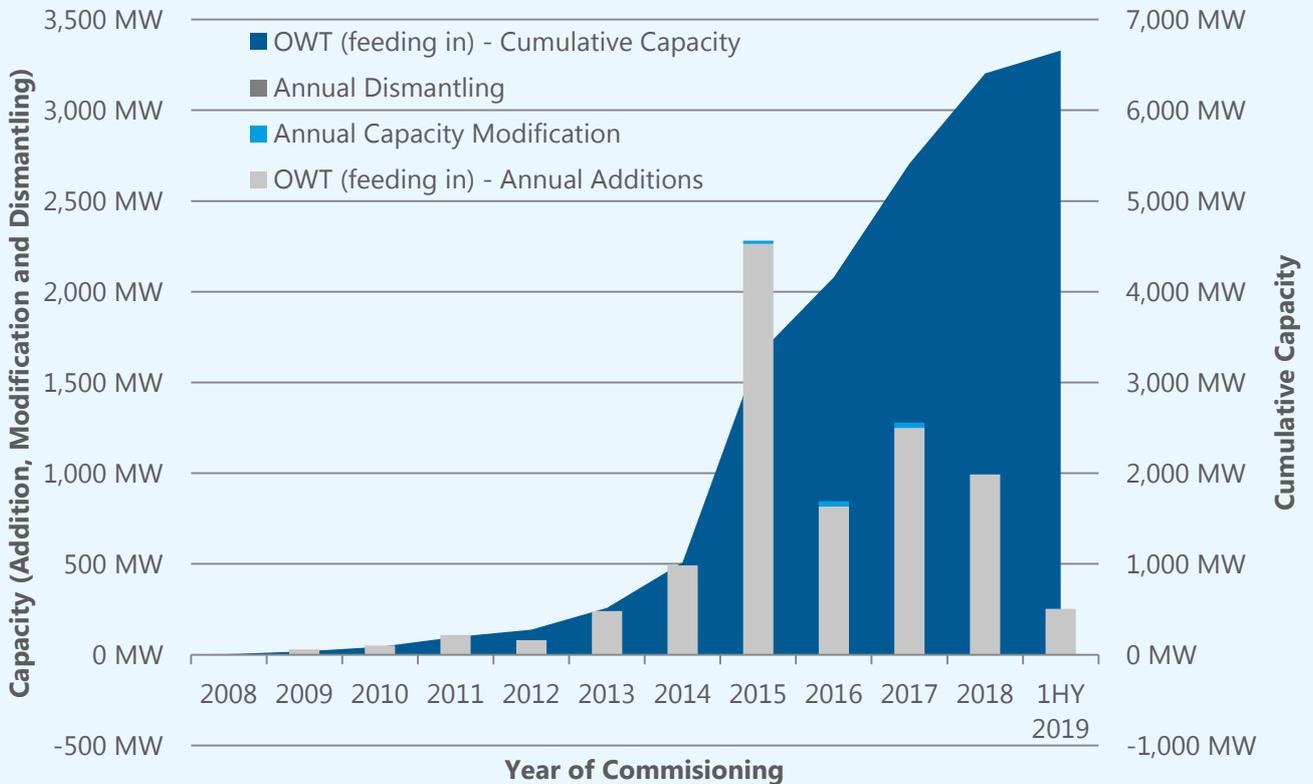
In the first half of 2019, 42 offshore wind turbine generators (OWT) with a total installed capacity of 252 MW fed into the grid for the first time in Germany. The total resulting 1,351 operational OWT have a cumulative installed capacity of 6,658 MW as of June 30, 2019.

In addition to the turbines already feeding into the grid, construction was completed on 56 further OWT with an overall capacity of 410 MW. All OWT erected during 2018 are now in operation.

The first six months of 2019 saw the installation of another 26 foundations, all of which have yet to be equipped with OWT. Along with those erected in 2018, there is a total of 94 foundations awaiting installation of their respective OWT.

Status of the Offshore Wind Energy Development

		Capacity	Number
Additions 1 st Half of 2019	OWT (feeding in)	252 MW	42 OWT
	Installed OWT (no feed-in)	410 MW	56 OWT
	Foundations w/o OWT		26 Foundations
Cumulative 2019-06-30	OWT (feeding in)	6,658 MW	1,351 OWT
	Installed OWT (no feed-in)	410 MW	56 OWT
	Foundations w/o OWT		94 Foundations



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

Turbine Configuration and Foundation Types

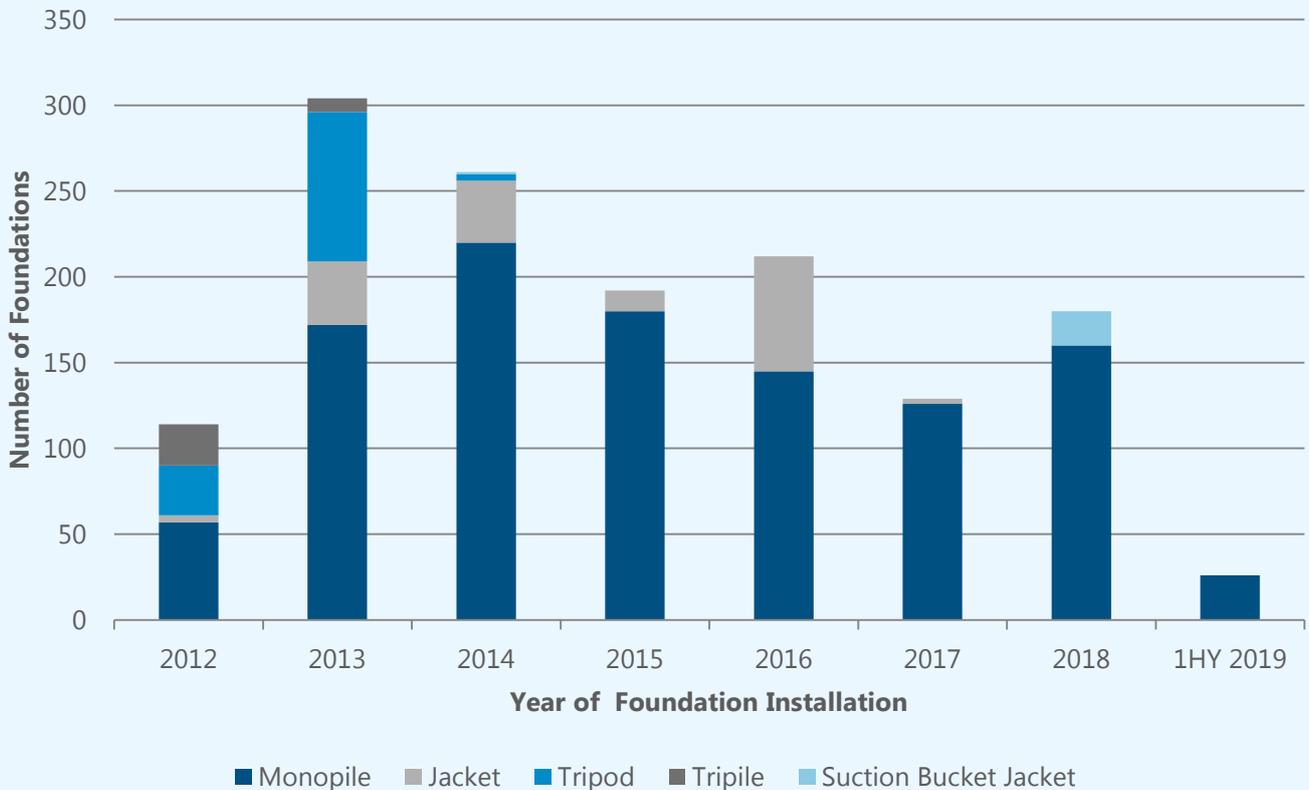
All OWT placed into operation during the first half of 2019 are part of the same project. Each turbine has a nominal capacity of 6 MW, a rotor diameter of 151 meters and a hub height of 103 meters. The capacity, rotor diameter and hub height values of current-year turbines are lower in comparison to the average of OWT installed in 2018. Due to the stronger decrease of the average nominal capacity in relation to the rotor area, the specific power of 335 MW/m² is also lower than that of the previous year.

Monopiles were used exclusively for OWT foundations in the first six months of 2019. Regardless of the expected erection of two mono-bucket foundations within the second half of 2019, monopiles remain by far the most employed technology.

This is also reflected in the overall portfolio, where nearly three-quarters of all foundations are monopiles. Jackets and tripods are in second and third place, respectively, but neither plays any role in the current additions.

Average Turbine Configuration of OWT Feeding into the Grid

Average Configuration	Additions 1HY 2019	Cumulative 2019-06-30
Nameplate Capacity (incl. upgrades)	6,000 kW	4,928 kW
Rotor Diameter	151 m	130 m
Hub Height	103 m	94 m
Specific Power	335 W/m ²	368 W/m ²



Foundation Types over Course of Time

Water Depth and Distance to Shore

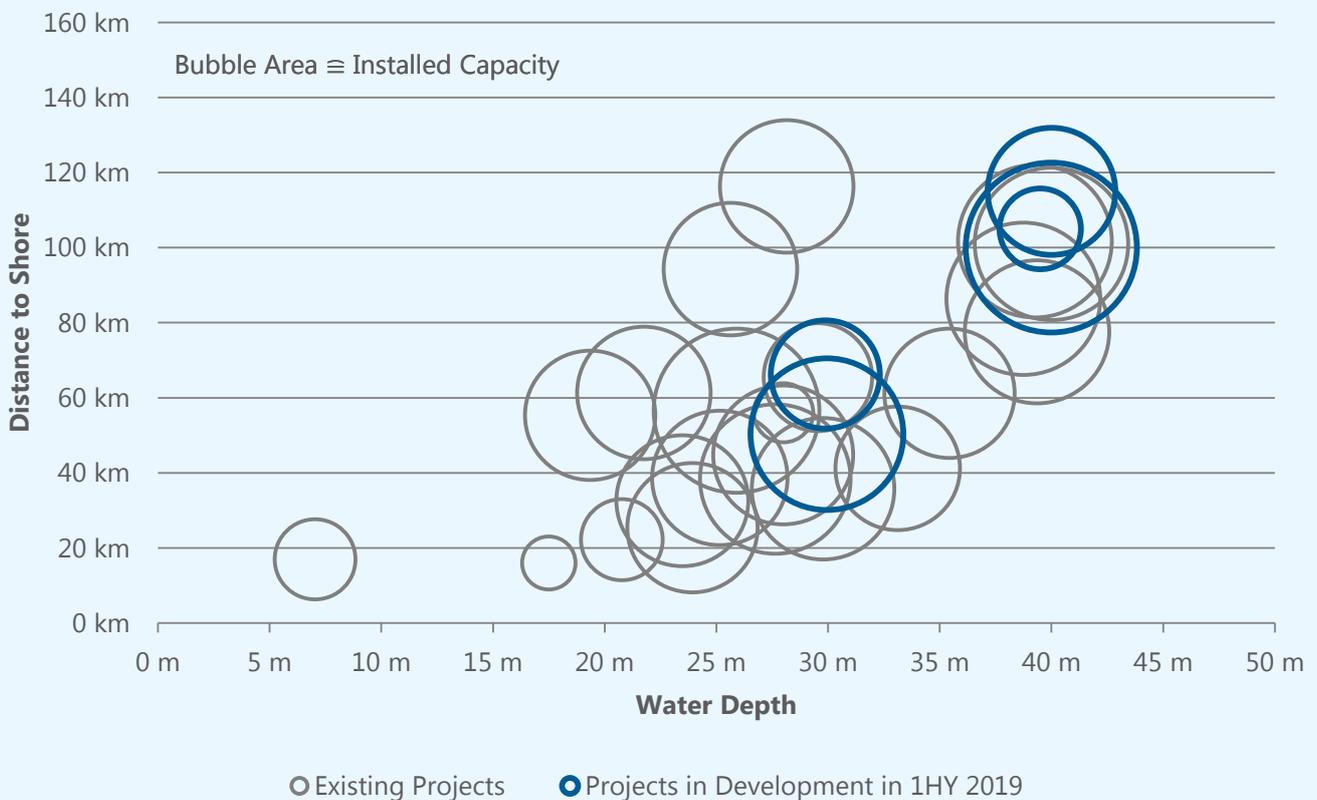
There is remarkable variation in the water depth and distance to shore of offshore wind energy projects (OWP) in Germany. Some projects are a mere 20 kilometers away from the mainland, while other projects located in the Exclusive Economic Zone (EEZ; German: Ausschliessliche Wirtschaftszone or AWZ) are far beyond 100 kilometers from shore. The water depths at which OWT are erected vary along those same lines.

A part of the OWP currently being realized belongs to projects located farthest away from the mainland at the largest water depths. Two further projects presently under construction are situated in midfield with regard to water depth and distance to shore.

At 30.5 meters, the median water depth of OWT with a first-time feed into the grid during the first half of 2019 is slightly larger than the median depth of the cumulative portfolio. The new OWT are located 48 kilometers from shore and are thus much closer to the mainland than portfolio turbines on average.

Average Location of OWT Feeding into the Grid

Average Location	Additions 1 st Half of 2019	Cumulative 2019-06-30
Water Depth	30.5 m	29.0 m
Distance to Shore	48 km	62 km

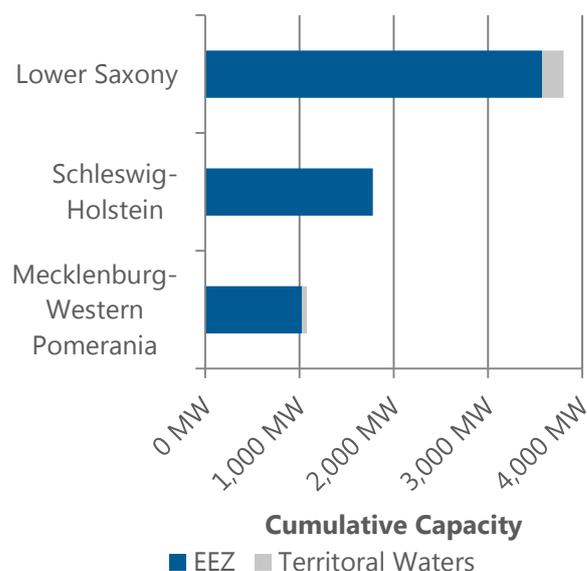


Water Depth and Distance to Shore

Distribution across Federal States and North and Baltic Seas

Foundation and OWT installations during the first half of 2019 occurred exclusively in the North Sea. Currently, no OWT construction activity is going on in the Baltic Sea. By June 30, 2019 in all, capacities feeding into the grid amounted to 5,582 MW from North Sea OWP and 1,076 MW from Baltic Sea OWP.

With regard to the distribution across the German federal states (allocation according to the grid access point location), the majority of the installed capacity is connected in Lower Saxony. The share of turbines installed in coastal waters is trivial compared to that of turbines erected in the EEZ.



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

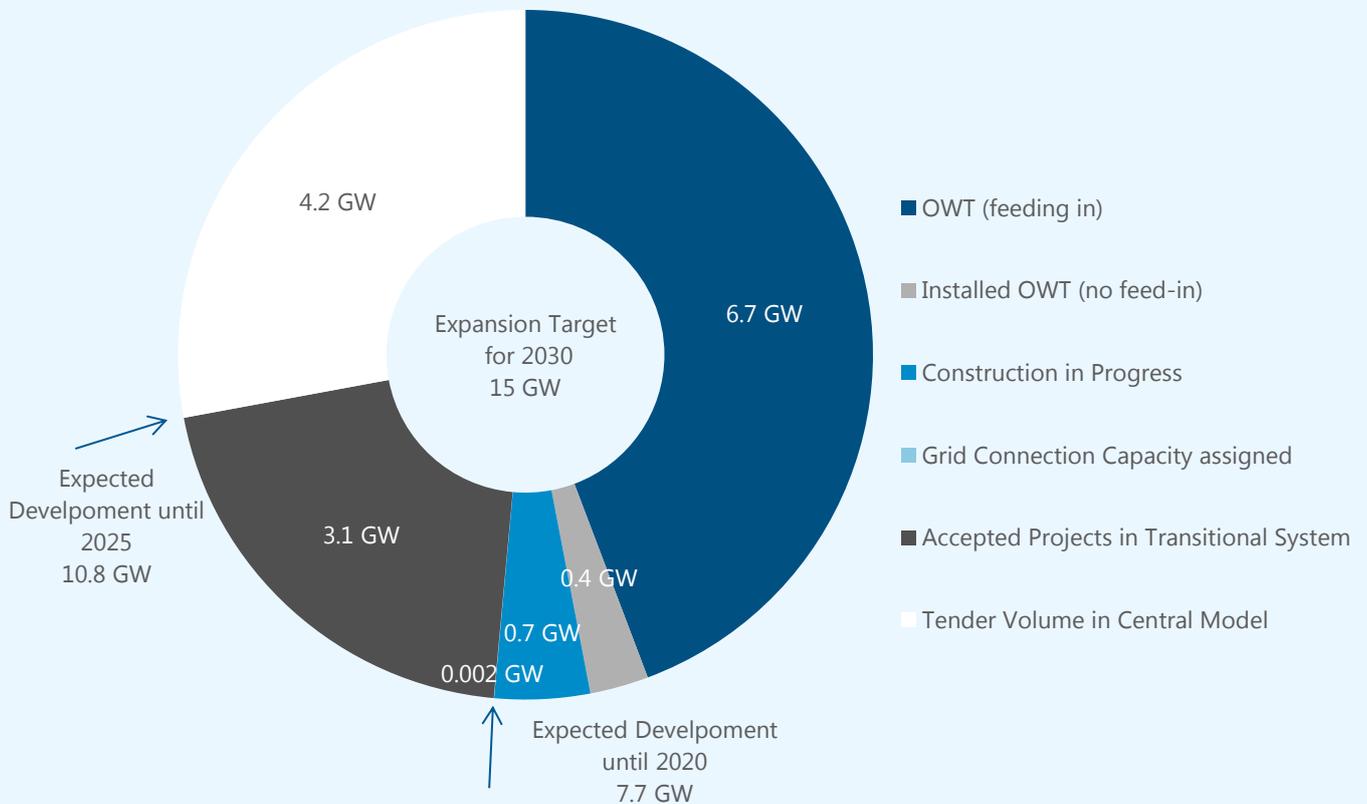
Distribution across the North and Baltic Seas

		North Sea		Baltic Sea	
		Capacity	Number	Capacity	Number
Additions 1HY 2019	OWT (feeding in)	252 MW	42 OWT	0 MW	0 OWT
	Installed OWT (no feed-in)	410 MW	56 OWT	0 MW	0 OWT
	Foundations w/o OWT		26 Foundations		0 Foundations
Cumulative 2019-06-30	OWT (feeding in)	5,582 MW	1,119 OWEA	1,076 MW	232 OWT
	Installed OWT (no feed-in)	410 MW	56 OWEA	0 MW	0 OWT
	Foundations w/o OWT		94 Foundations		0 Foundations

Expansion Target and Allocated Grid Connection Capacity

The German Renewable Energy Sources Act (German: Erneuerbare-Energien-Gesetz or EEG) currently defines an installed offshore wind energy capacity expansion target of 6.5 GW by 2020 and 15 GW by 2030. The 2020 target had already been reached by the end of the first half of 2019. A limitation of the development by 2020 is established by the maximum assignable overall grid connection capacity of 7.7 GW as defined by the Energy Industry Act (German: Energiewirtschaftsgesetz). This capacity is exhausted by projects currently under construction and is expected to be achieved by end of the year.

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 being realized between 2021 and 2025. In total, it is expected that a cumulative capacity of 10.8 GW will be achieved by 2025. The remaining 4.2 GW required to meet the currently defined 2030 offshore wind energy addition objective will be awarded through 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

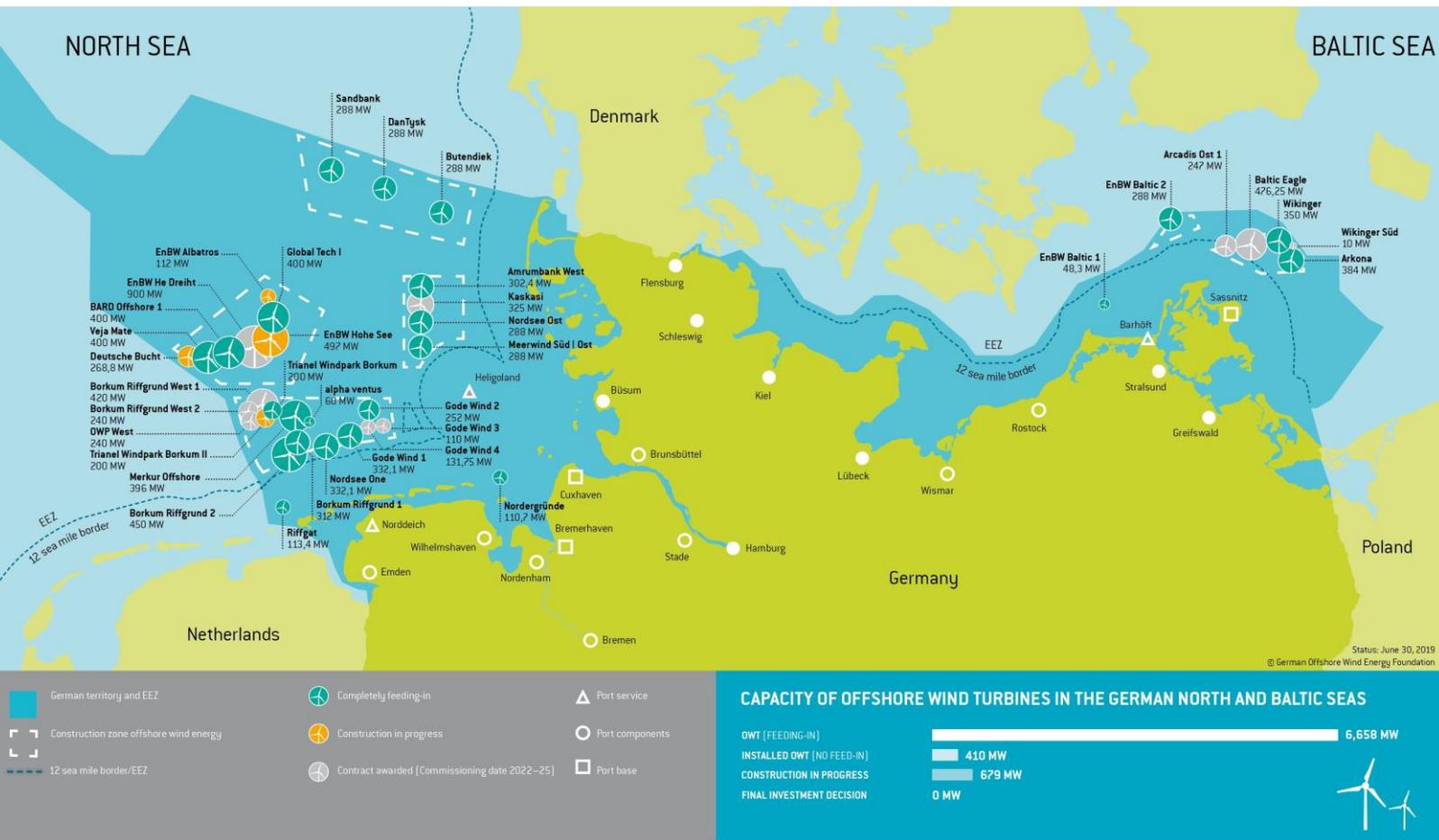
By June 30, 2019 there are 23 offshore wind energy projects in operation in Germany. Included in these is the Merkur Offshore project, in which the last OWT began feeding into the grid by the end of the first half of 2019. On top of this are four additional OWP that were under construction at the end of June 2019.

Foundations were erected in the Deutsche Bucht, EnBW Hohe See and EnBW Albatros projects over the course of the first six months of the year. Foundation installations in OWP Trianel Windpark Borkum II had been completed by the end of the previous year. With the exception of the two Deutsche Bucht project pilot turbine foundations, foundation installations have been completed in all offshore wind farms currently under construction.

OWP Deutsche Bucht and EnBW Hohe See already saw the erection of turbines within the first half of 2019. The start of turbine installations in the OWP Trianel Windpark Borkum II and EnBW Albatros is planned for the second half of this year.

The OWT GICON-SOF has received grid connection confirmation, but is still lacking its final investment decision.

A total of ten OWP were awarded during the two tendering rounds of 2017 and 2018. They have thus secured their grid connection capacity claim and are to be realized by 2025. Final investment decisions do not yet exist for any of these projects.



Overview Map of Offshore Wind Energy in Germany 1st Half of 2019 (© German Offshore Wind Energy Foundation)

Offshore Development until 2030

Offshore wind energy projects in the German North and Baltic Sea scheduled for completion by the end of 2025 have already been determined by the 2017 and 2018 tendering rounds. A total of 3,100 MW in ten projects were awarded in the two tendering rounds of the transitional system. Of that, 733 MW are located in the Baltic Sea and 2,367 MW are being built in the North Sea. The bid values of these ten OWP fell between zero and 9.83 € cents/kWh.

Starting in 2021, areas in which OWP may be realized will be tendered in the central model. Projects awarded in it are scheduled to become

operational from 2026 onward. By 2025, 4,200 MW located in nine (partial) areas will be tendered successively in order to reach the expansion target of 15 grid-connected GW by 2030. At 3,900 MW of the tendered volume, the majority of it is located in the North Sea, the remaining 300 MW are located in the Baltic Sea. The areas and the tendering years were defined by the Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie or BSH) in the Site Development Plan (German: Flächenentwicklungsplan or FEP).

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
Concluded Tenders within the Transitional System						
Kaskasi	2018	North Sea	Innogy	325.00 MW	2022	unknown
Wikinger Süd	2018	Baltic Sea	Iberdrola	10.00 MW	2022	0.00 € ct/kWh
Baltic Eagle	2018	Baltic Sea	Iberdrola	476.25 MW	2022/23	6.46 € ct/kWh
Gode Wind 3	2017	North Sea	Ørsted	110.00 MW	2023	6.00 € ct/kWh
Gode Wind 4	2018	North Sea	Ørsted	131.75 MW	2023	9.83 € ct/kWh
Arcadis Ost 1	2018	Baltic Sea	Parkwind	247.00 MW	2023	unknown
Borkum Riffgrund West 2	2017	North Sea	Ørsted	240.00 MW	2024	0.00 € ct/kWh
OWP West	2017	North Sea	Ørsted	240.00 MW	2024	0.00 € ct/kWh
Borkum Riffgrund West 1	2018	North Sea	Ørsted	420.00 MW	2024	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)						
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	

Overview of Grid Connection Capacities

By the end of June 2019, offshore wind projects have available to them a grid connection capacity of 6.8 GW in Germany. A further 1.4 GW are scheduled to become fully operational this year and by the end of 2025 another 3.45 GW of additional capacity are planned. This will be added by a grid connection for the planned

Offshore Test Field. Following the Site Development Plan, 4 GW of capacity will be developed by the end of 2030. This will be used along with available grid connection capacities realized previously to connect the OWP awarded in the central model.

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

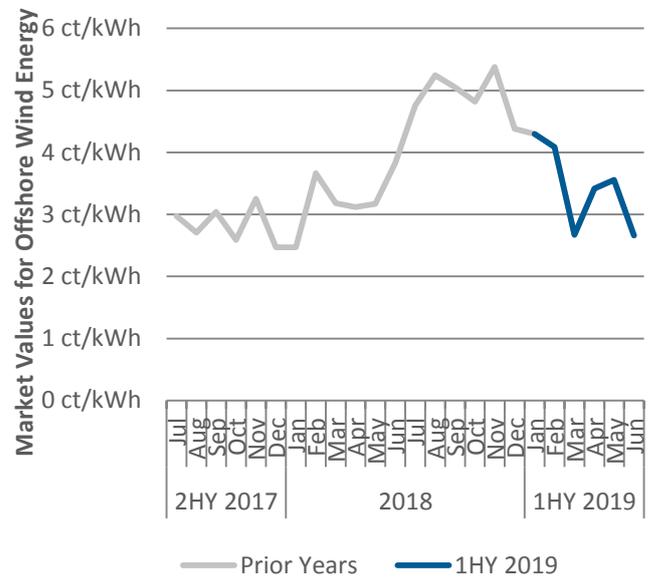
Grid Connection System	Status	(Expect.) Commissioning	(Plan.) Capacity	Assigned Offshore Wind Energy Projects until 2030
North Sea				
Nearshore Emden	In Operation	2004	4.5 MW	Single OWT Nearshore
NOR-2-1 (Alpha Ventus)	In Operation	2009	62 MW	alpha ventus
NOR-6-1 (BorWin1)	In Operation	2010	400 MW	BARD Offshore 1
NOR-0-1 (Riffgat)	In Operation	2014	113 MW	Riffgat
NOR-2-2 (DolWin1)	In Operation	2015	800 MW	Borkum Riffgrund 1, Trianel Windpark Borkum and 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
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 (DolWin2)	In Operation	2016	916 MW	Gode Wind 1 and 2, Nordsee One
NOR-0-2 (Nordergründe)	In Operation	2017	111 MW	Nordergründe
NOR-2-3 (DolWin3)	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 (interim NOR-6-2)
NOR-3-3 (DolWin6)	Under Construction	2023	900 MW	Gode Wind 3 and 4, N-3.7, N-3.8
NOR-1-1 (DolWin5)	Under Construction	2024	900 MW	Borkum Riffgrund West I and II, OWP West
NOR-7-1 (BorWin5)	In the Permitting Procedure	2025	900 MW	EnBW He Dreiht
NOR-7-2 (BorWin6)	Preparation of the Planning and Permitting Procedures	2027	900 MW	N-7.2
NOR-3-2 (DolWin4)	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)	Identified in FEP	2030	1,000 MW	N-9.1 TF 1
Baltic Sea				
Nearshore Rostock	In Operation	2006	2.5 MW	Single 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 preliminary Test Operation	2019	250 MW	Arkona
OST-1-3 (Ostwind 3)	In preliminary Test 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	2021	250 MW	Baltic Eagle
OST-2-3 (Ostwind 2)	Procurement, Permit still pending	2022	250 MW	Baltic Eagle
OST-1-4	Identified in FEP	2026	300 MW	O-1.3
OST-7-1	Identified in FEP			Offshore Test Field

Monthly Power Production and Market Values

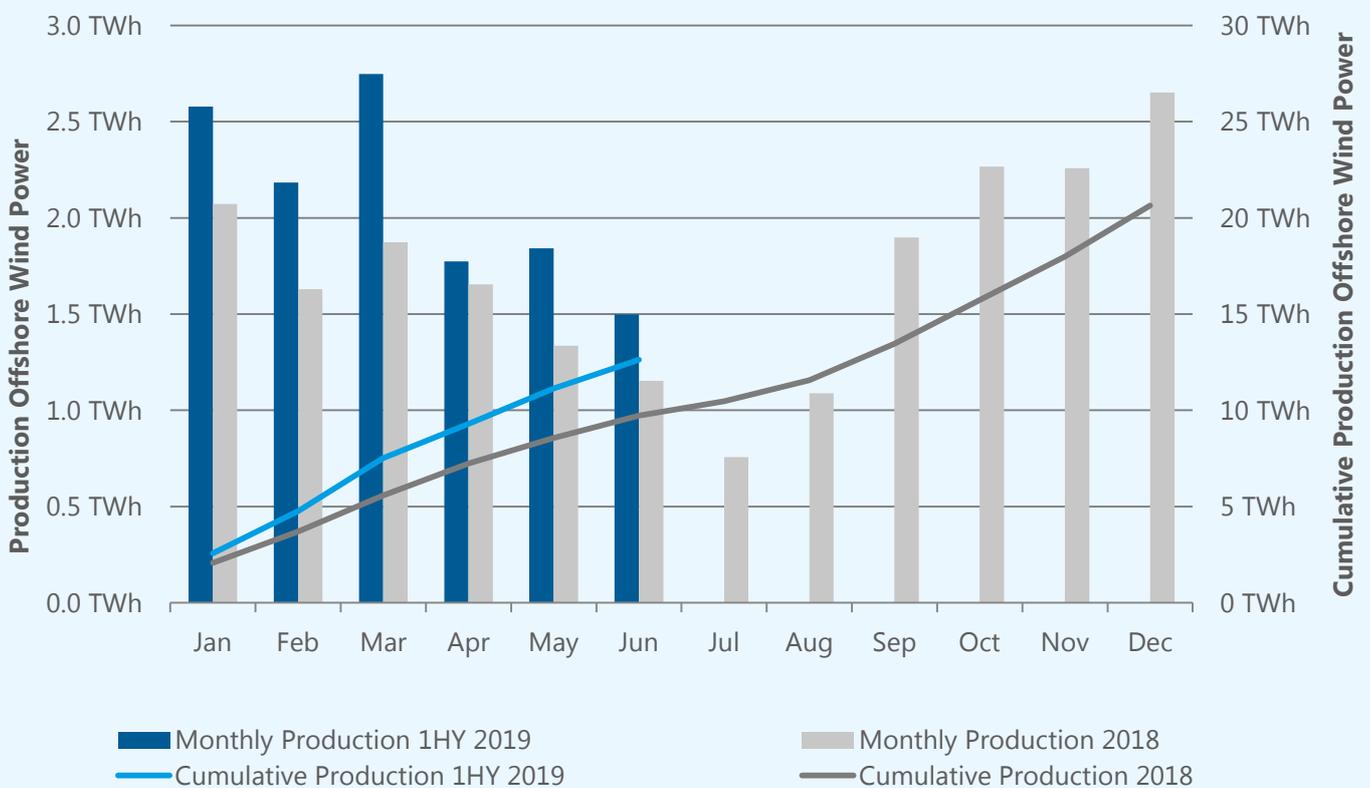
According to the projection data provided by Transmission System Operators (German: Übertragungsnetzbetreiber or ÜNB), German OWP fed 12.6 TWh of power into the grid over the course of the first half of 2019. This equates to a 30% increase compared to the same timeframe in 2018. Looking at the preliminary numbers of the German Association of Energy and Water Industries (German: Bundesverband der Energie- und Wasserwirtschaft or BDEW), offshore wind energy provided 4% of Germany’s gross inland power consumption during the first half of 2019.

Following the considerable increase in monthly market values of offshore wind energy in the second half of 2018, the values decreased noticeably again the beginning of 2019. The average volume-weighted market value for the first half of 2019 amounts to 3.5 € Cents/kWh, which is 15% less than the 2018 average. In March of 2019, the monthly market value of

offshore wind energy dropped below the 3 € Cents/kWh mark for the first time since January of 2018. By June of this year the monthly average had dropped to 2.7 € Cents/kWh.



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)

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 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 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.