2017

DEUTSCHE WINDGUARD

STATUS OF OFFSHORE WIND ENERGY DEVELOPMENT IN GERMANY

On behalf of:

AGOW Arbeitsgemeinschaft Offshore-Windenergie e.V.

BWE Bundesverband WindEnergie

STIFTUNG OFFSHORE WINDENERGIE

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STATUS OF OFFSHORE WIND ENERGY DEVELOPMENT IN GERMANY

The development of offshore wind energy in Germany is examined below. The development is highly dependent on the framework conditions, such as grid development and tender requirements. The factsheet presents these relationships in addition to the current status.

TURBINES FEEDING INTO THE GRID

Over the course of 2017, 222 offshore wind turbines (OWT) started feeding into the grid. Their installed capacity is 1 250 MW. The majority of these turbines (201 OWT generating 1,128 MW) were erected in 2017, the remaining 21 OWT (123 MW) were completed in the previous year. In addition to new construction, 152 existing OWT (13 of these OWT first fed into the grid in 2017) received performance upgrades in 2017 adding up to 29 MW. Thus, the annual addition comes to a total of 1,279 MW, making 2017 the second strongest year since the beginning of offshore development in Germany and exceeding the values of the previous year by 55%. The annual development of new construction, as well as cumulative capacity is shown in Table 1.

Table 1: Offshore Wind Energy Development, as of 2017-12-31

	Status of the Offshore Wind Energy Development	Capacity [MW]	Number of OWT
Additions Year 2017	OWT (feeding in)	1,250.3	222
	Capacity Modifications of existing OWT	28.8	152
	Installed OWT (no feed-in)	0.0	0
	Foundations w/o OWT		126
Cumulative (2017-12-31)	OWT (feeding in)	5,387.4	1,169
	Installed OWT (no feed-in)	0.0	0
	Foundations w/o OWT		126

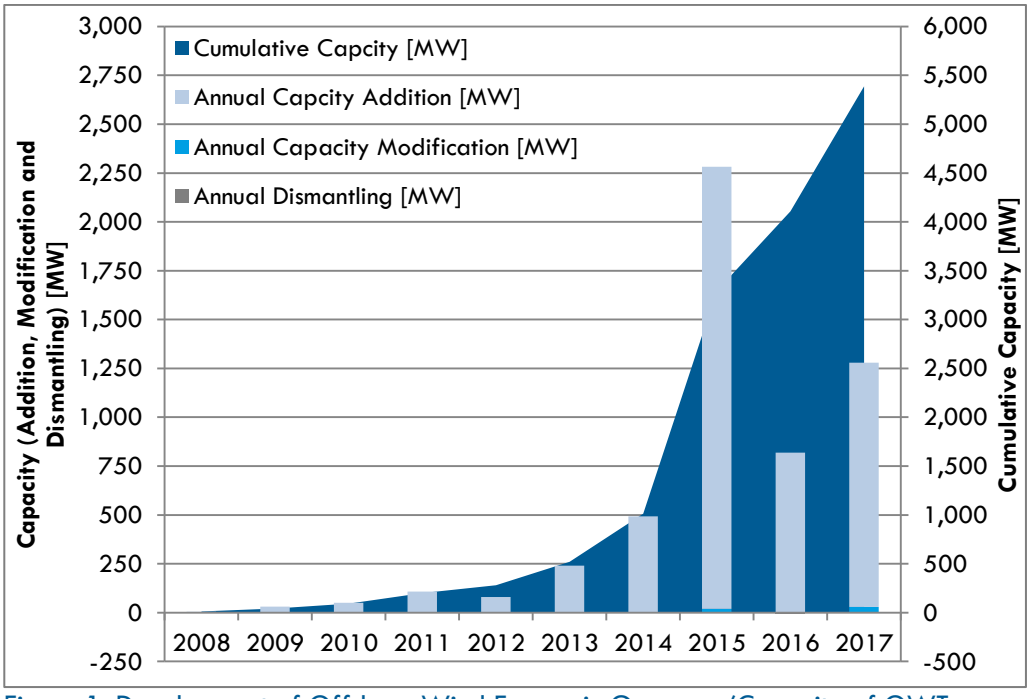

Figure 1: Development of Offshore Wind Energy in Germany (Capacity of OWT Feeding into the Grid) as of 2017-12- 31

The development over time is illustrated in Figure 1. The cumulative capacity of all 1,169 OWT installed and feeding into the grid in Germany as of December 31st, 2017 was 5,387 MW. This is equivalent to an increase of 31% compared to the cumulative capacity of the previous year.

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

These figures contain partly rounded values. There may be slight deviations in their addition.

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INSTALLED TURBINES AND FOUNDATIONS

During 2017, 201 OWT were erected generating 1,128 MW. All of these turbines started feeding into the grid over the course of that year. In addition, the turbines that had not started feeding into grid by the end of 2016 started to do so prior to the last day of 2017. Hence, by yearend 2017, all OWT installed in Germany were feeding into the grid.

However, of the 129 foundations that had been installed since January 1st, 2017, only three were equipped with a feeding OWT. Since there are no empty foundations from the previous year, by the end of December 2017 a total of 126 foundations were ready to receive their respective OWT.

TYPES OF FOUNDATIONS

With regard to the foundation types installed in 2017, the trend of using the monopile as the foundation of choice has continued. At 98% of the added foundations (126 out of a total of 129 foundations), monopiles make up the majority of foundations installed during the course of the year. Only three of the newly erected foundation structures are jackets. Subsequently, upon cumulative examination of the portfolio, at 71% the largest share of foundations are monopiles, followed by jackets at 13% of foundation structures. Another 10% are tripods and the final 6% are tripiles. Other foundation types have not been used in significant numbers in Germany at this time. The distribution of foundation types installed annually can be seen in Figure 2.

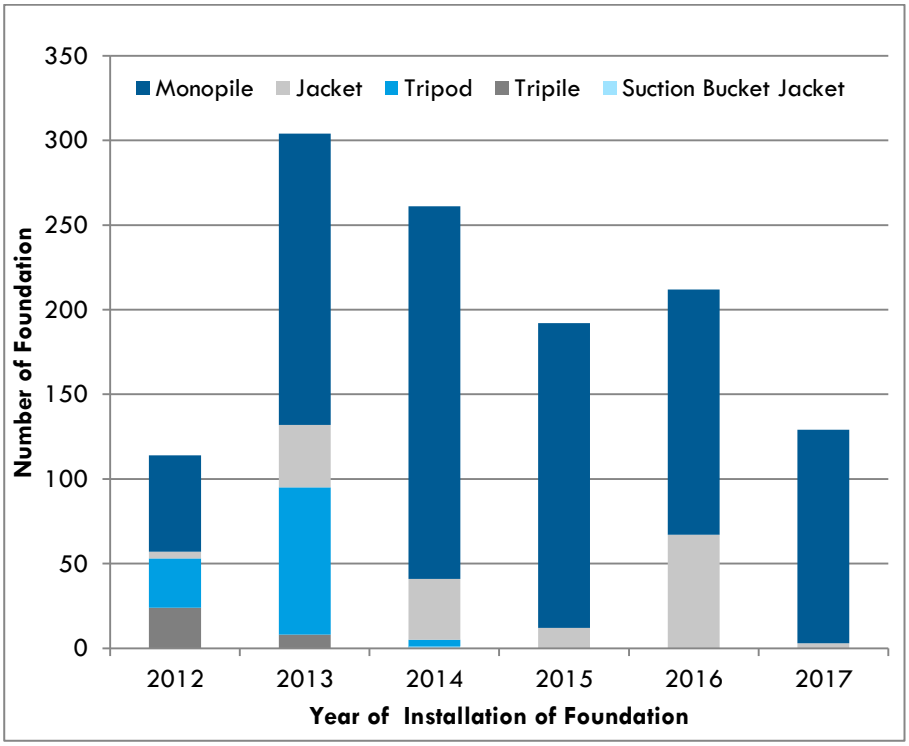

Figure 2: Foundation Types over Time, as of 2017-12-31

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

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TURBINE CONFIGURATION

On average, OWT installed during 2017 that fed into the grid that year had a capacity of 5,644 kW. This equates to a 6% increase of the average capacity of feeding OWT compared to the previous year. The average rotor diameter in 2017 was determined to be 138 meters. The average hub height of turbines put into service in 2017 was 96 meters. When compared to 2016, the rotor diameters and hub heights decreased by 5% and 8%, respectively. Resulting from the increase in capacity and the reduction of rotor diameters is a 21% increase of the average specific area power to 387 W/m² of OWT feeding into the grid for the first time compared to that of the previous year.

Table 2: Average Turbine Configuration of OWT (feeding in), as of 2017-12-31

Average Turbine Configuration of OWT (feeding in)	Additions 2017	Cumulative (2017-12-31)
Average Nameplate Capacity (incl. upgrades)	5,644 kW	4,609 kW
Average Rotor Diameter	138 m	126 m
Average Hub Height	96 m	92 m
Average Specific Power	387 W/m²	369 W/m²

On average across all OWT's feeding into the grid in Germany, the installed cumulative capacity at the end of 2017 was 4,609 kW, the average rotor diameter was 126 meters, the hub height was 92 meters and the specific power was 369 W/m².

WATER DEPTH AND DISTANCE TO SHORE

The average water depth in which OWT were erected that fed into the grid for the first time in 2017 was 33 meters. This equates to an increase of 10% over the average of the previous year. The average distance to shore of these turbines was 74 km. These same turbines are thus 9% further away from shore than those that were first connected to the grid in 2016.

In total, the average distance to the shore of all OWT feeding into the grid in Germany is 64 km. The average OWT installation water depth is 29 meters. Figure 3 shows the water depth and distance to the shore of existing projects, projects in realization in 2017 (implemented or under construction) and projects with final investment decision.

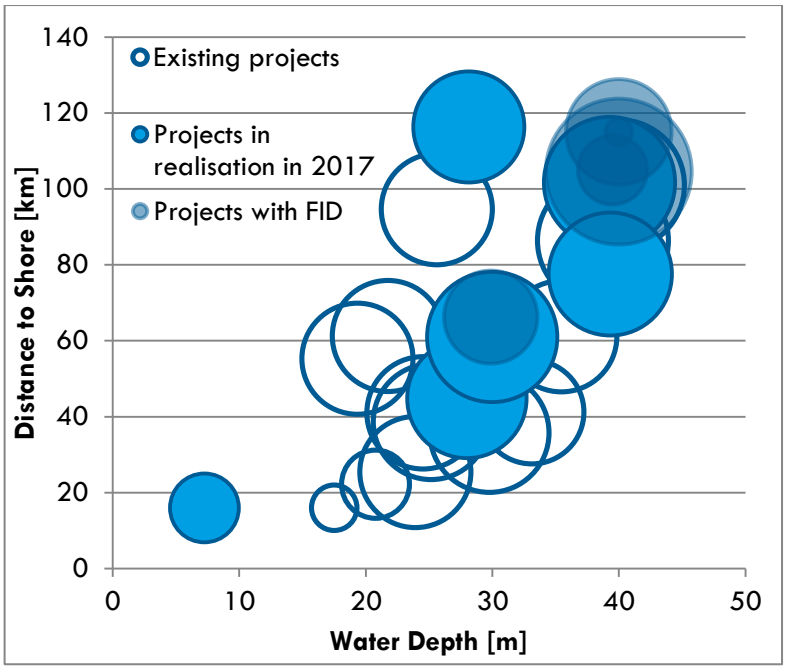

Figure 3: Water Depth and Distance to Shore, as of 2017-12-31

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

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DISTRIBUTION ACROSS THE NORTH AND BALTIC SEA

Table 3 shows the distribution of commissioning and installation activities across the North and Baltic Sea, as well as cumulative numbers. Of the 222 OWT that fed into the grid the first time in 2017, 152 are located in the North and 70 in the Baltic Sea. This equates to a new capacity of 897 and 354 MW, respectively. While no Baltic Sea OWT started feeding into the grid in the previous year, progress of new construction in the North Sea has been comparatively constant. The 29 MW performance upgrades of 2017 were applied exclusively on OWT in the North Sea. By the end of 2017, 66 foundations were ready for turbine installation in the North Sea and 60 in the Baltic Sea.

Of all OWT that were feeding into the grid by the end of 2017, 87% are located in the North Sea and 13% are in the Baltic Sea.

Table 3: Distribution Across the North and Baltic Sea, as of 2017-12-31

Regional Distribution		North Sea		Balitc Sea	
		Capacity [MW]	Number of OWT	Capacity [MW]	Number of OWT
Additions Year 2017	OWT (feeding in)	896.8	152	353.5	70
	Capacity Modifications of existing OWT	28.8	152	0.0	0
	Installed OWT (no feed-in)	0.0	0	0.0	0
	Foundations w/o OWT		66		60
Cumulative (2017-12-31)	OWT (feeding in)	4,695.1	997	692.3	172
	Installed OWT (no feed-in)	0.0	0	0.0	0
	Foundations w/o OWT		66		60

DISTRIBUTION ACROSS THE GERMAN STATES

Installed offshore capacities can be associated with the three federal states making up Germany's coastline where the offshore wind energy projects (OWP) have their grid connection point. Considering that new OWT initially started feeding into the grid in 2017, the distribution of the overall capacity across these federal states changed as shown in Figure 4. With 2,922 MW, the major share of 54% was held by Lower Saxony, followed by Schleswig-Holstein with a connected capacity of 1,778 MW. This is equivalent to a share of 33%. Mecklenburg-Western Pomerania had 692 MW connected and operational by December 31st, 2017. Its 13% share of the overall capacity is thus clearly the smallest of all three federal states.

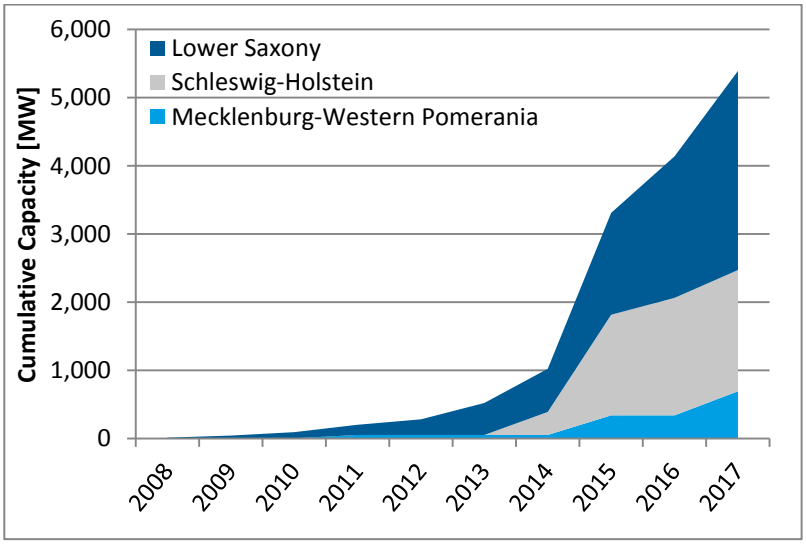

Figure 4: Distribution of Cumulative Capacity of OWT across the German States, as of 2017-12-31

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

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OFFSHORE WIND ENERGY PROJECTS – ACTIVITIES IN THE YEAR 2017

Over the course of 2017, five OWP had all of their turbines fully operational and connected to the grid. OWP Sandbank (partially commissioned in 2016) and OWP Veja Mate became fully operational in the first half of 2017, OWP Nordsee One, Nordergruende and Wikinger followed in the second half. By the end of 2017, 20 OWP had entered their operational phase in Germany. Two OWP, Merkur Offshore and Arkona, are currently in their construction phase. At the turn of the year, work was ongoing on the transition pieces of foundations installed during 2017 on both projects.

Final investment decisions had been made for five OWP: Borkum Riffgrund 2, Trianel Windpark Borkum II, Deutsche Bucht, EnBW Hohe See and Albatros. Foundation installations are planned for the beginning of 2018. Furthermore, three additional OWT (GICON SOF and two pilot turbines in the North Sea) currently have grid connection confirmations, but still did not gain final investment decisions. During the first round of tendering in April of 2017, an additional four OWP were approved and thus secured their respective grid connection capacity: OWP Borkum Riffgrund West II, Gode Wind 3, OWP West and EnBW He Dreiht. However, their implementation is not expected prior to 2024/25. An overview of the status and the geographic location of the OWP as described are provided in Figure 5.

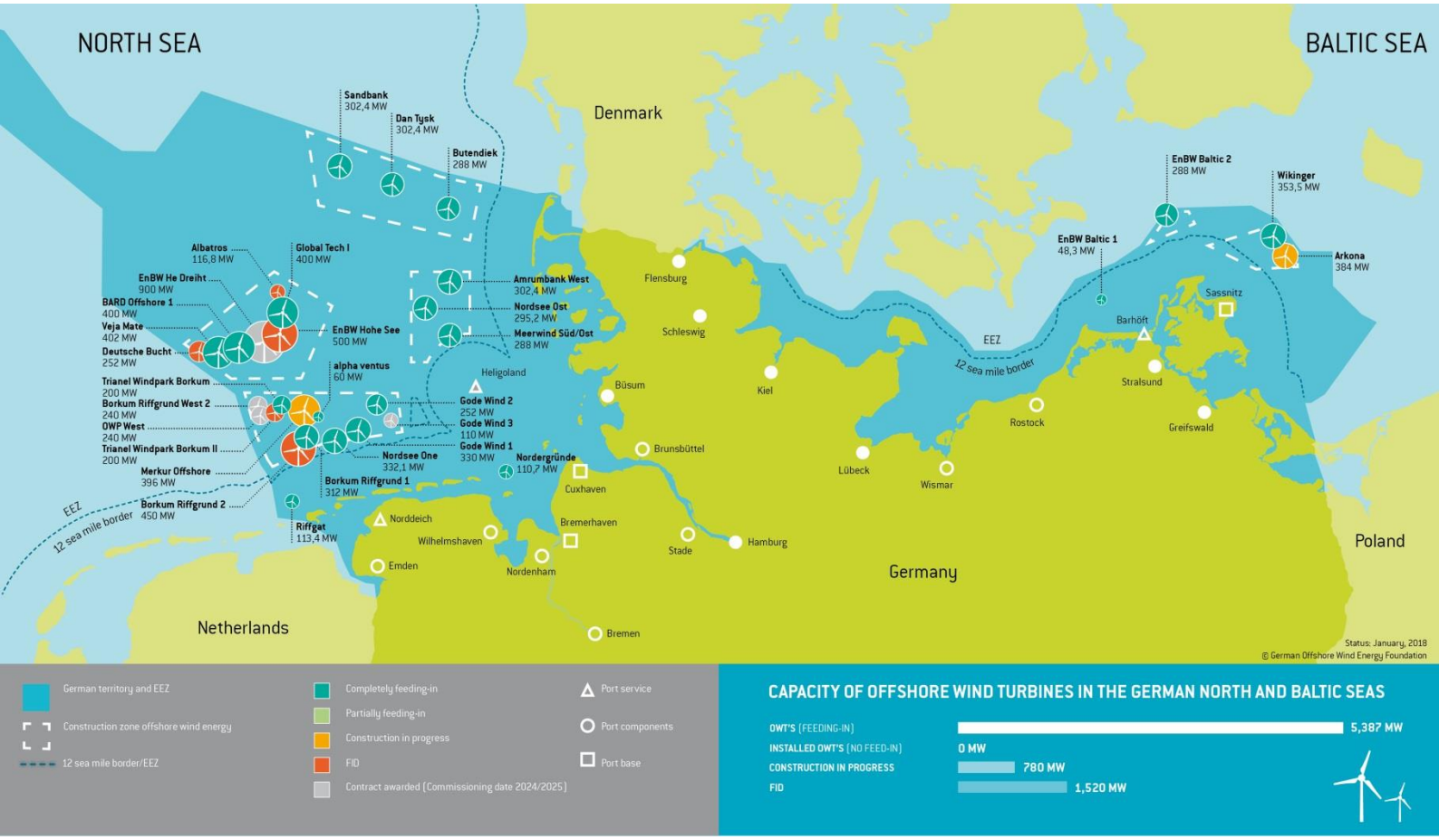

Figure 5: Completely / Partially Feeding-In OWP, OWP under Construction and OWP with Final Investment Decision, accepted Bids, as of 2017-12-31

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

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OVERVIEW OF ADDITIONAL GRID CONNECTION CAPACITY PROVISION

At the end of 2017, a grid connection capacity of 5.7 GW was available for offshore wind projects in the North and Baltic Sea. Furthermore, an additional 2.6 GW are in the pre-construction phase or currently under construction scheduled to be completed by the end of 2019. For OWP scheduled to be put into operation from 2021 to 2025, additional grid connection capacities of up to 4.4 GW in total are planned, but will not be completely filled with OWP due to the capacity tendered in the transitional system. Additional grid connections to be realized after 2025 are slated for projects from the central tendering system.

The grid connection capacity has been partially awarded to OWP that had received grid connection approval prior to the introduction of the tendering system or that were awarded in the first round of tendering. The remaining free capacity is relevant for the second round of tendering and highlighted in Table 1 along with further details about existing and planned grid connections.

Table 4: Installed and Planned Grid Connections (to Converter Station or Bundling Point) in the North and Baltic Sea [Source: O-NEP 2030 (2nd Draft and Confirmation), Additional Research]

Grid Connection	Status	(Planned) Comm. Year	Capacity [MW]	Cluster	Relevance for second Tender
North Sea					
Nearshore Emden	Operating	2004	4.5		no
NOR-2-1 (Alpha Ventus)	Operating	2009	62	2	no
NOR-6-1 (BorWin1)	Operating	2010	400	6	no
NOR-0-1 (Riffgat)	Operating	2014	113		no
NOR-2-2 (DolWin1)	Operating	2015	800	2	yes (88 MW)
NOR-4-1 (HelWin1)	Operating	2015	576	4	no
NOR-4-2 (HelWin2)	Operating	2015	690	4	yes (387 MW)
NOR-5-1 (SylWin1)	Operating	2015	864	5	no
NOR-6-2 (BorWin2)	Operating	2015	800	6 und 8	yes (14.4 MW)
NOR-3-1 (DolWin2)	Operating	2016	916	3	no
NOR-0-2 (Nordergründe)	Operating	2017	111		no
NOR-2-3 (DolWin3)	Under Construction/ Construction Preparation	2018	900	2	yes (50 MW)
NOR-8-1 (BorWin3)	Under Construction/ Construction Preparation	2019	900	8	no
NOR-3-3 (DolWin6)	Approved	2023	900	3	yes (790 MW)
NOR-1-1 (DolWin5)	Approval Procedure in Progress	2024	900	1	yes (420 MW)
NOR-5-2 (SylWin2)	Approval Procedure in Progress	2025	max. 900	5	yes (900 MW)
NOR-7-1 (BorWin5)	Approval Procedure in Progress	2025	900	7	no
NOR-3-2 (DolWin4)	Confirmed	2028	900	3	no
NOR-7-2 (BorWin6)	Confirmed	2030	900	6 and 7	no
NOR-6-3 (BorWin4)	Planned, not confirmed	2030	900	6	no
NOR-13-1	Planned	2034	900	13	no
NOR-11-1	Planned	2035	900	11	no
Baltic Sea					
Nearshore Rostock	Operating	2006	2.5		no
OST-3-1 (Baltic I)	Operating	2011	51	6	no
OST-3-2 (Baltic II)	Operating	2015	288	3	no
OST-1-1 (Ostwind 1)	Under Construction/ Construction Preparation	2018	250	1	no
OST-1-2 (Ostwind 1)	Operating in Test Mode	2019	250	1	no
OST-1-3 (Ostwind 1)	Under Construction/ Construction Preparation	2019	250	1	yes (15 MW)
OST-2-1	Approved	2021	250	1, 2 and 4	yes (250 MW)
OST-2-2	Approved	2021	250	1, 2 and 4	yes (250 MW)
OST-2-3	Approved	2022	250	1, 2 and 4	yes (250 MW)
OST-2-4	Confirmed	2027	900	1, 2 and 4	no
OST-6-1 (former OST-3-3)	Confirmed	2029	750	6	no
OST-3-4	Planned	2031	750	3, 6 or 8	no
OST-5-1	Planned	2033	500	5 or 7	no

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OFFSHORE WIND ENERGY TENDERING

Tendering rounds of the transitional system are currently ongoing. The four projects that received approval in the first tendering round are located in the North Sea, scheduled to become operational in 2024/25 and together would generate 1,490 MW: Borkum Riffgrund West II, OWP West, Gode Wind 3 and EnBW He Dreiht. In the second tendering round, occurring this April, another 1,610 MW are to be awarded, of which at least than 500 MW have to be located in the Baltic Sea. Only allowed to participate in this tendering round are projects located within coastal waters, as well as the clusters of zones 1 and 2 that had either been approved or discussed prior to August 1st, 2016.

Information about the four approved OWP and the 19 others that are qualified to participate in the second tendering round is listed in Table 5. The table also shows available, unassigned grid capacity that eligible projects in each respective cluster are competing for, in addition to the limitation of the overall volume.

Table 5: Approved and discussed Projects in the North and Baltic Sea [Source: BSH, BNetzA, Additional Research]

Zone	Cluster	Project	Project Sponsors	Status (Accepted Capacity)	Vacant Grid Connection Capacity
North Sea					
1	1	OWP West	Northern Energy OWP West GmbH	Bid Accepted (240 MW)	**420 MW**
		Borkum Riffgrund West II	Ørsted Borkum Riffgrund West II GmbH	Bid Accepted (240 MW)	
		Borkum Riffgrund West I	Ørsted Borkum Riffgrund West I GmbH	Approved	
	3	Gode Wind 3	Gode Wind 03 GmbH	Bid Accepted (110 MW)	**790 MW**
		OWP Delta Nordsee 1	OWP Delta Nordsee GmbH	Approved	
		OWP Delta Nordsee 2	OWP Delta Nordsee GmbH	Approved	
		Gode Wind 04	Gode Wind 04 GmbH	Approved	
		Nordsee Two	Nordsee Two GmbH	Approved	
		Nordsee Three	Nordsee Three GmbH	Approved	
	4	KASKASI II	innogy Kaskasi GmbH	Discussed	**387 MW**
2	5	Nördlicher Grund	Nördlicher Grund GmbH	Approved	**max. 900 MW**
		Nördlicher Grund - Teil Sandbank	Vattenfall Europe Windkraft GmbH	Approved	
	6	Atlantis I	Vattenfall Atlantis 1 und Global Tech 2 Offshore Wind GmbH	Discussed	**14.4 MW**
	7	EnBW He Dreiht	EnBW He Dreiht GmbH	Bid Accepted (900 MW)	**0 MW**
		Global Tech II	Vattenfall Atlantis 1 und Global Tech 2 Offshore Wind GmbH	Discussed	
Baltic Sea					
1	1	Adlergrund 500	Adlergrund 500 GmbH	Discussed	**15 MW** (solely Cluster 1) and **750 MW** (Cross-cluster Grid Connection)
		Adlergrund GAP	BEC Energie Consult GmbH	Discussed	
		Wikinger Nord	Iberdrola Renovables Offshore Deutschland GmbH	Discussed	
		Wikinger Süd	Iberdrola Renovables Offshore Deutschland GmbH	Discussed	
		Windanker	Iberdrola Renovables Deutschland GmbH	Discussed	
	2	Baltic Eagle	Baltic Eagle GmbH	Discussed	
		Ostseeschatz	Financial Insurance GmbH	Discussed	
	4	ARCADIS OST 1	KNK Wind GmbH	Approved	

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POLITICAL DEVELOPMENT TARGET AND ASSIGNED GRID CONNECTION CAPACITY

The status of capacity addition development up to the year 2025 as of December 31st, 2017 is shown in Figure 6. By the deadline, 5.4 GW of capacity were feeding into the grid and an additional 0.8 GW were under construction. An investment decision had been made for another 1.5 GW of capacity. A further 0.02 GW had received grid connection confirmation. The total operational capacity is estimated to reach 7.7 GW by 2020. This equals the total implementation of the capacity assigned to projects before introduction of the tendering system.

Projects with a capacity of 1.5 GW were awarded in the first tendering round for offshore wind energy. Another 1.6 GW are slated to be awarded in the second tendering round in April of 2018. It is planned that these projects will lead to a capacity addition of 3.1 GW between 2021 and 2025. In total, it is estimated that the cumulative capacity will reach 10.8 GW by 2025.

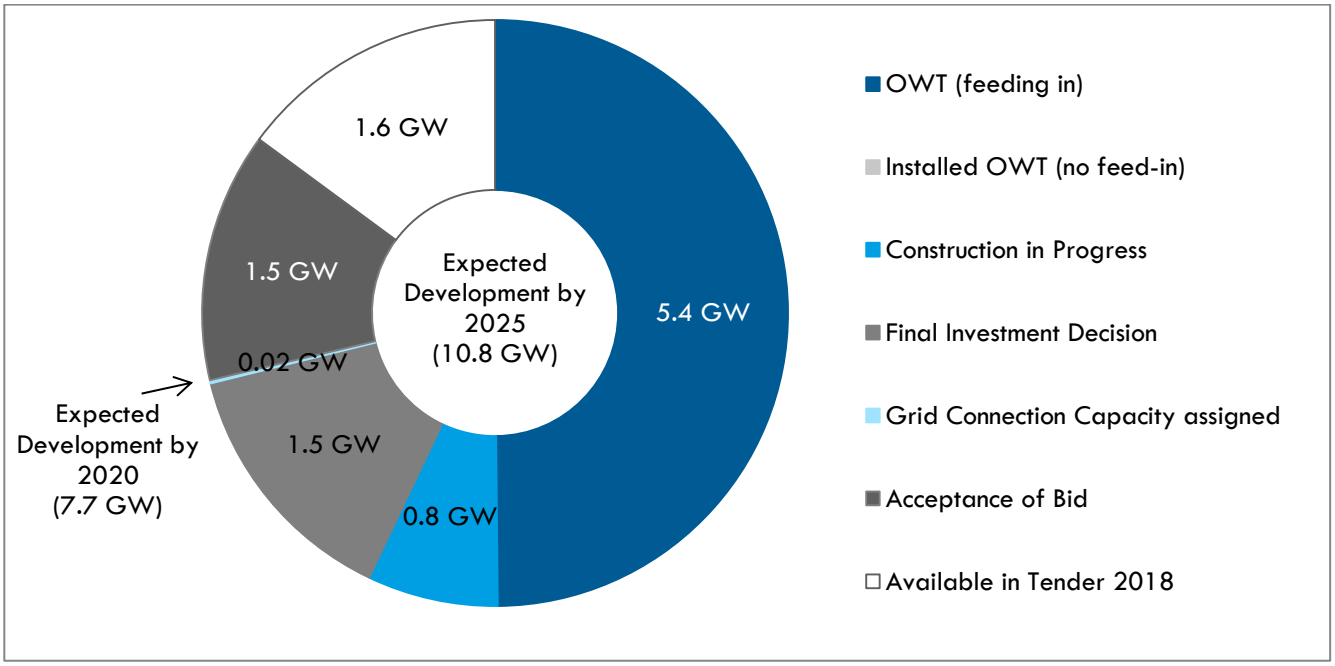

Figure 6: Offshore Capacity with High Degree of Certainty and its Share of the Assigned Grid Connection, as of 2017-12-31

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