1st half 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

VDMA Power Systems

wab windenergie agentur

Deutsche WindGuard GmbH - Oldenburger Straße 65 - 26316 Varel - Germany
+49 (0)4451/95150 - info@windguard.de - www.windguard.com

STATUS OF OFFSHORE WIND ENERGY DEVELOPMENT

The following factsheet analyses the development of offshore wind energy in Germany as of June 30, 2017. In addition to the new installations, this includes detailed information on turbine configurations, foundation types as well as regional distribution.

TURBINES FEEDING INTO THE GRID

In the first half of 2017, 108 offshore wind turbines (OWT) with an installed capacity of 626 MW fed into the grid for the first time. The majority of the newly feeding OWT were installed in 2017. Only three of the turbines were already erected by the end of 2016. In addition to the new installations, the capacity of 80 existing OWT was increased during the half-year. Each was upgraded by 180 kW and thus increased the total installed capacity by an additional 14.4 MW.

Table 1: Offshore Wind Energy Development, as of 2017-06-30

	Status of Offshore Wind Energy Development	Capacity [MW]	Number of OWT
Additions 1st half 2017	OWT (feeding in)	626.2	108
	Capacity Modifications of existing OWT	14.4	80
	Installed OWT (no feed-in)	185.1	36
	Foundations w/o OWT		69
Cumulative (2017-06-30)	OWT (feeding in)	4 748.9	1.055
	Installed OWT (no feed-in)	295.8	54
	Foundations w/o OWT		126

The gross installed capacity in the first half of the year already corresponds to 78% of the total number of new feed-ins in the previous year. Figure 1 shows progress of offshore wind energy development in reference to the capacity feeding in over time. The cumulative capacity of all 1 055 OWT, which have already completed the first feed into the grid, amounts to 4 749 MW at the end of the first half of 2017. This corresponds to an increase of 16% compared to the cumulative capacity at the end of 2016.

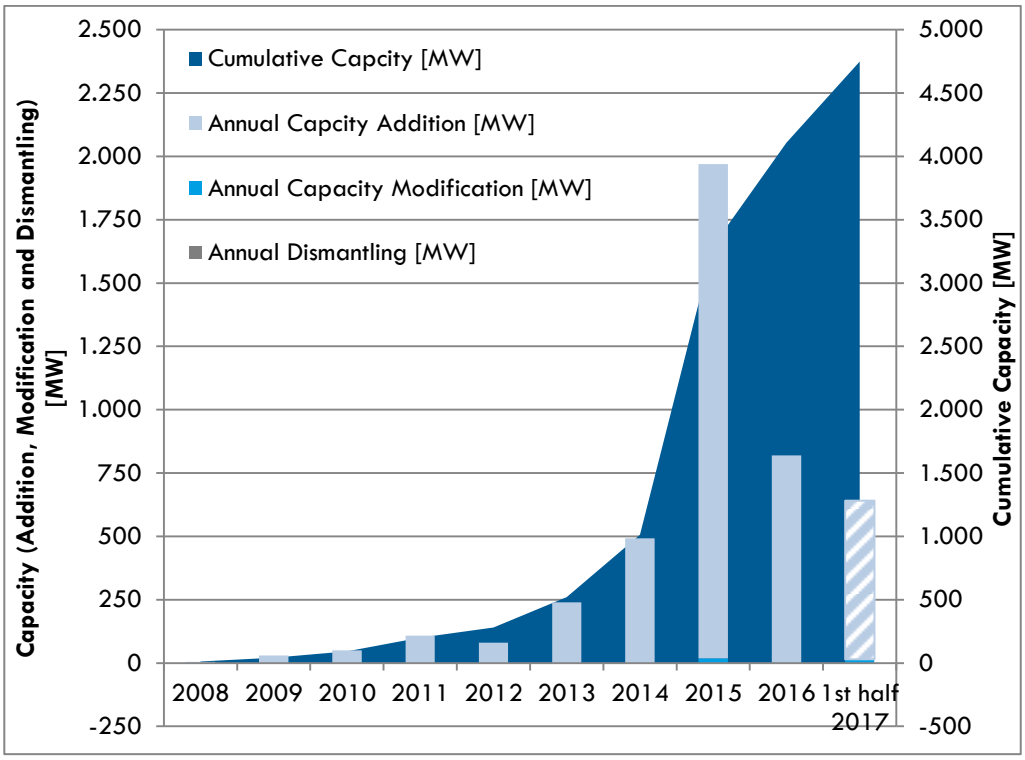

Figure 1: Development of Offshore Wind Energy in Germany (Capacity of OWT Feeding into the Grid) as of 2017-06-30

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.

On behalf of: AGOW BWE OFFSHORE WINDENERGIE wab VDMA

INSTALLED TURBINES AND FOUNDATIONS

During the first half of 2017, a total of 141 OWT with a capacity of 799 MW were installed. 36 of these OWT with 185 MW are not feeding into the grid as of June 30, 2017. In addition, 18 OWT with 111 MW were installed in the previous year and did not yet feed into the grid by the end of the first half of 2017. Including the OWT erected in 2016, 54 OWT with a capacity of 296 MW are still without feed-in by the end of June 2017.

During the course of the first half 2017, 69 foundations were erected. To none of the new foundations a OWT was added as of June 30, 2017. Plus the 57 foundations installed in the previous year, which have not yet been equipped with OWT by the end of June 2017, a total of 126 foundations are prepared for turbine installation.

TYPES OF FOUNDATIONS

In the first half of 2017 a total of 69 foundations were installed. Same to the years 2015 and 2016, only monopiles and jackets were erected, with monopiles again dominating the market with a share of 96%. Equally, regarding the total of 1 235 foundations installed by the end of June 2017 (including foundations with OWT), monopiles have been used in 70% of cases (862 Foundations). They are thus the foundation structure most frequently used in Germany.

Jackets account for 13% of foundations, tripods account for 10% and tripiles are used in 6% of cases. Further foundation types have not yet been installed in relevant numbers. Figure 2 shows the distribution of the foundation types installed annually since 2012.

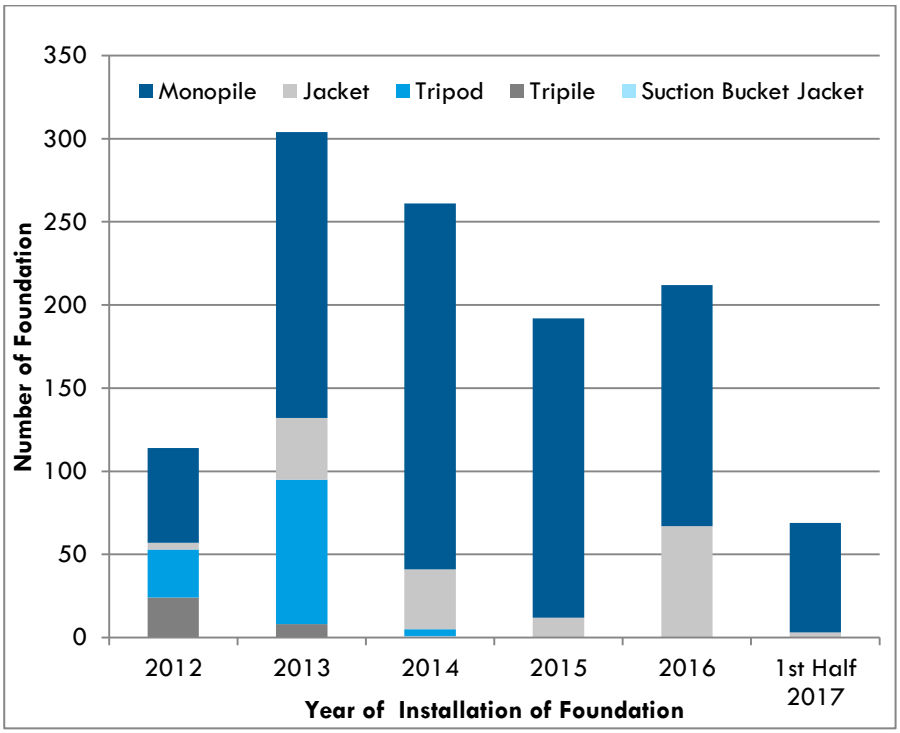

Figure 2: Foundation Types over Time, as of 2017-06-30

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

The average plant configuration of OWT that fed into the grid for the first time in the first half of 2017, as well as the cumulative operational portfolio is shown in Table 3. The OWT, which have been feeding in for the first time in the first half of 2017, have an average capacity of 5 798 kW. This equals an increase of 11% compared to the previous year. The average rotor diameter falls short of the previous year's figure by just one meter and drops to 144 m. As a result of the increased performance associated with a reduced rotor diameter, the OWT installed in the first half-year 2017 showed a 16% increase in the specific power (capacity per square meter swiped rotor area) from 314 W/m² to 364 W/m² compared to the 2016 OWT.

Table 2: Average turbine configuration of OWT (feeding in), as of 2017-06-30

Average turbine configuration of OWT (feeding in)	Additions 1st Half 2017	Cumulative (2017-06-30)
Average Nameplate Capacity [kW]	5 798 kW	4 826 kW
Average Rotor Diameter [m]	144 m	126 m
Average Hub Height [m]	98 m	92 m
Specific Power [W/m²]	364 W/m²	364 W/m²

The average nameplate capacity of all OWT in German portfolio by the end of June 2017 is 4 826 kW. The average rotor diameter is 126 m, the mean hub height is 92 m, and the OWT have a specific power of 364 W/m².

WATER DEPTH AND DISTANCE TO SHORE

The OWT, which went online in the first half of 2017, were installed at an average water depth of 35 m. This is 16% deeper than in the previous year. The average distance to shore of the new OWT is 88 km. OWT with the first feed-in in the first half of 2017 are on average 30% further from the shore than those of 2016.

The average distance to shore of all OWT in the German portfolio by June 30, 2017 is 65 km. On average the OWT are located in water depth of 29 m. Figure 3 shows the water depth and distance to shore of existing projects, offshore wind energy projects (OWP) which are being realised in the first half of 2017 as well as projects with investment decisions.

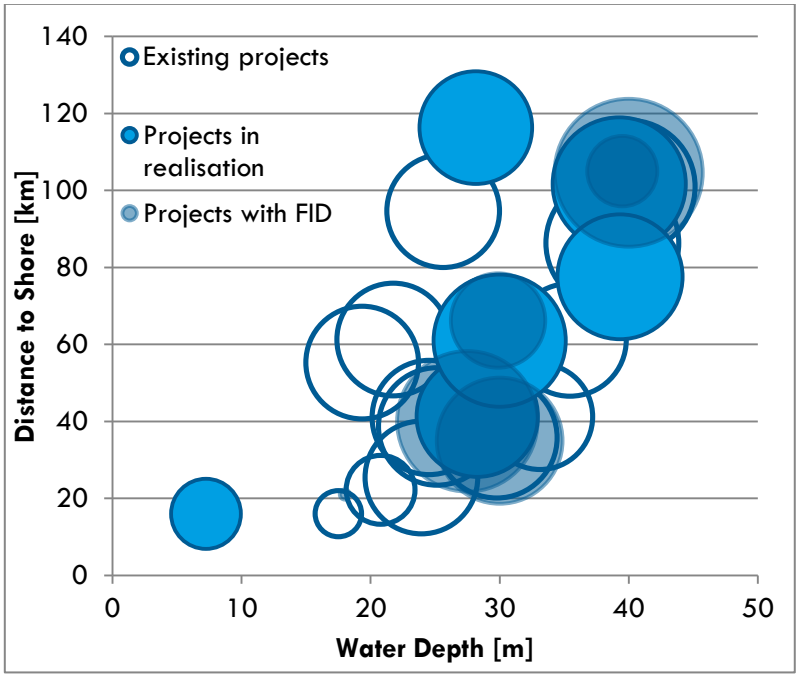

Figure 3: Water Depth and Distance to Shore, as of 2017-06-30

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

The distribution of installation and commissioning activities in the first half-year 2017 as well as the distribution of the cumulative turbine portfolio by the end of June 2017 in the North and Baltic Seas is shown in Table 3. All 108 OWT, which went online during the first half of the year are located in the North Sea and have an installed capacity of 626 MW. Also the power upgrade of 14.4 MW took place in the North Sea. As a result, 953 OWT located in the North Sea with a total capacity of 4 410 MW are feeding into the grid as of June 30, 2017.

A total of 102 OWT with a capacity of 339 MW were installed in the Baltic Sea by the end of June 2017. This corresponds to a capacity distribution (feeding in) of about 93% in the North Sea and 7% in the Baltic Sea. In the North Sea, further 21 OWT with 129 MW and 89 foundations have already been installed. In addition, there are 33 OWT with 167 MW and 37 foundations in the Baltic Sea.

Table 3: Distribution Across the North and Baltic Sea, as of 2017-06-30

Regional Distribution		North Sea		Baltic Sea	
		Capacity [MW]	Number of OWT	Capacity [MW]	Number of OWT
Additions 1st half 2017	OWT (feeding in)	626.20	108	0.00	0
	Capacity Modifications of existing OWT	14.40	80	0.00	0
	Installed OWT (no feed-in)	18.45	3	166.65	33
	Foundations w/o OWT		66		3
Cumulative (2017-06-30)	OWT (feeding in)	4 410.10	953	338.80	102
	Installed OWT (no feed-in)	129.15	21	166.7	33
	Foundations w/o OWT		89		37

DISTRIBUTION ACROSS THE GERMAN STATES

The onshore grid connection points of the respective grid connections of the OWP in Germany enable to assign these to the federal states in which the feed-in takes place. Figure 4 shows the distribution of the cumulative feed-in capacity to the federal states over the period since 2008 until today. With 56% of grid connected capacity, Lower Saxony leads before the other federal states. Since 2009, the capacity connected there has steadily increased to 2 646 MW by mid-2017. Since 2014 OWT have been connected in Schleswig-Holstein. At 1 764 MW, 37% of the total capacity is connected here. As of June 30, 2017, the capacity connected to Mecklenburg-Western Pomerania amounted to about 339 MW, corresponding to 7% of the total capacity. Significant increases were made here in 2011 and 2015.

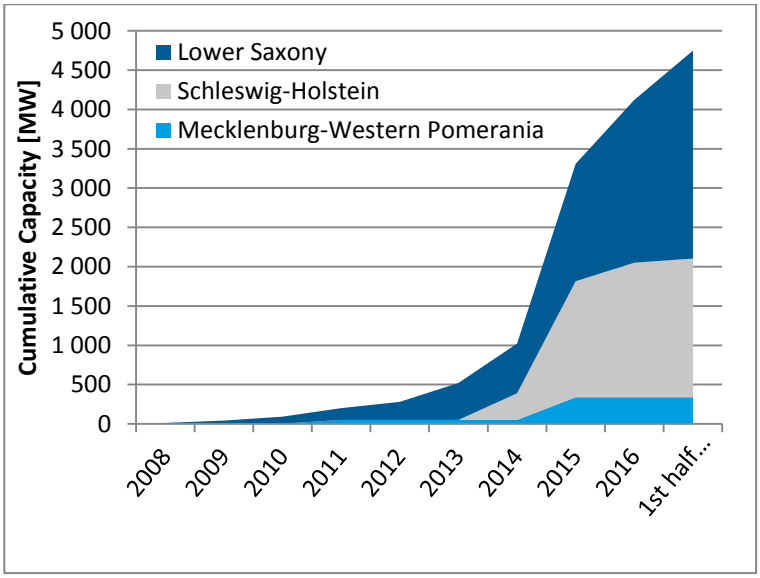

Figure 4: Distribution of Cumulative Capacity of OWT across the German States, as of 2017-06-30

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

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POLTICAL TARGETS AND ASSIGNED GRID CONNECTION CAPACITY

The Federal Government's objective is to reach 6.5 GW of offshore wind capacity by 2020. The maximum grid connection capacity assigned by the end of 2016 to projects which are to be implemented by 2020, was 7.7 GW. From 2021 onwards, the projects placing successful bids in the offshore tenders of 2017 and 2018 are going to be commissioned. Figure 5 shows in which development status the capacity to be commissioned until 2025 are situated as of June 30, 2017.
By the end of June 2017, in addition to the approximately 4.7 GW feed-in and the already installed 0.3 GW without feed in, 0.7 GW are under construction. The final investment decision has been made for about 1.6 GW and about 0.3 GW already received a grid connection commitment. Cumulated, by 2020, 7.7 GW of offshore capacity may be feeding into the German grid. According to WindSeeG between 2021 and 2025 an additional capacity of 3.1 GW should be connected to the grid. 1.5 GW of these have already been assigned to projects which placed a successful bid the first tender. The remaining 1.6 GW will be tendered in 2018.

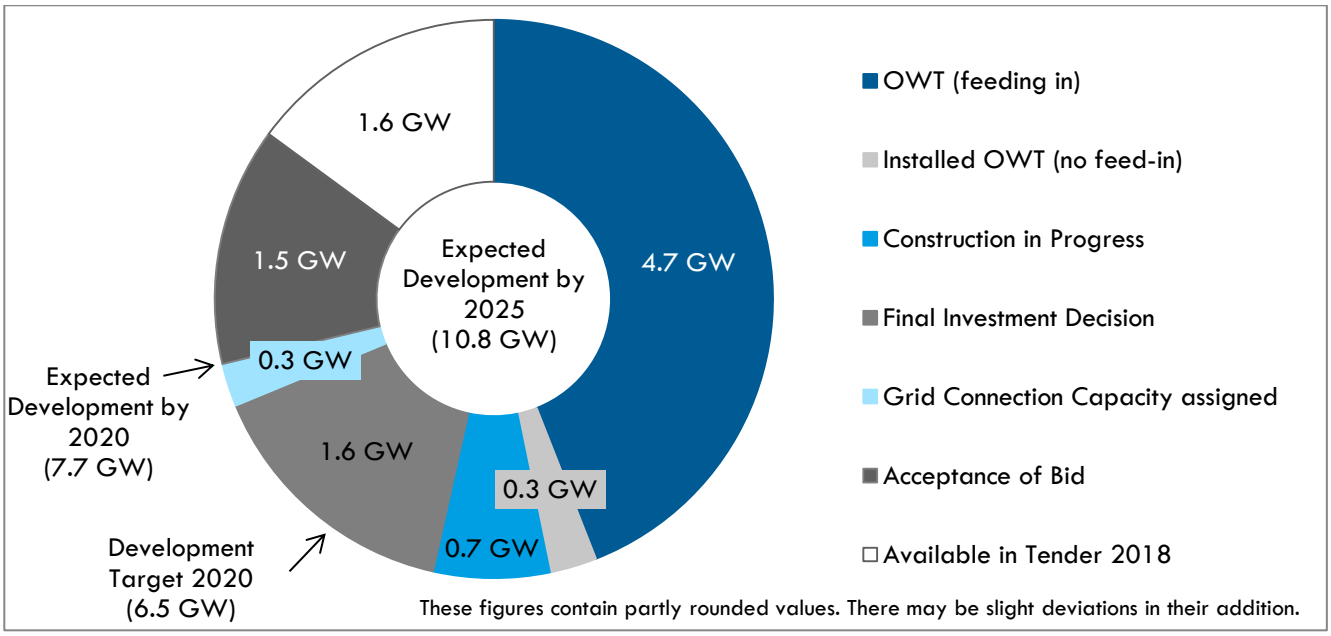

Figure 5: Development Status of Offshore Capacity to be commissioned until 2025, as of 2017-06-30

ACCEPTED BIDS IN FIRST TENDER

The first tender for OWP in Germany was closed on April 1, 2017. Four projects with a total of 1 490 MW were awarded on April 13, 2017. All four OWP are located in the North Sea. The projects, which are to be commissioned in 2024 and 2025 respectively, are being implemented by EnBW and DONG Energy. Table 4 lists the projects with their key data. The weighted average bid of accepted projects is 0.44 ct/kWh, whereby for three of the four projects the bid was 0.0 ct/kWh. These projects therefore are going to be realised without EEG-funding.

Table 4: OWP with accepted Bid in first Offshore Wind Energy Tender

Offshore Wind Energy Project	Operater	Location	Cluster	Capacity	Bid Value	Status	Planned Commisioning
Riffgrund West II	DONG Energy	North Sea	Cluster 1	240 MW	0.0 ct/kWh	discussed	2024
OWP West	DONG Energy	North Sea	Cluster 1	240 MW	0.0 ct/kWh	permited	2024
Gode Wind 03	DONG Energy	North Sea	Cluster 3	110 MW	6.0 ct/kWh	discussed	2024
EnBW He Dreiht	EnBW	North Sea	Cluster 7	900 MW	0.0 ct/kWh	permited	2025

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OFFSHORE WIND ENERGY PROJECTS – ACTIVITIES IN FIRST HALF OF 2017

By the end of the first half of the year 2017, all OWT of the projects Sandbank and Veja Mate achieved their first feed into the grid. Resulting, a total of 17 OWP as well as two individual nearshore turbines were fully operational by June 30, 2017. With the OWP Nordsee One, another project reached the first feed-in of turbines, but is not yet fully operating. In addition to further commissioning of OWT, more installations will take place in the further course of the year. In the project Nordergründe, the OWT-installation was already completed in the year 2016. The completion of the offshore substation is expected by the end of 2017. In the Baltic Sea-OWP Wikinger, the installation of foundations was completed in the first half of the year and several OWT were installed. In the OWP Merkur Offshore the installation of foundations was completed by June 30, 2017.

In the OWP Arkona Becken Südost, the installation of the foundations has not yet begun, but preparations have been made for internal cabling. A final investment decision took place for OWP Borkum Riffgrund 2, Albatros, Trianel Windpark Borkum II and EnBW Hohe See as well as an additional individual turbine. The OWP Deutsche Bucht and two pilot plants have a grid connection commitment by the end of June 2017, but no final investment decision yet. Four other projects were awarded in the first offshore tenders in April 2017. These are the OWP Borkum Riffgrund West II, Gode Wind 3, OWP West and EnBW He Dreiht. A graphical overview of the status and geographical location of the various OWP in Germany is provided in Figure 6.

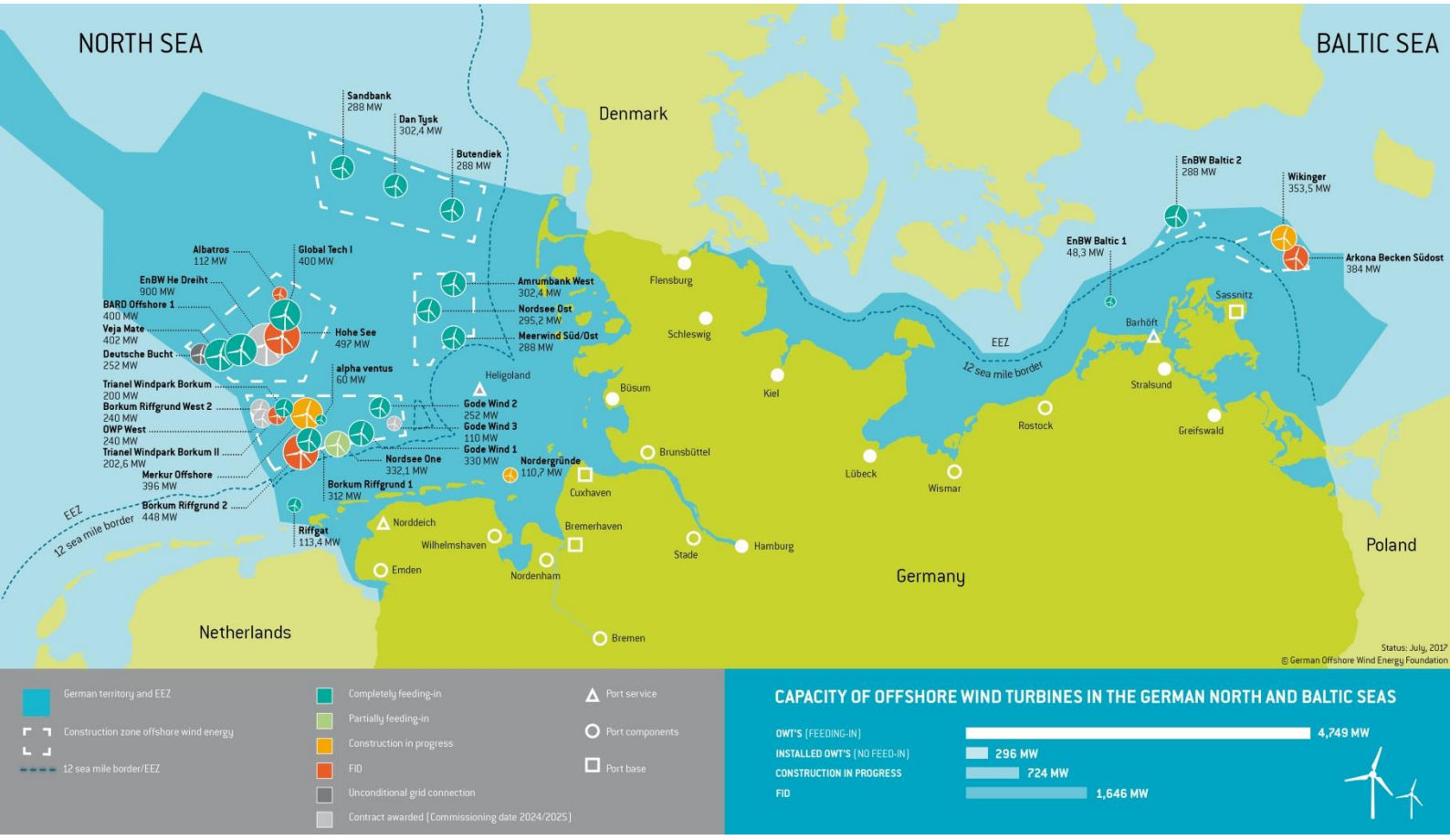

Figure 6: Completely / Partially Feeding-In OWP, OWP under Construction and OWP with Final Investment Decision, assigned Grid Connection Capacity or accepted Bid, as of 2017-06-30

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SECOND TENDER IN APRIL 2018

The second tender for offshore wind energy in Germany will take place in early April 2018. A total grid connection capacity of 1 610 MW, of which 500 MW will be assigned to bids in the Baltic Sea, will be tendered. Just like in the first tender for offshore wind energy, the participation is only open to existing OWP in Germany, which have already been approved or received a certain permitting status (discussed) by August 1, 2016 and are located in the coastal sea or the clusters of zones 1 and 2. The projects with successful bids are supposed to be commissioned between 2021 and 2025.

Table 5 lists the projects that are eligible to participate in the tender in 2018. In the North Sea, these are theoretically eleven projects, in the Baltic Sea eight projects. However, due to the grid connection situation, only for nine projects in the North Sea there are relevant grid connection capacities available in the respective cluster, since the capacity for cluster 6 and 7 is occupied by the project He Dreiht, which placed a successful bid in the first tender. In the Baltic Sea, theoretically, all projects can bid on the available capacity due to the permissible cross-cluster grid connection.

Table 5: Approved and Discussed Projects in the North and Baltic Sea [Source: BSH, own research]

Project	Operator	Zone	Cluster	Date Approval	Date Discussion
North Sea					
Borkum Riffgrund West I	DONG Energy Borkum Riffgrund West I GmbH	1	1	2004-02-25	
OWP Delta Nordsee 1	OWP Delta Nordsee GmbH	1	3	2005-02-11	
Nördlicher Grund (64 WEA)	Nördlicher Grund GmbH	2	5	2005-12-01	
Nördlicher Grund_Teil Sandbank	Vattenfall Europe Windkraft GmbH	2	5	2005-12-01	
OWP Delta Nordsee 2	OWP Delta Nordsee GmbH	1	3	2009-08-31	
Gode Wind 04	Gode Wind 04 GmbH	1	3	2013-07-31	
Nordsee Two	Nordsee Two GmbH	1	3	2013-08-26	
Nordsee Three	Nordsee Three GmbH	1	3	2013-08-26	
Global Tech II	Vattenfall Global Tech II Offshore Wind GmbH	2	7		2014-06-05
KASKASI II	innogy Kaskasi GmbH	1	4		2014-10-08
Atlantis I	PNE WIND Atlantis I GmbH (Vattenfall)	2	6		2014-11-06
Baltic Sea					
ARCADIS OST 1	KNK Wind GmbH	1	4	2014-09-09	
Adlergrund 500	Adlergrund 500 GmbH	1	1		2012-11-05
Adlergrund GAP	BEC Energie Consult GmbH	1	1		2012-11-05
Wikinger Nord	Iberdrola Renovables Offshore Deutschland GmbH	1	1		2012-12-14
Wikinger Süd	Iberdrola Renovables Offshore Deutschland GmbH	1	1		2012-12-14
Baltic Eagle	Baltic Eagle GmbH	1	2		2013-05-15
Ostseeschatz	Financial Insurance GmbH	1	2		2013-05-15
Windanker	Iberdrola Renovables Deutschland GmbH	1	1		2016-07-27

Data Collection and Adaptation:

Deutsche WindGuard GmbH

Silke Lüers
Anna-Kathrin Wallasch
Kerstin Vogelsang

www.windguard.de

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