1st Half 2018

DEUTSCHE WINDGUARD

STATUS OF OFFSHORE WIND ENERGY DEVELOPMENT IN GERMANY

On behalf of:

AGOW Arbeitsgemeinschaft Offshore-Windenergie e.V.

BWE Bundesverband WindEnergie

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STATUS OF OFFSHORE WIND ENERGY DEVELOPMENT IN GERMANY

The development of offshore wind energy is examined every six months on behalf of the industry organizations. The development status for the first half of 2018 is the primary focus of this fact sheet. The current and future development is closely tied to the political framework. Hence, in addition to the status of offshore wind turbine (OWT) installations, grid connections and tender results are also examined.

OFFSHORE WIND TURBINE GENERATORS AND FOUNDATIONS

In the first six months of 2018, 62 OWTs with an installed capacity of 430 MW were erected. None fed into the grid by the end of June. Since there were no additional OWTs without a grid connection from the previous year, the number of OWTs corresponds to the entire quantity of turbines prepared to feed into the grid. Out of all 75 foundations that were built, 50 had not been equipped with an OWT over the course of the first half of 2018. Those in addition to foundation structures installed in the previous year, which have not yet been equipped with OWTs, sum up to a total of 139 foundations ready for the construction of further OWTs. In the first six months of 2018, no OWT started feeding into the grid. By June 30th, 2018, the cumulative capacity of all 1,169 OWTs feeding into the German grid remained constant at 5,387 MW compared to the capacity at the end of 2017. The development during the first half of 2018, as well as the cumulative status at the end of June is shown in Table 1. The development of the portfolio over time is depicted in Figure 1.

Table 1: Offshore Wind Energy Development, as of 2018-06-30

	Status of the Offshore Wind Energy Development	Capacity [MW]	Number of OWT
Addition 1st Half 2018	Installed OWTs (no feed-in)	429.5	62
	Foundations w/o OWTs		50
Cumulative (2018-06-30)	OWTs (feeding in)	5,387.4	1,169
	Installed OWTs (no feed-in)	429.5	62
	Foundations w/o OWTs		139

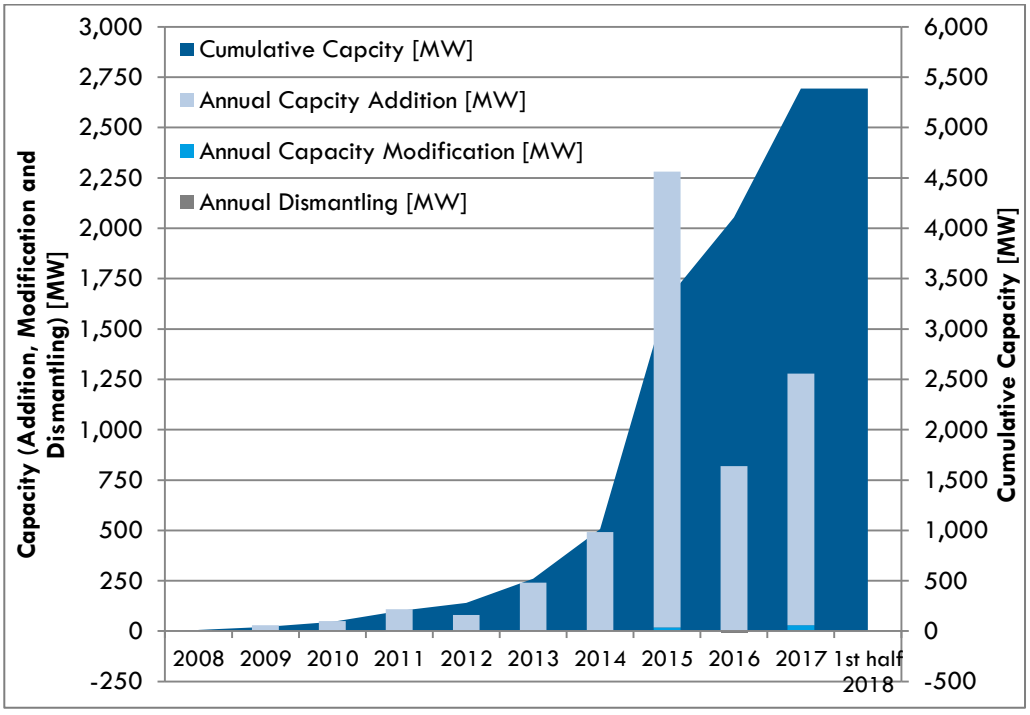

Figure 1: Development of Offshore Wind Energy in Germany (Capacity of OWTs Feeding into the Grid), as of 2018-06-30

The data was obtained through a survey with industry representatives, as well as additional research (e.g. BNetzA, BSH, ONEP, press releases etc.).
The figures contain partly rounded values. There may be slight deviations in their addition..

On behalf of: AGOW, BWE, Offshore Windenergie, VDMA, wab

TURBINE CONFIGURATION

When compared to 2017, the average turbine configuration of OWTs feeding into the grid remained unchanged. The average nominal capacity of all OWTs feeding into the German grid by June 30th, 2018 was 4,609 kW. The average rotor diameter was 126 meters and the hub height was 92 meters. The average specific area power across all OWTs feeding into the grid by the end of June amounted to 369 W/m².

Table 2: Average Turbine Configuration of OWTs (feeding in), as of 2018-06-30

Average Turbine Configuration of OWT (feeding in)	Cumulative (2018-06-30))
Average Nameplate Capacity (incl. upgrades)	4,609 kW
Average Rotor Diameter	126 m
Average Hub Height	92 m
Average Specific Power	369 W/m²

TYPES OF FOUNDATIONS

The two types of foundations installed during the examined time period were monopiles (89%) and suction bucket jackets (11%). The number of individual foundation types installed each year is depicted in Figure 2. By the end of June, 72% of all installed foundations are monopiles, 12% are jackets, 9% are tripods and 6% are tripiles. Suction bucket jackets are being used for the first time in a relevant number in a German project in 2018 and make up 1% of all installed foundations.

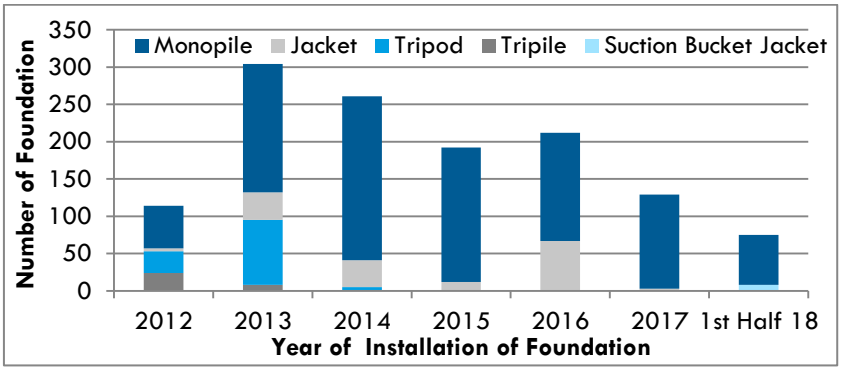

Figure 2: Foundation Types over Time, as of 2018-06-30

WATER DEPTH AND DISTANCE TO SHORE

OWTs built in the first half of 2018 were located in a median water depth of 32 meters. The turbines are at an average distance of 57 km from shore. When compared to current portfolio projects, the water depths and distances from shore of three projects under construction are situated mid-range. A further project under construction, as well as the two projects with investment decisions, are those furthest from shore at a water depth of about 40 meters. Depicted in Figure 3 are the projects arranged according to status, installed capacity, water depth and distance from shore.

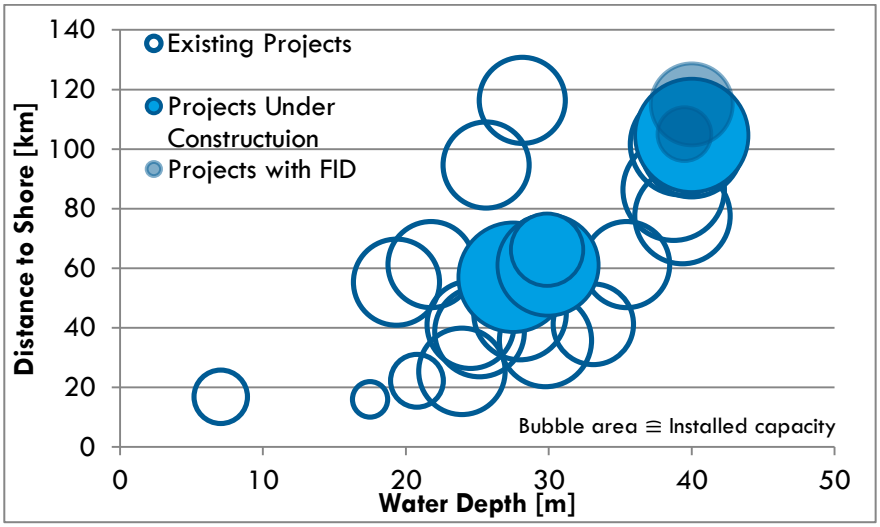

Figure 3: Water Depth and Distance to Shore, as of 2018-06-30

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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 for the first half of 2018, as well as cumulative numbers. Foundation and turbine installation activities in the first of half of June are concentrated around the North Sea region. 50 foundations and 62 turbines were newly erected, partially including the foundation, partially on existing foundations. One particular offshore wind farm is currently under construction in the Baltic Sea, but its turbines are not slated to be installed until sometime during the second half of 2018. With that, at the end of June there were 79 foundations in the North and 60 in the Baltic Sea ready to each receive their respective wind turbine. Additionally, 62 OWTs located in the North Sea are ready to start feeding into the grid. Of the overall capacity fed into the grid up to the end of June of 2018, 87% came from OWTs in the North Sea and 13% from those in the Baltic Sea.

Table 3: Distribution Across the North and Baltic Sea, as of 2018-06-30

Regional Distribution		North Sea		Baltic Sea	
		Capacity [MW]	Number of OWTs	Capacity [MW]	Number of OWTs
Addition 1st Half 2018	Installed OWTs (no feed-in)	429.50	62	0.00	0
	Foundations w/o OWTs		50		0
Cumulative (2018-06-30)	OWTs (feeding in)	4,695.10	997	692.30	172
	Installed OWTs (no feed-in)	429.50	62	0.00	0
	Foundations w/o OWTs		79		60

DISTRIBUTION ACROSS THE GERMAN FEDERAL STATES

Installed offshore capacities are associated with those coastal German federal states in which the grid connection points are located. Projects situated in the territorial waters of a specific federal state fall under the jurisdiction of that particular state. By the end of June, 2,917 MW or 54% of the installed capacity was sited in Lower Saxony. 229 MW of that capacity are located in its territorial waters. 1,781 MW of capacity has its grid connection in Schleswig-Holstein, an equivalent share of 33%. Aside from one nearshore turbine, all relevant projects are located in the exclusive economic zone (EEZ, German: Ausschließliche Wirtschaftszone or AWZ). By June 30th, 2018, Mecklenburg-Vorpommern shows a connected capacity of 690 MW. One 48 MW project is located in its territorial waters. The distribution across the German federal states and maritime areas, depicted in Figure 4, has remained unchanged compared to 2017.

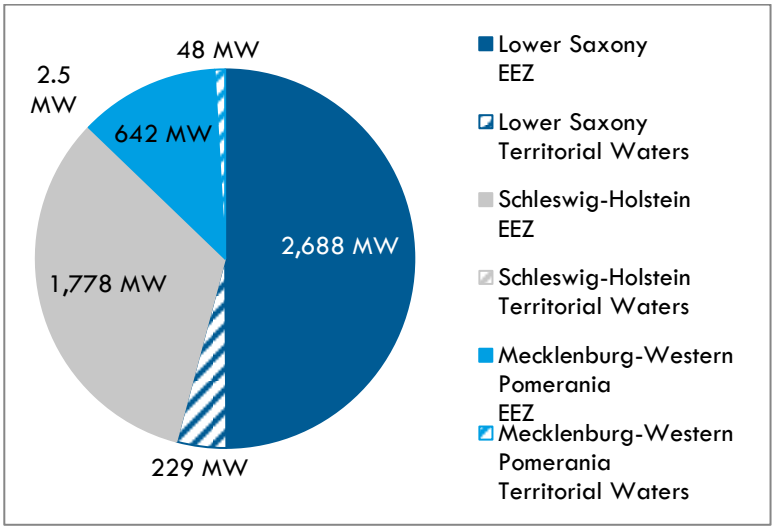

Figure 4: Distribution of Cumulative Capacity of OWTs feeding into the Grid Across German States and Maritime Areas, as of 2018-06-30

The data was obtained through a survey with industry representatives, as well as additional research (e.g. BNetzA, BSH, ONEP, press releases etc.).
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TENDERING FOR EXISTING OFFSHORE WIND ENERGY PROJECTS

In the months of April 2017 and April 2018, a total of 3,100 MW of the available offshore grid connection capacity was awarded in two tendering rounds for each respective month. Participation in these tendering rounds was only permitted to projects located within territorial waters, as well as the clusters of Zones 1 and 2 that had either been approved or discussed prior to August 1st, 2016. The projects with the lowest cost per kWh were awarded the winning bid. In addition to the four projects approved in 2017, six additional offshore wind projects (OWPs) were awarded a winning bid in 2018: Borkum Riffgrund West 1, Gode Wind 4, Kaskasi II, Wikinger Sued, Baltic Eagle and Arcadis Ost 1. OWPs with winning bids of the tendering process for existing projects (2017 and 2018) are shown in Table 4. These projects are scheduled to become operational starting in 2021 and until 2025. The respective commissioning dates as planned by the individual stakeholders are aligned with the corresponding grid connection availability.

Table 4: Awarded Offshore Projects in the North und Baltic Sea [Source: BSH, BNetzA, Additional Research], as of 2018-06-30

Project	Award Year	Developer/Owner	Accepted Capacity	Expected Year of Commissioning
North Sea				
Kaskasi II	2018	innogy	325 MW	2022
Borkum Riffgrund West 2	2017	Ørsted (formerly Dong)	240 MW	2024
OWP West	2017	Ørsted (formerly Dong)	240 MW	2024
Gode Wind 3	2017	Ørsted (formerly Dong)	110 MW	2024
Borkum Riffgrund West 1	2018	Ørsted (formerly Dong)	420 MW	2024/25
Gode Wind 4	2018	Ørsted (formerly Dong)	131.75 MW	2024/25
EnBW He Dreiht	2017	EnBW	900 MW	2025
Baltic Sea				
Arcadis Ost 1	2018	Parkwind	247.25 MW	2021
Wikinger Süd	2018	Iberdrola	10 MW	2022
Baltic Eagle	2018	Iberdrola	476 MW	2022

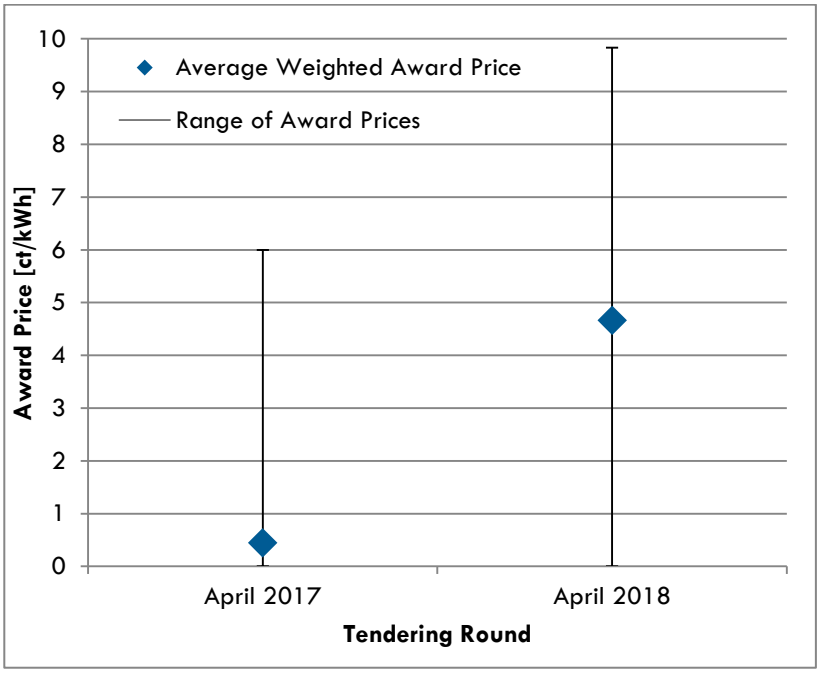

Figure 5: Range of Award Prices in the Tendering for Existing Projects, as of 2018-06-30

Across the six projects that received winning bids in April of 2018, the average weighted award price was 4.66 € cents/kWh. This was notably higher than the 0.44 € cents/kWh of the 2017 tendering round. Both for 2017 and 2018, bid values of 0 € cents/kWh were submitted. The maximum award value for the 2018 tendering round of 9.83 € cents/kWh was also markedly higher than the 6 € cents/kWh of 2017.

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DEVELOPMENT TARGET

The status of capacity addition development up to the year 2025 as of June 30th, 2018 is shown in Figure 6. In addition to the capacity of 5.4 GW already feeding into the grid by the deadline, OWTs with a capacity of 0.4 GW had been erected and 1.5 GW are under construction. For a further 0.4 GW capacity an investment decision had been made. Pilot turbines with 19 MW that had not received an investment decision by the June 2018 deadline did however receive a grid connection confirmation. The maximum possible total capacity of 7.7 GW until 2020 according to the German Energy Act (German: Energiewirtschaftsgesetz or EnWG) is expected to be reached.

In the two April 2017 and April 2018 tendering rounds for existing projects for offshore wind, projects with a total capacity of 3.1 GW received winning bids. These are anticipated to be commissioned between 2021 and 2025. It is assumed that the cumulative capacity of 10.8 GW will be reached by the year 2025.

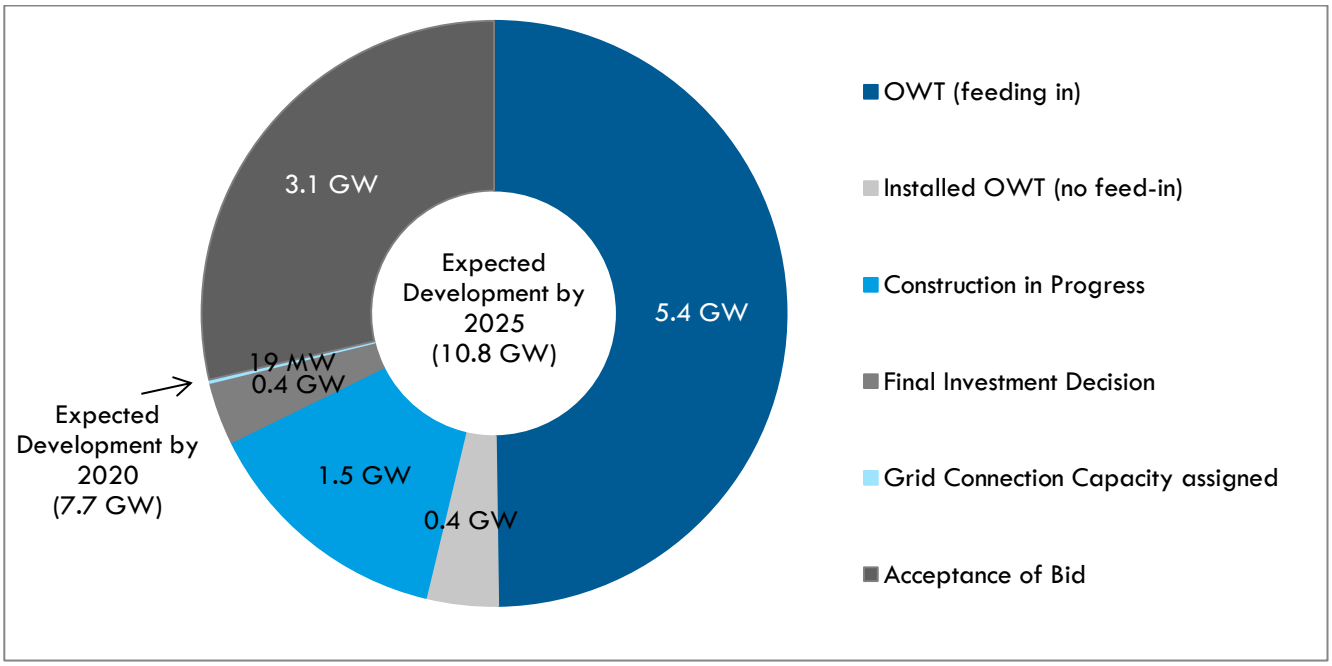

Figure 6: Development Status of Offshore Capacity with expected Commissioning by 2025, as of 2018-06-30

OFFSHORE WIND ENERGY – ACTIVITIES IN THE FIRST HALF OF 2018

By June 30th, 2018, twenty offshore wind energy projects (OWPs) were fully operational in Germany. In addition to those OWPs in operation, five projects are in the construction phase by the end of June 2018. First offshore wind turbines have already been installed in two of the OWP under construction. While the construction of the foundations has been completed in the OWP Merkur Offshore, in the project Borkum Riffgrund 2 the installation of foundations and turbines is being done in parallel. The two projects EnBW Hohe See and Trianel Windpark Borkum II also received their first foundations in the first half of 2018. Installation of all foundations in the OWP Arkona was completed in 2017, but turbine installation had not begun by June 30th, 2018.

The final investment decisions for two additional OWPs, EnBW Albatros and Deutsche Bucht, have been made and are expected to be implemented by the end of 2019. Furthermore, three additional OWTs, GICON-SOF and two pilot turbines in the North Sea, have received grid connection confirmations, but investment decisions are outstanding.

In the two tendering rounds of 2017 and 2018, a total of ten OWPs received approval and thus secured their respective grid connection capacity. An overview of the status and the geographic location of the OWPs as described are provided in Figure 7.

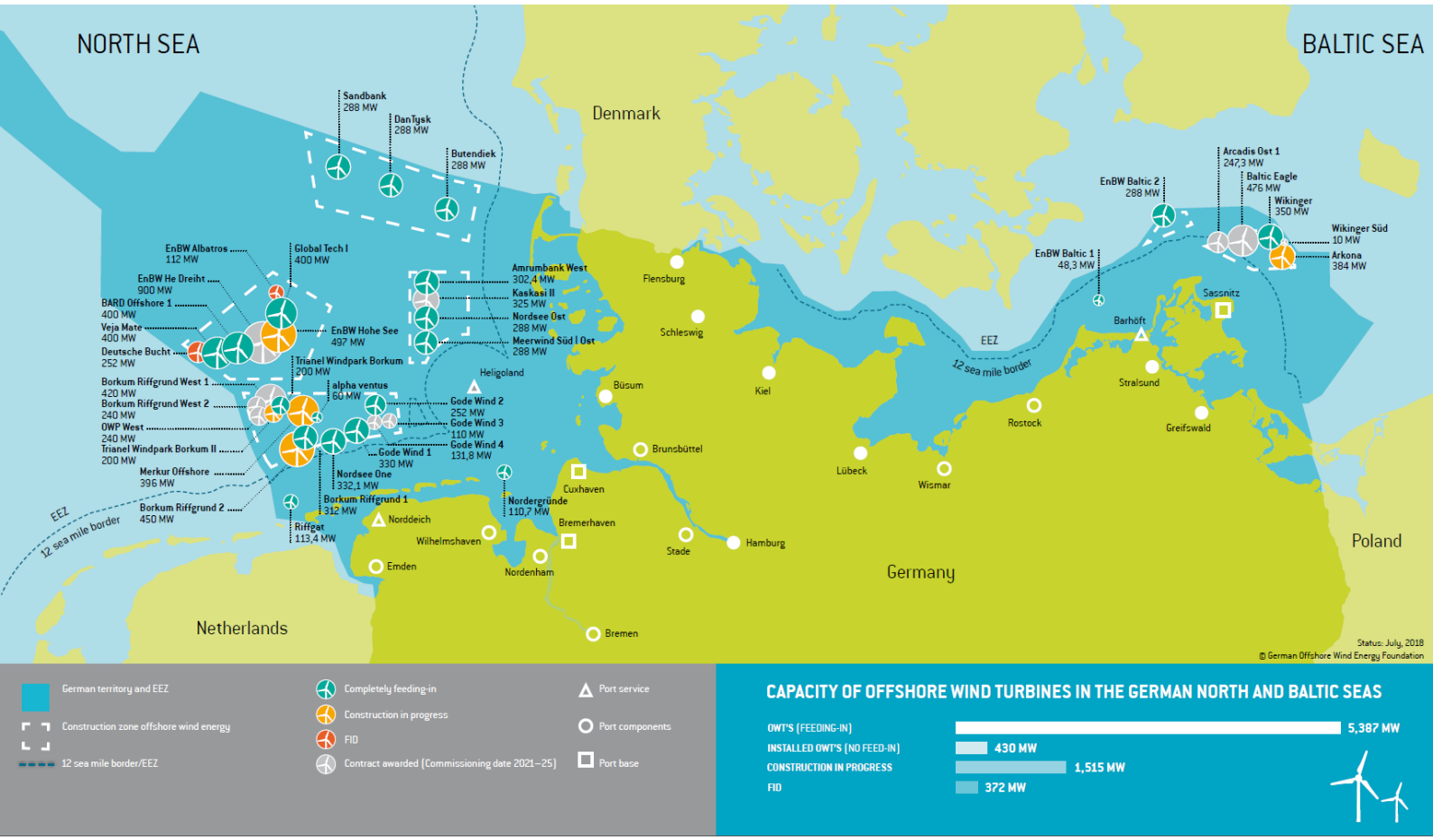

Figure 7: Completely Feeding-In OWPs, OWPs under Construction and OWPs with Final Investment Decision and OWPs with Awarded Bids, as of 2018-06-30

The data was obtained through a survey with industry representatives, as well as additional research (e.g. BNetzA, BSH, ONEP, press releases etc.).
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OVERVIEW OF ADDITIONAL GRID CONNECTION CAPACITY

At the end of the first half of 2018, a grid connection capacity of about 5.7 GW was available for offshore wind projects in the German North and Baltic Sea. Five additional grid connections with 2.6 GW are under construction, so that a capacity of 8.2 GW will be achieved at the close of 2020. Three additional grid connection systems will be realized by 2025 according to the Offshore Grid Development Plan (German: Offshore-Netzentwicklungsplan or O-NEP) for some OWPs that received approval in the first two tendering rounds for existing projects. With that, a capacity of 10.9 GW will be available by that time, which will not be entirely exhausted by the awarded capacity.

For OWPs that will be realized within the future central system starting 2026, the Area Development Plan (German: Flächenentwicklungsplan or FEP), which is to be prepared by the Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie or BSH), provides the basis to determine the need for offshore connection links. The FEP is currently available as a preliminary draft and will be finalized by the end of June 2019. According to the current status, a total grid connection capacity of about 16.4 GW is anticipated by the end of 2030. Table 5 lists information about installed and planned grid connections.

Table 5: Installed and Planned Grid Connections (to Converter Station or Bundling Point) in the North and Baltic Sea [Source: O-NEP 2030, Preliminary Draft FEP, Additional Research], as of 2018-06-30

Grid Connection	Status	(Planned) Comm. Year	Capacity	Available Capacity
Nordsee				
Nearshore Emden	Operating	2004	4,5 MW	
NOR-2-1 (Alpha Ventus)	Operating	2009	62 MW	
NOR-6-1 (BorWin1)	Operating	2010	400 MW	
NOR-0-1 (Riffgat)	Operating	2014	113 MW	
NOR-2-2 (DolWin1)	Operating	2015	800 MW	88 MW
NOR-4-1 (HelWin1)	Operating	2015	576 MW	
NOR-4-2 (HelWin2)	Operating	2015	690 MW	62 MW
NOR-5-1 (SylWin1)	Operating	2015	864 MW	
NOR-6-2 (BorWin2)	Operating	2015	800 MW	14 MW
NOR-3-1 (DolWin2)	Operating	2016	916 MW	
NOR-0-2 (Nordergründe)	Operating	2017	111 MW	
NOR-2-3 (DolWin3)	Under Construction	2018	900 MW	50 MW
NOR-8-1 (BorWin3)	Under Construction	2019	900 MW	
NOR-3-3 (DolWin6)	Approval Procedure in Progress	2023	900 MW	658 MW
NOR-1-1 (DolWin5)	Approval Procedure in Progress	2024	900 MW	
NOR-7-1 (BorWin5)	Approval Procedure in Progress	2025	900 MW	
NOR-7-2 (BorWin6)	Named in the preliminary FEP draft	2027	932 MW	932 MW
NOR-3-2 (DolWin4)	Named in the preliminary FEP draft	2028	1,100 MW	1,100 MW
NOR-6-3 (BorWin4)	Named in the preliminary FEP draft	2029	1,200 MW	1,200 MW
NOR-9-1	Named in the preliminary FEP draft	2030	1,200 MW	1,200 MW
Ostsee				
Nearshore Rostock	Operating	2006	2.5 MW	
OST-3-1 (Baltic I)	Operating	2011	51 MW	
OST-3-2 (Baltic II)	Operating	2015	288 MW	
OST-1-1 (Ostwind 1)	Under Construction	2018	250 MW	
OST-1-2 (Ostwind 1)	Under Construction	2019	250 MW	
OST-1-3 (Ostwind 1)	Under Construction	2019	250 MW	5 MW
OST-2-1	Named in the preliminary FEP draft	2021	250 MW	
OST-2-2	Named in the preliminary FEP draft	2021	250 MW	24 MW
OST-2-3	Named in the preliminary FEP draft	2022	250 MW	3 MW
OST-1-4	Named in the preliminary FEP draft	2026	300 MW	300 MW

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PROJECTION OF MONTHLY ELECTRICITY PRODUCTION FROM OFFSHORE WIND ENERGY

Figure 8 shows the preliminary projection from transmission grid operators of electricity produced by OWTs. In the first half of 2018, German OWTs fed just under 9 TWh of electricity into the grid. According to BDEW, this is equivalent to about 2.9% of the gross electricity production during that time. The energy yield of the first half of 2018 is hence about 16% above that of the previous year.

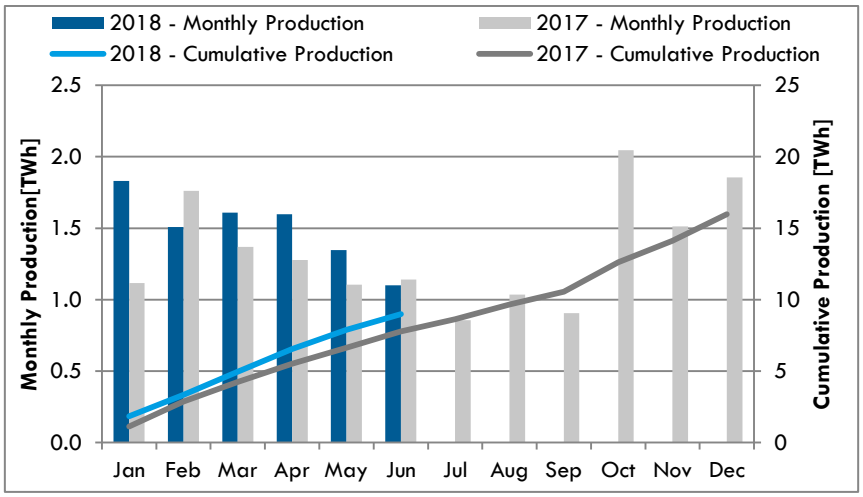

Figure 8: Electricity Production from Offshore Wind Turbine Generators in the First Half of 2018 and 2017, [Database: Projection TSOs]

MONTHLY MARKET VALUE FOR ELECTRICITY FROM OFFSHORE WIND ENERGY

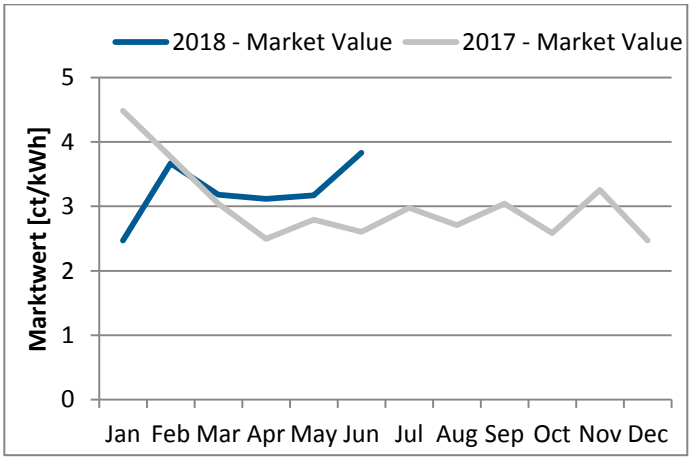

Figure 9: Monthly Market Value for OWTs in the First Half of 2018 and 2017 [Source: Netztransparenz]

The monthly market value is the average weighted electricity market revenue per kWh for those hours during which electricity was fed into the grid from offshore wind energy. As depicted in Figure 9, in the first half of 2018 the monthly market value increased from 2.5 € cents/kWh in January to 3.8 € cents/kWh in June. The average market value is 1% lower than in the first half of 2017. The level of the weighted monthly market values was 9% less in the first half of 2018 than the average value of the mean EPEX SPOT SE (European Power Exchange) hourly contracts.

INVESTMENT VOLUME OF OFFSHORE WIND ENERGY PROJECTS IN GERMANY

Offshore wind energy projects are characterized by large investment volumes. According to estimations, annual investments in the offshore wind energy sector have exceeded €3 billion every year since 2013 (see Figure 10). Compared to the time the projects were connected to the grid, investments are distributed more evenly over time since the realization of these projects always takes several years.

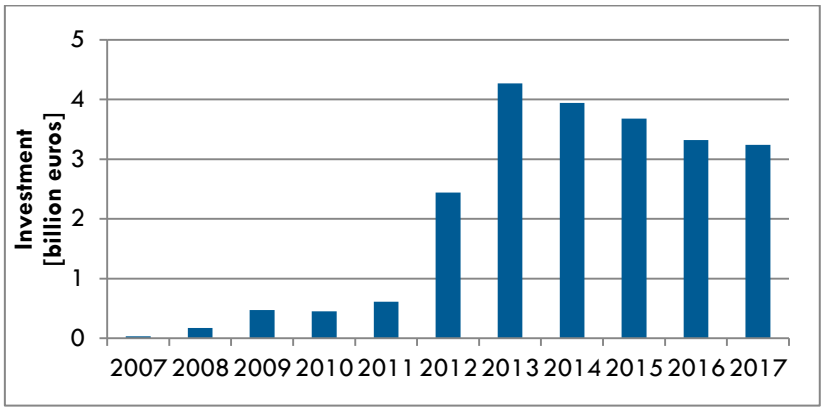

Figure 10: Investment in the Construction of Offshore Wind Turbines 2007 until 2017 [Source: AGEE Stat]

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