DEUTSCHE WINDGUARD

Status of Offshore Wind Energy Development in Germany

First Half of 2023

On behalf of

BWE Bundesverband WindEnergie

BWO Bundesverband der Windparkbetreiber Offshore e.V.

FOUNDATION OFFSHORE WIND ENERGY

VDMA Power Systems

wab It's only possible with wind

WindEnergy Network

Contents

Notes

The data was obtained through surveys with industry representatives as well as through additional research (sources e.g. BNetzA and BSH). Retroactive adjustments to the data are done based on corrected notifications if required.

The installed capacity of offshore wind energy projects is not always equal to the grid connection capacity. Future offshore wind energy projects are assigned with their total capacity to the respective expected year of commissioning.

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

Turbine installation at Arcadis Ost 1

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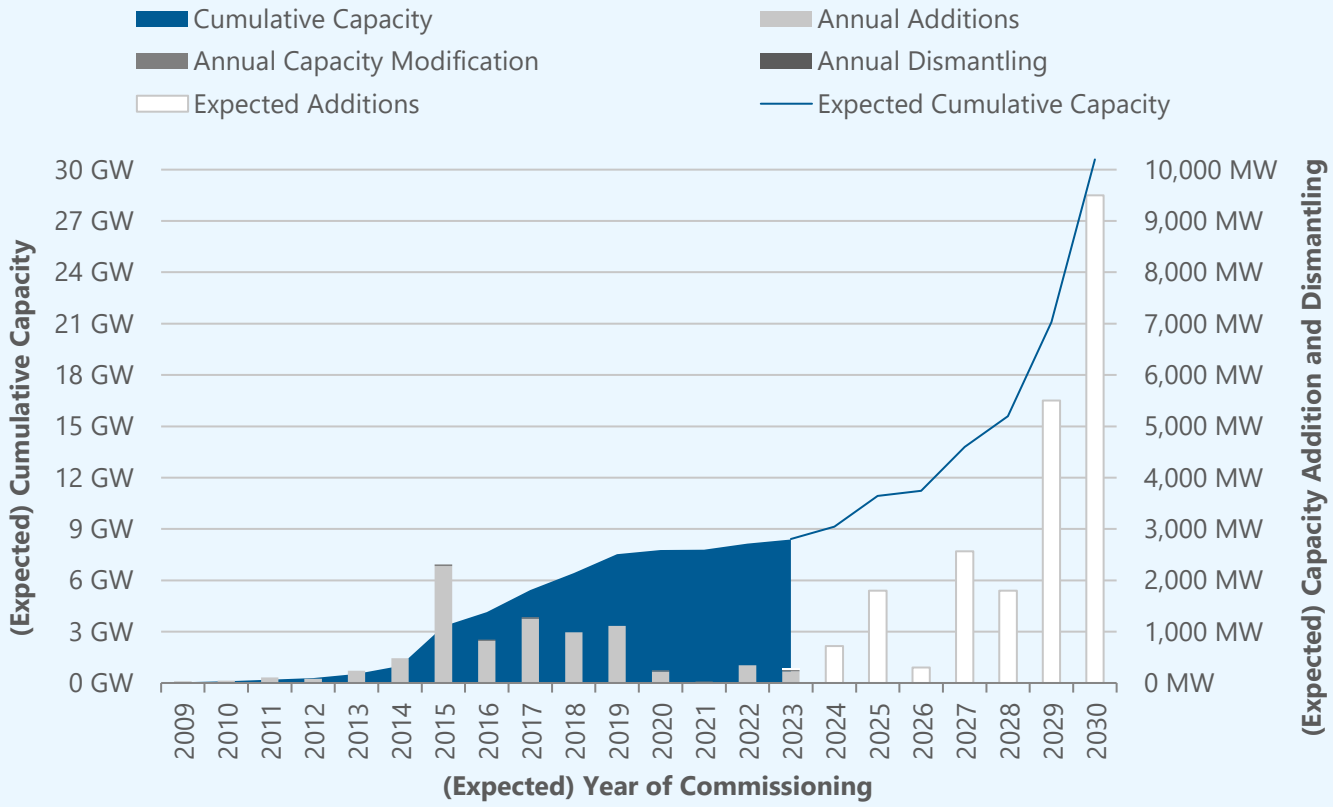
Offshore Wind Energy Development

As of June 30, 2023, 1,563 offshore wind turbines (OWT) with a total installed capacity of 8.4 GW were in operation in Germany. Of these, 24 turbines with a total capacity of 229 MW fed into the electricity grid for the first time in the first half of 2023. In the course of the first half of 2023, capacity modifications of existing turbines were also implemented and new foundations were installed; the associated offshore wind turbines have not yet been erected.

After the first offshore wind energy project (OWP) of the transitional system (projects with awards from tender rounds in 2017 and 2018) was commissioned in 2022, the implementation of the further projects of the transitional system is progressing. It is expected that all projects from the transitional system will be fully commissioned by the end of 2025.

Status of the Offshore Wind Energy Development

		Capacity	Number
Additions H1 2023	OWT (feeding in)	229 MW	24 OWT
	Capacity Modifications of existing OWT	20 MW	67 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT
	Foundations w/o OWT		17 Foundations
Cumulative 2023-06-30	OWT (feeding in)	8,385 MW	1,563 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT
	Foundations w/o OWT		20 Foundations



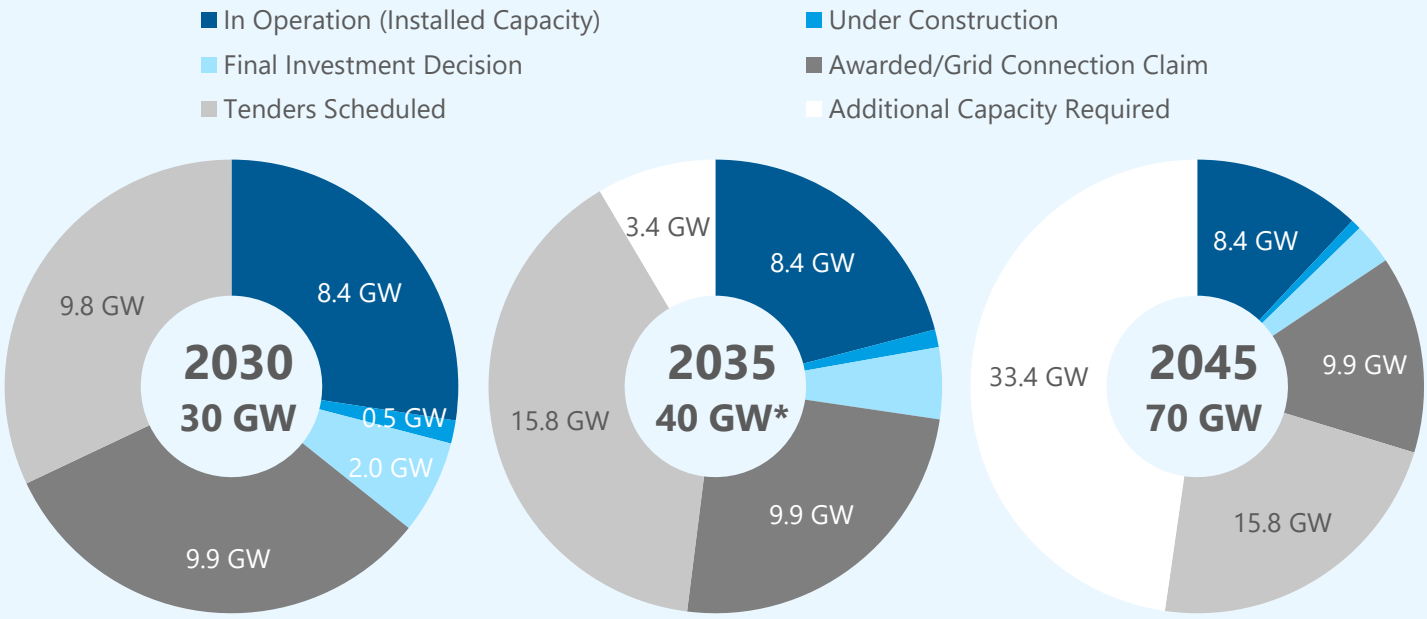
(Expected) Development of the Offshore Wind Energy in Germany
(Database: own surveys, MaStR, FEP 2023)

Expansion Targets Offshore Wind Energy

The amendment to the Offshore Wind Energy Act (German: Windenergie-auf-See-Gesetz or WindSeeG) to increase the expansion targets for offshore wind energy in Germany came into force on January 1, 2023. The increased targets aim to increase the installed capacity of offshore wind turbines connected to the grid to a total of at least 30 GW by 2030, to at least 40 GW by 2035 and to at least 70 GW by 2045.

As of June 30, 2023, the installed capacity of offshore wind turbines in operation was 8.4 GW. Two projects were still partially or completely under construction. In addition, a final investment decision has already been reached for three projects with a total capacity of 2 GW by the middle of 2023. Further projects with a total capacity of 9.9 GW have been awarded in the tenders for offshore wind energy or have a grid connection claim in accordance with the Energy Industry Act (German: Energiewirtschaftsgesetz or EnWG). However, these projects did not yet report a final investment decision.

In January 2023, the Federal Maritime and Hydrographic Agency (German: Bundesamt für Seeschifffahrt und Hydrographie or BSH) published the updated Site Development Plan (German: Flächenentwicklungsplan or FEP). This FEP 2023 contains further tender dates for sites that are to be taken into operation by 2032: Sites with an installed capacity of 9.8 GW are to be tendered and commissioned by 2030. Based on these plans, the expansion target of 30 GW by 2030 could be reached. Further sites with a total capacity of 6 GW shall follow in 2031 and 2032. In order to achieve the expansion target pf 40 GW by 2035, additional specifications are necessary. The FEP 2023 already provides an informational outlook on the possible sites.



* According to the Offshore Realisation Agreement 2022, the target of at least 40 GW by 2035 can be significantly exceeded through increased legal tender volumes, so that an expansion to 50 GW can be achieved by 2035.

Development Status of Offshore Capacity with Expansion Targets by 2030, 2035 and 2045 (Database: own surveys, MaStR, WindSeeG 2023, FEP 2023)

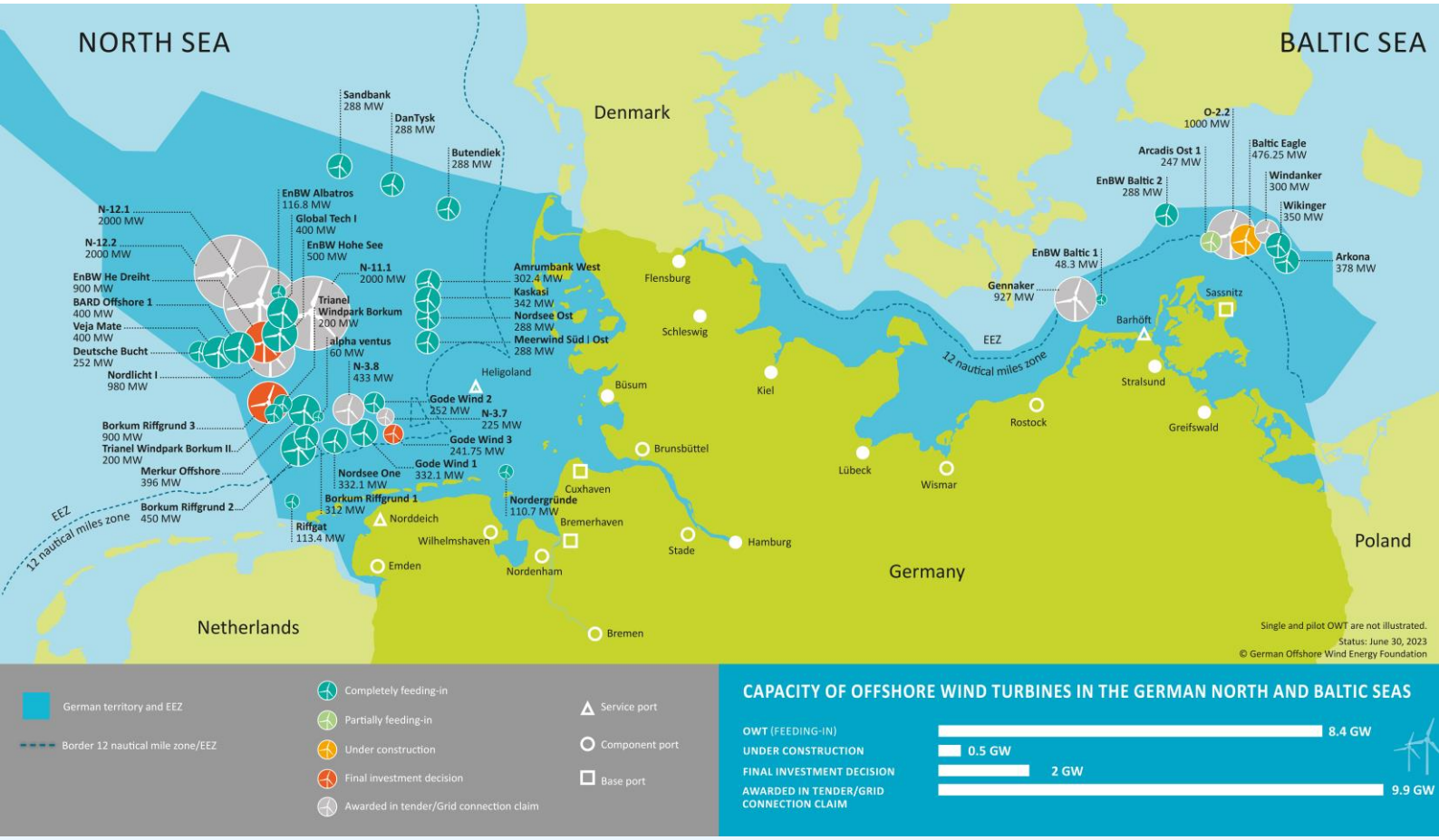
Activities in Offshore Wind Energy Projects

At mid-year 2023, 28 offshore wind energy projects were fully operational in Germany. In the Arcadis Ost 1 project, construction activities have continued to progress in the first half of 2023: The foundation work was completed and a major proportion of the turbines has already been commissioned. The full commissioning of the project is scheduled for the second half of 2023. At the OWP Baltic Eagle, the installation of the turbine foundations began in the first half of 2023. In the Gode Wind 3 and Borkum Riffgrund 3 projects, installation of the foundations is scheduled to begin in the second half of 2023. In the project EnBW He Dreiht, the final investment decision (FID) was made in spring 2023 and construction is expected to start at the beginning of 2024. Further projects, which have been awarded or are entitled to be connected to the grid, are preparing for implementation.

Overview of future offshore wind energy projects

OWP	Status	Expected Commissioning	Capacity*
Arcadis Ost 1	Partially feeding in	2023	247 MW
Baltic Eagle	Under Construction	2024	476 MW
Gode Wind 3	FID	2024	242 MW
Borkum Riffgrund 3	FID	2025	900 MW
EnBW He Dreiht	FID	2025	900 MW
Windanker	Awarded	2026	300 MW
N-3.7	Awarded	2027	225 MW
N-3.8	Awarded	2027	433 MW
Nordlicht I	Awarded	2027	980 MW
Gennaker	Grid connection claim	2027	927 MW
N-11.1	Awarded	2030	2,000 MW
N-12.1	Awarded	2030	2,000 MW
N-12.2	Awarded	2030	2,000 MW
O-2.2	Awarded	2030	1,000 MW

* grid connection capacity

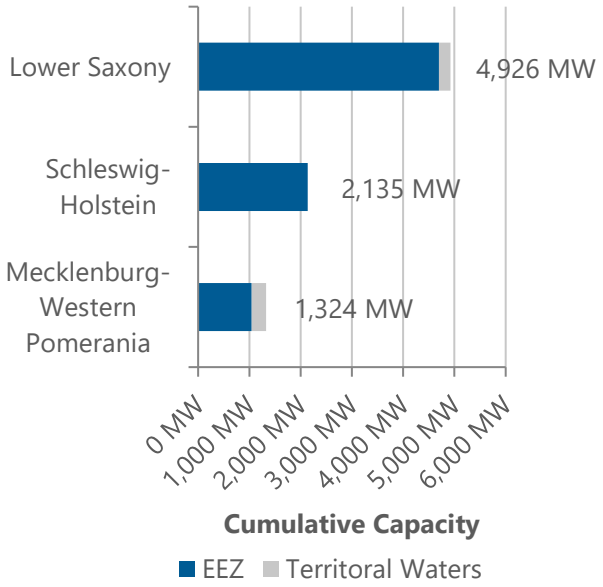


Overview Map of Offshore Wind Energy in Germany (© German Offshore Wind Energy Foundation)

Distribution across Federal States and North and Baltic Sea

In Germany, most of the offshore wind turbines feeding into the grid are located in the North Sea (7.1 GW), while the Baltic Sea accounts for 1.3 GW. In both the North Sea and the Baltic Sea, offshore wind turbines are mainly installed in the Exclusive Economic Zone (EEZ; German: Ausschließliche Wirtschaftszone or AWZ) (7.9 GW), with significantly fewer turbines installed in the territorial waters (0.5 GW). Construction and commissioning activities during the first half of 2023 took place mainly in the Baltic Sea, but the future expansion of offshore wind energy will be much more concentrated in the North Sea.

Based on the location of the respective grid connection point, the offshore installed capacity can be allocated to the German federal states. The installed capacity in the North Sea is distributed between Lower Saxony with 4.9 GW and Schleswig-Holstein with 2.1 GW. The 1.3 GW of installed capacity in the Baltic Sea is entirely assigned to Mecklenburg-Western Pomerania.



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

Distribution across the North and Baltic Sea

		North Sea		Baltic Sea	
		Capacity	Number	Capacity	Number
Additions H1 2023	OWT (feeding in)	0 MW	0 OWT	229 MW	24 OWT
	Capacity Modifications of existing OWT	20 MW	67 OWT	0 MW	0 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT	0 MW	0 OWT
	Foundations w/o OWT		No Foundations		17 Foundations
Cumulative 2023-06-30	OWT (feeding in)	7,060 MW	1,307 OWT	1,324 MW	256 OWT
	Installed OWT (no feed-in)	0 MW	0 OWT	0 MW	0 OWT
	Foundations w/o OWT		No Foundations		20 Foundations

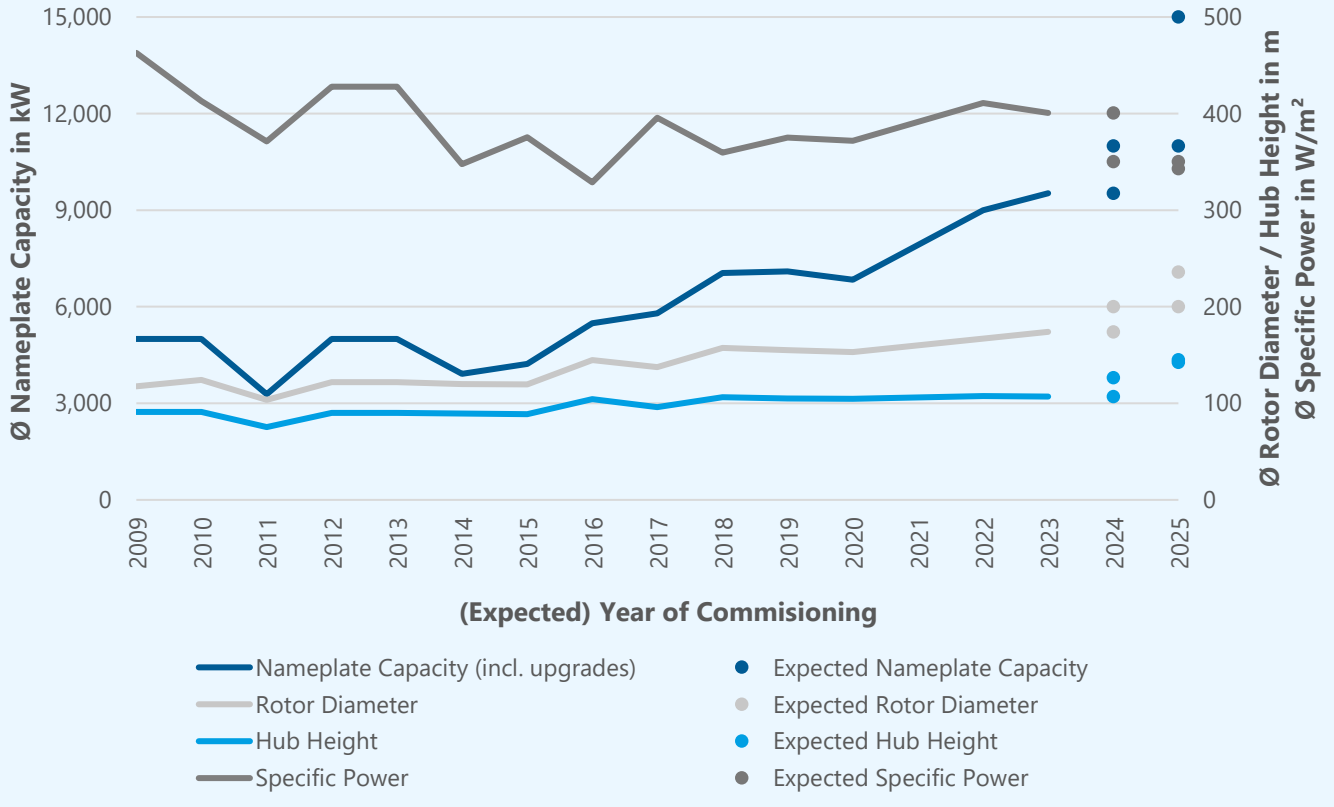
Turbine Configuration

The turbines commissioned in the first half of 2023 with 9.5 MW each represent the most powerful offshore wind turbines in Germany to date. For the entire portfolio of all offshore wind turbines in operation at mid-year 2023, the average capacity is just under 5.4 MW.

In the projects that are expected to be commissioned in 2024 and 2025, turbine types of at least 9.5 MW and up to 15 MW capacity are planned. This results in an average offshore wind turbine capacity of 11.8 MW for the future additions until 2025. The current plans for the future projects also provide for significant increases in rotor diameter and hub height by 2025 compared to the existing turbines. According to the project plans, rotor diameter and hub height will be between 174 m and 236 m (rotor diameter) and between 107 m and 145 m (hub height), depending on the project. The specific power (ratio of turbine capacity to rotor area) remains at a level comparable to previous years and will range between 340 W/m² and 410 W/m².

Average Offshore Wind Turbine Configuration

Average Configuration	Cumulative 2023-06-30	Additions H1 2023	Expected additions until 2025
Nameplate Capacity (incl. upgrades)	5,364 kW	9,525 kW	11,797 kW
Rotor Diameter	134 m	174 m	204 m
Hub Height	95 m	107 m	124 m
Specific Power	374 W/m²	401 W/m²	360 W/m²



* Illustration of expected turbine configuration by project and year of commissioning

(Expected*) Turbine Configuration over Course of Time

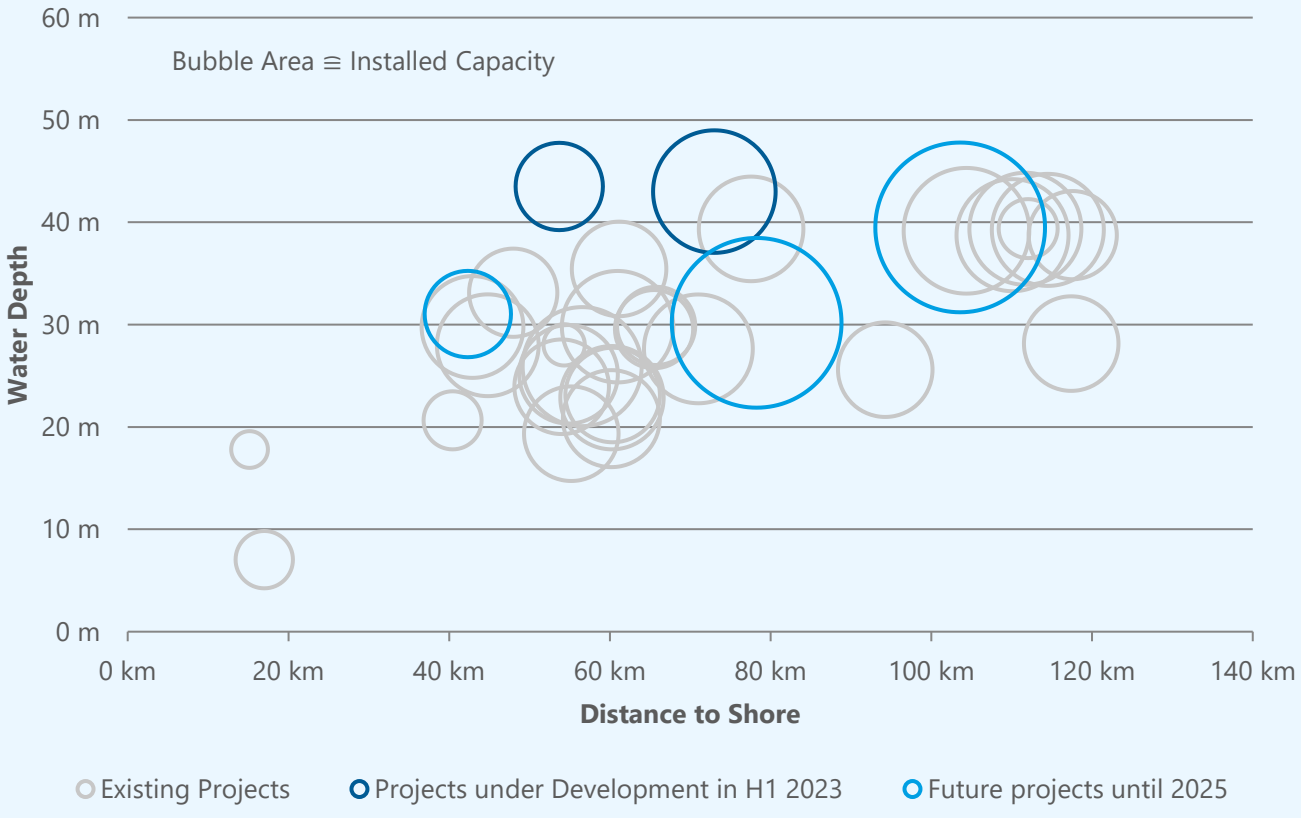
Water Depth and Distance to Shore

Offshore wind energy projects in German waters differ in terms of water depth and distance to shore. Only a few of the offshore wind turbines installed in Germany are located in shallow waters close to the coast; the majority is located at least 40 km from the coast in water depths of 20 m and more. Some of the turbines are installed at locations with a distance to the shore of more than 120 km and water depths of up to 44 m. On average, the existing projects have a water depth of about 30 m and a distance to the shore of 74 km. The two projects under development in the first half of 2023 in the Baltic Sea are installed in comparatively deep waters but are located slightly closer to the shore. The future projects, which are to be realised by 2025, are also distributed at locations with different conditions. On average, however, their water depth and distance to shore do not differ much from those of the existing projects.

With regard to the type of foundation, the monopile foundation has become the most commonly used type in Germany. All of the foundations installed during the first half of 2023 were monopiles, and the future projects have also already announced the installation of monopile foundations.

Average Water Depth and Distance to Shore

Average Location	Water Depth	Distance to Shore
Existing Projects	30 m	74 km
Projects under Development in H1 2023	43 m	66 km
Future Projects until 2025	34 m	85 km



Water Depth and Distance to Shore of Existing Projects, Projects under Development and Future Projects

Tenders for Offshore Wind Energy

The amendment to the WindSeeG, which entered into force at the beginning of 2023, provides for changes of the tender system for tenders from 2023. In addition to the sites that have been centrally pre-investigated by the BSH, sites that have not been centrally pre-investigated will also be tendered. The award procedure differs depending on the site.

In June 2023, the first tender round for four non-centrally pre-investigated sites with a combined total tender volume of 7 GW took place. Three sites in the North Sea (N-11.1, N-12.1, N-12.2) and one site in the Baltic Sea (O-2.2) were tendered. For all four sites, several bidders submitted 0-cent bids, so that the dynamic bidding procedure had to be carried out for the first time. The bidders with the highest willingness to pay for a site were awarded. The awards for the sites N-11.1 and N-12.2 were secured by the company BP. The company Total Energies won the awards for sites N-12.1 and O-2.2. The total payments offered by the two successful bidders amount to approximately 12.6 billion euros. Of the payments, a share of 90 % will go towards reducing electricity costs and 5 % each towards measures for marine nature conservation and promoting sustainable fishing.

In August 2023, the tender round for four centrally pre-investigated sites with a total volume of 1.8 GW will take place. The centrally pre-investigated sites will be awarded on the basis of various criteria. These include financial (bid for a payment) and non-financial criteria (e.g. contribution to decarbonisation and securing qualified employees). In addition, a site for other offshore energy generation (SEN-1) is to be tendered for the first time; the date is not yet announced.

Offshore Sites for Tenders until 2027 (Database: FEP 2023, BNetzA)

Site	Year of Tender	Expected Commissioning	Expected Capacity	Preliminary Investigation	Status
N-11.1	2023	2030	2,000 MW	not central	Awarded to BP Bid value: €1.83 mn/MW (€3.7 bn)
N-12.1	2023	2030	2,000 MW	not central	Awarded to Total Energies Bid value: €1.875 mn/MW (€3.8 bn)
N-12.2	2023	2030	2,000 MW	not central	Awarded to BP Bid value: €1.56 mn/MW (€3.1 bn)
O-2.2	2023	2030	1,000 MW	not central	Awarded to Total Energies Bid value: €2.07 mn/MW (€2.1 bn)
N-3.5	2023	2028	420 MW	central	Tender date August 1, 2023
N-3.6	2023	2028	480 MW	central	Tender date August 1, 2023
N-6.6	2023	2028	630 MW	central	Tender date August 1, 2023
N-6.7	2023	2028	270 MW	central	Tender date August 1, 2023
N-11.2	2024	2031	1,500 MW	not central	
N-12.3	2024	2031	1,000 MW	not central	
N-9.1	2024	2029	2,000 MW	central	
N-9.2	2024	2029	2,000 MW	central	
N-9.3	2024	2029	1,500 MW	central	
N-10.1	2025	2030	2,000 MW	central	
N-10.2	2025	2030	500 MW	central	
N-13.1	2026	2031	500 MW	central	
N-13.2	2026	2031	1,000 MW	central	
N-21.1	2027	2032	2,000 MW	central	
SEN-1					

Overview of Grid Connection Capacities

In Germany, a total of 17 grid connection systems with a total capacity of 8.2 GW were completely operational by mid-2023. Of these, twelve grid connections systems with approximately 7.1 GW are located in the North Sea and five grid connection systems with approximately 1.1 GW in the Baltic Sea. This capacity is used by the offshore wind energy projects in operation. Several grid connection systems in the North Sea and Baltic Sea, which will provide the necessary grid connection capacities for future offshore wind energy projects, were under construction in the first half of 2023.

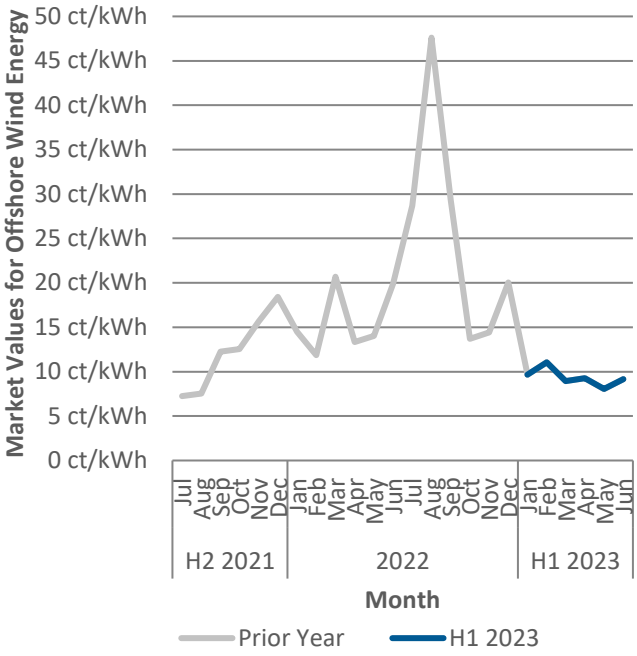
Installed and Planned Grid Connections (to Converter Station or Bundling Point) in the North and Baltic Seas (Database: Grid Development Plan Electricity 2037/2045 (Version 2023, 2nd draft), TSOs, additional research)

Grid Connection System	Status	(Expected) Commissioning	(Expected) Capacity	(Preliminary) Assigned Offshore Wind Energy Projects and Sites
North Sea				
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, Trianel Windpark 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, Gode Wind 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)	In Operation	2019	900 MW	EnBW Hohe See, Global Tech I
NOR-3-3 (DolWin6)	Under Construction	2023	900 MW	Gode Wind 3, N-3.7, N-3.8
NOR-1-1 (DolWin5)	Under Construction	2025	900 MW	Borkum Riffgrund 3
NOR-7-1 (BorWin5)	Under Construction	2025	900 MW	EnBW He Dreiht
NOR-7-2 (BorWin6)	Under Construction	2027	980 MW	Nordlicht I
NOR-3-2 (DolWin4)	Under Construction	2028	900 MW	N-3.5, N-3.6
NOR-6-3 (BorWin4)	Under Construction	2028	900 MW	N-6.6, N-6.7
NOR-9-1 (BalWin1)	In planning and approval procedures	2029	2,000 MW	N-9.1
NOR-9-2 (BalWin3)	Planned	2029	2,000 MW	N-9.2
NOR-9-3 (BalWin4)	Planned	2029	2,000 MW	N-9.3, N-10.2
NOR-10-1 (BalWin2)	In planning and approval procedures	2030	2,000 MW	N-10.1
NOR-11-1 (LanWin3)	Planned	2030	2,000 MW	N-11.1
NOR-12-1 (LanWin1)	Planned	2030	2,000 MW	N-12.1
NOR-12-2 (LanWin2)	Planned	2030	2,000 MW	N-12.2
NOR-11-2 (LanWin4)	Planned	2031	2,000 MW	N-11.2, N-13-1
NOR-13-1 (LanWin5)	Planned	2031	2,000 MW	N-12.3, N-13.2
Baltic Sea				
OST-3-1 (Baltic 1)	In Operation	2011	51 MW	EnBW Baltic 1
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)	In Operation	2019	250 MW	Arkona
OST-1-3 (Ostwind 1)	In Operation	2019	250 MW	Arkona, Wikinger
OST-2-1 (Ostwind 2)	Under Construction	2023	250 MW	Arcadis Ost 1
OST-2-2 (Ostwind 2)	Under Construction	2023	250 MW	Baltic Eagle
OST-2-3 (Ostwind 2)	Under Construction	2024	250 MW	Baltic Eagle
OST-1-4 (Ostwind 3)	Approval Procedure	2026	300 MW	Windanker
OST-2-4 (Ostwind 4)	Planned	2030	1,000 MW	O-2.2
OST-6-1 (Gennaker)	Planned		927 MW	Gennaker
OST-T-1 (Test Field)			300 MW	Test Field

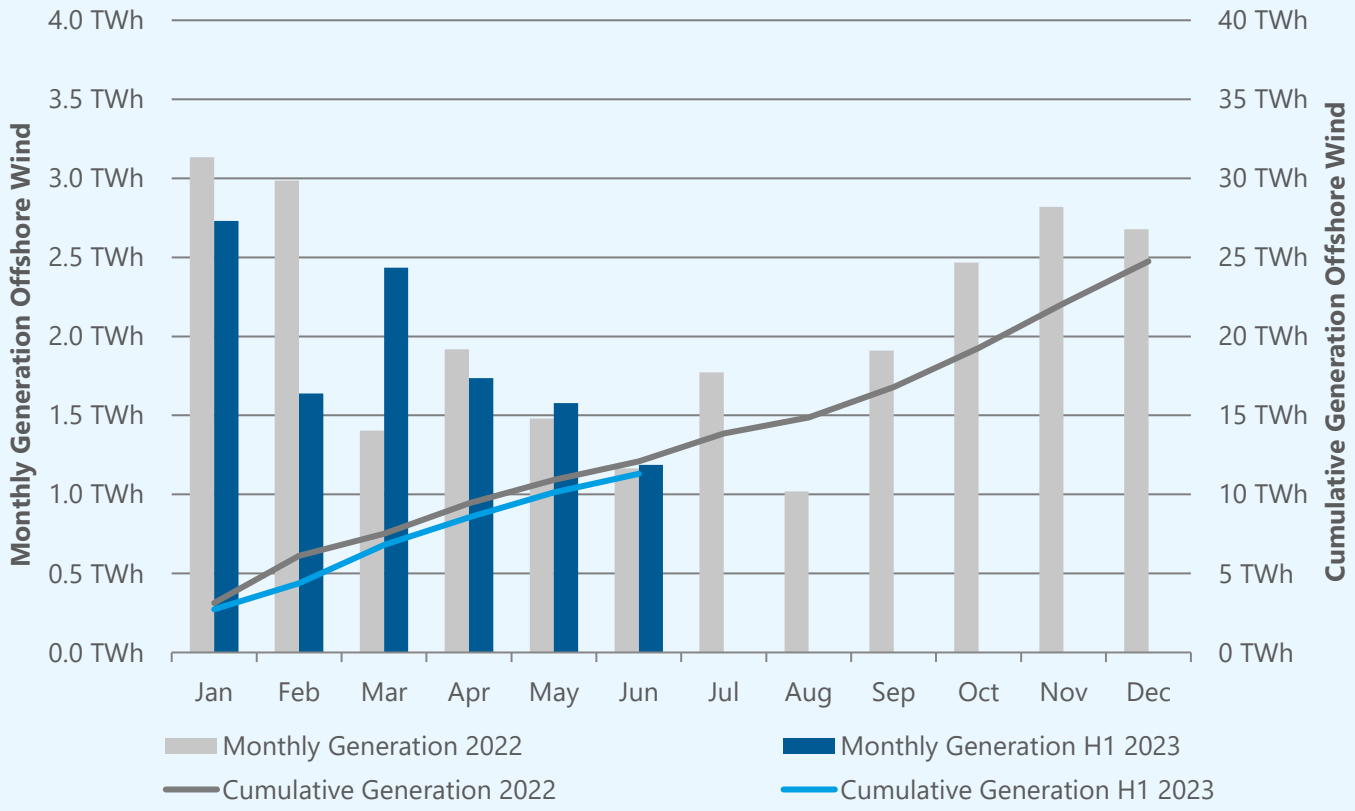
Power Generation and Market Values

After 2022 was characterised by strong distortions on the energy markets, the level of electricity market prices stabilised again in the first half of 2023. The monthly market values for electricity from offshore wind energy reached a constant level of approximately 9 ct/kWh in the six months of the first half of 2023. Only in February 2023 the value was at 11 ct/kWh. On average, the volume-weighted monthly market value for offshore wind energy in the first half of 2023 was 9.41 ct/kWh, a significantly lower value than the average value of 18.35 ct/kWh in 2022.

In the first half of 2023, 11.3 TWh of electricity was generated by offshore wind energy. Electricity generation from offshore wind was at a lower level in the first half of 2023 compared to the first half of 2022. Approximately 6 % less electricity was generated than in the first half of 2022 (12.1 TWh).



Monthly Market Values for Offshore Wind Energy (Database: Netztransparenz)



Power Generation Offshore Wind (Database: Bundesnetzagentur | SMARD.de)

About Deutsche WindGuard
In the complex energy market, Deutsche WindGuard is committed to providing unbiased, manufacturer-independent consulting and comprehensive scientific, technical and operational services.

About the German Windenergy Association (BWE)
The German Windenergy Association (BWE) is partner to over 3,000 companies in the wind energy industry and represents the interests of about 20,000 members. The entire know-how of a multifaceted industry is pooled through BWE.

About Bundesverband der Windparkbetreiber Offshore e.V. (BWO)
The association of German offshore wind farm operators (BWO) represents all companies that plan, construct and operate offshore wind farms in Germany. The BWO is the central contact on all questions concerning offshore wind energy.

About the German Offshore Wind Energy Foundation
The foundation is a leading non-partisan, supra-regional and independent ThinkTank for the development of offshore wind energy in Germany and Europe. It serves as a communication platform for stakeholders from the political, industrial and research sector, enables knowledge exchange and serves as driver of ideas.

About VDMA Power Systems
The trade association VDMA Power Systems and its working groups represent the interests of manufacturers and suppliers of power and heat generation plants.

About WAB e.V.
The WAB is the nationwide contact for the offshore wind industry, the onshore network in the Northwest and promotes the production of green hydrogen from wind power. Wind Industry and Hydrogen Association WAB e.V. includes around 250 smaller and larger companies as well as institutes from all areas of the wind industry, the maritime industry, the emerging hydrogen economy and science.

About WindEnergy Network e.V. (WEN)
The WEN is the leading company network for wind energy in the northeast region with currently approx. 100 member companies. The aim is to promote the expansion of companies and supply chains in order to enhance regional value creation in the future sector renewable energies. The key topics are windenergy on- and offshore, maritime technologies in connection with offshore wind as well as the development of green hydrogen.