WFO

Global Offshore Wind Report

2023

APRIL 2024

About WFO

WFO is the world's leading business platform for the offshore wind industry. By connecting and supporting our members, WFO is helping to make offshore wind one of the world's leading sources of renewable energy.

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Dear offshore wind community,

In 2023, 25 new offshore wind farms with a total capacity of 9.8 gigawatts (GW) were taken into operation, increasing the global offshore wind capacity to a total of 67.4 GW.

China remains the front runner with a total of 31.5 GW up and running. But we also see positive developments in Europe: France more than doubled its total capacity from 482 megawatts (MW) to 978 MW with the Saint-Brieuc project. And not to forget, the largest floating offshore wind farm so far was taken into operation: Hywind Tampen has a total capacity of 88 MW and is located about 140 km off the Norwegian coast.

Yet, 2023 was not an easy year for the industry: increased costs, supply chain struggles, delayed or even cancelled projects – we all remember the headlines.

However, scaling up offshore wind is not optional; it is crucial to decarbonize our economies. In our various WFO Committees we are therefore regularly bringing together experts from across the global offshore wind value chain to discuss the latest developments, share experiences and to address and overcome the industry's biggest challenges.

Beyond that, we have successfully established two annual WFO events: the next WFO Asia Pacific Summit will take place in Tokyo this June and I am happy to announce that after our successful debut this year, there will also be another WFO Global Summit in Barcelona in early 2025.

We as WFO feel the positive spirit of the offshore wind industry every day and we will continue to foster exchange and collaboration to make offshore wind one of the world's leading sources of renewable energy!

Let's work together to make offshore wind one of the world's leading sources of renewable energy.

Gunnar Herzig

Managing Director

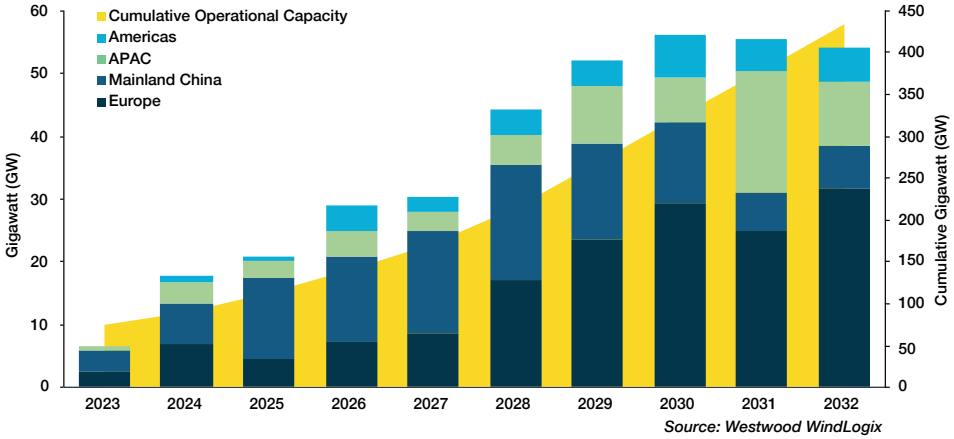
Global Offshore Wind Outlook

The industry has experienced a significant jolt in 2023. While leases and projects continued to be awarded / sanctioned, cost inflation coupled with mismatched support levels have resulted most tangibly in delayed or even cancelled proposed capacity build-outs. Developers have also recalibrated portfolios and taken the time to pause and refocus their strategies. Whilst policymakers have and are making attempts to bridge the gap, it remains to be seen how effective the recalibrated policies are. During this time of uncertainty, having a nuanced risked view of the pipeline has never been more relevant.

A total of 42 GW of lease capacity was awarded in 2023 and 2024 awards are expected to reach over 70 GW.

- Over 22.5 GW of lease capacity was awarded in 2H 2023, bringing the total awards for the year to 42.0 GW. Notable leasing rounds include Japan Round 2 with RWE winning the rights to the largest site (684 MW) in a consortium with Mitsui & Co. and Osaka Gas Co.
- Westwood expects more than 70 GW of lease capacity to be awarded in 2024, a 67% increase in comparison to 2023. This capacity will come from a mixture of incumbent as well as new markets such as Australia (at least 9.2 GW), India (4.6 GW) and Portugal (3.5 GW). The US is also anticipated to award at least 16.8 GW of capacity, with nearly 2.7 GW of this coming from floating wind sites located offshore Oregon.
- It is worth noting that tender requirements continue to evolve, with some jurisdictions including a 'wider benefit' criteria, beyond the traditional bid price. Westwood estimates over half of 2024's lease capacity will include some form of project benefit criteria alongside a price element, or they will just be selected via non-price criteria.

Global Annual Capacity Installations 2023-2032



Source: Westwood WindLogix

Cumulative global offshore wind capacity is forecast to reach 414 GW by 2032, a 7.4% decrease in comparison to what was forecast in 1H 2023.

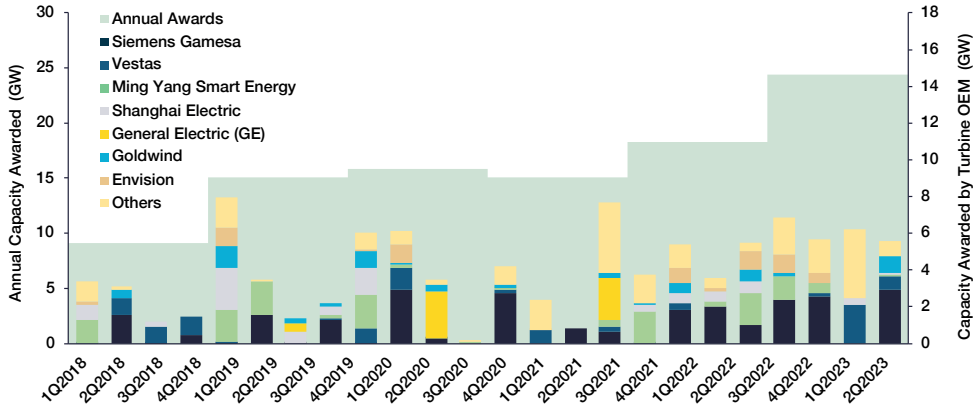
- Westwood's 10-year outlook has changed primarily due to project cancellations, including Orsted's Ocean Wind 1 and 2 projects offshore US. The official termination of Denmark's open-door scheme for offshore wind also contributed to over 2 GW of capacity removals.
- Despite this, 2023 has been a positive year of growth from a final investment decision (FID) standpoint, with a record level of project capacity (23.8 GW) crossing that milestone.
- Notable projects that took FID in 2H 2023 include the Baltic Power wind farm (Poland), Hai Long (Taiwan), Revolution Wind (US) and Hornsea Project Three (UK).

Global Offshore Wind Turbine OEM Market Share

22.9 GW worth of turbine contracts awarded in 2023, with Siemens Gamesa bagging 33% of the total.

- Siemens Gamesa led in terms of overall turbine awards for the year, with key contract wins in 2H coming from the Hornsea Project Three wind farm, where it will supply its SG 14-236 DD turbines. Vestas and Ming Yang came in second (3.1 GW) and third (1.8 GW) respectively.
- Considering the overall 2018-2023 period, Siemens Gamesa leads with a market share of 26%, MYSE (13%) holds the second position, followed by Vestas (10%).
- 2023 has also witnessed the further advancement of higher capacity turbines, with Mainland China (ML China) installing 16 MW turbines at two wind farms - Zhangpu Liuao Phase 2 and Pingtan Waihai.

Global Offshore Wind Turbine Capacity Awards



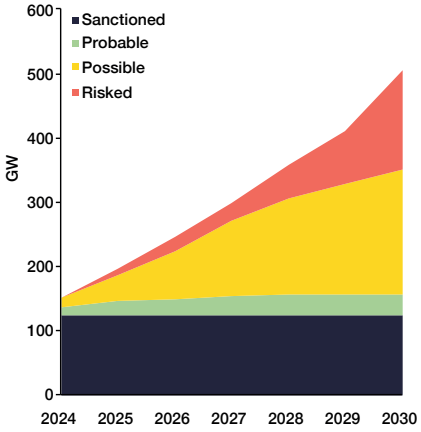
Source: Westwood WindLogix

Offshore Wind 2H 2023 Theme

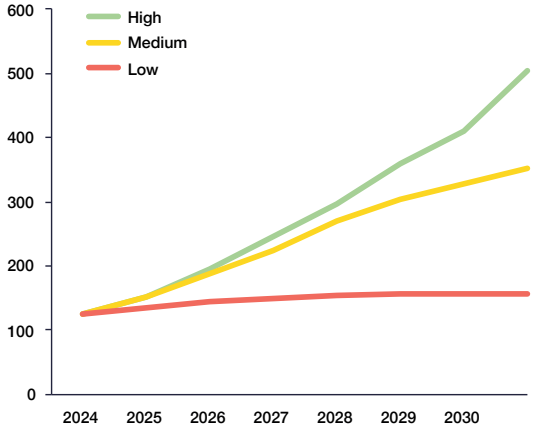
The offshore wind industry is experiencing structural shifts. In order to navigate through these complexities, Westwood hones in on project certainty / risks by segmenting the pre-sanctioned pipeline into three main project certainty statuses ('Probable', 'Possible' and 'Risked').

- At present, Westwood tracks almost 380 GW of pre-sanctioned offshore wind capacity that is forecast to take FID between 2024 and 2030. Breaking down this pipeline, 9% currently has a certainty status of 'Probable', 51% 'Possible' and 40% 'Risked', effectively implying that a sizeable chunk of the pipeline is currently considered to be less progressed / more vulnerable.
- Based on these certainty statuses, three scenarios have been projected to provide some context on potential outlooks.
- In the High Scenario, 504 GW of cumulative sanctioned capacity is projected, with Europe dominating (41%). This is followed by ML China (33%), the Rest of Asia (RoA) (16%) and finally the Rest of the World (10%).
- Cumulative sanctioned capacity will total over 351 GW in the Medium Scenario. Most of the capacity attrition will come from ML China which currently has over 46.7 GW of 'Risked' capacity. The RoA region currently has 43.3 GW of capacity that is 'Risked', and this is followed by Europe (41.4 GW) and the RotW (21.1 GW).
- The Low Scenario will only see an additional 32.6 GW reaching the FID stage, with global cumulative sanctioned capacity totalling just under 157 GW. On a regional basis, Europe will account for the highest share of this additional capacity (53%), followed by the RotW (40%), RoA (5%) and ML China (2%).
- Key enablers that could help the industry move towards a high case outcome include better support levels that reflect the cost environment, a strengthening of the corporate power purchase agreement (CPPA) market as well as a focus on enhancing grid capacity and port infrastructure.

Global Project Capacity Outlook by FID Year to 2030



Project Certainty Status Scenarios



Source: Westwood WindLogix

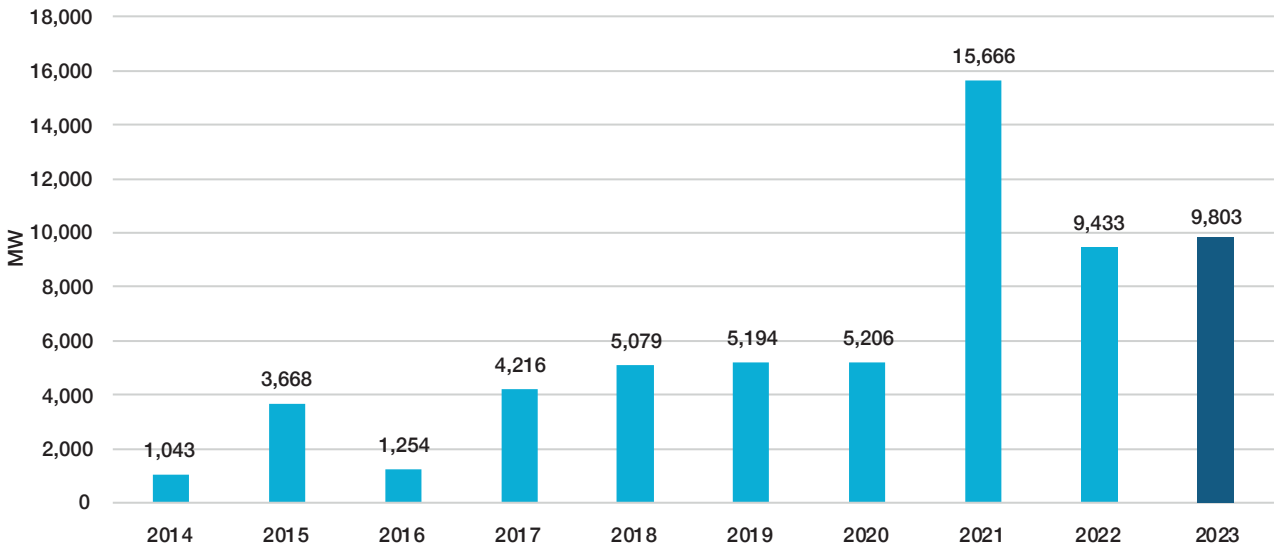
Please note: Data and charts reflected in the report are dated 3 Jan 2024

To learn more about the methodology behind Westwood's Project Certainty and the Scenarios that have been derived, please reference Westwood's Project Certainty White Paper, "The need for a risk-based assessment of the pipeline"

Global Offshore Wind Growth

Global growth slightly increases compared to 2022

Annualy Added Offshore Wind Capacity



A total of 9.8 GW of global offshore wind capacity was added in 2023.

New capacity in 2023 was slightly higher than in 2022 (9.4 GW).

Globally, 25 new offshore wind farms were taken into operation in Asia (18) and Europe (7).

9.8 GW

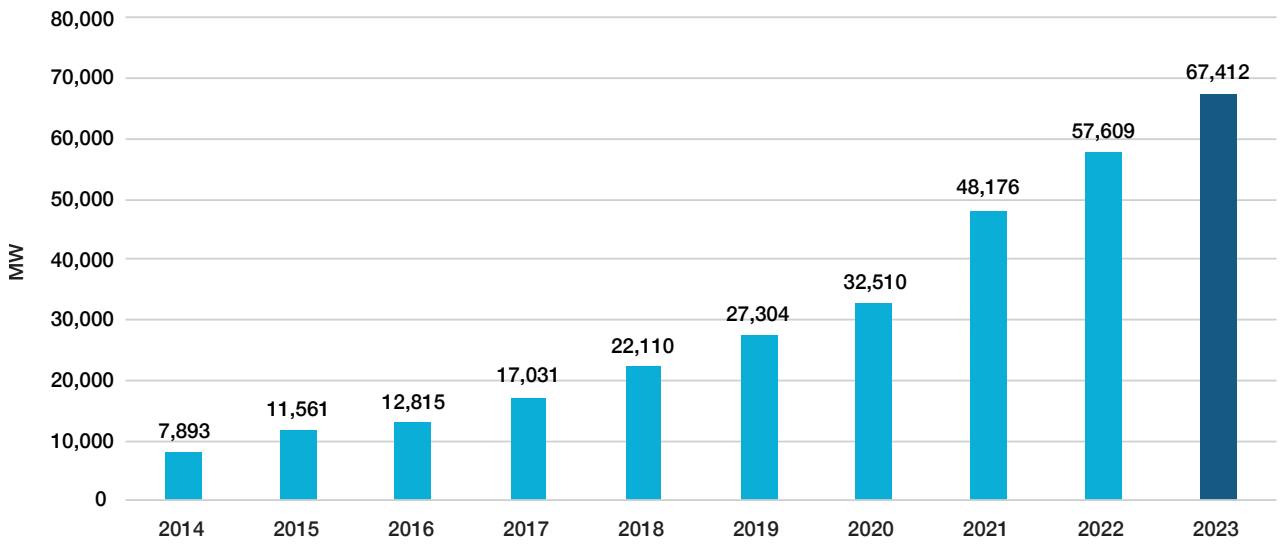
Globally added offshore wind capacity in 2023

Global Growth

Global offshore wind capacity reaches nearly 70 GW

Global offshore wind capacity in operation[1] - Cumulative

IN OPERATION



Globally installed offshore wind capacity reached 67.4 GW by the end of 2023, almost 47% of which is now installed in China.

The average size of a newly added offshore wind farm in 2023 was 392 MW compared to 225 MW in 2022.

Worldwide, 282 offshore wind farms are currently in operation, 158 of which are in Asia, 122 in Europe and 2 in the USA.

67 GW

Global offshore wind capacity in operation

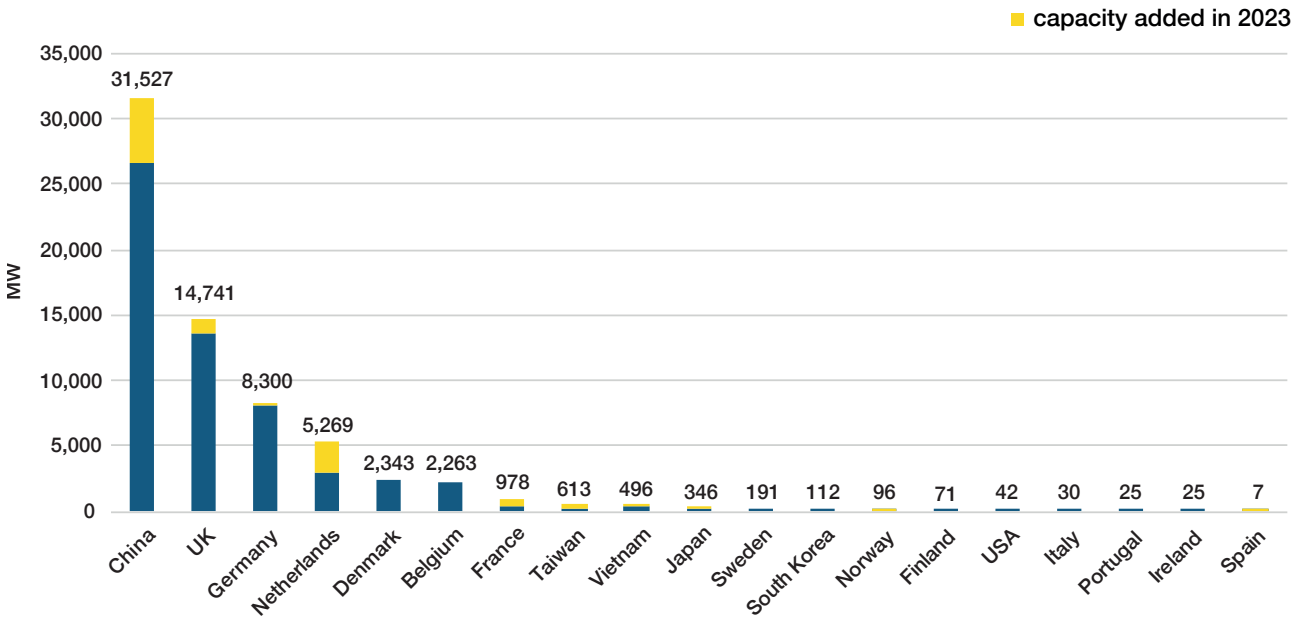
1 In operation: all turbines installed and first power

Top Markets

Floating offshore wind turbines installed in Europe and Asia

Global offshore wind capacity in operation — by country

IN OPERATION



China's growth continues with almost 5 GW of newly installed capacity in 2023, increasing its total installed capacity to 31.5 GW.

The Netherlands completed two offshore wind farms in 2023: Hollandse Kust Noord (759 MW) and Hollandse Kust Zuid (1.5 GW).

Floating offshore wind turbines were successfully installed in Norway (88 MW), China (7.5 MW) and Spain (2 MW).

5 GW

Offshore wind capacity added in China

In Detail:

Global offshore wind farms put into operation in 2023

No.	Wind farm	MW	Units	MW/Unit	Turbine	Location
1	Hollandse Kust Zuid	1,500	139	11	SG 11.0-200 DD	NL
2	Seagreen	1,140	114	10	V164-10 MW	UK
3	Hollandse Kust Noord	759	69	11	SG 11.0-200 DD	NL
4	CGN Huizhou 2	750	64	8.5/12/14	-	CN
5	Huaneng Shantou Lemen 2	594	54	11	-	CN
6	Shandong Bozhong B2	502	59	8.5	EW230-8500	CN
7	Huadian Yangjiang Qingzhou III	500	67	6.8/8.3	MySE6.8-158. MySE8.3-180	CN
8	Saint-Brieuc	496	62	8	SG 8.0-167 DD	FR
9	SPIC Shandong Peninsula South Site U 1	451	53	8.5	MySE8.5-230	CN
10	Qingzhou I	407	37	11	MYSE11-230	CN
11	Cangnan 1 - Phase 1	400	49	6.25/10	-	CN
12	Shandong Bozhong B	400	47	8.5	SEW8.5-230	CN
13	Formosa 2	376	47	8	SG 8.0-167 DD	TW
14	Changle Area A	300	36	10/8	DEW-D10000-185. GW175-8.0	CN
15	Changle Area C 2	300	30	10	DEW-D10000-185. SG 10.0-193 DD	CN
16	Arcadis Ost 1	257	27	9.5	V174-9.5 MW	DE
17	Rudong H13	150	30	5	H171-5.0	CN
18	Ishikari	112	14	8	SG 8.0-167 DD	JP
19	Fujian Pingtan	111	11	11/8	D10000-185. GW175-8.0	CN
20	Tan Phu Dong 1	100	24	4.2	V150-4.2 MW	VT
21	Shenquan Phase 1 Part 2	91	13	7	-	CN
22	Hywind Tampen (floating)	88	11	8	SG 8.0-167 DD	NO
23	Nyuzen	9	3	3	MySE3.0-135	JP
24	CNOOC Guan Lan (floating)	7.5	1	7.5	MySE7.25-158	CN
25	DemoSATH (floating)	2	1	2	-	ES
	Total	9,803				

1.5 GW

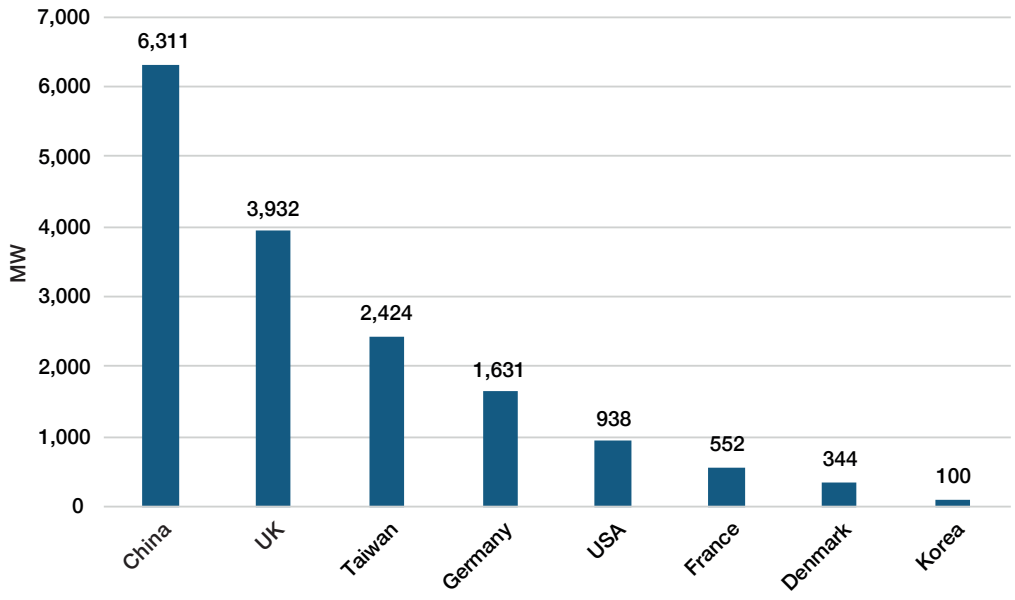
Largest project put into operation in 2023

Construction

Offshore wind growth picks up speed in 2023

Global offshore wind capacity under construction[2] by the end of 2023

UNDER CONSTRUCTION



China's offshore wind sector picks up speed significantly with a total capacity of 6.3 GW currently under construction.

UK and Taiwan are following in considerable distance with 3.9 GW and 2.4 GW, respectively.

South Korea is currently constructing its largest project so far – the Jeju Hanlim offshore wind farm (100 MW).

16 GW

Global offshore wind capacity under construction

2 Under construction: first offshore wind foundation installed

In Detail:

Offshore wind farms under construction

No.	Wind farm	MW	Units	MW/Unit	Turbine	Location
1	Sofia	1,400	100	14	SG 14-222 DD	UK
2	Dogger Bank A	1,200	95	13	Haliade-X 13MW	UK
3	CGN Yanjiang Fanshi I	1,000	73	14	-	CN
4	Borkum Riffgrund 3	913	83	11	SG 11.0-200 DD	DE
5	Greater Changhua 1 2a	900	111	8	SG 8.0-167 DD	TW
6	Moray West	882	60	14	SG 14-222 DD	UK
7	Vineyard Wind 1	806	62	13	Haliade-X 13MW	US
8	Guangxi Fang Cheng Gang A	706	83	8.5	-	CN
9	Yunlin	640	80	8	SG 8.0-167 DD	TW
10	Yuedian Yangjiang Qingzhou 2	600	55	11	MYSE11-230	CN
11	Hainan Lingao	600	60	10.0	-	CN
12	Changfang and Xidao	589	62	9.5	V174-9.5 MW	TW
13	Huaneng Shandong Peninsula North	510	60	8.5	-	CN
14	Guodian Xiangshan 1 2	504	56	9	WD225-9000-OS	CN
15	Mingyang Yangjiang Qingzhou IV	500	43	12/11	MySE 11-230. MySE 12-242	CN
16	Fécamp	497	71	7	SWT-7.0-154	FR
17	Baltic Eagle	476	50	9.5	V174 9.5	DE
18	Neart na Gaoithe	450	54	8	SG 8.0-167 DD	UK
19	Zhangpu Liuao Phase 2	400	21	13/16	D13000-245. GWH252-16MW	CN
20	Vesterhav Nord/Syd	344	41	8	SG 8.0-167 DD	DK
21	Guohua Peninsula South Phase 1	306	36	8.5	-	CN
22	CTG Shandong Yantai Muping Phase 1	301	36	8.35	-	CN
23	Guohua Peninsula South Phase 2	300	35	8.5	-	CN
24	Zheneng Taizhou 1	300	40	7.5	DEW-D7500-186	CN
25	Zhong Neng	295	31	9.5	V174-9.5MW	TW
26	CGN Xiangshan Tuci	280	35	8	-	CN
27	Gode Wind 3	242	23	11	SG 11.0-200 DD	DE
28	South Fork	132	12	11	SG 11.0-200 DD	US
29	Jeju Hanlim	100	18	5.5	WinDS5500/140	KR
30	Eoliennes Flottantes du Golfe du Lion (floating)	30	3	10	V164-10.0	FR
31	Provence Grand Large (floating)	25	3	8	SWT-8.0-154	FR
32	Longyuan Nanri Island (floating)	4	1	4	G4-146	CN
	Total	16,232				

1.4 GW

Largest offshore wind farm under construction

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