



Renewables
Consulting
Group



**Norwegian
Energy Partners**

Global Offshore Wind Snapshot 2020

Commissioned for Norwegian Energy Partners

January 2021



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Executive Summary

2020 Q4 has seen a continuation of the elevated development activity from Q3, with offshore wind seen as a key factor in 'green recoveries' implemented in response to the economic impacts of the COVID-19 pandemic.

Global

In 2020 momentum increased for large-scale offshore wind development in emerging markets. Countries in Europe, South America and Asia Pacific, with no operational offshore wind, announced projects upwards of 1 GW capacity during the course of the year. Ambitious site designs utilising next generation turbines, floating foundations and multi-purpose interconnectors (MPIs) entered development across all global regions.

EMEA

In Europe's established offshore wind markets, operational capacity increased at a rapid rate during 2020 with commercial project construction ongoing in Belgium, France, Germany, the Netherlands and the UK. Early-stage portfolios in the Baltic Sea emerged as prominent global players partnered with local firms to advance projects in anticipation of new lease auctions in Poland and a revised grid connection model in Sweden. In Italy and Spain new floating projects were announced, whilst the novel Hywind Tampen project reached FID in Norway.

APAC

China's offshore wind market is dominated by local developers; but international players are starting to enter via partnerships. Site construction continues as numerous projects seek to qualify for the FiT rate, due to expire at the end of 2021.

In Q3 the continued interest and activity in Japan's pipeline of projects grew to become the largest in the region (excluding China), only to be surpassed by Taiwan in Q4 as developers prepare sites for future tenders. In 2020 the first projects were announced in the Philippines.

Americas

New project activity in the Americas during 2020 was focused on Brazil, where approximately 16 GW of development capacity was added. Despite the increased activity from both local and international developers, the government is yet to formalise an offshore wind framework.

In the US, oil and gas giant BP entered the offshore wind industry, buying into Equinor's East Coast project pipeline, acquiring a 50% stake. Additional offshore wind solicitations were announced for New York and New Jersey, and the CVOW demonstrator became the second operational project in the region when it delivered power to the Virginia grid in September.

Floating Offshore Wind

Floating offshore wind developments remain largely concentrated in emerging markets where fixed bottom technology remains less viable. New projects have been announced in Italy and the Canary Islands, a hub for floating wind innovation projects. Further floating wind plans were also announced in South Korea for Equinor, Aker Offshore Wind, CIP, Total and Macquarie.

In July, WindFloat Atlantic – the world's second multi-turbine floating project – was commissioned off the coast of Portugal.

Financial investment activity

With the final investment decisions for the Dogger Bank A and B projects in November, 2020 became the largest year on record for financed offshore wind capacity. Whilst investments were mostly settled on European projects, Japan's first commercial fixed foundation development – Marubeni, Obayashi Cosmo Eco

Power's Akita sites also reached the pre-construction phase.

Mergers & Acquisitions

Iberdrola led global acquisition activity with transactions on large portfolios in Sweden, Poland and Japan, as well as an expanded interest in South Korea. Oil and gas players BP and Eni notably entered the sector, acquiring de-risked assets in the USA and UK respectively.

Policy and leasing

Offshore wind leasing activity has ramped up globally in 2020, with the progression of the TCE Round 4 and CES ScotWind lease auctions in the UK, continued preparations and clarifications for upcoming tenders in France, Japan, Norway, Poland, Taiwan and Germany, and the announcement of future leasing plans in emerging markets such as Lithuania.

With the election of democrat Joe Biden as US President, leasing conducted by federal authorities is expected to ramp up in 2021.

Forecast

Large-scale projects upwards of 700 MW in the mature European markets dominate the near-term offshore wind forecast. Utility-scale projects are also due to come online in the Asia Pacific region – outside of China – for the first time in 2021.

Despite multiple US projects submitting construction plans, revisions to project capacities have resulted in planning delays for sites across the market. New projects announced in Brazil are unlikely to come online until at least 2030, after the initial forecast period.

Section 1: Global Market Landscape

The offshore wind industry is in a period of transition as its continued expansion beyond Europe gathers pace.

Offshore wind capacity installations, investment, and development continues to spread to all corners of the world.



Global portfolio

Offshore wind capacity installations, investment, and development continues to spread to all corners of the world. Europe remains the largest market, but momentum is building in China, Asia-Pacific and the Americas.

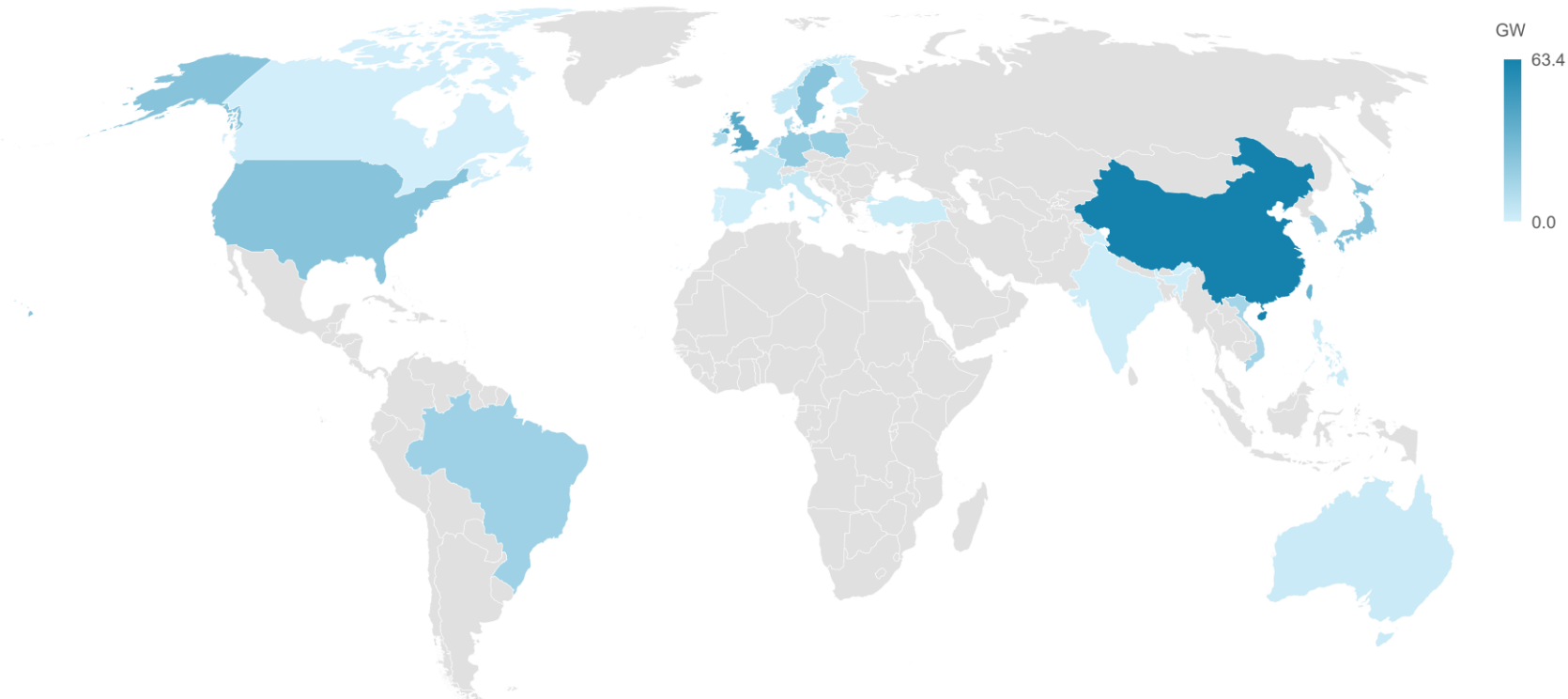
Total offshore wind portfolio (GW)*

*includes capacity without owners that is scheduled for auction

Top 15 (Q4 2020)

1	China	-
2	United Kingdom	-
3	Taiwan	▲ 6
4	Japan	▲ 1
5	USA	▼ 2
6	Sweden	▼ 2
7	Germany	▼ 1
8	South Korea	▼ 1
9	Poland	▲ 2
10	Brazil	▼ 2
11	Vietnam	▲ 3
12	Ireland	▼ 2
13	The Netherlands	▼ 1
14	Denmark	▼ 1
15	France	-

Ranking based on total size of portfolio in GW



30.8 GW

Operational

▲ 13.3% from Q3

58.9 GW

Secured

▼ 4.9% from Q3

290 GW

In development

▲ 17.5% from Q3

379.6 GW

Total*

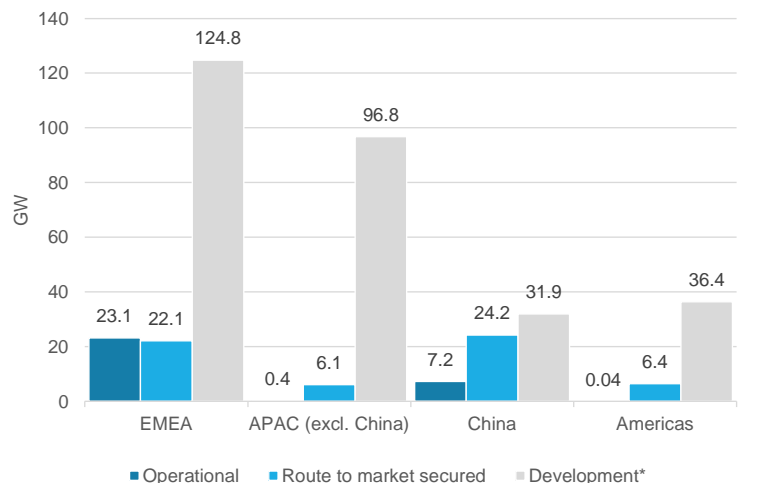
▲ 13.0% from Q3

Global - portfolio

Despite the effects of the COVID-19 pandemic, the offshore wind industry expanded massively in 2020, with large scale projects unveiled in markets at various levels of maturity across all global regions.

Portfolio

Development capacity soared by over 60 GW in the APAC region in 2020.

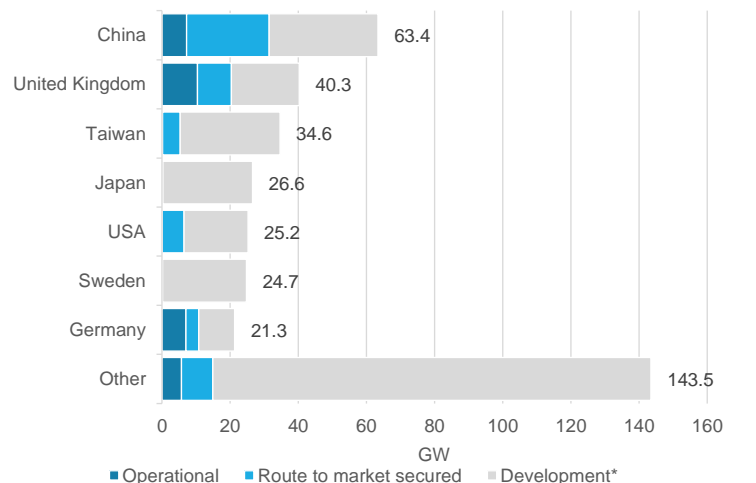


*includes capacity without owners that is scheduled for auction

- The APAC region was the focus for early-stage project development in 2020, with upcoming project tenders in Japan and Taiwan encouraging development from both local and international players.
- In Europe large portfolios were made public in the Baltic region, with Sweden and Poland advancing rapidly. Floating development also ramped up in Spain and Italy.
- In the Americas large projects were announced in Brazil, whilst multiple sites in the USA secured a route to market.

Key markets

China is now second in operational capacity behind the UK; Taiwan and Japan have surpassed the USA in overall capacity.

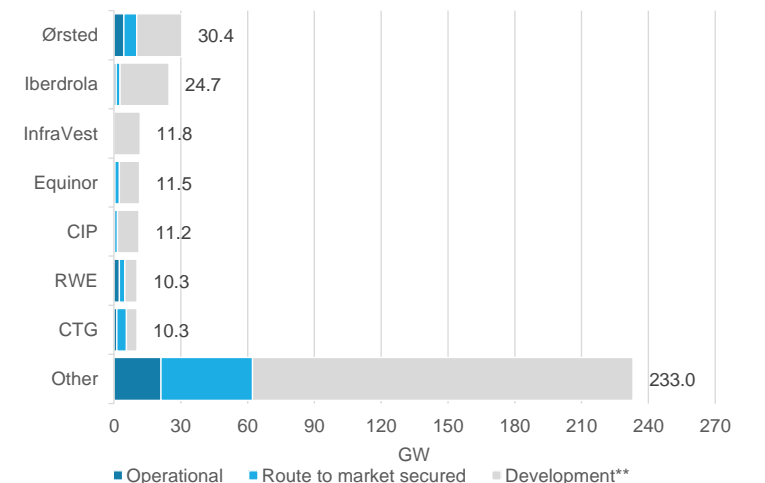


*includes capacity without owners that is scheduled for auction

- Ongoing construction of projects in the UK, as well as permitting approval for more large-scale sites in 2020, mean the market will solidify its place as the leading country in the EMEA region in the near-term.
- With additional sites of over 1 GW in capacity unveiled in Q4, Taiwan secured its place as the largest market in the APAC region (excluding China) at the end of the year.
- In Japan rapid development has taken place as the country looks to allocate its first large-scale projects in 2021.

Key owners

Iberdrola has closed the gap to Ørsted at the top of the global portfolio ranking.



**does not include capacity without owners (i.e. projects that are scheduled for auction)

- Ørsted remains the largest offshore wind developer in the world with a portfolio capacity of over 30 GW.
- After a year of high-profile portfolio acquisitions and expansion into new markets, Iberdrola has closed the gap to Ørsted in overall capacity.
- InfraVest set out a diverse portfolio of fixed and floating projects in Taiwan during the second half of 2020, however the developer lacks experience of project delivery in comparison to other global leading players.

Floating offshore wind

The floating offshore wind market offering continues to develop, but remains on the margins for the time being as proponents seek to demonstrate its near-term commercial viability and cost reduction potential.

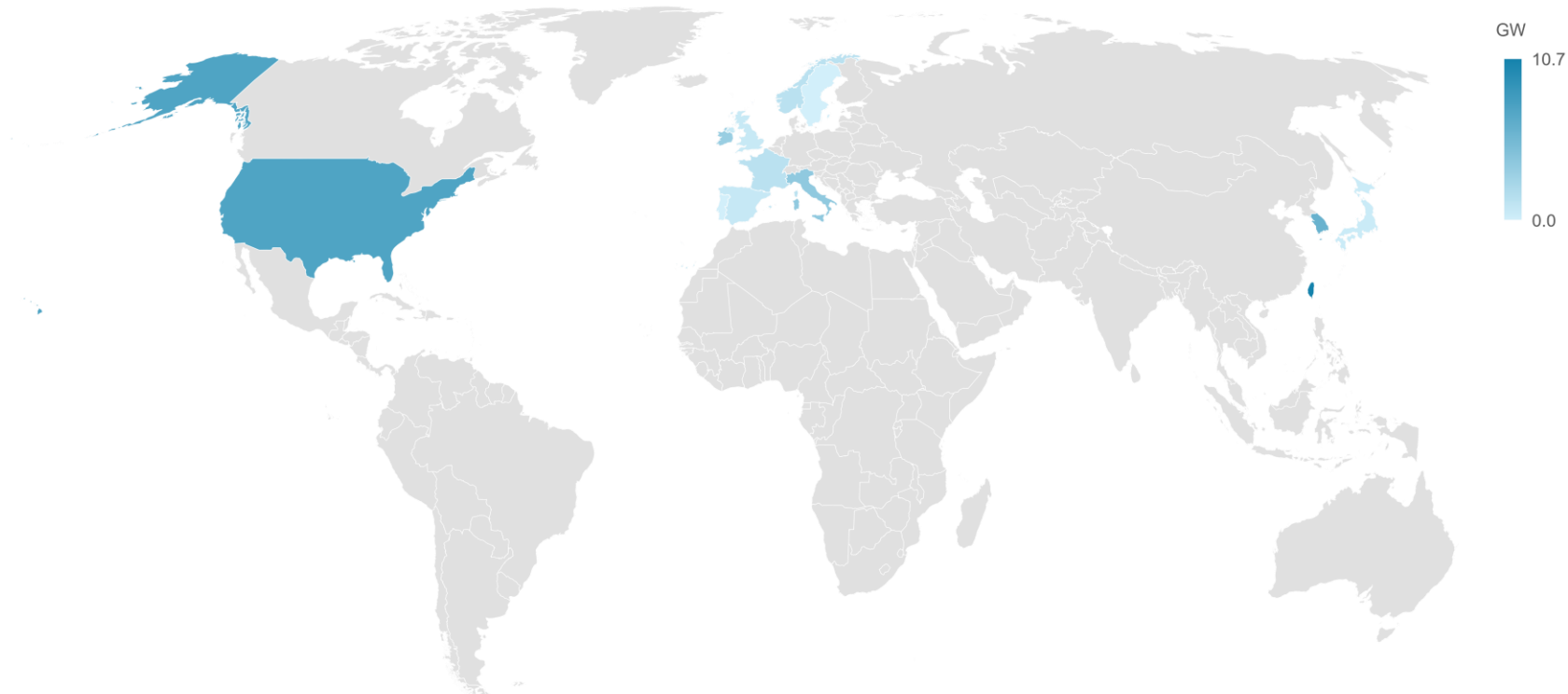
Total floating offshore wind portfolio (GW)*

*includes capacity without owners that is scheduled for auction and US lease areas without owners (i.e. call areas that have yet to be leased)

Top 10 (Q4 2020)

1	Taiwan	New
2	USA	▼ 1
3	South Korea	▼ 1
4	Italy	▲ 1
5	Ireland	▼ 2
6	Norway	▼ 2
7	France	▼ 1
8	Spain	▼ 1
9	United Kingdom	-
10	Japan	▼ 2

Ranking based on total size of portfolio in GW



0.08 GW

Operational

- no change from Q3

0.15 GW

Secured

▲ 0.1% from Q3

35.3 GW

In development

▲ 80.1% from Q3

35.6 GW

Total*

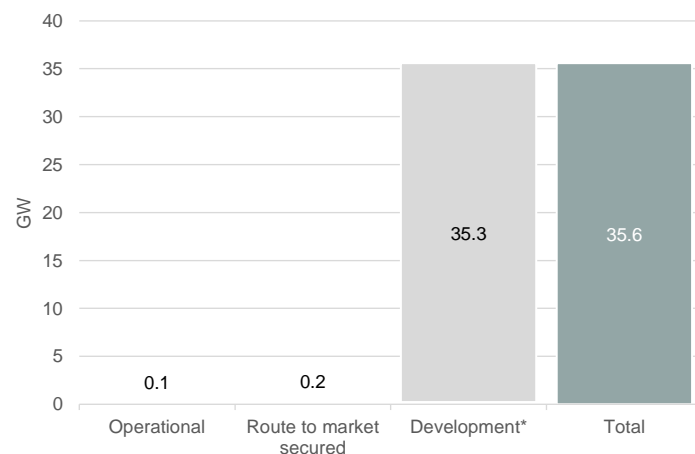
▲ 79.1% from Q3

Floating offshore wind

Floating offshore wind further cemented its status as a viable technology in Q4, with new projects exceeding 2 GW in capacity revealed in Italy and Taiwan.

Portfolio

The majority of the pipeline remains in development, with the first utility scale projects set to come online from 2022 onwards.

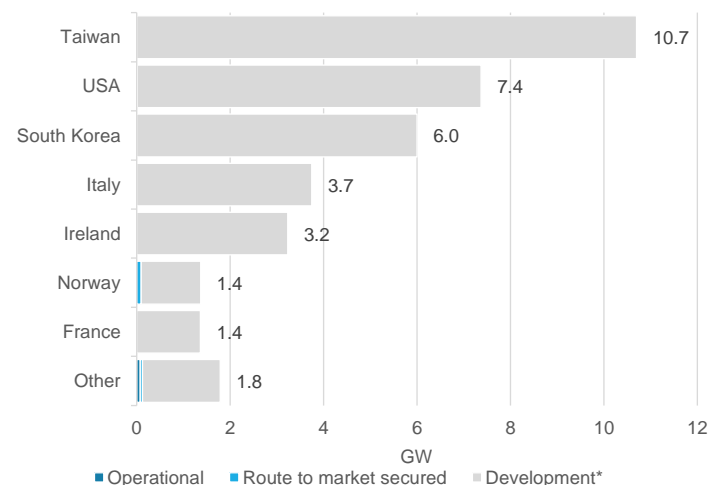


*includes capacity without owners that is scheduled for auction and US lease areas without owners (i.e. call areas that have yet to be leased)

- With the commissioning of the 25 MW WindFloat Atlantic project in July, the operational capacity of floating offshore wind increased by 45% in Q3 2020.
- The dramatic increase in floating wind development capacity during Q4 was largely driven by new projects in the APAC region. Italy and Spain continued to lead development of the technology in Europe, with Renexia's 2,793 MW Straight of Sicily project set to be the largest floating wind farm in the world upon completion.

Key markets

Markets unable to deploy fixed foundation projects in areas of strong wind resource are adopting floating technology.

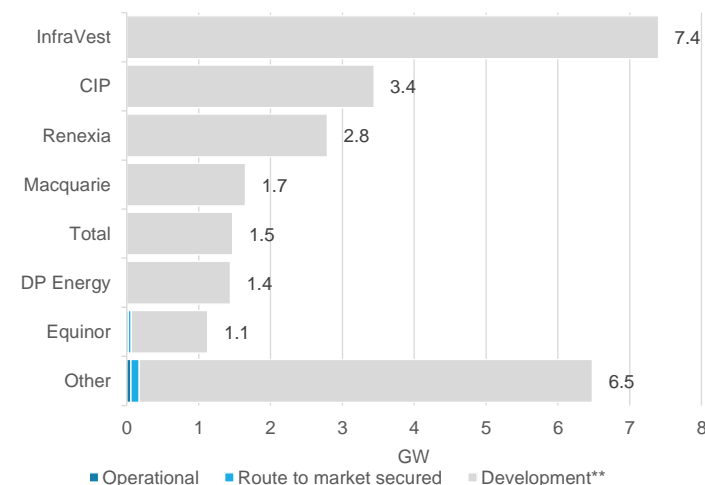


*includes capacity without owners that is scheduled for auction and US lease areas without owners (i.e. call areas that have yet to be leased)

- As a result of the new capacity additions from InfraVest, Taiwan has moved to the top of the global market ranking.
- In the UK, CIP partnered with Hexicon to develop a 100 MW project off the coast of Scotland. RCG has also identified a 300 MW project in the Celtic Sea owned by Total and Simply Blue Energy which began development in September.
- Italy and Spain both built on capacity increases seen in Q3 with more new projects announced in Q4.

Key owners

InfraVest now leads the global market, with oil and gas players having a key role.



**does not include capacity without owners (i.e. projects that are scheduled for auction)

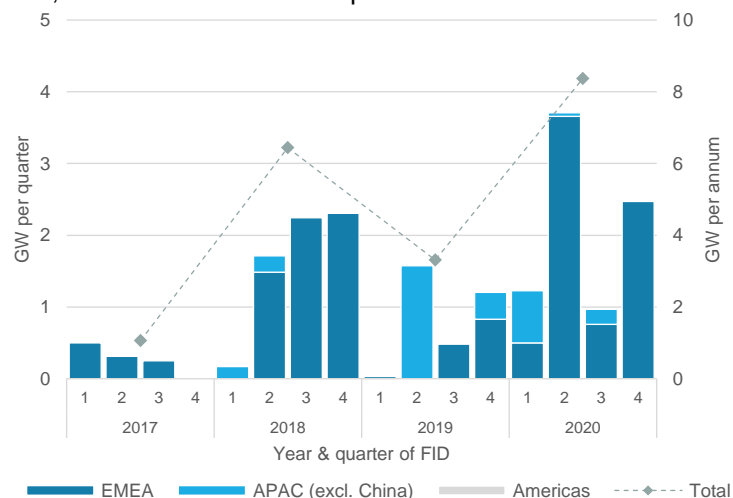
- InfraVest's project pipeline in Taiwan propelled it to top of the global floating portfolio ranking.
- Is floating wind is seen as a more viable offshore wind solution, a larger variety of companies have entered the market. Offshore wind and renewable energy developers such as Renexia and Ocean Winds have recently joined oil and gas majors such as Total and Equinor in commanding large market shares.

Financial investment activity

With multiple sites reaching pre-construction in the first half of 2020, as well as the FID of the world's largest offshore wind project in Q4, more capacity was financed in the sector than any previous year.

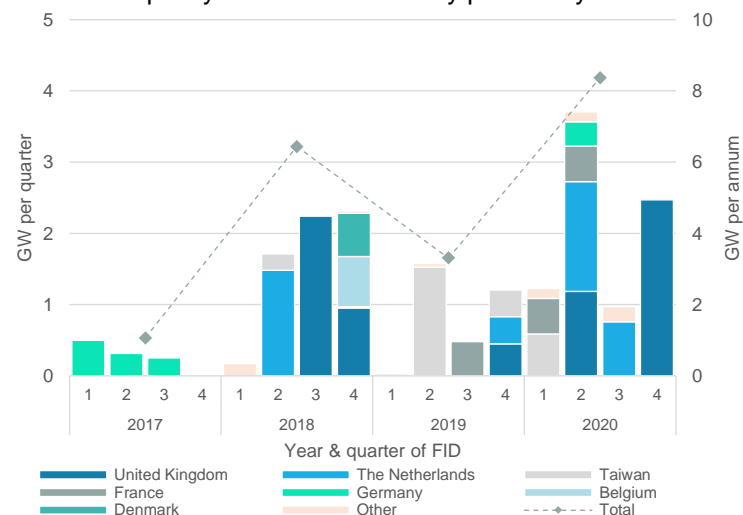
Financial investment activity by region, year & quarter

After a flurry of investment activity in the APAC region from 2019, EMEA returned to the top in 2020.



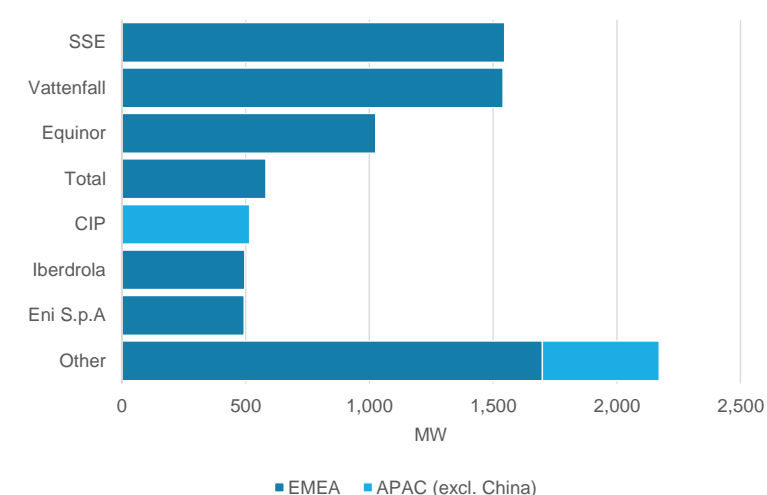
Financial investment activity by country, year & quarter

With the financing of the world's two largest OSW projects, 2020 saw more capacity investment than any previous year.



Financial investment activity by region & owner (2020)

Multi-phase projects in mature markets dominated financing in 2020.



- Financial investment decisions in the European region were focused on mature markets throughout 2020, with ground breaking merchant financing deals, innovative projects and the world's largest offshore wind sites reaching pre-construction. Notably, despite differences in the profiles of the major project investment decisions, all sites were developed through regulated tenders and auctions.
- With offshore wind auctions planned for Taiwan and Japan in 2021, activity can be expected to swell in the APAC region again. Polish projects also look to benefit from a CfD auction.

- Major project financing predominantly took place in markets that have undertaken offshore wind tenders, such as France, Taiwan, the Netherlands and the UK. In the UK the Seagreen Bravo project became the world's first merchant offshore wind farm when it reached FID without subsidy in June.
- With markets across the Americas, Europe and Asia Pacific regions set to secure route to market for large scale projects in 2021, investment capacity in the coming year is expected to increase in multiple countries.

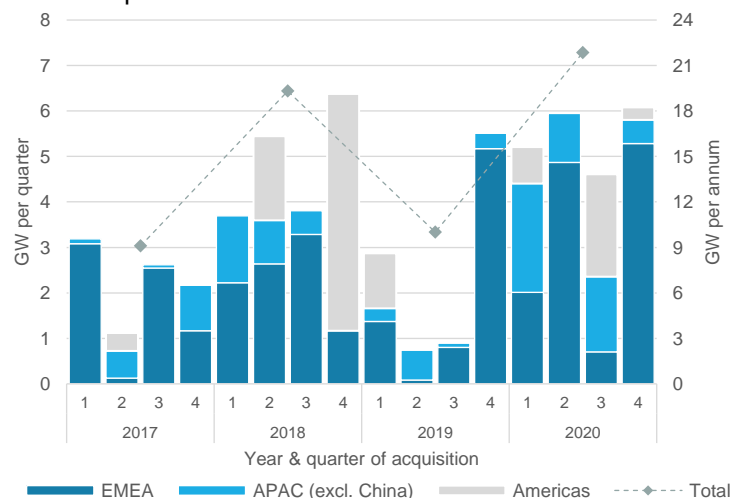
- SSE topped the ranking of offshore wind investment in 2020 after financing two ground breaking sites. In June the Scottish utility reached FID on the Seagreen development alongside Total, the second phase of which will be built without subsidy. SSE also committed to the Dogger Bank A and B project in November with Equinor and Eni.
- Vattenfall took the final investment decision for Hollandse Kust Zuid 1-4 on 4th June 2020. Prior to the Dogger Bank FID in November it was the largest offshore wind project in the world to be financed.

Acquisition & sell down activity

Portfolio transactions and project capacity acquisitions for sites across all stages of the development cycle took place in each quarter of 2020. Iberdrola proved to be the most active buyer globally, with a preference towards early-stage projects in emerging European markets.

Project acquisition activity by region, year & quarter

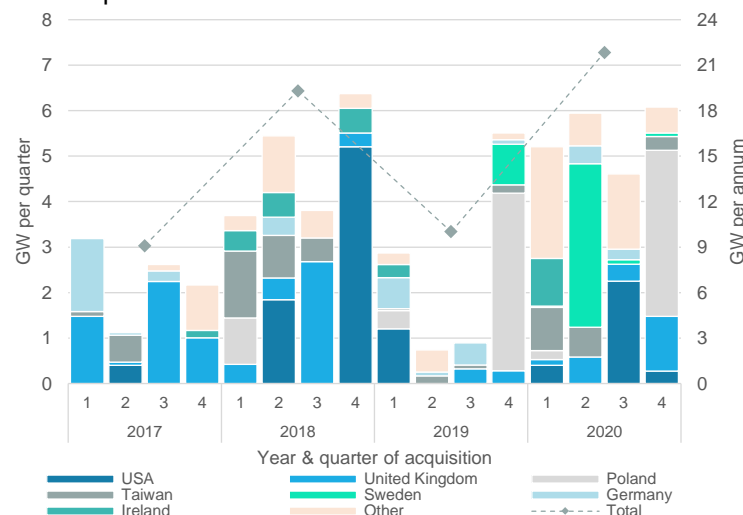
Acquisition activity coincides with new national offshore wind framework plans.



- Project acquisitions in 2020 took place across all regions, further highlighting the appeal of offshore wind globally as a renewable energy solution.
- Activity in the EMEA region was driven by Iberdrola's acquisition of a 50% stake in Sea Wind's Polish early-stage pipeline, as well as a transaction controlling stake in the Svea Vind portfolio in the Swedish market.
- In the Americas there was investment in de-risked projects by bp and Public Service Enterprise Group (PSEG).

Project acquisition activity by country, year & quarter

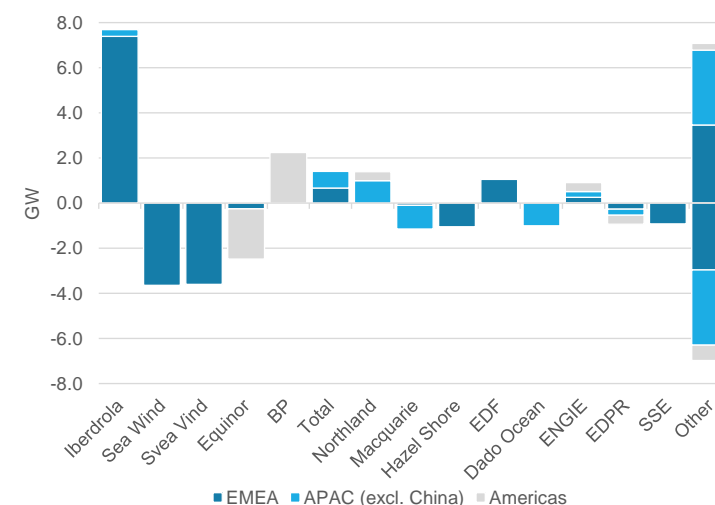
Increased activity in Poland reflects anticipation of introduction of a comprehensive offshore wind framework in 2021.



- Acquisition activity in a variety of markets throughout each quarter of 2020, with portfolio acquisitions accounting for the large capacity changing hands in Sweden during Q2, the USA in Q3 and Poland in Q4.
- In the UK transactions were made operational and pre-construction sites, demonstrating a preference for de-risked acquisition in the market. In both the US and Taiwan, sell downs similarly took place on sites that have secured route to market. By contrast, portfolio transactions in Sweden and Poland included early-stage development projects.

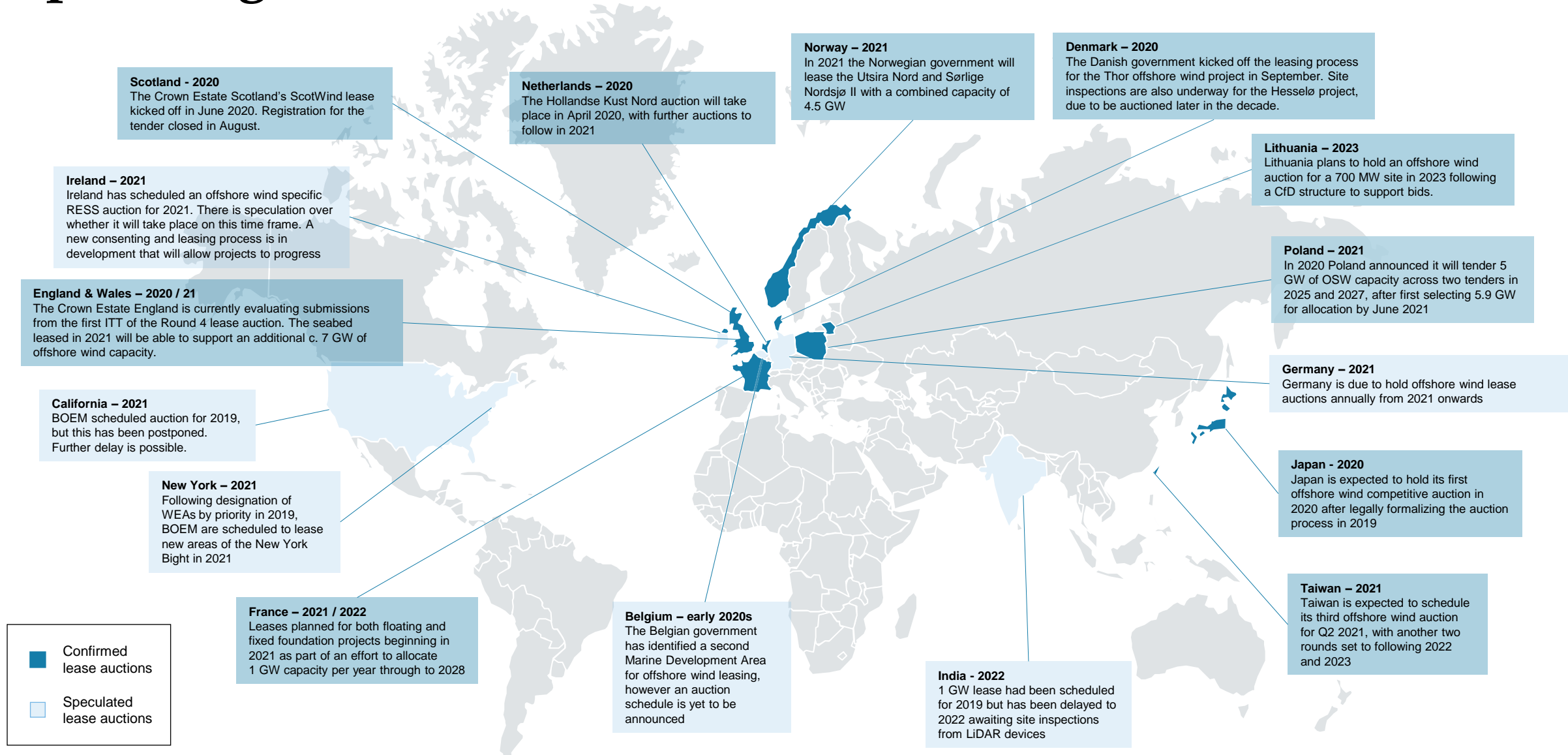
Project acquisition & sell down activity by owner (2020)

Iberdrola dominated offshore wind transaction activity in 2020.



- Iberdrola was the most developer in project acquisitions throughout 2020, acquiring early-stage capacity in Sweden and Poland, as well as more developed sites in Japan.
- bp and Eni became the most recent oil and gas firms to enter the offshore wind industry, through acquisitions in projects with a secured route to market.
- Beyond the portfolio acquisitions conducted by Iberdrola and bp, most transactions took place on single projects.

Upcoming offshore wind lease auctions



Section 2: Regional Market Update

This section covers the key market updates in each region, detailing major new stories from 2020, new policy announcements and market breakdowns by technology, territory and project owners.



EMEA – market update

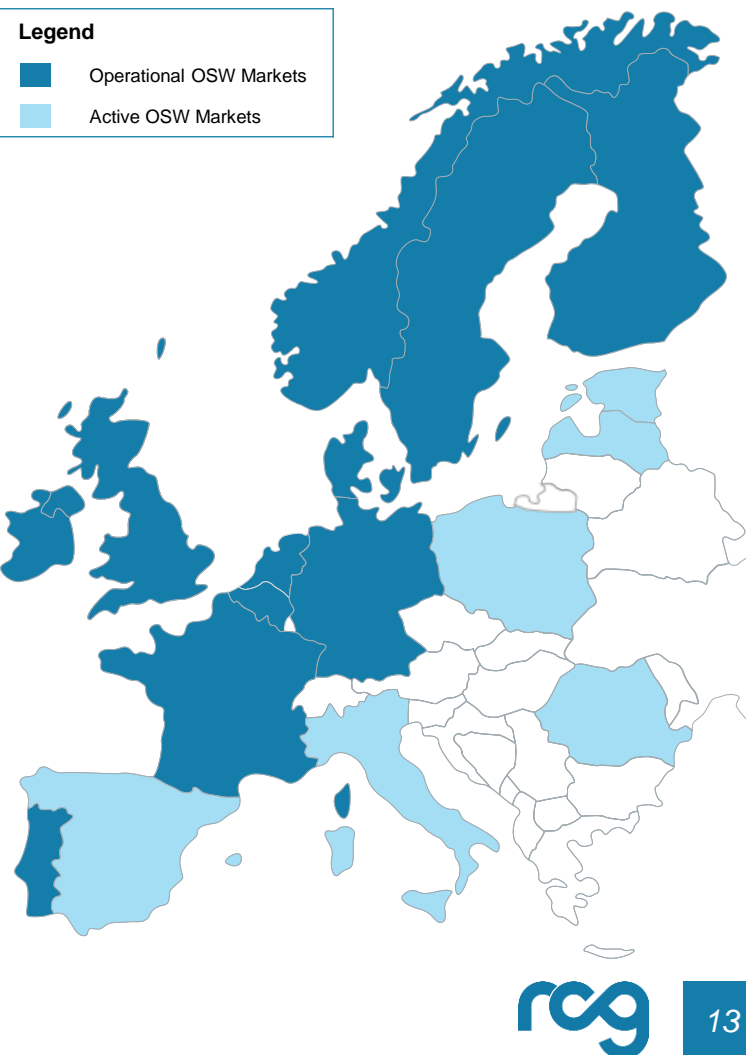
With mature markets constructing and commissioning large scale projects, and prominent portfolio expansions in emerging countries, the offshore wind sector has continued to grow throughout the European continent.

Hot spots

- In 2020 large scale project entered construction and full operation across mature markets. The United Kingdom led the way with the commissioning of the 1,218 MW Hornsea 1 site, the world's largest operational offshore wind project. Construction also took place on the Hornsea 2, Moray East, NnG and Triton Knoll projects which will add a cumulative 3,639 to the operational capacity when completed.
- In Belgium and the Netherlands also installed significant capacity additions throughout the year, with the final turbines switched on at the SeaMade, Norther, Northwester 2 and Borssele 1&2 and 3&4 projects.
- The Baltic region was the centre of large portfolio transactions in 2020, with Iberdrola acquiring interest in two separate Swedish and Polish early-stage pipelines, each in

excess of 7 GW. Ocean Winds and Vattenfall also expanded interest in the Polish market, partnering with local developers.

- Offshore wind auctions were prepared and initiated in 2020 that will tender seabed and offtake capacity in France, Ireland, Netherlands, Norway, Poland and the UK during 2021, paving the way for more project development through to 2030. There was significant activity in the Norwegian market in anticipation of the tender, with Eni partnering with HitecVision to form Vårgrønn, a JV targeting project development in Norway. Local firms Fred. Olsen
- The floating wind market reaffirmed its position in 2020 as projects were unveiled, invested in and commissioned. Italy and Spain have emerged as leading markets with large scale projects announced throughout the year.



23.1 GW

Operational

22.1 GW

Secured

124.8 GW

In development

170 GW

Total

EMEA operational portfolio

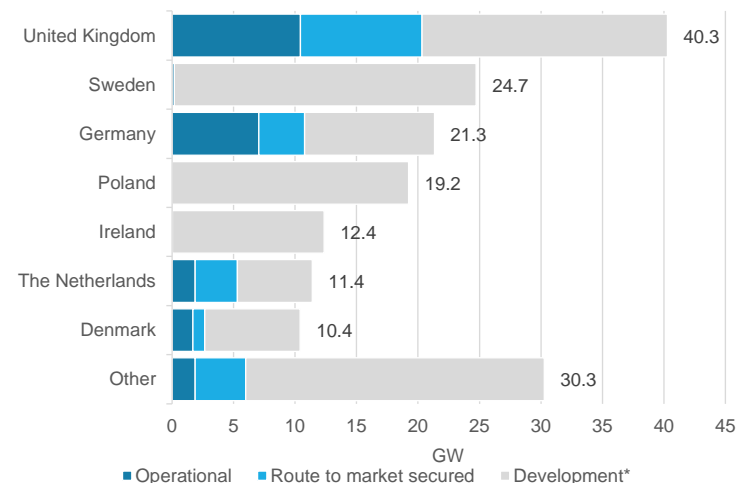
#	Country	MW	#	Country	MW
1	United Kingdom	10,432	6	Sweden	191
2	Germany	7,044	7	Finland	68
3	The Netherlands	1,870	8	Ireland	25
4	Belgium	1,774	9	Portugal	25
5	Denmark	1,701	10	Spain	5
Total					23,135

EMEA - portfolio

Despite the continued pressure of COVID-19 on European countries, the offshore wind industry continued to expand during 2020. In the UK the world's largest project was given the green light, whilst novel floating site designs were outlined in Italy and Sweden.

Key markets

Markets with untapped potential such as Poland and Ireland look to progress projects in 2021 as site tenders are introduced.

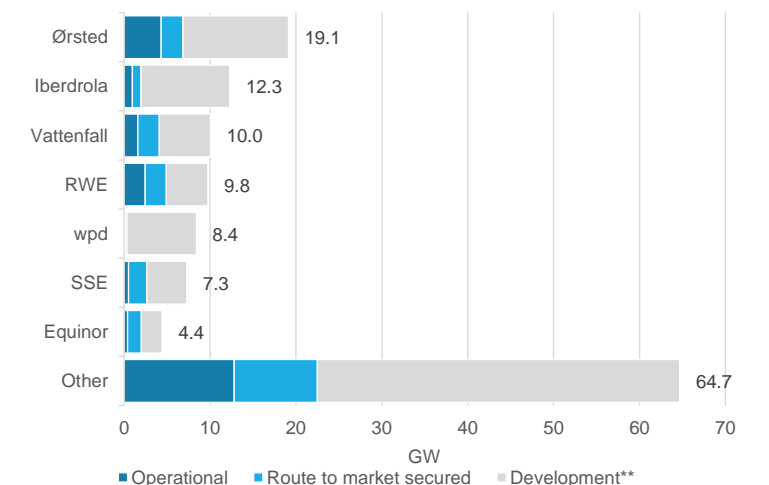


*includes capacity without owners that is scheduled for auction

- Sweden Poland jumped up the EMEA ranking after additional capacity was made public through Iberdrola's acquisition activity in 2020. Poland is expected to hold its first offshore wind tender in 2021 for up to 5.7 GW in capacity, allowing sites to secure a route to market.
- Activity was seen on projects at various stages of development across the wider region, with previously dormant sites in Denmark granted updated approval, late stage development activity in the UK and new sites in multiple markets.

Key owners

The market is dominated by European utilities.

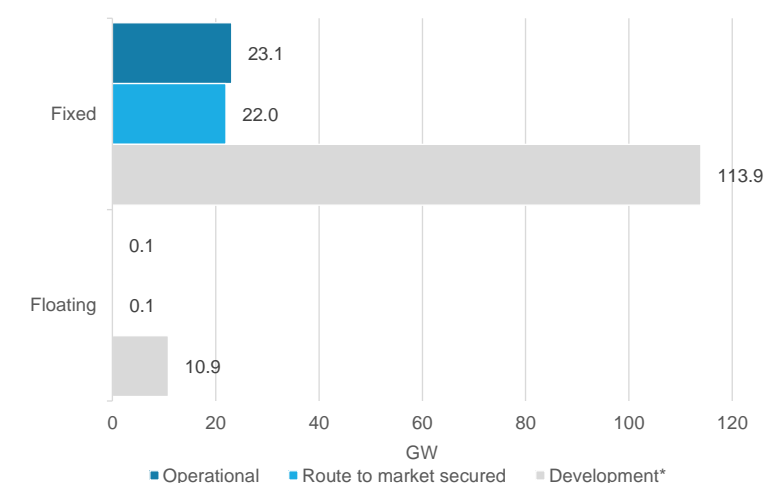


**does not include capacity without owners (i.e. projects that are scheduled for auction)

- Iberdrola jumped from fourth to second in the EMEA portfolio ranking following the purchase interest in early-stage development pipelines in Sweden and Poland.
- SSE and Equinor both saw reductions in portfolio capacity through the sale of 20% of the Dogger Bank A & B development to Italian energy company Eni.
- Elsewhere ESB, Ocean Winds, Renexia, Vattenfall and wpd all significantly increased ownership capacity in the region.

Technologies

Fixed foundation projects remain the leading technology, whilst new floating projects emerge across various markets.



*includes capacity without owners that is scheduled for auction

- Both the fixed and floating markets expanded in the EMEA region during the year. The Spanish and Italian markets were the major proponents of new floating development activity in 2020, with commercial scale projects announced off the coast of the Canaries and Sicily. New sites were also identified in the UK off the coast of Scotland and in the Celtic Sea.
- Fixed foundation projects remain the dominant technology in Europe with new increases in capacity at each development phase throughout 2020.

Policy and leasing - EMEA

The coronavirus crisis has brought renewed calls for governments to orchestrate transitions to green economies – offshore wind is seen in many countries as a potential driver for green energy production.

Denmark

The Danish Energy Agency (DEA) has kicked-off the tendering process for the Thor offshore wind farm. On 25 Sep 2020 the DEA published the tender conditions and relevant material for the process. The Thor tender will be the first offshore wind tender in Denmark to include the offshore grid connection system. Previously Danish offshore transmission networks have been developed and managed by the TSO, Energinet. The deadline to apply for the pre-qualification phase of the Thor tender is 1 Dec 2020.

France

The 1 GW Normandie tender was opened in December 2020, with a winner expected to be announced in 2022. The project site is located off the Cotentin Peninsula with precise boundaries being refined as the tender continues.

Germany

After the German government increased the national offshore wind targets to 20 GW installed capacity by 2030 and 40 GW installed by 2040, the Federal Council called for an increase in the targets to 30 GW by 2035. The council also argued against the proposed dynamic tendering process in the market with a second bidding component, favouring a CfD structure instead.

In August the German Federal Constitutional Court approved the 2017 Offshore Wind Energy Act stipulating the centrally planned auction system. The government is required to submit regulations outlining a financial support model by 30 Jun 2021. The decision from the court on the centrally planned auction system will allow offshore wind tenders planned for 2021 and

beyond to take place.

Latvia and Estonia

In late July the Estonian and Latvian governments signed an MoU to co-develop a 1 GW offshore wind project in the Gulf of Riga. The two countries will work together to establish a site location and fully permit the project, before an auction is held for a developer to build and operate the wind farm.

Lithuania

The Lithuanian Ministry of Energy announced in September that it has submitted draft laws to the government for an offshore wind framework, with a lease auction planned for 2023. The MoE has suggested the auction will follow a CfD structure and development of project transmission networks will be the responsibility of the TSO.

Netherlands

Throughout April the Netherlands Enterprise Agency (RVO) received tender applications for the Hollandse Kust Nord Zone. Auction favourite, Vattenfall, announced it would not take part unless the tender was delayed to at least August 2020, due to concerns over the affect of Covid-19 on the offshore wind supply chain. The RVO announced in late-July that the Shell/Eneco JV ("CrossWind") had won the tender.

Norway

In June the Norwegian government outlined the details of the country's first offshore wind auction, to be launched in January 2021. Two areas with a combined capacity of 4.5 GW, Utsira Nord and Sørlige Nordsjø II, will be tendered.

Poland

The Polish government announced in September that plans to phase-out coal-based power production would be expedited and investment in renewable and nuclear energy projects would be increased dramatically. The government stated it plans to install between 8 to 11 GW of offshore wind capacity by 2040 at an estimated investment of 130 billion zlotys (c. EUR 29 billion).

United Kingdom

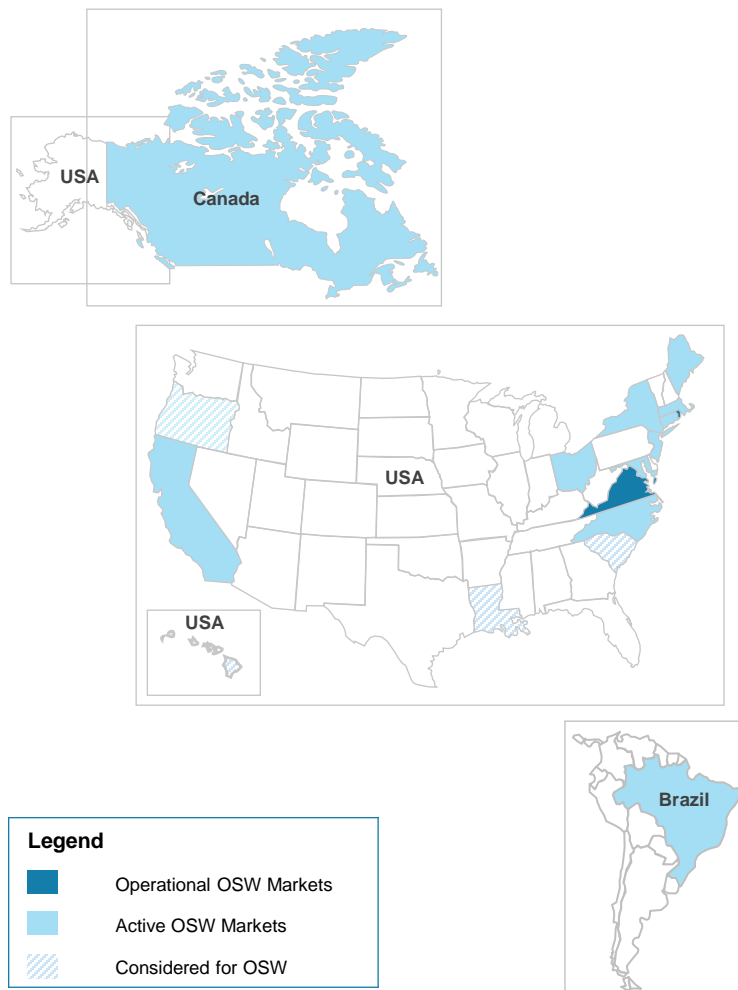
Throughout 2020 the Crown Estate Round 4 and Scotwind lease auctions took place. The Round 4 auction to lease seabed off England and Wales, ENI and Mainstream have publicly acknowledged participation as a JV, as has Spanish developer Iberdrola. Other major offshore wind developers are expected to participate.

After the ScotWind leasing round was delayed from late 2019 due to the release of a marine habitats plan, Scotland's first offshore wind lease auction managed by Crown Estate Scotland kicked off in April 2020.

In late September the Crown Estate finalised leases to six offshore wind project extensions in the UK as part of the 2017 project extensions opportunity. The Sheringham, Dudgeon Offshore Wind Farm, Greater Gabbard, Galloper, Rampion and Gwynt y Môr projects received the extension leases. The additional developments to the Greater Gabbard, Galloper and Gwynt y Môr projects will be known as North Falls, Five Estuaries and Awel y Môr respectively.

Americas – market update

Global offshore wind developers opened up the Brazilian market in 2020, whilst established US projects continue to move towards pre-construction.



Brazil grabs the spotlight

- In 2020 the focus of offshore wind development in the Americas shifted to Brazil, where new projects totalling more than 16.2 GW were announced. International developers Iberdrola and Equinor entered the market with multi-gigawatt projects, whilst local developers Bi Energia and Votu Winds also introduced large scale developments.
- Throughout 2020 the Brazilian government has worked on an offshore wind framework for the country. Despite the closure of consultations and support from government members, formal legislation is yet to be published, hindering project deployment in the near-term.
- No new capacity was leased in the United States by Federal Authority BOEM in 2020. However, state solicitations for renewable energy capacity will allow projects in New Jersey

0.04 GW

Operational

6.4 GW

Secured

36.4 GW

In development

42.8 GW

Total

and New York to secure route to market in 2021.

- The 12 MW CVOW demonstrator became the second multi-turbine project was commissioned in the United States during October. Project developers Dominion Resources filed the Construction and Operations Plan (COP) for the utility scale 2,640 MW CVOW project in December.
- Multiple projects in the United States submitted Construction and Operations Plans (COPs) throughout 2020, in many cases outlining designs with larger turbines than first proposed in previous lease auctions. The long awaited Final Environmental Impact Statement for the first commercial scale project in the US, Vineyard Wind, was delayed further in December after the project developers rescinded the original COP in order to plan for larger turbine units.

Americas operational portfolio

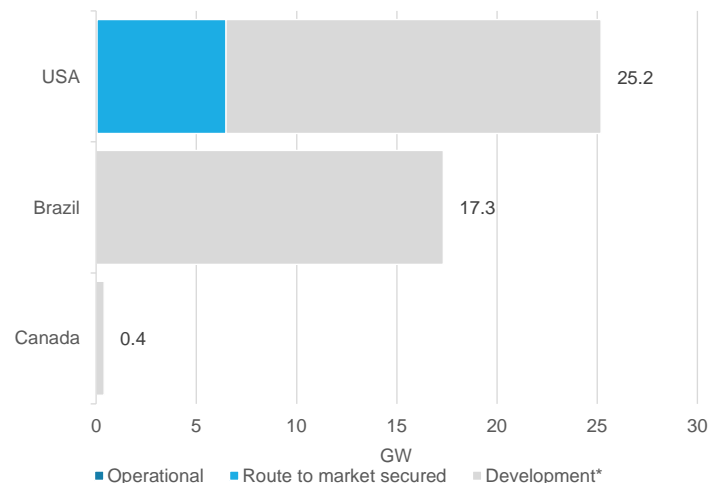
#	State (Country)	MW
1	Rhode Island (USA)	30
2	Virginia (USA)	12
Total		42

Americas - portfolio

The United States remains the largest market in the Americas region, however Brazil has expanded rapidly throughout 2020.

Key markets

US continues to move forward with firm projects whilst the Brazilian market grew significantly in 2020.

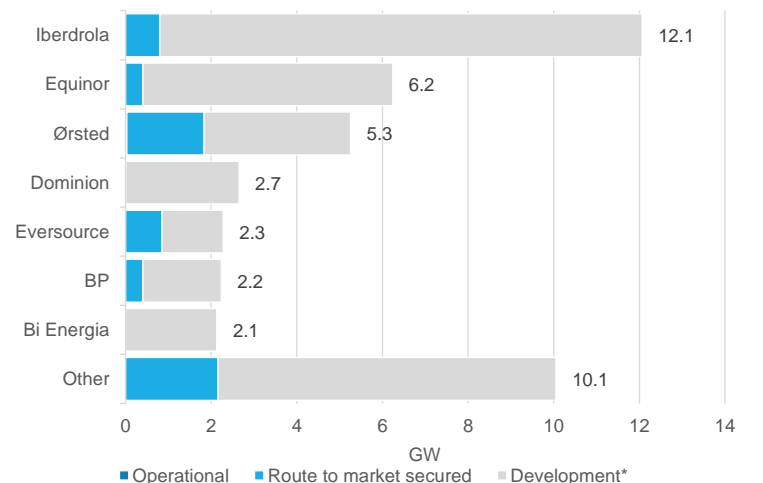


*does not include US lease areas without owners (i.e. call areas that have yet to be leased)

- The United States is the only country in the region with operational capacity and projects with a firm route to market. Solicitations for offshore wind in New York and New Jersey will allocate up to 4,900 MW of additional capacity secure a route to market in 2021.
- Large project portfolios were announced in Brazil by Iberdrola, Equinor, Votu Winds and Bi Energia, expanding the market pipeline by approximately 16 GW.
- Canadian project capacity is limited to one early-stage site in British Columbia, acquired by Northland Power in early 2020.

Key owners

Global developers are active in the Americas region; Iberdrola and Equinor maintain interest in both the US and Brazil.

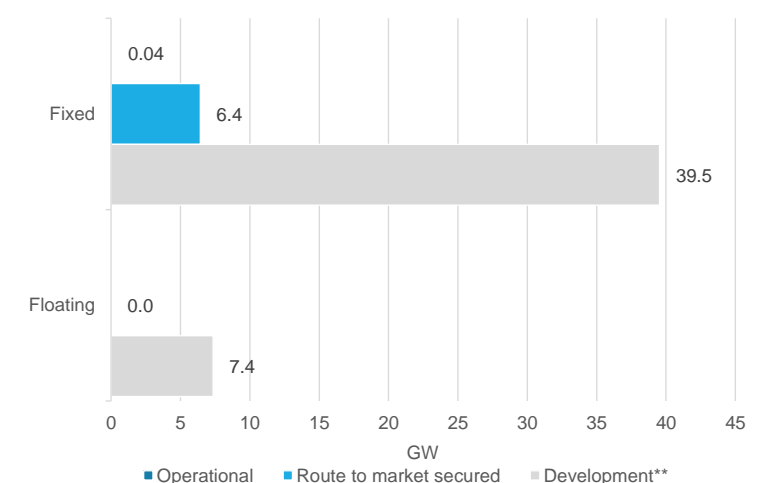


*does not include US lease areas without owners (i.e. call areas that have yet to be leased)

- Iberdrola and Equinor lead the Americas market and remain the only project developers with capacity in both the USA and Brazil. Iberdrola's US projects are owned by local subsidiary Avangrid Renewables.
- BP acquired 2.2 GW in portfolio capacity through the purchase of a 50% non-operable stake in Equinor's US project portfolio in September.
- Bi Energia announced two new projects in Brazil in 2020 to increase its share in the region.

Technologies

Floating wind is yet to be developed outside the US.



**includes US lease areas without owners (i.e. call areas that have yet to be leased)

- Project development in the Americas remains focused on fixed foundation technology. The regional development capacity was increased in 2020 by new projects in as well as capacity increases for existing projects in the USA seeking to uprate the proposed turbines at multiple sites.
- Whilst there were no new floating projects announced in 2020, RCG has identified two existing projects off the coast of California. The two sites, developed by Cierco Projects Corporation and Ideol respectively since 2019, have a combined capacity of 100 MW.

Policy and leasing - Americas

Despite COVID-19, US states continue to undertake supply chain and transmission studies and continue to move forward on pro-renewable policy development.

United States - Federal / National

On 29 Sep 2020, President Trump announced the extension to a moratorium on offshore leasing for all forms of energy production for North Carolina, South Carolina, Georgia and Florida.

Avangrid's Kitty Hawk offshore wind project, and other existing offshore projects, are not expected to be affected by the ruling. The block on future lease sales will last for 10 years, beginning 1 Jul 2022. In April 2020 BOEM released a study into offshore wind potential of the Gulf of Mexico identifying it as the leading technology for future development in the area. Following the announcement of the moratorium any offshore wind leasing in the Gulf of Mexico through to 2032 may be jeopardized.

The United States House of Representatives passed an amendment to the Clean Economy Jobs and Innovation Act enforcing Jones Act requirements for offshore wind development. However, the bill will require approval from the senate and the president, both of which remain unlikely. The Jones act requires that vessels completing installation or operations works in US waters from a US port are both built and flagged in the United States. Dominion Energy and Ørsted US are currently building a Jones Act compliant jack-up vessel and SOV respectively.

California

In September BOEM published a study on the load compatibility of floating offshore wind projects in the Humboldt Call Area of Northern California. The report concluded that an outside revenue stream, such as government RECs, would be necessary to make projects in the area economically viable. Two potential sites with the largest project size scenarios did however yield potential costs below the 'notional threshold' for viable offshore

wind development at USD 100/MWh. CM-1836 and HB-1836 presented costs of (USD 78.90 and USD 88.90, respectively). BOEM did however concede that California's RPS requirements are likely to raise the cost of viable PPA prices, as the lowest-cost renewable energy resources in the state become exploited.

New Jersey

The New Jersey Board of Public Utilities (NJBP) voted unanimously on September 10 to open the application window for the State's second offshore wind capacity solicitation. The competitive tender will award between 1,200 MW and 2,400 MW of offshore wind energy, potentially tripling the state's committed capacity from 1,100 MW to 3,500 MW. New Jersey Governor Phil Murphy in November 2019 set a goal of 7,500 MW installed capacity in the state by 2035.

The New Jersey Economic Development Authority (NJEDA) and the NJBP approved two MoUs in September providing funds to support workforce development projects and local clean energy start up companies, with values of USD 4.5 million and USD 1.25 million respectively. Upon announcing the funding NJBP President Joseph L. Fiordaliso noted the rapid expansion of offshore wind in New Jersey as a principal target area for investment.

New York

New York Governor Andrew Cuomo announced the next round of offshore wind solicitations for the state in July 2020. Up to 2.5 GW of offshore projects can be solicited as part of the competitive process. The announcement was supplemented by a USD 400 million investment in port infrastructure to support the

offshore wind industry. Developers bidding into the solicitation are required to partner with one of eleven pre-qualified New York ports to stage, construct, manufacture key components, or coordinate operations and maintenance activities. In 2019 the State announced a target of 9 GW of installed capacity by 2035.

Brazil

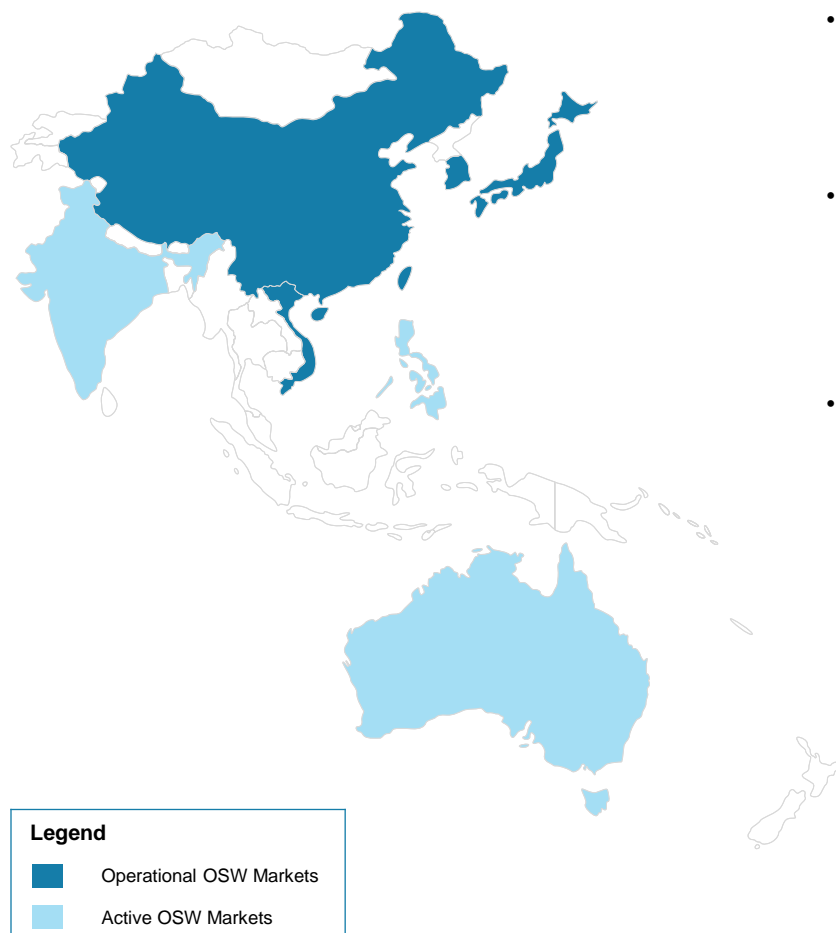
The Ministry of Energy published a second draft of the national offshore wind roadmap in June, although there were no significant revisions from the initial March publication outlining the project potential in the market. The report concluded that Brazil has about 700 GW of technical potential for offshore wind (in waters less than 50 m in depth). No formal policy framework was detailed in as part of the roadmap.

The Brazilian government issued an energy expansion plan for public consultation in July that outlines a target of 16 GW of installed offshore wind capacity by 2050. Mines and Energy minister Bento Albuquerque noted that there remain major hurdles to offshore wind in the country, such as ill-equipped port infrastructure and the lack of offshore wind specific regulatory framework. In 2019 Rio de Janeiro governor Wilson Witzel called for the de-federalisation of renewable energy auctions, allowing states within Brazil to conduct their own renewable energy auctions and provide state concessions to promote competition.

In July 2020, local media in Brazil reported that Senator Jean Paul-Prates would present an offshore wind bill imminently, but this has not materialised.

APAC – market update

The market responds to new lease auctions in Japan and Taiwan with multiple large scale projects entering development.



The future of offshore wind

- The Asia Pacific Region saw unprecedented growth in 2020, with over the regional portfolio growing by more than 60 GW. The most notable activity as focused on Taiwan and Japan, were projects competing for seabed area in upcoming tenders were introduced by local and international project developers.
- In Taiwan the market advanced at all phases of the development cycle. The Yunlin Phase 1 and Taipower 1 projects both began offshore construction in 2020. Over 2 GW of capacity is currently in the pre-construction phase in Taiwan, with multiple sites scheduled to begin construction in 2021.
- Japan kicked off its first offshore wind tenders in the market in 2020. The 12 MW Goto Islands floating site was auctioned in June whilst the bidding process for the first round of fixed foundation allocations opened in November. More projects

were announced in prospective areas for future tenders during the year, as well as locations not yet prioritised for future development by leasing authority METI.

- New projects were unveiled in Australia, the Philippines, South Korea and Vietnam during 2020. International developers PNE and Ørsted announced solo projects in Vietnam and South Korea respectively, whereas global firms Mainstream Renewable Power and Ocean Winds partnered with local players.
- The Chinese market continued to grow as projects seek to secure FiT rates by commissioning sites before the end of 2021. The rush of activity in response to the deadline has resulted in China becoming the second largest market in operational capacity globally, surpassing Germany in December 2020.

7.6 GW

Operational

30.3 GW

Secured

128.7 GW

In development

166.6 GW

Total

APAC operational portfolio

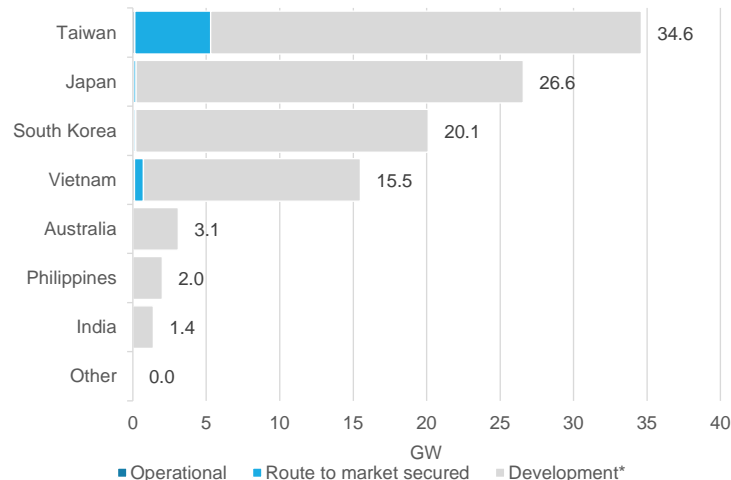
#	Country	MW
1	China	7,217
2	Taiwan	128
3	Vietnam	99
4	South Korea	95
5	Japan	68
Total		7,607

Asia Pacific - portfolio

As Japan and Taiwan look to allocate large-scale offshore wind capacity in 2021, local and global developers have jumped on the enthusiasm in the markets and announced new projects during 2020. South Korea and Vietnam have also seen significant market growth.

Key markets

Beyond China, Taiwan leads in all major phases of development after a busy year for early-stage projects.

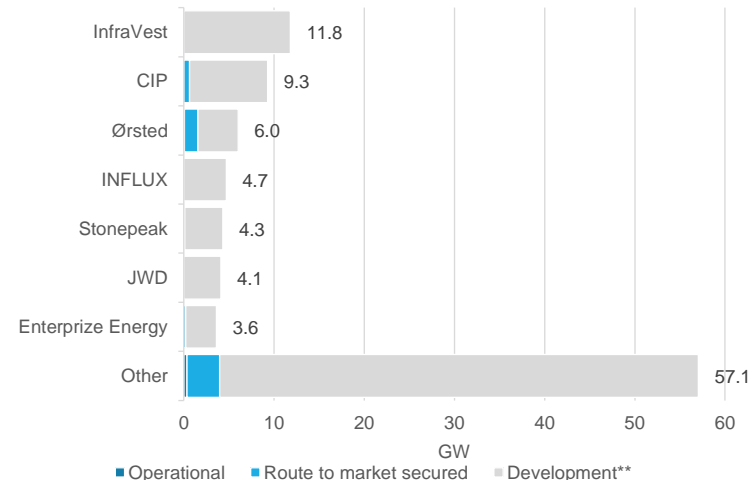


*includes capacity without owners that is scheduled for auction

- New projects announced by Copenhagen Infrastructure Partners (CIP), Stonepeak, Ørsted and InfraVest dramatically increased the early-stage development capacity of Taiwan in 2020. Some of the recently announced sites will compete for seabed with existing projects, meaning the full development capacity will not be realised.
- Early-stage projects were also announced in Australia, Japan, South Korea and Vietnam during 2020. International developers were particularly prominent, with Mainstream, Ørsted and Ocean Winds all active in the emerging markets.

Key owners

The APAC market is led by local players, however international interest in the region continues to grow.

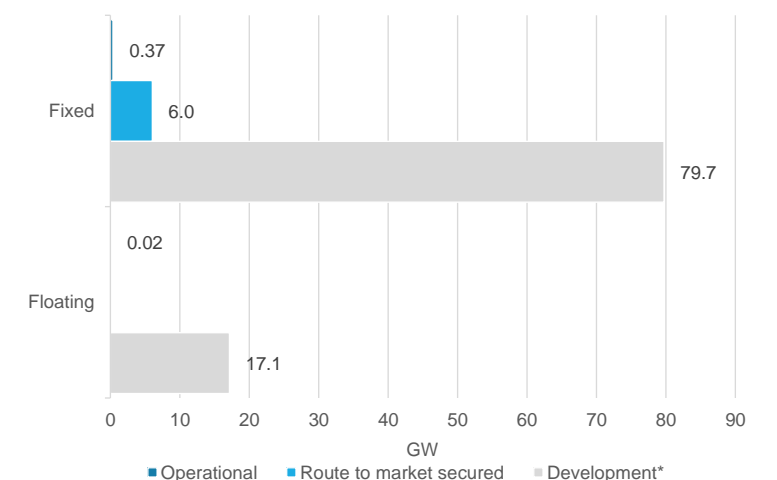


**does not include capacity without owners (i.e. projects that are scheduled for auction or where the owner is unknown)

- The APAC region is led by local players across all markets. International players have however secured modest pipelines through partnerships with local companies.
- Stonepeak, InfraVest, CIP and Ørsted all increased their capacity in Taiwan with multiple new large-scale sites. Outside of the top seven, Mainstream and Ocean Winds expanded their development portfolios. Canadian and local Taiwanese partners CDPQ and Cathay PE also acquired route to market capacity, purchasing shares in the Greater Changhua 1 project.

Technologies

Development of floating offshore wind is prominent in the region, most notably in South Korea and Taiwan..



*includes capacity without owners that is scheduled for auction

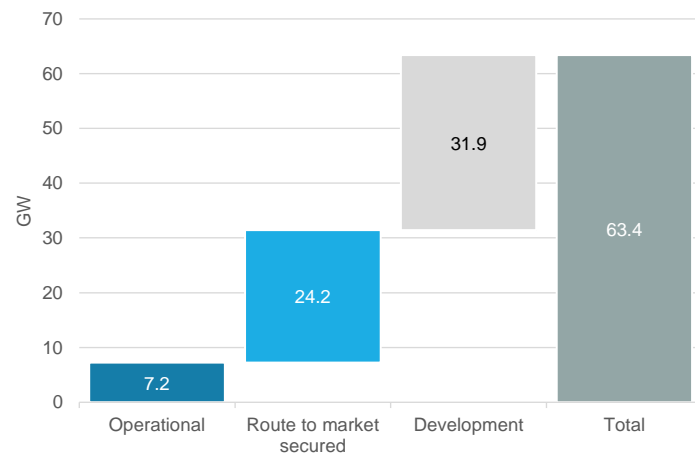
- The APAC region has been a focus point for floating wind development, with multiple large-scale projects planned in South Korea and Japan. The Taiwanese market is also opening up to large floating projects, with 7,400 MW added to the portfolio by InfraVest.
- Fixed foundation projects continue to be announced across the region. New project sites published by CIP in Taiwan are yet to disclose foundation types. The sites are located in waters ranging between 60-100m in depth and could utilise either deep-water jacket or floating foundation designs.

China - portfolio

China has built momentum in offshore wind and now stands among the market leaders. By 2022 it may maintain the worlds largest operational project portfolio, but there are concerns over stress on the local supply chain to deliver such rapid development.

Portfolio

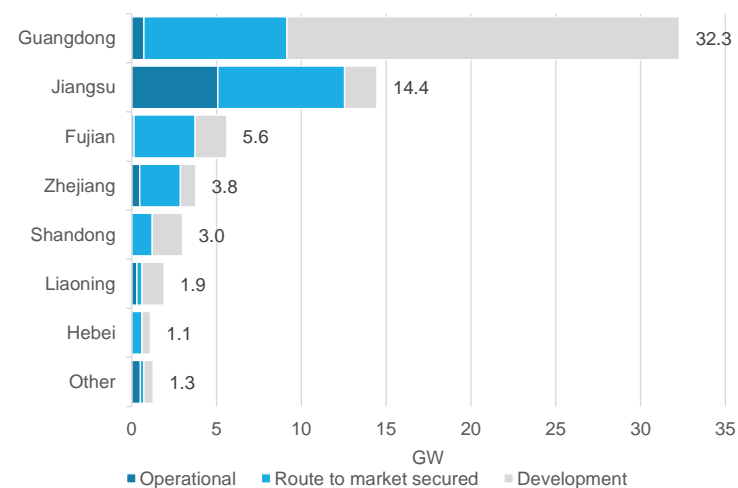
A surge to secure route to market has taken place before revisions to the FiT scheme.



- China now has a large operating capacity. This includes floating wind demonstrators and hybrid offshore wind projects powering bridge infrastructure.
- Over 10 GW of projects are currently in various stages of construction, aiming to meet a commissioning deadline of 2022 in order to secure favourable FiT rates.
- The development surge has created a supply chain bottleneck, with the COVID-19 pandemic compounding delays.

Key markets

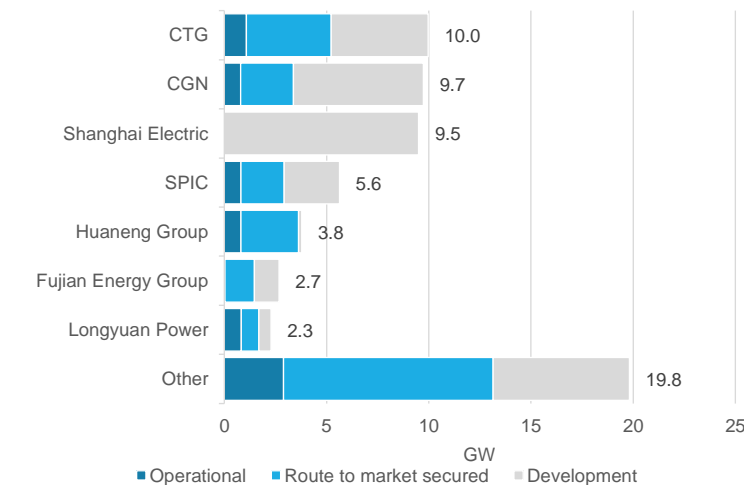
Guangdong and Jiangsu are key markets within China.



- China's Guangdong province has a large development pipeline driven by an ambitious target of 30 GW installed capacity by 2030.
- Jiangsu owes its large operational capacity in part to a shallow seabed area in comparison to other coastal provinces.
- Despite high average wind speeds, geographical constraints prevent Fujian from matching Guangdong and Jiangsu in development capacity.

Key owners

Chinese offshore wind is dominated by local developers; international players are starting to enter via partnerships.



- The Chinese offshore wind market is dominated by local developers. Some international developers such as Total, Equinor and EDF have partnered with local players.
- After successful commissioning on the Liaoning Dalian Zhuanghe 3 in November, The China Three Gorges (CTG) Corporation leads the market in both operational and route to market secured capacity.
- Shanghai Electric significantly increased development capacity with new projects in 2020.

Policy and leasing - APAC

Japan and Taiwan governments have continued to support offshore wind with policy and leasing initiatives.

Japan

On June 24th, 2020 the Ministry of Economy, Trade, and Industry (METI), responsible for offshore wind leasing, launched the first offshore wind lease auction in the market. The 21 MW Goto Islands floating wind energy area is the first development zone to be auctioned under the auspices of the 2019 Marine Renewable Energy Bill.

Japan's second offshore lease auction was opened in on November 27th. Four fixed foundation offshore wind zones will be covered in the auction, with three located off Akita Prefecture: Noshiro (Mitane Town and Oga City), Yurihonjo City North, and Yurihonjo City South. The fourth zone, Choshi City, is situated off Chiba Prefecture..

The leasing structure in Japan may not permit all projects to be developed or follow their expected development trajectory. Participants in the Japanese lease auctions have initiated the development process of their projects before securing the lease rights to the seabed, meaning multiple projects are being developed in the same area. Once a project is selected for a lease permit as part of the upcoming auctions, other projects seeking development in that area will be forced to shut down or re-evaluate project areas should additional seabed remain available.

Philippines

Despite the recent establishment of two projects with a combined capacity of up to c. 2 GW, there remains no framework for offshore wind development in the Philippines. Developer Triconti ECC secured the rights to build initial 100 MW phases of the

projects directly from the Philippines Department of Energy. Details of the government concessions for the projects have not been made publicly available.

South Korea

During a visit in July to the South Korea's 60 MW Southwest Sea Demonstration project, which came online in January, President Moon Jae-In committed to a target of 12 GW installed capacity by 2030. During the visit developers of the project, Korea Offshore Wind Power, signed an MoU with local government authorities to progress the remaining 2.4 GW of the Southwest Sea Project.

Taiwan

On June 19th, 2020, the Taiwanese Bureau of Energy (BoE) unveiled a proposal for the Third Round of offshore wind leasing. Under the proposal, 1 GW to be commissioned by 2026 will be auctioned in Q2 of 2021, 2 GW for 2027/28 will be auctioned in Q2 of 2022 and 2 GW for 2029/30 auctioned in Q2 of 2023. Taiwanese government plan to add 10 GW during 2025 – 2035 with 1GW per year principle.

Auction Date	Auction Capacity	COD Target
Q2 – 2021	1 GW	2026
Q2 – 2022	2 GW	2027 / 2028
Q2 – 2023	2 GW	2029 / 2030

Vietnam

In September 2020 the Danish Energy Agency (DEA), in partnership with the World Bank Group, published a Roadmap to Offshore Wind Power Development and Policy Recommendations for Vietnam. The report projects that 10 GW of offshore wind could be deployed in Vietnam by 2030 and outlines the importance of establishing development targets and a clear legal framework for offshore wind in the country, including a PPA mechanism in line with international practices. The Vietnamese Ministry of Industry and Trade (MoIT) commented that the findings in the report will contribute to the National Power Development Master Plan VIII.

Section 3: Forecast

The mature European markets continue to dominate commissioning activity, but with growth forecast in APAC and US markets in the near-term.

China is expected to surpass the UK as the leader in installed capacity by the end of 2021.

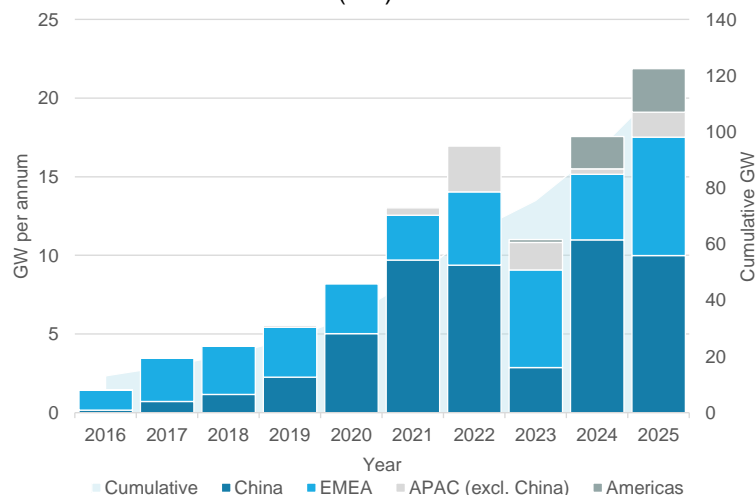


Global Commissioning Forecast

China is forecast to surpass the UK as the leading offshore wind market by the end of 2021. In addition to the leading markets of EMEA, Taiwan and the USA are expected to add significant capacity between 2021 and 2025.

Commissioning activity and forecast by region (2016 - 25)

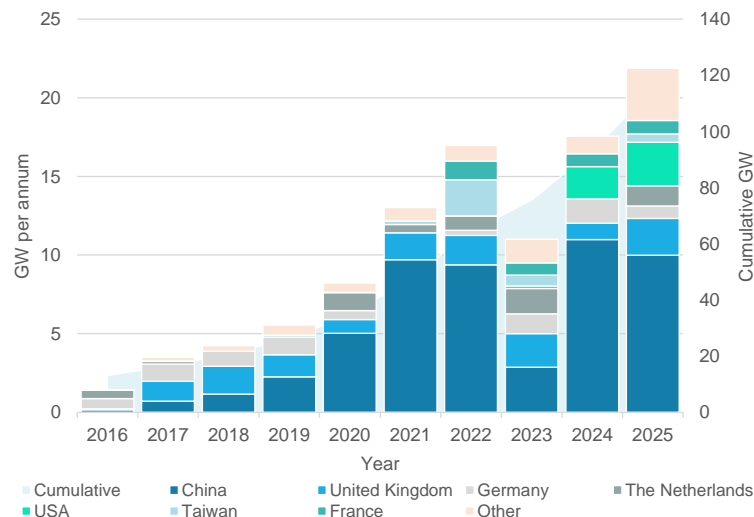
China is forecast to lead deployment as projects race to qualify for the national feed-in-tariff (FIT).



- China is expected to lead installation in 2021 and 2022. Whilst the project FiT rate in China expires at the end of 2021, supply chain bottlenecks are expected to force some projects into 2022 commissioning dates.
- Projects that received CfDs in the UK, FiT clarifications in France and permits in the Netherlands in 2019 are scheduled to enter construction from 2021 onwards.
- APAC ramps up from 2022 and US projects from 2024, as schemes with grid connection are expected to be installed.

Commissioning activity and forecast by country (2016 - 25)

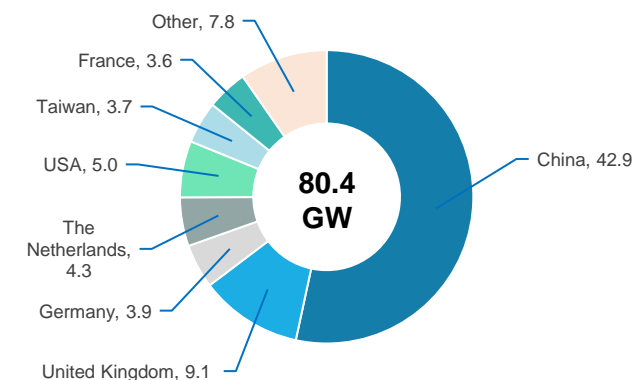
China will surpass the UK in installed capacity during 2021.



- Due to the drive to install projects before the expiry of the national FiT rate, China is expected to overtake the UK as the leader in operational capacity by the end of 2021.
- The UK is set to remain a leading offshore wind market with over 10.5 GW of new capacity due to be commissioned from 2020 to 2025.
- Large-scale projects in Taiwan from the first auction round (2018) are scheduled to come online from 2021, with major additions taking place in 2022.

Commissioning forecast by country (2021 - 25)

France, Taiwan and the USA are expected to deploy their first large-scale projects in the forecast period.



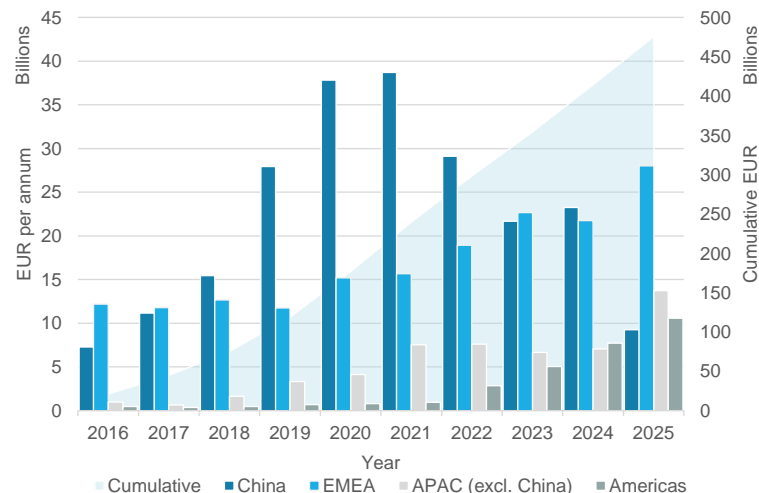
- The 42.9 GW of growth in China is initially driven by the FiT surge. After a hiatus in 2023 with projects not fully funded, commissioning is expected to pick up from 2024.
- Mature markets still dominate the near-term commissioning forecast. However, the global market is trending towards a more diversified commissioning pattern as offshore wind technology penetrates new markets, including the US which sees a larger share of annual installations by 2025.

Global Expenditure Forecast (1)

Despite cost reductions and increases in efficiency, overall expenditure is expected to rise in the forecast period as more projects are developed and commissioned.

TotEx activity & forecast by region (2016 - 25)

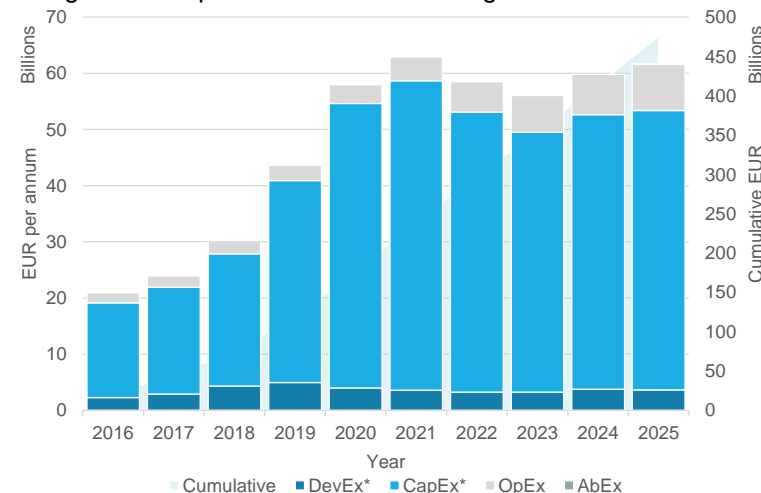
China is having a significant impact on investment in the market in the near-term.



- TotEx is expected to fall in China from 2022 as the expiring of the national FIT rate increases demand for further LCoE reductions on future projects.
- In EMEA, the Americas and APAC, increasing project size, project deployment in challenging seabed areas and adoption of next generation turbines is forecast to increase expenditure across all markets. With scheduled deployment rates increasing in neighbouring territories, supply chain bottlenecks may also contribute to rising costs.

TotEx activity & forecast by sub-category (2016 - 25)

Excluding the Chinese market, expenditure across all sub-categories is expected to increase through to 2025.

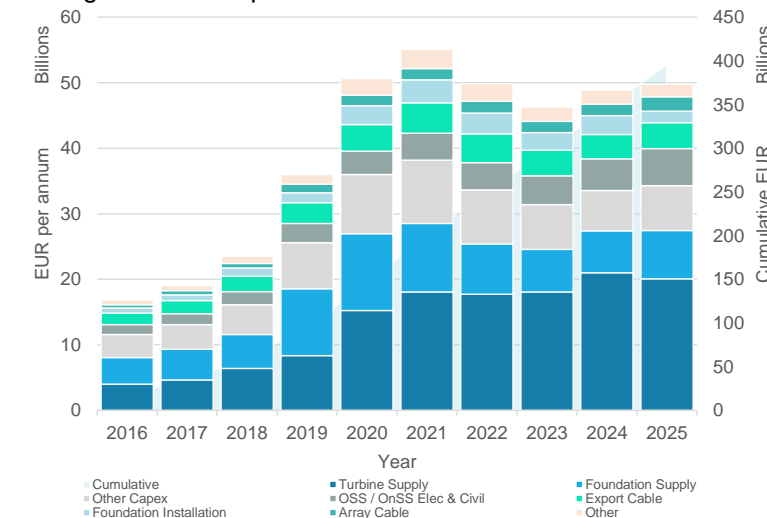


*does not include estimates associated with projects yet to be leased as part of TCE Round 4 and ScotWind

- As more countries formalise offshore wind frameworks, project DevEx will remain stable during the forecast period, despite site competition.
- The construction push in China in 2021 and 2022 is expected to be so significant that it will have an immediate impact on overall project CapEx prior to 2023, before growth is forecast to gradually increase at a more consistent rate.
- AbEx is not visible up to 2025, as no major projects are due to be decommissioned during the forecast period.

CapEx activity & forecast by sub-category (2016 - 25)

Adoption of next generation turbines drives cost increases during the forecast period.



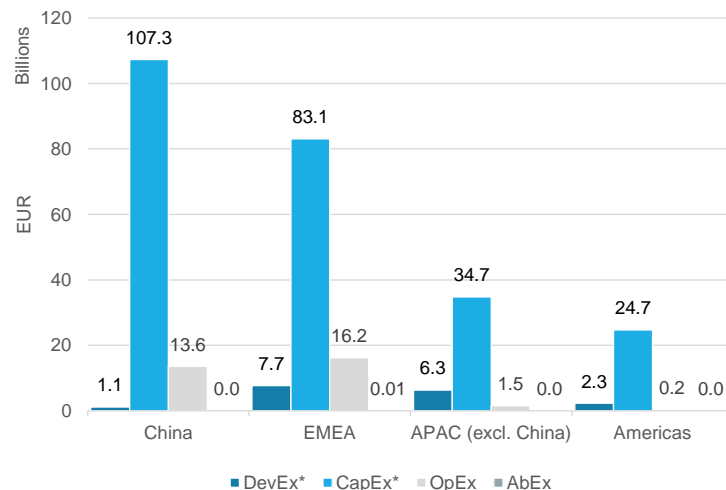
- The key driver of expenditure during the forecast period is the turbine supply package. The adoption of the next generation turbine fleet (10 MW+) has elevated cost per WTG. Large-scale developments are also requiring more turbines to be contracted per project, raising costs further.
- Foundation costs are forecast to increase, with more projects coming online in deep water sites and areas of difficult seabed conditions, such as Taiwan. Multi-OSS projects forecast in Europe have also raised costs of the OSS package respectively.

Global Expenditure Forecast (2)

Mature markets are forecast to see the highest expenditures at each stage of development during the forecast period. Whilst robust offshore wind frameworks and supply chains facilitate efficient development, rapid market growth mandates investment for new projects.

TotEx forecast by sub-category and region (2021 - 25)

High DevEx in EMEA and APAC reflect the continued activity around new large-scale developments.

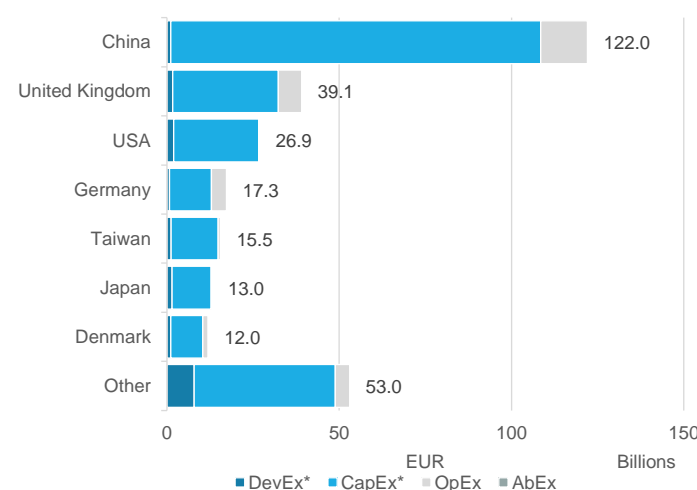


*does not include estimates associated with projects yet to be leased as part of TCE Round 4 and ScotWind

- OpEx in the Americas and APAC regions remains low due to the comparative lack of utility-scale projects.
- Despite the significant growth in the development portfolio of the Americas and APAC regions in 2021, new large-scale developments are due to begin construction towards the second half of the forecast period, limiting CapEx prior to 2025.
- Some small early build projects and demonstrators in EMEA will be decommissioned by 2025, resulting in an increase in AbEx.

TotEx forecast by sub-category and country (2021 - 25)

The impact of a leasing hiatus in Germany has lowered investment in new sites.

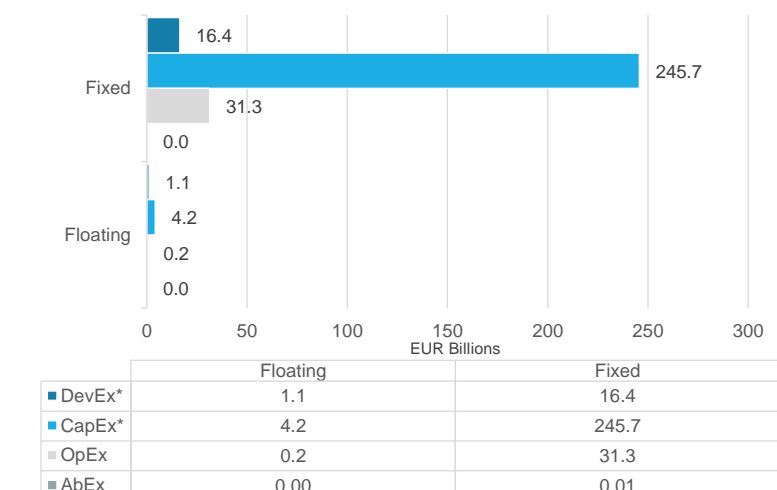


*does not include estimates associated with projects yet to be leased as part of TCE Round 4 and ScotWind

- DevEx in China remains low, despite the rapid build out of projects in the near-term. As offshore wind targets set by state governments are high, local authorities have facilitated low-cost development. Additionally, the uncertainty in the market beyond the expiry of the FIT rate has discouraged development for long-term projects.
- The comparatively low CapEx in the German market is the result of a hiatus in tendering from 2019 to 2021, meaning construction for sites to be leased will take place towards the end and after the forecast period.

TotEx forecast by sub-category and technology (2021 - 25)

Whilst momentum builds for floating wind, overall global costs reflect global the preference for fixed foundation development.



*does not include estimates associated with projects yet to be leased as part of TCE Round 4 and ScotWind

- Fixed foundation offshore wind dominates the near-term investment forecast at each phase of project development. Project leasing (excluding small sites in Japan and the ScotWind auction) remains focused on the established fixed foundation technology, dictating expenditure trends for projects in the near-term.
- Expenditure associated with floating projects is expected to increase through to 2030, as more markets adopt the technology and the lengthy development process for recently announced sites comes to fruition.

The Renewables Consulting Group:

RCG is a specialized expert services firm, focused solely on the global renewable energy industry. We deliver integrated market intelligence, management consulting and technical advisory for both mainstream and emerging energy technologies. Our professionals come from a wide range of industry and consulting backgrounds, providing us with unique perspectives of our client's business, and a fresh approach to navigating the complex challenges they face. Headquartered in London in the United Kingdom, with offices in New York, United States, and regional offices elsewhere, we serve our clients worldwide.

Contact information:

Please contact our representatives below if you have any questions regarding this report:

Lee Clarke

COO

Mobile: +44 7738 948275

lee.clarke@thinkrcg.com

Sebastian Rae

Associate Director

Mobile: +44 7557 095465

seb.rae@thinkrcg.com

Maxwell Clarke

Associate

Mobile: +44 7851 761413

maxwell.clarke@thinkrcg.com

London

Gilmoora House, 57 - 61 Mortimer Street
London, W1W 8HS

New York

433 Broadway, 6th Floor
New York, NY 10013

