2021 Global Offshore Wind

Volume 2

Market and Forecast Report

2021 - 2034

SAMPLE BROCHURE

'Green is the New Black'

Vision

Prepared by the Q FWE Analyses Team

Foreword

Renewables are considered one of the primary fuels to satisfy the world's growing energy demand and wind is a vital component. Many countries are looking-to offshore as a more beneficial effective environment to harvest larger volumes of wind energy. The offshore wind sector continues to deliver increasing numbers of offshore wind farms across the world and until recently, have exclusively been developed with 'Bottom-fixed' structures in relatively shallow water, near-to-shore. With the advent of Floating wind and its enormous growth potential, there will be new developments further from shore and in deeper water.

Cumulatively installed offshore wind capacity reached 32.5 GW in operation worldwide by the end of 2020 buoyed by 5.2 GW of newly added global capacity additions from both Bottom-fixed and Floating.

In 2020, there were 5.2 GW of newly added global capacity additions for offshore wind (Bottom-fixed and Floating) bringing the total installed offshore wind capacity in operation to 32.5 GW worldwide. In fact, the top five offshore wind markets, ranked by capacity in operation, are the UK (10.4 GW), Germany (7.7 GW), China (7.1 GW), The Netherlands (2.6 GW) and Belgium (2.3 GW).

Q FWE is passionate about the ultimate potential for offshore wind and the force of influence it2will demonstrate over time across the renewables landscape. This report entitled Global Offshore Wind Market and Forecast Report, Volume 2, is a comprehensive review of the global offshore wind market's total potential in addition to a unique focus on Bottom-fixed and Floating market segments together and separately. Please note that Q FWE also maintains comprehensive market intelligence, 'Deep Data' and reports on the Floatng Wind Market exclusively, so we are your GO TO source for continual, in-depth analysis across the sector.

I would like to extend my sincere thanks and appreciation to the entire Q FWE team for their collective work in creating our proprietary CapEx/LCoE Cost Model and Q Vision database architecture and insight which drives the bulk of this reports Quantitative and Qualitative market analysis.

We look forward to exploring 'the Offshore Wind' journey with you!

This comprehensive 150-page market report dedicated to Global Offshore Wind illustrates the tremendous market opportunities globally across the supply chain for Bottom-fixed and Floating wind over the next ~15 years including the most active developers, potential market size, pertinent project activity details and other vital metrics illustrated by region and construction timeline.

Report Findings

- Over the forecast period analyzing contract awards to 2034 and project start-ups to 2035, Quest has identified projects representing more than 208 GW of offshore wind scheduled for commissioning worldwide, a number that will grown exponentially following the addition of newly sanctioned projects and accelerated commercialization. In total, 21,117 Wind Turbine Generating units are forecast globally to 2035 signifying a nameplate capacity of 207,741 MW and capital spending of $609 billion. While the mix between Fixed and Floating is 85% to 15%, respectively (on a MW basis), a regional analysis signifies a 43% share of capital spend to Europe followed by AsiaPac at 37%, and The Americas with a 20% portion.

- A year-over-year comparison to the global opportunity pipeline sees CapEx gains exceeding $180 billion with new Bottom-fixed wind projects surging in all core regions. Shown Right, AsiaPac sees CapEx gains of $70 billion while increases in Europe are $61 billion followed by $50 billion in The Americas.

- Globally, the 50% increase in turbine units to 18,038 was led from Europe with the addition of 2,243 units followed closely by AsiaPac with 2,331 and The Americas seeing a net gain of 1,470.

- The United Kingdom is the most active European sector counting 23 'Under development' projects denoting a spend of $58 billion. France ranks second with 14% of the spend, $15 billion, for three projects offshore Normandie (Dunkirk, Saint-Brieuc, Saint-Nazaire); and five others (Calvados, Courseulles-sur-Mur, Dieppe-Le Tre'port, Fe'camp, ILes d'Yeu et de Noirmoutier). Poland, Germany and The Netherlands round-out the top five countries and collectively represent 21% of the spend, $24 billion.

- Europe's Top 10 Developers collectively represent about 70% of the capital spending for Fixed wind these are: Orsted, Equinor, Vattenfall, Shell, Iberdrola, EON, EDF, SSE Renewables, RWE and Ocean Winds. 'Under development' projects denote 51% of the CapEx ($112.4 billion) while 32% ($69 billion) of spend is tied to 'Planned' projects. Projects with status 'Possible' represent (17%) of the total ($37.5 billion).

- The Asia Pacific's concentration by Developer is highly fragmented compared to other regions. The Top 10 Developers collectively represent about 43% of the capital spending for Fixed wind at $78.3 billion these are: The Korea Electric Power Corp. (KEPCO), Enterprize Energy of Vietnam, Orsted, Copenhagen Infrastructure Partners/Offshore Energy, Pacifico Energy KK, Mainstream Renewable Power, EnBW Energie, Saemangeum and Japan Wind Development. 'Under development' projects denote 16% of the CapEx ($29 billion) while 32% ($58 billion) of spend is led from 'Planned' projects. Projects with status 'Possible' represent (52%) of the total ($93 billion).

- The vast majority of Developer activity in The Americas with status 'Under development' is held by the Top 10 who collectively represent about 97% of the capital spending for Fixed wind at $106 billion these are: Orsted, Neoenergia, Equinor, Avangrid Renewables, Dominion Resources, Votu Wind, Vineyard Wind, EDF, Shell and PrimoEnergia.

- Floating wind is a global opportunity ramping-up for commercialization across six to ten distinct markets. Over the long-term, Floating wind is projected to become a critical component of the energy mix. The pace and rhythm of this nascent market is profound, with upward projections of potentially 180 GW of installed capacity by 2050, comprising nearly 13,000 Floating turbine units.

- The Floating opportunity pipeline continues to gain momentum. A year-over-year comparison (Jan. 2021 vs. Jan. 2020) to our Floating wind outlook reveals Double Digit increases with the number of Projects up 61% while the total number of Units gaining by 25% and Total MW rising 14%.

- Likewise, CapEx gains of nearly $33 billion new Floating wind projects surging in Asia Pacific and Northern Europe with spending increases of $19 billion and $17 billion, respectively. In Asia, there are nearly 6 GW of projects earmarked for South Korea alone led by these Developers: TOTAL Energies, Ocean Winds/Aker Offshore Wind, Equinor, MOTIE and Shell/CoensHexicon.

Report Findings - Continued

- Current tenders for commercial-scale Floating offshore wind farms, in a number of key regions, are accelerating the potential for rapid growth. As an example, the ongoing ScotWind seabed licensing round will include a carve-out for floating projects in Scottish waters. ScotWind awards are expected to be announced during the first half of 2021. It is estimated that 10 new sites will eventually be chosen for wind farm developments.

- We observe that moving forward, Developers are mainly de-coupled from technology and now start each early development project with an agnostic-based technology approach; this results in each company working with a variety of Floater designs and designers. Q FWE developed an infographic "Developers' Floater Technology DNA" to highlight these relationships which is detailed in sister report to our companion report entitled "Global Floating Wind Market and Forecast Report 2021-2034", Volume 3.

Executive Summary

Our accelerated Energy Transition is being led from more aggressive stated Net Zero carbon emissions goals coupled with more influential economic and political factors along with shifts in societal preferences. This is matched by a corresponding increase in the role of renewable energy as the world increasingly electrifies. Environmental, Social and Governance (ESG) are drivers influencing our energy transition. In line with that, 2020 has been the year of aggressive commitments to Net Zero carbon emissions by 2050 for a large swath of companies. This group has been led by Europe's largest integrated oil companies —Shell, BP, TOTAL Energies and Equinor. This group remains at the forefront of their peers, and they are transparent about transitioning to cleaner energy in the future.

What does the energy transition mean to us?

- The scale of this shift varies significantly across the three scenarios (Rapid, Net Zero and Business-as-usual) outlined in BP's Energy Outlook - 2020 edition. In 'Rapid" (according to report), renewable energy sees increasing share towards 50% while the share of hydrocarbons in primary energy are shown declining to around 40% by 2050.
- The global energy transition to a lower carbon footprint presents many opportunities across industries to tackle new challenges through innovation and applied technology. Renewables are set to penetrate the global energy system more rapidly compared to any other fuel in history.
- Renewables led by wind, offshore wind and solar are growing exponentially and delivering bigger capacities and cheaper economic solutions.
- Cheap renewable energy and batteries are remaking electricity systems globally and will take a growing share of power generation from fossil fuels which could reach parity well before 2050. Modern natural gas power plants can provide the flexibility needed to integrate more renewables into the grid.
- Wind energy is a growing form of cheaper energy supply in many markets. According to the Global Wind Energy Council, wind capacity installations continue to outpace new fossil fuel capacity in multiple mature and emerging markets. In 2020, there were 5.2 GW of newly added global capacity additions for offshore wind (Bottom-fixed and Floating) bringing the total installed offshore wind capacity in operation to 32.5 GW.

Executive Summary - Continued

- The IEA's World Energy Outlook sees increased spending on offshore wind power projects through 2040 benefiting in part from the decline in offshore oil investments under their Sustainable Development Scenario.
- In 2020, according to the IEA, the OECD region as a whole produced its highest share of electricity from natural gas at 30% closely followed by renewable sources at 28%, coal 19%, nuclear 17% and oil 5%.
- In 2020, renewable energy's share in global power markets increases substantially, an amount five and seven times greater than the overall increase in primary energy.
- By 2040, the IEA projects total offshore wind energy generated electricity to reach 2,072 TWh in the Sustainable Development scenario At the same time, long-term projections indicate that cumulatively installed offshore wind capacity worldwide will reach 562,000 MW, a level almost ~20 times larger than the cumulatively installed offshore wind capacity at the end of 2020 (32,500 MW).
- Advanced technology will continue to be an enabler for wind energy. Digitalization shows great potential for its ability to transform the power sector by offering demand-side flexibility including opportunities to integrate power sources. Digital technologies and Artificial Intelligence can also aid-in reduced TotEx and drive lower operation and maintenance costs in large wind parks.
- Pundits' projections for onshore wind indicate over 50 GW of installed wind capacity on an annual basis in addition to more than 40 GW of offshore wind capacity additions each year in the Sustainable Development Scenario. Meanwhile, Q FWE's rolling forecast of 400 presently identified projects signify a nameplate offshore wind capacity of 207 GW - a number that will grow exponentially as newly sanctioned projects are added to the forecast over time.

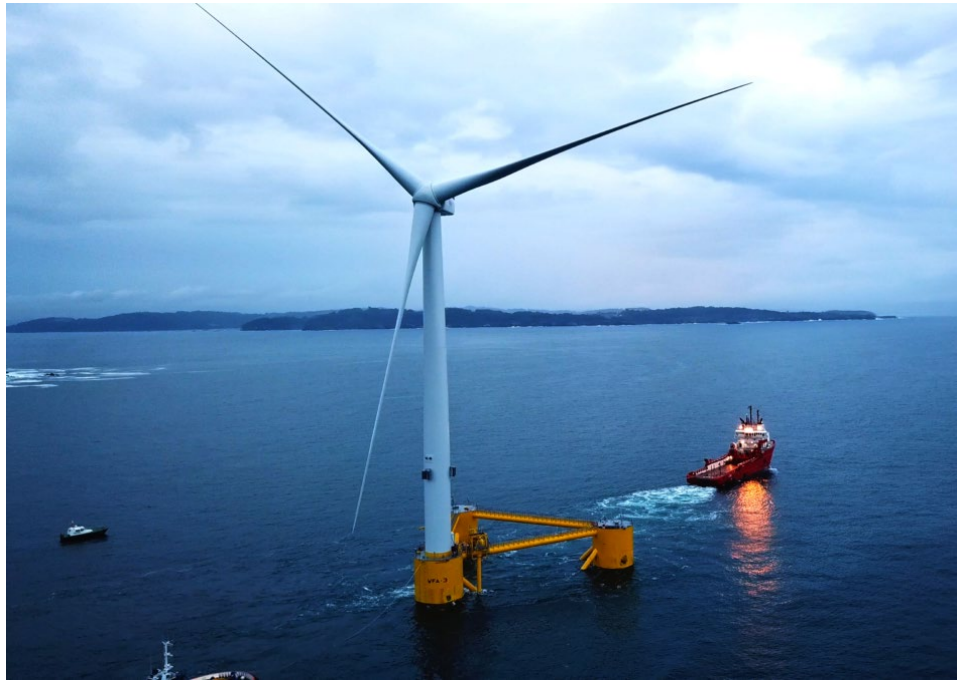


Image Source: PPI

Executive Summary – Continued

Robust Outlook for Global Offshore Wind

- The top five offshore wind markets delivered over 30 GW of new capacity in 2020 led by the UK (10.4 GW), Germany (7.7 GW), China (7.1 GW), The Netherlands (2.6 GW) and Belgium (2.3 GW).
- The European Union is leading projected installed capacity additions in offshore wind (Floating and Bottom-fixed) totaling 92 GW at 2030e in the Sustainable Development Scenario possibly growing to 175 GW by 2040.
- Ranking second is China which the IEA projects will total 65 GW of installed offshore wind capacity (Bottom-fixed and Floating) at 2030 and a whopping 177 GW by 2040. Similarly, the highest growth rates for annual additions is led by China followed by the European Union.
- South Korea's Green New Deal, a pledge to invest billions in renewable energy and electric vehicles and phasing out coal by 2030, will drive the government's plans to make South Korea "one of the world's top five offshore wind energy powerhouses by 2030."
- On the Developer front, the last two years have seen accelerated initiatives by new companies, joint ventures and other collaborations. These evolving players include experienced utilities such as Iberdrola and EnBW Energie plus leading developers such as Orsted, Ocean Winds and Aker Offshore Wind. Increasingly, legacy oil and gas companies (Equinor, Shell, TOTAL Energies and BP) are rapidly entering the sector with vast experience in long-term capital intensive projects and impeccable track records in risk management, project execution and complex logistics.
- The wind industry continues to deliver value to enhance wind's cost competitiveness and efficiency with steady improvements in the Levelized Cost of Electricity (LCoE). Since 2016, offshore wind particularly has pushed LCoE reductions well in excess of 60%.
- Shell aims to make power a significant part of its business and emphasized that offshore wind is critical to that mission, with a current opportunity pipeline of 5 GW and expanding. Equinor has made no secret of its high ambitions and restated a goal of becoming a global major within offshore wind. The firm has equity ambitions of 12 to 16 GW by 2035, as well as accentuating their determination to maintain a world leadership position in floating offshore wind.

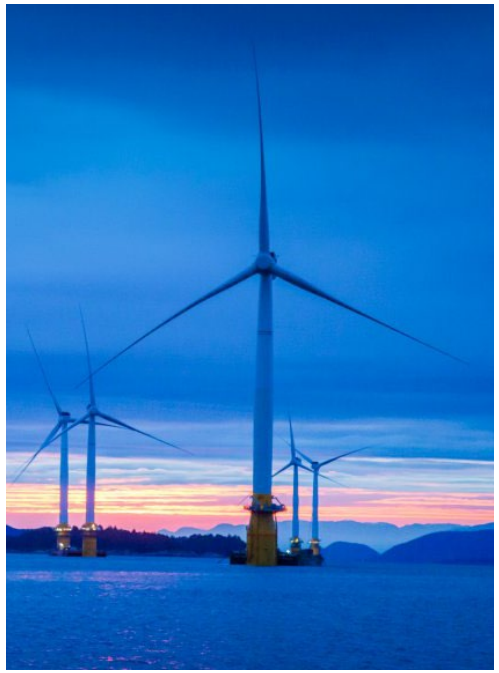


Image Source: Equinor

Executive Summary - Continued

Robust Outlook for Global Offshore Wind

A Focus on Bottom-fixed Wind

- When compared to Floating, there is more velocity to the capacity additions in Bottom-fixed.
- A year-over-year comparison (Jan. 2021 vs. Jan. 2020) to our Bottom-fixed wind outlook reveals strong Double Digit increases to the Project Opportunities Pipeline. The number of Projects are up 51% gaining by 95; the total number of Units have risen by 50% to 18,038; and Total MW have gained 67% to 176,451 MW.
- A year-over-year comparison to the global opportunity pipeline for Fixed wind sees CapEx gains exceeding $180 billion with new Bottom-fixed wind projects surging in all core regions. AsiaPac sees CapEx gains of $70 billion while increases in Europe are $61 billion followed by $50 billion in The Americas.
- Globally, the 50% increase in Fixed turbine units to 18,038 was led from Europe with the addition of 2,243 units followed closely by AsiaPac with 2,331 and The Americas seeing a net gain of 1,470. Northern Europe sees plans for 7,557 units a 42% increase from one-year ago across 101 projects. In Asia Pacific, 142 projects comprising 7,086 units are forecast which is 49% increase from one-year ago. The Americas gained 13 projects more than doubling MW capacity year-over-year from 18,364 MW to 38,886 MW.
- Bottom-fixed offshore wind sees $85 billion in potential fabrication contracts over the outlook period to 2025. Project activity volumes are likely to see in excess of $15 to $20 billion in contract awards per annum.
- A review of Bottom-fixed wind projects with status ‘Planned’ reveals 72 projects comprising 4,920 Fixed Turbine Units totaling a CapEx of $136.7 billion. The most active region is Europe counting one-half of these projects highlighted and denoting a spend of $69.1 billion while AsiaPac denotes a 43% share of spend totaling $57.8 billion.
- A review of Bottom-fixed wind projects globally with status ‘Under development’ shows 116 projects comprising over 6,500 Fixed Turbine Units totaling a CapEx of $180 billion. The most active region is Europe counting nearly one-half of these projects highlighted and denoting a spend of $113 billion. The USA Atlantic, a nascent market just a few years ago, is the second most active region for Fixed wind counting 17 ‘Under development’ projects totaling 1,262 total units and representing a total spend of $38.6 billion.
- A review of Bottom-fixed wind projects with status ‘Possible’ reveals 95 projects comprising 6,599 Fixed Turbine Units totaling a CapEx of $189.3 billion with the highest allocation of spend is these countries: South Korea (20%), Brazil (19%), Japan (18%) and USA (11%). The expected tranche of projects denote11 ‘mega-sized’ Fixed wind projects, each over $4 billion in CapEx, representing a 33% share of total capital spending. Additionally, 17 ‘large’ projects, each ranging between $2 billion and upwards of $3.8 billon in CapEx, represent a sizeable share ($42 billion) of the Total Addressable Market.
- In Asia Pacific, there is an abundance of major projects ‘Under development’ with the largest eight comprising 46% of the spend ($13.5 billion).
- There is an abundance of major projects ‘Under development’ off the United States’ Northeastern Seaboard. These Developer-led projects include three by Avangrid Renewables ($10.8 Billion), three for Dominion Resources ($6.5 billion), three by Equinor with partner BP ($9 billion), six for Orsted ($9.5 billion), one off Massachusetts for Shell ($2.1 billion), and lastly one for US Wind off Maryland ($839 million). Avangrid Renewables’ 1,680 MW Vineyard Wind 1 is the first utility-scale offshore wind installation in America.

Table of Contents

Table of Contents - Continued

Table of Contents - Continued

Table of Contents - Continued

1. Q FWEconomics – Macro Market Perspective

in a Global Context

Sustainability and ESG Are Permanent Fixtures

"The Technologies required to reach net zero exist today – the challenge is to use them at pace and scale, and I remain optimistic.."

- BP's CEO Bernard Looney

2050

Equinor Sets Goal for 50% Reduction in Net Carbon Intensity

BP Sets Net Zero CO_2 Target

Bank of America Achieves Carbon Neutrality @ Jan. 2020

Shell Sets Net Zero Emissions Goal

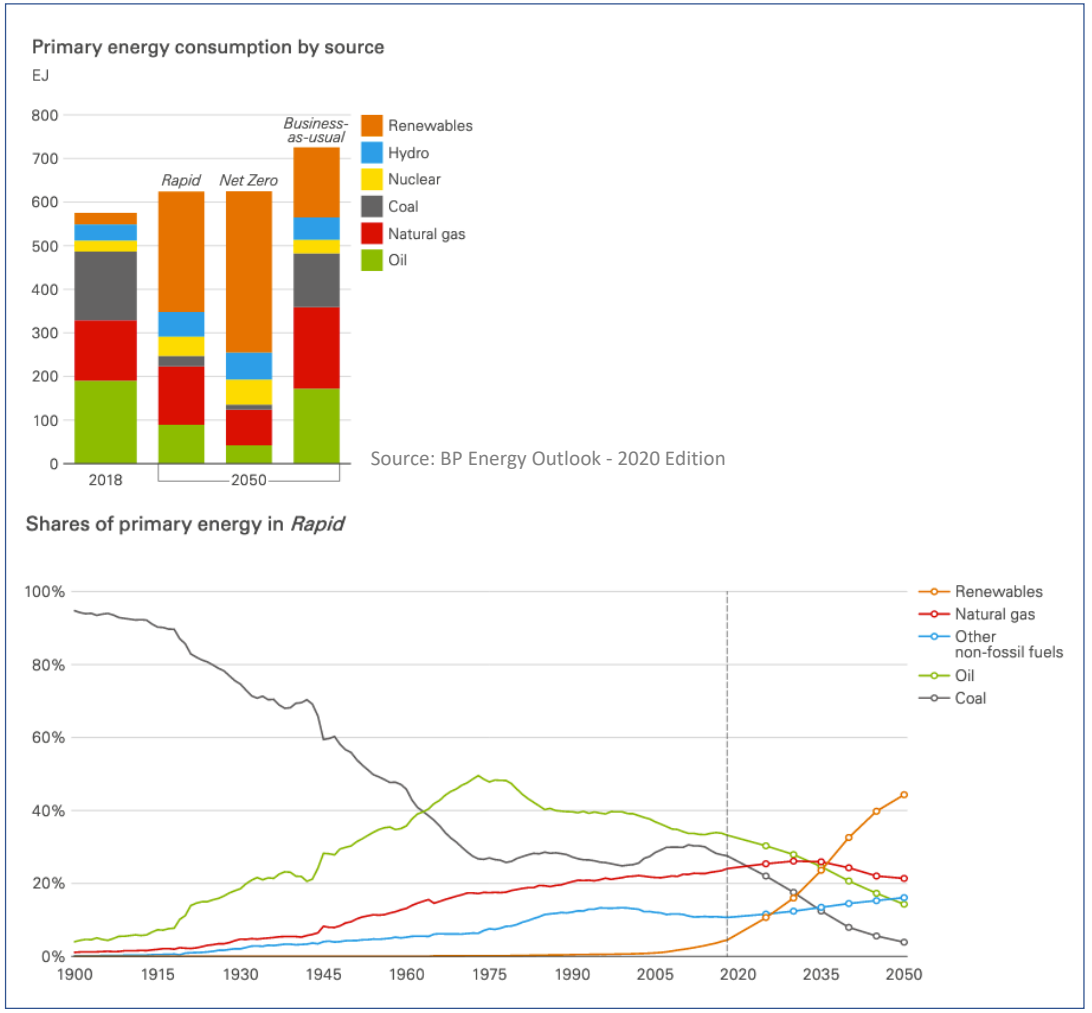
TOTAL Adopts Net Zero Climate Ambition

amazon

Ford

Global Context, The Energy Transition

- Over the Outlook period, BP's 2020 Energy Outlook Report analyzes three scenarios which explore different pathways for the global energy system to 2050; these are BAU-Business as Usual, Net Zero and Rapid Transit.
- Primary energy demand increases by around 10% in Rapid and Net Zero over the forecast and by around 25% in BAU. Interestingly, a noted decline in the share of hydrocarbons (coal, oil and natural gas) applies in all three scenarios.
- Our accelerated Energy Transition is being led from more aggressive stated Net Zero carbon emissions goals coupled with more influential economic and political factors along with shifts in societal preferences.
- This is matched by a corresponding increase in the role of renewable energy as the world increasingly electrifies. The scale of this shift varies significantly across the three scenarios; however, 'Rapid" sees the share of renewable energy increasing towards 50% while the share of hydrocarbons in primary energy declining to around 40% by 2050.

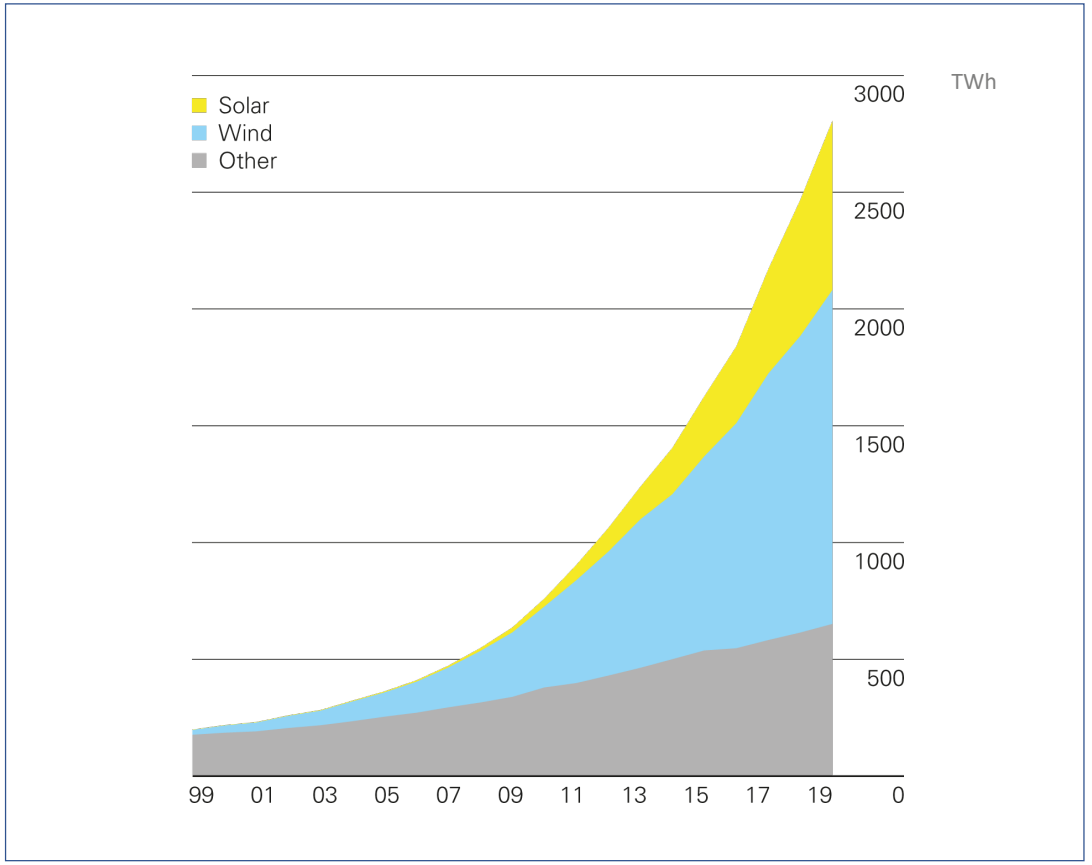


Source: BP Energy Outlook - 2020 Edition

Wind Drives Growth in Power Generation

Renewable Energy Generation by Source - Terawatt-hours

- Wind has grown to represent over 50% of renewables generation outpacing solar and other renewables since ~2011.
- In 2019, Renewable energy consumption led by wind and solar power was the highest increase on record in energy terms (3.2EJ) and the largest for any fuel.
- Over the next decade, offshore wind (Bottom-fixed and Floating) will become one of the most competitive sources of electricity commensurate with fossil fuels, solar PV and onshore wind.
- Offshore wind provides higher capacity factors than other renewables and this is even more pronounced in Floating wind where the resource is more prolific.



Source: BP Statistical Review of World Energy 2020 – 69th edition

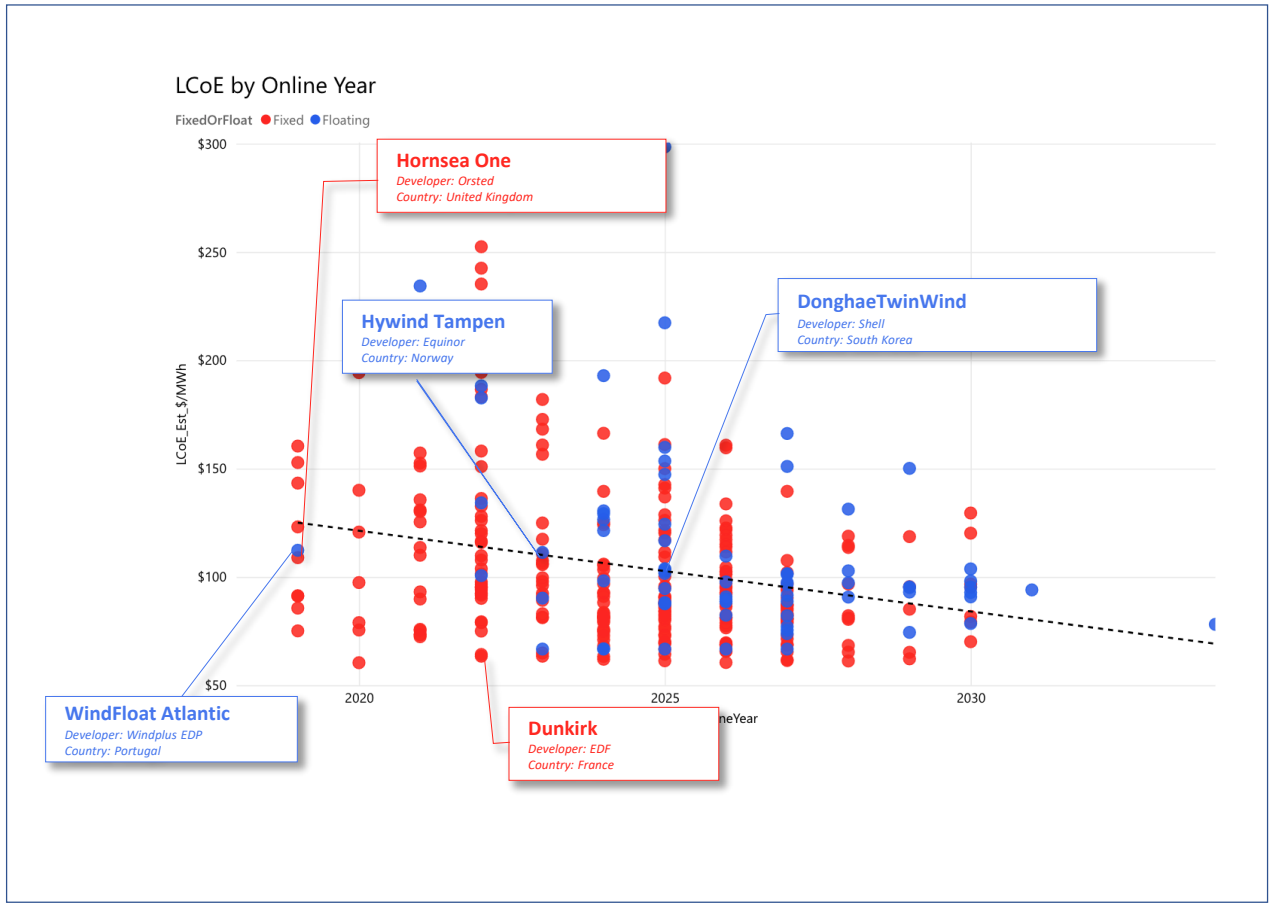
Floating Wind's Levelized Cost of Energy (LCoE) in $/MWh

Costs are Dropping Significantly

- This chart illustrates high-level results from Quest's 'LCoE Modeling' rendered as a scatter plot chart for 279 Fixed and 100 Floating wind Projects. This figure demonstrates modeled values allowing comparisons between projects already built and those Planned in the future. As shown, when comparing the Levelized Cost of energy between Fixed and Floating wind projects by Online Year, it's clear to see that costs are falling rapidly, both in Fixed and Floating. Apart from some outliers, we clearly recognize this trend.

- In Bottom-fixed projects (the-red-dots), looking at Hornsea One (2019) #174 units (1,218 MW) reveals an LCoE of $108.9 MW/h while EDF's Dunkirk project off France (2025) comprising #50 units (600 MW) is one of the lowest cost Fixed wind projects settling at an LCoE of $66.6, almost $43 lower. As a benchmark in 2019, Europe's Avg. LCoE is $69 MWh which is less than half the cost as compared to 2012.

- In Floating (the-blue-dots), we see two projects in Europe, WindFloat Atlantic pre-Commercial, #3 units (25 MW) at an LCoE of $112.3 and Donghae TwinWind, #20 units (200 MW) at an LCoE of $103.4, both which are linear with the regression analysis trendline.

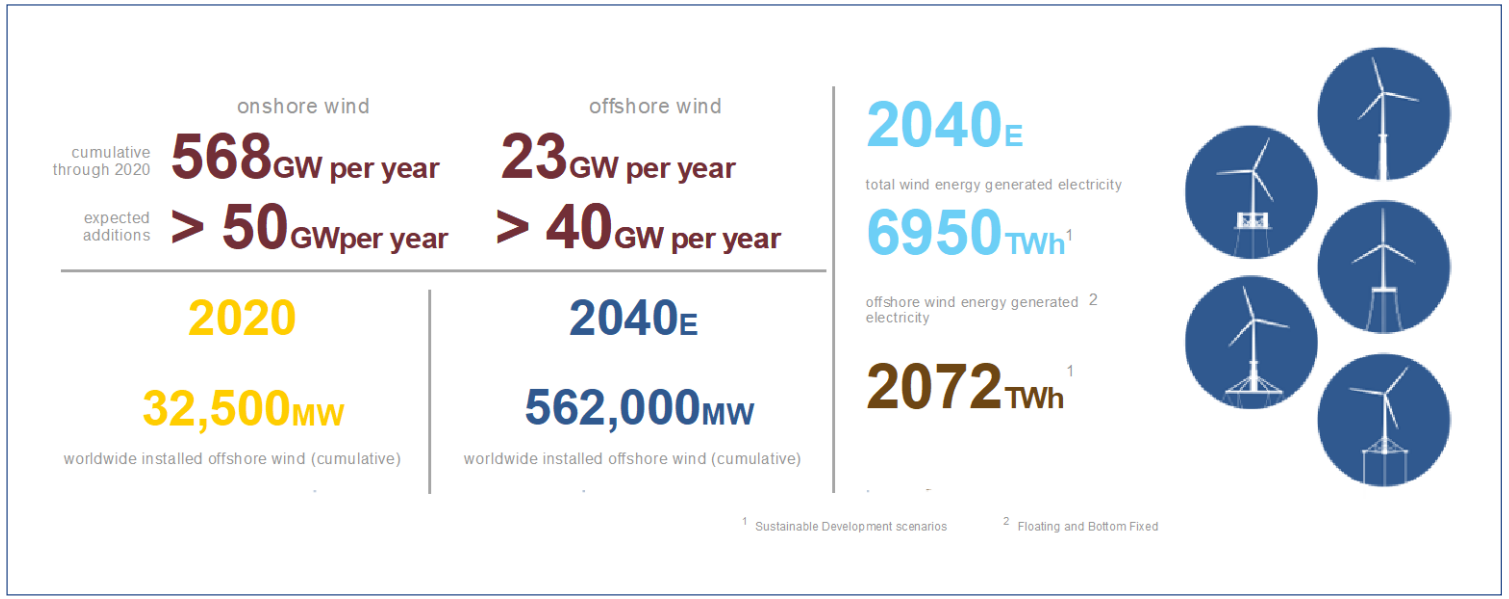


Source: Q Vision CapEx/LCoE

Global Context, by the Numbers

Exponential Growth in Wind Power

- Wind energy is a growing form of cheaper energy supply in many markets. According to the Global Wind Energy Council, wind capacity installations continue to outpace new fossil fuel capacity in multiple mature and emerging markets. In 2020, there were 5.2 GW of newly added global capacity additions for offshore wind (Bottom-fixed and Floating) bringing the total installed offshore wind capacity in operation to 32.5 GW.
- Renewables led by wind, offshore wind and solar are growing exponentially and delivering bigger capacities and cheaper economic solutions. By 2040, the IEA projects total offshore wind energy generated electricity to reach 2,072 TWh about 30% of the total in the Sustainable Development scenario where projected capacity growth is much faster.
- At the same time, projections indicate that cumulatively installed offshore wind capacity worldwide will reach an estimated 562,000 MW. This is almost ~20 times the cumulatively installed offshore wind capacity compares to the end of 2020 (32,500 MW).
- Pundits' projections for onshore wind indicate over 50 GW of installed wind capacity on an annual basis in addition to more than 40 GW of offshore wind capacity additions each year in the Sustainable Development Scenario. Meanwhile, Quest Floating Wind Energy's rolling forecast of 400 presently identified projects representing more than 79,295 MW of offshore wind capacity by 2030 - a level that will accelerate as more named projects are added to the forecast over time.



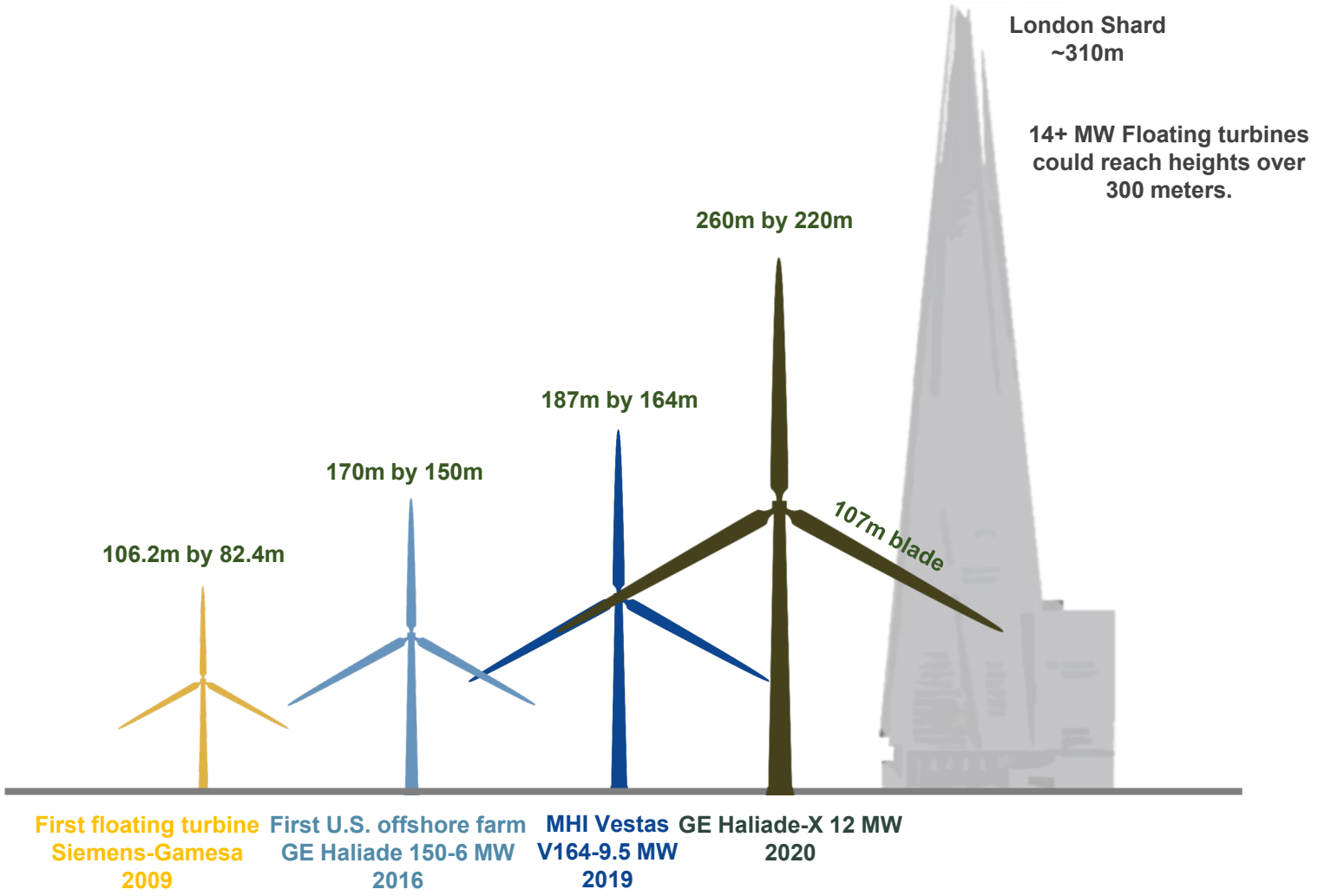
Source: IEA, GWEC

3. Fixed and Floating Comparison 2021 to 2035

By Total MW, Status and No. of Units

A Surge in Wind Turbine Scale and Capacity

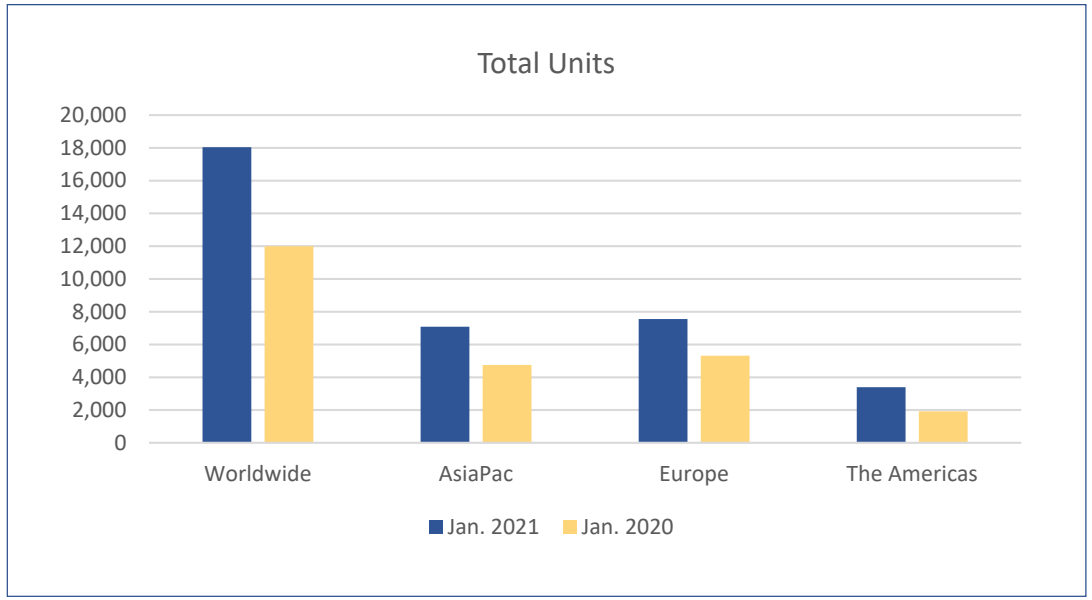
- The scalability of wind turbine generators (turbines) in both size and capacity continue to deliver meaningful increases in output and efficiency.
- MHI-Vestas is the latest company to push forward with the development of a sizeable 15 MW offshore wind turbine while other major players in the wind turbine sector, GE Renewable Energy and Siemens Gamesa, continue to develop their own highly optimized designs.
- Vestas recently announced their plans for a jumbo 15 MW offshore wind turbine with the intent to install a prototype next year before ramping up serial production in 2024. The giant V236-15.0 MW turbine capable of generating roughly 80 GWh/year. V236 will have a rotor diameter of 236 meters, a total height of 261 meters, plus a wind-swept area of 43,743 square meters.

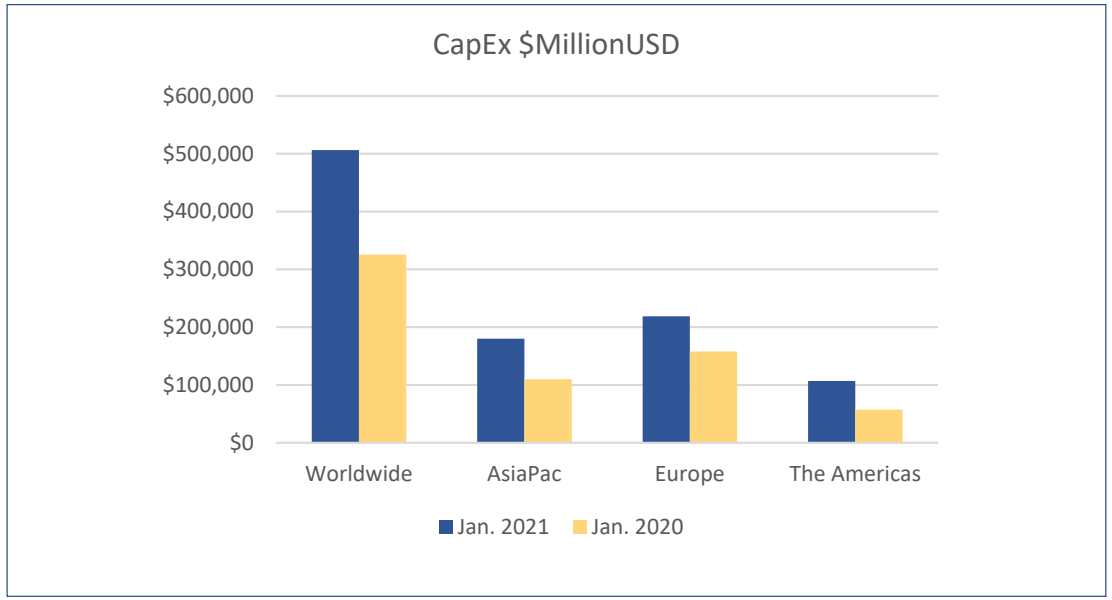


The Bottom-fixed Opportunity Pipeline, Momentum Is Gaining

Jan. 2021 vs. Jan. 2020

- Globally, the 50% increase in turbine units to 18,038 was led from Europe with the addition of 2,243 units followed closely by AsiaPac with 2,331 and The Americas seeing a net gain of 1,470.
- Northern Europe sees plans for 7,557 units a 42% increase from one-year ago across 101 projects.
- In Asia Pacific, 142 projects comprising 7,086 units are forecast which is 49% increase from one-year ago.
- The Americas gained 13 projects more than doubling MW capacity year-over-year from 18,364 MW to 38,886 MW.
- A year-over-year comparison to the global opportunity pipeline sees CapEx gains exceeding $180 billion with new Bottom-fixed wind projects surging in all core regions. Shown Right, AsiaPac sees CapEx gains of $70 billion while increases in Europe are $61 billion followed by $50 billion in The Americas.





Source: QVision

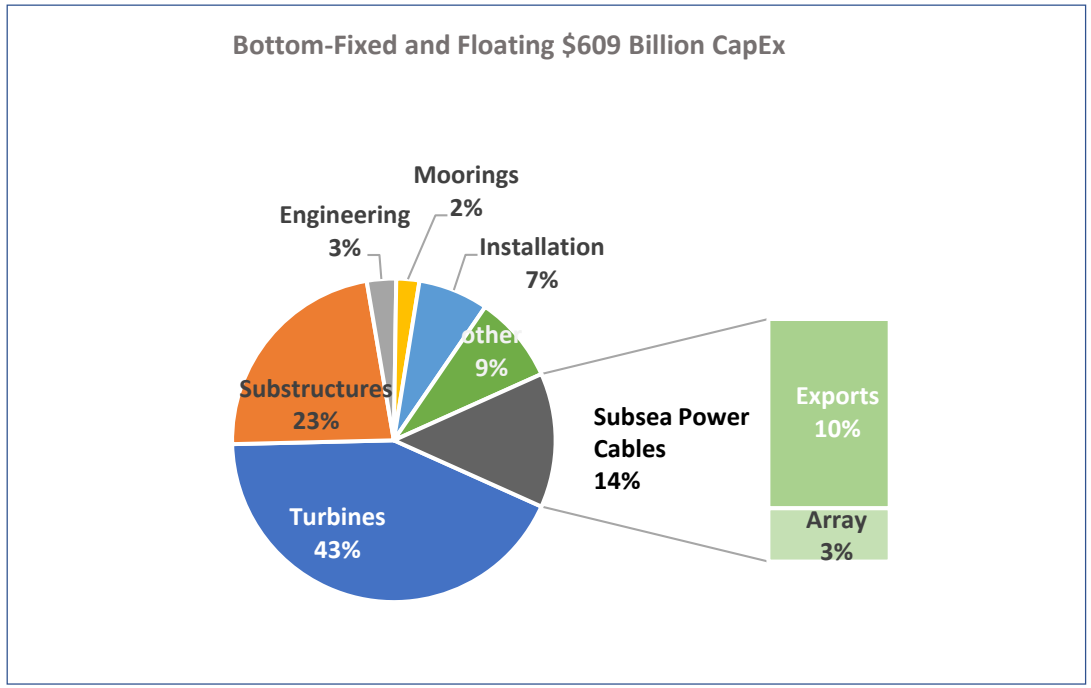
4. Contract Award Opportunities 2021 to 2035e

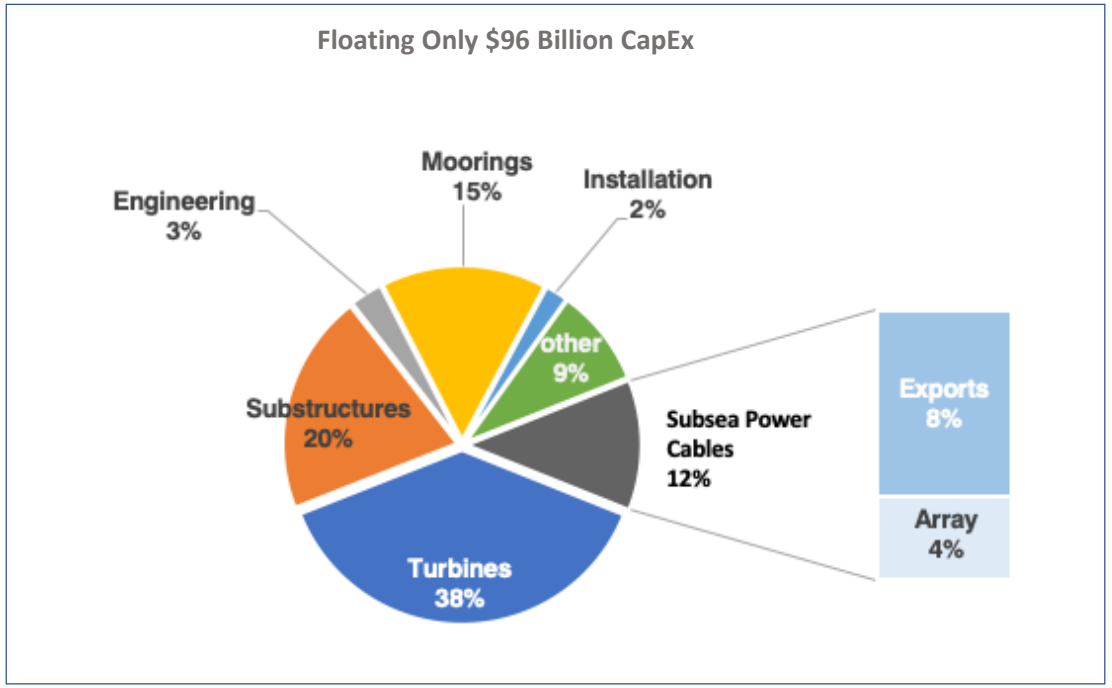
Bottom-fixed and Floating by Supply Chain Segment

Total Market Is a $609 Billion Opportunity

Contract Awards to 2032e, Online Year to 2035e

- A review of Q FWE's rolling project forecast for Bottom-fixed and Floating Wind Sees a $609 Billion Opportunity across the supply chain segments highlighted.



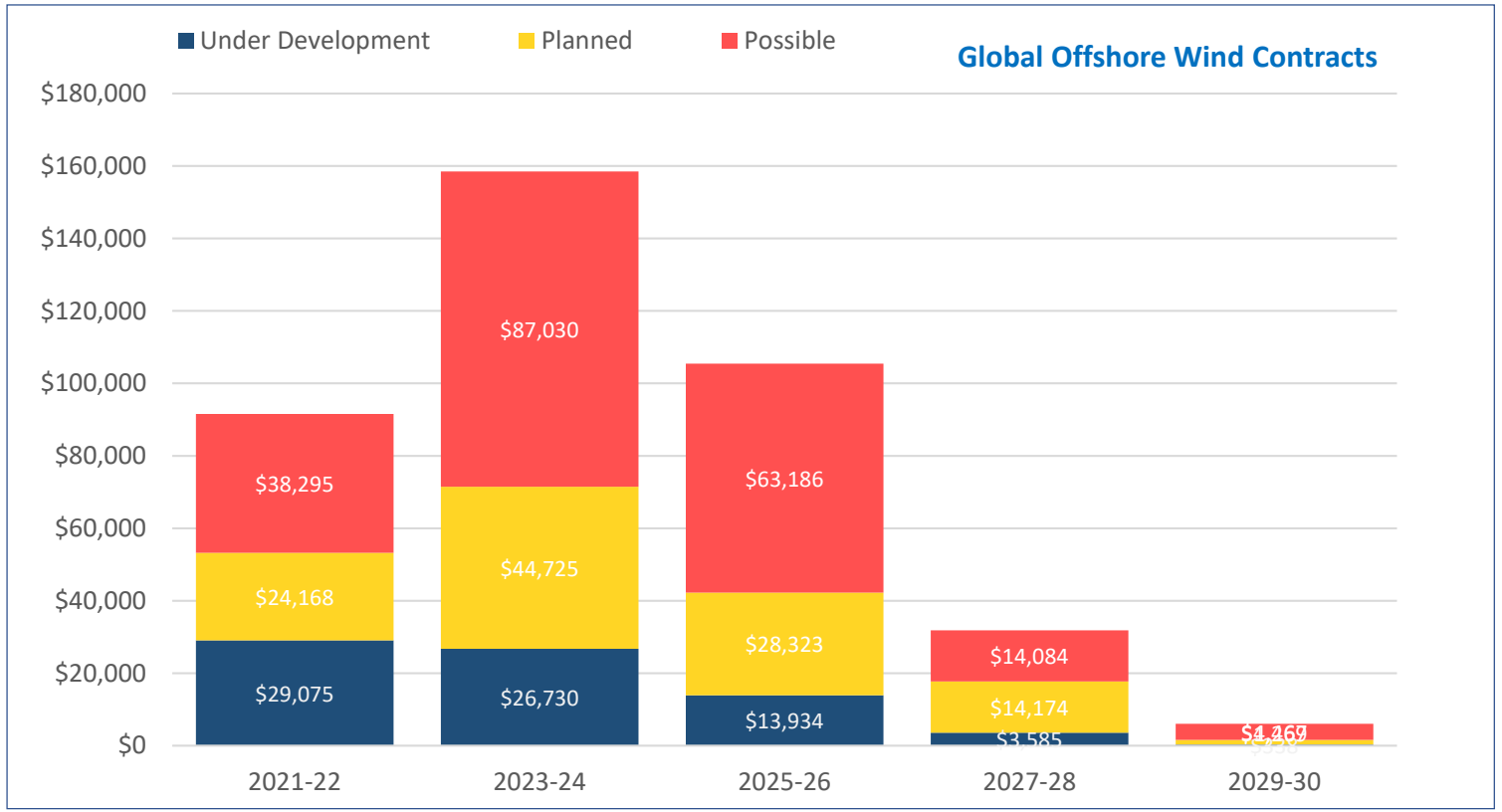


Source: QVision

$394 Billion in Projected Contract Awards

Awards to 2030e, Online Year to 2035e

- Bottom-fixed and Floating wind is a sizeable market with nearly $400 billion in contract award opportunities likely over the outlook with significant contributions anticipated from Planned and Possible projects.
- Under development projects shown represent nearly 20% of the total or about $73 billion in capital spending.
- The period 2023 to 2026 is likely to see well over $50 billion in CapEx per annum. Note, as this outlook is a 'bottom-up' analysis geared to named projects, the latter years taper off until known projects are added to the rolling forecast.



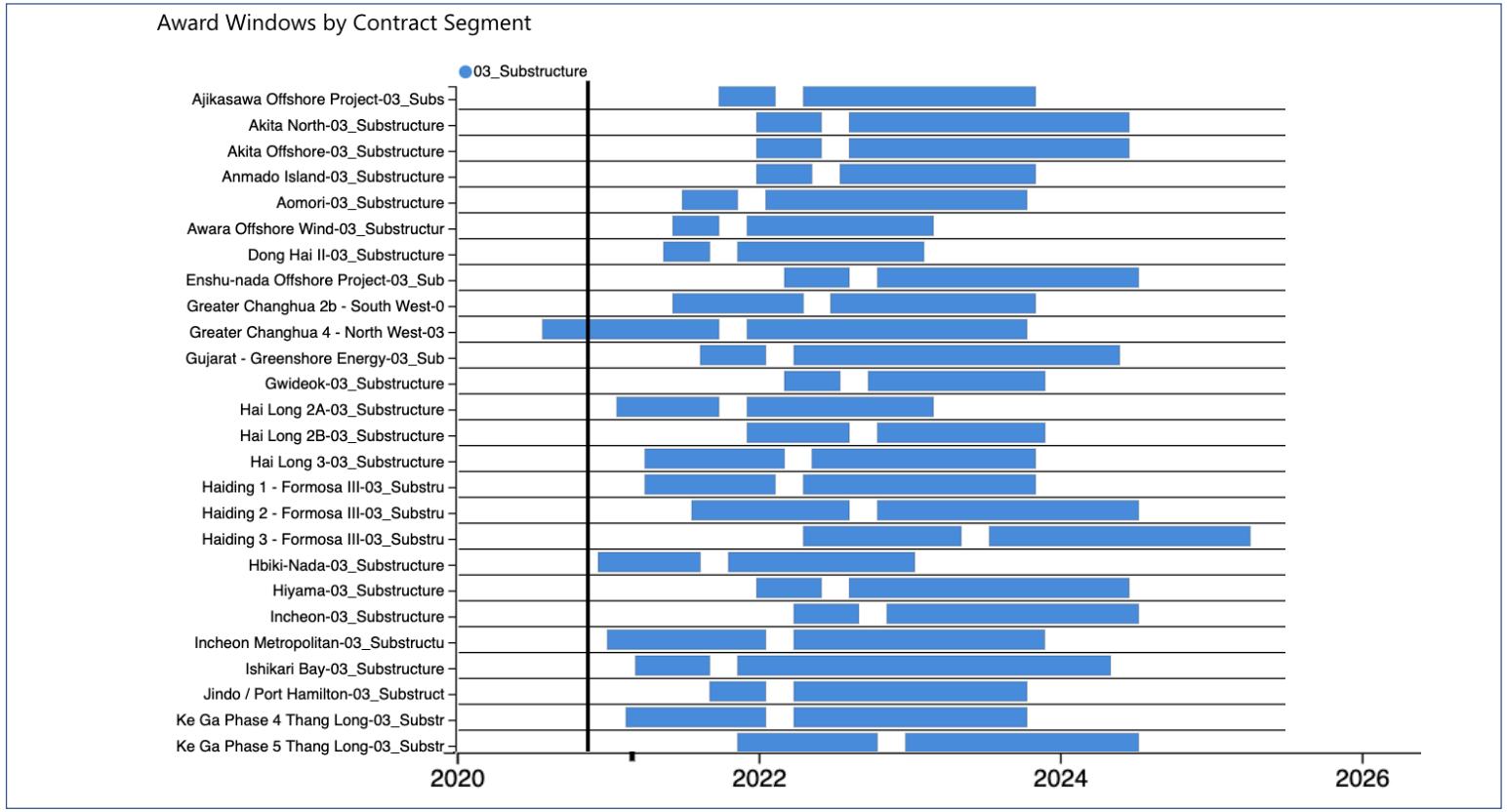
Source: QVision

Bottom-fixed Fabrication Contracts in Asia Pacific

Likely Project Awards 2022e to 2024e

- This chart (and the one following) depicts likely near-term contract awards for Bottom-fixed fabrication in Asia Pacific. The first bar in the series (Left) plots the projected contract award window while the second series (Right) indicates the likely construction timeline.

- Over thirty projects shown are the most probable to see tenders for contract awards over the next 24-months.



Source: QVision

5. Offshore Wind Overview, Capacity Additions and CapEx

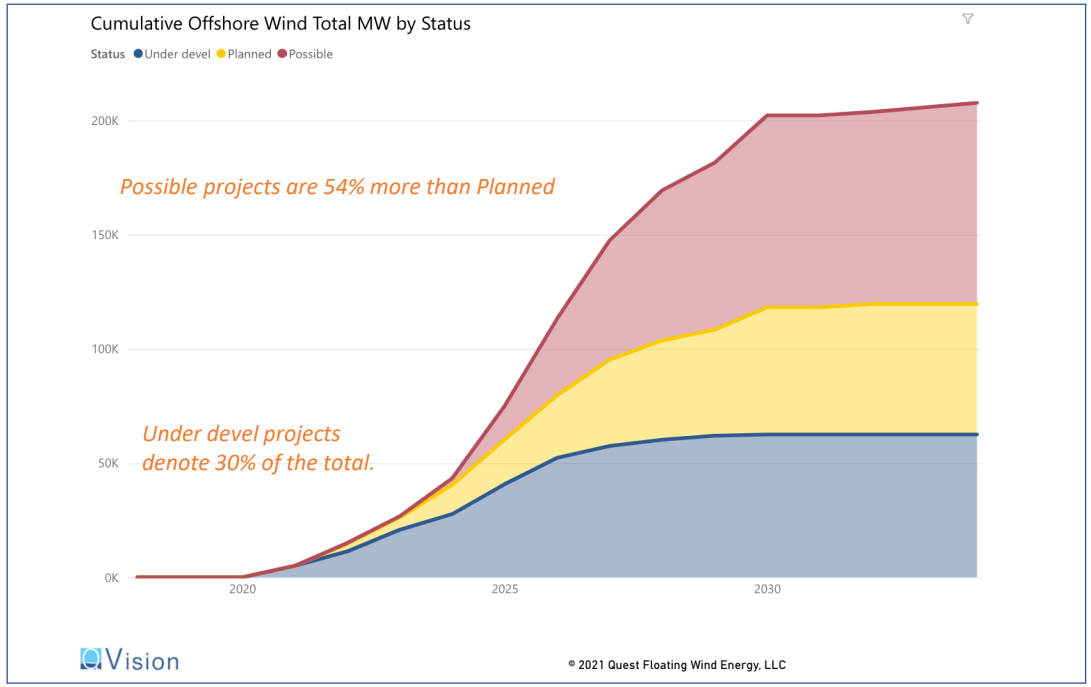
by Total MW, Status and No. of Units

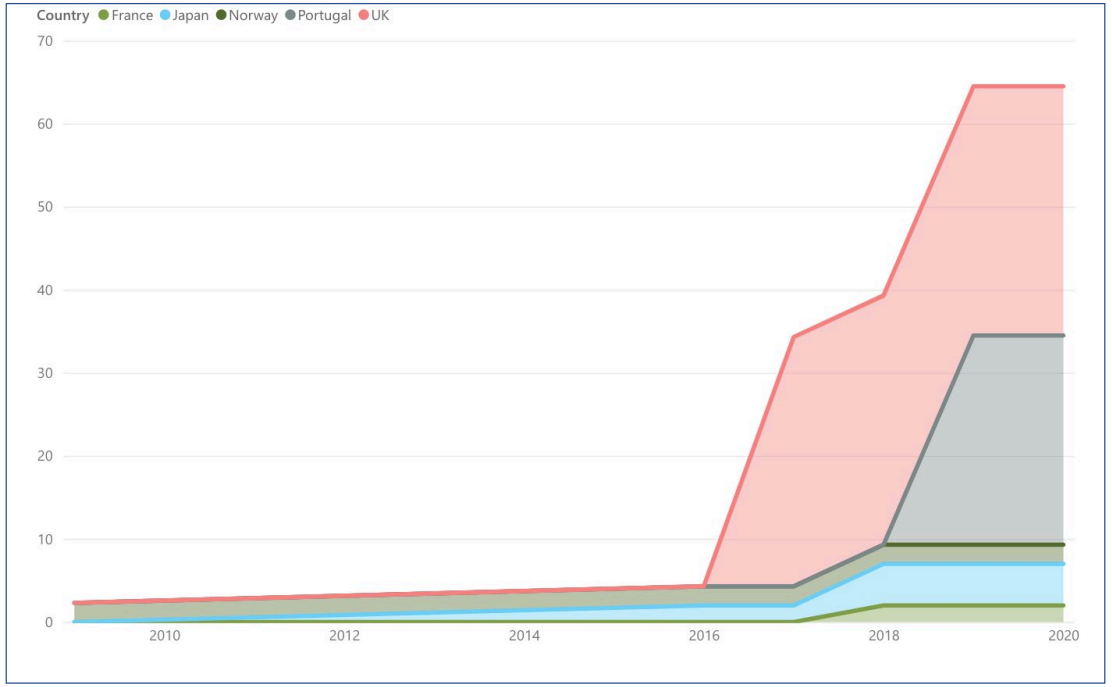
Forecast Capacity Additions by Country

Cumulative Total MW 2021 to 2035

- There are 207,741 MW forecast over the outlook period. Projects with status Under development number 62,546 MW and represent about 30% of the total while Planned projects denote 57,157 MW. Possible projects signify 88,039 MW a 54% increase over Planned.

- The largest contributors to capacity additions are: Europe with a 44%, AsiaPac 36% and The Americas 20%. The largest MW contributors by country are the UK which represents 20% of the world total, followed by the USA and South Korea (note, India and China are excluded for Fixed).



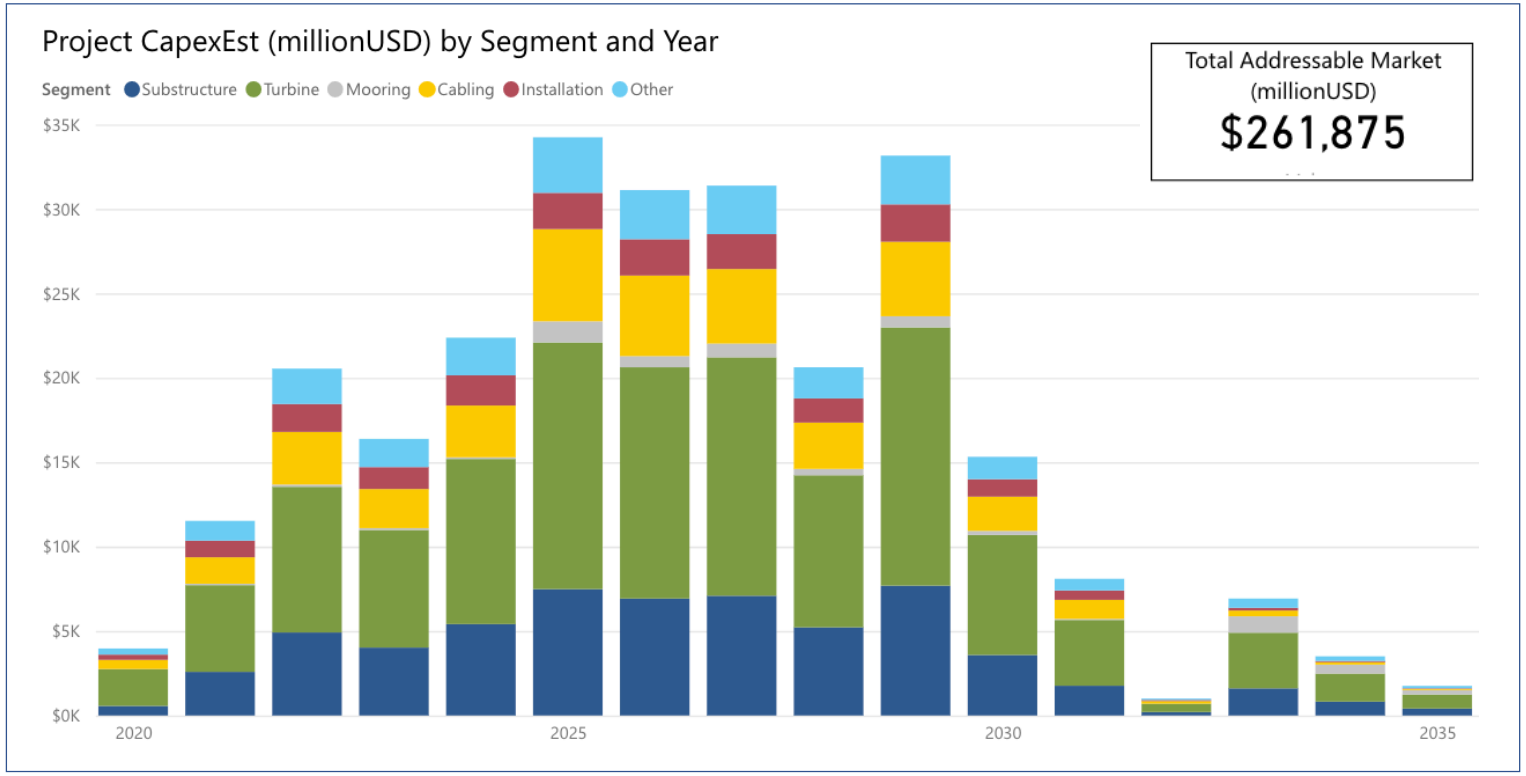


Source: QVision

II. Regional Outlook

Europe Forecast by Supply Chain Segment

- Europe's investment in offshore wind is significant denoting a 43% share ($262 billion). The bulk of CapEx originates in the United Kingdom totaling $114 billion. Poland and The Netherlands together represent 15% while France Germany, Denmark and Sweden each account for a 6% share.
- Capital spending by supply chain segment over the forecast period consists of $118 billion for Turbines, $60.3 billion for Substructures, $36 billion for Subsea Power Cables, $18 billion in Installation activities and $6.3 billion for Mooring Systems.



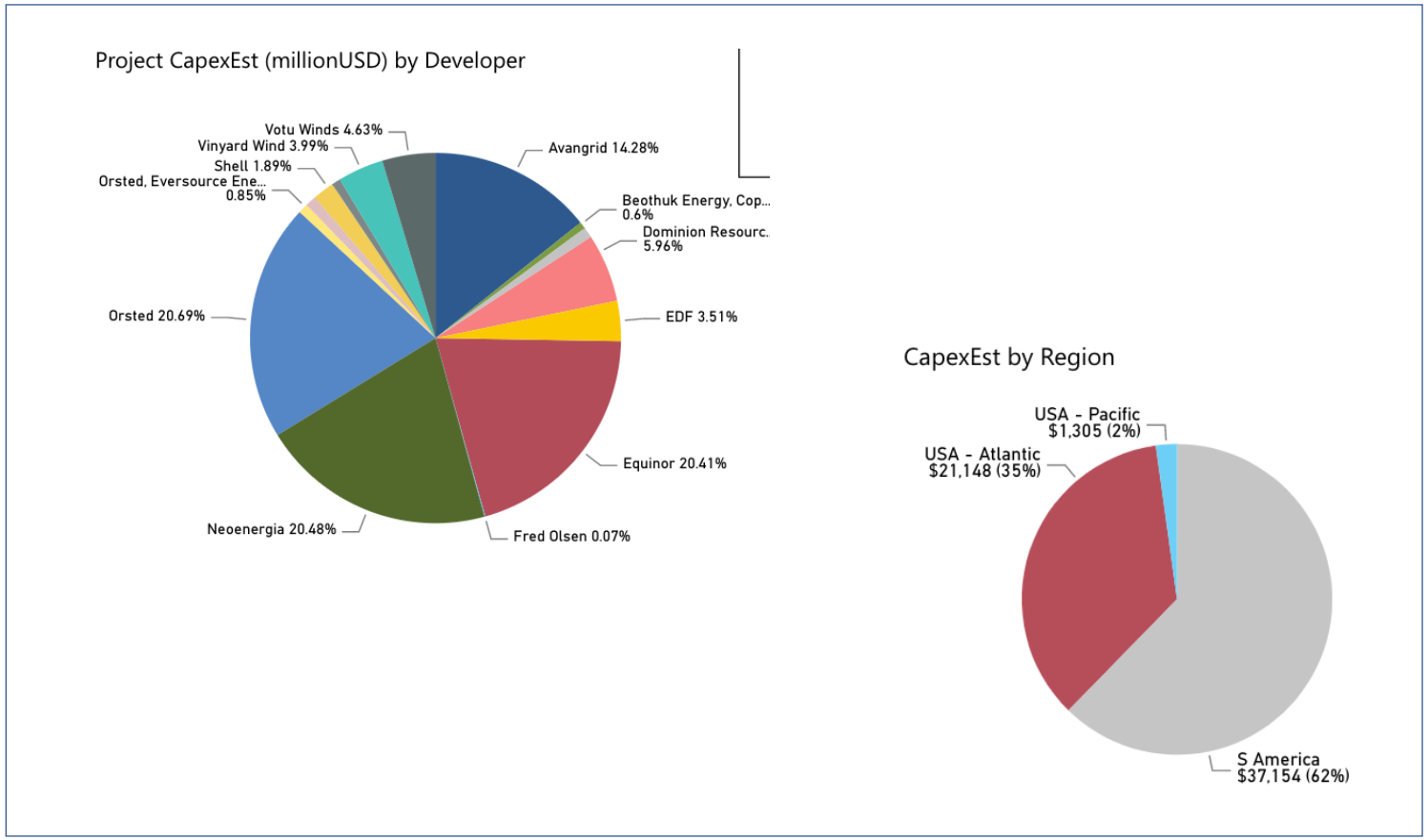
Source: QVision

6. Regional Activity Outlook by Developer

Bottom-fixed Wind

The Americas Outlook by Developer

- The vast majority of Developer activity in The Americas is held by the Top 10 shown who collectively represent about 97% of the capital spending for Fixed wind at $106 billion these are: Orsted, Neoenergia, Equinor, Avangrid Renewables, Dominion Resources, Votu Wind, Vineyard Wind, EDF, Shell and PrimoEnergia.
- Under development projects denote 36% of the CapEx ($39 billion) while 9% ($10 billion) of spend is tied to Planned projects. Projects with status Possible represent (55%) of the total ($60 billion).



Total Addressable Market (millionUSD)
$108,792

Source: QVision

7.

Fixed Wind, Key Project Opportunities

A Focus on Size and Status

Global Possible Projects by Name

Status Possible

- A review of Bottom-fixed wind projects with status Possible reveals 95 projects comprising 6,599 Fixed Turbine Units totaling a CapEx of $189.3 billion.
- Highlighted Right are the expected tranche of Possible projects globally. As illustrated, 11 ‘mega-sized’ Fixed wind projects, each over $4 billion in CapEx, denote a 33% share of total capital spending. Additionally, 17 ‘large’ projects, each ranging between $2 billion and upwards of $3.8 billon in CapEx, represent a sizeable share ($42 billion) of the Total Addressable Market.
- For Possible Fixed wind projects, the highest allocation of spend is by these top countries: South Korea (20%), Brazil (19%), Japan (18%) and USA (11%).

CapexEst by Project Name

Total Addressable Market (millionUSD)
$189,337

Source: QVision

Global Possible Projects by Name

CapexEst (millionUSD) by Project

Developer	ProjectName	Region	Country	SubCountry	Online Year	FixedOrFloat	DevType	Status	LocAvg WD (m)	Total Units	TotalMW*	CapexEst USD
Neoenergia	Maravilha	S America	Brazil	Rio de Janeiro	2027	Fixed	Commercial	Possible	50	200	3000	$7,441
Neoenergia	Aguas Claras	S America	Brazil	Rio Grande do Sul	2028	Fixed	Commercial	Possible	50	200	3000	$7,426
Neoenergia	Jangada	S America	Brazil	Ceara	2029	Fixed	Commercial	Possible	50	200	3000	$7,411
Vattenfall	Kattegatt Syd	N Europe	Sweden		2030	Fixed	Commercial	Possible	24	300	2100	$7,157
Min. For Climate	The Energy Island Ph !	N Europe	Denmark		2030	Fixed	Commercial	Possible	50	200	3000	$6,660
Equinor	Aracatu I	S America	Brazil	Rio de Janeiro	2027	Fixed	Commercial	Possible	25	160	1920	$4,408
Equinor	Aracatu II	S America	Brazil	Espirito Santo	2028	Fixed	Commercial	Possible	25	160	1920	$4,399
Vinyard Wind	Liberty Wind	USA - Atlantic	USA	New York	2026	Fixed	Commercial	Possible	50	130	1300	$4,340
Mainstream Renewable Power	Phu Cuong Phase II	Asia/Pacific	Vietnam		2025	Fixed	Commercial	Possible	50	140	1400	$4,117
KEPCO	Sinan Complex V	Asia/Pacific	South Korea	South Jeolla	2029	Fixed	Commercial	Possible	22	133	1995	$4,101
KEPCO	Sinan Complex VI	Asia/Pacific	South Korea	South Jeolla	2030	Fixed	Commercial	Possible	22	133	1995	$4,092
Eesti Energia Group	Gulf of Riga Wind Park	N Europe	Estonia		2030	Fixed	Commercial	Possible	35	143	1001	$3,739
Jeunbuk Technopark	Gunsan I	Asia/Pacific	South Korea	Jeonbuk	2025	Fixed	Commercial	Possible	50	125	1000	$3,677
KEPCO	Sinan Complex IV	Asia/Pacific	South Korea	South Jeolla	2028	Fixed	Commercial	Possible	22	100	1500	$3,113
Orsted	Hornsea Four	N Europe	UK		2027	Fixed	Commercial	Possible	50	100	1000	$2,993
Cosmo Eco Power	Ishikari Bay	Asia/Pacific	Japan	Sapporo	2026	Fixed	Commercial	Possible	27	125	1000	$2,896
Korea Western Power (KOWEPO)	Wandokolon	Asia/Pacific	South Korea		2025	Fixed	Commercial	Possible	50	100	600	$2,792
Orsted	Sunrise Wind 2	USA - Atlantic	USA	New York	2026	Fixed	Commercial	Possible	50	80	800	$2,754
Orsted	Deepwater ONE South	USA - Atlantic	USA	Rhode Island	2027	Fixed	Commercial	Possible	50	80	800	$2,702
Orsted	Ocean Wind 2	USA - Atlantic	USA	New Jersey	2028	Fixed	Commercial	Possible	35	90	1080	$2,642
KEPCO	Sinan Complex III	Asia/Pacific	South Korea	South Jeolla	2027	Fixed	Commercial	Possible	22	80	1200	$2,529
Avangrid	Vineyard Wind 2	USA - Atlantic	USA	Massachusetts	2025	Fixed	Commercial	Possible	55	84	798	$2,502
Orsted	Bay State Wind	USA - Atlantic	USA	Massachusetts	2026	Fixed	Commercial	Possible	45	80	800	$2,491
Pilot Energy	Pilot West Australia	Asia/Pacific	Australia	West Australia	2028	Fixed	Commercial	Possible	30	78	1092	$2,465
Japan Wind Development	Akita Offshore	Asia/Pacific	Japan	Akita	2026	Fixed	Commercial	Possible	37	76	760	$2,246

8.

Floating wind, Key Project Opportunities

A Focus on Size and Status

I. Global Review of CapEx

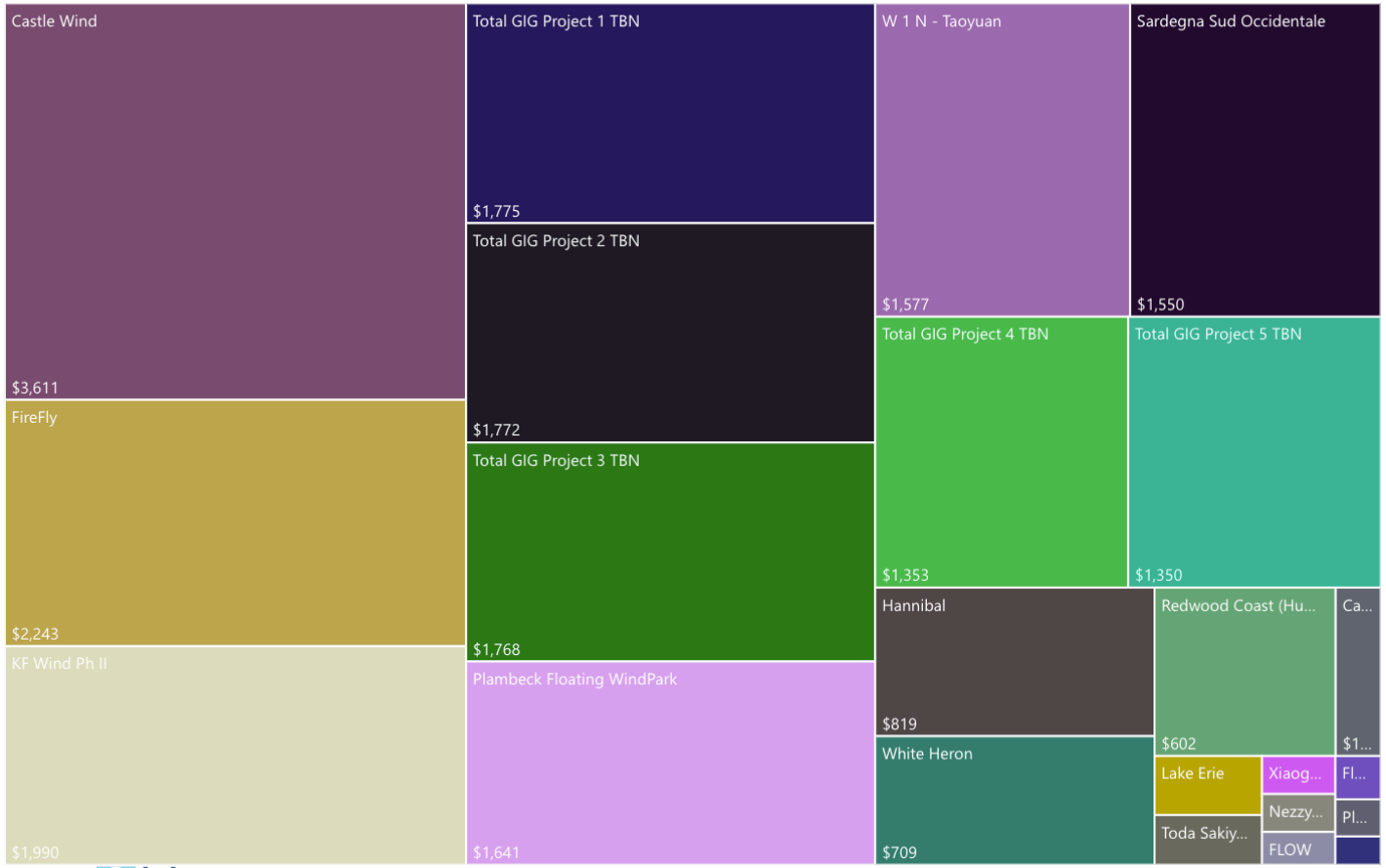
Under development, Planned and Possible

Global Planned Projects by Name

Status Planned

- Eleven super-sized Floating offshore wind projects with status Planned shown right, each ranging between $1.3 billion and upwards of $3.6 billon in CapEx, represent a growing share (10%) of the $96 billion Total Addressable Market of presently identified Under Development, Planned and Possible projects.

CapexEst by Project Name



Total Addressable Market (millionUSD)
$23,396

Source: QVision

Global Planned Project Details

CapExEst (millionUSD) by Project

ProjectName	Region	Country	SubCountry	Online Year	FixedOrFloat	DevType	Status	LocAvg WD (m)	Total Units	TotalMW*	CapexEst USD	Developer	Designer
Castle Wind	USA - Pacific	USA	California	2027	Floating	Commercial	Planned	900	100	1000	$3,611	EnBW	TBD
FireFly	Asia/Pacific	South Korea	Ulsan, Seosang-myon	2027	Floating	Commercial	Planned	150	57	798	$2,243	Equinor	Equinor (Reported)
KF Wind Ph II	Asia/Pacific	South Korea	Ulsan, Seosang-myon	2027	Floating	Commercial	Planned	150	53	504	$1,990	KFWind/Principle Power	Principle Power (Reported)
Total GIG Project 1 TBN	Asia/Pacific	South Korea	Ulsan, Seosang-myon	2026	Floating	Commercial	Planned	150	50	500	$1,775	Total	Principle Power (PSR)
Total GIG Project 2 TBN	Asia/Pacific	South Korea	Ulsan, Seosang-myon	2027	Floating	Commercial	Planned	150	50	500	$1,772	Total	Principle Power (PSR)
Total GIG Project 3 TBN	Asia/Pacific	South Korea	Ulsan, Seosang-myon	2028	Floating	Commercial	Planned	150	50	500	$1,768	Total	Principle Power (PSR)
Plambeck Floating WindPark	Asia/Pacific	Saudi Arabia		2025	Floating	Commercial	Planned	55	50	500	$1,641	Plambeck/Saipem	Saipem (Reported)
W 1 N - Taoyuan	Asia/Pacific	Taiwan		2025	Floating	Commercial	Planned	53	50	500	$1,577	EOLFI/Gruppo Cobra	TBD
Sardegna Sud Occidentale	N Europe	Italy	Sardinia	2026	Floating	Commercial	Planned	100	42	504	$1,550	TBD	TBD
Total GIG Project 4 TBN	Asia/Pacific	South Korea	South Jeolla	2029	Floating	Commercial	Planned	150	40	400	$1,353	Total	Stiesdal (PSR)
Total GIG Project 5 TBN	Asia/Pacific	South Korea	South Jeolla	2030	Floating	Commercial	Planned	150	40	400	$1,350	Total	Stiesdal (PSR)
Hannibal	N Europe	Italy	Siciliy	2025	Floating	Commercial	Planned	250	25	250	$819	Copenhagen Offshore Partners	Stiesdal (Reported)
White Heron	Asia/Pacific	South Korea	Ulsan, Seosang-myon	2026	Floating	Commercial	Planned	150	25	200	$709	SK E&C / Copenhagen Infrastructure Partners	Stiesdal (Reported)
Redwood Coast (Humboldt)	USA - Pacific	USA	California	2025	Floating	Commercial	Planned	755	15	150	$602	Redwood Coast Energy Authority (RCEA)	Principle Power (Reported)
CanArray	S Europe	Spain	Gran Canaria	2023	Floating	Pre-Commercial	Planned	85	4	48	$150	EnerOcean	W2Power (Reported)
Lake Erie	USA - Atlantic	USA	Ohio	2024	Floating	Commercial	Planned	75	5	30	$125	Magellan	Stiesdal (Reported)
Toda Sakiyama	Asia/Pacific	Japan	Goto	2025	Floating	Commercial	Planned	97	5	20	$105	Toda Corporation	Toda (Reported)
Xiaoguan Island, 12 MW (6)	Asia/Pacific	China		2022	Floating	Demonstrator	Planned	45	2	12	$55	Tonex	TBD
Nezzy2 Demo	Asia/Pacific	China		2022	Floating	Demonstrator	Planned	45	1	15	$55	EnBW	Aerodyn (Reported)
FLOW	N Europe	Sweden		2024	Floating	Demonstrator	Planned	100	1	10	$48	FlowOcean	FlowOcean (Reported)
Flagship Canary Demo	S Europe	Spain	Gran Canaria	2022	Floating	Demonstrator	Planned	100	1	10	$39	Iberdrola	TBD
Plocan Canary	S Europe	Spain	Gran Canaria	2022	Floating	Demonstrator	Planned	80	1	5	$33	WunderHexicon	Hexicon (Reported)
Penglai	Asia/Pacific	China	Chuandong	2022	Floating	Demonstrator	Planned	45	1	5	$25	Shuangdong Government	TBD
Total									**668**	**6860**	**$23,396**		

9.

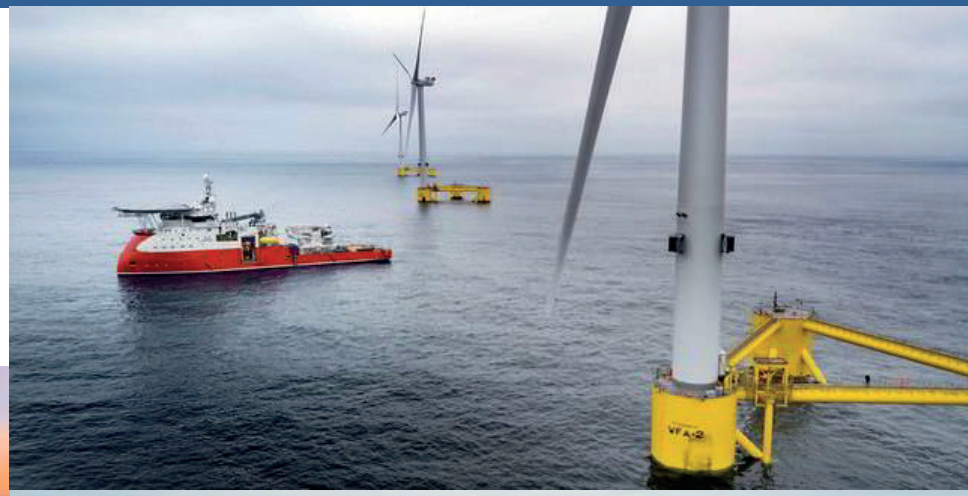
Appendix
About Q FWE

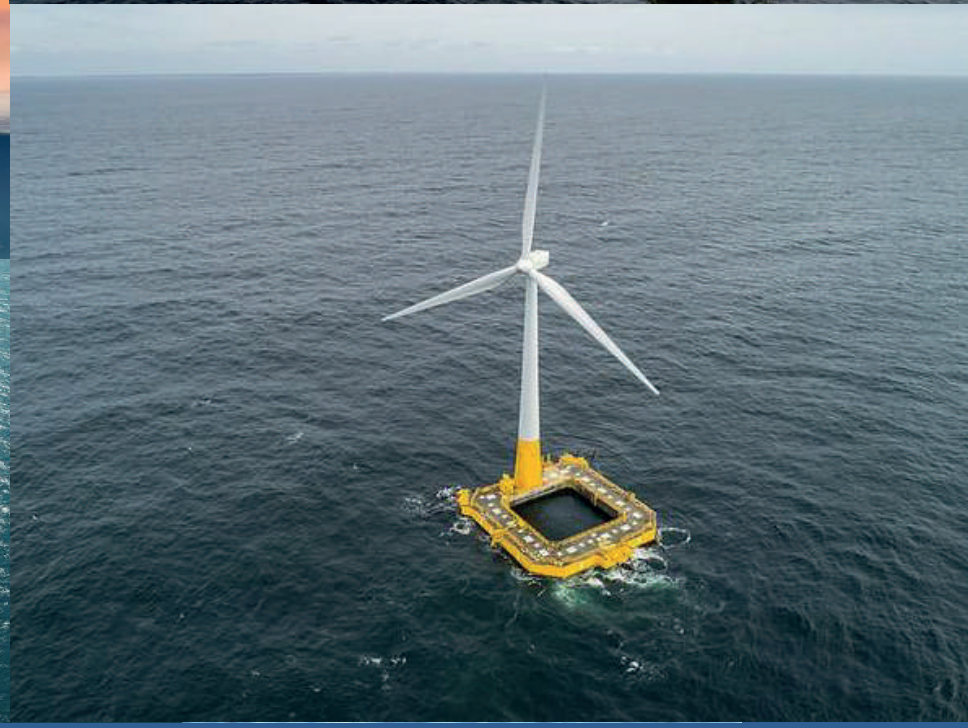
Client Presentation | Q1 2021

QFWE

Quest Floating Wind Energy

a Quest Offshore Resources company





Quest Offshore's Evolution – Decades of Empowering Our Clients with Clarity, Insight and Vision.

Twenty-years of expertise in predictive analytics, technical market analysis and the development of offshore floating projects provides us with the means and the network to offer critical insight on the Offshore Wind industry going forward.

Quest's DNA

Energy

- Oil & Gas
- Renewables
- Deepwater* Data
- Offshore Wind

Quest Offshore CLARITY • INSIGHT • VISION

QFWE QVision

*Sold Quest's **Data Division** to Wood Mackenzie

- Project Benchmarking CapEx and LCoE Modeling
- Thought Leadership
- Expert Technical Competence
- Primary Research
- Data Analytics
- Rigorous Qualitative & Quantitative Research
- M&A Advisory and Market Evaluation

Finance

- Buy Side
- Sell Side
- Quest Offshore

Quest Consulting

QFWE

II. Q Vision and Our Methodology

About Q Vision

QVision

Q Vision provides instant access to real-time data for the world's Fixed and Floating wind energy projects. Driven from Q FWE's proprietary database, these *Microsoft Power BI* tools allow for dynamic analysis of relationships across Markets and Technologies, and an enhanced understanding of project Economics.

Q FWE's **Predictive Analytics** and **Market Expertise** enable clients to see the consequence of change led from this rapidly accelerating market. Q FWE's **Subscription Products** provide timely and actionable strategic market information.

Floating Matter Expertise …

QVision

- **2.5 Decades Experience in the O&G Deepwater (Floating & Subsea) Space. Sold to WoodMac (2016).**
- **Combined 75 years of Subject Matter Expertise in Floating Technology and Business.**
- **Identified potential of Floating Wind 10 years ago. Exclusive Focus since 2016.**
- **Global Recognition, Industry-wide Presence, Tier 1 & Supply Chain Clientele.**

…and, we Love what we Do.

Contact Us

Quest Floating Wind Energy, LLC

Houston | Amsterdam | Rio de Janeiro | New York

Paul Hillegeist, President and Director
Paul.Hillegeist@QuestFWE.com
+1 713.569.9987

Erik Rijkers, Director - Market Development & Strategy
Erik.Rijkers@QuestFWE.com
+31 6 53350555
Rotterdam, The Netherlands

Andrew Chadderdon, Sales & Business Development Manager
Andrew.Chaderdon@QuestFWE.com
+1 281.725.7664

corp@QuestFWE.com

77 Sugar Creek Center Blvd. | Suite 310 | Sugar Land | Texas | 77478 | U.S.A.