

Global Offshore Wind Market Report 2018

Presented by Norwegian Energy Partners
Jon Dugstad, Knut Erik Steen and David S. Ottesen
Ålesund 13. September 2018

Agenda

| | |
|---|----------------|
| Welcome and presentation of ÅKP Blue Innovation Arena Frank Støyva Emblem | 09:00 |
| Welcome Jon Dugstad Norwegian Energy Partners 2018 Offshore Wind Market Report presented by Jon Dugstad, Knut Erik Steen and David S Ottesen all Norwegian Energy Partners | 09:20 09:30 |
| Networking break | 10:30 |
| Discussion Vard Design, Thomas Brathaug, Senior Naval Architect, Conceptual Design Department | 10:50 11:20 |
| SFI MOVE (NTNU), Professor Hans Petter Hildre, Instituttleder Institutt for havroms operasjoner og byggteknikk, Leder for SFI Marine Operations. | |
| Discussion and Close | 12:00 |

Norwegian Energy Partners

We **map capability, technology and competitiveness** of the Norwegian suppliers to **match with industry and client demand** internationally.

We **add competitiveness** and **reduce risk** of international business development.

Norwegian Energy Partners has **260 independent**, operating companies as partners.

Founders:

Norwegian Government

- Ministry of Petroleum and Energy
- Ministry of Trade and Industry
- Ministry of Foreign Affairs

Professional Organisations

- Energy Norway
- Federation of Norwegian Industries
- Norwegian Oil and Gas Association
- Norwegian Shipowners' Association
- The Norwegian Confederation of Trade Unions

Industry

- Equinor
- Statkraft

Who we are



Jon Dugstad
Director
Wind and Solar



David S. Ottesen
Director
Wind



Knut Erik Steen
Director
Wind



FRANCE

Guillaume Simon



GERMANY

Lars Engelmann



**UK
NETHERLANDS**

Mike Blanch



USA

Andy Geissbuehler



BRAZIL

Adhemar Freire



AUSTRALIA

Tore Moe



CHINA

Jian Guo



SCOTLAND

Scott Hamilton



KOREA

Jae Keun Ha



INDIA

We are not giving up on oil & gas ...

but ..

**....utilising our expertise from
offshore and shipping to add
value in the offshore wind
industry!**



Market Reports & Mapping capabilities and solutions



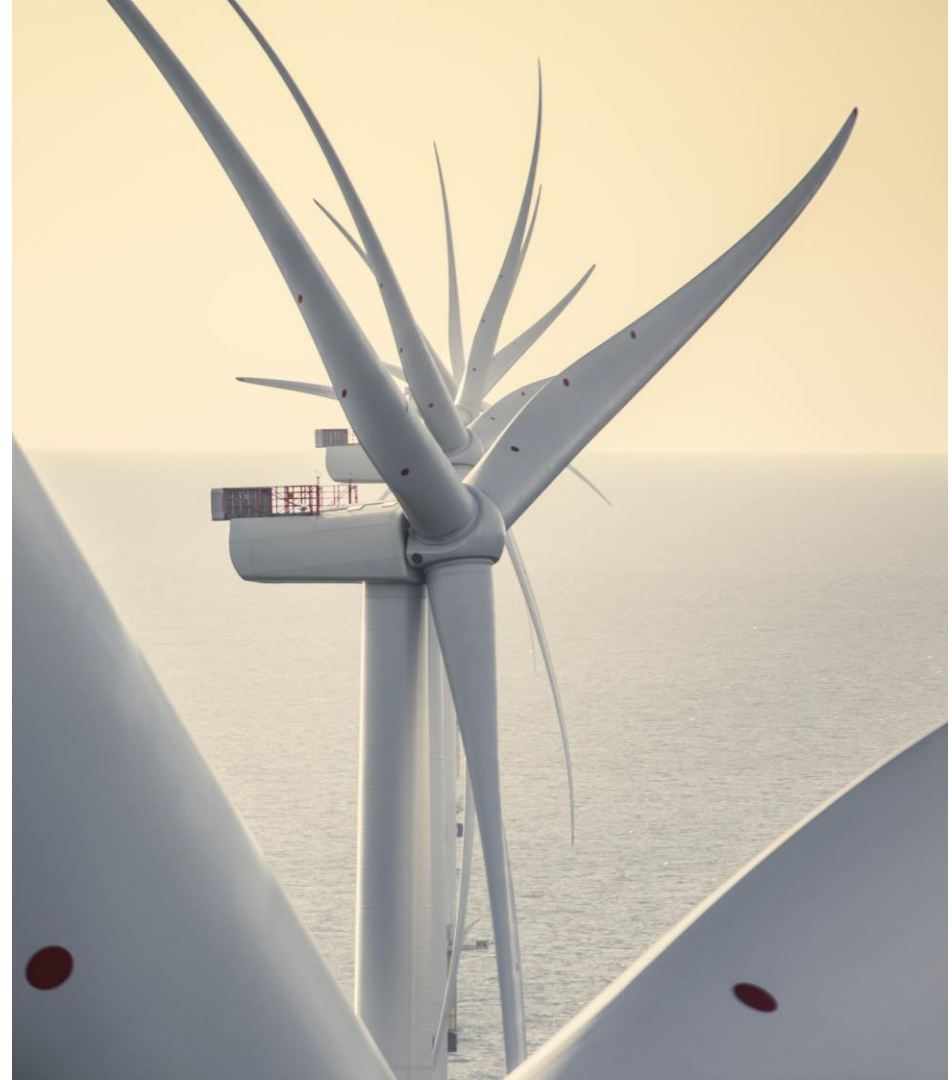
Presented by Norwegian Energy Partners

ANNUAL OFFSHORE WIND MARKET REPORT 2018

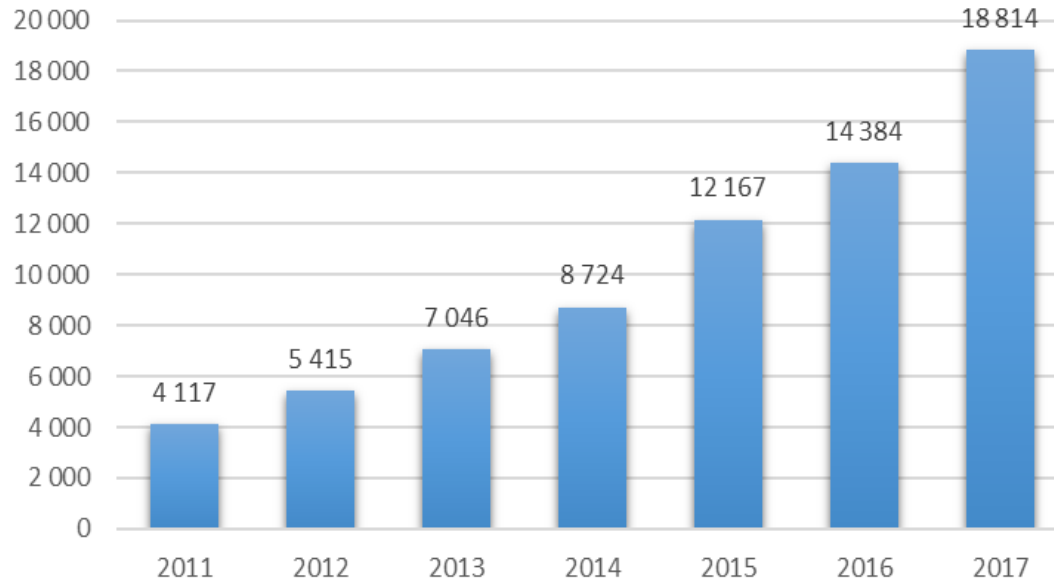


Contents

- Summary & changes year on year
- Global offshore wind – a summary
- Market forecasts
- Expenditure and levelized cost of energy
- Markets;
 - Europe
 - Asia
 - North America
- Emerging markets
- Floating Wind
- Priority Projects

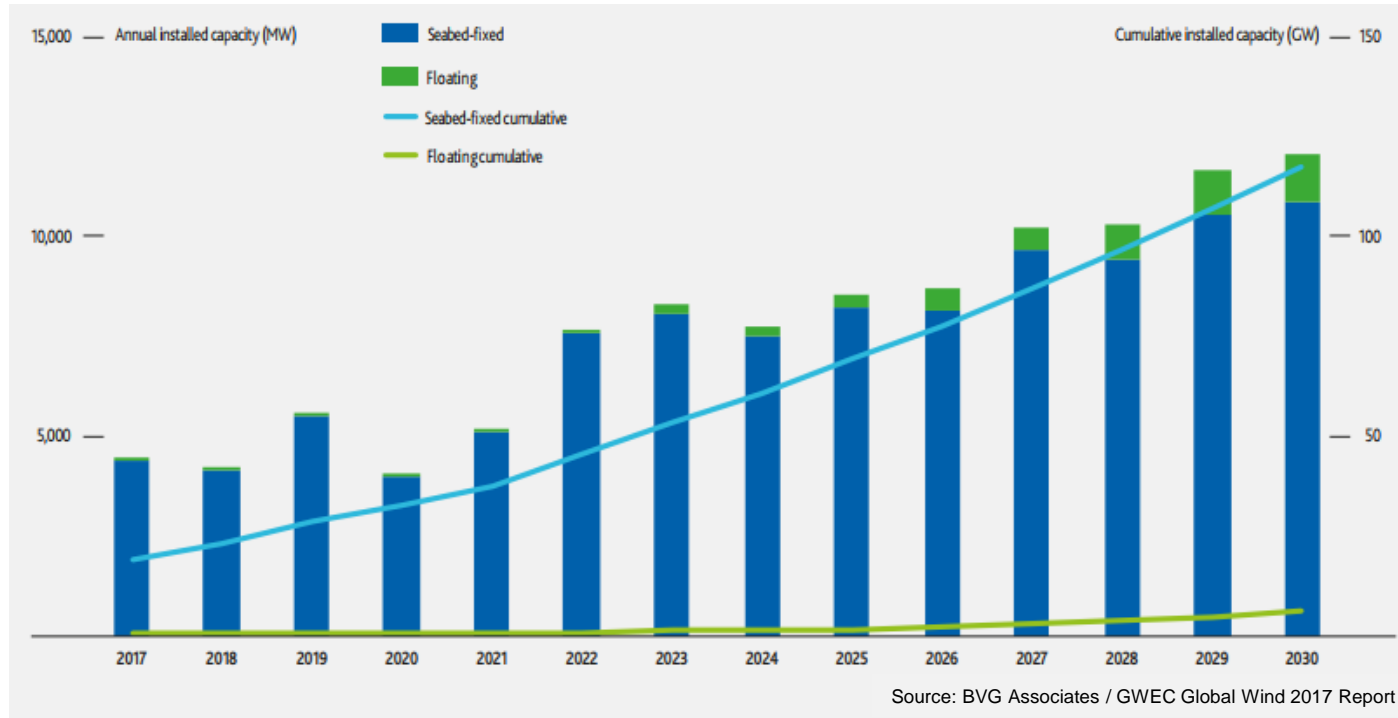


Offshore wind - a fast growing industry



Source: GWEC

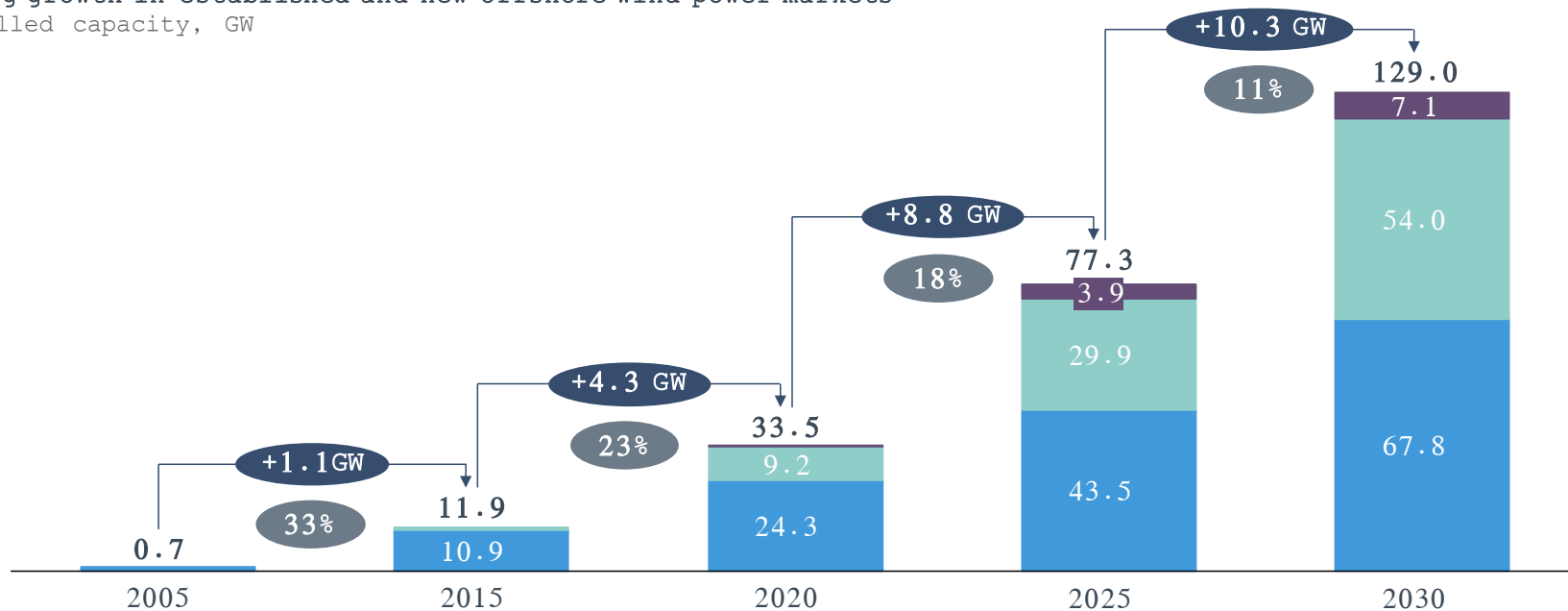
..outlook to 2030



By 2030 the market will be truly global

Strong growth in established and new offshore wind power markets

Installed capacity, GW



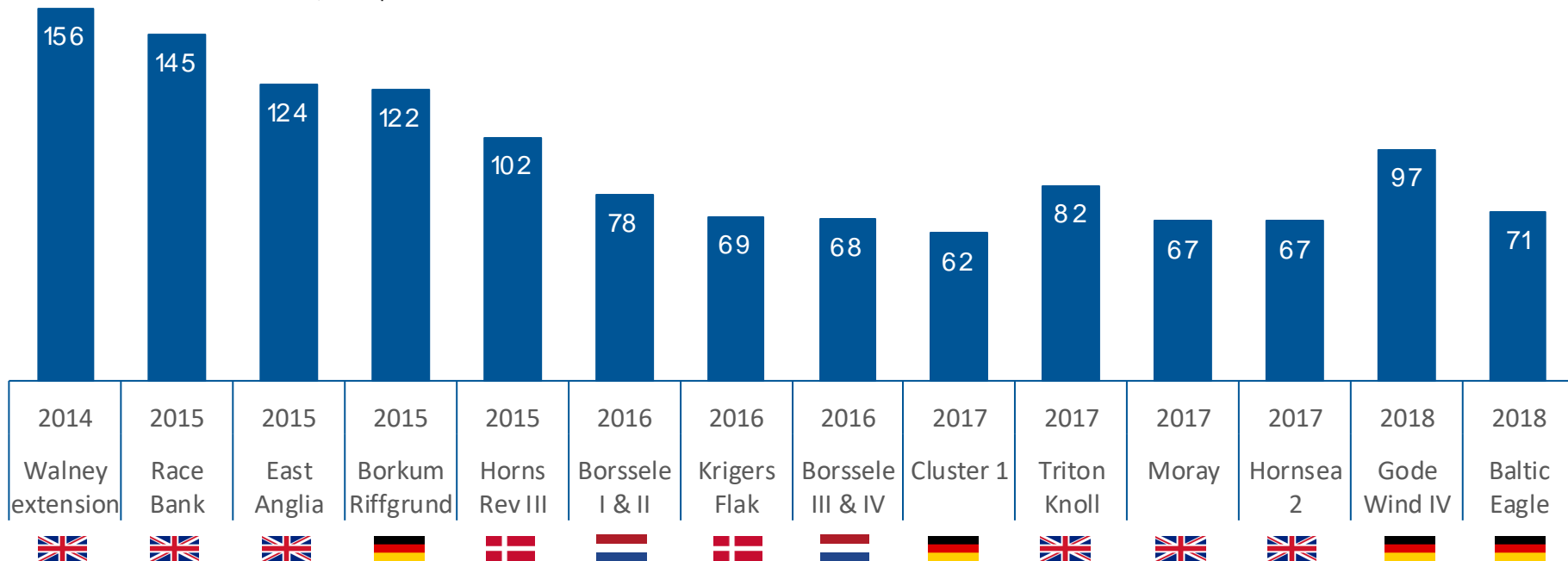
Americas Asia Pacific Europe

GW addition/year % CAGR

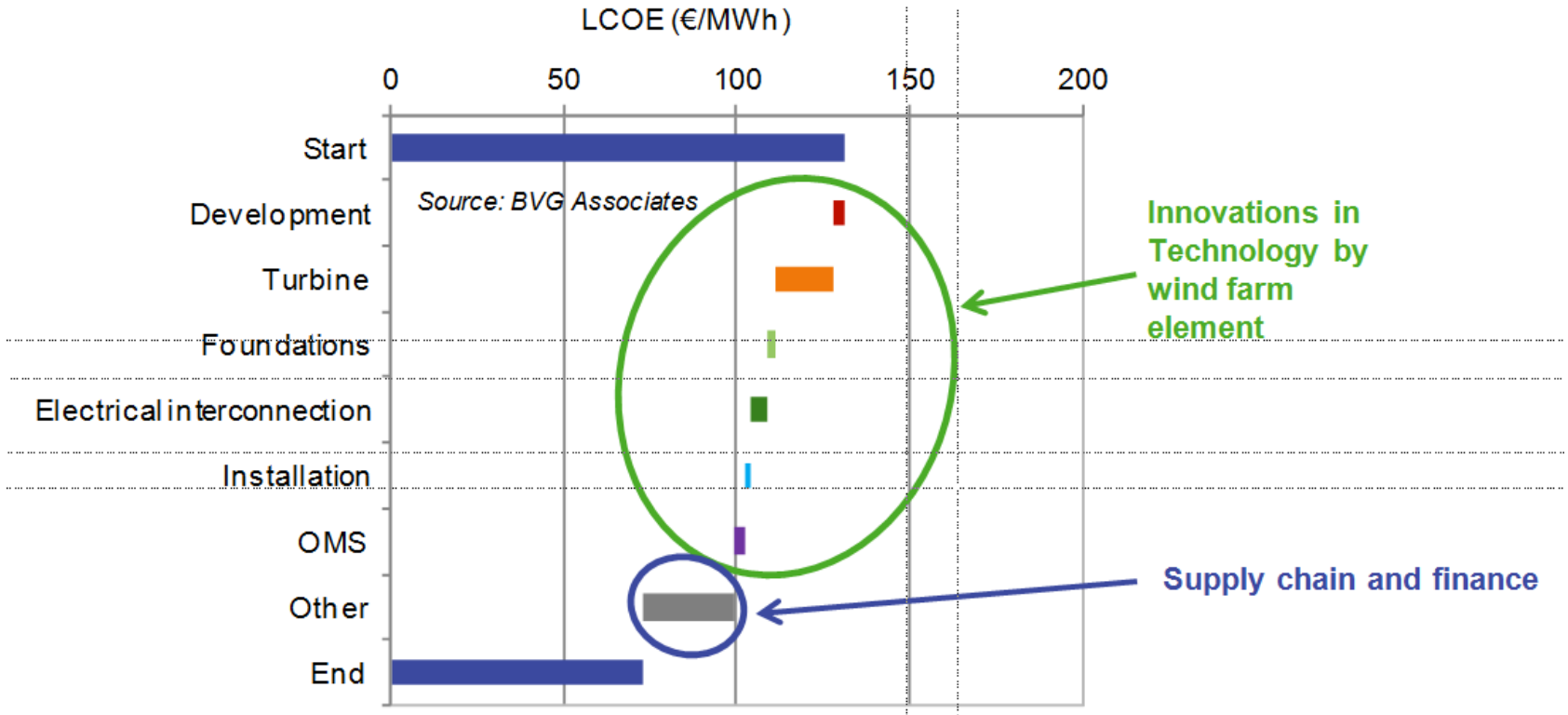
Source: Bloomberg New Energy Finance (BNEF), 1H 2018 offshore wind market outlook

Price reduction offshore wind

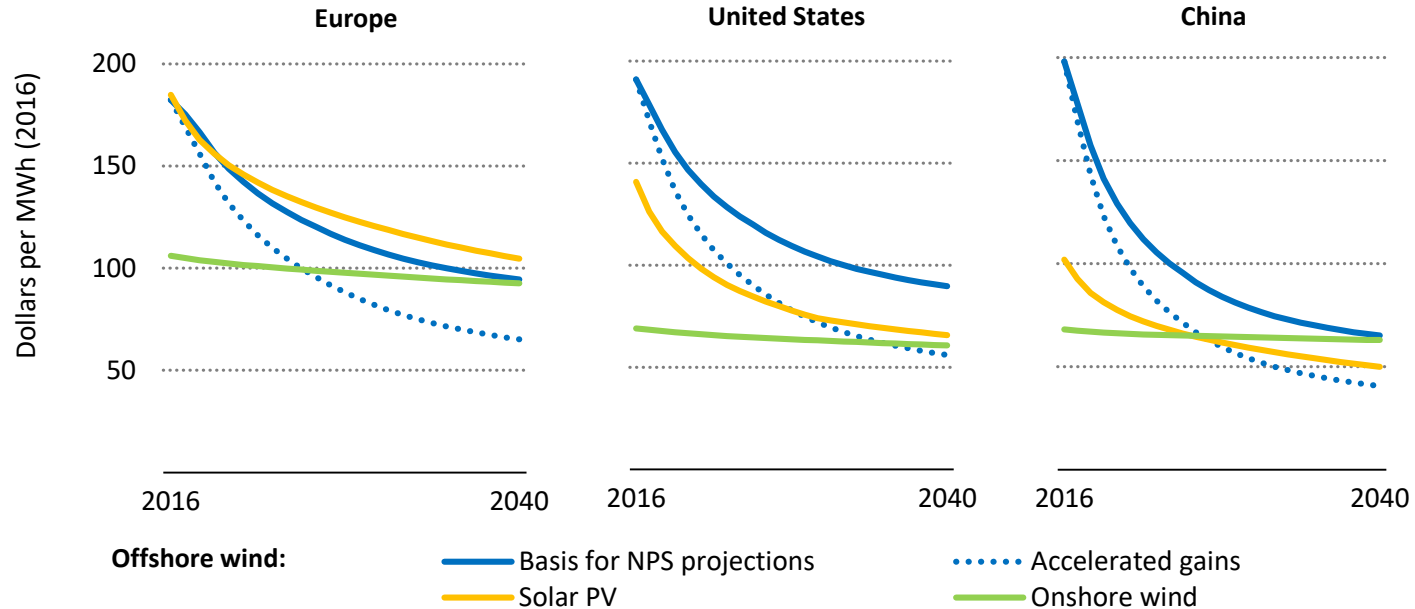
Levelised revenue of electricity, incl. transmission costs
EUR/MWh¹, 2016-prices



Where cost reduction has come from

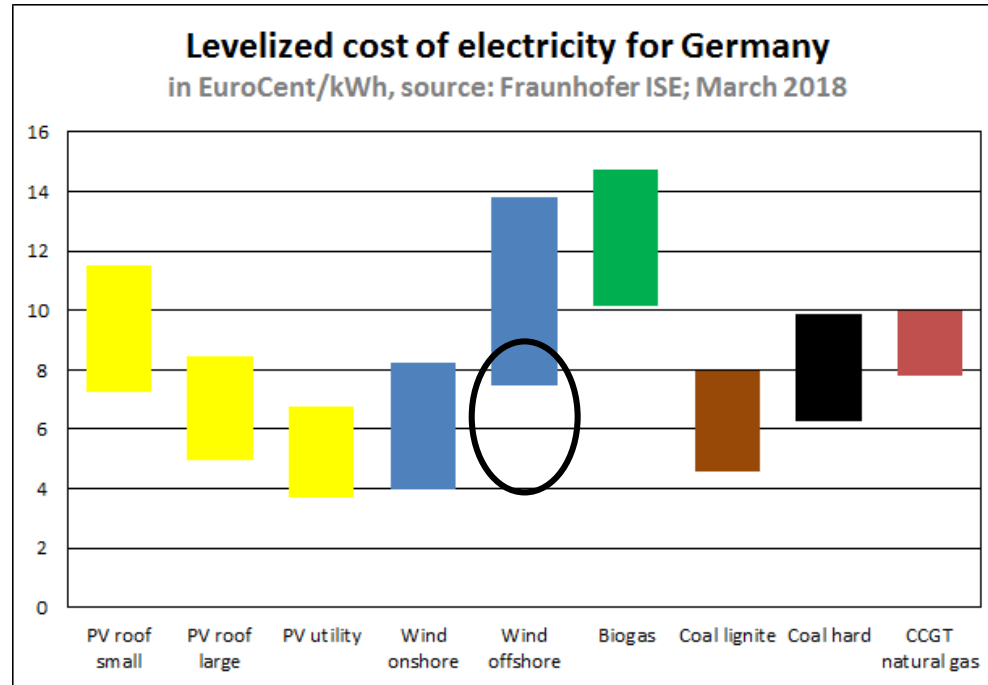


Offshore wind closing in on other renewables

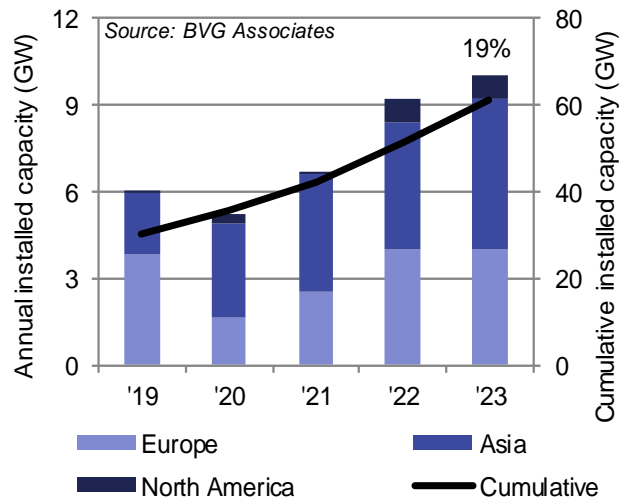


Source: IEA Offshore Energy Outlook 2018

Future offshore wind LCOE will be competitive



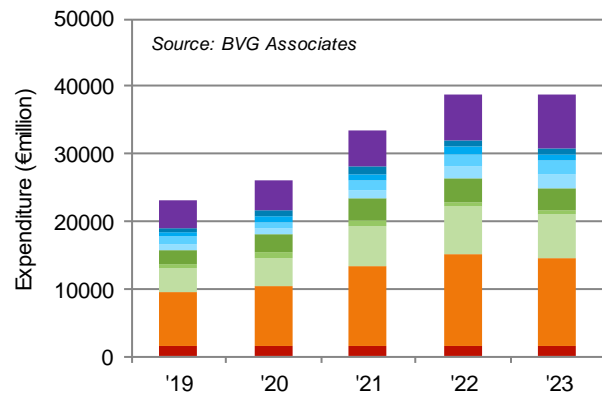
The market – Global forecast to 2023



Installed capacity

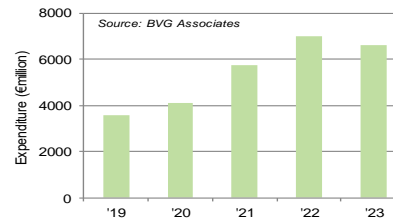
- Global
 - Installed capacity by 2023: 61.3 GW
 - Major markets: China, Germany, Netherlands and the UK
- Europe
 - Installed capacity by 2023: 35.2 GW
 - Major markets: Germany, Netherlands and the UK
- Asia
 - Installed capacity by 2023: 23.9 GW
 - Major markets: China, Japan, South Korea and Taiwan
- North America
 - Installed capacity by 2023: 2,1 GW
 - Major markets: The US (East Coast)

Technology, supply chain and expenditure

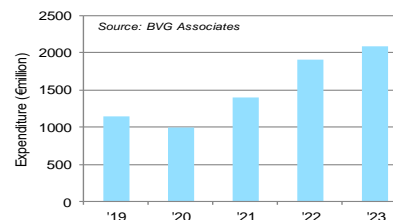


- Project development
- Turbine
- Foundation
- Array cable
- Transmission
- Foundation installation
- Array cable installation
- Transmission installation
- OMS

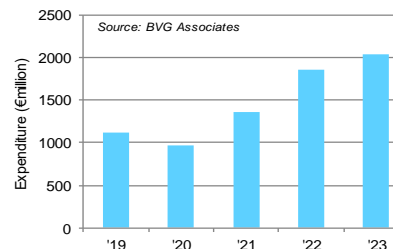
- Global expenditure for offshore wind activities estimated to be €39 billion in 2023.
- Expenditure between 2019 and 2023 estimated to be €160 billion



Likely global expenditure for foundations

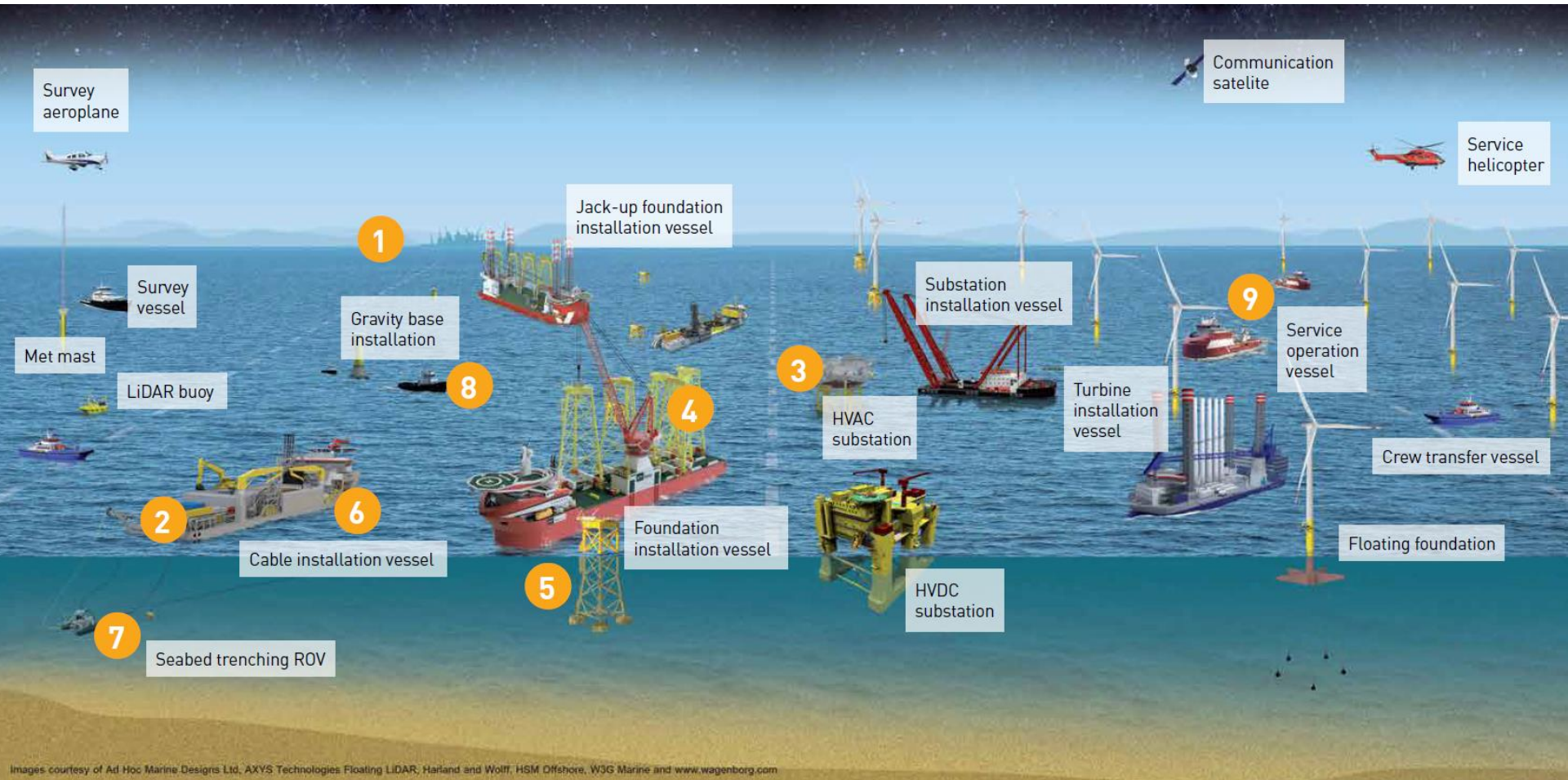


Likely global expenditure for turbine installation



Likely global expenditure for foundation installation.

The supply chain – the real opportunities



Survey aeroplane

Communication satellite

Service helicopter



Jack-up foundation installation vessel

1

Survey vessel

Gravity base installation

8

Met mast

LiDAR buoy

Foundation installation vessel

4

Substation installation vessel

3

9

Service operation vessel

Turbine installation vessel

Crew transfer vessel

2

6

Cable installation vessel

HVAC substation

HVDC substation

Floating foundation

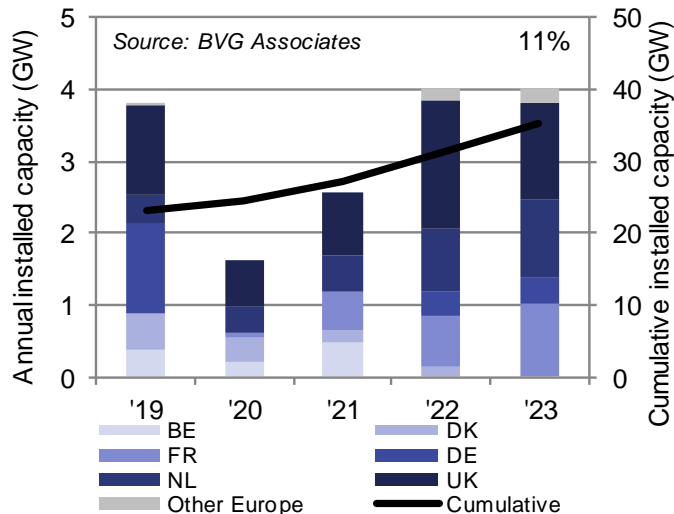
7

Seabed trenching ROV

The European market – forecast to 2022

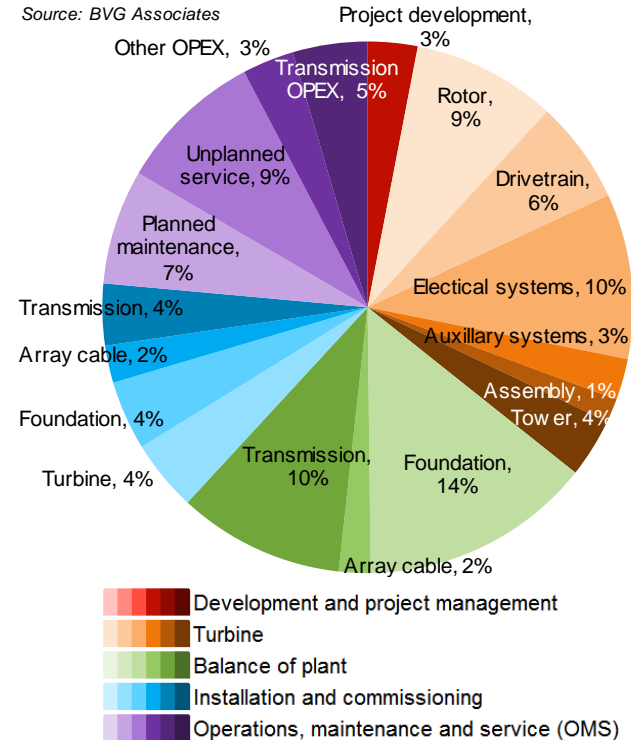
Europe leads globally

- Europe's forecast shows 19 200 MW of total installed capacity in 2018, reaching 35 200 MW by 2023, with a CAGR of 11%
- The UK and the Netherlands are likely to contribute the most installed capacity by 2023, with 37% and 20% respectively
- Other European countries that will play a key role are France, Germany, Denmark and Belgium



Likely contribution to LCOE in Europe

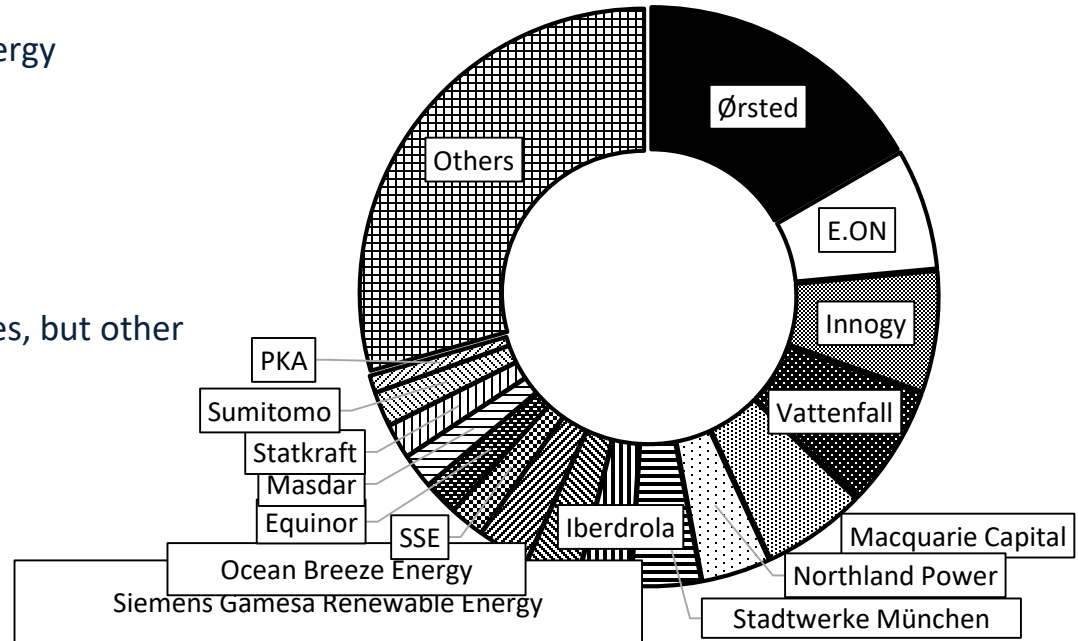
Source: BVG Associates



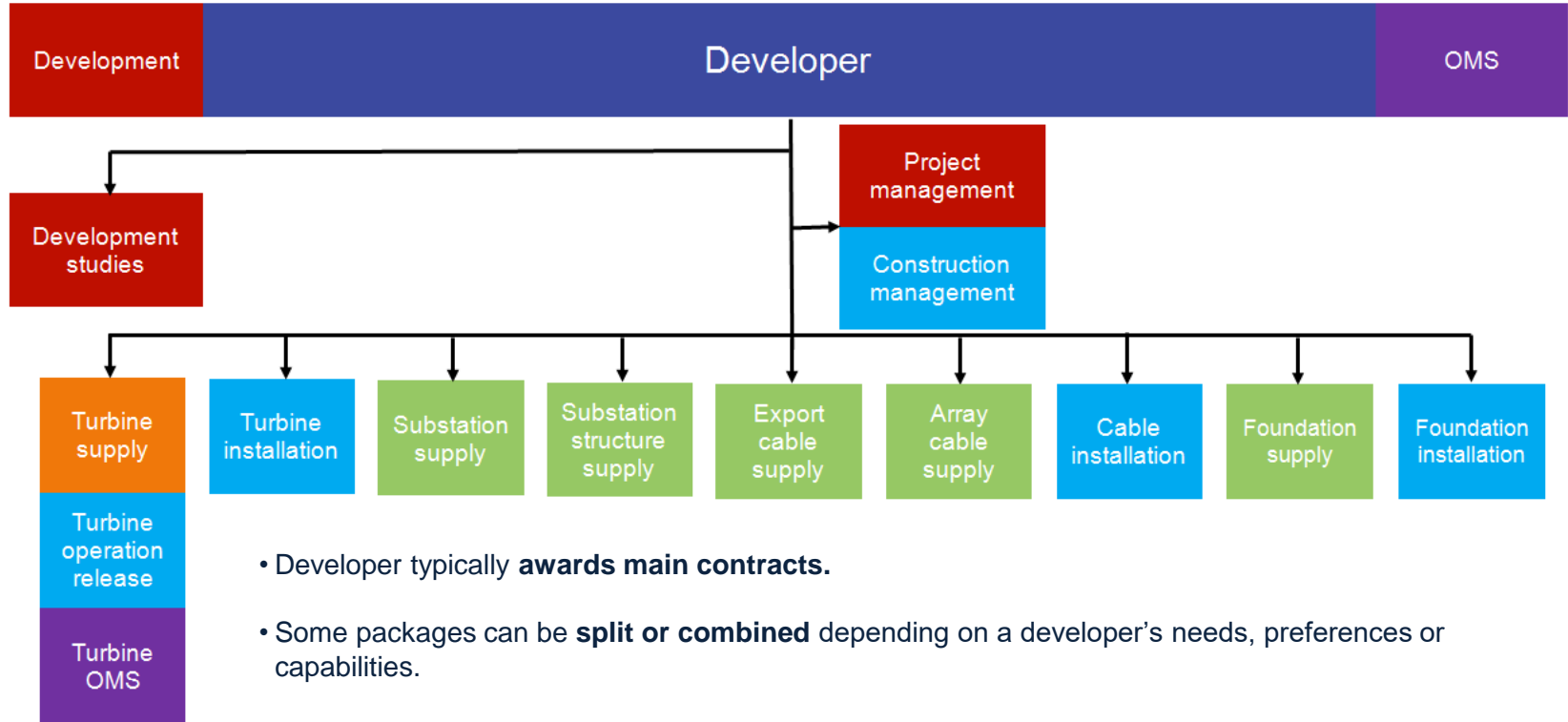
European trends

- Expenditure and leverised cost of energy
- Key driver auction
- Increased size of turbine
- Mainly shallow water
- Turbine capital expenditures increases, but other OPEX expenditure decreases
- Positive view on investment in OPEX
- Development expenditures

European developers share of installed capacity



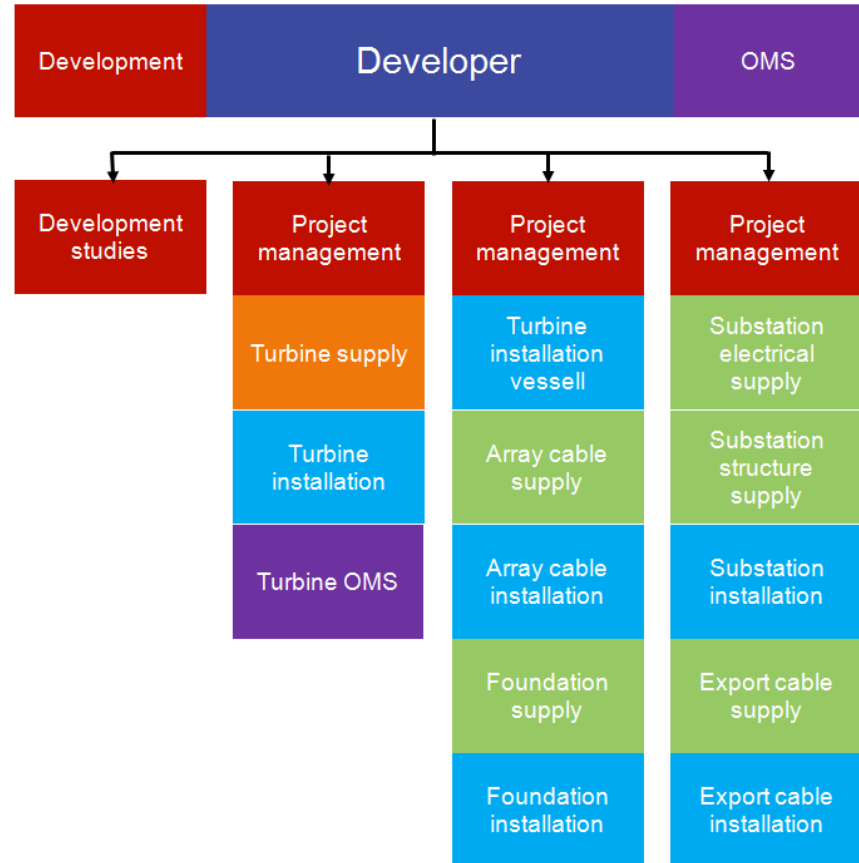
Procurement strategies – Multi contracting



- Developer typically **awards main contracts**.
- Some packages can be **split or combined** depending on a developer's needs, preferences or capabilities.
- Multi-contracting is often preferred by large utilities, particularly if the project is **funded from their balance sheet**.

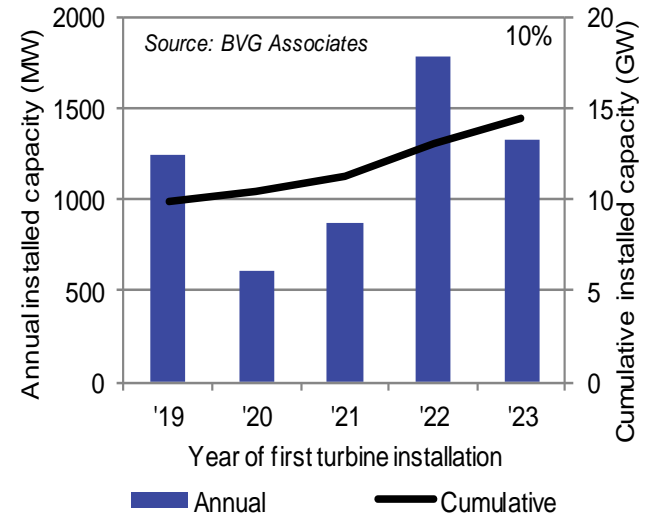
Procurement strategies – EPCI

- EPCI contracting usually involves **three main packages**. The turbine package is typically kept separate. The **other two packages vary in scope** according to the strengths of the bidders.
- Contract values can exceed £1 billion, which is a major **risk** for all but the largest and most experienced contractors.
- The interfaces between the non-turbine packages are not difficult for the developer to manage.
- Independent developers and **less experienced** utilities prefer this approach.



UK – the largest European market

- At the end of 2018, the UK will have around 8,6 GW of installed capacity
- This is likely to reach 14,5 GW by the end of 2023
- CAGR between 2019 and 2023 of 10%.
- Between 2019 and 2023, the annual installed capacity is likely to be between 600MW and 1,800MW



UK Background

Regulations

- Sites in UK and Scotland
- England and Wales
- Support mechanisms
- OFTOs are granted licences
- 3 GW potential new extension projects
- 18 favourable areas for new leasing round (Round 4)
- Main players

Capex & Opex

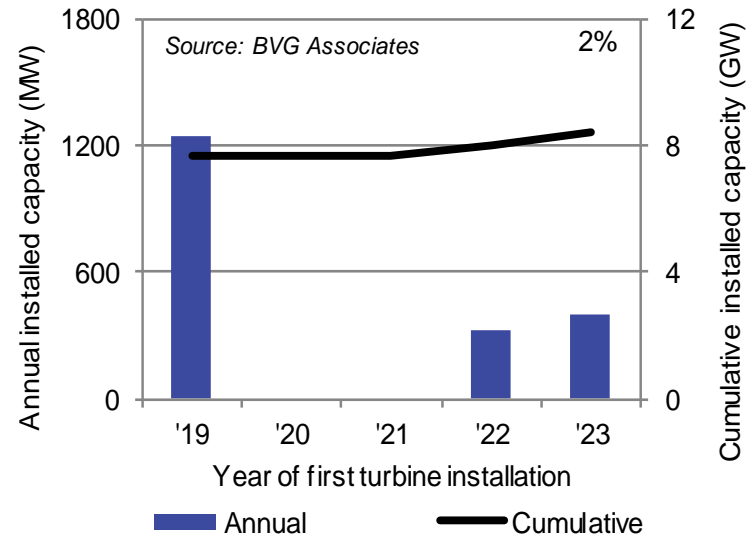
- Across all supply chain in 2023 likely to be €5 500 million.
- Expenditure between 2019 and 2023 likely to be €25 600 million
- Likely that 71 % between 2019 and 2023 will be spent on DEVEX and CAPEX. 29 % will be spent on OPEX

Main Players

- Ørsted
- Vattenfall
- SSE
- Scottish Power Renewables
- INNOGY
- Equinor
- Siemens Gamesa
- MHI Vestas
- MPI Offshore

Germany

- At the end of 2018, Germany is forecast to have 6 400 MW of installed capacity
- It is likely to reach 8 400 MW by the end of 2023
- Between 2019 and 2023 the CAGR is 2% and the annual installed capacity is likely to be between 0 MW and 1 240 MW
- The reason for this is due to the most recent auction, where bidders had a construction window up to 2025. Therefore, developers have opted to wait for the availability of larger MW turbines and other future cost benefits



Background Germany

Regulations

- WindSeeG (Offshore Wind Act) 1 Jan 2017
- Centralised planning approach
- A transitional mechanism provides support to projects anticipated to be commissioned between 2021 and 2025
- Offshore grid connections are constructed, owned and operated by transmission system operators (TSOs) TenneT (North Sea) and 50Hertz Transmission (Baltic)
- Under WindSeeG, this process is incorporated into the Area Development Plan

Capex & Opex

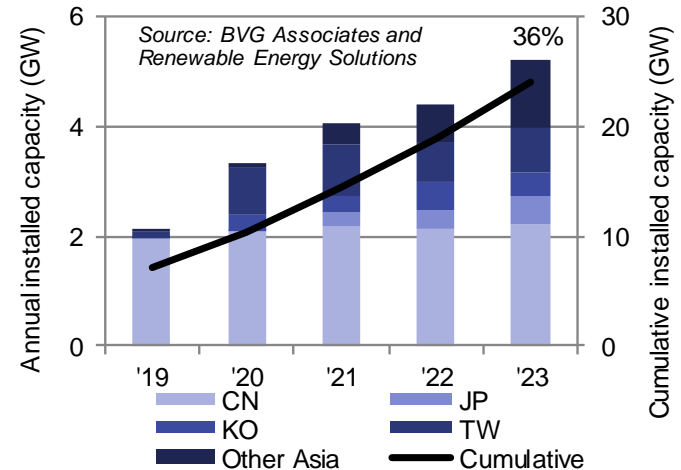
- Expenditure across all supply chain activities in 2023 likely to be €3 200 mill
- Expenditure between 2019 and 2023 is likely to be €11 400 mill
- Likely that 58% of expenditure between 2019 and 2023 will be spent on DEVEX and CAPEX. It is likely that 42% will be spent on OPEX.

Main Players

- Orsted
- EnBW
- Northland Power
- E.ON
- Ibedrola
- WPD
- Innogy
- Vattenfall

The Asian Market

- At the end of 2018, Asia will have about 4 900 MW of total installed capacity
- Current forecast shows a significant increase in capacity, 23 900 MW by 2023, with a CAGR of 36% between 2019 and 2023. Significantly up from last years projections.
- China will contribute the most installed capacity to the region by the end of 2023, with 55% of the market share.
- Other countries that are likely to play a role in the market to 2030 include Taiwan, South Korea and Japan.



Background Asia

Regulations

- Variety of factors driving the use of offshore wind in Asia. For China it is the high demand from east coast population centres and a lack of suitable onshore wind sites. In Japan, the phase-out of nuclear generation is a catalyst for offshore wind development.
- Expenditure across all supply chain activities in 2023 is likely to be €16 billion.
- Expenditure between 2019 and 2023 is likely to be €72 billion.
- It is likely that 83% of expenditure between 2019 and 2023 will be spent on DEVEX and CAPEX. It is likely that 17% will be spent on OPEX.
- The balance of plant and logistics supply chains are generally less developed than in Europe, with European expertise increasingly being brought in for both the CAPEX and OPEX phases in several countries

Capex & Opex

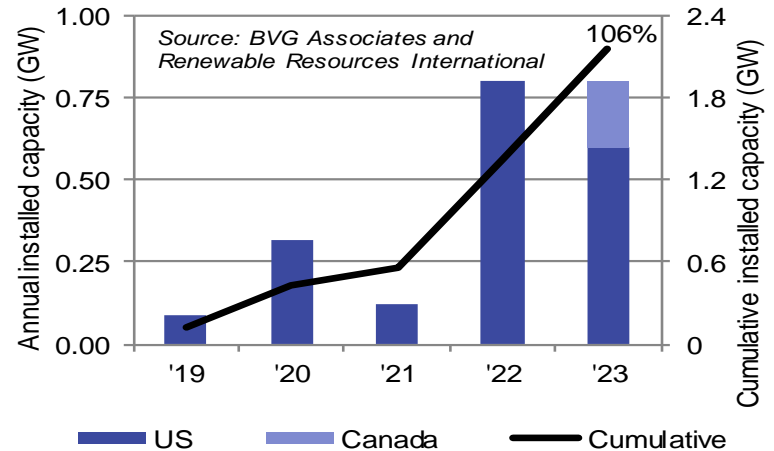
- Multicontracting preferred by developers to gain experience, developers tend to contract a greater number of individual contracts
- Government involvement in projects coupled with support from major local conglomerates
- The contracting approach for Asian operating market is still emerging

Main Players

- China Longyuan (China Guodian Group)
- CGN Group
- SPIC
- China Huaneng Group
- CNOOC
- Goldwind
- Dongfang Electric Corporation
- Jiangsu Hangtong Ship Heavy Industry
- Ming Yang

The North American Market

- North America has 30MW installed capacity at the end of 2018
- By end of 2023, anticipated to reach about 2,0, almost exclusively in the US
- Leading indicators such as PPAs (power purchase agreements) confirm a strengthening of the market, with approximately 1 900 MW of PPAs formalised as of July 2018 and an additional 2 700 MW likely over the following 12 months.



Background North America

Regulations

- Majority of interests come from states with strong business cases
- The cost of energy is likely to be higher than Europe for several reasons:
 - To mitigate the currently limited industrial base for offshore wind, components can be sourced globally. Other key elements, however, such as coastal staging of components, installation, commissioning and service must be performed locally. In this, the requirement for Jones Act compliant vessels is especially challenging, and significant investment will be needed to serve the larger scale projects.
 - Deeper waters are likely to result in the use of jacket foundations. They use less steel than monopiles but are more expensive to manufacture, increasing the overall cost of energy.
 - Another significant difference compared to Europe (excluding UK) is that the transmission cable to shore is within the project scope as it is not provided by the states.

Capex & Opex

- Ørsted and Equinor etc are likely to multicontract with mature, global suppliers, which may collaborate with North American partners
- EPCI contracting is likely to be preferred by less experienced US developers

Main Players

- Orsted
- Dominion Energy
- Massachusetts Clean Energy Centre
- Deepwater Wind
- Equinor
- Avangrid Renewables
- US Wind
- CiP
- GE

Emerging Markets

- **Estonia**

- Plan to install up to 500MW of offshore wind capacity by 2018
- No offshore wind installed capacity so reaching this target is unlikely. Additional project of 1 100MW expected to be commissioned in 2021

- **Finland**

- 3 demonstration projects, total capacity of 32MW.
- 2 GW of planned offshore wind capacity.

- **Ireland**

- Approval of Renewable Electricity Support Scheme (RESS) in July 2018
- Renewable energy auctions will be held annually from 2019-2025 with auction capacities ranging from 1 GW to 4 GW.

- **Poland**

- The total auction budget is PLN 87 600 million (EUR 20 300 million), of which offshore wind farms will be eligible for up to PLN 450 per MWh (EUR 121 per MWh).
- No offshore wind farms operating or under construction however, the market is likely to grow to 2 GW by 2030.

- **Australia**

- Australia's Clean Energy Innovation Fund was established in 2015 to provide AUD \$1 billion to support offshore technologies (including offshore wind)

- **Canada**

- Canada has no installed offshore wind capacity. In 2016 the government of Ontario, announced it is to keep a moratorium on offshore wind projects until potential environmental impacts are fully understood

- **India**

- India has the world's fourth largest onshore wind market (33 GW of installed capacity).
- The government targets for offshore wind are 5 GW by 2022 and 30 GW by 2030.

- **Vietnam**

- Vietnam has almost 100 MW of capacity installed in the Bac Lieu offshore wind farm, installed in phases between 2013 and 2015
- 100 MW is currently under construction with potential for an additional 200 MW to be developed at that site

Priority projects Wind

| Project name | Country | Owner 1 | Project |
|--------------|---------|---------|---------|
|--------------|---------|---------|---------|

PRIORITY PROJECTS

Project

Link to project website

Region

Country

Total potential capacity (MW)

Sea basin

Distance to shore (km)

Project status

Background to project

Recent project information since last update

Link to project supplier registration site

Owner 1

Turbine rating (anticipated)

Number of turbines / foundation (anticipated)

Foundation type (anticipated)

Onshore grid connection point

Transmission type (known)

Number of offshore substations (anticipated)

Substation collector station (known)

Array cable voltage (kV) (anticipated)

Array cable length (km) anticipated

Export cable voltage (kV) (anticipated)

Export cable length (km) (anticipated)

Number of export cables (anticipated)

Installation port 2 (anticipated)

OMS base (known)

OMS strategy (known and anticipated)

Turbine supplier

Foundation supplier

Array cable supplier

Export cable supplier

Offshore substation electrical supplier

Offshore substation topside supplier

Turbine installation supplier

Foundation installation supplier

Array cable installation supplier

Export cable installation supplier

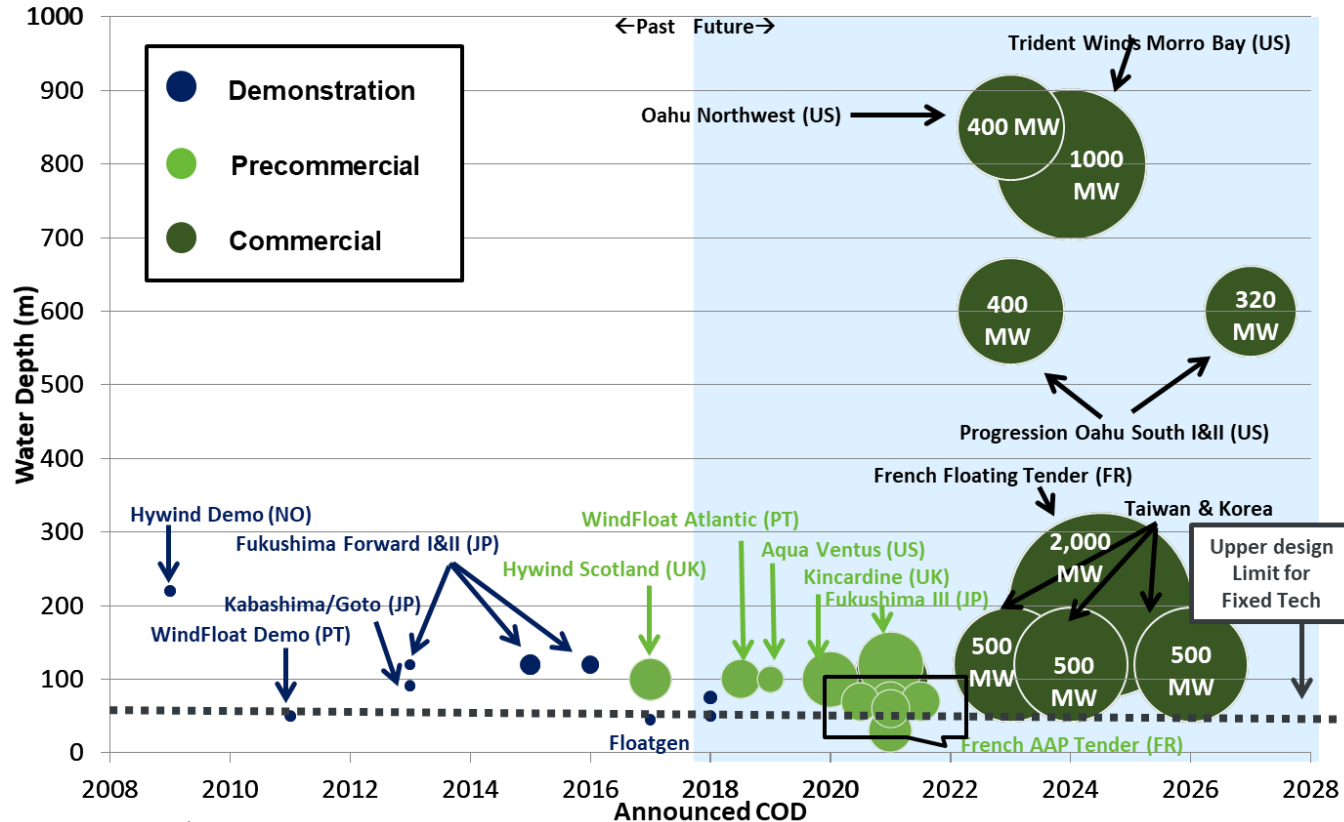
Offshore substation installation supplier

Contracting structure

A brief status floating wind

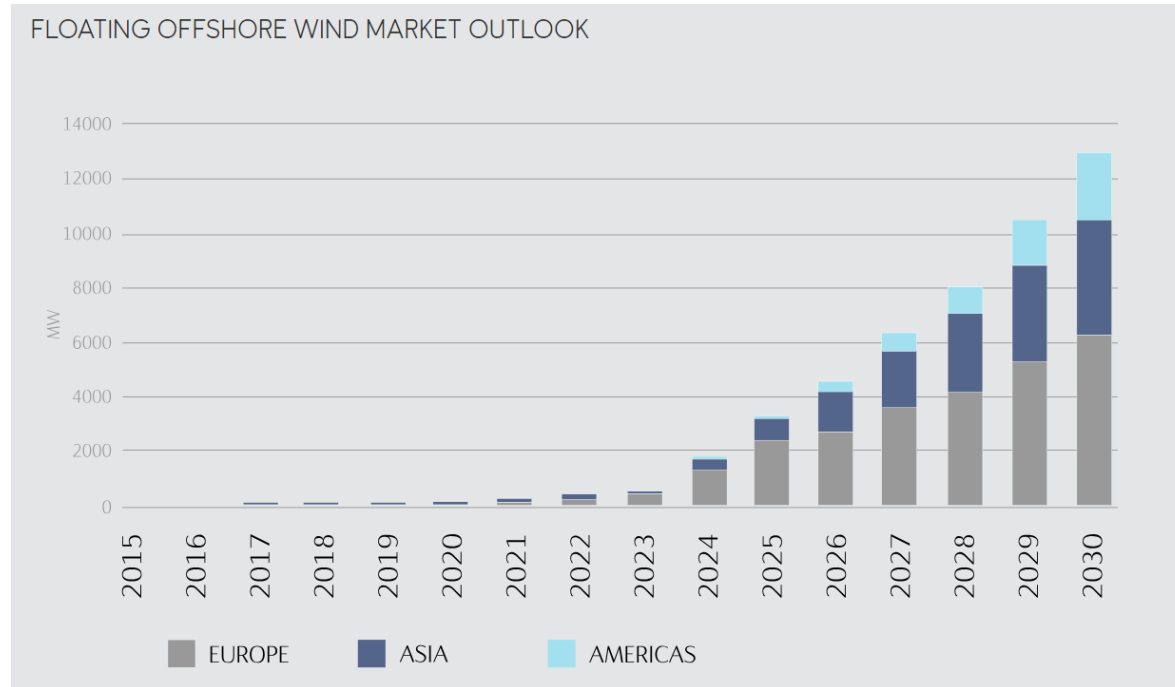
- In 2017, the world's largest floating foundation project (Hywind Scotland), was installed.
- A second floating demonstration in Scottish waters, Kincardine, is completing the first part of its installation in second half of 2018.
- Four floating demonstration projects in France received consent (Golfe du Lion, Groix & Belle-Île, Grussian and Provence Grand Large) with construction beginning from 2020.
- Principle Power is in the early stages of planning their 150 MW project off the West Coast of the US. They have stated that this is a 'pre-commercial' project.
- Equinor planning to electrify parts of Tampen O&G field by use of Hywind FWT
- There are currently no commercial floating projects in development
- Principle Power reports start of construction for "WindPlus' 25 MW WindFloat Atlantic" approximately 20 km offshore Viana do Castelo in Northern Portugal

300+ MW demos /+7 GW large projects worldwide



Source: Principle Power

Floating wind market outlook (Equinor)



- First commercial developments around 2023
- Europe likely to drive development

Hywind Scotland - 30% Norwegian content



- Engineering of substructure, tower, mooring and cables
- System integration
- Procurement of equipment
- Transport of substructure
- Engineering and preparation of assembly of substructure and tower elements
- Logistics
- Commissioning
- Tow to site and mooring operation
- Dynamic and static cables
- Type approvals and 3rd party verifications

Renewable Market events 2018/2019

| 2018 | | | | | |
|-------------|------|--|-------------|---------------|--|
| Norway | Wind | Roadshow Annual Offshore Wind Market Report (AOWR) 2018 | 10 Sep | Bergen | |
| Norway | Wind | Roadshow Annual Offshore Wind Market Report (AOWR) 2018 | 11 Sep | Stavanger | |
| Norway | Wind | Roadshow Annual Offshore Wind Market Report (AOWR) 2018 | 11 Sep | Haugesund | |
| Norway | Wind | Roadshow Annual Offshore Wind Market Report (AOWR) 2018 | 12 Sep | Arendal | |
| Norway | Wind | Roadshow Annual Offshore Wind Market Report (AOWR) 2018 | 12 Sep | Kristiansand | |
| Norway | Wind | Roadshow Annual Offshore Wind Market Report (AOWR) 2018 | 13 Sep | Ålesund | |
| Norway | Wind | Roadshow Annual Offshore Wind Market Report (AOWR) 2018 | 14 Sep | Oslo | |
| Germany | Wind | Wind Energy Hamburg Conference & Exhibition/client meetings | 25 - 28 Sep | Hamburg | |
| Denmark | Wind | Treffpunkt Denmark Norwegian Danish Technology Hackathon | 9-10 Oct | Ålborg | |
| USA | Wind | AWEA Offshore Wind 2018 | 16 - 17 Oct | Washington DC | |
| China | Wind | China Wind Power and state visit | 16 - 19 Oct | Beijing | |
| South Korea | Wind | South Korean floating wind seminar (TBC) | 22 Oct | Ulsan | |
| Japan | Wind | Norwegian Japanese R&D seminar on OW (TBC) | 22-23 | Tokyo | |
| Netherlands | Wind | Offshore Energy 2018 | 22 - 24 Oct | Amsterdam | |
| UK | Wind | Renewable UK and Scottish Renewables Floating Offshore Wind 2018 | 30 Oct | Aberdeen | |
| 2019 | | | | | |
| Scotland | Wind | Scottish Offshore Wind Supply Chain Dinner & Event | Late Jan | Glasgow | |
| Norway | Wind | Norwegian OW Supply Chain Conference - including floating | Mid March | Oslo | |
| TBA | Wind | Developer NN supplier day | TBA | TBA | |
| USA | Wind | IPF | 9-10 April | New York | |
| France | Wind | Floating Offshore Wind Turbines 2019 | April | TBA | |
| France | Wind | Seenergy 2019 (TBC) | 5-6 Jun | TBA | |
| China | Wind | China Offshore Wind Summit 2018 | TBA | TBA | |
| UK | Wind | Global Offshore Wind - Conference & Exhibition client meetings | Jun | London | |
| Ireland | Wind | Delegation Ireland (TBC) | Sept | Dublin | |
| Taiwan | Wind | Delegation Taiwan (TBC) | TBA | Taipei | |
| Poland | Wind | Delegation Poland (TBC) | TBA | Warsaw | |
| USA | Wind | AWEA Offshore Wind | 22-23 Oct | Boston | |



Q&A

Jon Dugstad
jon@norwep.com

Knut Erik Steen
Knut.erik.steen@norwep.com

David S. Ottesen
david@norwep.com