



GLOBAL TRENDS OF OFFSHORE WIND

KOREA, 2019

A quality assurance and risk management company

OUR PURPOSE:

**TO SAFEGUARD LIFE, PROPERTY
AND THE ENVIRONMENT**

OUR VISION:

**GLOBAL IMPACT FOR A SAFE AND
SUSTAINABLE FUTURE**

150+ years

100+
countries

100,000
customers

12,000
employees

5%
of revenue spent on
R&D

MARITIME



OIL & GAS



ENERGY



**BUSINESS
ASSURANCE**



**DIGITAL
SOLUTIONS**



We apply deep insights and diverse industry domain competence



- We **classify, certify, verify and test** against regulatory requirements, standards and recommended practices
- We develop new **rules, standards and recommended practices**
- We **qualify new technologies** and operational concepts
- We give **expert advice** on safety, technology, data management, efficiency, performance, risk management

Broad and deep expertise in offshore wind projects

ENERGY

90

90 years experience in the power industry, including 40 years in wind energy and energy management

2300

2,300 energy experts in wind, solar, grids, storage and energy management

| FEASIBILITY

- › Market intelligence
- › Strategic advice
- › Technology evaluation/Technology qualification
- › Certification of wind turbines, offshore substation and cables

| DEVELOPMENT

- › Concept selection
- › Measurements
- › Resource and energy optimization
- › Technical due diligence
- › Pre-construction energy assessment
- › Certification of wind turbines, offshore substation and cables

| ENGINEERING

- › Project engineering optimization
- › Operation and maintenance planning
- › Turbine and support structures consulting
- › Interconnection review
- › Certification of wind turbines, offshore substation and cables

| CONSTRUCTION

- › Construction optimization
- › Monitoring and marine warranty
- › Project management
- › Construction monitoring
- › Banks' engineer
- › Certification of wind turbines, offshore substation and cables

| OPERATION

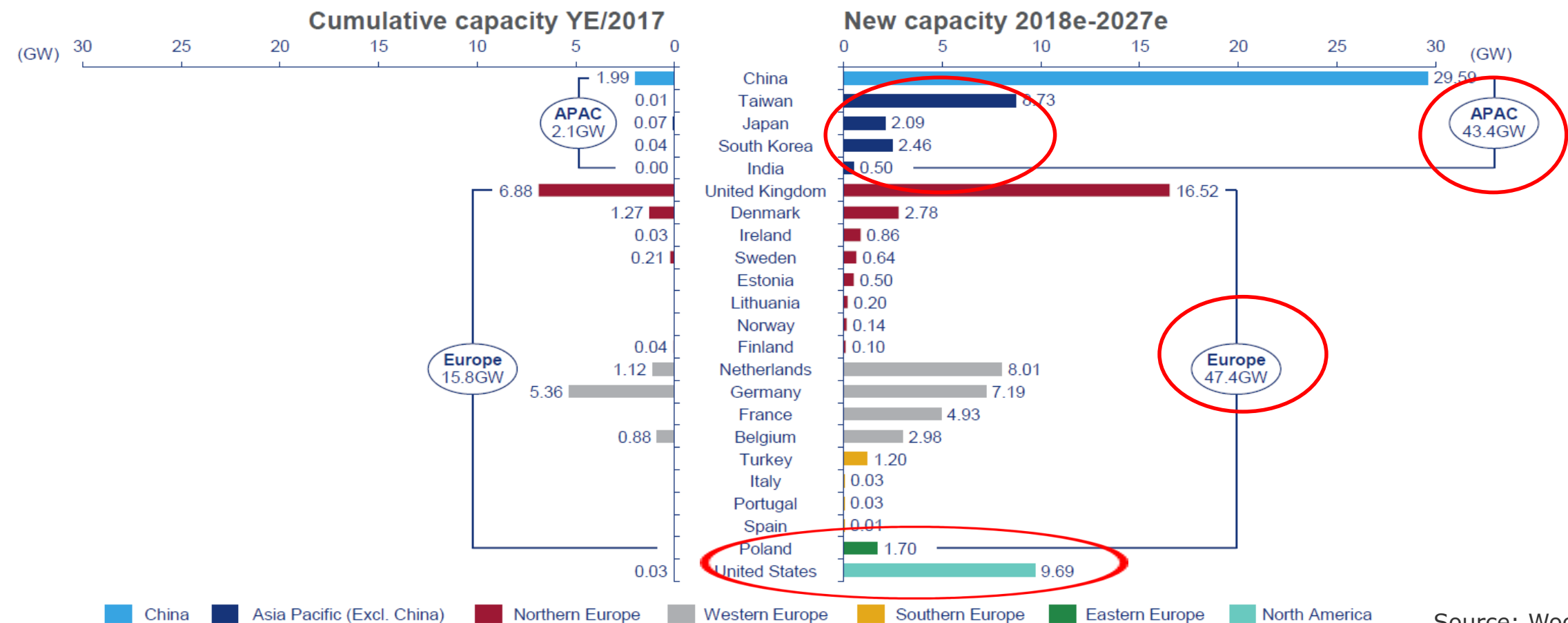
- › Asset management optimization
- › Operation and maintenance optimization
- › Performance and condition monitoring
- › Inspections and audits
- › Operational energy assessments
- › Project portfolio due diligence
- › Certification of wind turbines, offshore substation and cables
- › Condition monitoring systems

Strategic challenges, Markets and Trends:

Offshore Wind to be increased six fold towards 2030.

Europe in lead, but APAC and US will pick up towards 2020/2050

Growth and dispersion of offshore wind demand forces the supply chain to rethink its long-term footprint.

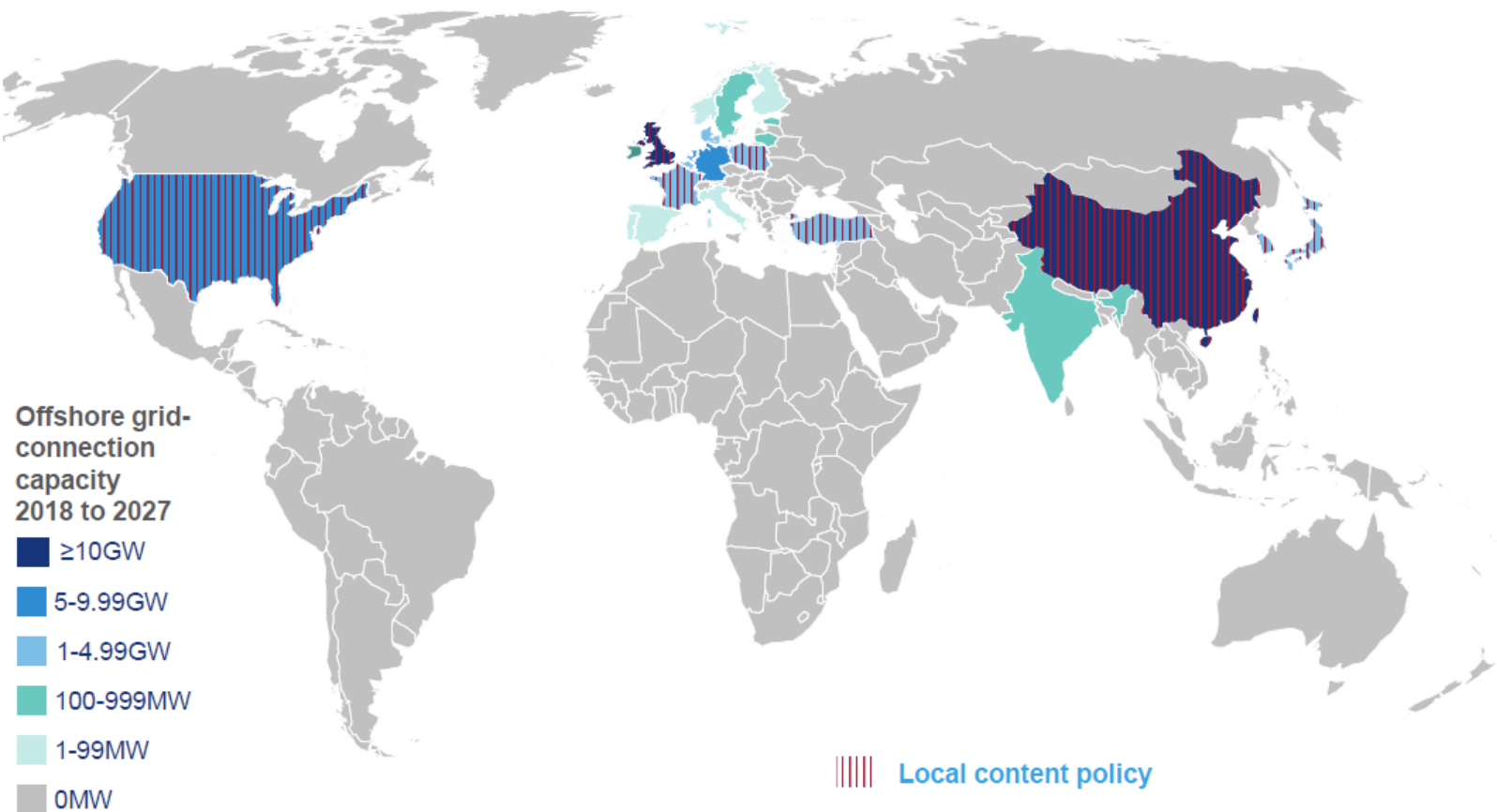


Note: Based on annual grid-connected capacity.
Source: Wood Mackenzie

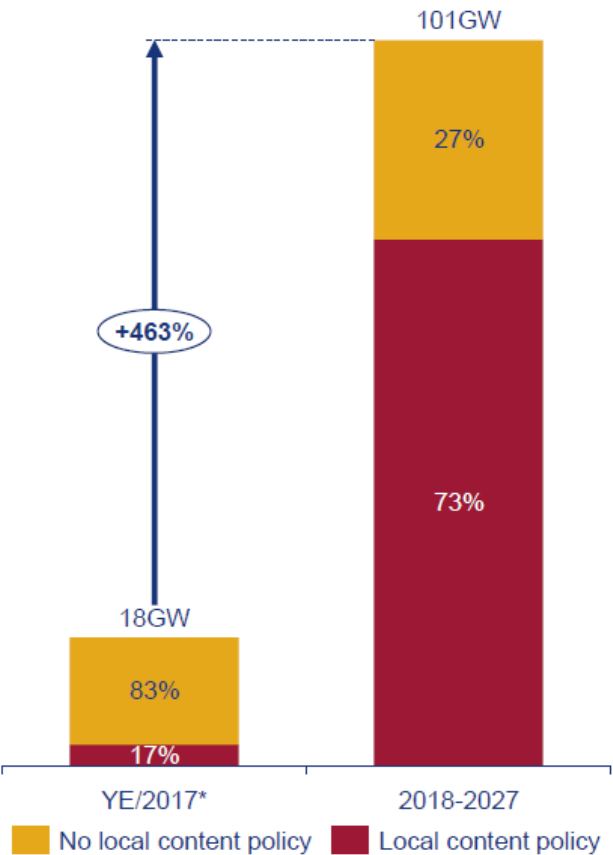
Source: Woodmac

How the local content requirement pans out – is the real joker for OW next...

Local content requirements for offshore in established and emerging markets



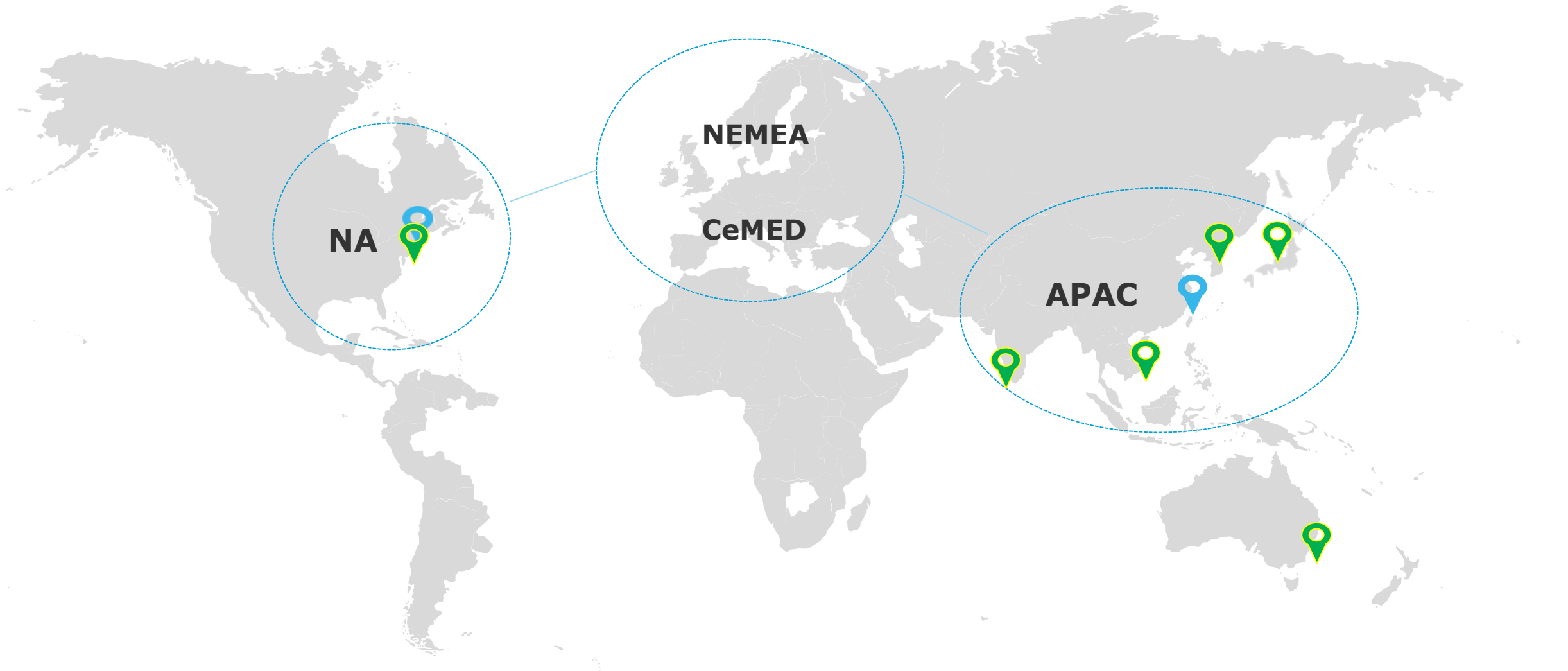
Outlook by local content requirements



Note: *YE/2017 refers to cumulative capacity grid-connected by the end of 2017. US local content policies are state-level, not national. Not two local content policies are identical, and its implications will therefore vary

Source: Woodmac

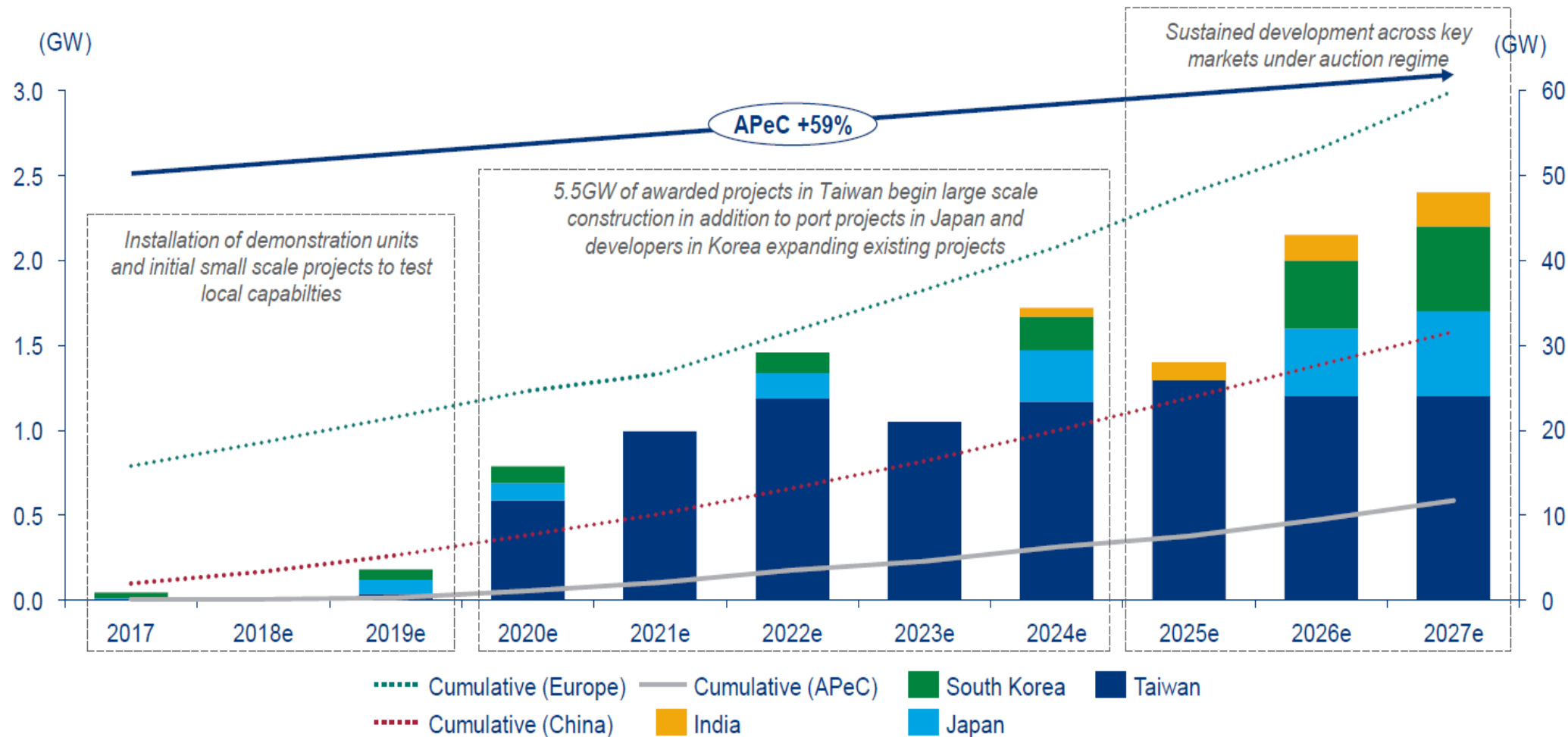
Biggest challenge short-term is how to transfer experience from core Europe to emerging markets



APAC

Highlight 2: Offshore wind in APeC (ex China). Taiwan to become largest offshore wind market in APeC region by 2020 and beyond

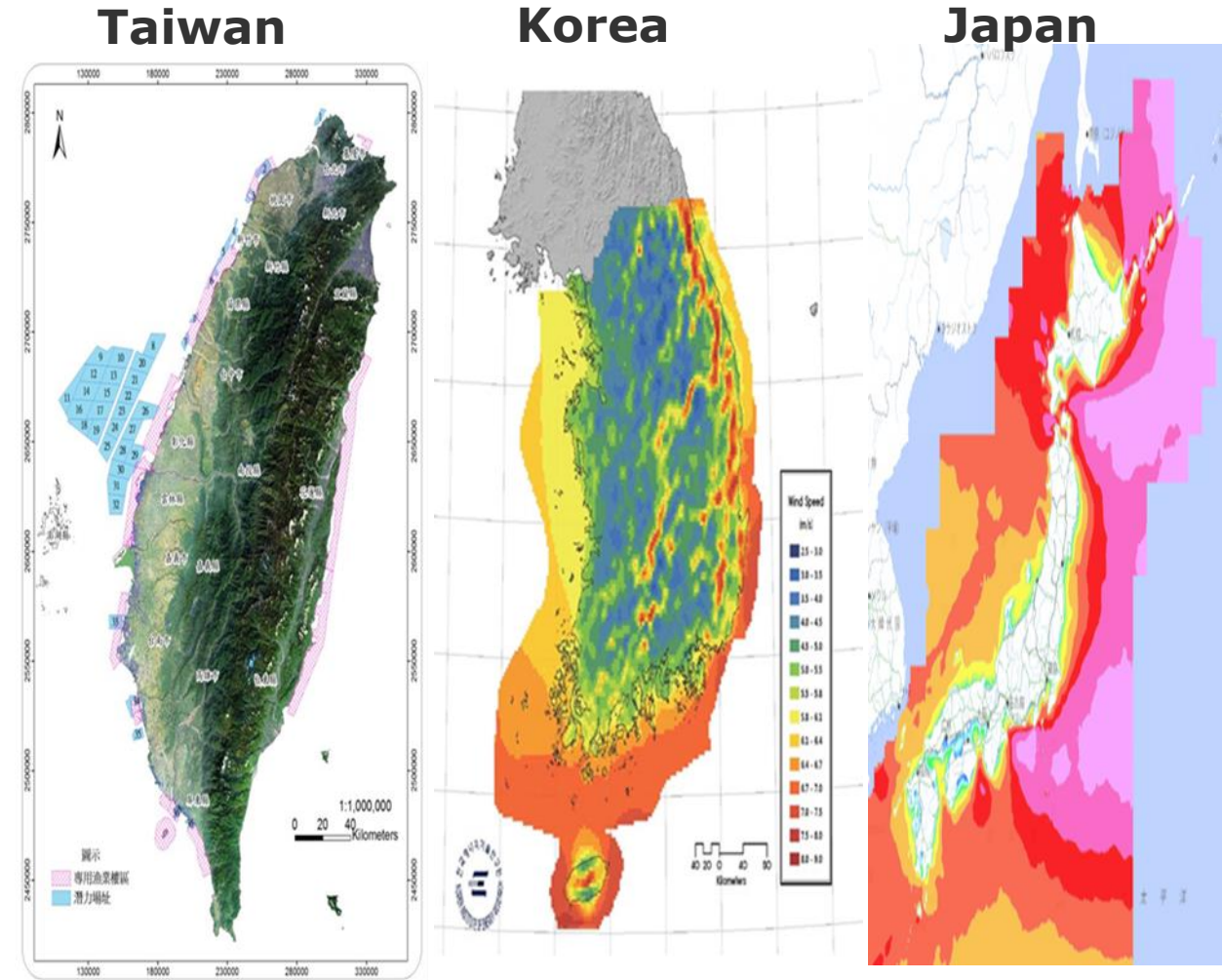
APeC offshore wind power outlook, 2017-2027e



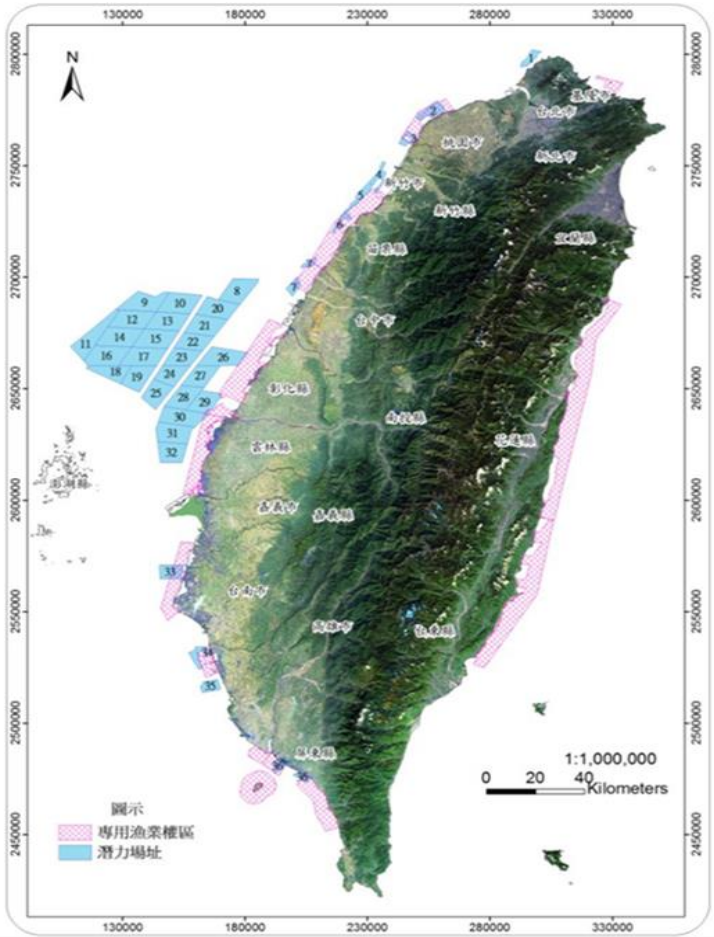
Source: Woodmac

Lead players likely focus on targeted Markets

- Based on discussions and previous projects with CIP, Ørsted, WPD, EoN, Shell, Innogy, Equinor etc, seems like they are focused on the following three (3) key areas:
 - **Taiwan** (Mature Development – FID 2019-21)
 - **Korea** (Early Stage Acquisition)
 - **Japan** (Early Stage Acquisition)
 - **Australia** (Early Stage development)



Taiwan pipe-line



Taiwan Offshore Wind Allocations

Owner	MW	CoD Year
Taipower	110	2019
Swancor - Macquarie - Orsted	120	2019
China Steel - CIP	300	2024
CIP	100	2021
CIP	452	2023
CIP (West Island)	48	2024
Northland - Yushan	300	2024
Orsted	605.2	2021
Orsted	294.8	2021
Swancor - Macquarie	378	2020
Taipower	300	2024
wpd	350	2021
wpd (Yunlin I)	360	2020
wpd (Yunlin II)	348	2021

South Korea plans

Progress Report: South Korea

Renewable Energy 3020

The Renewable Energy 3020 Implementation Plan (RE3020), developed by the South Korean government in December 2017, provides a roadmap of clean energy development until 2030.

Following election in 2017, President Moon Jae-in pledged to cancel all nine new coal projects and partially shut down the nuclear power stations in the coming years.

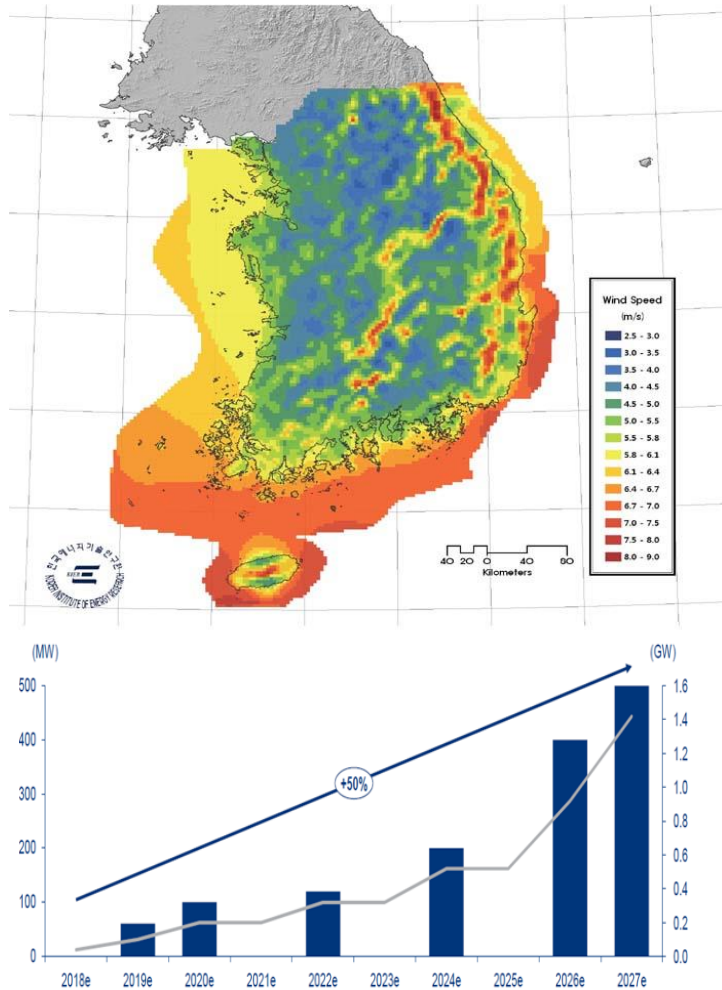
According to RE3020, renewables consumption should reach 20% by 2030 (63.8GW), requiring an RES capacity increase of 48.7GW between 2018 and 2030; of this, 24.6% (12GW) will be generated from offshore wind.

According to RE3020, MOTIE is planning to introduce a feed-in tariff system which may be mandatory to the six public power generators to purchase renewable energy. The energy will be purchased at a fixed price for the next twenty years.

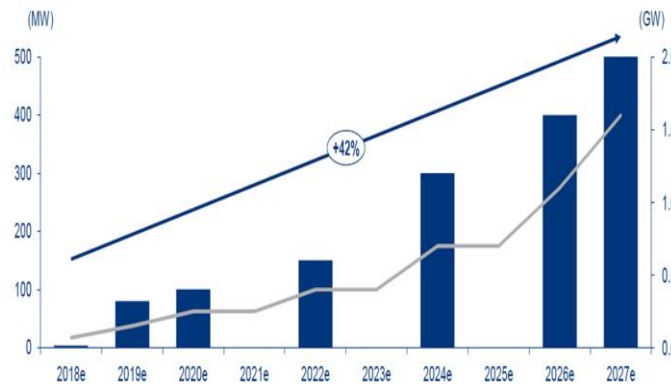
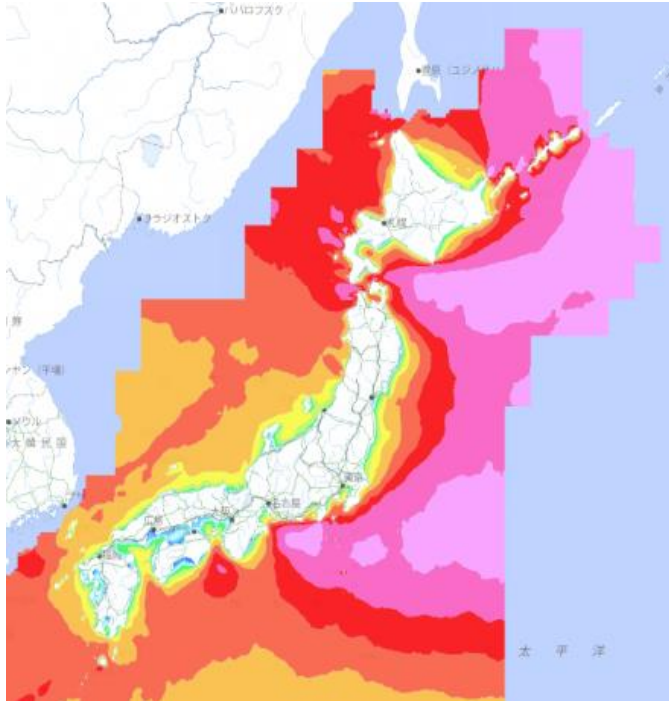
On 1st November 2018, the South Korean and Danish governments signed a renewable energy cooperation agreement with particular focus on offshore wind.

Proposed new services that might be interesting:

- Floating wind advisory services
- Package management
- Wind Measurement Campaign (Flidar, Lidar, etc)
- Typhoon Extreme Wind Speed analysis
- Digital services for project development
- Project Certification



Japan plans



Progress Report: Japan

- In March 2018 the government cabinet approved a new bill, the "Draft Law on Promotion of Utilization of Marine Areas pertaining to Improvement of Marine Renewable Energy Power Generation Equipment" (also known as the "General Waters Bill") providing a framework for awarding a 30-year occupation of the "general sea" area beyond the jurisdiction of ports.
- This bill which will see 'at least five' promotion zones (leases) issued by 2030 was passed at the end of November.

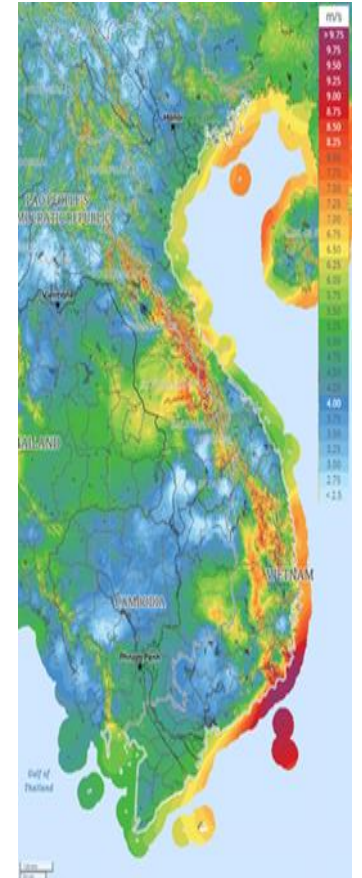
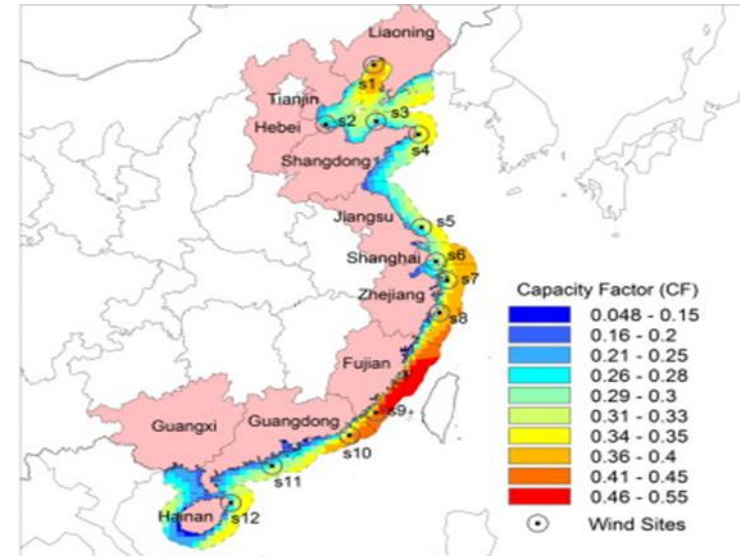
CIP in Japan:

- RA - DNV GL first Early Project Development Evaluation on project in Japan end 2018. Customer satisfied with result and execution flexibility.

Vietnam, India, China – markets for “second-movers” ?

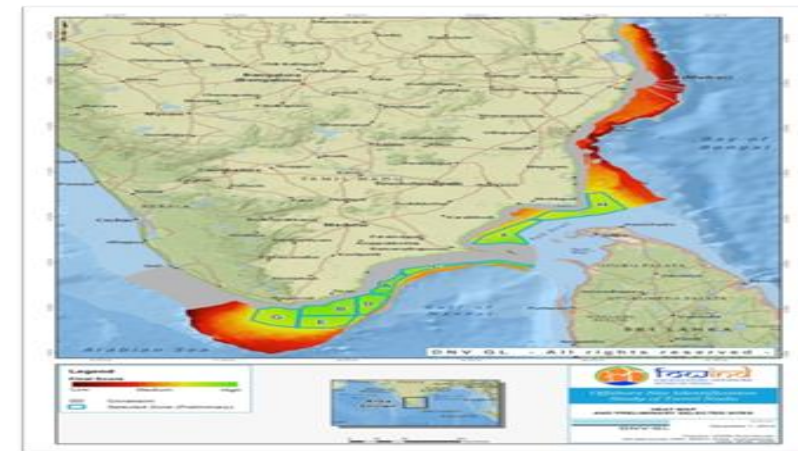
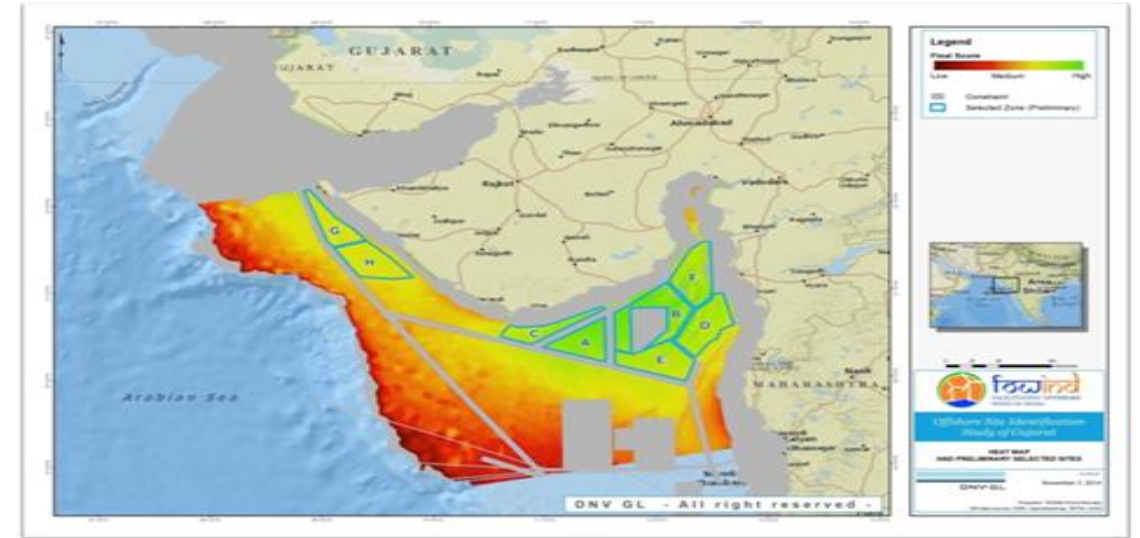
Opportunistic markets for players with no APEC pipeline:

- Vietnam – Will likely take somehow longer. So far, most “offshore” are only inter-tidal projects, but government could change game. Customers:
- India – Reverse auction is expected which has always been very competitive for the onshore market, likely to be more attractive for players not engaged in OW in APAC currently.
- China – Given the presence of local developers and local investors in China, it might be difficult for foreign developers to get really involved



India offshore wind

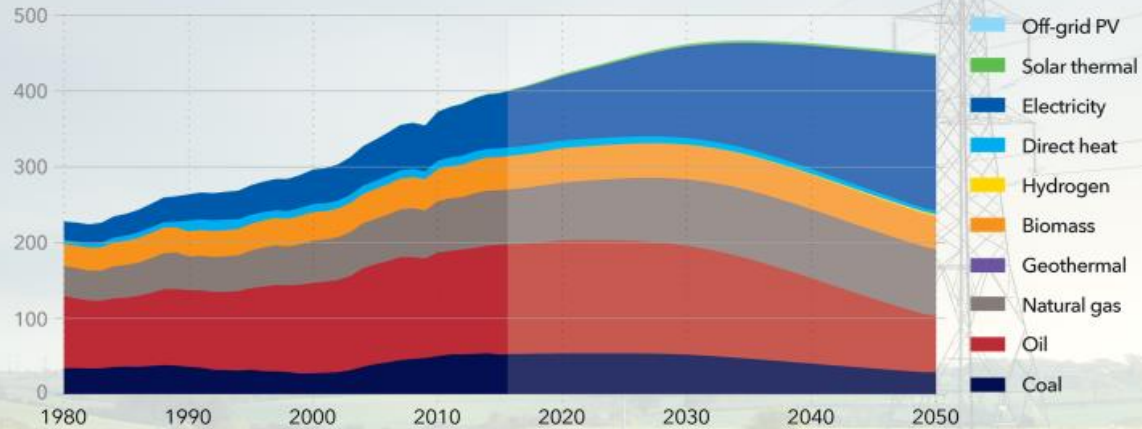
- Government will issue 1 GW tender in 2019. Plans for more than 5 GW+ in 2025-2030
- Wind tariff of 4 Rupies + gap financing,
- Gap financing – front loaded 1-3 years
- Plans to issue new tender for Tamil Nadu when Lidar data available
- Geotech studies to be issues in 1H 2019
- Issues of grid offtake – still outstanding
- Equinor partner with local developer ReNew Power.
- + 30 developpers have indicated interest.



Energy Transition Outlook 2018: Very good news for Renewables and electrification

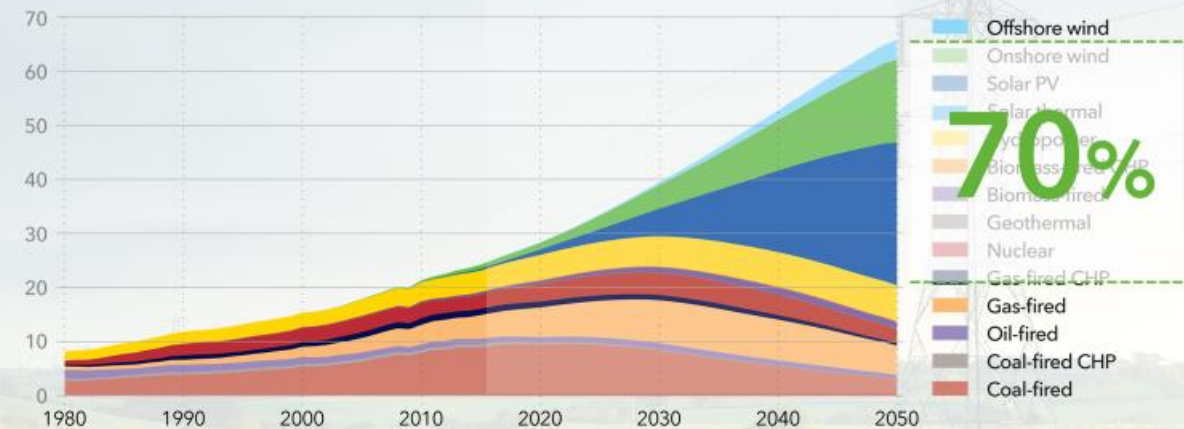
ELECTRICITY WILL DOUBLE

Units: EJ/yr



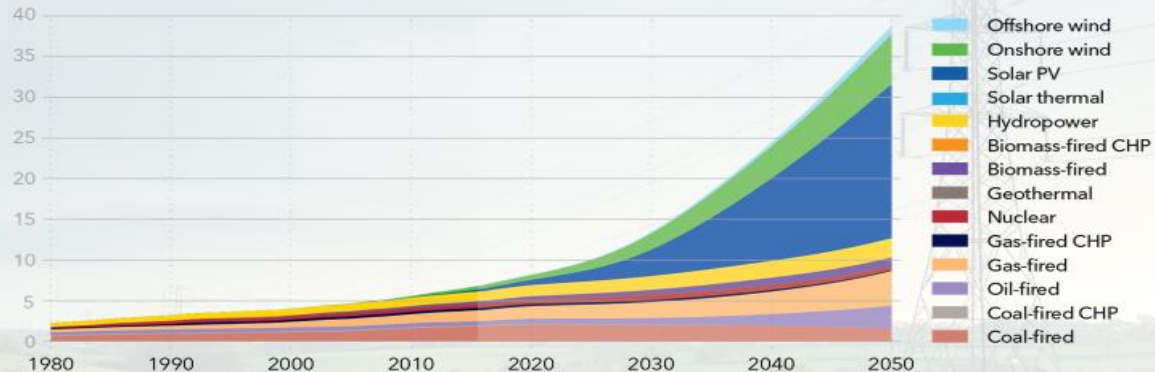
DRAMATIC RISE IN SOLAR PV AND WIND

Units: PWh/yr



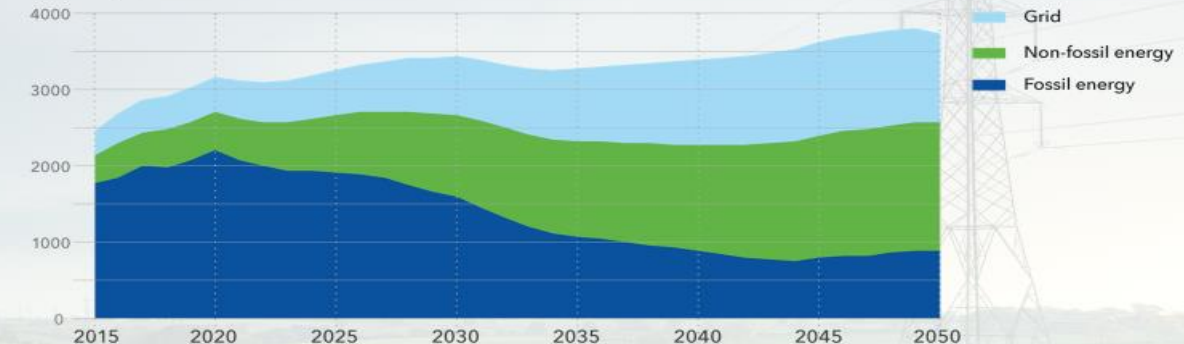
MORE THAN 5x NEW INSTALLED CAPACITY

Units: PW



SHIFT CAPEX TO RENEWABLES AND GRIDS

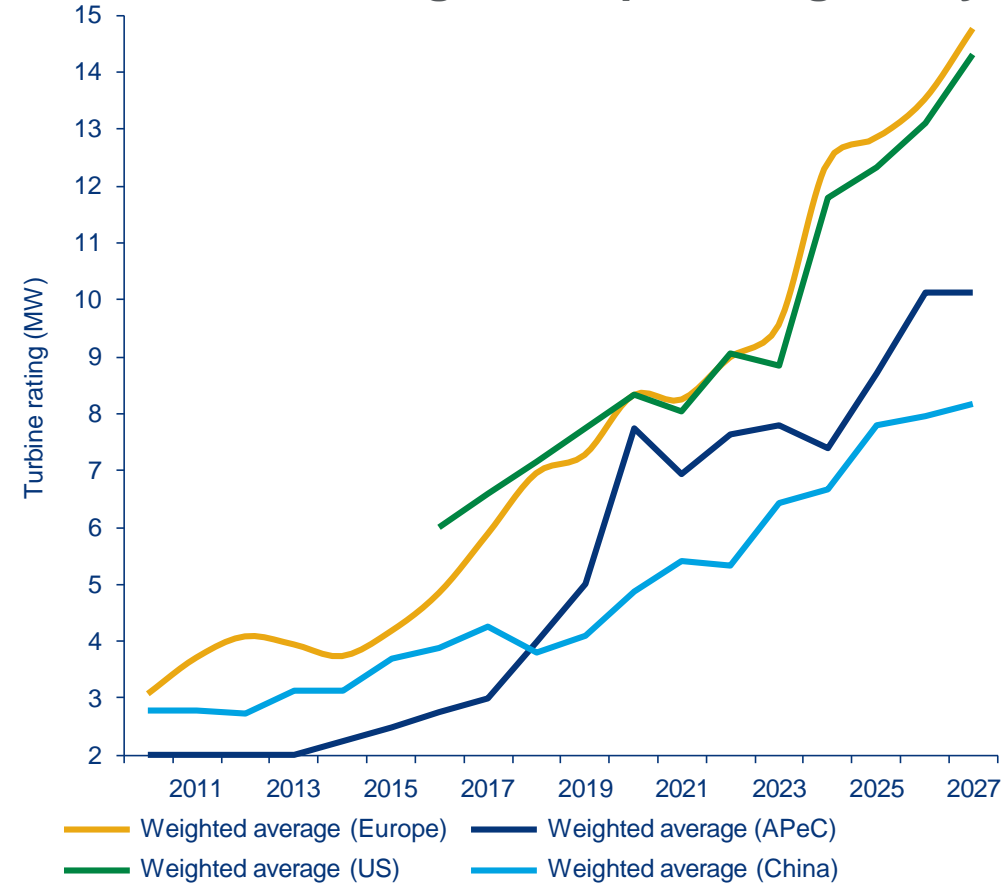
Units: Bn\$/yr (2005 USD)



Technology Trends

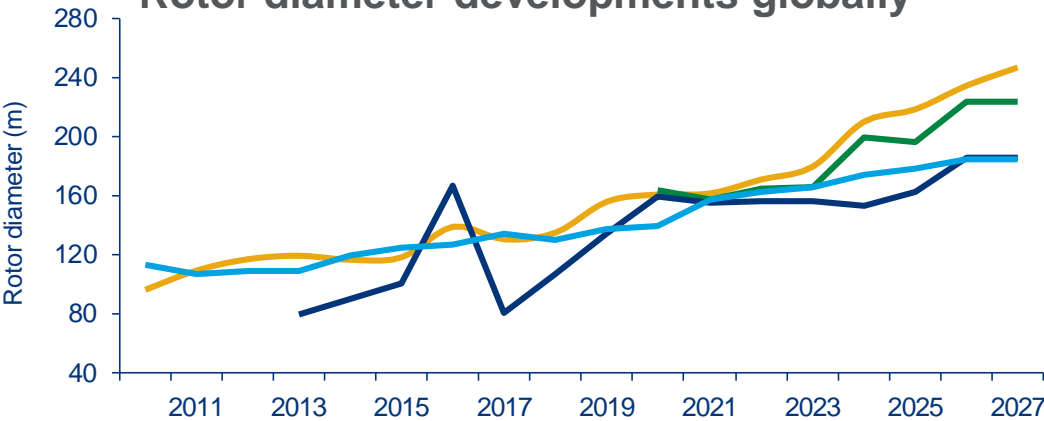
WTG trends

Turbine rating developments globally



Note: Based on annual grid-connected capacity. Interpolated.
Source: Wood Mackenzie

Rotor diameter developments globally



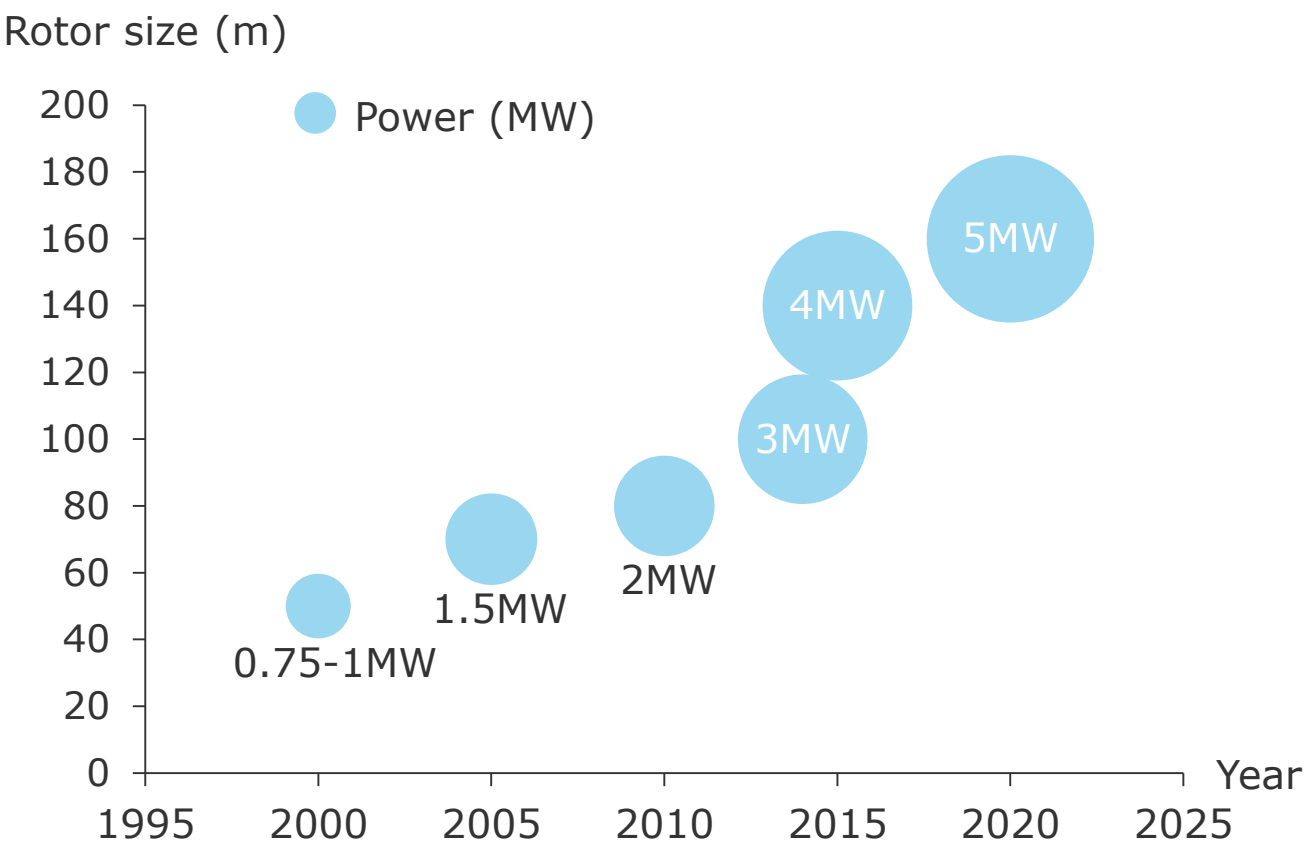
Hub height developments globally



Innovation and efficiency are key growth drivers (Courtesy of GWEC)

Turbine sizes and power rating to increase

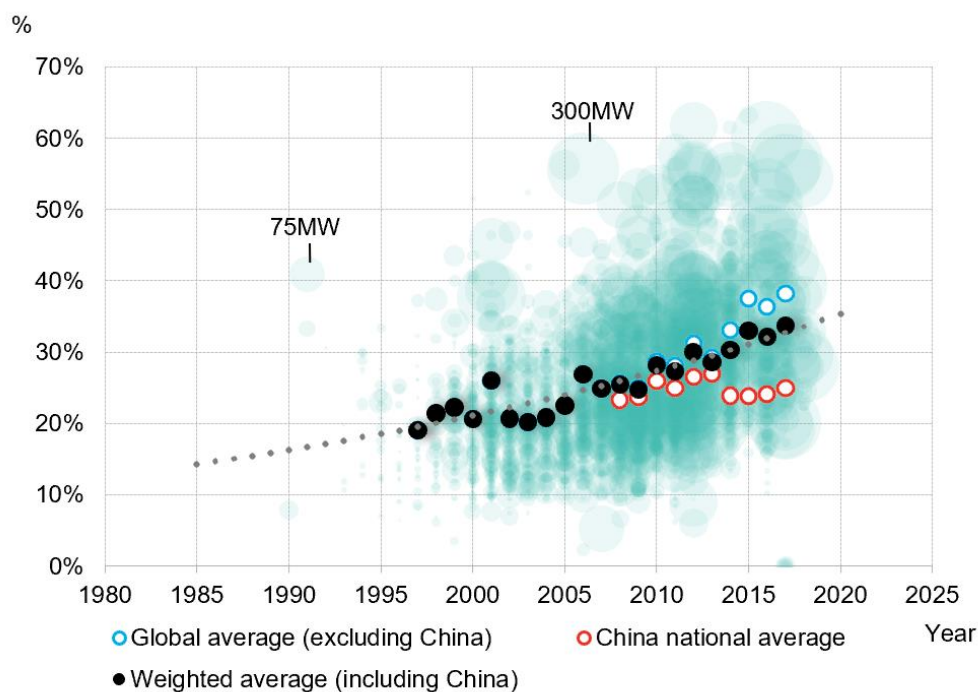
Onshore wind turbine size development*



* Average turbine size
Source: GWEC Market Intelligence, WindEurope, BNEF

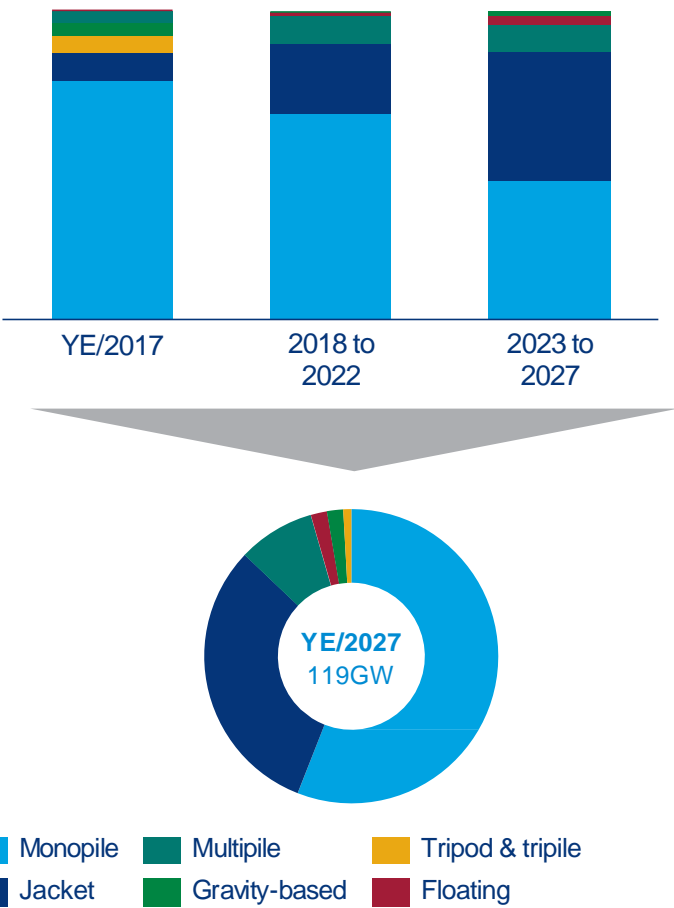
Capacity factors continue to improve

Development of onshore wind capacity factor, per cent

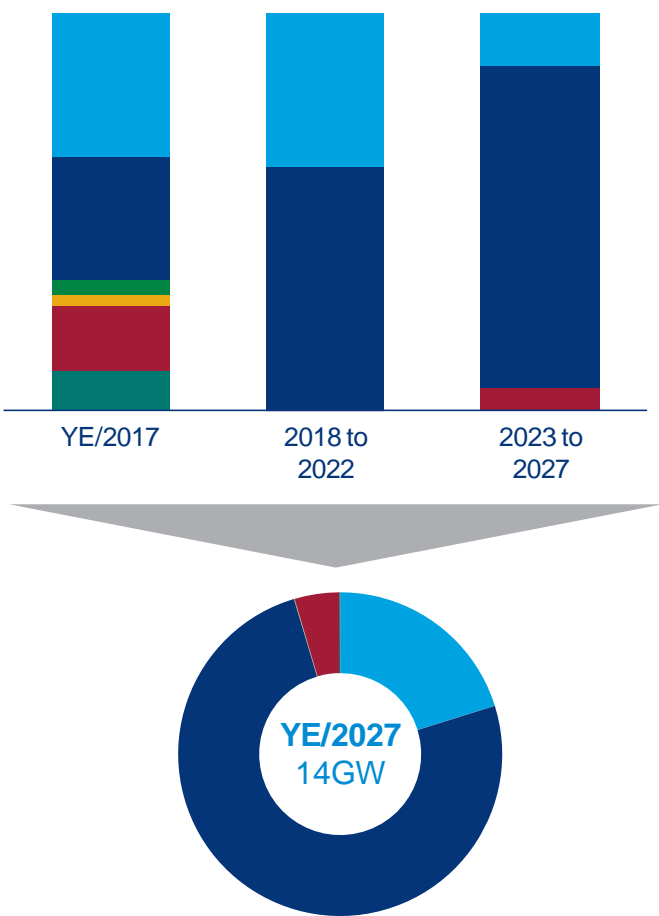


Substructures and Foundations trends

Foundation outlook globally



Foundation outlook in APeC



Factors affecting developments

- Costs (As overall driver)
- Water levels
- Seabed conditions
- Wind conditions
- Seismic conditions
- Manufacturing capacities
- Manufacturing qualifications
- Designated areas and targets

Installations Vessels trends

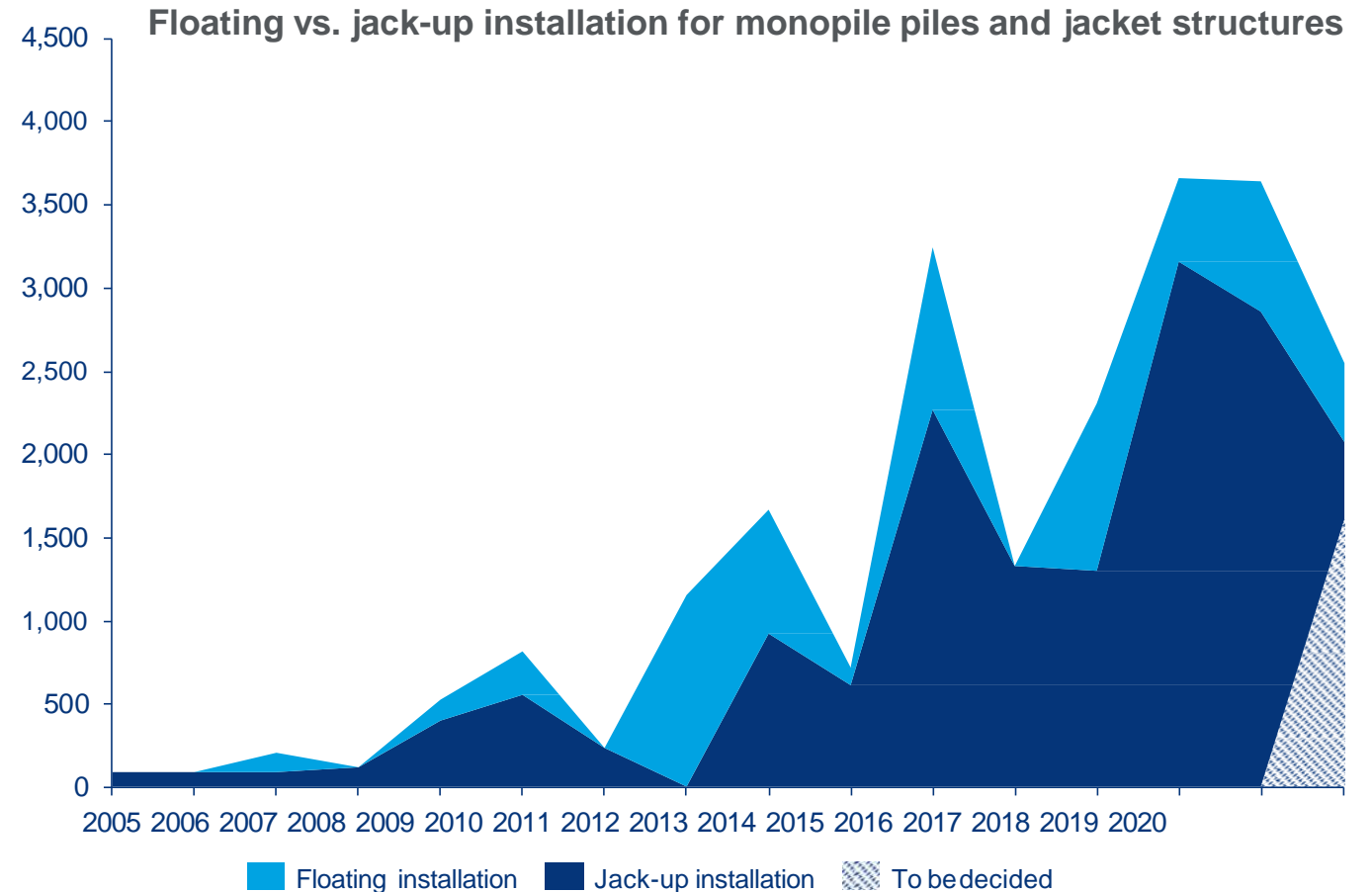
Common to the **potential** new vessels into offshore wind is that they are floating and on average has double the **deck space** and **crane** capacity compared to the existing fleet with a **backlog**.

Potential new entrants originate from:
Existing vessels active in **O&G** converted for turbine installation due to decreased activity in O&G

Existing **offshore wind** installers looking to strengthen their fleet.

Companies **launching** new vessels to break into the offshore wind.

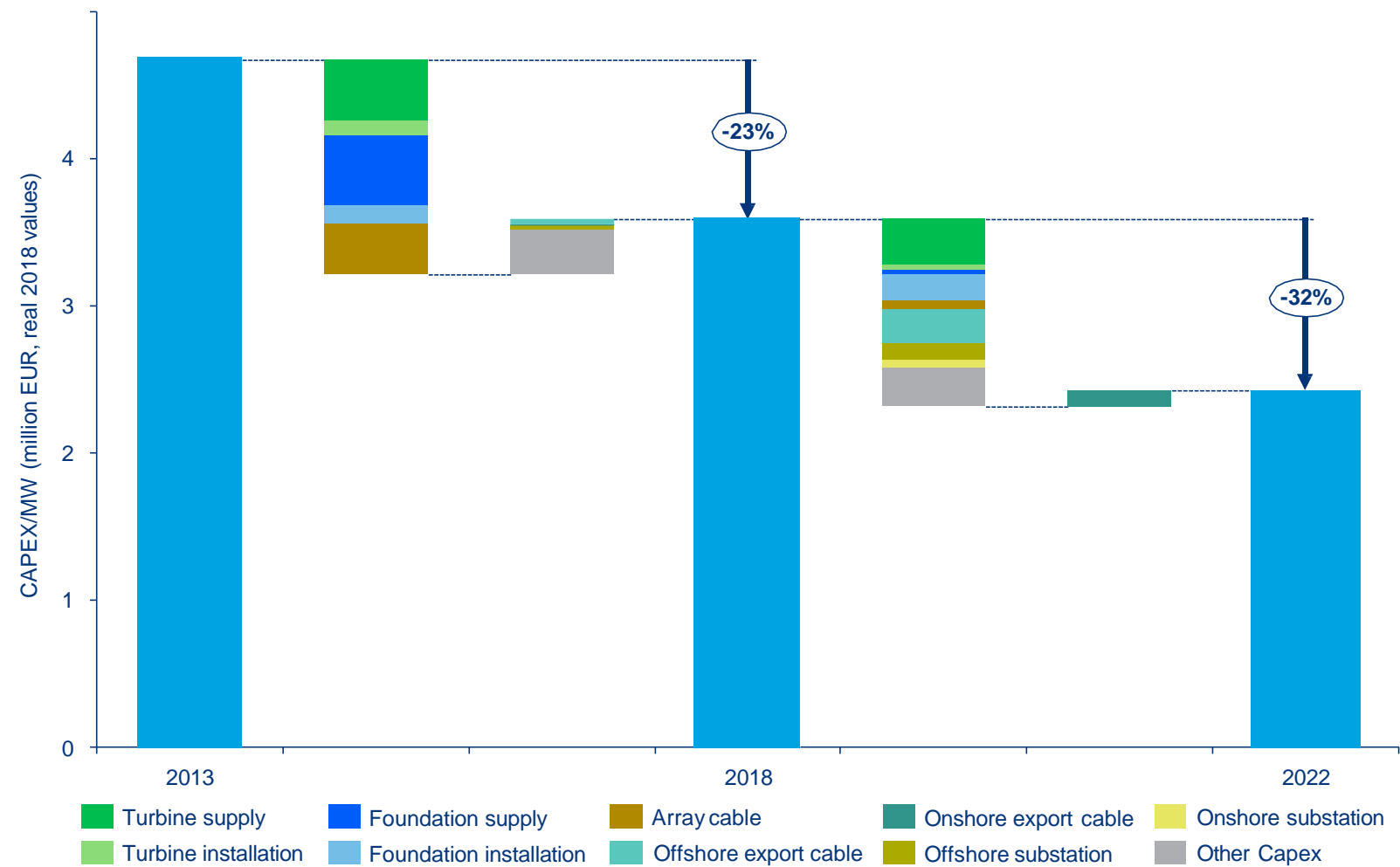
Driving factors: Capacity, Seabed conditions, Deck space.



Note: Based on the year a project becomes fully grid-connected.
Source: Wood Mackenzie

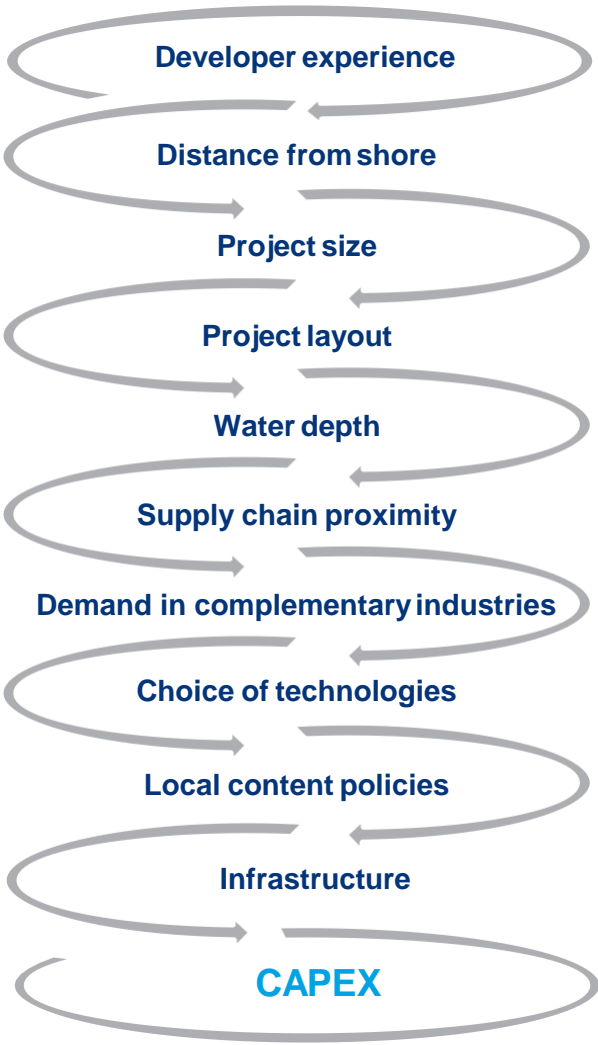
Finacial Trends

CAPEX Europe Expectations and Break Down



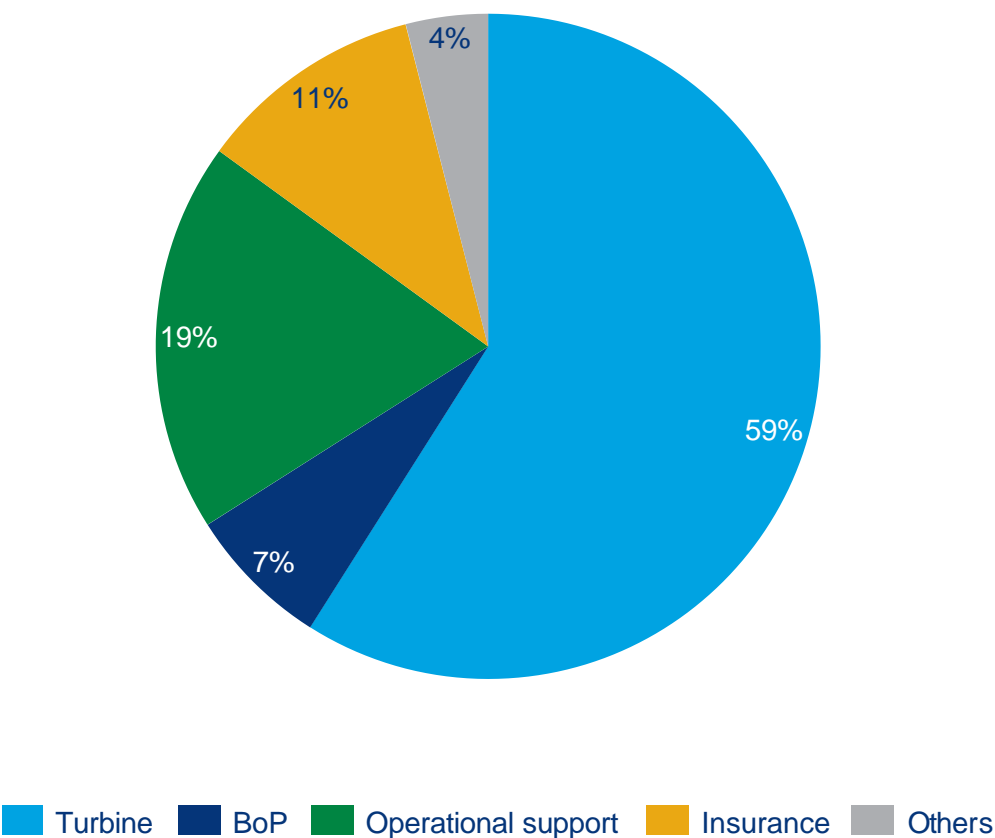
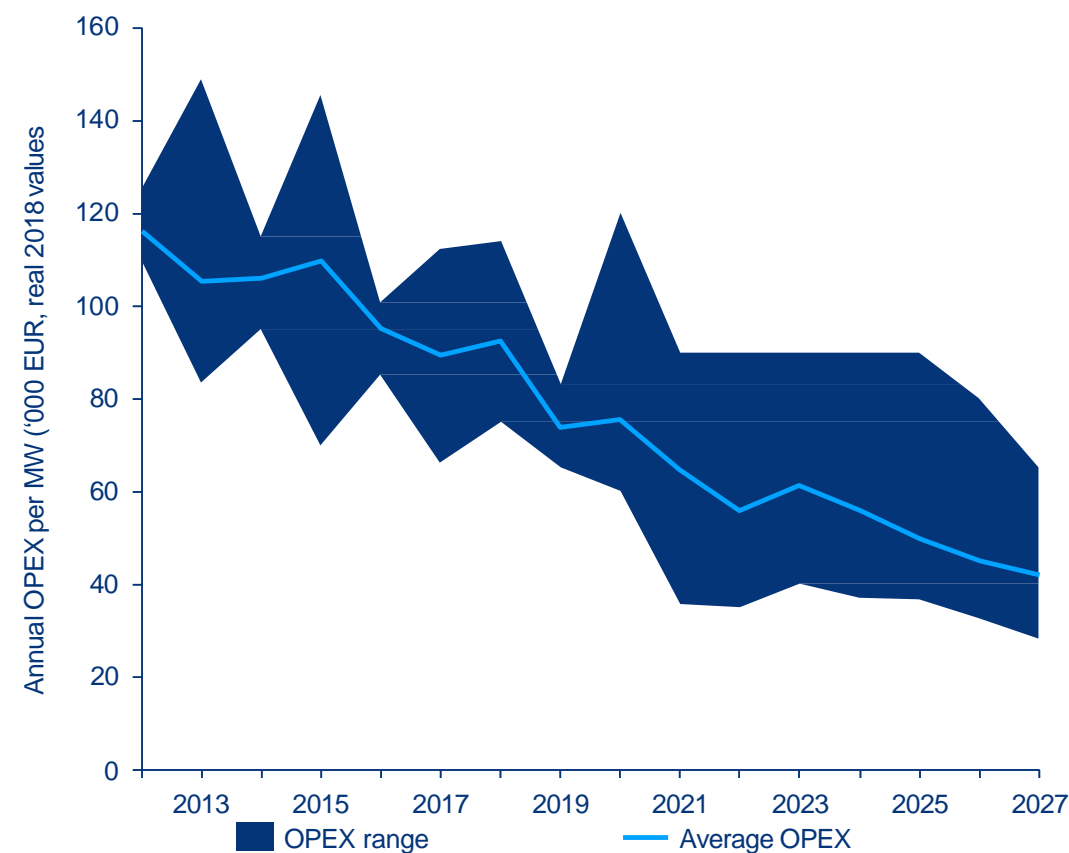
Note: CAPEX is an output of multiple project-specific factors. Hence, the cost-out breakdown will vary from project to project.

Source: Wood Mackenzie



OPEX developments in Europe

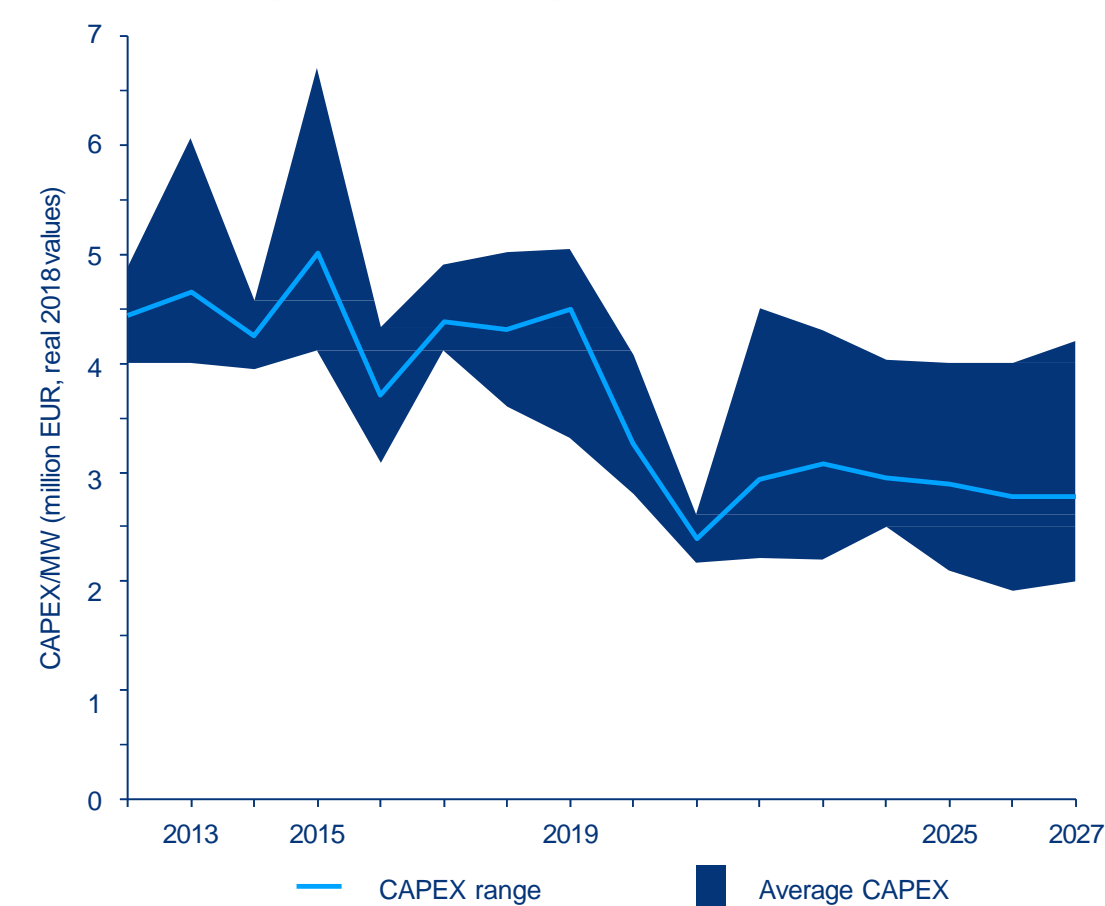
Technical OPEX developments in Europe



Note: Based on the year a project becomes fully grid-connected. Technical OPEX excludes grid use of system charge, land lease and transmission assets maintenance.
Source: Wood Mackenzie

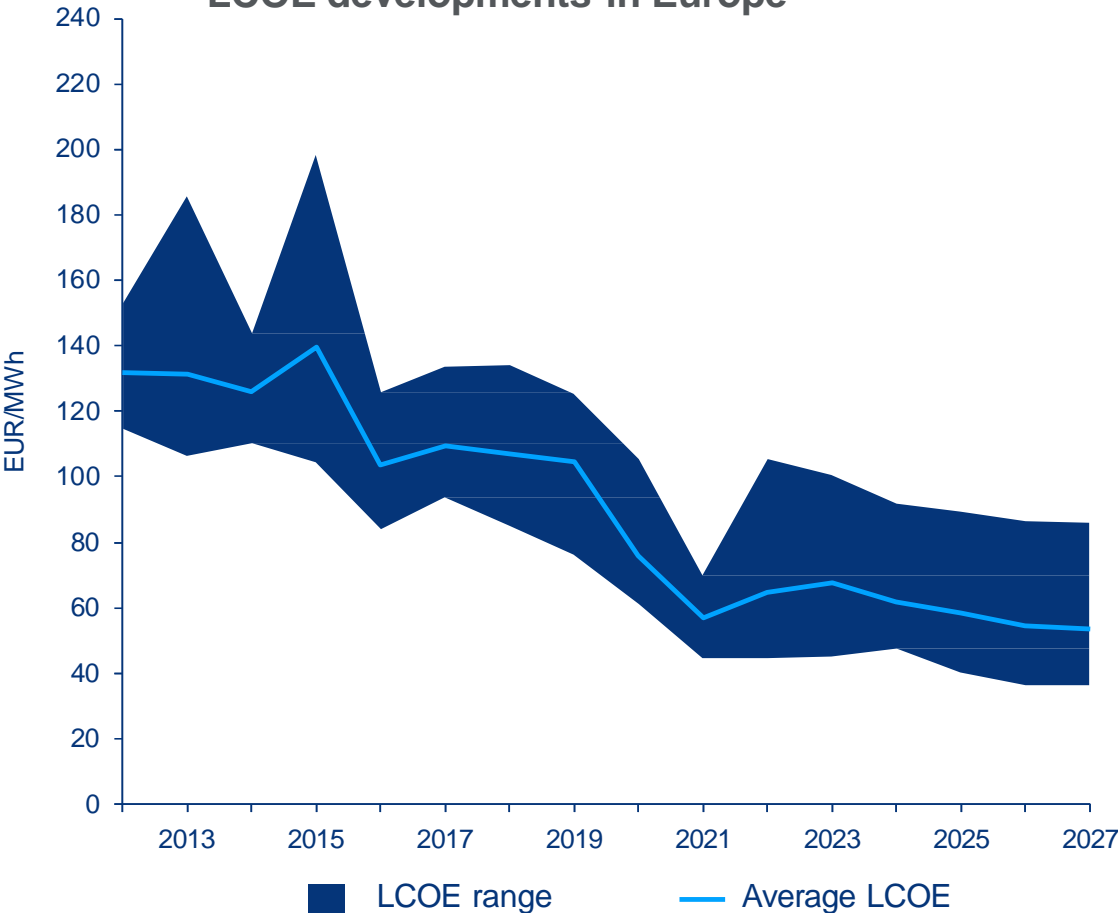
LCOE and CAPEX trends in Europe

CAPEX developments in Europe



Note: Demonstrators are excluded. Based on the year a project becomes fully grid-connected.
Source: Wood Mackenzie

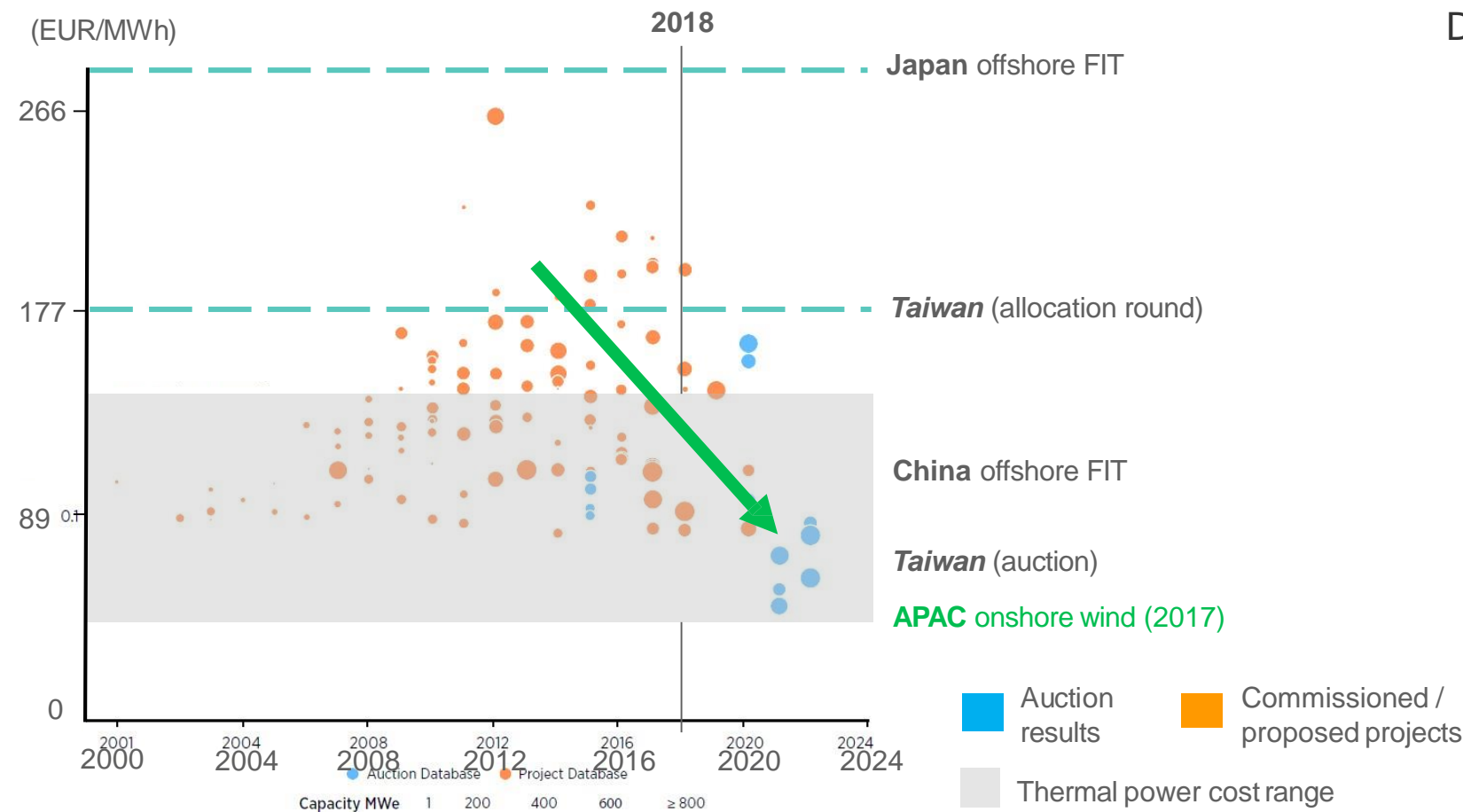
LCOE developments in Europe



LCOE Global and Regional

Global offshore wind LCOE and Asia Pacific offshore wind prices

Data from MAKE 2018



Opportunities in APAC

Use of international standards is key for successful new offshore wind projects

- **Certification schemes for offshore wind are available:**
 - International: IEC(RE), DNV GL
 - National schemes are often based on IEC with local amendments (Germany, USA, The Netherlands, Denmark, Taiwan etc.)
- **Design and fabrication standards for offshore wind are available**
 - International: IEC(RE), ISO, DNV GL Standards
 - National standards are based on local requirements and often on standards for onshore construction or for offshore O&G
 - Standardization is the **process** of implementing and developing **technical standards** based on the *consensus* of different parties that include firms/developers, users, interest groups, standards organizations and governments
 - Standardization can help to **maximize** compatibility, interoperability, **safety, repeatability**, or **quality** (TDD or PC)
- **Standards for onshore construction and offshore O&G are not appropriate for offshore wind!**
- **HSE requirements for working in wind is covered mainly by GWO**
- **Use of international standards and certification will help facilitate international project financing**

Areas of local opportunities – Helping to bring down LCOE

- Development
 - Site investigations
 - Methodologies for Design
- Fabrication
 - WTG and components
 - Substructures
 - Cables
 - Vessels
- Installation
 - All Parts of an OWF
- O&M industry
 - WTGs
 - CTVs
 - Substructures
 - Cables

- **Cooperation is important – but not always easy**

