Renewables Consulting Group

Floating Offshore Wind Presentation

Supergen ORE Hub Early Career Researchers Forum

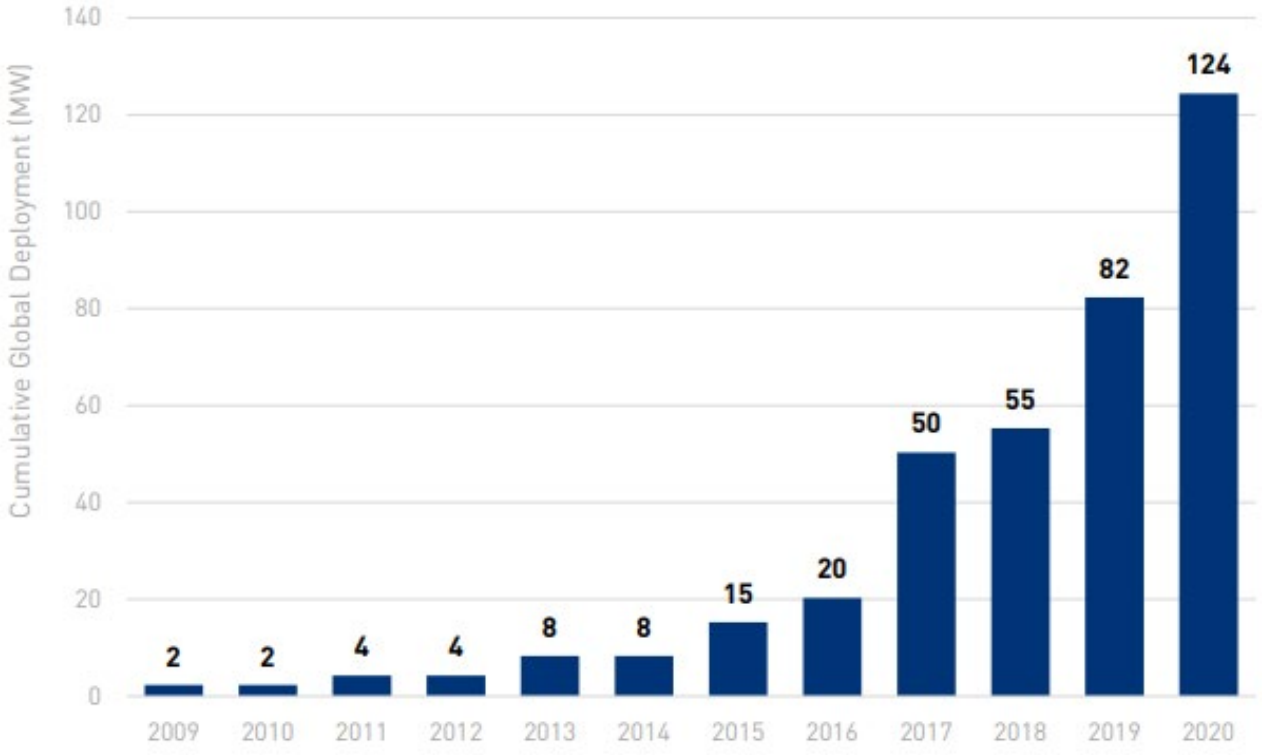
20th January 2020

Floating Wind Current Status

» Demonstrators and pilot projects up circa 2025

» Projects from 2MW to 66MW

» Single floater up to 11 floaters



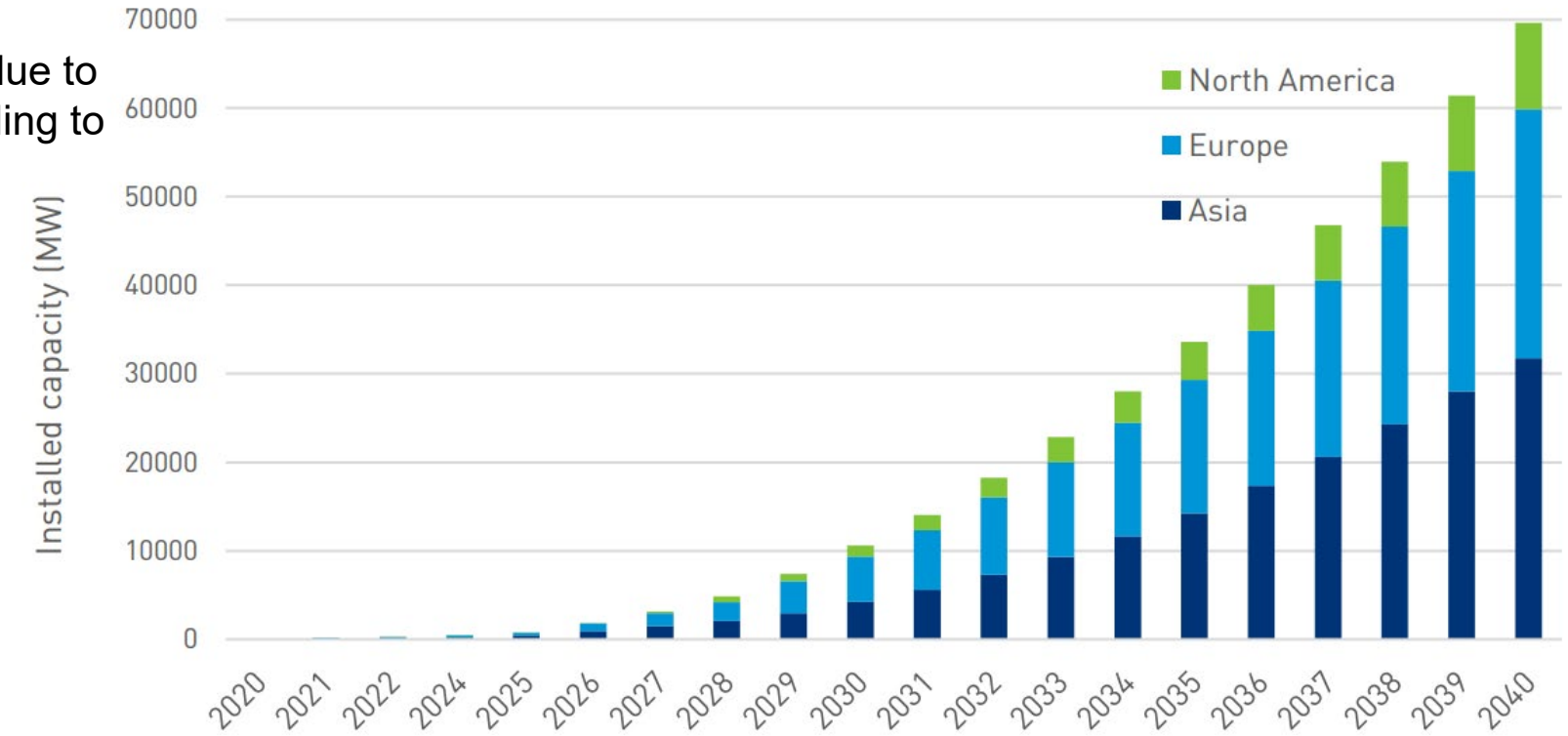
Source: Carbon Trust

Floating Wind Deployment

- Scaling up to 200 MW projects in later 2020s
- Beyond 2030 utility-scale (>300 MW) projects expected
- Visibility beyond 2025 still challenging due to current scaling and cost reduction needing to be proven

<u>Expected deployment:</u>

- 10 GW by 2030
- 34 GW by 2035
- 70 GW by 2040



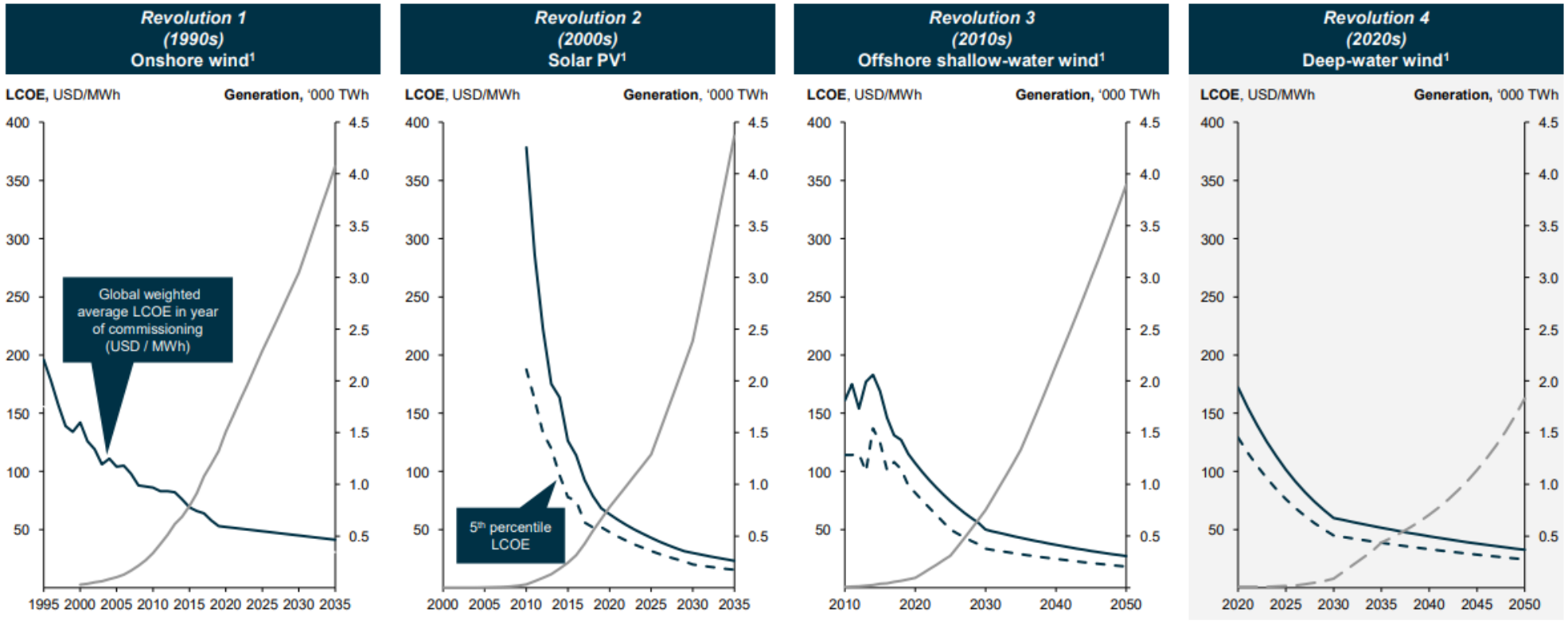
Source: Carbon Trust

Cost Reduction

Drivers

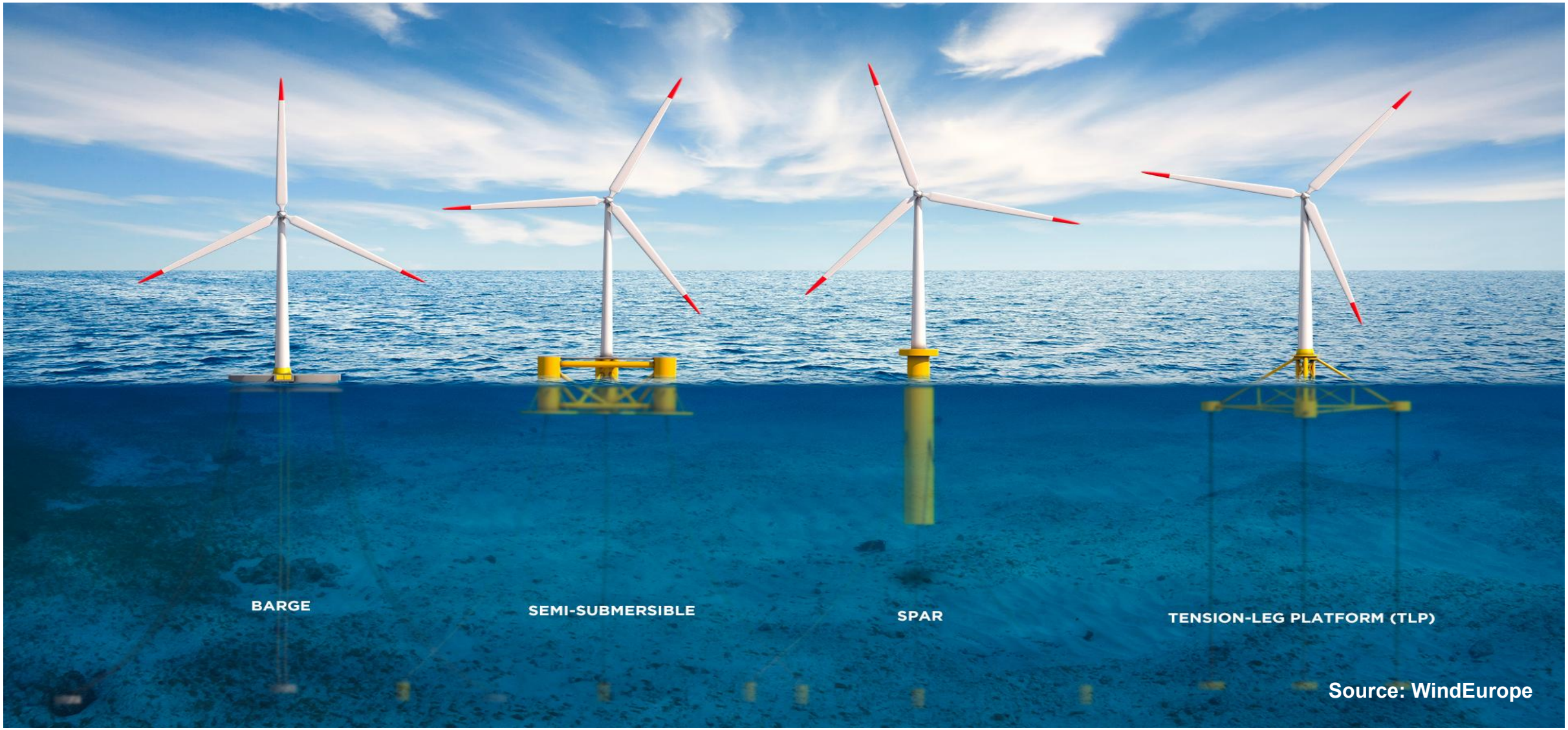
» Design / technical

» Commercial



Source: Aker Solutions

Types of FOW foundations



Challenges when comparing FOW to FBOW

Despite the similarities, there are a few aspects that are completely different between FBOW and FOW or that have some particularities.

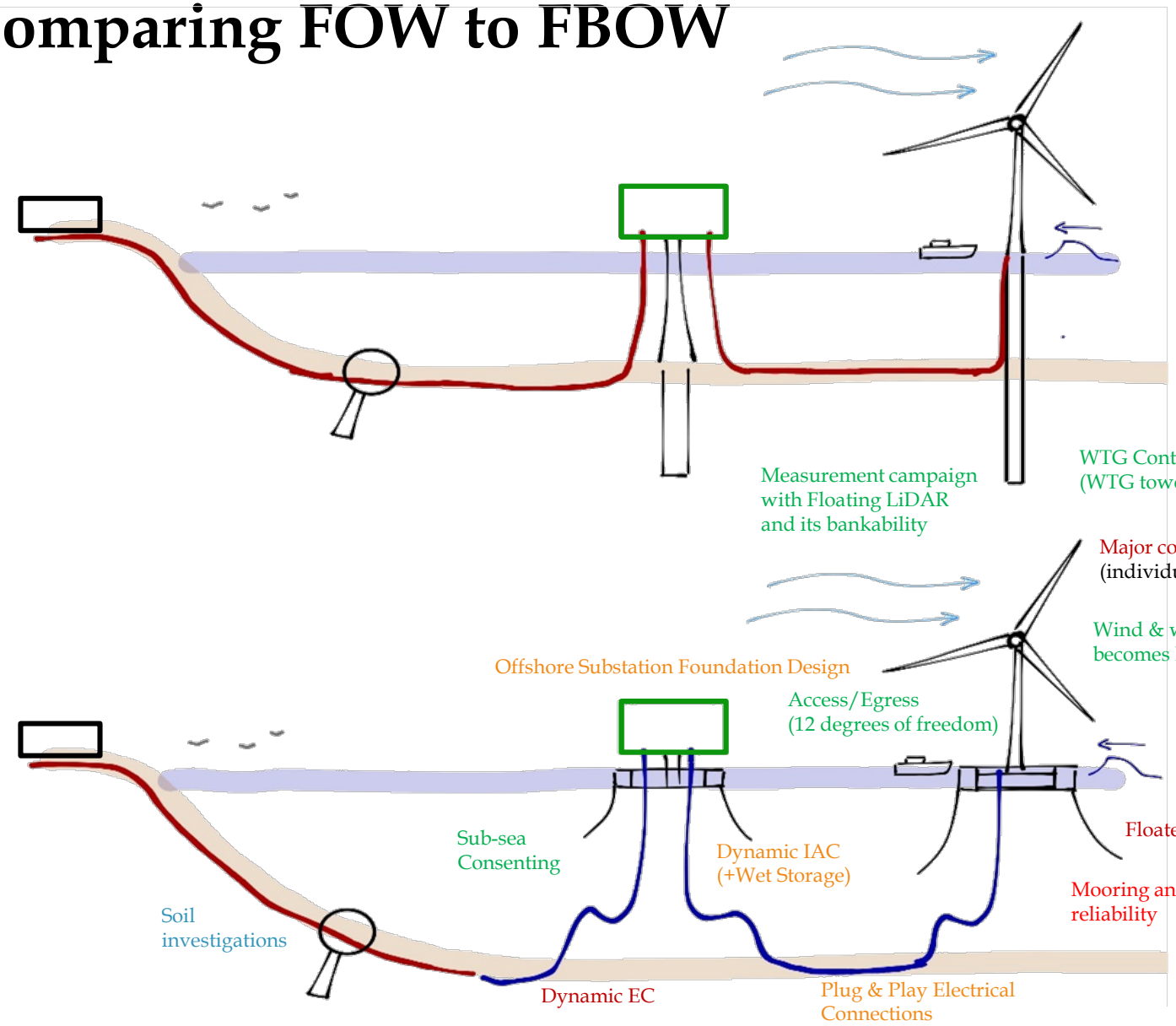
The main highlights are shown here.

Criteria:
- Low concern items (Green)
- Medium concern items (Amber)
- High concern items (Red)
- Benefits/Upsides (Blue)

Note that a concern (or focus area) becomes a risk if it is not properly mitigated following a detailed technical due diligence

Benefits vs FBOW:
- Standardisation
- Serial Fabrication
- No need for jack-up vessel

Additional Challenges:
- Understanding of Wakes.
- Additional yield losses (e.g. mooring line failures)
- Fabrication facilities constraints.



New Design Challenges

» Similar loading, but:

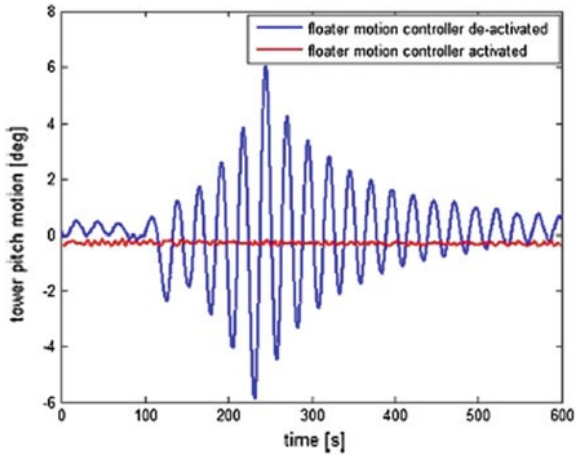
– Floating environment – Buoyancy!

– Interaction Substructure – WTG – Moorings

- WTG Agnostic concepts important
- Interface between OEM and substructure designer

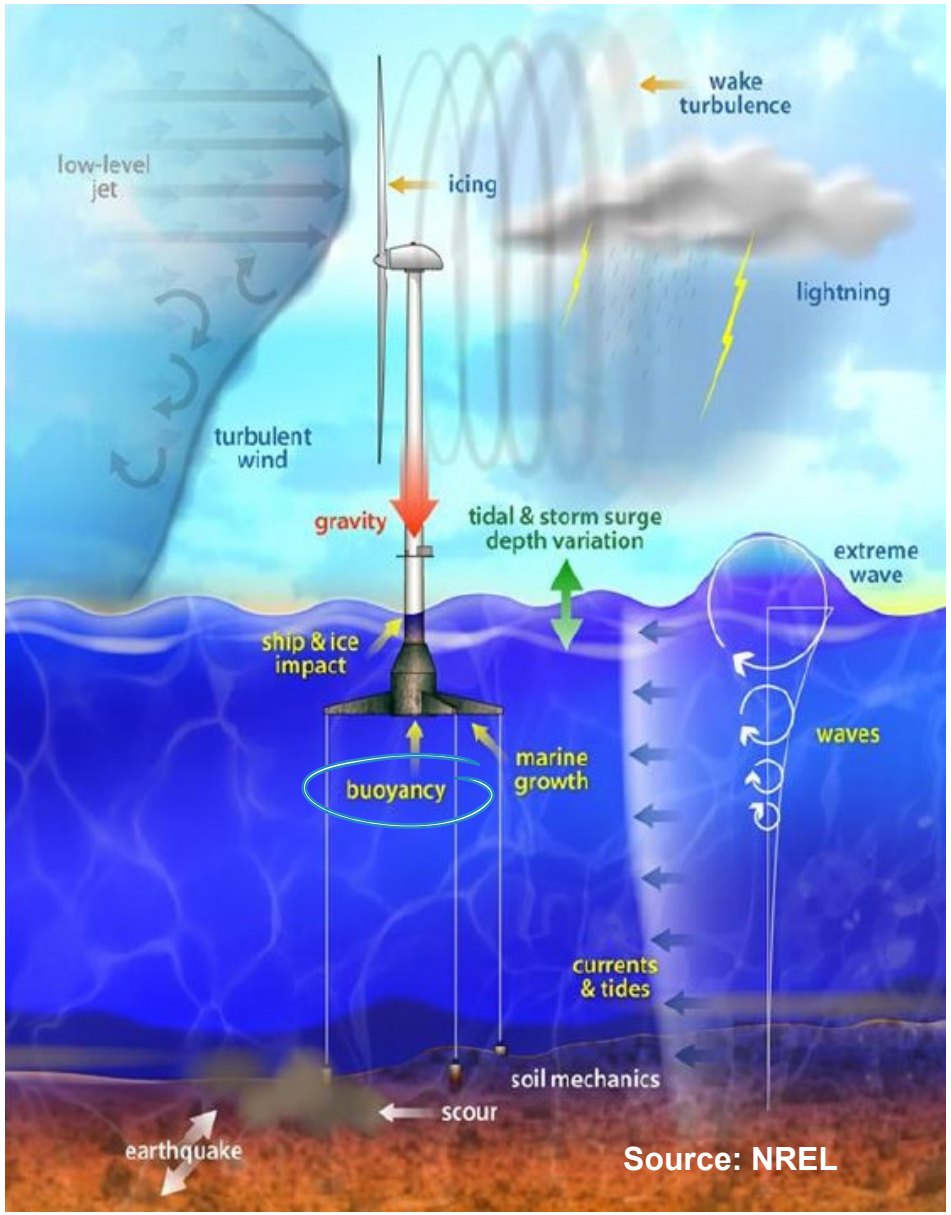
– Optimisation from Demo to Commercial

- Less sensitive to WTG size increase



Hywind Demo with the floater motion controller (Cruz and Atcheson, 2016)

Hywind: Scale from demo to pre-series (Equinor)



Summarising Key challenges

- Coupled aero and hydrodynamics
  - Creates technical and design challenges due to coupled behaviour
  - Commercial challenges

- Material Handling
  - From fabrication right through to offshore operations (Floater transport, WTG installation, mooring systems, etc.)
  - As offshore wind scales, components will get very large and infrastructure required to support

- Asset integrity

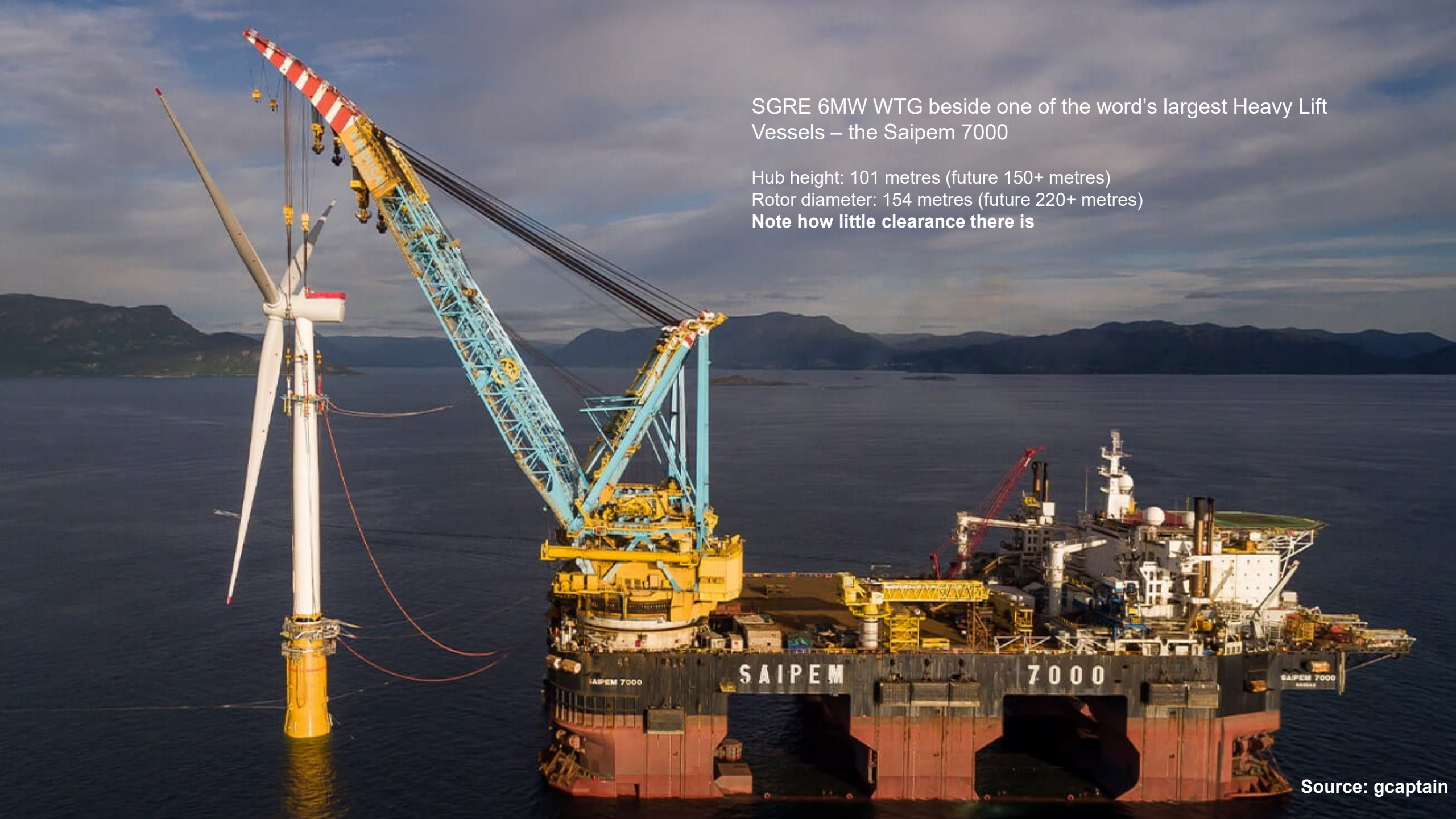
- Mooring Systems

- Heavy / Main Component maintenance

- Dynamic export cables

Turbine size

- WTGs with ~220m rotor diameter to be installed in 2022
  - GE Haliade X (14 MW) for Dogger Bank
  - Siemens Gamesa have similar size WTG
  - Hub height of 140-150 metres
- MHI Vestas expected to announce new larger WTG
- When FOW reaches commercial-scale, WTGs of up to 20 MW will likely be available. Meaning..
  - 240m rotor diameter
  - Hub heights 150-160 metres



SGRE 6MW WTG beside one of the word's largest Heavy Lift Vessels – the Saipem 7000

Hub height: 101 metres (future 150+ metres)
Rotor diameter: 154 metres (future 220+ metres)
Note how little clearance there is

Source: gcaptain

Floating Wind Commercial Challenges

CONTRACTUAL

» No “simple” static interface between foundation and WTG tower

» Challenge is the interface between Developer, WTG supplier and EPC

  – WTG supplier and EPC are keen to reduce warranty obligations

  – Verifying design and agreeing liabilities important

  – WTG power performance validation

PROCUREMENT

» Developers preference still to use BFOW tendering methods

» Front End Engineering Design specific to a floater type and more time consuming

	Construction packages	Scope	Providers
1	Construction Management Agreement (“CMA”)	Construction management services and certain asset management services related to the construction and commissioning of the wind farm	EDF renewables UK
2	Connection Agreement (“CA”)	Grid connection agreements with National Grid covering the connection to the existing Crystal Rig substation	nationalgrid
Construction Packages 3	Turbine Supply (“TSA”)	Fabrication, supply, pre-assembly, installation and commissioning of 54 SG-8.0-167 WTGs	SIEMENS Gamesa RENEWABLE ENERGY
4	EPCI Foundations (“FOU”)	Design, fabrication, supply and installation of jacket WTG and OSS foundations Transport and Installation of Substation topsides	SAIPEM
5	WTG Installation Vessel (“WIG”)	Charter for WTG installation vessel	Fred.Olsen & Co.
6	High Voltage Stations (“HVS”)	Design, fabrication, supply and pre-commissioning of onshore and Offshore Substations, electrical system design and SCADA	GE, HSM offshore
7	Export cables (“EXP”)	Design, fabrication, supply, installation, termination and pre-commissioning for onshore and offshore export cables	Prysmian Group
8	Inter-Array Cables (“IAC”)	Design, fabrication, supply, installation, termination and pre-commissioning of inter-array cables EPCI of the 66kV platform interconnecting cable	Tideway

Example of Bottom-Fixed Offshore Wind Contractual set up (Neart Na Gaoithe used as example)

Opportunities

- WTG scales more favourably for FOW than BFOW, hence the drive to bigger WTGs
- Opportunity to not utilise expensive offshore heavy lifts if work completed onshore (possible also for O&M)
- Standardisation of components and foundations
- Market size much larger: globally water depths deeper than European North Sea
- Access to resource further offshore
- Benefit in areas with poor seabed conditions; eg Baltic Eagle where potential punch through issues with JUV

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