Centrale-Energies / Centrale Métiers de la mer
Eolien Maritime
Mercredi 13 Janvier 2021

Maxime GOUGET
ECN Promotion 2012
Service Sales Manager - MHI Vestas Offshore Wind

1. WTG Market and suppliers

MVOW : Established in 2014 on decades of experience

Delivering affordable offshore wind power

- A joint venture between two **industry leaders**: Vestas Wind Systems A/S (50%) and Mitsubishi Heavy Industries Ltd (50%)

- Founded 1 April 2014, now employing **~3,500 employees**

- Sole focus on **offshore wind**

- Our business is to **design, manufacture, install and service wind turbines**

- Our approach is truly **collaborative** – we aim to create strong partnerships with customers, suppliers and other stakeholders in the industry

Main market players join forces to de-risk & gain market volumev

MHI Vestas and SGRE account for >80% of the market (installed capacity in Europe)
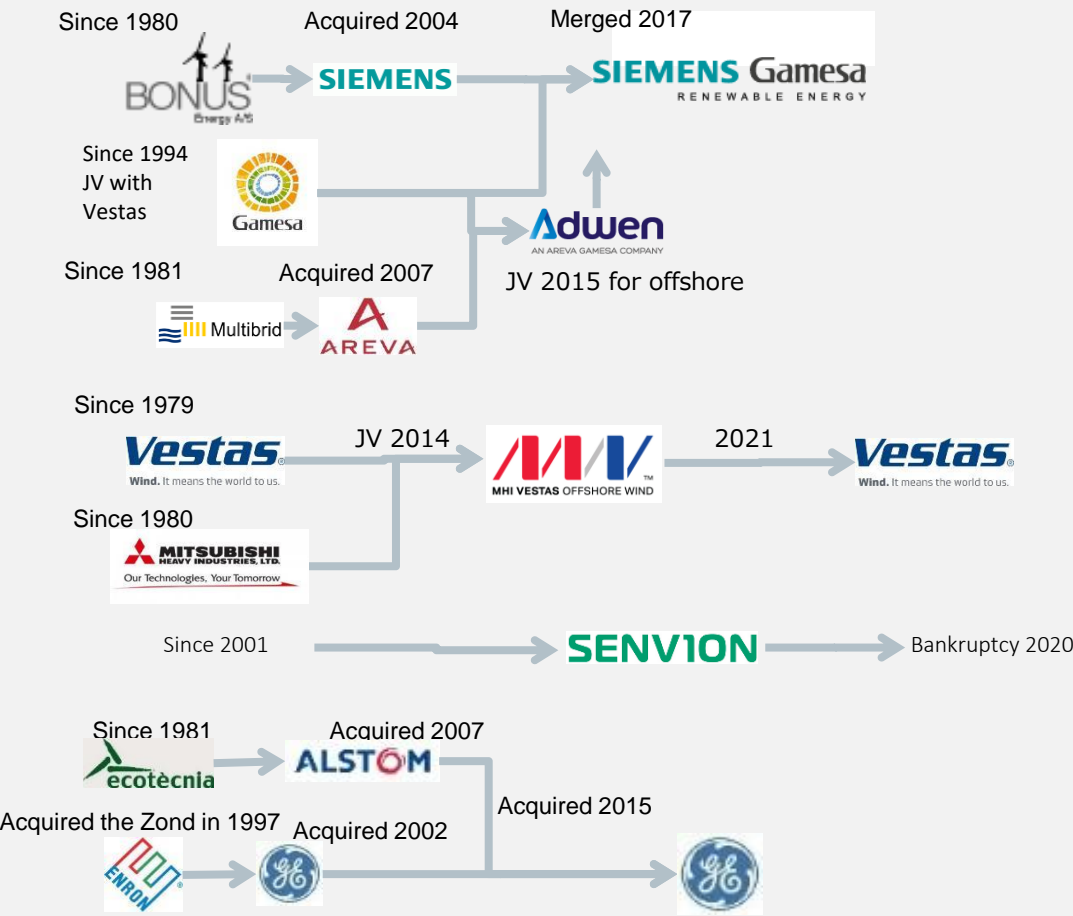
Since 1980   Acquired 2004   Merged 2017

BONUS Energy A/S → SIEMENS → SIEMENS Gamesa RENEWABLE ENERGY

Since 1994 JV with Vestas — Gamesa

Since 1981   Acquired 2007

Multibrid → AREVA

Adwen AN AREVA GAMESA COMPANY

JV 2015 for offshore

Since 1979

Vestas Wind. It means the world to us.   JV 2014 → MHI VESTAS OFFSHORE WIND   2021 → Vestas Wind. It means the world to us.

Since 1980

MITSUBISHI HEAVY INDUSTRIES, LTD. Our Technologies, Your Tomorrow.

Since 2001 → SENVION → Bankruptcy 2020

Since 1981   Acquired 2007

ecotecnia → ALSTOM

Acquired 2015

Acquired the Zond in 1997   Acquired 2002

ENRON → GE → GE

FIGURE 12
Wind turbine manufacturers' share at the end of 2019

Siemens Gamesa Renewable Energy	68.1%	15 GW / 3,438 turbines
MHI Vestas	23.5%	4.8 GW / 1,187 turbines
Senvion	4.4%	1.3 GW / 222 turbines
Bard Engeneering	1.6%	0.4 GW / 80 turbines
GE Renewable Energy	1.5%	0.4 GW / 74 turbines
Others	0.9%	0.07 GW / 45 turbines

TOP 3 REPRESENT

96%

OF ALL CAPACITY CONNECTED

Source: WindEurope
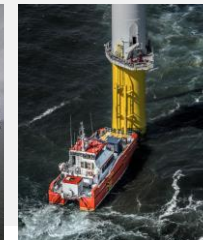
Turbine Supplier Scope of Work

- ## Turbine Supply Agreement TSA
  - ### Turbine
    - Nacelle
    - Blades (Hub)
    - Tower
  - ### Transport
  - ### Offshore Installation

- ## Service & Maintenance Agreement SMA

Duration : 5, 10, 15,… years
  - ### Turbine Remote supervision
  - ### Turbine preventive Maintenance
  - ### Turbine corrective Maintenance

Availability Warranty

2. WTG Technology

New Generation of Offshore Wind Turbines

GE HALIADE X

12 to 14 MW
Rotor Diameter 220m
Blade lenght 107m
Nacelle mass 600tons
Hub Height 135m

Direct Drive
Prototype in Rotterdam

SGRE SG 14-222 DD

14+ MW
Rotor Diameter 222m
Blade lenght 108m
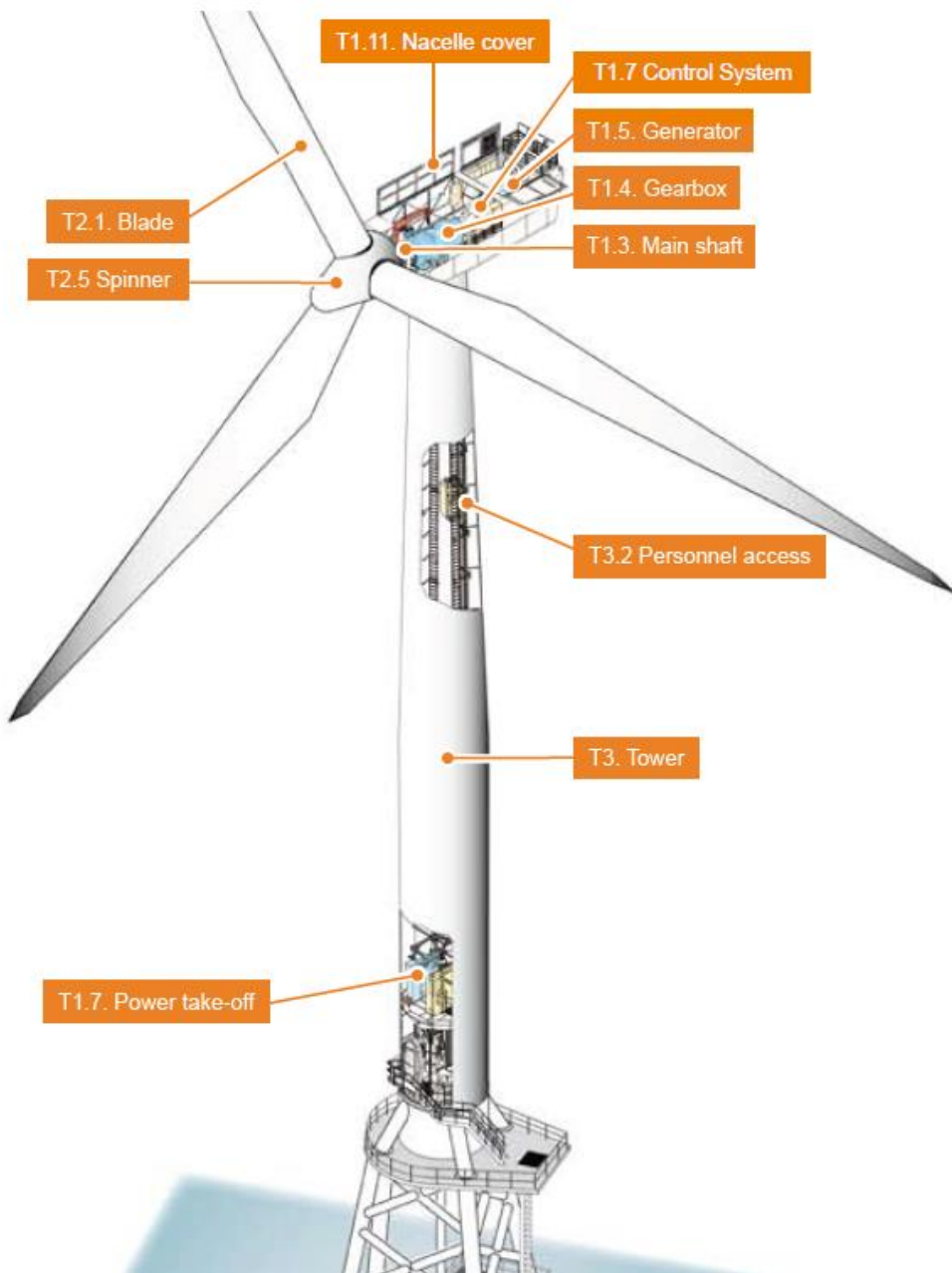Nacelle mass ~500tons
Hub Height *Site Specific*

Direct Drive

MHI VESTAS : TBA

To be Announced

XX MW
Rotor Diameter XX.
Blade lenght XXX m
Nacelle mass XXX tons
Blade mass XX tons
Hub Height *Site Specific*

$$P_T = \frac{1}{2} * \rho * A * v^3 * C_p$$

ρ = Densité de l'air

A = Surface balayée : la puissance est proportionnelle au carré du diamètre de l'éolienne

v = vitesse du vent : la puissance est proportionnelle au cube de la vitesse du vent

Cp = Ratio de puissance extraite par la turbine par rapport à la puissance totale du vent Cp = PT/PW. La limite de Betz est le rendement maximum avec une éolienne conventionnelle et est égal à 16/27 (59%).
Pour les éoliennes modernes, les rendements avoisinent les 45%
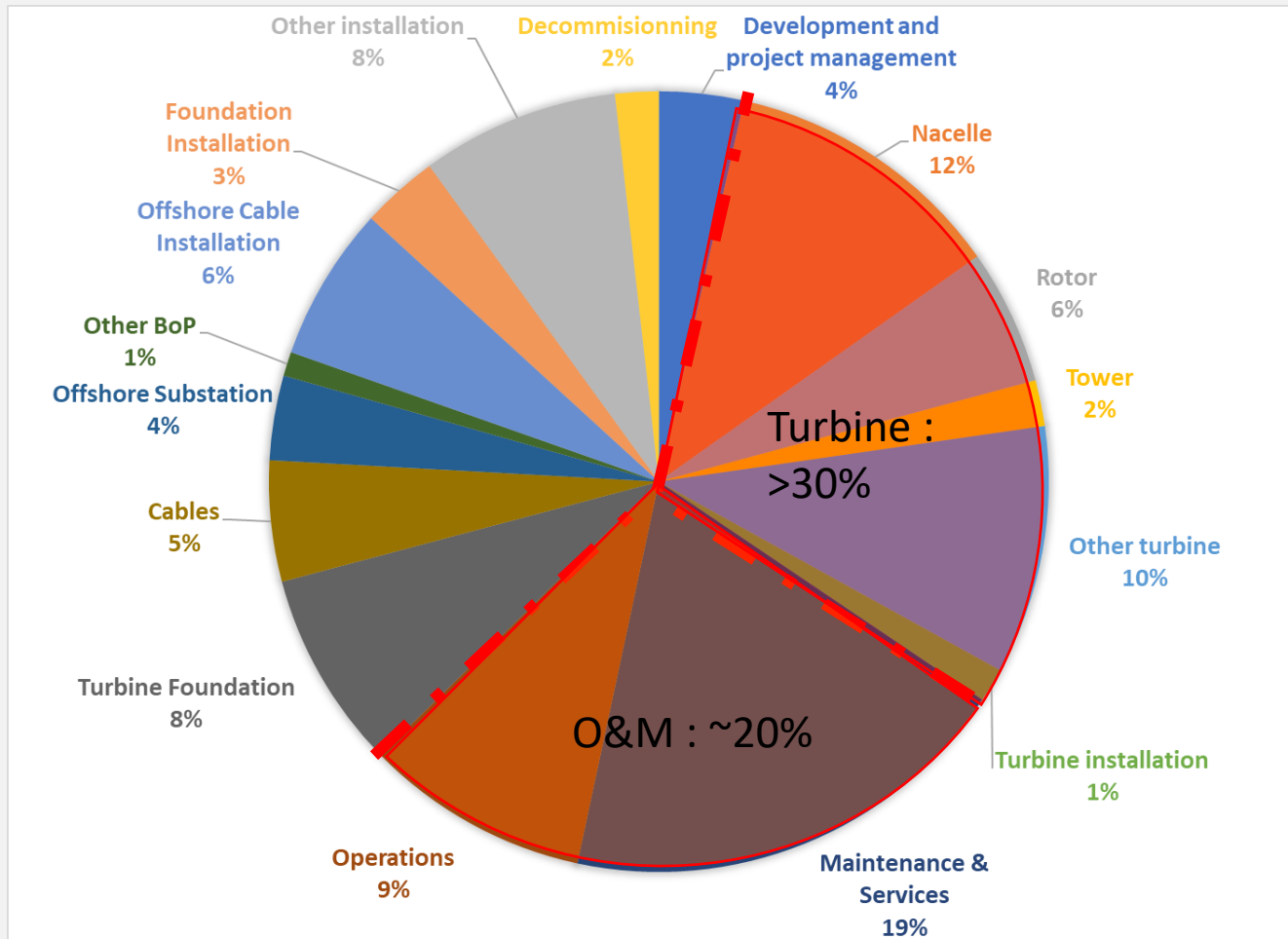
Wind Turbine Power Curves
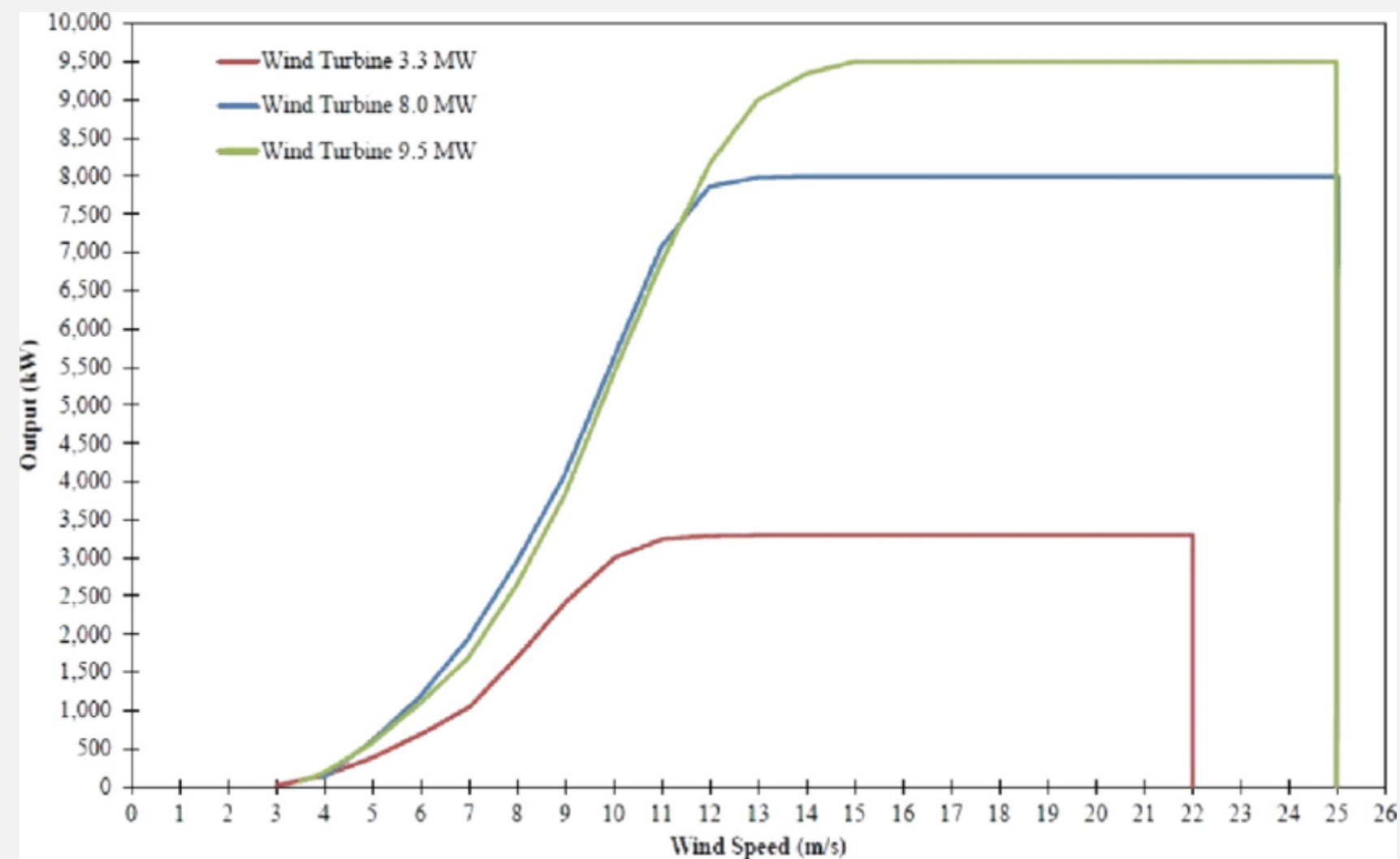
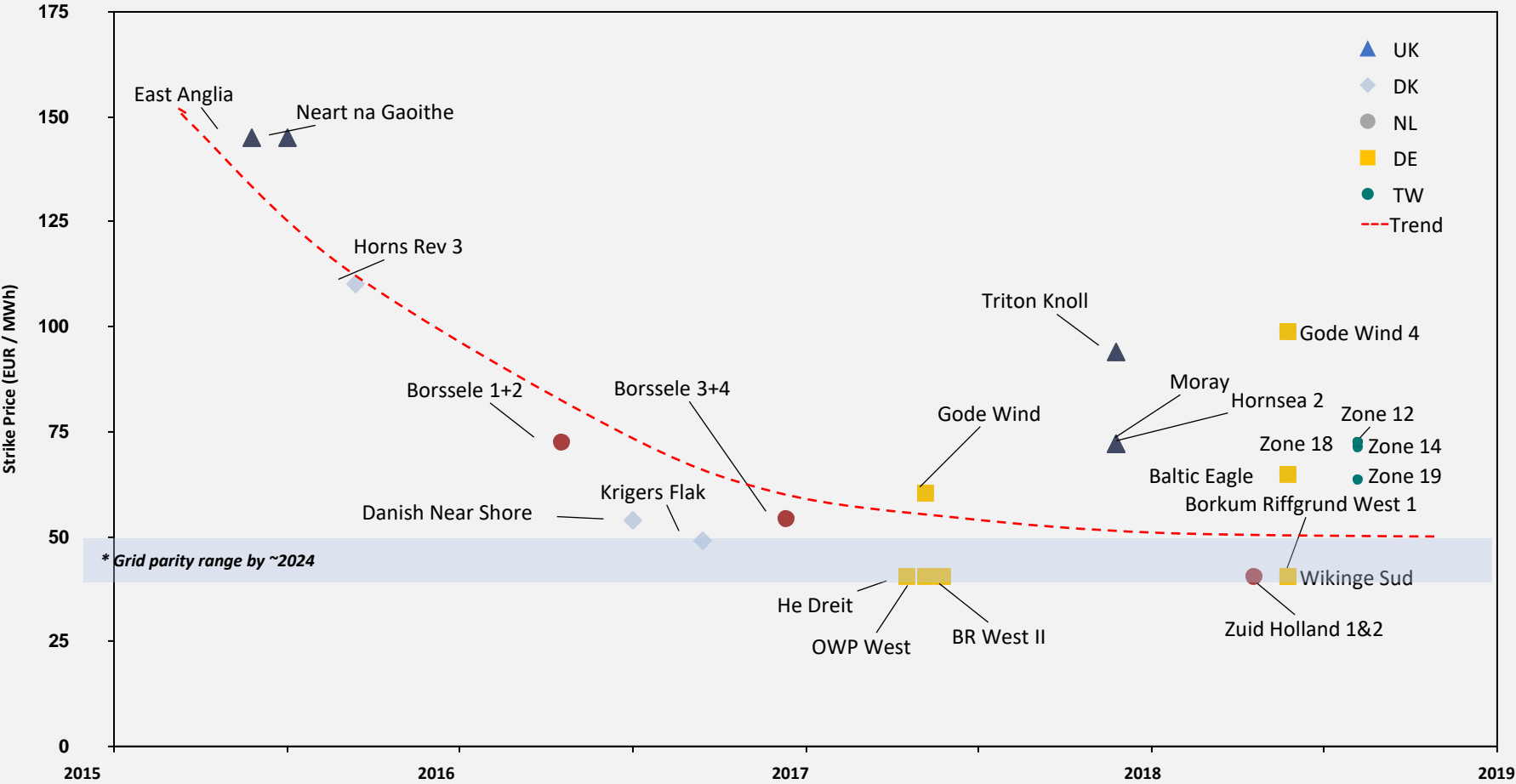# Wind Turbine Power Curves
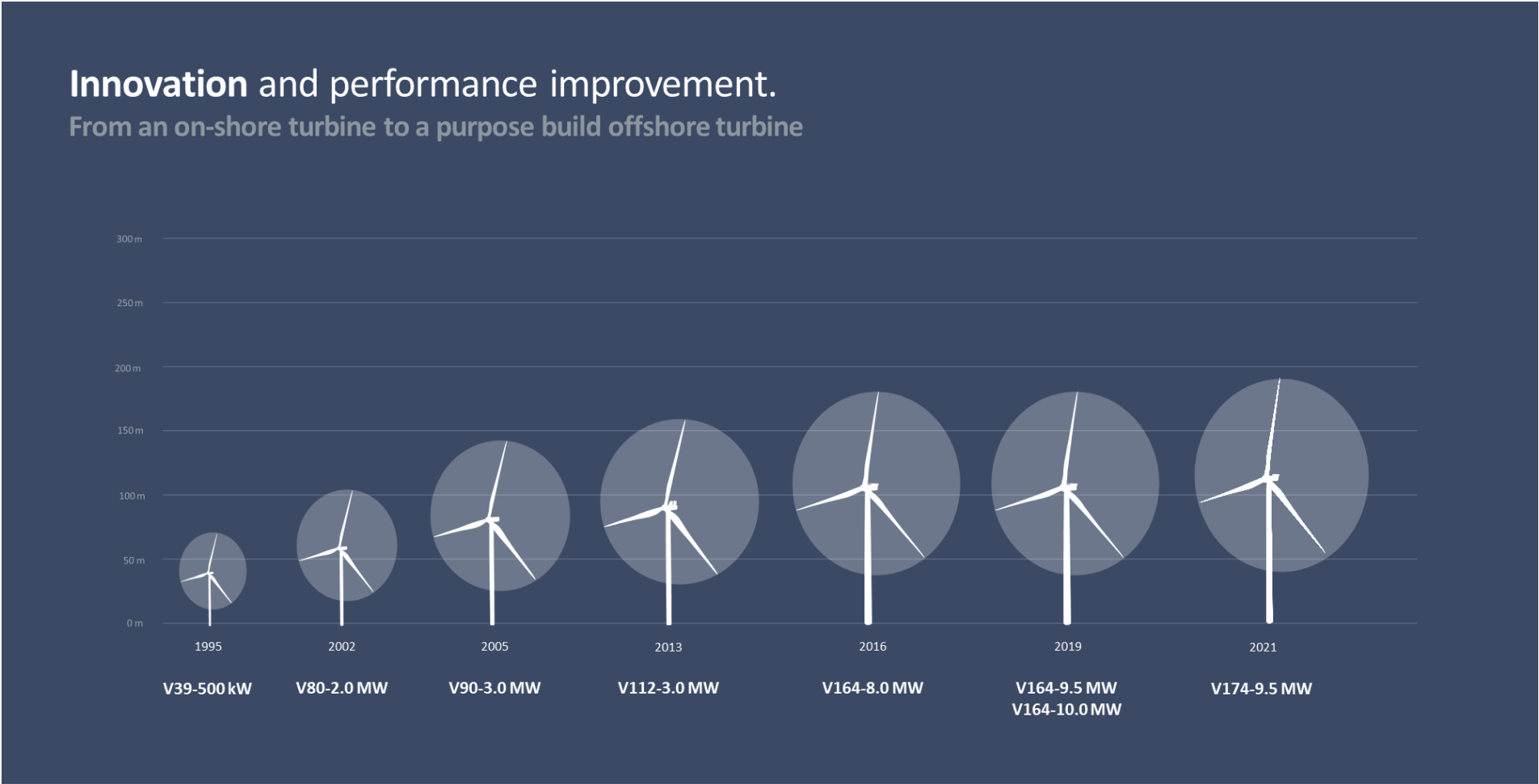
4. WTG Economics

Wind Turbine and its O&M accounts for ~50% of total project value

- 30% of project value linked to WTG pure CAPEX, transport and Installation

- WTG OPEX accounts for 20-30% of project value

- Others contributors are :
  - Project development
  - Foundations
  - Cables
  - Substation

- Installation is ~20% of project value, including decommissioning

Offshore wind CoE is approaching grid parity

Market volumes driven by strong political frameworks and reduced subsidies

Legend:
- ▲ UK
- ◆ DK
- ● NL
- ■ DE
- ● TW
- --- Trend

Chart data points (Strike Price EUR/MWh):
- East Anglia
- Neart na Gaoithe
- Horns Rev 3
- Borssele 1+2
- Borssele 3+4
- Triton Knoll
- Gode Wind 4
- Moray
- Hornsea 2
- Zone 12
- Zone 18
- Zone 14
- Baltic Eagle
- Zone 19
- Borkum Riffgrund West 1
- Danish Near Shore
- Krigers Flak
- Gode Wind
- * Grid parity range by ~2024
- He Dreit
- OWP West
- BR West II
- Wikinge Sud
- Zuid Holland 1&2

Y-axis: Strike Price (EUR / MWh) — 0, 25, 50, 75, 100, 125, 150, 175
X-axis: 2015, 2016, 2017, 2018, 2019

Right side diagram:
- Aggressive long-term policy 【Economies of scale】
- Larger and reliable wind turbine 【Technical Innovation】
- Maturation of offshore industry 【Learning effect】

- Government led auction enables fierce competition
- Plunge of strike price reduces subsidy amount, leads to further offshore market volume
- Forms a virtuous circle

- UK and TW Strike Price has been converted to EUR with the currency rate at timing of the tender
- Subsidy free tenders are described with the expected market price

Source: MAKE Consulting, MHI Vestas Offshore Wind, MOEA TW

Reducing installation cost
Construction and value chain optimisation

Factory

€

Pre-assembly

€€

Offshore

€€€€

- We are building **offshore projects onshore**
- Building on **experience**
- **Moving more processes** back to the factory
- Pre-assembly **concept**
- Improvement of **safety and quality**

4. WTG O&M Strategies

MVOW global footprint – our offices, service and O&M bases

PORT OF BLYTH
Service / O&M base

WARRINGTON
Office

AARHUS
Office

ABERDEEN
Service / O&M base

BARROW IN FURNESS
Service / O&M base

ESBJERG
Service / O&M base

GRIMSBY
Service / O&M base

EEMSHAVEN
Service / O&M base

HOLYWELL
Service / O&M base

EMDEN
Service / O&M base

NORTHEAST
Office

LONDON
Office

HAMBURG
Office

NORDEN-NORDDEICH
Service / O&M base

TOKYO
Office

SEACOMBE / WALLASEY
Service / O&M base

IJMUIDEN
Service / O&M base

TAIPEI
Office

NEWHAVEN
Service / O&M base

OOSTENDE
Service / O&M base

OFFICE location

SERVICE / O&M base

MHI VESTAS OFFSHORE WIND™

Offshore Wind O&M strategies
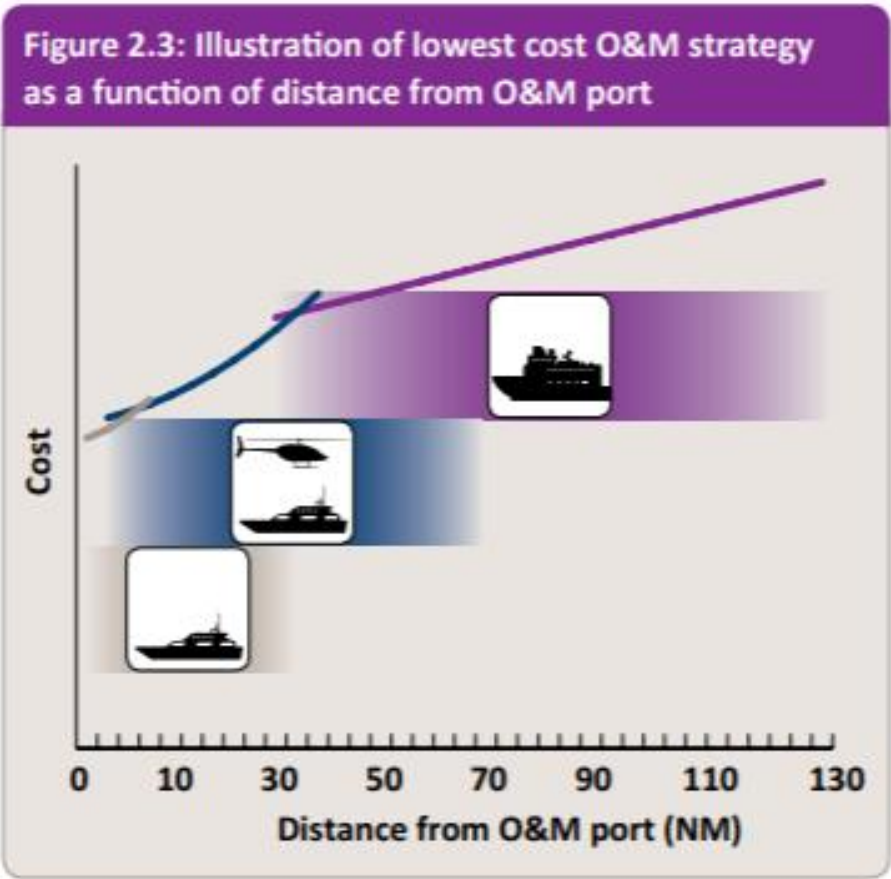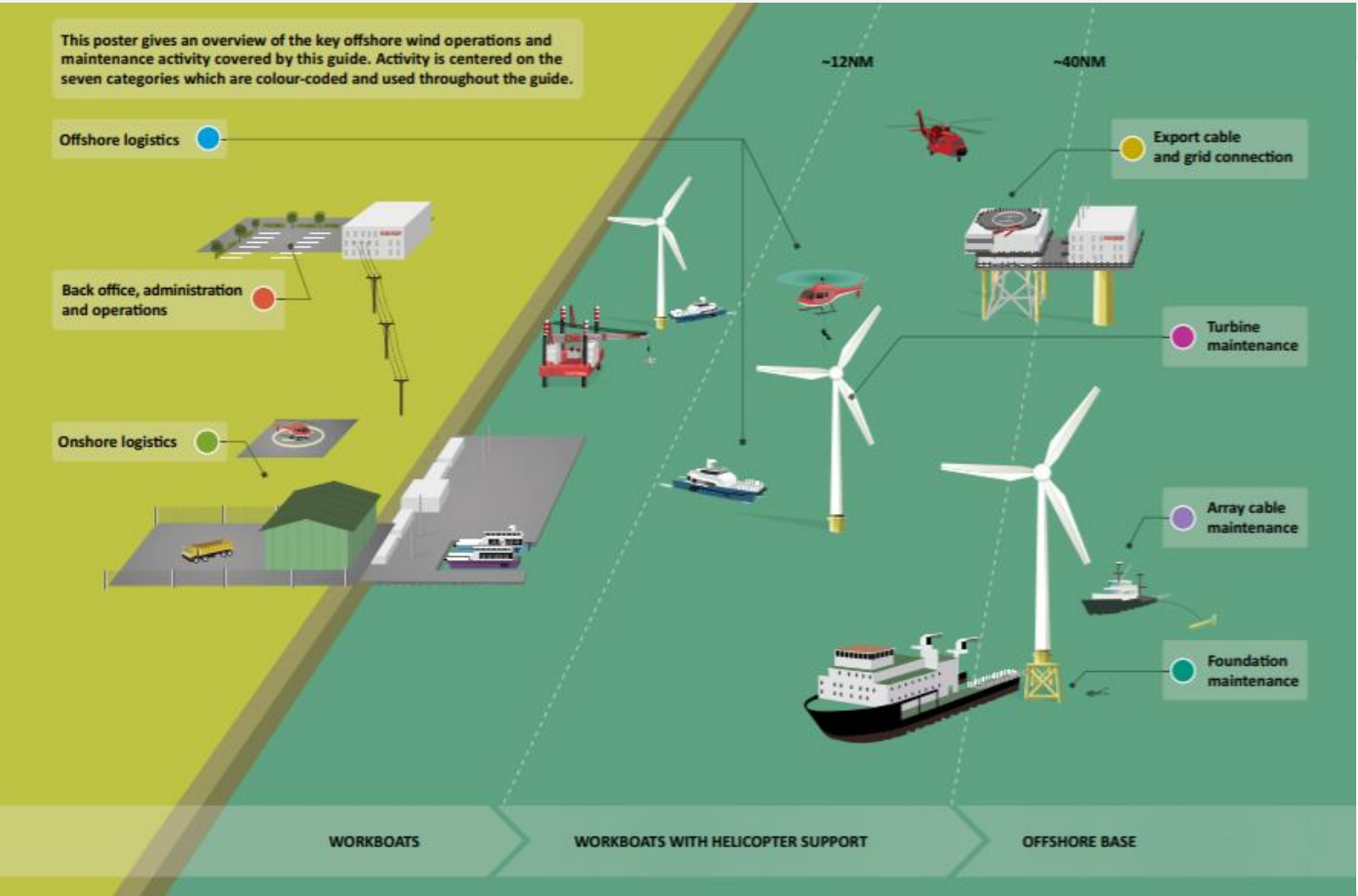
(Source: A Guide to UK Offshore Wind Operations and Maintenance, The Crown Estate)

Near-shore Setup
Crew Transfer Vessel - CTV

GENERAL CONCEPT

- Design and requirements for the setup will vary from project to project

- Open foredeck for cargo, to be hoisted between CTV and offshore structure

- Clear view of the horizon from any passenger seat

- Storage space for PPE accessible from passenger area

- Fender system to enable safe transfer between CTV and ladder systems

- Navigation bridge to have a clear overview of the transfer area and loading zones

- CTV to comply with all international and local rules and regulations and to have documented safety management system

- Vessel to be equipped with redundant propulsion system, optimized for high bollard pull and acceptable transit speed

Far-shore Setup

GENERAL CONCEPT

- Far shore setup to save significant resources by reducing transit time from shore

- Technicians to stay onboard the Service Operation Vessel (SOV) or accommodation vessel

- Technician crews to be distributed to WTGs by means of daughter crafts, CTV's or Walk to Work (W2W) solutions

- W2W solutions to use motion compensated gangways, enabling safe transfer from vessel to platform on Transition Piece

- High importance to ensure safe approach with vessel to turbine without risking collision with blades – height restrictions might apply

- Vessel to provide both open and sheltered cargo deck space

5. Floating WTGs

WindFloat 1

Our first floating experience.

2MW Wind Turbine
Connected December 2011
Developer : EDPR
Floater : Principle Power

- Demonstration of **system dynamics** and verification of **responses**

- Weathering of wave and wind induced **fatigue loads**

- Fabrication and **commissioning** concept.

- Performance of **O&M** activities

- Return of **WTG to shore** for decommissioning

MHI VESTAS OFFSHORE WIND™

WindFloat Atlantic
Serialized WTG installation.

3 x 8.4 MW Wind Turbines
Connected 2020
Developer : EDPR / ENGIE
Floater : Principle Power

- Optimized design balancing power output and dynamic behaviour

- Full-scale WTG commissioning and model validation

- Installation and commissioning process tailored to serial installation

- Few changes with respect to WTG design

Preparing for commercial scale
Time to enter the LCOE reduction journey.

- **Kincardine Phase I**
  5 x V164-9.5 MW
  Foundation:
  Principle Power semisubmersible

- **Groix & Belle-Île**
  3 x V164-9.5MW
  Foundation:
  Naval Energies semisubmersible

- **"Les éoliennes flottantes du golfe du lion"**
  3 x V164-10MW
  Foundation:
  Principle Power semisubmersible

- **EOLMED**
  3 x V164-10MW
  Foundation:
  IDEOL barge foundation
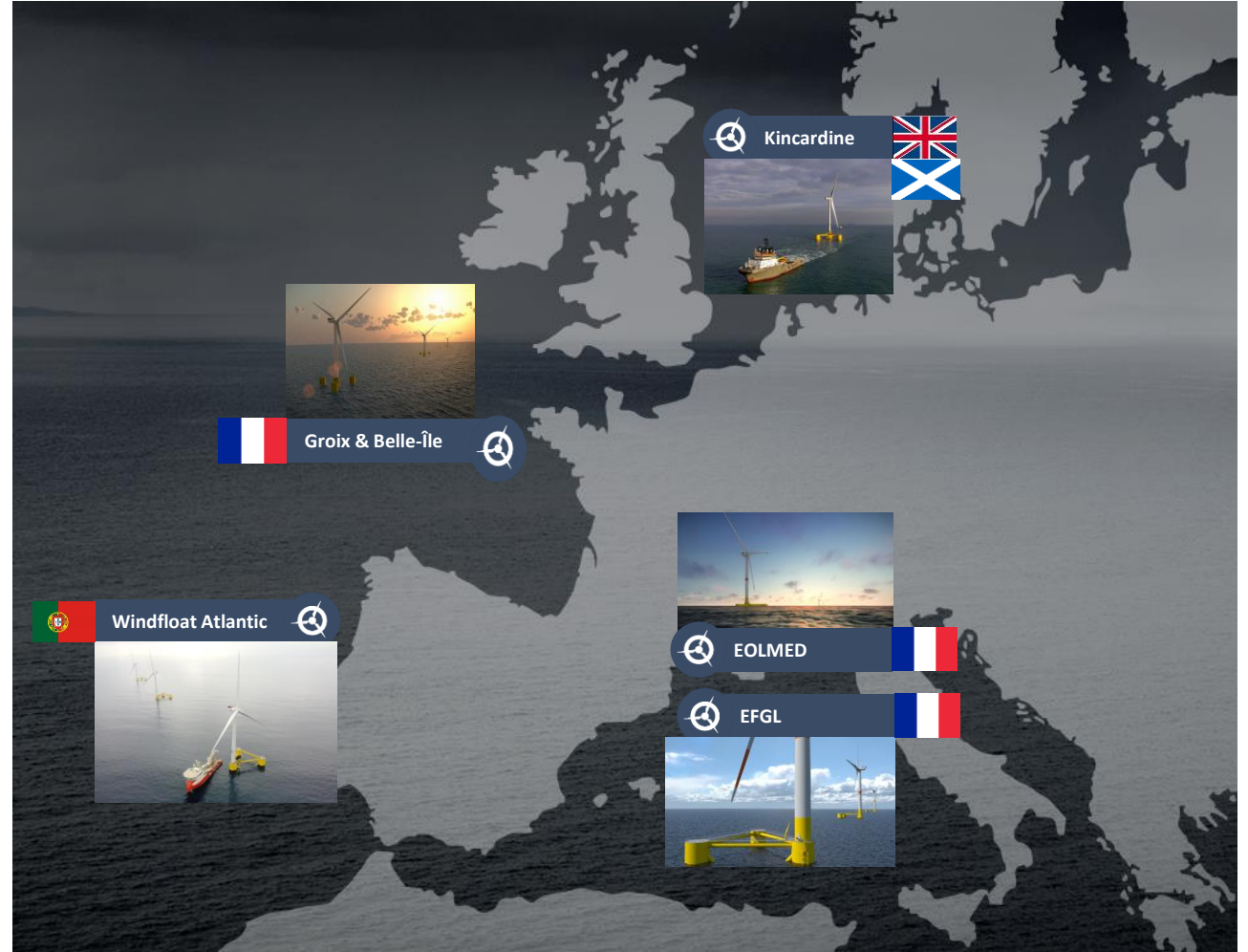
Merci de votre attention

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