



Offshore Wind – The Innovations and Opportunities

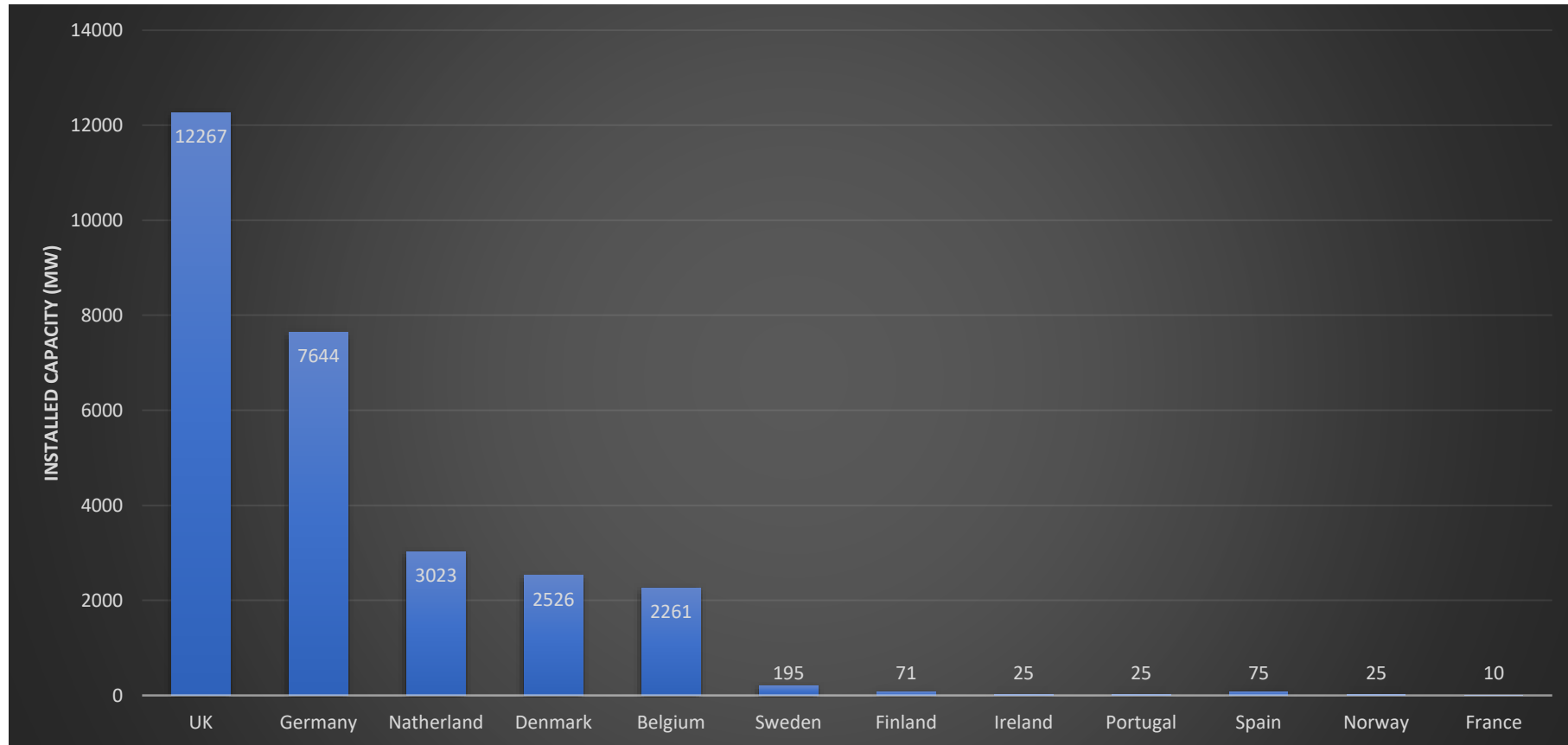
Chong Ng - Associate Director, Applied Research

5th July 2022

AGENDA

- Offshore wind industry development
- ORE Catapult – a quick introduction
- Technology development trend

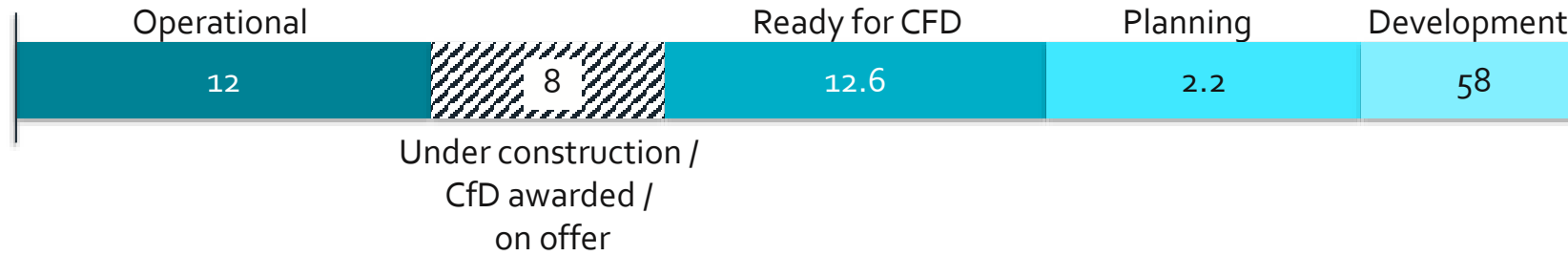
European Offshore Wind




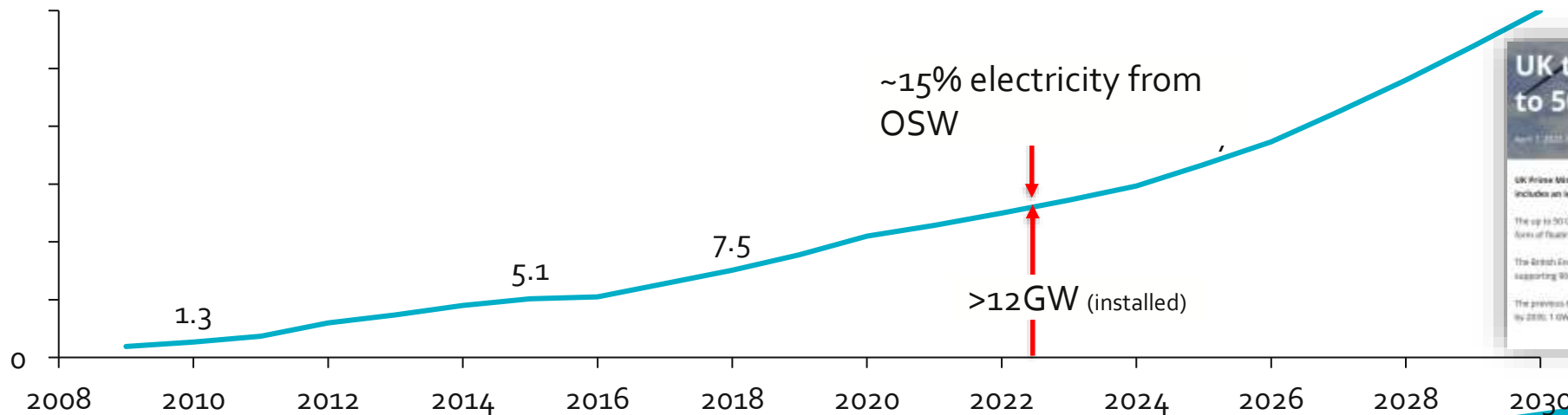
European offshore wind installed capacity by country

UK Offshore Wind

 UK projects pipeline (2022)
GW



 Total cumulative deployment of offshore wind in UK
GW






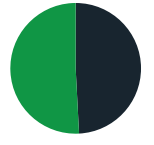

>60% electricity from OSW

>80GW by 2050!!


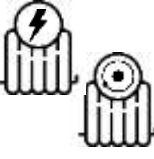

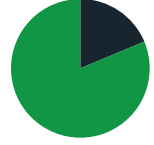

Source: ORE Catapult database

Future Energy System will be more decentralised, multi-vector and rely on renewables


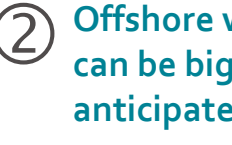
Current Energy System >>

-  >12 GW of offshore wind
-  Majority of properties heated by natural gas
-  Fuel engine vehicles are the most popular
-  ~40% Electricity generation comes from fossil fuels
-  Meter reading send once every half a year

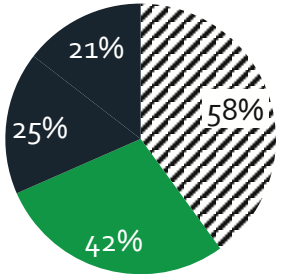
Future Energy System >>

-  Target 50GW of offshore wind by 2030
-  Properties use electric heating or gas network converted to hydrogen
-  All new vehicles are electric, hybrid or hydrogen-powered
-  <20% of electricity generation comes from fossil fuels by 2030
-  Smart meter reading send every half an hour

Outcomes

-  Intermittency of renewables will be largely overcome
-  Offshore wind deployment can be bigger than we anticipate now

Total primary energy consumption



Category	Percentage
Transport	58%
Domestic	42%
Other	25%

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THE OFFSHORE RENEWABLE ENERGY CATAPULT

The UK's leading technology innovation and research centre for offshore renewable energy

Mission: to accelerate the creation & growth of UK companies in the offshore renewable energy sector.

8 UK Regional Centres

Aberdeen, Blyth, Fife, Glasgow, Hayle, The Humber, Lowestoft, Pembroke Dock

3 UK Academic Research Hubs

Universities of Manchester & Strathclyde – Electrical Infrastructure
University of Bristol – Blades
University of Sheffield – Power Trains

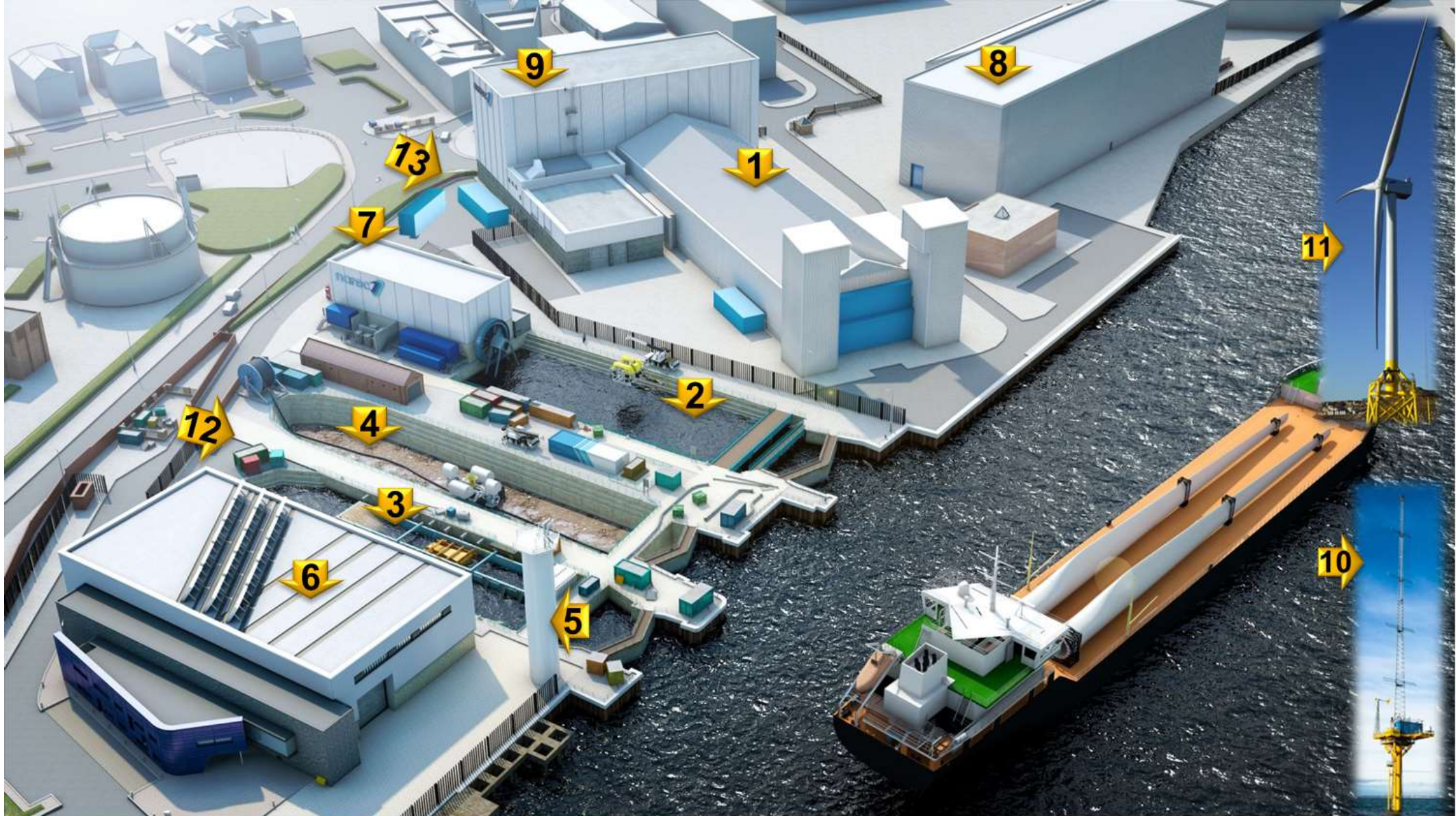
International Research and Innovation Centre

Yantai, China



802 SMEs
supported
since 2013

556
Academic
collaborations
2013



Accelerate Tomorrow Technology Today

CATAPULT
Offshore Renewable Energy



BLADES

- Test & validate next generation 100m+ offshore wind turbine blades
- Develop and test innovative solutions for rain erosion (e.g. composite materials)
- Accelerate innovative blade designs and materials

FACILITIES:

100m and 50m Blade Test Halls

Blade Erosion Test Rig

Wind Turbine Blade Test Facility



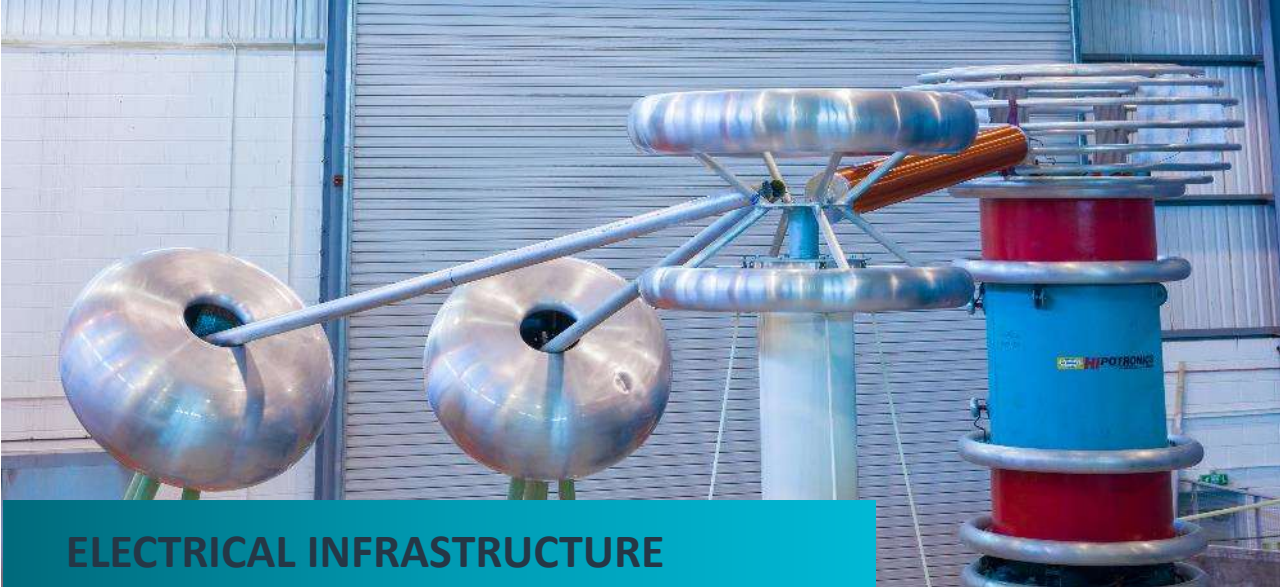
POWERTRAINS

- Test & validate next generation 10MW+ offshore wind turbine powertrains
- Accelerate innovative powertrain technology, from Sub-1MW to 3MW
- Support development of critical powertrain components: bearings, gearbox, generator

FACILITIES:

1MW, 3MW, 15MW Powertrain Facilities

Wind Turbine Bearing Test Facility

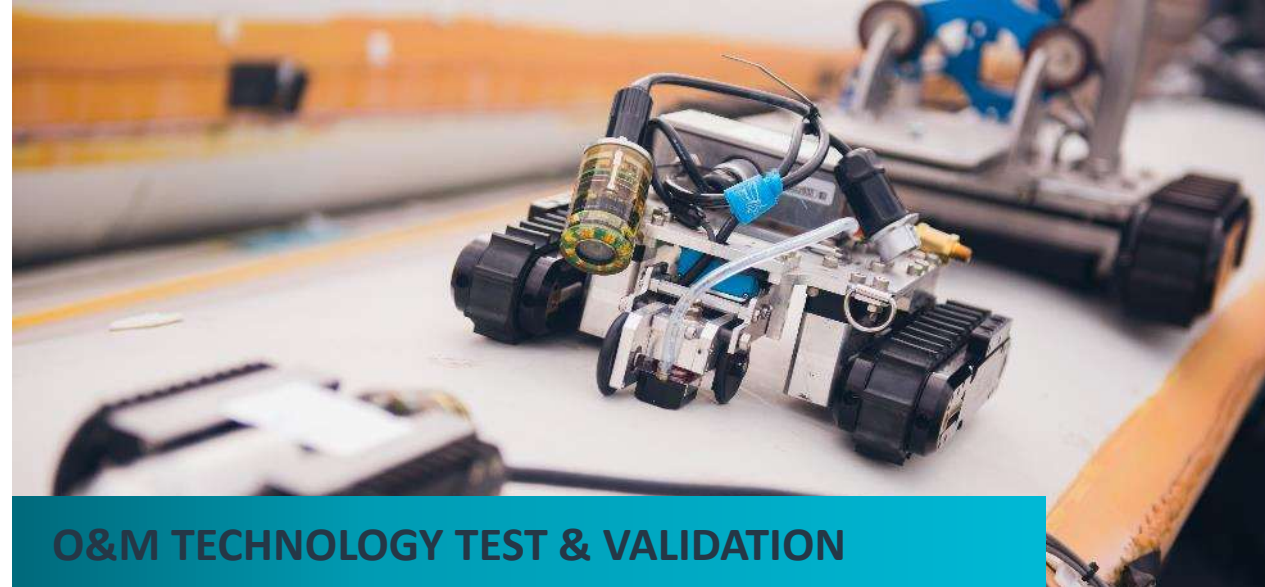


ELECTRICAL INFRASTRUCTURE

- Test & validate the market's largest cables - 66kV - through ageing, insulation breakdown and failure analysis
- Dynamic cable fatigue testing - for the future development of floating wind

FACILITIES:

HV and Materials Labs
Pre-qualification bays
Dynamic cable rig



O&M TECHNOLOGY TEST & VALIDATION

- Test robotics & autonomous systems (RAS) using controlled subsea dock environment, training tower (drones) and blades (blade inspection)
- Wet and dry controlled dock environment testing:
 - Cable inspection, protection and connection systems
 - Subsea & topside balance of plant

FACILITIES:

Subsea docks
Training tower
Blade sections

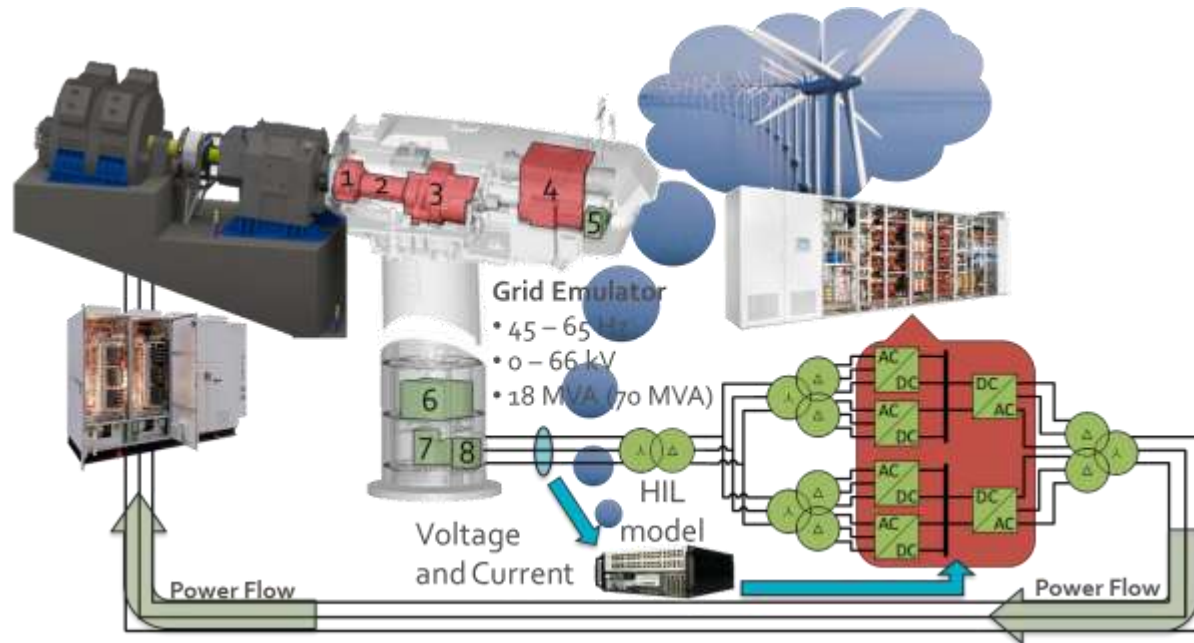
Support Floating Wind – Dynamic Cable Test Rig



Qualification of dynamic cables for floating wind and tidal connectors

- **Mechanical + Electrical thermal + Wet test**
- Allows cable up to 250mm diameter
- Bending stiffness up to 120kNm
- 10 bend cycles per minute
- Simultaneous HV and heating testing
- Allow fully submerged in seawater

eGrid – an 18MVA Grid Emulator



Traditionally full scale tests are run in the field which has several disadvantages:

- **Time Consuming** - planning permission required, standards tests take years to finish
- **Costly** - replacing broken parts and updating designs is difficult
- **Weather Dependant** - have to rely on wind conditions at site \Rightarrow limited repeatability

15MW test rig + eGRid:

- Main Bearing
- Drive Shaft
- Gearbox
- Generator
- Central Controller
- Power Converters
- Transformer
- Switch Gear



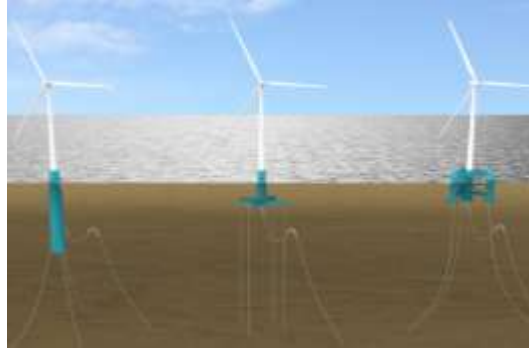
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Current Innovation Interest in Wind Industry



Next Gen 20MW+ wind turbine



Floating Wind Technologies



Digital Twins Applications –
Advanced Predictive O&M



Robotic & Autonomous Systems



Additive Manufacturing

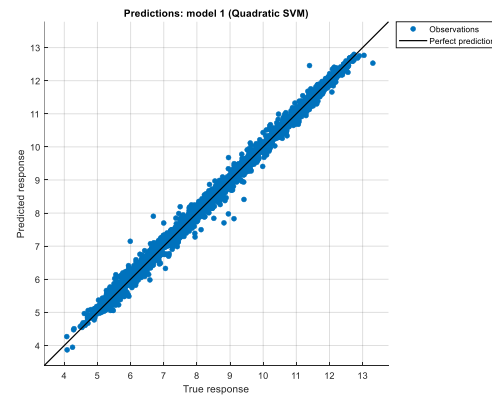
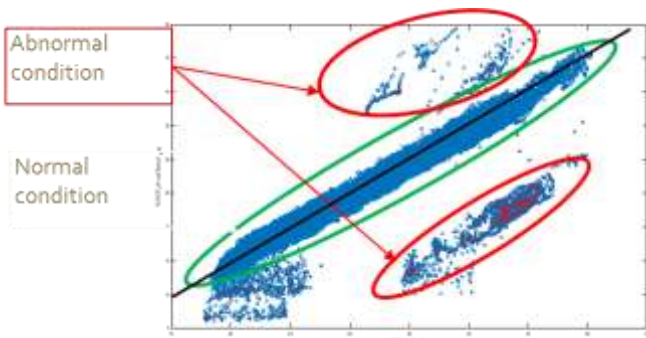
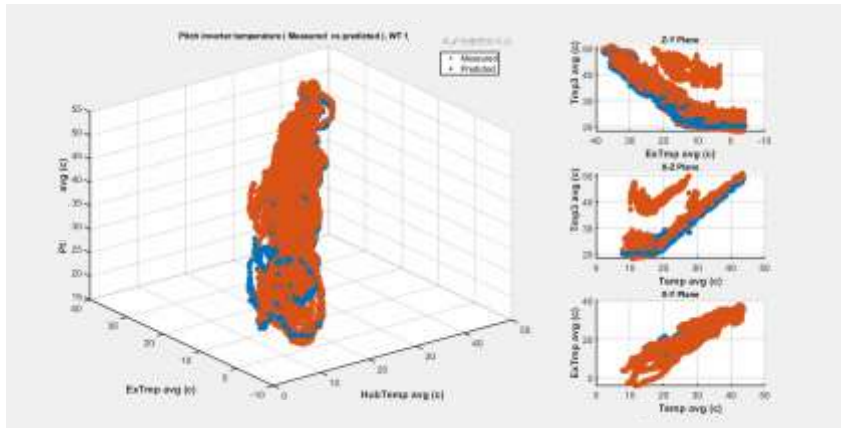


Energy Storage Solutions

Digital Twin – AI/ML health monitoring solutions

Pitch system health prediction & monitoring:

- Higher than 97% of accuracy
- Abnormality detection without additional sensor



Cable monitoring
CATAPULT

Using minimized measurements (cable sheath and ambient temperatures) on turbine to develop NP-CAM tool with three key models:

1. Cable sheath temperature model (correlation of operating condition with Tsurf)
2. Cable core temperature model (correlation of operating condition with Tcore)
3. Cable ageing monitor (consumed lifetime calculation, Corrosion lifetime estimation)

Converter monitoring
CATAPULT

- Turbine converter is **non-linear** and **multiphysics** system (electrical + thermal)
- It is a **complex integration** of power module, gate drive, capacitor, heat sink, water cooling, etc.

ANN converter health monitoring
Fully Automated Non-Disruptive Converter CM

SCADA Data → Data → Model → Status → Converter Status

Generator vibration monitoring
CATAPULT

- Detect the early stage failure by using SCADA and 2 vibration sensors
- >15 failure modes around the generator can be detected including
 - Generator bearing
 - Bolt looseness
 - Unbalance and misalignment

Generator vibration 1 (TUB A, 10 months)

Period	Value
Nov - Mar (5%)	~15
Apr - Jun (2%)	~10
Jul - Aug (5%)	~15
Sep (10%)	~20
Oct - Nov (20%)	~25

Pitch bearing Usage monitoring
CATAPULT

Pitch bearing usage monitoring:

- Life time damage estimation
- Abnormality detection without additional sensor

SCADA Input for case study

- 2020 SCADA data
- Data from individual turbine in wind farm

Pitch angles

Change in damage index

Blade loads

Total damage index

CONTACT US

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