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Technology and innovation challenges for UK Offshore Wind Energy

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Offshore Wind Operations/Science Meets Industry, Bergen 2013

10 September 2013

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Who is the ETI?



- The Energy Technologies Institute (ETI) is a public-private partnership between global industries and UK Government
- Safeguarding affordable and secure future energy mix
- Delivering proof of concept for new energy technologies
- Our projects impact economic development

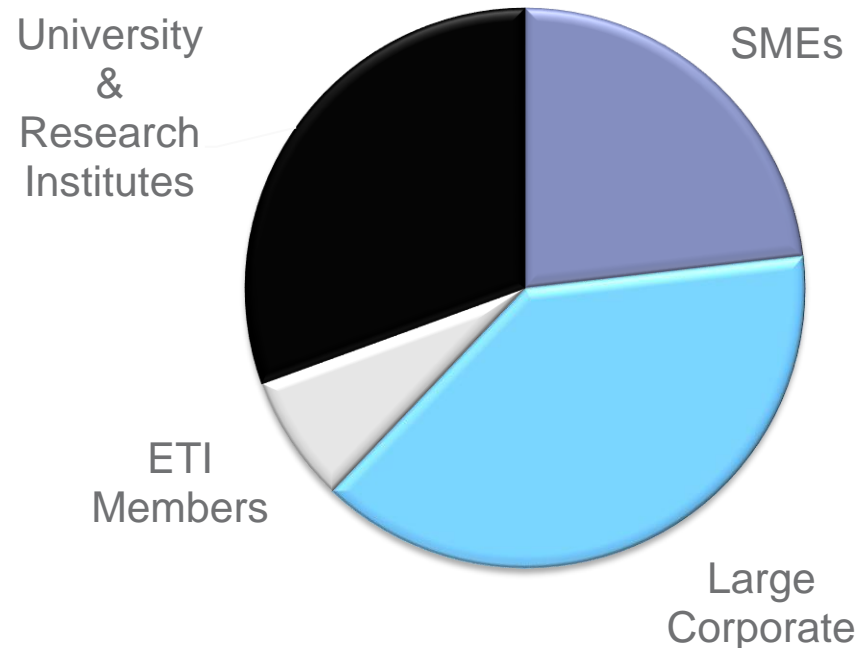


Commissioning and funding projects

£208m
major projects
underway

£162m
further projects in
development

Organisations working with the ETI



Cost reduction is crucial to long term industry success



- Current levelised cost of energy (LCoE) around £150/MWh
- 2020 goal of £100/MWh
- UK wholesale price around £40-50/MWh
 - Most of the capital has already been repaid
- Longer term, lowest cost low carbon energy price likely to be around £80 - £90/MWh
- Need to demonstrate to stakeholders that costs will come down

The Low Carbon Energy 2050 “opening team”



- Demand management
- Nuclear
- Fossil fuel, with carbon capture and storage
 - Including gas
- Biomass, with carbon capture and storage

Provided all technology options are available

The super-sub!



- Offshore Wind is the main hedging option for 2050 UK energy mix
- The Offshore Wind super-sub plays an important role: not just on the bench.
- ETI modelling of 2050 indicates up to 18 GW of Offshore Wind generating capacity would be economic for the UK
 - Assumes other technologies (e.g. Nuclear, CCS and Biomass) deliver on performance and timeliness

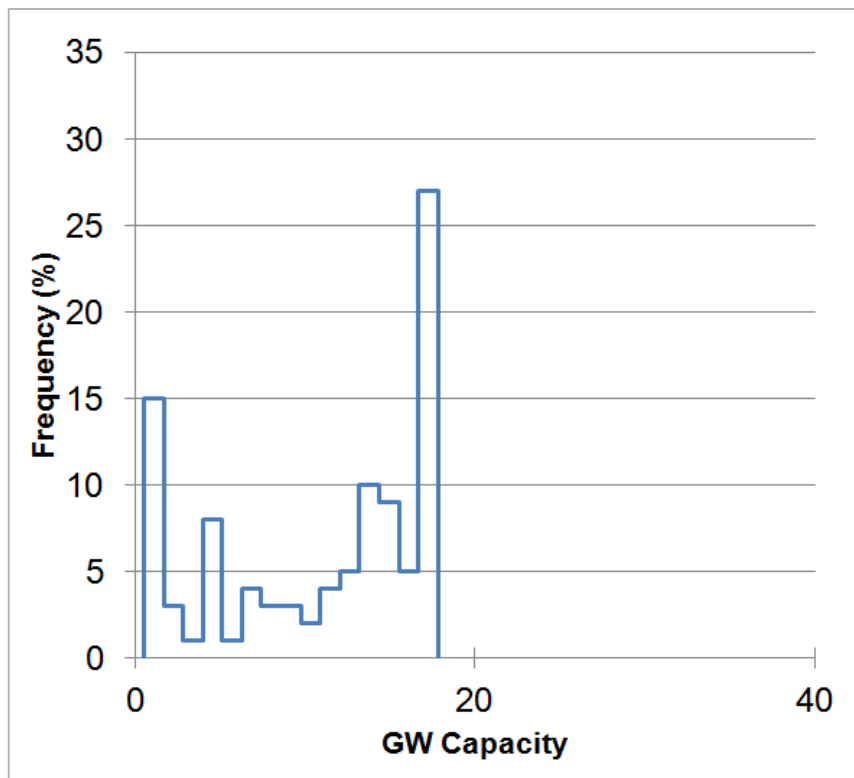
Technology intervention that reduces LCoE can make a big impact on actual level of offshore wind deployed



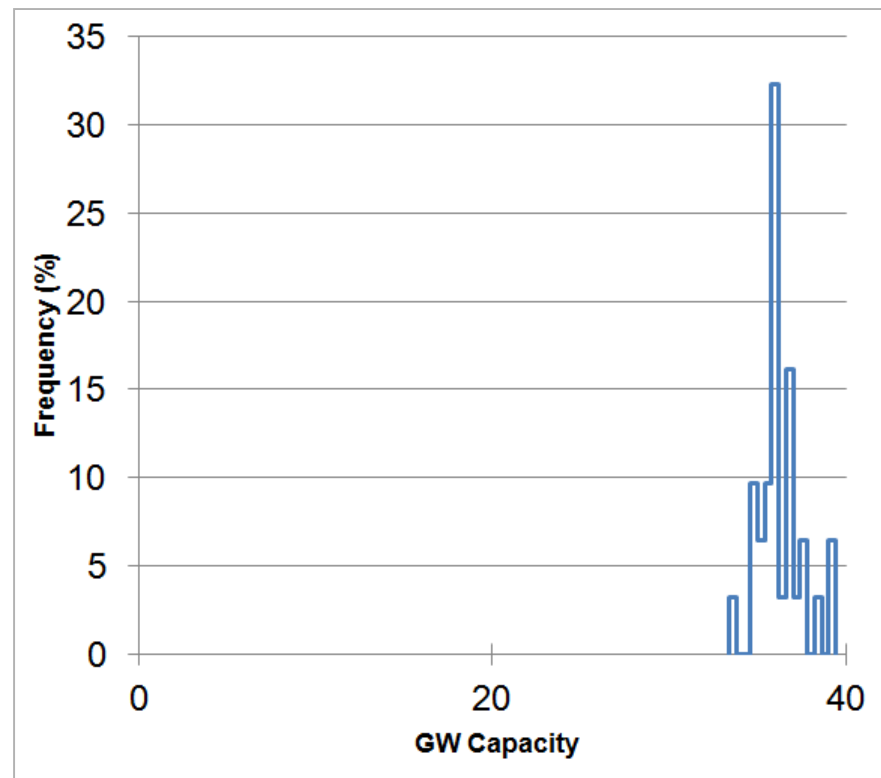
- If Levelised Cost of Energy (LCOE) achieves ~£85/MWhr by 2030
 - ETI modelling indicates installed capacity would increase substantially
 - Offshore Wind start to appear in the “opening team”
- With alternative assumptions, the importance of Offshore Wind increases further
 - Nuclear, CCS or Biomass deployed at less than reference case
 - Highly likely that Offshore Wind hedging will be needed

Example of Offshore Wind as a “CCS Hedge”

Optimised 2050 world (i.e. with CCS)

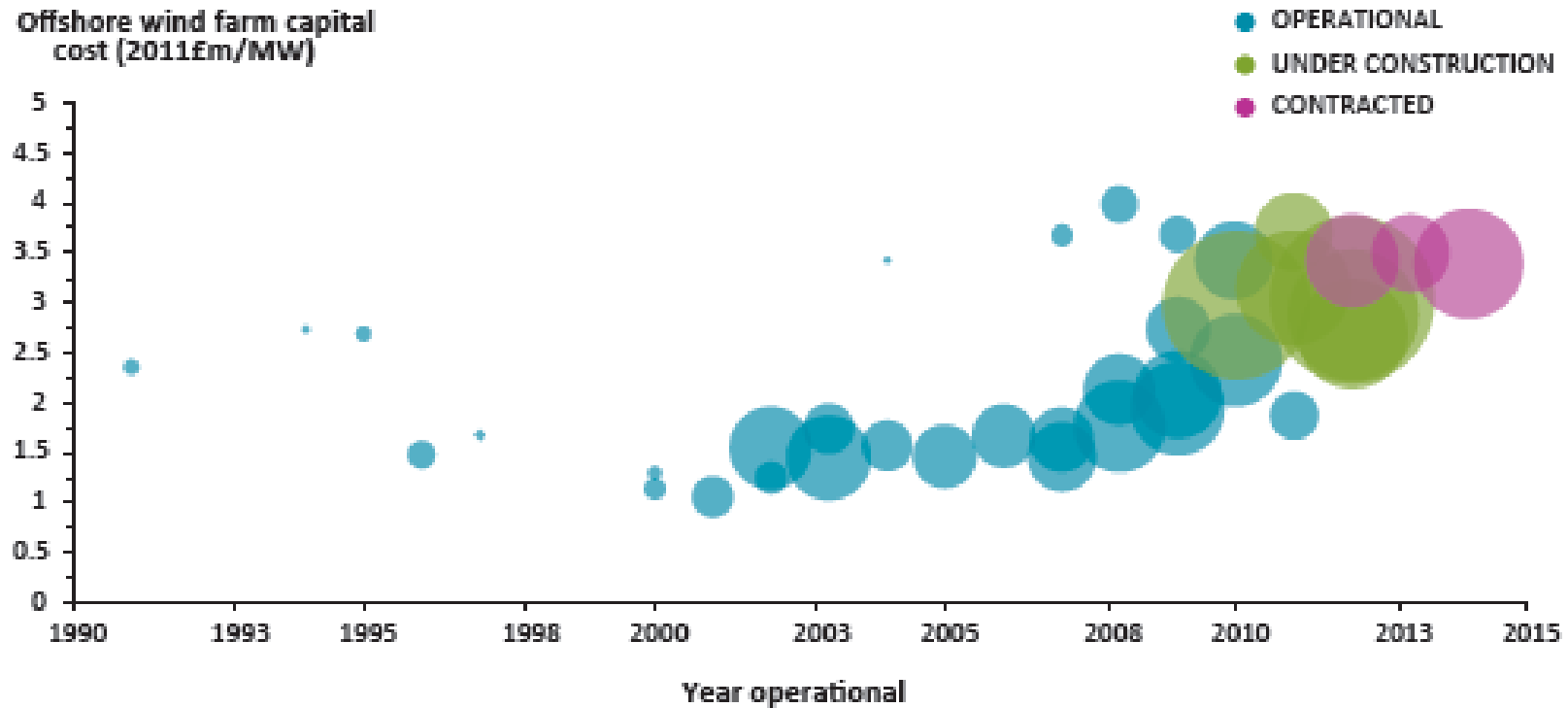


Optimised 2050 world without CCS available



Across Europe installed capital costs have risen since 2000

Offshore wind farm capital cost (2011£m/MW)



Source: the Crown Estate / Garrad Hassan

UK Offshore Wind Deployment July 2012



- Operational 2.5 GW
- Under Construction 2.7 GW
- Awaiting Construction 2.2 GW
- Applications being considered 3.2 GW

- Total **10.6 GW**

- In addition more than 30GW in pre-planning stage

Source DECC UK Energy Roadmap Update, 7 Dec 2012

UK Offshore Wind: summer 2013



- Operational 3.3 GW
 - Wind farms 20
 - Wind farms in construction / approval 13
 - Applications being considered 10 GW
 - UK net supply contribution 3%
-
- UK has more offshore wind capacity than the rest of the world put together
 - On 2012, there were 13 offshore wind projects in the EU
 - 8 of which were in the UK

Reports from DECC and The Crown Estate identify the key cost reduction areas

- Bigger, better turbines
- With bigger, more efficient blades
- Installed more cheaply
- With improved, system, cost of energy
- Accessing better wind resource
- Benefitting from volume economics
- With clear returns for stakeholders
- Ability to test new innovation quickly



What are the disruptive technologies going to be?

The ETI has projects that tackle 4 of these areas



Bigger Better Turbines

With higher rated power and higher reliability

Offshore Wind Drive Train Test Facility at Narec

Condition Monitoring

Installed More cheaply

Floating Offshore System Demonstrator

Bigger, more efficient blades

Accelerating deployment of very long blades project

larger swept area

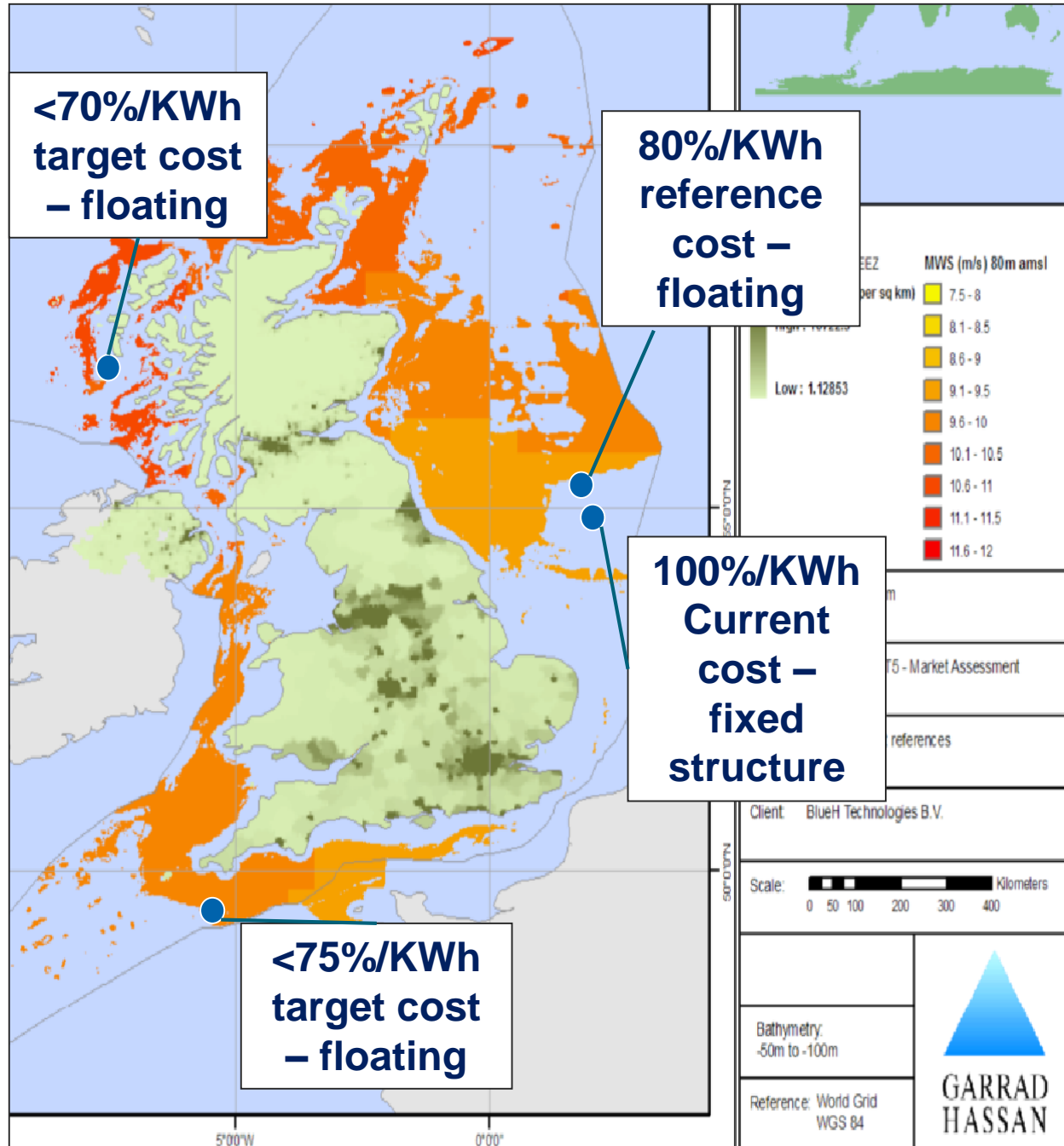
Lighter

Improved manufacturing, with better tolerances

Accessing better wind resources (in deeper water)

Floating Offshore System Demonstrator

OFFSHORE WIND FLOATING SYSTEM DEMONSTRATOR



- Average wind speeds over UK waters which are 50-100m deep range from 9-12 m/s

- Cost figures from ETI design and cost modelling projects

Opportunities

- Energy yield proportional to (wind speed)³
- 11 m/s wind (Western Isles) offers >180% of the energy of 9 m/s wind (Dogger Bank)
- Highest mean wind speeds are in Scottish waters off the South West coast of England.
- Short distances to shore in SW England

Why floating wind?



- Floating foundations will cost less than fixed foundations somewhere in range 30m to 100m
- Access to higher wind speeds to west of UK in 60m to 100m water depth could be cheaper than current UK R3 sites
 - Higher mean wind speed
 - Closer to shore
 - Reduced O&M costs
 - Reduced cabling costs and losses
 - Shore build and tow out

Floating wind: Benefits and concerns



Benefits

- Potential for competitive cost of energy
- Access to areas of higher wind speed
- Production line approach
- Maximise work shore side, reducing impact of weather and offshore working
- May reduce requirement for specialist ships
- Existing demonstrators have performed well

Concerns

- Needs demonstrators to build investor confidence
- Higher winds are linked with more severe sea state
- Technology route not clear
- Technology and operational issues not well understood
- May require specialist ships
- Constraints from competing use of deeper water
 - Shipping, fishing, military

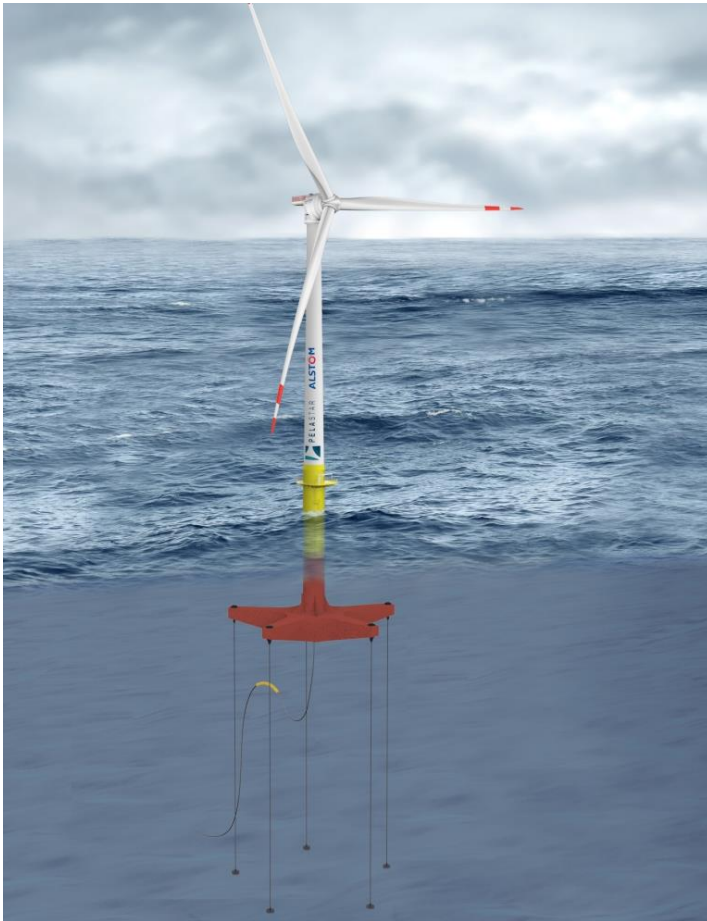
Several floating wind approaches



- Spar Buoy
 - Hywind
 - Demonstrated off Norway
 - Needs deeper water than most of UK waters
- Semi-submersible
 - Wind Float
 - Demonstrated off Portugal
- Concrete barges
 - Eg Ideol
- Tension Leg Platform
 - Glosten TLP
 - Potentially a light hull; with higher vertical load mooring challenges
 - Could provide very attractive energy costs
 - Good additionality for an ETI investment

Floating Offshore Wind System Demonstrator

Up to £25m project



- Front End Engineering Design (FEED study)
 - TLP approach
 - Best “additionality for ETI”
 - Led by Glosten Associates
 - Alstom 6MW turbine
 - Contracts signed February 2013
 - 12 month project
 - Preferred site: Wave Hub, off NW coast of Cornwall
- Followed, if good enough investment case, by full scale demonstrator
 - In water 2015/16

Glosten's PelaStar TLP Technology



- Lightweight Steel Hull
- Synthetic Tendons
- Production line approach, with Quay-side Turbine Assembly
- Efficient Farm Layout
- Potential for an attractive cost of energy
- Enough for Offshore Wind to be part of the 2050 opening line up



LONGER BLADES

Bigger, more efficient blades is a key contributor to lowering energy costs



- ETI has commissioned a project with Blade Dynamics to develop next-generation blades using unique seamless modular technology.
- Blade Dynamics claim their blades will be transformational in their performance and reliability
 - enabled by a fundamentally different manufacturing approach
- 3 year project
- £15.5m project cost
- Technology could lead to a 3% to 5% reduction in energy costs
- Building 80m+ blade in the UK by Summer 2014
- Designing \approx 100m blade

Based on Blade Dynamic's 49 2MW Technology

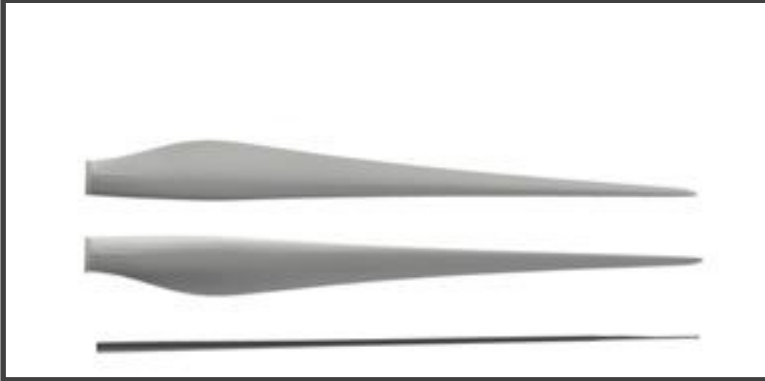


- Weighing only 6150kg, the lightest blade in its class
- Awarded world blade of the year 2012 by Windpower Monthly
- GL tested and certified



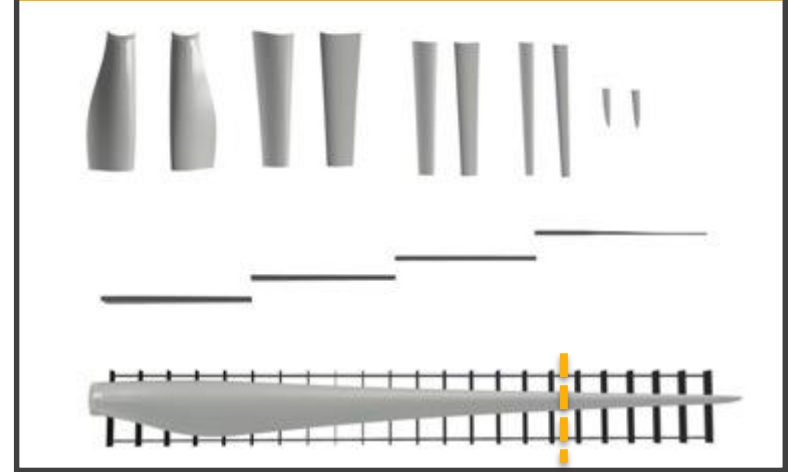
Industrialization of blade manufacture

Conventional Blade Factory

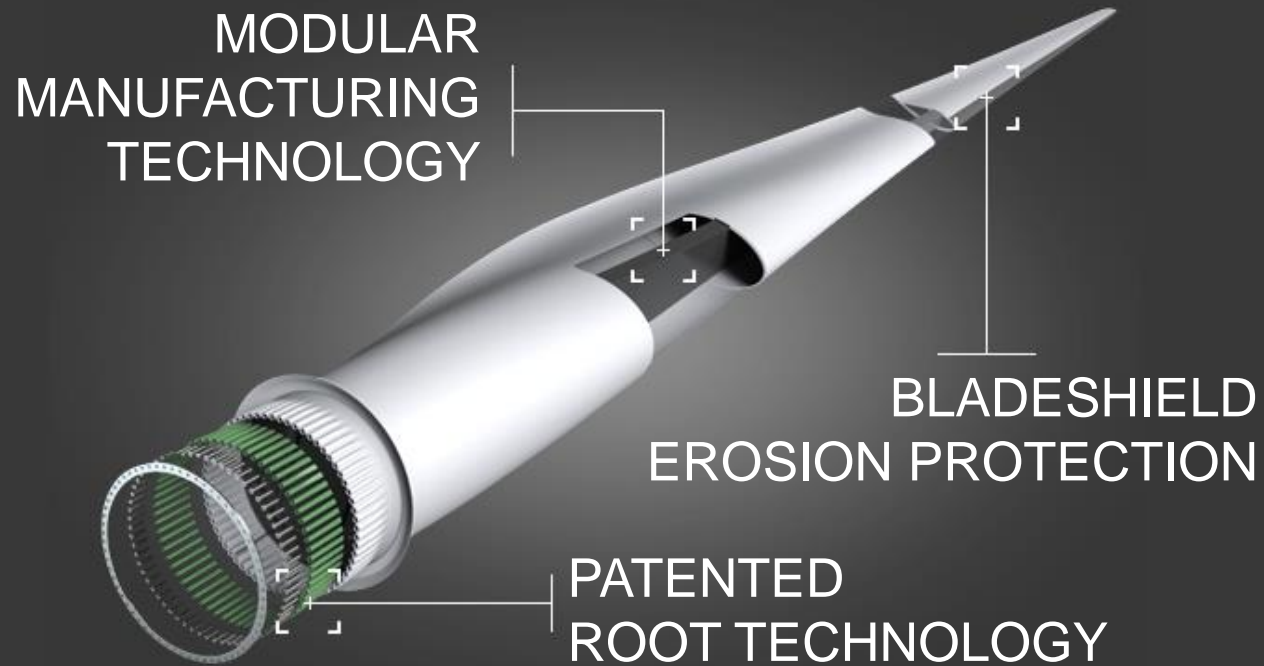


- Ultra-large components
- Difficult manufacturing process
- Quality difficulties
- Heavy blades
- High CAPEX

Blade Dynamics Factory

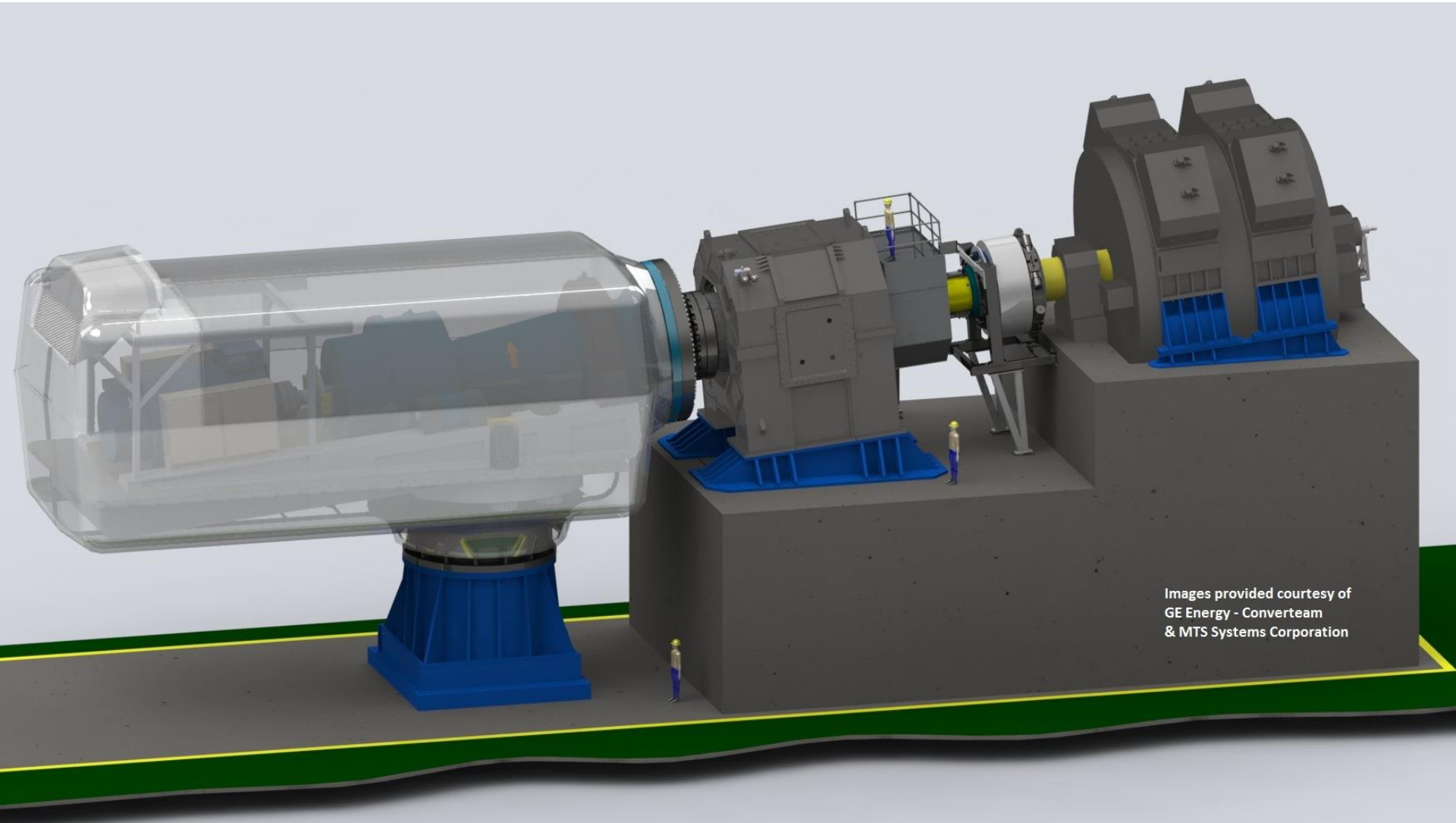


- Small component manufacture
- Simple subcomponent assembly
- **High quality**
- **Lightweight**
- Low CAPEX



UK OFFSHORE WIND DRIVE TRAIN TEST FACILITY

UK Drive Train Test facility



Images provided courtesy of
GE Energy - Convertteam
& MTS Systems Corporation



Fujin Building: January 2013
35m high, 70m long and 60m wide





Arrival of 1st Nacelle for testing

August 2103



OTHER TECHNOLOGY DEVELOPMENT ACTIVITY

The Carbon Trust - Offshore Wind Accelerator



- Fixed foundations for deeper water
- Access systems to improve O&M costs
- Wake effects
- Electrical systems
- Cable installation methodology

Offshore Renewable Energy Catapult



- Standardisation
- Offshore cables
- Performance and reliability

Key messages



- To “earn its place” in the 2050 UK energy mix, offshore wind needs to reduce Levelised Cost of Energy
 - Main hedging option if other technologies don’t deliver their full potential; Nuclear, CCS, Bio-energy and Demand Management
- Technology innovation will
 - Help reduce costs
 - Make a big difference to the amount of offshore wind deployed in 2050
- ETI is active in key technology innovation areas that have potential to drive down costs
 - Floating offshore wind has potential to make offshore wind part of the technology starting line up for 2050; rather than the best reserve
 - Lighter, longer blades have potential to reduce costs by 3% to 5%
 - UK Drive Train Test Rig

Key messages



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