Technology and innovation challenges for UK Offshore Wind Energy
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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
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

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**

- **Bigger, more efficient blades**
  Accelerating deployment of very long blades project
  - Larger swept area
  - Lighter
  - Improved manufacturing, with better tolerances

- **Installed More cheaply**
  Floating Offshore System Demonstrator

- **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 \((\text{wind speed})^3\)
• 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 ≈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
MODULAR MANUFACTURING TECHNOLOGY

BLADESHIELD EROSION PROTECTION

PATENTED ROOT TECHNOLOGY
UK OFFSHORE WIND DRIVE TRAIN TEST FACILITY
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
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