2017 California Offshore Wind Industry Symposium:

1 March '17

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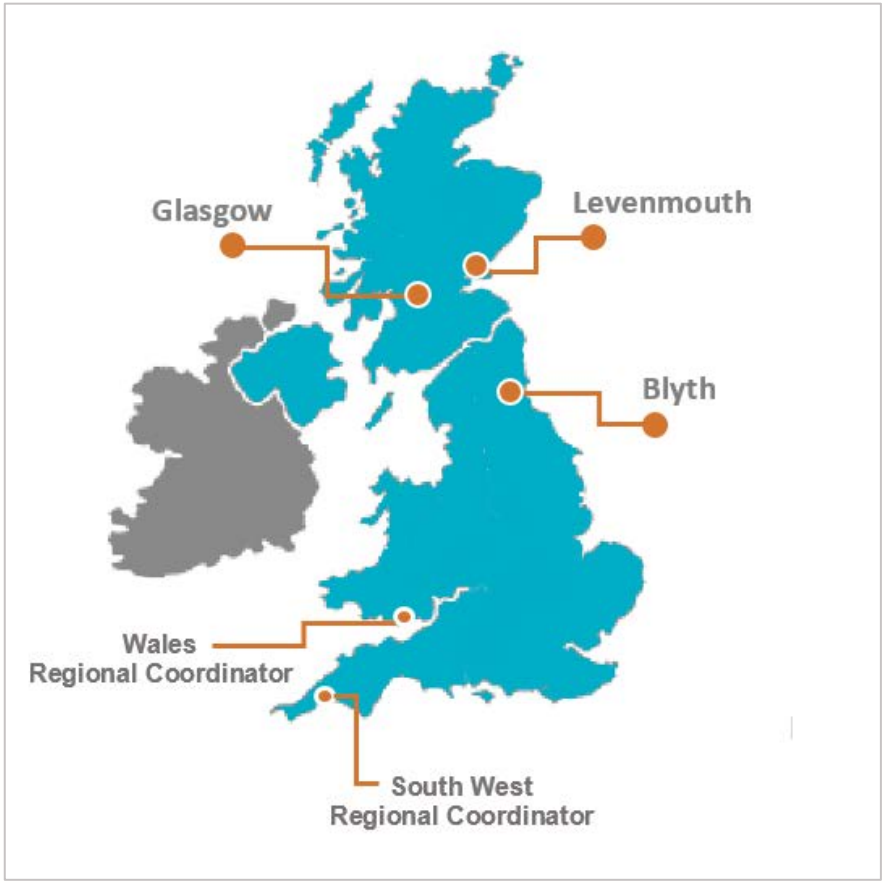
CATAPULT
Offshore Renewable Energy

ORE Catapult

Our Vision:

Abundant, affordable energy from offshore wind, wave and tide

- Reduce the cost of offshore renewable energy
- Deliver UK economic benefit
- Engineering and research experts with deep sector knowledge
- Independent and trusted partner
- Work with industry and academia to commercialise new technologies



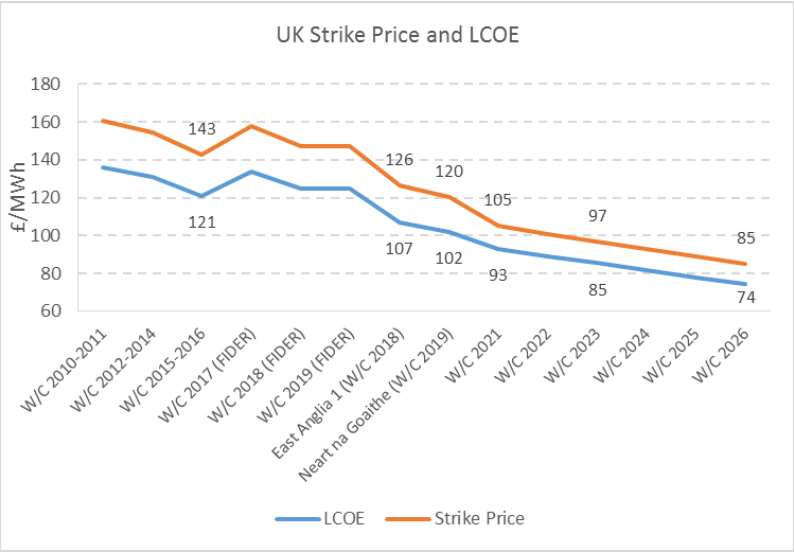
80+ technical experts

Accelerating Innovative technologies

Cost Reduction in Offshore Wind

Fixed

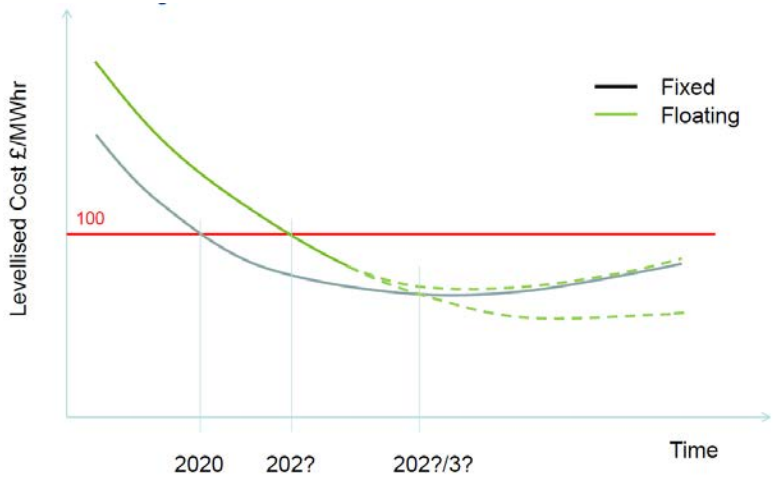
- Each year ORE Catapult tracks cost reduction on behalf of the industry though financial "audit" and interviews with the supply chain.
- The resultant "CRMF" is the dash board which is used to inform where we focus efforts
- Offshore wind has fallen by 32% since 2012



Floating

Cost/Risk reduction in floating wind requires:

- learning-by-doing,
- R&D investment,
- Appropriate technology transfer from marine, oil and gas, and fixed-bottom offshore wind,
- Economies of scale



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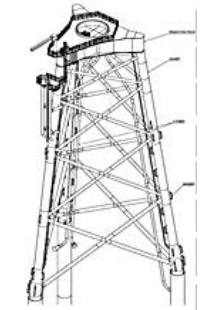
Cost Reduction in deep water solutions



2006 Beatrice Demonstrator 10MW

- Funded by Scottish Government and EU
- Powered Beatrice Alpha gas platform

2009 Alpha Ventus 60MW

- Demonstrating arrays in deep water
- Mixed concepts (jacket/tripod)

2012 Ormonde 150 MW

- First commercial project
- Exploring hybrid business models

2017 Wikinger 350 MW

- Introducing competition in supply chain

2018 Beatrice 588MW

- Design for manufacture
- Smulders, Bladt and BiFab

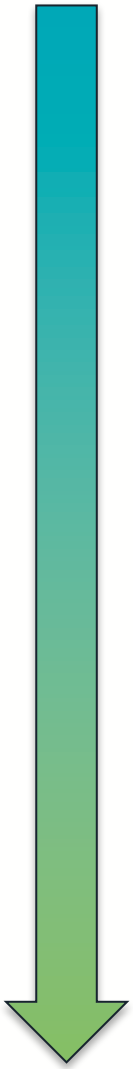
2020 Hornsea One 1218 MW/ Borkum Riffgrund

- Design optimisation and innovation

2020 East Anglia One 714MW

- Design optimisation and innovation

LCOE



De- risking

Demonstrating

Demand

Environmental learnings for floating

Workshops lead by UK's National Environmental Research Council and Arup: Stakeholders from across the offshore sector

- Already a significant body of R&D – Don't start again!
- Inaccurate assumptions in relation to existing technologies from industry, regulators and stakeholders
- Data Sharing – It's essential….
- Regular updates and sharing of evidence required, including which issues we should retire
- Develop environmental technologies
    - characterising environmental receptors,
    - monitoring post deployment
    - drive down costs and risks
- Ensure updated methodologies and models are used in EIA.

Floating Wind Joint Industry Project

Three work packages:

1. **Policy & regulation:** Outlining the policy & regulatory requirements for the floating wind industry

2. **Cost sensitivity analysis:** Assessment of the current and expected future cost of floating wind, including sensitivity attributed to changing environmental and technical parameters

3. **Technology & risk:** Assessment of technology risk to develop, construct, and operate a floating wind farm, together with identification of key innovation needs

Commissioned by:

The Scottish Government, DONG energy, EDF, E.ON, innogy, Statoil

Delivered by:

Offshore Renewable Energy Catapult, Carbon Trust

The findings and recommendations of this study are solely those of the authoring organisations based upon their respective inputs and do not necessarily reflect those of the supporting joint industry partners.

Advancing innovative foundation types

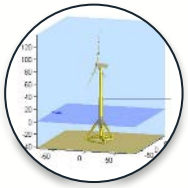
ORE Catapult supporting research across the sector and TRL levels:

Design Tools
- Improving design tools for sector

De-risking
- Proving, validating & leveraging expertise

Demonstrating
- Methodologies and potential of technologies

Demand
- Increasing attainable market



CLOWT

LIFES 50+

FSFOUND

1 2 3 4 5 6 7 8 9

WinWin

TLP Wind

Batwind

CLOWT

The CLOWT programme is developing an aero-elastic model of a 7MW turbine:

- Instrumentation is being undertaken to meet IEC 61400-13:2015 requirements
- Verification of turbine design tools: FAST/Bladed
- Optimising control systems
- Design optimisation
    - Verification of safety factors
    - Fatigue monitoring of substructures
    - Flexible blade behaviour

Figure 1: Levenmouth Wind Turbine[1]

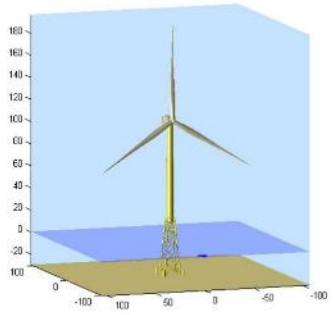


Figure 2: Aero-elastic model from Bladed©

Open access aero-elastic model

Reference design structures

TLP Wind

- Iberdrola E&C, with University of Strathclyde and ORE Catapult
- Levelised Cost of Energy (LCoE) calculations and basin tests using scale models.
- Current UK market regulations & East coast Scotland site potential for £95/MWH by 2025 (with 5MW turbine)
- Increased turbine size (10MW) potential for £88/MWH by 2030

Tank testing at University of Strathclyde

TLPWIND and Scottish Reference Sites

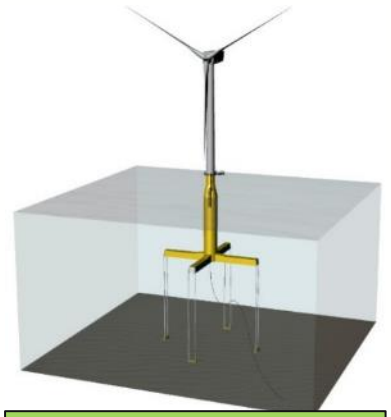
LIFES 50+

Overview

- Horizon 2020 project, 12 partners, €7+ M
- 40 months, started 06/2015

Objectives

- Development of a methodology for evaluation and qualification of floating wind substructures
- Progressing two designs to TRL 5 for 10MW wind turbines



TLPWIND

IDEOL

OO-STAR

NAUTILUS

Float…….and submerge (FSFOUND)

Lessons applicable to floating, ORE Catapult are working with industry to

- **Demonstrating** and **Validating**: design, manufacture and quayside construction, delivery to the port site, preparation and loadout, seabed preparation, **towing**, **installation**, commissioning and operations of FS GBF
- Conducting a range of **simulation** and **modelling** studies to minimise the uncertainties and inefficiencies in the **deployment** process and in **various weather windows**;
- **Assessing** **structural response** to **extreme** and **fatigue** loads on the FS GBF and compare theoretical loads with real ones;
- **Establishing** the effect of **cyclic loadings** on seabed through monitoring and measurement and verify/calibrate models for differential settlements in the soil;
- **Establishing** the optimal **seabed preparation** requirements
- **Verifying** the **manufacturing** and **installation** methodology and benefit from the lessons learnt in order to optimise plans for the **future** exploitation of FS GBF

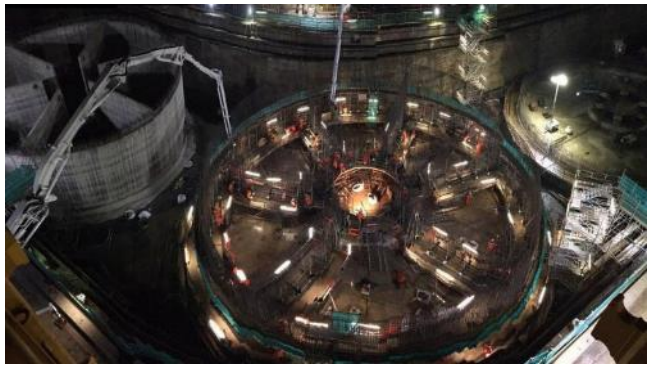


Image Reference BAM Nuttall

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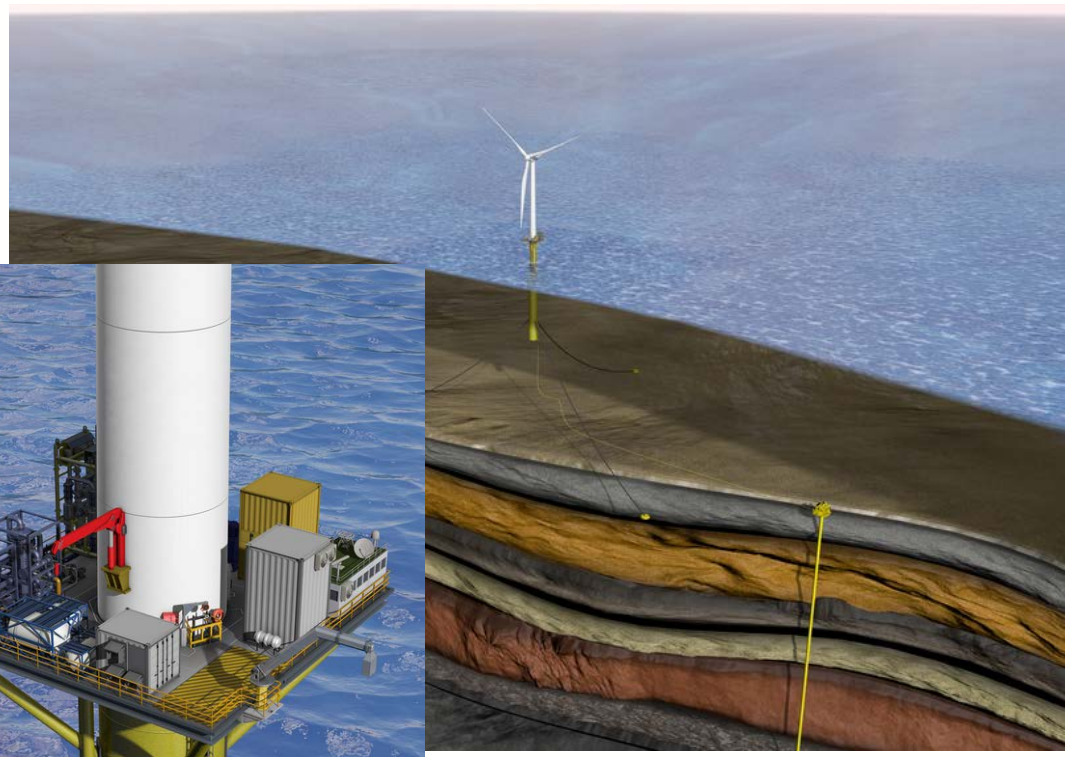
Win Win (Phase 1): Enhanced oil recovery with floating wind



nexen

Eni

ExxonMobil

Statoil

DNV·GL

Batwind

- Integrating Lithium storage into Statoil's Hywind technology
- Establishing and proving new business models for renewables and storage
- Supporting higher penetration of offshore wind and reducing grid constraints
- Displacing Carbon base loads

Batwind

Hywind Scotland

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