Floating Wind *Solutions*

A collaborative approach to de-risking and commercialising floating offshore wind: spotlight on major component exchange

Alistair Morris – Offshore Wind Logistics and O&M Lead

CARBON TRUST

Organized by FWE Quest Offshore

FWS

The Marriott Marquis, Houston 1-3 March 2022

Our mission is to accelerate the move to a decarbonised future.

CARBON TRUST

5

continents

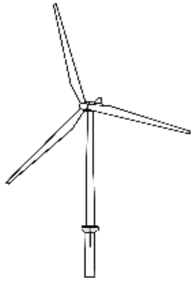
300+

experts and consultants

20

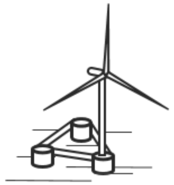
years of experience in sustainability consultancy

World leading offshore wind programmes



The Offshore Wind Accelerator (OWA)

Carbon Trust's flagship collaborative RD&D programme for bottom-fixed offshore wind.



The Floating Wind JIP (FLW JIP)

The Floating Wind JIP Overcomes challenges and advance opportunities for commercial scale floating wind

The Offshore Renewables JIP (ORJIP)

Offshore Renewables JIP aims to reduce consenting and environmental risks for offshore projects.

The Integrator

The Integrator is designed to examine the interplay between offshore wind, existing infrastructure, and other technologies to highlight opportunities for innovation investment.

£110m

Invested in projects since 2008

25

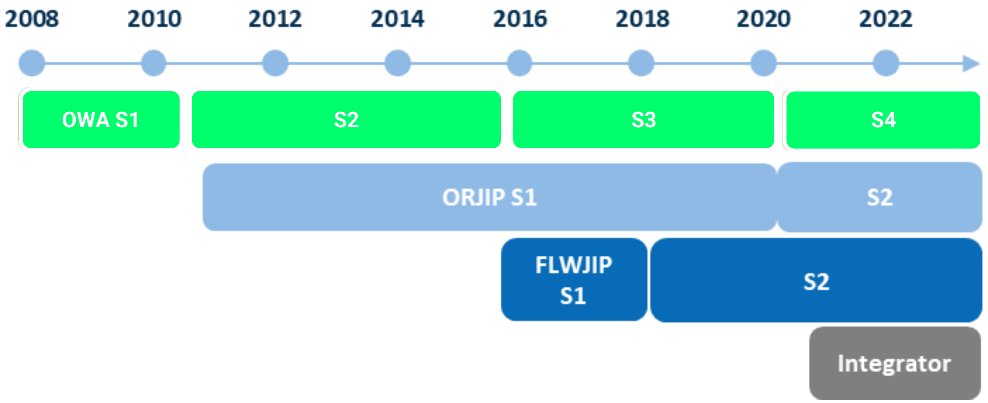
Partners across government and industry

218

Research and Development Projects

26:1

Industry leverage for FLW JIP common R&D projects



Floating Wind Joint Industry Programme

Objective: Overcome challenges and advance opportunities for commercial scale floating wind

Since 2016

Driving international, cross-industry engagement

> £5m

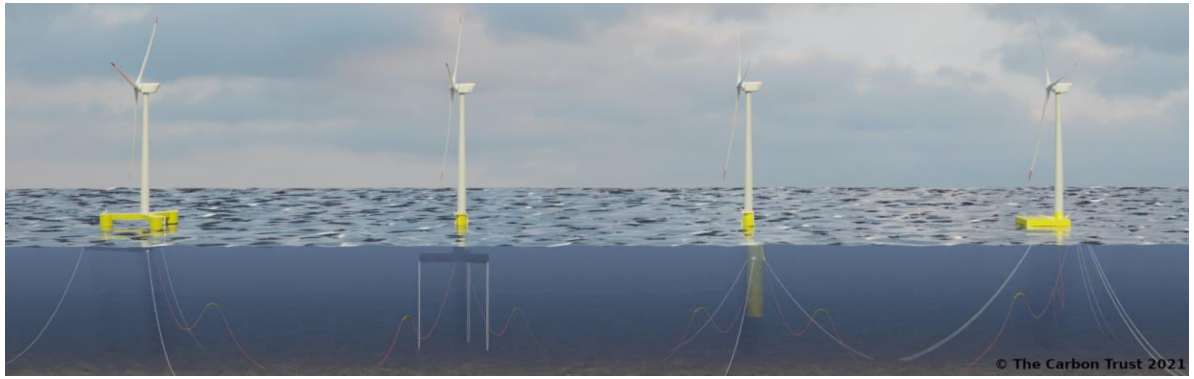
Invested in R&D projects

17

Industry partners

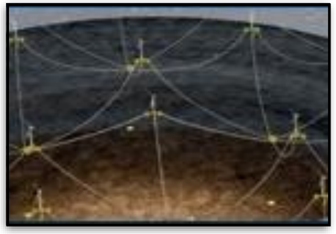
> 38

R&D projects



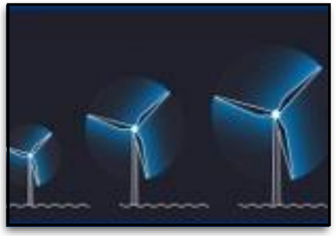
Key research areas:

Electrical Systems



Mooring Systems

Logistics



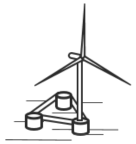
Turbine & Foundation Optimisation

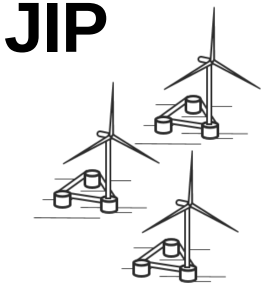
Asset Integrity and monitoring

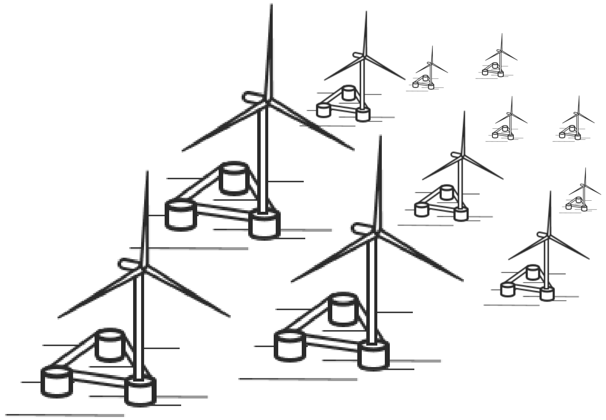
Floating wind industry partners:

- Carbon Trust
- Shell
- Kyuden Mirai Energy
- RWE
- Ørsted
- Parkwind
- TotalEnergies
- Ocean Winds
- bp
- SSE Renewables
- EnBW
- equinor
- ScottishPower Renewables
- EDF renouvelables
- Vattenfall
- Tohoku Electric Power Co., Inc.
- TEPCO
- wpd think energy

Evolution of the Floating Wind JIP







Stage 1 (2016 – 2017)

Feasibility of floating offshore wind

Partners: 5

Projects: 3

Budget: £150,000

Focus:

Initial feasibility studies focussed around three key topics: policy and regulation, cost sensitivity analysis, and technology risk. These projects identified five critical focus areas to be addressed in future research.

Stage 2 (2017 – 202X)

Technical challenges of floating offshore wind

Partners: 17

Projects: 35

Budget: £4,119,000

Focus:

Undertake more detailed assessments of key technology challenges common to multiple floating wind concepts and to support innovation to develop the solutions needed for large-scale floating wind arrays.

Stage 3

Technology development for large-scale deployment of floating wind

Partners: -

Projects: -

Budget: -

Focus:

During Stage 1 and 2 the technical feasibility and cost reduction potential of floating offshore wind were demonstrated. Future stages will build on these learnings to accelerate the buildout of commercial scale floating farms

- 2009 – Hywind Demo (2 MW)
- 2011 – Windfloat Demo (2MW)
- 2017 – Hywind Scotland (30 MW)
- 2020 – Windfloat Atlantic (25 MW)
- 2021 – Kincardine (50 MW)
- 2022 – Hywind Tampen (88 MW)
- 2023 – France Demos (114 MW combined)
- 2026 – Erebus (96 MW)

Floating Wind JIP – projects overview

Stage 2

2021 – Phase V
- Mooring Redundancy, Reliability & Integrity (AMOG)
- Dynamic Cable Failure Rates (OWC)
- Fabrication, Infrastructure & Logistics (ARUP)
- Major Component Exchange with Self-Hoisting Cranes (OWC, WavEC)
- Stick Building of Turbines On-Site (H Engineering Solutions)
- High Voltage & Electric Equipment Fatigue (Petrofac)

2020 – Phase IV
- Access & Availability (Seaspeed Marine Consulting, SeaRoc Group)
- Floating wind yield (Frazer-Nash Consultancy, NREL)
- Wind Turbine Generators for Floating Wind (Ramboll, MasH Engineering Team)
- Numerical Modelling Guidelines & Standards (Innosea, Sowento)
- Phase IV Reference Platform Designs (Ramboll)
- Floating Wind Technology Acceleration Competition

Dynamic Export Cable Development Competition

2019 – Phase III
- O&M Heavy lift Offshore Maintenance (LOC Renewables, WavEC)
- O&M Tow-to-Port Maintenance (LOC Renewables, WavEC)
- Mooring Systems in Challenging Environments (Leask Marine)

2018 – Phase II
- Monitoring & Inspection (Oceaneering)
- Heavy Lift Offshore Operations (Seaway 7)
- Turbine Requirements & Foundation Scaling (Ramboll)

2017 – Phase I
- Electrical Systems (Petrofac)
- Mooring Systems (Ramboll)
- Infrastructure & Logistics (LOC Renewables)

Stage 1

2016
- Policy & Regulation (Carbon Trust, Catapult)
- Cost Analysis (Carbon Trust, Catapult)
- Technology & Risk (Carbon Trust, Catapult)

Major Component Exchange

Key Issues

- As the industry grows and larger floating wind turbines are installed in deeper waters, attention must be placed on practical alternatives to the use of jack-up vessels and novel solutions for O&M activities relating to major component exchange within floating wind.

- Currently the most viable method of undertaking major component exchange in waters too deep for conventional jack-up vessels is to tow a floating wind platform to port for the exchange to take place or use expensive semi-submersible heavy lift vessels.

- However there is currently a limited heavy lift maintenance vessel availability globally and tow to port can be restrictive to certainly port locations with sufficient water depths.

- With larger turbines looking to be installed any substantial delays in responding to O&M maintenance relating to major component exchange issues will result in significant impacts on AEP.

Heavy Lift Maintenance (HLM) and Tow-to-Port (TTP)

Project overview

- The two projects were undertaken simultaneously with similar methodologies in order to better understand the two main alternative strategies for performing large component exchange on floating wind turbines.

- Offshore floating wind farm maintenance is expected to be significantly more difficult when compared to fixed bottom due to the motions of both the floating turbine and maintenance vessel.

- The Heavy Lift Maintenance (HLM) and Tow-to-Port (TTP) studies focused on two alternative strategies for performing large component exchange on floating wind turbines:
  - Performing of operations from a floating platform within the wind farm array (HLM) and;
  - Towing the turbines to shore for port-side maintenance (TTP)

- In the HLM study the semi-submersible crane vessel (SSCV) Thialf, was selected as a baseline technology which a shortlist of different technologies were assessed against.

SSCV Thialf vessel

WindFloat Atlantic turbine being towed into position

Heavy Lift Maintenance (HLM)

Key findings

- The main aim of the HLM study was to examine the general principles and requirements for large component exchange within a floating wind farm array.

- The main project outcomes were:
  - Many of the existing fleet of heavy lift vessels are unable to lift to the hub height of a 10MW offshore wind turbine.
  - The development of crane technologies and associated lead-time will be key to reducing costs associated with major component exchange campaigns.
  - The reduction of relative motion between the crane hook and turbine nacelle is a key technical challenge to HLM operations.
  - Vessel-mounted cranes are currently the most suitably available solution for HLM operations whilst other technologies still require further development.

Hywind Scotland 6MW turbine installation

Tow to Port (TTP) Operations

Key findings

- The main aim of the TTP study was to examine the recurrent requirement for towing floating offshore wind substructures back and forth and to understand the need for innovative technologies that can optimise the towing process in terms of duration and cost.
- The project found that:
  - The more promising technologies evaluated benefited semi-sub structures whereas few addressed the specific challenges of TTP maintenance for TLP and spar substructures.
  - Port infrastructure, quayside loadbearing capacity as well as current onshore crane lifting height may be limiting factors for successful commercialised TTP maintenance.
  - Significant reductions in operation duration were found with technologies that provided integrated solutions to the mooring and electrical cable disconnection/reconnection.
  - Most technologies showed reduced costs and durations compared to the baseline but implementing a combination of technologies would yield the best results.

Hywind Scotland 6MW turbine being towed to site

Current O&M Project Summary

Major Component Exchange with Self-Hoisting Cranes (SHC) Project:

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- This project builds upon the findings of the Phase 3 Heavy Lift Maintenance (HLM) project with the aim of developing a greater understanding of the different technology options surrounding major component exchange, specifically self-hoisting cranes or climbing cranes.

- The project will progress beyond the results of the HLM project by focusing on the required steps to commercial deployment of the different crane concepts identified and analysed.

- The major advantage of using self hoisting and climbing cranes is that they overcome the relative motion challenge by being fixed to the floating turbine. In addition because the final crane height is provided by the turbine structure rather than a heavy lift vessel, smaller less expensive vessels can be used.

- It will enable solutions to be found regarding the on-site exchange of major WTG nacelle without using a tow to port strategy.

OWC AqualisBraemar LOC Group

WavEC Offshore Renewables

Mammoet Wind Turbine Maintenance Crane WTM 100

Current O&M Project Summary

Stick Building of Turbines On-Site (SBOS) Project:

- Floating wind turbine generators (WTGs) can be assembled both at port, or at the wind farm site. The assembly location can be seen to be influenced by a number of factors, including the foundation type and the port specifications.

- The aim of the project is to identify and assess the innovative methods to permit WTG assembly at floating offshore wind farm sites.

- The project will identify enabling technologies that allow for WTG assembly on-site and define the required operational procedures for stick-building on site. It will also look to set the frame and limitations for on-site assembly by identifying potential major showstoppers.

- It will bring about a greater understanding of the different installation methods that can be used for floating WTGs in context to their versatility and potential to reduce costs.

- Through developing greater installation options this will help reduce port facility and availability bottlenecks as well as constraints upon WTG assembly for different floating foundation concepts.

Kincardine 9.5MW turbine being installed

Find out more

Public resources and social media:

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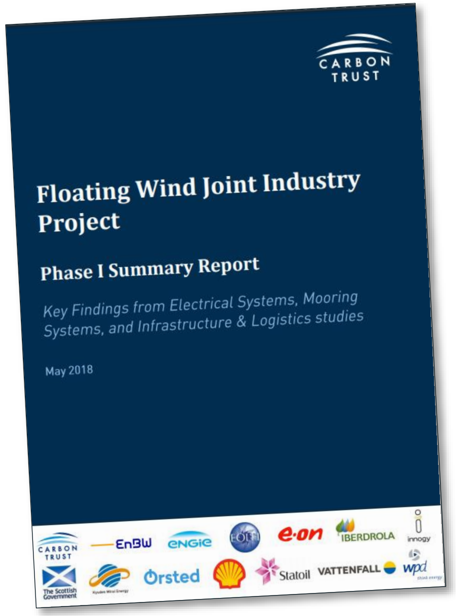
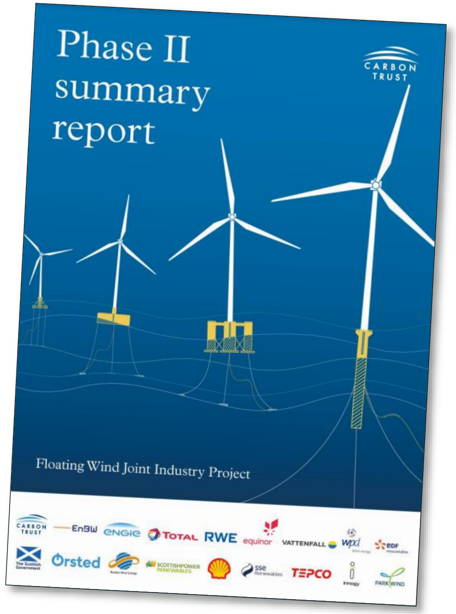
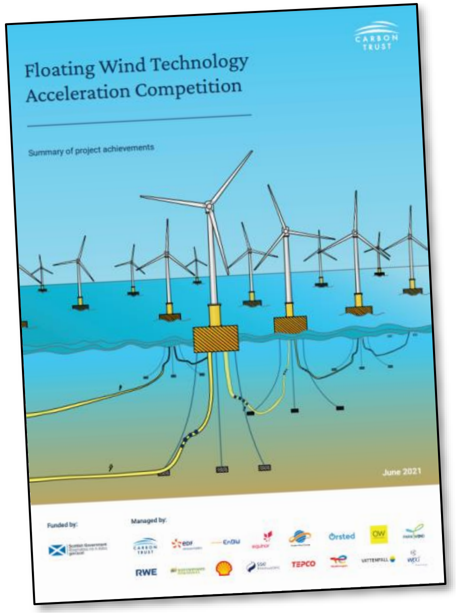


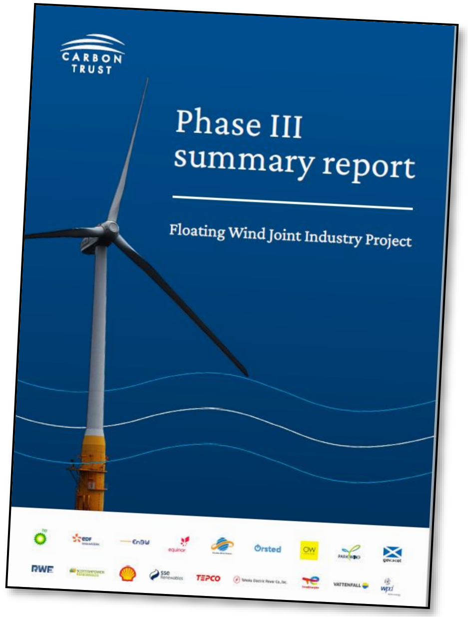
May 2018



June 2020



June 2021



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Thanks for listening

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