**Floating Offshore Wind and foundation types**

**Background to Natural England**

Within Natural England’s Approach to Offshore Wind[[1]](#footnote-1) we aim to focus on accurate evidenced environmental sensitivity information, with evidence-based mitigation to be implemented at all stages where impact is predicted.

**Background to the project**

Globally Floating Offshore Wind (FLOW) is predicted to be in a pre-commercial phase (2021-2025) and moving to a commercial phase from 2026 onwards[[2]](#footnote-2). The British Energy Security Strategy (April 2022) includes an ambition to deliver 5 GW of FLOW by 2030. The Crown Estate has confirmed it wants to unlock up to 4 GW of FLOW capacity in the Celtic Sea, awarding leasing rights by the end of 2023.

There are several precommercial trial and commercial FLOW projects established globally (please see Table 1). The main concepts for floating foundations are spar-buoy (Single Point Anchor Reservoir buoy), semi-submersible and tension leg platform. There are various options for anchors and mooring lines. Anchors can take the form of deadweight anchors that sit on the seabed, drag anchors that are set by pulling them through the soil, or dynamically embedded anchors. Suction assisted foundations include suction anchors, suction piles, caissons, and suction buckets. Gravity based foundations and clump weights are generally used in hard soils where conditions are not suitable for suction anchors due to soil penetration limitations. Catenary mooring lines are connected to the platform, hang freely in the water column, and are anchored to the seafloor. Tensioned mooring lines are stretched until the lines are taut.

There is currently an opportunity to gather information on environmental effects from global trial and precommercial FLOW projects to provide an evidence base to inform decision making and spatial planning in relation to upcoming commercial scale FLOW in England.

**The requirement**

Contractors are required to complete a desk-based review of available literature, grey literature and environmental monitoring and reporting from international FLOW projects to identify potential environmental benefits and risks of FLOW in relation to the technical design envelop identified for England.

Objective 1:

Review the FLOW foundation design envelope for the Celtic Sea as identified by the Crown Estate, based on technology and design boundaries for above and below water elements.

Objective 2:

Identify, assess, and describe potential pressure pathways including new and novel pressure impact pathways associated with FLOW projects, and pressures that that will have differing effects to traditional Offshore wind foundation types. Examples of impacts may include, but not be limited to, those considered in Table 2. The identification of pressures should be in line with the Advice on Operations for SAC and SPAs for Electricity from renewable energy sources and Cables <https://designatedsites.naturalengland.org.uk>.

Objective 3:

From known and new pressures associated with the development of FLOW design envelope, assess the impacts on Habitats and species, including features/sub feature or supporting habitat sensitivity to those pressures. Pressures are to be identified, described, and assessed against established pressure benchmarks where these are available and effect pathways stated.

Objective 4:

Assess the worst-case scenario design envelope of FLOW in relation to impacts to each environmental receptor or group of receptors. i.e. benthic, ornithology, marine mammals etc.

Objective 5:

Present potential mitigation measures for impacts associated with each design (category of turbine and seabed attachment) within the FLOW design envelope, as identified from trial projects or included within the literature. This may include, but not be limited to:

* considerations of rotor height
* use of specific foundation types in specific habitats
* integrated load cells within mooring lines potentially detect entanglement
* micro siting of anchors
* nature based design standards

Objective 6:

Identify evidence gap and suggest further research.

**Estimated cost**

Under £24,999 including VAT

**Estimated timeline/duration**

Invitation to Tender September 2022

Contract Award October 2022

Draft Report due February 2023

Final Report to be completed for publication by March 2023

**Key Contacts**

Tamara Rowson

**Output**

The contractor to produce a comprehensive report, setting out the key considerations for

* Identify potential impact pathways from FLOW design envelope
* Assess potential pressures on environmental receptors, in accordance with pressure benchmarks
* Present mitigation measures
* Identify Worst Case Scenario FLOW design envelope for England
* Provide recommendations to Natural England on follow up research

**Project Management**

* Inception meeting
* Monthly updates
* Draft Report to be issued by 1st Feb
* Final report to be issued by 1st Mar

**Possible Contractors**

Table 1 Examples of precommercial and commercial FLOW trials globally:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name | Country | Capacity  (MW) | Commissioned | Type | Anchor system |
| Hywind | Norway | 2 | 2009 | Spar | Suction Caissons |
| Principle Power Wind Float 1 | Portugal | 2 | 2011-2016 |  |  |
| University of Maine | USA |  | 2013 |  |  |
| Hywind | Scotland | 30 | 2017 | Spar | Suction Caissons |
| Fukushima FLOW Farm Demo Phase 1 | Japan | 2 | 2016-2021 | Semi-submersible |  |
| Fukushima FLOW Demo Phase 2 | Japan | 5 | 2016-2021 | Semi-submersible |  |
| Sakiyama | Japan | 2 | 2016 | Semi-submersible | Three-point catenary mooring system |
| Windfloat Atlantic | Portugal | 25 | 2020 | Semi-submersible |  |
| Kincardine | Scotland | 50 | 2021 | Semi-submersible |  |
| Ming Yang | China | 5.5 | 2021 |  |  |
| Oceanic Platform of the Canary Islands (Plocan) Prototype | Canary Islands |  | 2021 | TLP |  |
| Ideol Floatgen | France | 2 | 2018 | Semi-submersible | 6 mooring lines |

Table 2 Examples of potential impact pathways associated with FLOW

|  |  |
| --- | --- |
| Abrasion/disturbance of the substrate on the surface of the seabed | A heavy ground chain (or rode) is attached to the anchor. The rode increases the tension on the mooring line as it is lifted from the seabed and reduces the shock in the line. The movement of the rode may disturb the seabed during operation. |
| Abrasion/disturbance of the substrate on the surface of the seabed | Protection of benthic habitats due to restricted trawling |
| Habitat structure changes- removal of substratum | Will sand wave pre sweeping be necessary? |
| Physical change (to another seabed type) | Area of habitat change due to placement of cables and scour protection? |
| Physical change (to another seabed type) | Area of habitat change due to mooring lines and scour protection? |
| Physical change (to another seabed type) | Attraction effects by creating artificial reef habitats? |
| Physical change (to another seabed type) | Area of habitat change due to anchor types |
| Penetration and/or disturbance of the substratum below surface of the seabed, including abrasion | Number of piles required compared to fixed foundation |
| Penetration and/or disturbance of the substratum below surface of the seabed, including abrasion | Number of anchors required |
| Underwater noise changes | Noise associated with pin piling / helical technologies needs to be evaluated for its significance for range of UK species |
| Underwater noise changes | Noise associated with piling method compared to fixed |
| Underwater noise changes | Vibrating mooring lines / twisting snapping noises may be an issue at some sites depending on the species present and technology context |
| Underwater noise changes | Construction Noise compared to traditional foundations |
| Above Water Noise | Likely scale, intensity and duration of above water noise associated with FLOW |
| Barrier to species movement | Avoidance effects and barrier effects on birds |
| Barrier to species movement | Impacts to marine migratory species |
| Barrier to species movement | Fish aggregating potential of development |
| Barrier to species movement | Indirect effects on prey species |
| Changes in suspended solids | How many cables are likely to be required for FLOW, will this effect suspended sediment concentrations |
| Smothering and siltation rate changes | Are there likely to be issues in relation to smothering |
| Introduction or spread of invasive non- indigenous species | Structures can be towed from port to windfarm site and back for maintenance |
| Waterflow (tidal current) changes, including sediment transport considerations | Impacts to atmospheric and oceanographic dynamics |
| Waterflow (tidal current) changes, including sediment transport considerations | Wake and scour effects depending on foundation type and currents and depths |
| Wave exposure changes |  |
| Electromagnetic changes | Effects of EMF on the water column from floating cables |
| Temperature Increase | Will there be any temperature increase associated with operation of cables in the water column |
| Visual disturbance | Nature and scale of disturbance of FLOW, likely vessel movements during construction and operation |
| [Collision ABOVE water with static or moving objects not naturally found in the marine environment (e.g., boats, machinery, and structures)](javascript:__doPostBack('ctl00$ContentPlaceHolder1$grdfapmatrix$ctl14$lnkView0','')) | Consideration of location and scale of FLOW and hub height restrictions in accordance with design envelop |
| [Collision BELOW water with static or moving objects not naturally found in the marine environment](javascript:__doPostBack('ctl00$ContentPlaceHolder1$grdfapmatrix$ctl15$lnkView0','')) | Primary entanglement risk: risk of marine life becoming tangled with FLOW suspended cables / mooring lines |
| [Collision BELOW water with static or moving objects not naturally found in the marine environment](javascript:__doPostBack('ctl00$ContentPlaceHolder1$grdfapmatrix$ctl15$lnkView0','')) | Secondary entanglement risk: marine debris, such as derelict fishing gear may become snagged on FLOW cables which could potentially lead to entanglement |

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Natural England’s Approach to Offshore Wind: Our ambitions, aims and objectives (TIN181): <http://nepubprod.appspot.com/publication/5400620875120640>

1. Natural England’s Approach to Offshore Wind: Our ambitions, aims and objectives (TIN181): <http://nepubprod.appspot.com/publication/5400620875120640> [↑](#footnote-ref-1)
2. ([GWEC-Report-Floating-Offshore-Wind-A-Global-Opportunity.pdf](https://gwec.net/wp-content/uploads/2022/03/GWEC-Report-Floating-Offshore-Wind-A-Global-Opportunity.pdf) [↑](#footnote-ref-2)