ENABLING ELECTRIC CREW TRANSFER VESSELS IN OFFSHORE WIND

Offshore charging buoys for electric Crew Transfer Vessels.
Decarbonising offshore wind operations and maintenance.
Minimising fuel costs and emissions.

A STUDY BY OASIS MARINE FOR SCOTTISH POWER RENEWABLES - JUNE 2025

1.

EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

Oasis Marine have been engaged by Scottish Power Renewables, part of the Iberdrola Group, to perform a feasibility study of an offshore charging solution for Crew Transfer Vessels. The study was based on a 1GW southern North Sea wind farm 30 Nautical miles from its operating port. The offshore charging solution presented in this study is applicable to both existing and future offshore wind farms.

The offshore wind and maritime sectors are seeking to decarbonise. Once a wind farm enters its operations and maintenance phase, the main carbon emissions come from fossil-fuelled maintenance vessels.

The wind farm's purpose is to generate renewable electricity offshore. The logical and most efficient zero-emission fuel for the wind farm maintenance vessels to use is the electricity the wind farm itself generates.

This study, for a specific 1GW wind farm, recommends two Oasis Power Buoys to charge three electric Crew Transfer Vessels, significantly reducing emissions and costs. This publicly available summary report is provided through Operation Zero to highlight offshore charging technology and the decarbonisation and fuel savings it unlocks.

The range limitations of battery vessels mean offshore charging is key to enabling the use of electric maintenance vessels. Oasis Marine are the developers of an innovative range of Oasis Power Buoys which allow vessels to charge while moored to the buoy and also power down propulsion, minimising required charging time and maximising energy savings.

Oasis Power Buoys are elegantly simple reducing build and installation costs and delivering high levels of reliability. The Oasis Power Buoy system is customisable dependent on specific application requirements. This enables solutions for all vessel types, including larger Service Operations Vessels.

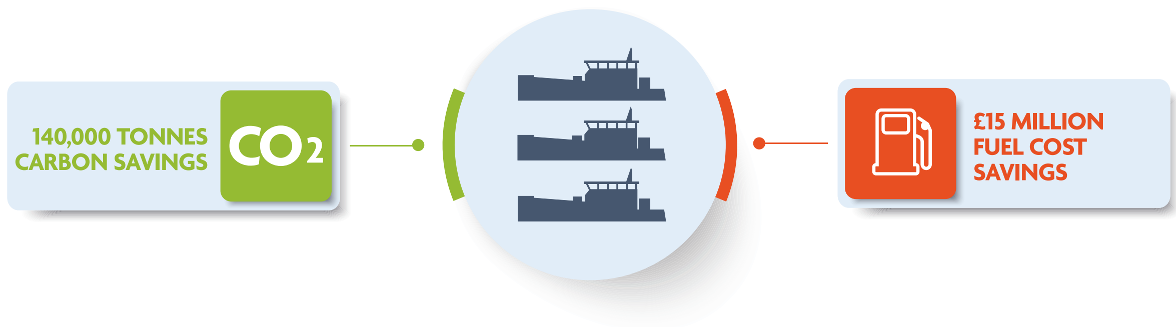
A floating vessel moored to a floating buoy is the mariners' preferred offshore charging solution. The natural elasticity of the mooring chain catenary absorbs peak mooring loads. Vessels can moor and charge well away from valuable assets, minimising collision risk between vessel and turbine, or vessel and offshore sub-station, while avoiding the need for dedicated offshore structures e.g. monopile solutions. The Oasis Power Buoy is made of materials that can absorb impacts without damage to vessel or buoy.

This study confirms that it is technically, operationally and economically beneficial to install Oasis Power Buoys and use electric crew transfer vessels, offering financial and carbon savings compared to fossil-fuelled vessels.

Newbuild wind farms will achieve significant cost savings by implementing offshore charging while substantially decarbonising their operations and maintenance phase. Retrofitting the Oasis Power Buoy to existing (*and already-designed*) wind farms is also technically and economically viable, enabling decarbonisation and cost savings for the current generation of wind farms globally.

In our study, utilising three electric Crew Transfer Vessels instead of diesel-fuelled vessels will save 140,000 tonnes of CO2 emissions over this wind farm's lifetime.

Savings on fuel costs over this twenty-five-year wind farm lifetime are around £15m. This includes the cost (CAPEX and OPEX) of the two Oasis Power Buoy offshore charging systems.



Using electric Crew Transfer Vessels provides protection from volatile fossil fuel prices, and the high costs of alternative green fuels. Instead, it enables maintenance vessel costs to be predictable, in line with the wind farm operator's business model.

Governments globally are seeking to meet net zero targets and are creating policy in line with this e.g. the UK's Maritime Decarbonisation Stratergy, published March 2025. This includes imposing carbon taxes on maritime operations. In the UK this carbon tax is known as the UK Emissions Trading Scheme (ETS) which is scheduled to apply to vessels greater than 5000 gross tonnes by 2026. This will be reviewed in 2028 to potentially include smaller vessels (*likely >400 tonnes*) and it is expected some form of carbon tax will include all commercial vessels including crew transfer vessels in the future.

Electric vessels produce no CO2 and therefore will be exempt from any future carbon tax. As Government and Company policies are increasingly promoting Net Zero targets, future offshore wind licence rounds will favour low emission solutions. A zero-emission maintenance strategy in licence bids will inevitably be required for offshore wind farm operators to win future business.

2.

CHARGING SYSTEM OVERVIEW

2. CHARGING SYSTEM OVERVIEW

The case study proposed two Oasis Power Buoy installations, strategically positioned within the wind farm, following a standard system design (**FIGURE 1**):

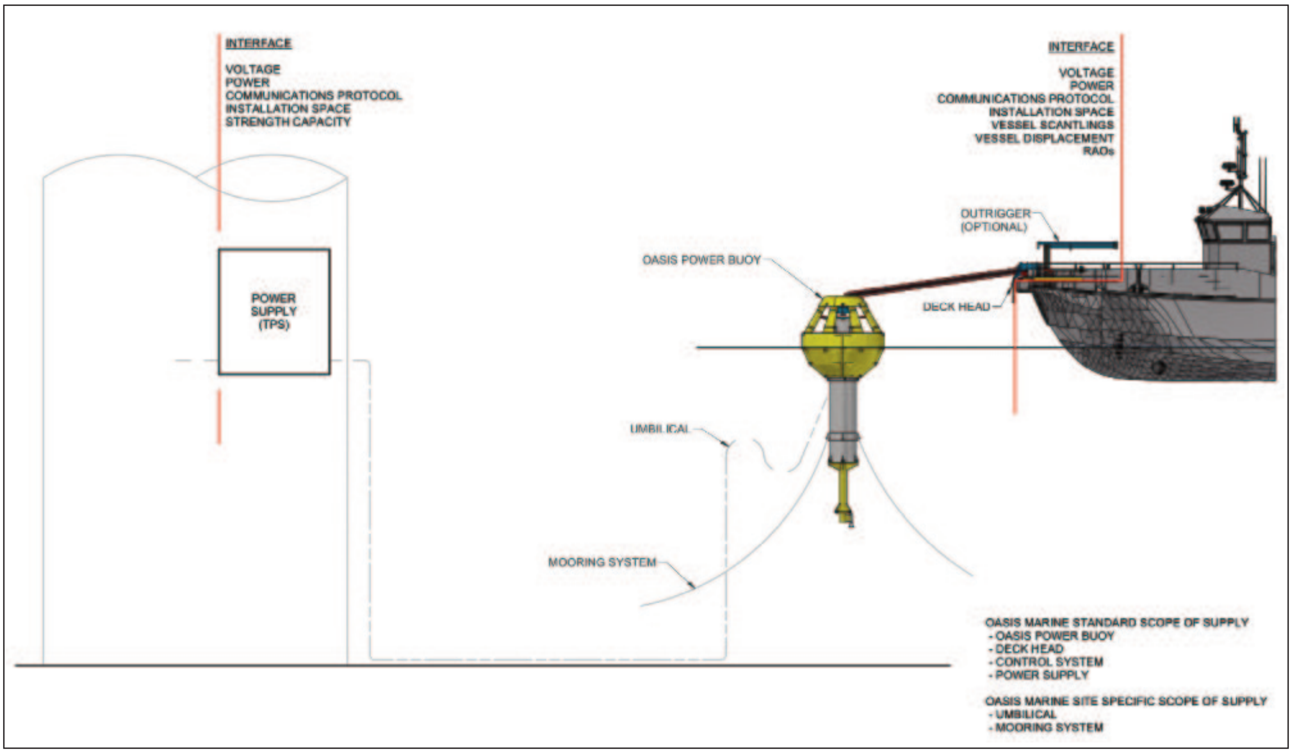


FIGURE 1: OASIS CHARGING SYSTEM OVERVIEW

- Each Power Supply Unit will be installed on a Wind Turbine Generator adjacent to the moored Oasis Power Buoy. This will utilise the 66 kV 3 phase AC power within the distribution array network and convert it to DC power for direct charging of the crew transfer vessel batteries. 132 kV distribution network could also be utilised with correctly matched transformers and associated switchgear. *(N.B. AC power would be used for an Oasis Power Buoy charging larger Service Operations Vessels)*

- An umbilical will transfer the power from the Power Supply Unit to the Oasis Power Buoy through the cable hang-off within the wind turbine transition piece, through a 'J-Tube' to the charging buoy, via a sub-sea arch.

- Fibre optic conductors are contained within the umbilical to enable data communication. In order to provide remote monitoring from shore locations, a Supervisory Control and Data Acquisition (SCADA) data link connection is provided. This would be through a cyber secure firewall port, assigned and controlled by the wind farm operators' data network.

- The Oasis Power Buoy acts both as a mooring point for the vessel and as a distribution point for the electricity and data communications.

2. CHARGING SYSTEM OVERVIEW (CONT)

- The vessel moors to the Oasis Power Buoy (OPB) via an automated outrigger (**FIGURE 2**) which positions the mooring line from the vessel around the Power Head. Using a windlass, the vessel mooring line then pulls in the Power Head, cables and buoy mooring line to secure these to the Deck Head (**FIGURE 3**).

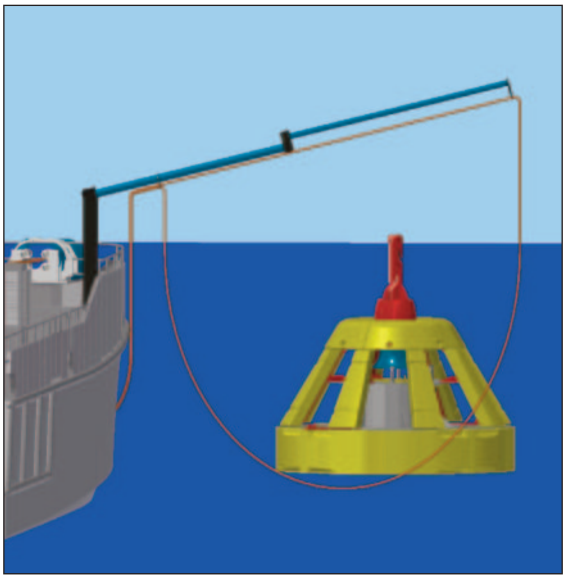


FIGURE 2: OUTRIGGER DEPLOYMENT

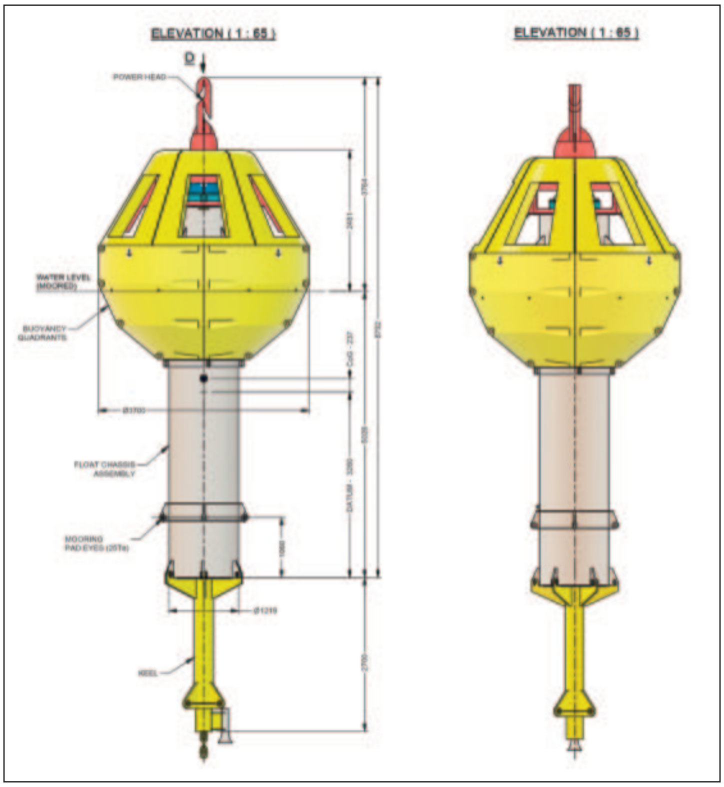


FIGURE 3: OASIS POWER BUOY GENERAL ARRANGEMENT

- The Control and Communications System is critical to the safety and operation of the integrated system. Oasis have led the development of this system working with a communications and control systems specialist contractor, Tierney Strachan.

- Once the communication system detects safe mooring and connection, battery charging can commence.

- When charging is completed, the system communications will signal power down, the system is safe for disconnection and the vessel is ready for its next task.

- The Power Head is disconnected from the Deck Head and the cables retract into the buoy. Emergency disconnection capabilities are built into the whole system.

3.

STUDY PARTNERS

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3. STUDY PARTNERS

Oasis Marine are the originators of the Oasis Power Buoy design and the overall system integrator. Oasis worked with specialist industry partners on this study, who have applied their specialist expertise to elements of the integrated system.

TURBO POWER SYSTEMS LTD are market leaders in the provision of high-power electronics and have been working with Oasis on the provision of a MW scale system which rectifies high voltage AC to DC at levels suitable for recharging electric Crew Transfer Vessel batteries. Their role in this project was to detail the Power Supply Units including costs, sizes, weights, tie-ins and the configuration required for this installation.

FIRST MARINE SOLUTIONS offer expert mooring design and installation. They have worked with Oasis to provide simulations, models and studies on Oasis Power Buoys and their moorings. Their brief was to design and cost the mooring system, based on the specific environmental conditions and water depth encountered.

4.

TECHNICAL FEASIBILITY

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CHARGING LOCATIONS

The Oasis Power Buoy can be installed alongside an Offshore Sub Station and/or adjacent to wind turbine generators to provide a spread of location options throughout the wind farm. In this study two locations adjacent to different turbines were selected to allow for strategic positioning of charging points. This ensured charging vessels will be close to where technicians are working, reducing transit time in emergency situations and enabling a common design for the two charging systems.

SYSTEM COMPONENT OVERVIEW

The full charging system can be broken down into system components: the Oasis Power Buoy, the Mooring System, the Umbilical (*connecting the buoy to the wind turbine*), the Power Supply (*connecting the umbilical to the wind farm grid*) and the Vessel Interface (*connecting the buoy to the vessel*).

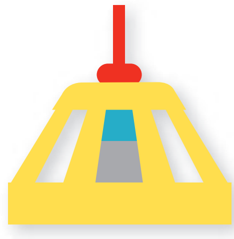
4.1 OASIS POWER BUOY

The Oasis Power Buoy is designed to be as simple as possible, leading to low build and maintenance costs and high reliability. The buoy itself has minimal equipment, with system components located on either the wind turbine/offshore substation or on the vessel where possible for easier access during routine maintenance. Several water trials have already been conducted on OPB prototypes proving system marine components.

A key element of the Power Buoy is the patented passive gravity system which counterbalances the weight of the power cables as they extend to the vessel. This ensures key components are isolated from the harsh offshore environment inside a water free cavity which protects the transfer cables and mooring line from chafe, marine growth, and UV light. A bilge pump drains this cavity should it become wet in storm conditions.

No slip ring is required for the Oasis Power, which greatly reduces capital and maintenance costs compared to other offshore charging solutions. Instead, the mooring system has sufficient mechanical capacity to absorb any rotational weather-vane effect experienced during the charging period. In this case, the expected charging period is up to ninety minutes.

The vessel approaches and attaches to the Power Head on the buoy using an outrigger, then pulls the Power Head across to the Deck Head using a windlass. No human is ever in the load path during this operation. As the Power Head is winched in, it automatically aligns and engages with



OASIS POWER BUOY SPECIFICATION

- **POWER RATING**
  3MW @ 1000V nominal voltage
- **STRUCTURE**
  Welded steel with corrosion protection.
- **BUOYANCY**
  Polyurethane coated foam.
- **MOORING SYSTEM**
  3-leg anchor spread.
- **SEASTATE**
  2.5m Hs (Operational upper limit - discretion of vessel master/company policy)
- **NAVIGATION**
  Navigation lights, AIS beacon.
- **DIMENSIONS**
  Diameter 4.6m, draft 8.0m, displacement 11 tonnes, connection length 9m.

the Deck Head, completing electrical connections and safety checks automatically.

The umbilical is connected to the buoy via a junction box, splitting power and communication circuits into flexible Transfer Cables with calculated multi-use-case design life. The Transfer Cables hang vertically within the buoy when not in use, protected from weather, marine growth and UV light.

The Power Head contains both the mechanical mooring system to hold the vessel in place and the electrical system to re-charge the vessel's batteries. It has been designed for easy pull-in and automatic orientation, with the final stage utilising precision pins to guide the electrical connectors for accurate mating.

The Carbon Trusts Offshore Wind Accelerator commissioned the design and development of a universal offshore charging connector for CTVs with input from nine offshore wind developer partners. The Carbon Trust Offshore Wind Accelerator is also working on the development of a larger standardised connector for Service Operation Vessels (SOVs) which will be published later this year. Oasis Marine alongside wider relevant stakeholders have been engaged as part of this project and Oasis Marine are interested in incorporating the standardised SOV connector into an offshore charging buoy for SOVs. This larger Oasis Power Buoy has both can buoy and spar buoy designs for different metocean conditions.

Oasis is committed to using standardised connectors and is planning to incorporate the Carbon Trust connector design into Oasis Marine's offshore trials in 2025. In addition, Oasis are maintaining close interest in standardised connector designs in other geographies and can readily incorporate such connectors in future.

4.2 MOORING SYSTEM

The mooring system ensures optimal performance for charging in operational conditions, reducing snatch loading, and providing stability in survival conditions, protecting the umbilical connection point. For this wind farm location, the catenary mooring system consists of three legs spaced 120° apart.

The moorings are designed to withstand harsh environmental conditions, in this case with water depths of around 50m and operational conditions of Hs 2.5m.

4.3 UMBILICAL

The umbilical includes outer sheath protection with multiple copper cores, fibre optic cables for data transfer, and a safety pilot circuit.

Calculating the umbilical's fatigue life during operations is crucial and is carried out by an experienced umbilical supplier collaborating with the mooring contractor. This ensures that selected umbilical designs have appropriate wear characteristics, buoyancy, stiffness, and minimum bend radius to suit the environmental conditions in this wind farm location. The umbilical design is in selection phase and is being developed with a cable supplier incorporating Orcaflex simulations, storm conditions and fatigue.

The charging dynamic cable riser exiting the Wind Turbine will be routed via a J-Tube and protected from abrasion with Uraduct or similar materials.

The umbilical installation features a tether clamp attached to a clump weight to manage the umbilical's touch down. Ancillary components are bolted in position during installation, which can be performed using a multi-cat vessel.

4.4 POWER SUPPLY

One of the challenges for widespread implementation of offshore charging is the diverse range of turbine models and power systems in use across the industry. In this study the power supply for the DC charging equipment will be situated on the Wind Turbine Generator (WTG). Several viable options for the power supply connection were considered and discussed with Scottish Power Renewables:

A: Adding additional switchgear and protection equipment to the WTG 66kV 3 phase switchboard;

B: Increasing the capacity of the Auxiliary supply system and cabling at 400V 3 phase output;

C: Siting the DC charging equipment within the Offshore Sub Station and having the umbilical carrying DC directly to the Power Buoy at the proposed locations.

Option A was selected - to install additional switchgear and protection equipment to the 66kV switchboard. This option does not require changes to the nacelle's transformer/cabling, which was not possible in this case study, as the wind farm design was already finalised. However, Option B is worthy of consideration for future designs.

A modification to the 66kV switchboard will provide isolation and protection for the stepdown transformer feeding the DC charging equipment. An unused motorised disconnector can then be used as a connection point to the 66kV supply, requiring detailed work by specialist engineers and equipment suppliers. The offshore charging system is integrated into the electrical architecture of the wind farm in such a way that any technical problems experienced in the charging system cannot migrate to the turbines and substation and therefore will not impede energy generation and distribution.

Multiple options for the DC charging equipment were also considered, with preference given to a stepdown transformer from 66kV to 12kV which is a more readily available option compared to the others considered. Supply voltage variation is critical, and transformer protection will be established.

Initial transformer load requirements for charging vessels with 3, 4, or 5 MWh battery systems within 90 minutes were assessed:

- **3 MWh:** 2 MW output, 3368 A current, 2.4 MVA transformer rating.
- **4 MWh:** 2.67 MW output, 4330 A current, 3.1 MVA transformer rating.
- **5 MWh:** 3.33 MW output, 5292 A current, 3.75 MVA transformer rating.

A Direct Current Billing Meter within the Power Supply Unit Charging Equipment monitors energy supplied to vessels. It interfaces with a web-based 'back office' for accurate billing. An energy meter with Current Transformers and Voltage Transformers at the supply point ensures accurate energy consumption measurement.

4.5 VESSEL OASIS POWER BUOY INTERFACES

There are various potential providers of the three 100% electric Crew Transfer Vessels to carry out operations in the case study. The Oasis system has been designed to be compatible with all known suppliers. Vessel battery systems typically come from a small group of manufacturers and adopt industry-wide communications protocols, including CCS and MCS charging.

The Deck Head is the interface which connects to the Crew Transfer Vessel. This is installed on the vessel connected to structurally secure points, able to withstand mooring loads and housing the reciprocal connectors which mate with the Power Head.

The Deck Head is straightforward to mount onto the port or starboard bow, and vessel integration using these communications protocols is readily achievable.

The Deck Head is connected to the vessel electronics and a Human Machine Interface (HMI) installed on the vessel bridge for the vessel master to control and monitor charging operations. Warning alarms, isolators, ground fault detection and emergency stops are integral to the system.

The vessel is also fitted with an automated outrigger which connects to the Oasis Power Buoy and a winch (windlass) which is used to pull the Power Head from the buoy to the vessel.

4.6 VESSEL CONTROLS AND COMMUNICATION

The Vessel Master controls the charging operation, in this study following the Combined Charging System (CCS) standard protocol. The charging system is energised from wind turbine supply, and DC charging is enabled once the Power Buoy connection is established. Power is always available even if that particular wind-turbine isn't generating, as connection is made grid-side on the turbine. The Vessel Master initiates the charge via the Vessel's Control system, with safety interlocks ensuring secure operation.

The control system monitors equipment at the vessel, Power Buoy, and charging equipment locations. A fibre optic network links the Power Buoy to the charging equipment, with ultra-high frequency (UHF) signal transmission for wake-up communication. Data transferred includes charge parameters, battery state, and connection confirmation. Emergency stop buttons ensure safety, and data is available remotely for monitoring via SCADA.

4.7 CODES & STANDARDS

As offshore charging technology is developed and adopted, offshore charging suppliers are adopting appropriate adjacent standards to enable safe operations. Close relationships are maintained with the relevant standards bodies and all stakeholders are involved to ensure that new standards developed are universally adopted.

The standards and codes used for the Oasis Power Buoy charging system include, but are not limited to, those listed in **TABLE 1**.

AUTHOR	NUMBER	TITLE
DNV	DNV-OS-D201	Electrical Installations
DNV	DNV-OS-E301	Position Mooring
DNV	DNV-OS-E403	Offshore Loading and Infrastructure Buoys
DNV	DNV-ST-N001	Marine Operations and Marine Warranty

TABLE 1 STANDARDS USED

PHOTOS FROM WET TRIALS OF OASIS POWER BUOY PROTOTYPES

5.

OPERATIONAL FEASIBILITY

5. OPERATIONAL FEASIBILITY

5.1 MARINE OPERATIONS AND CHARGING

The following figures (FIGURE 4 & 5) illustrate the procedure of attaching a Crew Transfer Vessel to an Oasis Power Buoy. The mooring line is preloaded from Deck Head onto the outrigger as specified and is fully deployed, ready to connect to the Power Head. Once the outrigger is deployed, the vessel approaches the buoy, aided by cameras on the vessel bow and the tip of the outrigger. Minimum standoff for the Crew Transfer Vessel will be around 1m. The buoyancy material on the Oasis Power Buoy is polyurethane sprayed foam, thereby allowing the vessel and buoy to impact without damage to either.

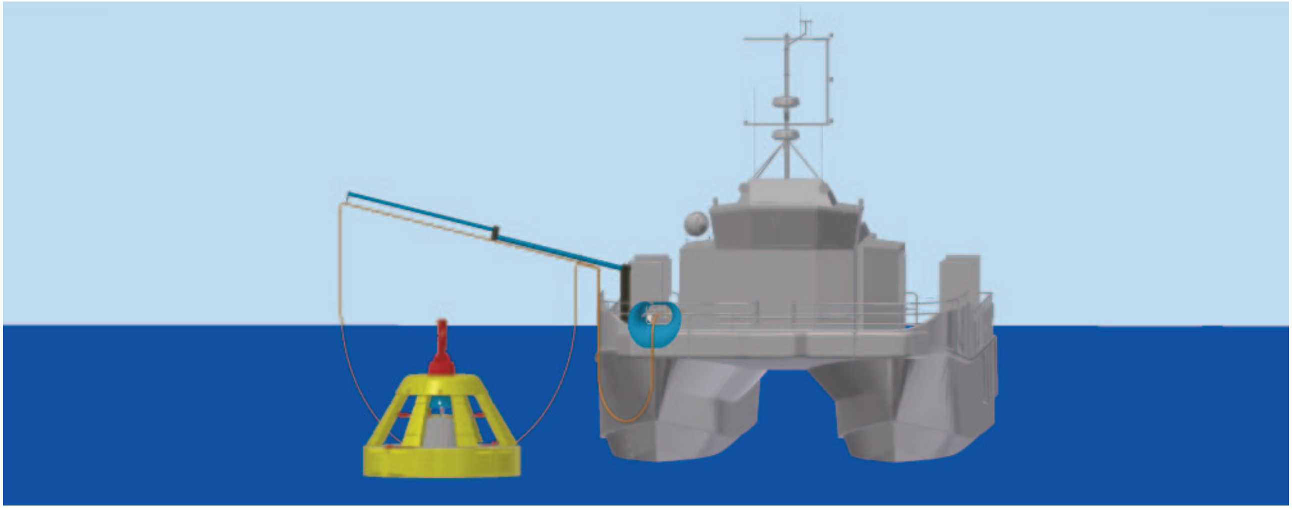


FIGURE 4 THE CREW PREPARE FOR CONNECTION BY RIGGING THE MOORING LINE AND DEPLOYING THE OUTRIGGER. FORWARD VIEW

The Power Head retrieval operation is then carried out. The vessel moves past the buoy, with outrigger extended directly above the buoy. The mooring line catenary rides up the structure of the buoy until it reaches the Power Head and is clipped in place by a carabiner mechanism. This then allows the Power Head to be winched to the Deck Head located on the bow of the vessel.

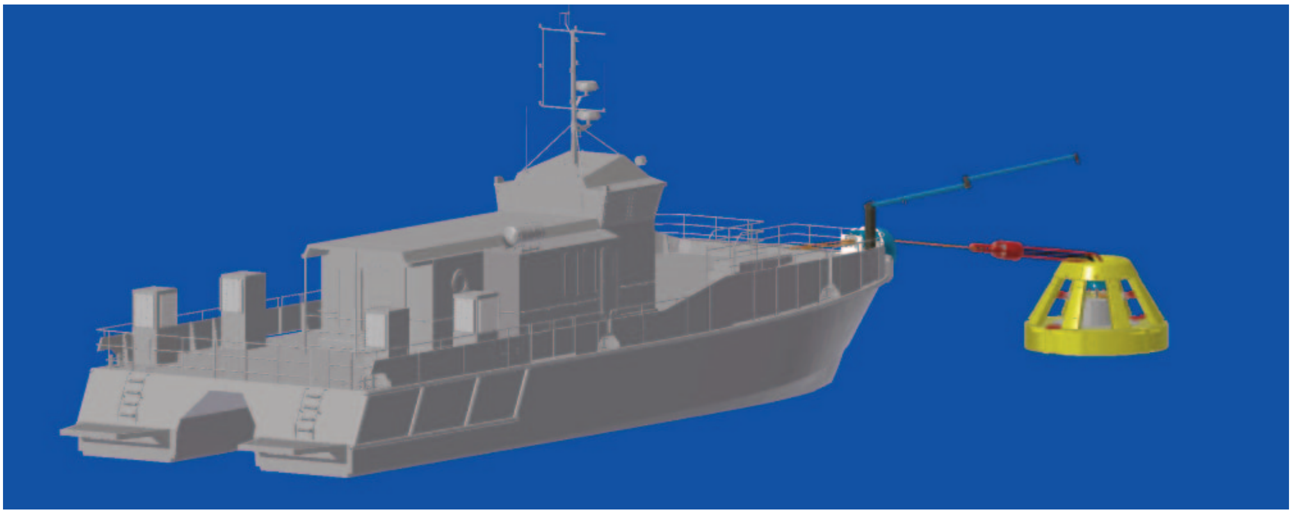


FIGURE 5 THE WINDLASS PULLS IN THE POWER HEAD, WHICH SELF-ALIGNS AS IT ENTERS THE DECK HEAD. AFT VIEW

The vessel-side components of the system are sea-fastened to the vessel deck and secures the Deck Head guide, connectors and transfer cables to a junction box (*which in turn connects to the vessel electrical systems*). The grillage also supports the mechanism for pulling across the Power Head.

Handrails and protective barriers are fitted in line with vessel specifications.

In an emergency, the mooring line can be immediately disconnected, remotely or locally. The mooring line is to be released from the windlass mechanism. Backing up the vessel from the buoy will naturaly release the power head.

The retraction system (*that which recovers the transfer cables controlled by the mooring line to the buoy internals*) will work in a controlled disconnection i.e. manouvering the vessel towards the buoy to allow the retraction system sufficient payout in air.

HYBRID CREW TRANSFER VESSEL, NR REBELLION, FOR USE IN SCOTTISHPOWER RENEWABLE'S EAST ANGLIA 3 OFFSHORE WIND FARM

6.

HEALTH AND SAFETY

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Safety considerations apply to all stages of the charging system's lifespan covering installation, commissioning, standard operations and decommissioning. All personnel accessing offshore wind assets must have mandatory Global Wind Offshore (GWO) certification, medical clearance, induction, competent person training, and required safety documentation. Vessel crew need Maritime and Coastguard Agency safety training, including sea survival and first aid. The three locations where safety considerations are required during normal operations are on the wind turbine, at the Oasis Power Buoy and on the vessel.

On the wind turbine, compliance with operational safe systems of work is required, including Wind Turbine Safety Rules (WTSR) and Operational Safety Rules (OSR). Understanding site electrical mechanical safety rules is essential for planning the installation of power conversion assets. The control system network, including status signals from the Power Supply Unit, Power Buoy, and vessel, can be monitored remotely, providing valuable safety and operational resources.

On the Power Buoy the process to connect the power head, electrical connection and mooring line to the CTV requires no manual handling of the power head. The vessel master oversees operations, determining the availability and status of the Oasis Power Buoy and the suitability of the connection, based on weather and sea conditions and visual inspections of the charging system.

At the Vessel the system status and alarm states are communicated to the vessel's Human Machine Interface via telemetry link when disconnected, and are hardwired when connected. The Power Head connects to the Deck Head with minimal human interaction. Charging commences when the vessel master accepts the 'safe' condition status and can be stopped at any time at the bridge or via emergency stop buttons accessible throughout entire charging system. Planned de-energisation and disconnection follows the reverse process.

Charging system maintenance involves analysing serviceable parts, their intervals, and methodology; critical parts, their design life, and repair methodology; recommended spares list; and routine maintenance timescales. Ensuring safe operation and compliance with Health and Safety guidelines is paramount.

7.

SYSTEMS OPERATIONS & MAINTENANCE

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7. SYSTEMS OPERATIONS & MAINTENANCE

7.1. INSTALLATION PHILOSOPHY

The installation of the Oasis Power Buoy and its components can be performed in stages, ensuring operations are managed to prevent overlap or conflict. Pre-installation commissioning should be completed before mobilisation and installation and full risk analysis and method statements must be followed.

Consideration must be given to the electrical installations. Safety measures include isolating and locking out High & Low Voltage supply, observing safety distances, and managing any stored charge held in isolators.

Any such operations must only be carried out by suitably qualified personnel. Specifically, moorings and the buoy will be installed by a marine contractor utilising a workboat with crane capacity allowing installation of the mooring equipment/dead weights and umbilical from the vessel. On the Wind Turbine Generator, lifts and install of charging equipment shall be carried out under Lifting Operations and Lifting Equipment Regulations (LOLER) guidance. Isolations and electrical connections to be performed by suitably trained personnel only, in accordance with Wind Turbine Generator procedures and controls.

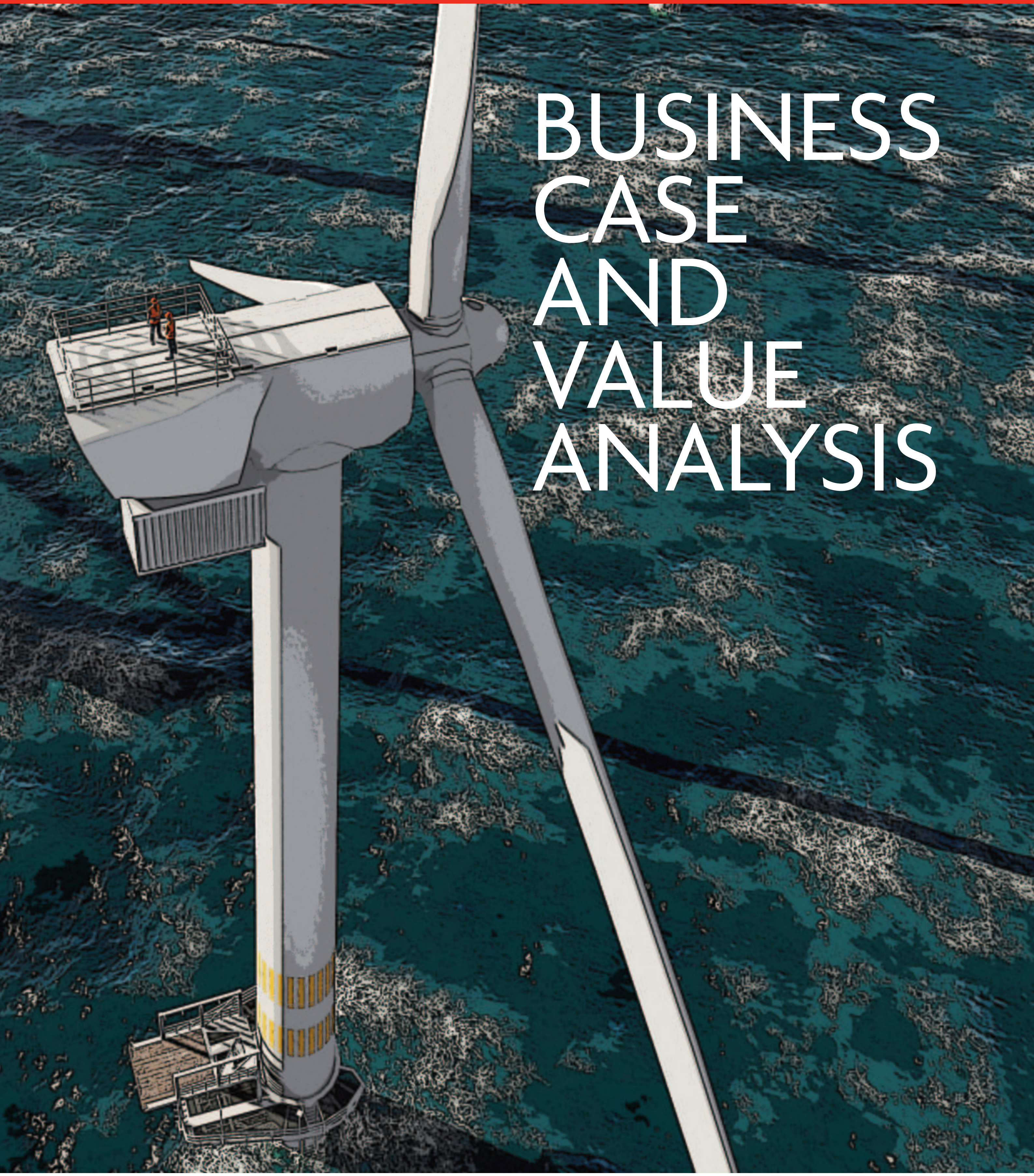
7.2. OPERATIONAL MAINTENANCE

The Oasis Power Buoy has been designed from inception to be low maintenance and offer high reliability. The outer shell / structure is a combination of polyurethane sprayed foam and mild steel. This is a tough combination and will be able to withstand reasonable vessel impact.

Within the buoy there is minimal equipment, which greatly reduces the chance of any failures. The inspection/maintenance schedule is broken into daily inspection, yearly and 5 yearly interventions.

8.

BUSINESS CASE AND VALUE ANALYSIS



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8. BUSINESS CASE AND VALUE ANALYSIS

Many factors play into the business case for an Oasis Power Buoy offshore charging solution. The location and size of the wind farm, the met-ocean conditions, the turbine model and the power requirements will all impact the total Capital Expenditure on the charging system.

8.1. BUSINESS CASE

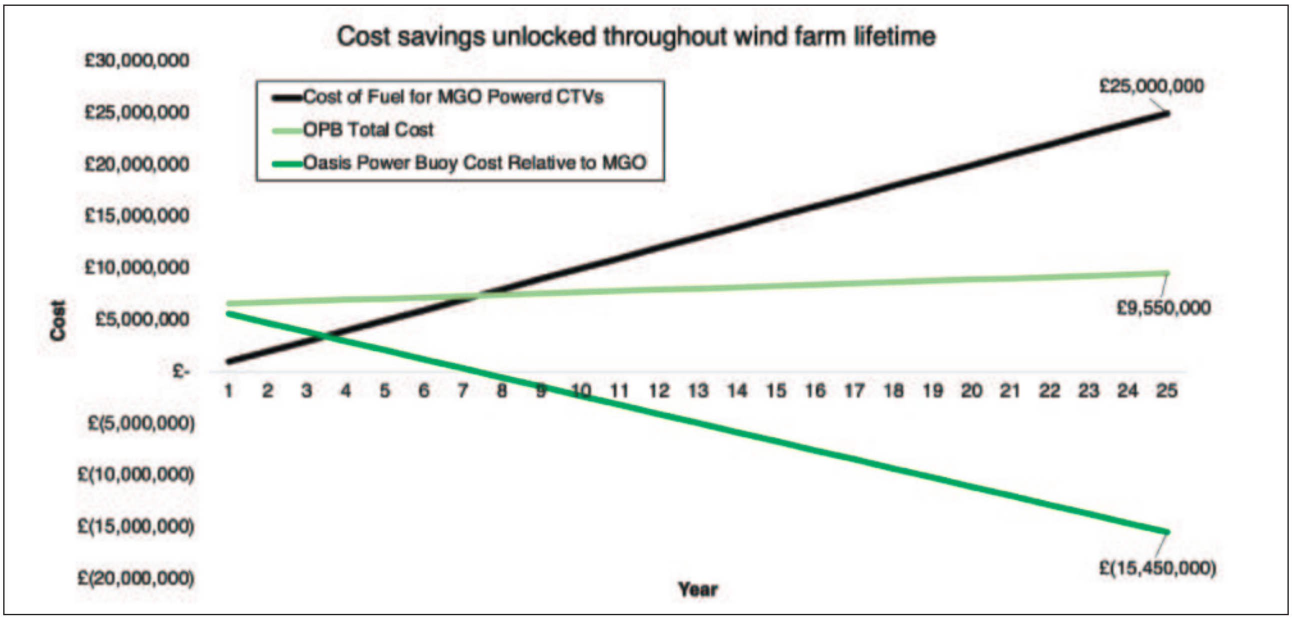
A business case was developed for the specified wind farm parameters to evaluate the costs of the Oasis Power Buoy offshore charging system in terms of CAPEX and OPEX. This was then compared to the cost of fossil fuelled equivalent operations e.g. the fuel cost of marine gas oil (diesel) fuelled CTVs.

The capital cost included allowances for transformers (*with potential reductions if low voltage supply from the nacelle could be used*). Installation costs will increase if electrical equipment cannot be installed at the same time as the Wind Turbine Generator.

Operational expenditure includes annual inspections consisting of visual checks and camera inspections. The 5-year refit includes replacing anodes, transfer cables, mooring lines, foam bend formers, and connector pins and sockets, along with ROV inspections.

Some key assumptions have been made for the model:

- **The cost** of an electric Crew Transfer Vessel was modelled to be equivalent to that of an Marine Gas Oil CTV with comparable capabilities. With the rapid ongoing cost reduction in battery technology, simplicity of electric moters compared to diesel engines and fabrication savings from increased vessel orders in the future, the cost of eCTV's is projected to decrease with time. It is anticipated that the electric CTV cost will be lower than that of an MGO CTV in the future.
- **The Oasis** Charging system maintenance costs have excluded vessel costs - as vessels already in-field will be used for routine maintenance.
- **Unforeseen** repair costs are also excluded.



COST SAVINGS THROUGH TIME FROM INCORPORATING OASIS POWER BUOYS AND ELECTRIC CTVS IN MAINTENANCE STRATEGY COMPARED TO USING MARINE GAS OIL (MGO) FUELLED CTVS

The results from this evaluation showed substantial savings from switching to electric CTVs utilising the Oasis Power Buoy charging solution. The analysis demonstrated potential savings of around £15 million pounds over the wind farm lifetime.

8.2 VALUE ANALYSIS

Additional benefits of Oasis Power Buoy offshore charging to enable electric CTVs include:

- **helping** operators meet sustainability targets.
- **protection** from volatile fuel markets.
- **avoiding** future potential carbon taxes.
- **winning** future business through low emission solutions.

Notably over the design life of this wind farm, it was calculated that around 140,000 tonnes of carbon emissions would be saved. This equates to savings of 5,600 tonnes of carbon emissions saved per year.

Maintenance vessels reliant on fossil fuels such as Marine Gas Oil suffer from price volatility. This is affected by regional and world events and is outwith the control of an operator. On the other hand, electricity is available at a set price to a wind farm operator charging their maintenance vessels - currently at the strike price in the UK.

Although the current UK Carbon Tax, known as UK Emissions Trading Scheme (ETS), will only apply to vessels greater than 5000 gross tonnes from 2026, this will be reviewed periodically, with the first review in 2028. Vessels over 400 gross tonnes will have to monitor carbon emissions, and a likely next step will be for these vessels to be included in the UK ETS. Although CTVs are below this cut-off it is possible this, or an alternative carbon tax, will be applied to all commercial vessels at some point within the next years. As of January 2025, UK ETS is at a rate of $41.84 per tonne of CO2 as set. If this level of tax was applied during operations of our case study wind farm, this would increase the cost of using diesel fuelled vessels by over £230,000 pa.

Governments have been including sustainability goals within policy for many years now and these have an impact on future offshore wind licensing rounds. Preference will be given to the most sustainable proposals: including offshore charging will significantly reduce a project's overall carbon emissions and therefore contribute to success in future licence rounds.

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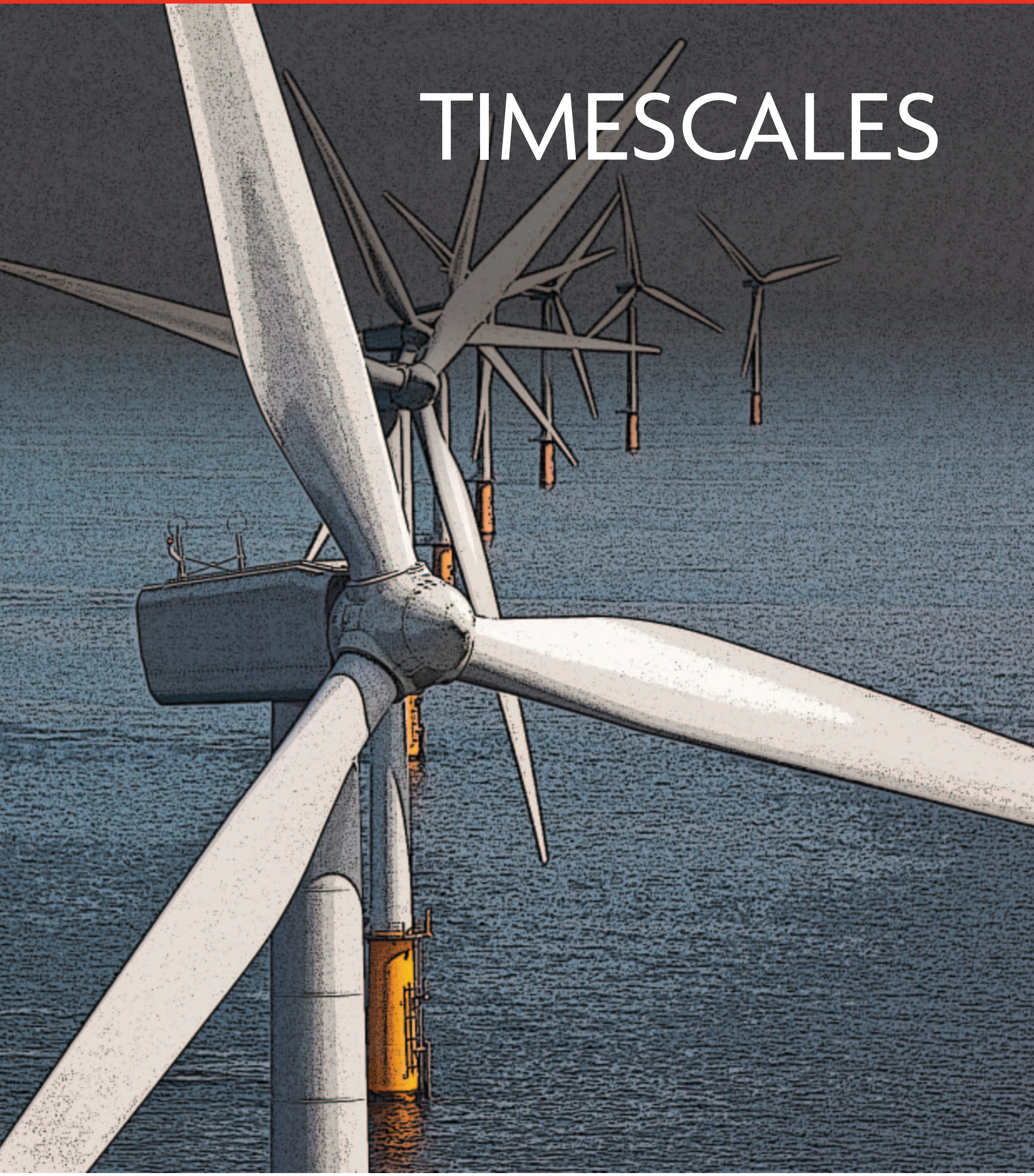
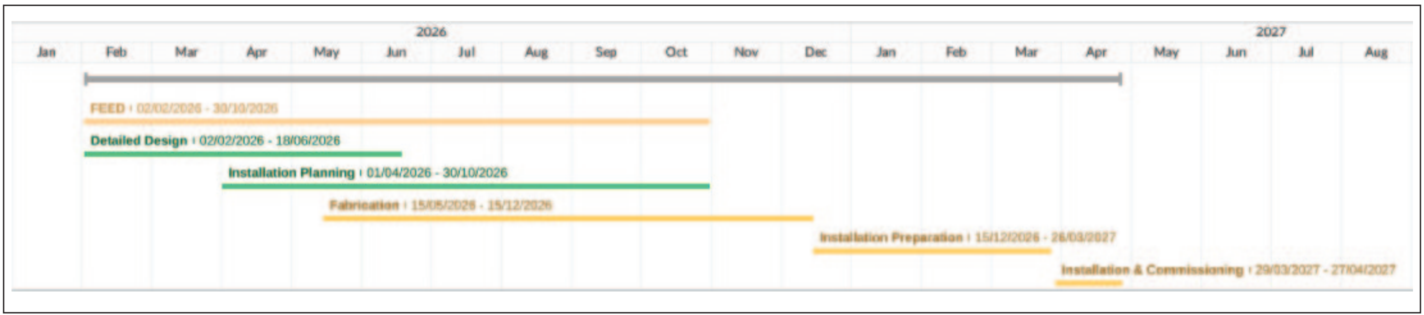


TIMESCALES

9. TIMESCALES

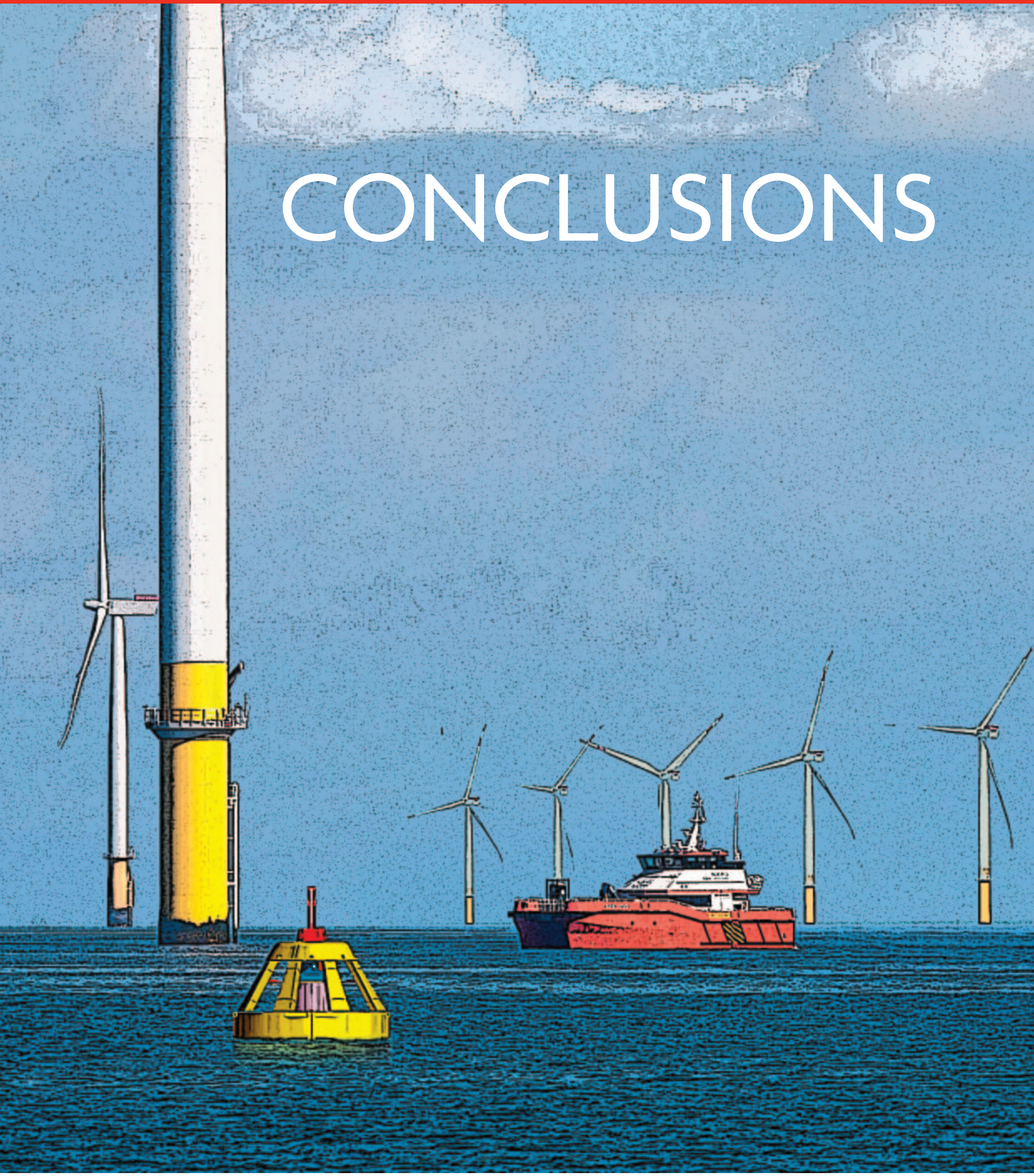
In this feasibility study a project plan was developed that showed, from the date of commissioning a full FEED study, the Oasis Power Buoy offshore charging system could be deployed within eighteen months. Twelve to eighteen months is anticipated to be a representative timeframe for similarly scoped projects, subject to wind farm location and specific regulatory requirements.



EXAMPLE OASIS POWER BUOY PROJECT TIMELINE FROM FEED TO INSTALLATION

10.

CONCLUSIONS



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10. CONCLUSIONS

The Oasis Power Buoy offshore charging system is a technically, operationally and economically feasible solution to enable electric maintenance vessels to service offshore wind farms, greatly reducing emissions.

- The Oasis Power Buoy is a reliable purpose designed marinised solution developed for offshore charging operations.
- This offshore buoy charging solution maintains a safe distance (*~125 metres*) between valuable assets (*Turbine or Offshore Sub Station and Crew Transfer Vessel*). This reduces collision risk compared to fixed-structure reeling solutions (*which require very close vessel approach to connect*).
- The Oasis Power Buoy provides a combined mooring and charging solution, which maximises fuel savings, as the vessel does not require its dynamic positioning system while charging.
- The business case shows substantial savings using the Oasis Power Buoy offshore charging solution over Marine Gas Oil-fuelled Crew Transfer Vessels.
- The Oasis Power Buoy unlocks huge potential for carbon emission reductions during the operations and maintenance phase of offshore wind farms.
- Offshore charging of electric vessels protects against volatile fuel prices.
- Oasis Power Buoy charging of electric CTVs protects against anticipated future carbon taxes.
- Including this offshore charging solution in future wind farm bids will aid operators to win future business as preference is given to net zero operations.
- Mooring a floating vessel to a floating buoy minimises 'snatch loading' (*which is experienced by vessels moored to fixed structures in reeling solutions*).

Decarbonisation of the maritime sector is set to advance rapidly ahead of net zero 2050 ambitions. The International Maritime Organisation (IMO) agreed in April 2025 to the sector's first binding targets to reduce greenhouse gas emissions from ships. The shipping sector is now the first industry with internationally mandated targets to reduce emissions. Electric Crew Transfer Vessels, enabled by Oasis Power Buoys, will help the Offshore Wind industry to meet these targets.

oasis marine

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