



Service Operating Vessel Logistics at Dudgeon Offshore Wind Farm

Owner-led selection, setup, and early experience in use

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Summary

The owners of the Dudgeon offshore wind farm have evaluated logistics options to enable workers to safely and effectively access offshore structures at the wind farm. They have selected to use a combination of a service operating vessel (SOV) and single crew transfer vessel (CTV) based from Great Yarmouth during the first five years of operation, and will use this period to evaluate the performance and effectiveness of this solution to inform the long term operations and maintenance (O&M) strategy.

Key Findings

- An owner-led SOV solution is being used to enable a wide range of maintenance tasks to be delivered including seabed surveys, balance of plant maintenance and subsea inspection, including the potential to support diving and use of remotely operated vehicles (ROVs) as well as routine and non-routine work on the wind turbines.
- The Dudgeon project has taken existing oil and gas vessel experience and engaged with the supply chain to develop an SOV concept that maximises benefits for the wind farm owners. The main factors that led to the choice of an SOV for early maintenance work were its ability to maximise working time offshore, reduce the impact of seasickness, minimise health and safety (H&S) risks during transfer, and make effective use of weather windows.
- Modelling was used to assess different logistics options, leading to the integration of the SOV with a single CTV to further improve access and mitigate potential risks.
- The team at Dudgeon plans to use its first five years of operation to assess the effectiveness of an SOV, and have implemented a flexible contracting strategy to mitigate risk.

Key Success Factors

- The direct-to-owner contracting strategy has maximised the vessel's suitability as a platform for a wide range of wind turbine and balance of plant tasks.
- Detailed specification and layout design focuses on workflow and comfort.
- Optimisation of controls for vessel motion control and walkway compensation have been included, speeding up transfer times, while positioning of the gangway at midships reduces the levels of compensation required.
- The additional provision of a CTV mitigates single-point-of-failure risks from the SOV and provides additional operational flexibility when deploying teams across the wind farm.
- A key design objective was to facilitate teamwork between the crew and different teams of wind farm workers.
- The clear delineation of roles and responsibilities is essential in delivering efficient maintenance planning and delivery, as well as ensuring compliance with international shipping regulations.

Introduction



Dudgeon Offshore Wind Farm Key Facts and Figures

Owner/Operators:
Statoil, Statkraft & Masdar

Capacity:
402 MW

Turbines:
67

Turbine Model:
Siemens 6.0 MW

Full Commission Date:
Installation ongoing

A joint venture between Statoil, Statkraft and Masdar, Dudgeon Offshore Wind Farm will deploy 67 Siemens 6MW direct drive turbines 20 miles off the coast of Cromer, North Norfolk. The wind farm will be operated from a base in Great Yarmouth. With journeys between potential operational ports and the wind farm lasting up to two-and-a-half hours, transit time and weather windows present significant challenges. This case study outlines the approach taken by Dudgeon's management team to select and implement an SOV logistics strategy to provide access to the wind farm.

The Challenge

The Dudgeon wind farm is located further offshore than earlier projects, extending transit times and increasing the impact of poor weather. With the current generation of CTVs, transit time is between two and two-and-a-half hours. Particular concerns have been raised about transit comfort as wind farms move further offshore, and it remains critical to minimise the effects of seasickness on offshore workers. Increasing travel times also give rise to practical challenges around providing sufficient time on the turbines to complete planned tasks, and to take full advantage of favourable weather windows to undertake maintenance activities.

Planning of the logistics concept for Dudgeon began in 2014, when there were no operationally-proven far-offshore concepts. A number of operators had made orders for SOVs, but the solution had not been used widely. Advanced access concepts, such as novel CTVs (e.g. Surface Effect Ships

(SES) and Nauti-Craft), launch-and-recovery-systems, and CTV-mounted access systems had not been deployed and proven operationally. The wind farm's owners had expressed concerns about the deployment of helicopters, due to the potential for a serious accident and also the limitations due to restricted payload and team size that could be deployed. They were also keen to utilise a solution that provided comfortable transit to the wind farm.

Dudgeon is one of the first deployments of the new 6MW direct drive wind turbine platform, which – while offering reduced maintenance requirements – has an unproven service history, making it difficult to predict the level of maintenance activity required and the associated optimum number of technicians required to support day-to-day O&M.

The Approach Adopted

With its favourable quayside access and lack of tidal restrictions, the Dudgeon team selected Great Yarmouth for the wind farm O&M base following an assessment of potential options on the east coast. Transit times to the wind farm were comparable to the team's other options. The Dudgeon team have converted an existing warehouse to use as an O&M facility, and benefit from a dedicated, secure length of quayside immediately outside the O&M building. Dudgeon's distance from shore – it lies outside the 12nm limit for UK territorial waters – triggered the consideration of the International Ship & Port Security (ISPS) Code, which sets internationally-agreed minimum security arrangements for ships and ports. The ISPS Code prescribes responsibilities to governments, shipping companies and shipboard and ports personnel to detect and take preventive measures against security incidents that could affect ships or ports involved in international trade.

Selecting an O&M Logistics Solution

Seven scenarios were initially considered, based around the use of an accommodation platform, various Crew Transfer Vessel CTV solutions and a Service Operating Vessel (SOV). The accommodation platform option was eliminated early in the process. Two O&M optimisation models were used to assess:

1. Platform (permanent accommodation module)
2. Converted SOV
3. Purpose-built SOV
4. Floatel and CTVs
5. Advanced CTV
6. Standard CTV

A combination of modelling and economic assessment was used to compare the different logistics solutions. Both the ECN and MaintSys model were used, along with operational experience gained from the Sheringham Shoal wind farm, of which both Statoil and Statkraft are owners. This was coupled with knowledge of oil and gas logistics including the use of Service Vessels within Statoil. An SES expert was brought in to advise on advanced CTVs (in particular the SES, which was emerging from the Carbon Trust OWA Programme). The use of a permanent platform offshore was discounted

early in the process due to the ongoing maintenance/facilities management challenges and costs involved.

The SOV solution emerged as the lead contender based on the number of technicians proposed by the turbine original equipment manufacturer (OEM). Further modelling showed that there was a benefit from combining the SOV with a single CTV to provide support and flexibility. Experiences from operating in the oil and gas sector pointed to the importance of the details within the design of an offshore service vessel, leading to the decision being taken to adopt a purpose-built SOV, which enabled detailed design features to be more closely controlled.

Developing the SOV Specification

While SOVs were being considered and designed in 2014, when this project started, there was no actual experience in using such a vessel in the real world. Some specifications for SOVs existed, and Statoil used a panel of experts to ensure that all aspects of the vessel's functionality were considered. The most important factors for the design were:

- Technician comfort and recreational facilities
- Demarcation between operational areas and recreational areas, including a "quiet deck" between the engine room and technician accommodation
- A walk to work system
- Short turnarounds when the vessel is at the shore base
- Cranage to support foreseeable activities within the wind farm, including heave compensation
- Open-plan offices
- Ability to work in water depths at site and when berthing in Great Yarmouth
- Within maximum width requirements of the port
- Fast, reliable internet connectivity and modern IT capability.

A two-stage tender process was used to engage with shipping companies. During the first stage, around 20 companies were asked to submit designs and available shipyard build slots. Over the following three months this information was evaluated and the design was fine-tuned. A shortlist of companies was developed for the second stage, when the final vessel selection was made. Discussions were also held with the turbine OEM to ensure the SOV specification was also incorporated into the Service Contract with the turbine OEM.

Developing an O&M Strategy Around the SOV

The Dudgeon team took the decision to charter the SOV directly rather than through the wind turbine OEM. This will more easily enable them to use the vessel for a wider range of tasks and has allowed the oil and gas experience from Statoil to be directly used in the design and specification of the vessel. The Dudgeon team has developed an O&M concept which considers what activities will take place aboard the vessel, who will require accommodation, and when and how the vessel will be used. The SOV will remain within the wind farm for two weeks and return to shore to change over the wind farm workers and replenish stores.



Figure 2: The Esvagt Nord – a vessel developed and chartered by the Dudgeon project's owners.

One particular challenge was the lack of clarity over how international shipping regulations from the International Maritime Organisation (IMO) should be applied to the SOV. In particular, the status of the turbine technicians who would live on board was called into question; they were neither crew nor passengers, given they had some specialist knowledge and training for working offshore and their familiarity with the vessel. Experts from Statoil worked with the authorities to ensure the proposed use of the SOV would comply with international standards and in particular the ISPS, along with any specific requirements of the UK authorities and flag state. This led to the quayside area being designed to comply with the ISPS port security standard which was possible with the available space at Great Yarmouth. There was also a safety management system adopted which met the requirements of the ISPS Code.

All short-term task planning and marine coordination will take place aboard the vessel and, in addition to the wind turbine technicians, there will also be planners, storekeepers, and a representative from the wind farm owners. As the Dudgeon team are responsible for providing a safe system of work for the high-voltage apparatus, there is also likely to be a need for their Senior Authorised Persons (SAP) to spend time on the vessel. Work planning and work control software will be operated offshore to plan and control maintenance, along with access to the SCADA system, people tracking and weather monitoring, therefore a strong IT connection is required. The project has included a large offshore booster that provides internet access across the site and the SOV.

The Dudgeon team expects approximately 30 people to regularly stay aboard the SOV:

- 15 to 18 wind turbine technicians
- Marine coordinators
- Up to three inspectors when statutory inspections are carried out

- One owner's representative
- Two storekeepers
- Four work planners
- A turbine OEM site supervisor
- One Statoil SAP
- Additional crew for the CTV

The vessel is equipped with 40 cabins for wind farm workers, meaning there are spare cabins which can be used to accommodate ad-hoc workers and additional staff from either the OEM or owners. Providing effective communications for both operational reasons and for use during recreational periods was an important consideration for the project. An internet connection is available within the wind farm with sufficient bandwidth for internet access, use of work control systems, weather forecasting, people tracking and other operational requirements as well as supporting an entertainment system for use by workers once the working day is done.

In order to maximise the working day for offshore workers, the Dudgeon team plans to use a system of staggered shifts, reducing the amount of unproductive time spent waiting to get dropped off onto the turbine. There is also the potential to deploy teams by CTV from the SOV, as well as using the walk to work system.

The CTV will be supplied with a double crew to achieve a longer working day – designed to be 16 hours – which allows weather-sensitive work to take advantage of a wider range of short weather windows. This also enables more rapid repairs, reducing unplanned downtime. It is also feasible for the CTV to return to shore to collect and deliver specialist spare parts and specialist engineers and technicians. The CTV can be refuelled from the SOV to provide additional flexibility.

The SOV has been designed so that air diving, seismic survey and ROV spreads can be easily added, extending the range of duties that can be performed. There are controlled areas for storing spare parts, tools and other equipment. The crane and walkway are co-located in the midships area to facilitate efficient loadout of spares and tools. There is a containerised spare parts concept, enabling rapid loading and unloading when the vessel returns to Great Yarmouth for crew changes. Up to three 40-foot containers can be accommodated on the vessel. All of these considerations influenced the layout of the vessel, including choice of deck usage and positioning of accommodation quarters, cranes, and the walk to work system.

Assessing and Mitigating Risk

During the development of the SOV solution, the team was mindful of the possible risks and developed mitigation options. While the SOV offers many benefits, the vessel itself and the walk to work systems are both a single point of failure. The inclusion of a CTV mitigates this risk. There was also a significant risk from illness, derived from Norovirus for example, onboard the vessel. The team



Figure 3: The Esvagt Nord working at the Dudgeon construction site.

considered this as part of the service/welfare contract arrangements and also ensured the design minimised the risks of disease spread, coupled with a strict cleaning regime and “house rules” to ensure good housekeeping practices. IT access interruptions could seriously hamper operations on site but this has been mitigated through the use of an offshore communications hub, which provides a more robust internet connections and communications facility.

The Results

Current Status

An SOV has been chartered by the Dudgeon project from the Danish support vessel operator Esvagt. Named the “Esvagt Njord,” the vessel spends two weeks in the wind farm and then returns to shore for staff changeover and stock replenishment. A flexible charter arrangement has been used, with the initial contract spanning five years with options to extend for up to a further five years. The team intends to use the first five year period to evaluate the practical use of the vessel and assess its performance. This approach allows future flexibility in the choice of logistics solution, and allows experience to be assessed of both the maintenance requirements of the 6MW turbines in use of site, as well as the tracking of developments around CTVs and other logistics solutions. The SOV and its facilities are now in use on the wind farm, having arrived on site in August 2016.

The Esvagt Njord is 83.7m long and 17.6m wide, and has 58 cabins to accommodate people including vessel crew and wind farm workers. It has a large mess room, a day room and 4 customer offices, along with a conference room and range of welfare facilities including a gym, two cinema/ games rooms, and an entertainment system. There are changing rooms, personal protective equipment (PPE) storage areas and a laundry. There is warehousing for 430m² of parts and tools including a workshop area, and temperature and humidity-controlled storage areas for special

components.

The vessel engines are designed to be highly fuel efficient, with an innovative diesel electric propulsion system and DC power system enabling optimised energy efficiency and comfort.

The team at Dudgeon is currently preparing an interface document which explains responsibilities between themselves, the vessel crew, and turbine OEM staff.

Range of Uses

The SOV will be used for a wide range of tasks around the wind farm, including:

- Standard wind turbine servicing
- Troubleshooting and repairing wind turbines
- Balance of plant maintenance including use of ROVs, divers and seabed surveys
- Routine work on the offshore substation
- Drone surveys/camera-based blade inspections
- Supporting transformer change outs without a jack-up, should this be required
- Ladder cleaning
- Refuelling temporary diesel generators
- Refuelling the CTV
- Loading out spare parts

Transfers to the turbine using the walk to work system will be possible in sea states over 2.5m, and – should the need arise – it will be possible to increase manning on the vessel so that 24-hour working can be introduced.



Figure 4: Meeting space onboard the Esvagt Nord.

Effectiveness of the Walk to Work System

The walk to work system uses a compensating gangway to access the wind turbine through a gate in the transition piece handrail. To maximise the access potential in different weather conditions, the Dudgeon project elected to include three gates at different points in the circumference of the foundation handrail. This provided more flexibility in approach and enabled a wider choice of route planning between turbines, speeding up the transfer process.

The operation of the walk to work gangway requires complex software to position the walkway safely and securely, which also needs to work alongside the existing forms of motion compensation used on the vessel. The Dudgeon project integrated the motion control systems to ensure they worked together effectively, which shortened the transfer time. Based on early trials it is anticipated that it will take around 45 minutes to transfer a team to the wind turbine structure from an adjacent turbine. This time will be longer for transfers between turbines which are further apart.

A Holistic Approach to Logistics and Preparation for Emergencies

The reduction in travel time from shore of up to five hours per day offers a significant advantage. However, to add flexibility, the team are also contracting a single CTV to complement the SOV solution. The availability of a CTV will allow specialist workers to be deployed to the SOV for shorter periods than the standard two week offshore operational shift pattern and avoid the need to contract (and pay) for them to remain onboard the SOV when they are not required. It also allows additional spare parts to be fast-tracked to sites. While the SOV reduces transit time for technicians, it is only possible to drop off a team to a turbine using the gangway which takes time to set up. The CTV can also deploy teams from the SOV directly to turbines during suitable weather windows, thus allowing work to be spread across a wider area of the site and speeding up the daily deployment process. Finally, it also supports an effective Emergency Response Plan and provides a back-up in case of a failure of the walk-to-work system, which is a single point of failure.

The SOV will act as the incident control point in the event of an emergency. There will also be a 24/7 onshore control room to support emergency coordination in the event of an incident. An owner-led Emergency Response Plan will be used during the operational phase of the wind farm utilising the SOV for incident support. Even though the project team do not envisage the use of helicopters for technician transfer, the turbines are equipped with helidecks which can be utilised in the event of an emergency.

Team Working

The layout of the vessel has been designed to encourage and facilitate the creation of one team between crew, owners and contractors. This has been achieved through carefully locating public areas and developing as much open plan space as possible. There are a wide range of entertainment and welfare facilities on board to encourage interaction and create interesting activities during non-



Figure 5: Cabin interior onboard the Esvagt Nord.

working time.

A clean and welcoming environment onboard is encouraged through the use of clear house rules for living together on the vessel and the provision of cleaning and laundry facilities. Healthy eating is encouraged and a gym is provided too. Each technician is allocated their own cabin which they will use each time they come on board, fostering a sense of ownership.

The Dudgeon project team has also designed the vessel and organisational arrangements to ensure the vessel crew and wind farm support team can work effectively together. Marine coordination will be undertaken from the SOV and is closely related to vessel operations sharing common elements such as weather forecasting, agreeing and planning turbine transfer plans and priorities for the working day. Therefore the marine coordination has been integrated into the vessel's bridge to facilitate close cooperation and team work between the wind farm support team and the vessel crew.

The Dudgeon team is directly contracting the vessel and then providing these facilities to their turbine service provider, Siemens. The team has worked with Siemens to understand their requirements and to ensure cranes, storage and the layout of onboard facilities are suitable for the work likely to be undertaken on the wind turbines. The use of an interface document will add further clarity on the roles and responsibilities of all who will work on board including vessel crew, the owner's team, and the turbine OEM.

Ensuring Future Flexibility

There are several possible contracting models for SOVs at offshore wind farms with either the wind farm owners or the turbine OEM taking responsibility for the charter arrangements. In some cases,

the provision of SOVs has been undertaken by the turbine OEM. The owners of Dudgeon have chosen to directly contract the vessel and make it available to contractors who will be working on the site, including the turbine OEM.

While this has required the owners to take on vessel management arrangements it has given the project a number of advantages. Firstly, it is straightforward for the wind farm owners to use the vessel to undertake tasks across the whole wind farm, including balance of plant maintenance, seabed surveys and any future support required to the offshore transmission (who has yet to be appointed at the time of publication). It also enables any future retrofit work (on the turbines, foundations or offshore substation) to be supported by the SOV and also for any required blade maintenance to be supported from the vessel. The vessel has also been specified to support a dive spread and ROV survey, neither of which may have been possible if the SOV was dedicated solely to the maintenance of the turbines.

As the operator of Dudgeon and the nearby Sheringham Shoal offshore wind farm, Statoil will be responsible for overall management of the SOV. While there are no plans yet to use the SOV for work at Sheringham Shoal, the chosen contracting model makes this more feasible should the need arise in the future.

Cost Implications

The use of SOVs at operational wind farm sites is still relatively untested, and has a higher deployment cost per day when compared with traditional CTV operations. By taking on responsibility for SOV operations, the owners can more closely monitor the costs and benefits of this approach and as they assess the lessons learned, it is possible to make any required improvements quickly. At the time the O&M strategy was decided, an SOV (supported by a single CTV) offered the best logistics approach given the weather and turbine failure rate information available. By contracting on a five-year basis, the owners also have the flexibility to change logistics arrangements if alternatives emerge or real-life operating experience shows that there are better options for providing transfer of workers to the wind farm. This contractual flexibility is a real benefit, and it offsets the potential risks from lack of SOV experience at offshore wind farms.

Appendices

Author Profile



Sally Shenton is the Managing Director of the offshore wind O&M consultancy Generating Better. Prior to this, she held the position of Operations Manager for various offshore wind farms.

Contributors

Meindert Jan van der Velde is a vessel expert within Statoil, supporting their offshore wind development and operations teams. With a background in the Merchant Navy, Marine Salvage and the oil and gas sector, Meindert has been able to bring this experience to support logistics planning for Dudgeon, Sheringham Shoal and the Hywind projects since joining Statoil in 2008.

Harriet Green is Senior Mechanical Engineer with the Operations and Maintenance team for the Dudgeon wind farm. Before joining Statoil, Harriet worked at the Sheringham Shoal wind farm within the O&M team.

About the O&M Case Studies series



This is one in a series of offshore wind O&M-focused case studies, supported by ORE Catapult's O&M forum and funded by The Crown Estate and the Offshore Wind Programme Board. These studies aim to highlight game-changing O&M projects, and promote the dissemination of knowledge among the offshore wind O&M community.

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