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An Alternative End-of-Warranty O&M Contracting Strategy

Increasing value in post-warranty periods by developing new approaches to O&M management and delivery.

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Summary

In 2013, Centrica reviewed the costs and benefits it received from the warranty-based operations and maintenance (O&M) service contract for the Lynn and Inner Dowsing (LID) offshore wind farms. The objective of the review was to determine the most appropriate way forward after the end of the wind farms' initial warranty period. In December 2014, the 17 lenders involved in these project-financed offshore wind farms agreed to the recommended end-of-warranty strategy. This case study focuses on the project that Centrica implemented in order to develop the end-of-warranty contracting approach. It describes the project, the new approaches adopted to O&M activities in the post-warranty period, and explains the key benefits that have emerged as a result.

Key findings

The development of an alternative post-warranty O&M strategy has:

- Reduced O&M costs by 25% through the introduction of competitive tendering. It has also improved performance by five percentage points and improved response times.
- Enabled Centrica to deliver its objective of being an "informed operator in control of risk" by improving performance and managing long-term asset integrity in a more structured way.
- Enabled post-warranty contracts to be competitively tendered. The development of a modular scope for O&M contracts has been a key element in unlocking the third-party market and opening up access to additional service providers.
- Retained the turbine original equipment manufacturer (OEM)'s technical support and parts supply, while developing new suppliers.
- Improved the long-term management of risk. Creating a more dynamic and proactive approach to maintenance gives Centrica direct ownership of the maintenance strategy and the prioritisation of tasks, which has improved incident/component failure response times.
- Secured approval from the lenders' technical adviser and the consortia of banks. The owner-led approach to the O&M strategy helped it pass the bankability test.

Recommendations

- Build an owner's team early so they can gain experience and deliver technical procurement support.
- Engage potential suppliers and build a robust understanding of the market at an early stage. This will give suppliers a fuller picture of the project's requirements, help to align values, develop stronger relationships, and better prepare suppliers for the procurement process.
- Evaluate costs and revenue losses during the warranty phase and externally benchmark data to improve the value of information available to the owners.
- Consult with banks, investors and their technical advisers to ensure the O&M strategy changes are understood and so they can independently validate the proposed approach.
- The wider offshore wind industry should promote an innovative and competitive O&M supply chain to contribute to strategic cost-reduction targets.

Introduction

The Lynn and Inner Dowsing (LID) offshore wind farms are located in The Wash and were part of the Round 1 UK offshore wind developments (see Figure 1). Centrica has been involved in offshore wind from an early stage and previously owned Barrow offshore wind farm. Centrica subsequently constructed a cluster of offshore wind farms in The Wash, including LID, which it operates and part-owns. Centrica has developed an integrated O&M service base in Grimsby.

Owner operator:	Centrica
Wind farm:	Lynn & Inner Dowsing
Capacity:	194.4 MW
Number of turbines:	54
Wind turbine model:	Siemens 3.6MW-107
Full commission date:	23 December 2008
OEM warranty handover date:	23 December 2013

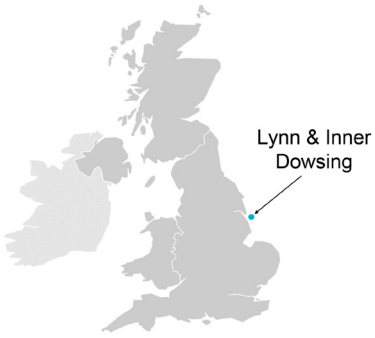

Figure 1: Lynn and Inner Dowsing offshore wind farms - key facts and figures

In addition to the LID wind farms, Centrica is also part-owner of the Lincs offshore wind farm. During the preparation of this case study, Centrica signalled its intention to exit the sector and has divested the LID wind farms, although it will continue to operate them on behalf of the new owners for a transition period.

The teams that operate and maintain the Centrica offshore wind farms have built up considerable experience, and are keen to pass on this learning to the wider industry.

The LID offshore wind farms are situated 5km from shore on England's east coast, near Skegness. The wind turbines are installed on monopile foundations and power is exported to shore using 33kV subsea cables, without the need for an offshore substation. Grimsby was identified by Centrica as the nearest suitable port on the Humber estuary from which to operate an O&M base. The journey time by vessel to the wind farm is around 1 hour 40 minutes. Working closely with Grimsby Fish Dock Enterprises, the Centrica team and their contract partners have developed extensive experience and expertise in the field of logistics planning and management.

During the project's early stages, Centrica established an O&M team consisting of safety professionals, engineers and project managers. The team focussed on managing the long-term integrity of the asset, and the contracts in place to deliver maintenance activities. The team expanded to cover all of Centrica's onshore and offshore assets. As a result of the proposed strategy changes at the end of the warranty period, the team was increased from 28 to 42.

The O&M lifecycle of a typical offshore wind farm is shown in Figure 2.

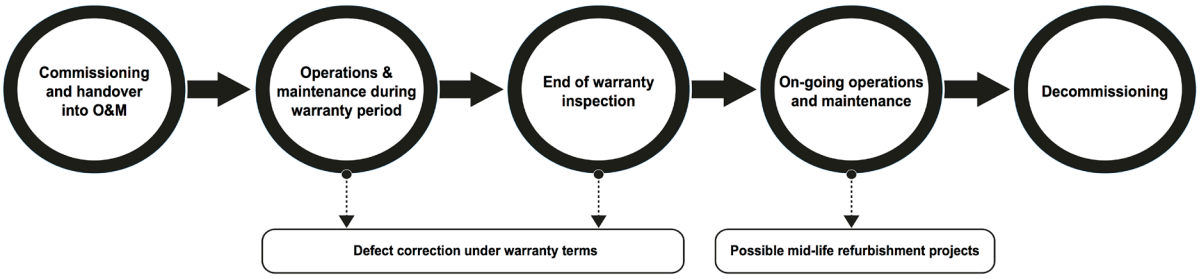

Figure 2: The offshore wind O&M lifecycle

During the first five years of LID's operational life, when the wind turbine warranty was active, wind turbine O&M was provided under the OEM's service and warranty agreement. This is a common industry approach – at the end of the initial contract, owners need to decide how to deliver turbine O&M after the warranty period has finished. Maintenance of the balance of plant was subcontracted to the original supplier of the equipment, who provided the warranty for the first five years of the wind farm's operational life. However, the Centrica team took an active role in planning and scheduling the balance of plant maintenance.

To prepare for the end of the initial contracting period with the OEM, Centrica launched a project to evaluate the options for O&M delivery and agree a future contracting strategy. This case study outlines the approach taken by Centrica in developing a post-warranty contracting strategy. It details the key elements to be considered, in-source and out-source service options, and the eventual route that was taken. The key drivers and benefits of the selected O&M route are discussed, which are particularly pertinent for:

- offshore wind farm owner/operators;
- component suppliers;
- O&M service providers (including OEMs and independent service providers);
- investors and insurers.

The new strategy has been in operation for a short time, with early experience being shared. The information for this case study has been gathered by interviewing the site-based operations team.

The challenge

One of the key challenges for any wind farm operator is how to predict future maintenance requirements. This is generally possible for preventative maintenance, but the lack of through-life experience of operating offshore wind turbines means that predicting future failure rates is difficult. This, in turn, presents challenges when forecasting long-term operational costs.

Developing a proactive maintenance strategy improves reliability and reduces breakdown risks. This approach is effective in both lowering costs and reducing the risk of unplanned failures.

Service contracts need to take into account how technicians are deployed, and who has responsibility for deciding when maintenance work is carried out. Weather conditions are an important influencing factor, as work can only be undertaken when it is safe to access the turbines. Weather conditions can also impact on the ability to carry out specific tasks because of the constraints of working in the nacelle or hub or using lifting equipment. Additionally, where an external service provider is used, this may be delivered using a

shared labour pool from other contracts. This can introduce competing priorities, which affects availability of personnel.

If work is carried out under an all-inclusive, fixed-price contract, the incentive mechanisms and treatment of weather risk will also influence the timing of maintenance work. Often this style of contract includes performance criteria (so-called “availability guarantees,” based on either downtime criteria or a power generation target). While these incentives appear to offer a guaranteed minimum level of performance (often backed by compensation mechanisms in the event of under-performance), they can be influenced by weather, access and other risks.

Variable weather conditions mean that it is not possible to access offshore wind turbines every day of the year. This reduces the time available to undertake planned maintenance and can delay the repair of faulty turbines. In order to ensure the long-term integrity of offshore turbines, it is important that operators consider the impact of weather downtime (and hence levels of power generation) alongside standard reliability and availability criteria. This will help to determine the optimum size of the O&M labour pool.

Wind farm owners need to develop approaches to manage these factors. For instance, weather-inclusive contracts attract a premium that allows the contractor to take on the risk or make an allowance for “waiting on weather” time. This kind of contract incorporates appropriate stand-down rates for contracted services, and takes into account the impact of weather downtime on in-house staff productivity.

Uncertainties around the level of unplanned maintenance and defects, coupled with uncertainties around all-year access because of the weather, has resulted in most offshore wind farms initially adopting an “O&M wrap.” This type of contract places the risks with the turbine OEM in an attempt to secure fixed prices and provide greater investor confidence. It includes a defect warranty alongside planned preventative maintenance, remote monitoring and technical support. The fixed price often includes weather downtime costs. There are sometimes exclusions – particular types of failures, warranty caps, or weather downtime limits, for example – but the general principle is to provide a fixed price to cover all risks.

The industry recognises that achieving long-term cost certainty is challenging. A lack of experience and uncertainty over how reliability will change as turbines age means that the scale of major repair work is an unknown quantity.

When all-inclusive contracts are implemented, it is common for the service provider to use a pool of technicians working across several wind farms. Labour is then allocated from the pool and deployed on individual farms. Decisions about resource allocation are influenced by each wind farm’s contract requirements. These will detail specific weather and access constraints and include different performance incentives. If weather downtime arises, repeat visits are often required.

A significant downside of this model is its lack of technician continuity and consequential risk to the quality of work. The service provider is incentivised to avoid attracting damages through the availability warranty, which can result in repair work at all the sites for which they provide service contracts being prioritised above planned preventative maintenance. This can lead to maintenance backlogs. There is a disincentive to deliver proactive maintenance because it removes the turbines from service. This exacerbates and stores up future issues, resulting in downtime outside of the contracted period.

At LID, Centrica adopted a continuous service model with a dedicated site service team. This resulted in zero additional weather payments and improved the quality of work.

The total cost of maintenance is determined by the fixed contractual costs, alongside additional payments (for example, where weather downtime assumptions are exceeded, or to cover other exclusions and exceptions – so-called carve-outs – in the contract). When the OEM sells turbines to the wind farm owner, it usually provides some form of defect warranty. Should defects emerge during the initial operating period, the OEM is responsible for repairing the defect and covering the cost of any associated spare parts and labour. The OEM covers these costs as part of the turbine supply agreement (TSA). The initial service and maintenance contract only needs to reflect scheduled maintenance costs, plus any breakdowns that are not covered by the defect warranty.

An evaluation of the costs of delivering post-warranty wind turbine maintenance at the LID offshore wind farms identified a significant increase in operating costs beyond the level assumed in the original financial model. This was, in part, due to the transfer of the component failure costs (which were initially covered by a defect warranty through the TSA).

Key cost and performance challenges included:

- The fixed-price, post-warranty contract costs were based on a low risk of component failure suggested by the OEM. This was the basis upon which the risks were transferred to the operator. In practice, the outcome resulted in potentially significantly higher costs and reduced profitability to an unacceptable level.
- Higher operational performance levels were assumed by the owners.
- The carve-outs in the warranty provisions led to warranty guarantee coverage that was lower than anticipated.
- An outcome of underperforming in the above areas led to unsustainable revenue reductions.
- A number of concerns around safety performance were also raised.
- A disparity between the actual safety performance at the site and the high safety aspirations of Centrica was identified.

Centrica set up a project to explore a range of different approaches to contracting. The objective was to look at a wider spectrum of options that encouraged a competitive approach while addressing cost and performance challenges.

The approach

The original O&M strategy at the LID wind farms centred on a full “service and maintenance” contract provided by the OEM. The OEM was responsible for undertaking planned preventative maintenance and correcting defects and breakdowns. The original contract offered an availability guarantee, and included spare parts and labour coverage for turbine breakdowns and defects. The contract guaranteed an availability target and paid compensation should this target not be met.

Within the contract there are exclusions for events that are deemed to be beyond the control of the OEM, including access issues and poor weather. The OEM provided staff, spare parts and technical support, as well as supporting the site by providing out-of-hours offsite turbine monitoring.

In part, the OEM’s O&M contracting strategy was selected to provide cost certainty – an important factor for investors – and to ensure technical support and know-how was available to the owners.

The defect warranty and availability guarantee provided mitigation against new technology risk, which is an important bankability consideration when due diligence is being carried out by lenders. Contracts are assessed by the lenders’ technical, commercial and legal advisors and determined by the lenders’ risk committees. The contracts tend towards the lender with the lowest risk appetite. While it is necessary to secure bank finance, this approach can be sub-optimal in minimising costs and driving owner profits. While experience of warranty-

backed contracts is growing, some of the benefits may not be realised due to the negative effects of carve-outs.

What is bankability?

Where investors are seeking bank finance, it is particularly important to ensure that cash flows generated by the project in the operational phase are sufficient to cover the payment of loans and interest. It must also be clear that technical and commercial arrangements will deliver a successful outcome.

There is no clear definition of the specific terms and factors required in an offshore wind project for it to pass a bankability test for the O&M phase of a project. Investors rely on their technical adviser, who appraises the contracting strategy, as well as the owner's approach to O&M, resources, costs and risk. Technical advisers draw heavily on models and their experience of previous projects. Typical factors considered in the assessment of O&M bankability include:

- Access to competent engineers and technicians.
- Access to spare parts.
- Technical support from the OEM.
- Cost.
- Approach to managing any risks from new technology or up-scaling.
- Access to availability warranties and their effectiveness.
- Logistics concepts and management of weather risk.

Ultimately, bankability is defined either by previously successful approaches or concepts which are backed up with a full technical and commercial case.
It is important to have a good relationship with the lenders' agents to communicate an appropriate risk profile, and to have good investor relations with the lenders to resolve potential risk committee issues.

From the beginning of the O&M phase, the Centrica team assumed responsibility for foundation O&M, and for managing and maintaining the high-voltage network outside of the turbine structure. Centrica also established a permanent operating base in Grimsby during the early operating years of the LID wind farms, allowing the O&M team, many of whom had power generation experience, to expand their offshore wind capability.

The O&M base included a local control room, facilities for marine coordination, a warehouse and vessel access, as well as offices and meeting rooms. In addition to managing the balance of plant maintenance, Centrica developed performance monitoring systems, which enabled plant issues to be tracked and performance reports to be automated.

The Centrica team built up a robust knowledge of the value provided by the initial warranties and availability guarantee. They also acquired an overall picture of the additional maintenance activities required to effectively mitigate long-term risk. They looked hard at what activities could be scaled back or stopped without impacting on the risk profile of the site.

Developing options to improve the contracting strategy

As part of a post-warranty contracting strategy, Centrica identified a number of options, which included:

- Re-negotiating improvements with the existing service provider.
- Dividing the turbine O&M service into smaller packages to run a competitive tendering exercise.

Centrica chose to go out to the market with a modular scope covering the original elements of the turbine O&M wrap, as illustrated in Figure 3.

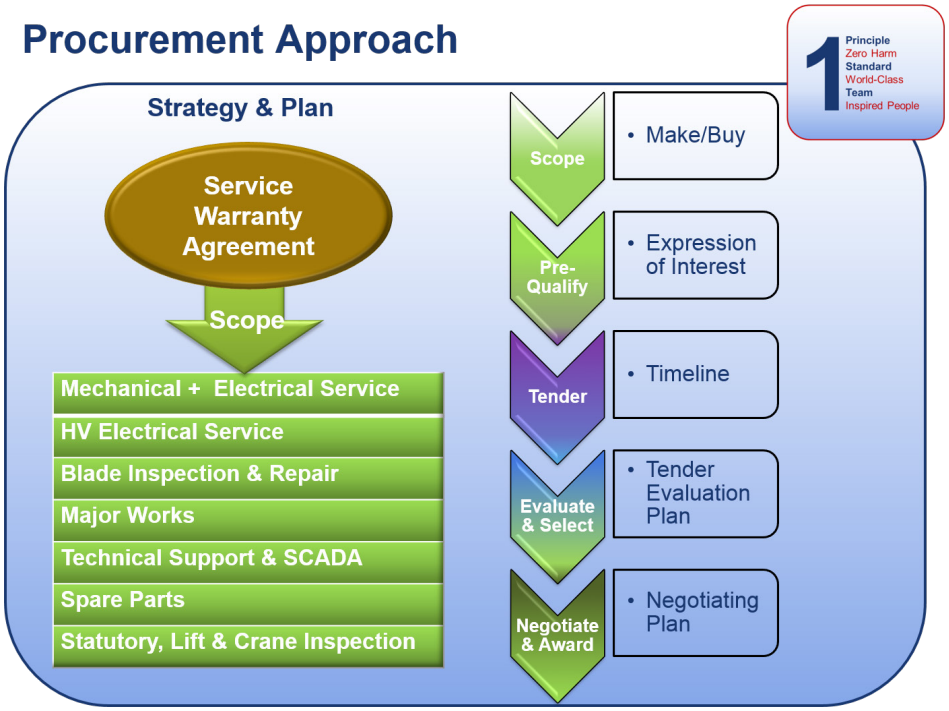

FIGURE 3: Centrica's procurement strategy for LID post-warranty

The division of O&M services into a number of discrete O&M packages enabled a wider range of suppliers, as well as the incumbent supplier, to participate in the procurement process. This strategy was supported by Centrica's existing O&M team, who already had experience in contract management, maintenance planning, site management services and, importantly, could coordinate health and safety (H&S) and environmental activities.

Market knowledge

Prior to the formal tender period and procurement process, market surveys and pre-qualification due diligence were carried out, and requests were issued for expressions of interest. The inclusion of this "market testing" step in the procurement process enabled Centrica to assess the extent to which the market could meet the requirements of the site; otherwise, the process followed a standard procurement approach.

Centrica has worked extensively with an O&M cost model throughout the operational life of the LID wind farms and built up a robust understanding of costs, which supported the negotiation phase of the project. The cost-modelling undertaken by Centrica included assessing the case base for planned preventative service costs and cost-modelling equipment failure rates. The modelling of equipment failure rates helps to improve understanding of the potential variation in costs, given the uncertainty around failure rates and the day-to-day impact of weather on the ability of technicians to access the offshore wind turbines.

Ensuring robust technical support is available

Centrica explored alternative models to provide technical support. It did this by breaking down the key elements to further understand the maturity of the third party market and how its internal team could be used and further developed to add value.

Centrica's technical support model included:

- **Control and operation:** All-hours turbine monitoring, alarm investigation and remote reset; condition monitoring alarm and error handling; reporting and diagnostics.
- **Rotor and drive train:** Condition monitoring system and analysis; drive train inspection; drive train health assessment; troubleshooting support.
- **LV and HV electrical:** Inspection, testing, analysis and assessment; troubleshooting support.
- **Structural and ancillary equipment:** Inspection, testing, analysis and assessment; troubleshooting support.

Implementing the contracting strategy

A number of third-party companies with the experience and skills necessary to support offshore wind turbines O&M were identified. Some were already providing similar services at other wind farms. Centrica found sufficient third-party O&M service providers for all the packages tendered and also included the wind turbine OEM on tender lists for each work package.

Centrica's expert and experienced team provided support to the third-party contractors – especially with first-line maintenance, where the on-site presence of the in-house team ensured a fast response. This was an important factor in minimising repair times and reducing waiting-on-weather costs and risk.

To manage the interfaces between contracts and coordinate activities at the wind farm, the Centrica team called on the expertise that had been developed during the initial warranty period.

A number of known key processes and systems were implemented to support the O&M team:

- **Safety rules (a formal safe system of work):** Centrica's operational safety rules for high voltage systems were established at the start of the project. However, Siemens wind turbine safety rules (WTSR) were used during the warranty period. At the end of the warranty period, Centrica implemented their own WTSR and validated the technicians who were working at the site.
- **Work planning and scheduling:** Existing processes were extended and developed to plan in-house all of the work carried out on-site, using the existing computerised maintenance management system.
- **Spare parts management:** Centrica already managed spare parts for the balance of plant, and this approach was extended to incorporate turbine spare parts. Centrica are also responsible for all important decisions about stock holding levels.

Following a formalised procurement process, contracts were awarded to six companies to support post-warranty O&M at the LID wind farms (shown below in Table 1). The turbine OEM was retained to provide technical support and SCADA services. As part of this package, Siemens still provides a "Platinum" remote monitoring service, two troubleshooting teams and a single site-based technical expert. HV electrical service contractor ABB originally supplied the turbine switchgear and generators, but broadened its offer by providing maintenance services for other equipment it had not supplied initially.

Function	Post-warranty contract partners
Mechanical and electrical service	ENGIE Fabricom Oil, Gas & Power
HV electrical service	ABB
Blade inspection and repair	Altitec
Major works	ENGIE Fabricom Oil, Gas & Power
Technical support and SCADA	Siemens
SCADA	Scada International
Statutory, lift and crane inspection	Skyform (Scotland)

TABLE 1: Companies awarded contracts to support post-warranty O&M

The procurement process included a robust assessment of H&S standards. The site now operates wholly under the owner's safety rules, which has reduced the number of interfaces. Centrica also runs successful safety campaigns and initiatives to drive up safety performance, which has improved since implementing the new approach. Initiatives implemented by Centrica include its Generation Safe behavioural safety programme and Project Boy Scout, which involved a series of workshops and simulations to better understand H&S risks and mitigations. Project Boy Scout included a review and improvement of emergency response arrangements, and is the subject of another ORE Catapult O&M Case Study, "Responding to an emergency: the power of teamwork and real-life experience in improving health and safety [1]."

Centrica was also able to include H&S criteria in its contractor selection process, which is managed through its robust procurement procedure and engages bidders on their safety ethos and performance.

Figure 4 shows the improvement in H&S performance during the end-of-warranty project in 2013/14.

"Key to success would be ensuring that ABB could support the third-party equipment as well as the 3.6MW ABB generators."

- Peter Wright, ABB Service Manager

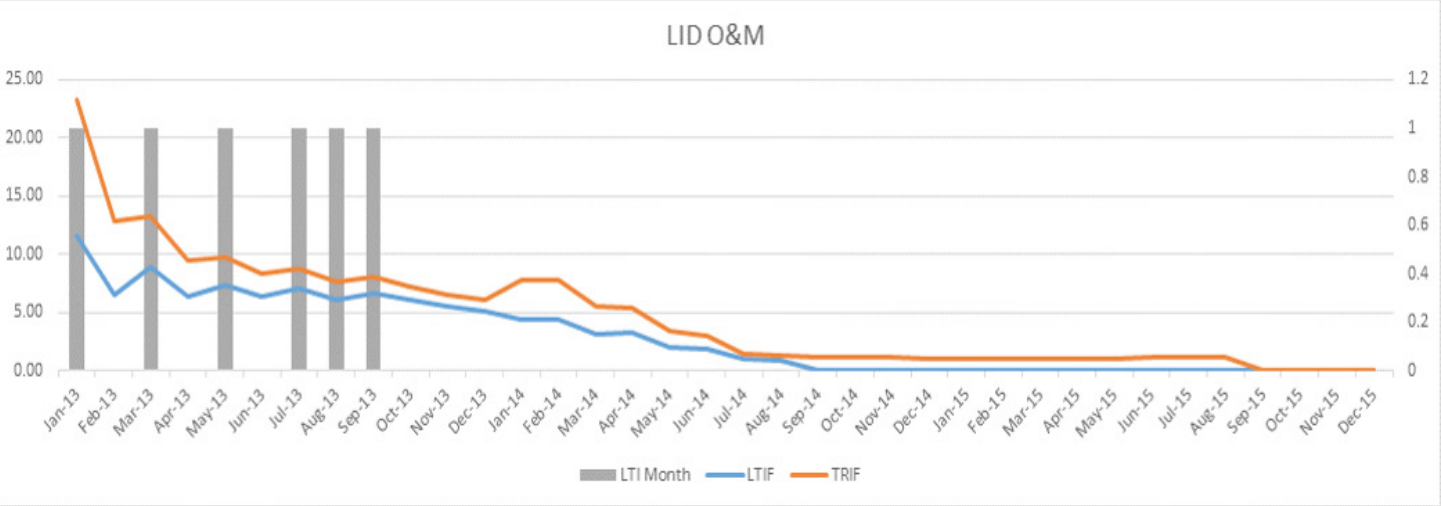

FIGURE 4: Safety performance at LID during the O&M phase

Convincing investors and technical advisors

The contracting strategy pursued by Centrica was relatively innovative: only one other wind farm in the UK (E.ON's Scroby Sands) had taken O&M service provision fully in-house at the time the project was launched. Another wind farm was preparing to take over turbine maintenance planning and troubleshooting; further information is provided in ORE Catapult's Case Study "Self-perform operations and maintenance at Robin Rigg: a strategic approach to planned and reactive maintenance." Others were already implementing an active owner strategy through owner-led work planning and site management processes. Up to half the technicians were provided by owners to work as part of the OEM's team.

The structure of the financing for LID – and the decision to use a third-party, multiple contract approach for the first time – meant that it was vital to clearly set out the business case and the risks and opportunities to the project's investors and their technical advisers.

Stakeholder management was essential to the success of the strategy. As the wind farm was project-financed, majority lender consent was required. It was essential to ensure that the lenders' technical adviser was fully informed about the project so that it could be progressed.

Work with the lenders' technical adviser began over 12 months before the change in O&M strategy. Much of that time was spent convincing the adviser that Centrica had the capability to manage multiple contract interfaces and risks. The technical adviser provided the lenders with their opinion late November 2014, and lender consent was received towards the end of December 2014.

The results

The revised contracting strategy has delivered:

- **Improved H&S performance:** the lost time injury frequency (LTIF) and total recordable injury frequency (TRIF) have both fallen to zero.
- **Improved financial performance:**
  - with lower costs and higher availability.
  - availability performance has increased by around 5 percentage points.
  - costs have reduced by 25% in the first year of running with the new O&M strategy.
- **Information and confidence within the UK supply chain** alongside direct benefits in terms of:
  - development of local suppliers.
  - strong level of UK-based expertise/products/services.
  - evidence that there is sufficient experience to ensure a viable competitive market for offshore wind O&M services.
- **Bankability:** the new strategy was signed off by the group of banks which provide finance for the project.
- I**mproved control of long-term integrity risks.**

"Safety standards are improved and we have already seen a step change in performance by improving the alignment of owner and contractor objectives. Whilst it is still early days the outlook is good and we expect to see sustainable cost reductions."

- Tony Lyon, Head of offshore wind O&M

The main financial benefits came from internalising risks – namely spare parts and weather. This improved availability and reduced risk. There is a greater focus on improving reliability which reduces long-term costs, the number of offshore visits and increases power production. By developing an improved understanding of O&M at Lynn & Inner Dowsing, Centrica and the investors are better able to understand the risks.

Experience has provided greater context and real-life operational information to set against the early risks that were originally identified in the development stage of the site. The new contracting approach has delivered significant Opex savings. The savings in Opex provide a buffer against unexpected maintenance costs which is a much more cost-effective method than paying a 'risk premium' for a fully wrapped O&M service contract.

The approach has also delivered improvements in the availability of the turbines and this has led to an increase in the energy yield from the site. This is as a result of a closer alignment of the objectives of the owner, the O&M team and its suppliers. A good example of this is the adoption of preventative maintenance projects to eliminate failures by addressing root causes. There is often little incentive within warranty contracts to invest in proactive replacement of parts which have not yet failed, as these are not always covered under 'defect' definitions. Owners are incentivised to minimise downtime across the whole life of the asset, whereas incentives and penalties in contracts – including availability guarantee periods, can drive a more reactive approach.

Previous performance-related guarantees included 'carve-outs' to protect suppliers against aspects of weather risk, despite the fact that they included a premium for carrying risk. The new approach removes premium payments and costs are incurred only where risks actually materialise.

Significant improvements in performance in terms of availability (in excess of a 5 percentage point average improvement) and cost savings (around 25% in the first year) have been seen. Careful planning and the development of an experienced owner's team have ensured a smooth transition to the new working arrangements.

Lessons learned

The LID site management identified a range of key lessons that contribute to the effective management of post-warranty O&M services:

- Collect information as early as possible in the operational life of a wind farm and use this to build up a picture of the true cost of O&M services.
- Identify companies who can best support O&M in terms of H&S, cost and availability performance.
- Invest early in in-house team members – lenders want to see that in-house team members can take the lead.
- Develop a plan to engage early with stakeholders – particularly the lenders' technical adviser.

> *"Under the new arrangements a marked improvement in maintenance scheduling and performance has been noted and DNV GL would expect to see some further improvement as they are being more proactive in the management of projects."*
>
> **Quote from Vendor Due Diligence Report by DNV GL**

Appendices

References

[1] Shenton, S., *Responding to an emergency: the power of teamwork and real-life experience in improving health and safety, 2016.*

Recommended reading

A Guide to UK Offshore Wind Operations and Maintenance. The Crown Estate
http://www.thecrownestate.co.uk/media/5419/ei-km-in-om-om-062013-guide-to-uk-offshore-wind-operations-and-maintenance.pdf

Author profiles

Sally Shenton is the managing director of the offshore wind operations and maintenance consultancy Generating Better. Prior to this, she held the position of operations manager for various offshore wind farms.

Dr Conaill Soraghan is a Renewable Technology Engineer at the Offshore Renewable Energy Catapult. He has a background in applied mathematics and completed a PhD in wind turbine design. Conaill's main area of interest is the management and optimisation of operational assets and he has extensive experience in the design and development of benchmarking systems and data/knowledge sharing for the offshore wind industry.

Contributors

With over 35 years' experience working in the UK power industry, **Tony Lyon** is an electrical engineer by profession. The early part of his career was focussed on large coal-fired generation followed by the construction, commission and ultimate operation of gas-fired power plant. Today, Tony is responsible for the asset management and performance of Centrica Energy's portfolio of joint venture wind farms, which are operated out of the company's dedicated renewables base in Grimsby.

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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