

Self-perform operations and maintenance at Robin Rigg: a strategic approach to planned and reactive maintenance

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In December 2014, the turbine warranty period and initial service contract at the Robin Rigg Offshore Wind Farm ended. The wind farm owner, E.ON, decided to take all operations and maintenance in-house in a strategy it calls 'self-perform'.

Using information gathered through a series of interviews with the Robin Rigg operations team in June 2015, this case study describes the building blocks required to implement this strategy and explains the key benefits and lessons learned.

This is one in a series of offshore wind operations and maintenance (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 share knowledge among the offshore wind O&M community.

Summary of findings

The implementation of the self-perform strategy has allowed E.ON to improve four aspects of its operations:

- Greater control and ownership of the maintenance strategy.
- Improved staff satisfaction and working environment.
- Enhanced supply chain engagement.
- Improved health and safety.

Recommendations

- Investing in O&M infrastructure prior to operation of the wind farm helps build the necessary infrastructure and operational experience required to transition to self-perform.
- Forming an active team throughout the warranty period and hiring key Original Equipment Manufacturer (OEM) staff at the end of warranty maximises knowledge transfer.
- Collection of critical data and documentation, the deployment of an independent data historian to store and analyse plant information and mapping of spares and supply chain are necessary to facilitate self-perform.
- Development of duplicate in-house 24/7 control room tasks such as turbine monitoring ahead of the change-over ensures minimal disruption to operations throughout the transition.
- Development of supplier relationships for key secondary services is necessary.

Introduction

E.ON is an energy company involved in energy generation, distribution and retail. As part of its generation portfolio, it wholly owns and operates the Robin Rigg Offshore Wind Farm.


Owner Operator:	E.ON	
Wind Farm:	Robin Rigg	
Capacity:	180MW	
Number of Turbines:	60	
Wind Turbine Model:	3MW Vestas V90	
Full Commission Date:	April 2010	
OEM Warranty Handover:	December 2014	

Figure 1: Robin Rigg offshore wind farm key facts and figures

The organisation's operational offshore wind portfolio also includes Blyth, Scroby Sands and Humber Gateway in UK waters and Rodsand II, Amrunbank and Kareham outside the UK. Furthermore, E.ON is a shareholder in both London Array and Alpha Ventus.

In December 2014, the initial service contract and warranty period at the Robin Rigg Offshore Wind Farm ended and E.ON took all O&M in-house with an O&M strategy it calls 'self-perform'.

This case study outlines the key benefits, lessons learned and success factors of the self-perform strategy based on the experience gained in the first six months of post-warranty operation of the Robin Rigg Offshore Wind Farm.

It also outlines the key elements of an in-house O&M strategy that should be considered to ensure successful implementation of such a strategy, as well as examining the key drivers and benefits of this approach to O&M. The information supporting this case study was gathered through a series of interviews with the site-based operations team in June 2015.

The challenge

The Robin Rigg Offshore Wind Farm is located 13 kilometres off the coast of Cumbria. The site operated under a linked five year warranty and service agreement, which was reduced to 56 months during settlements at the end of the construction phase.

The warranty and service period – a period of time which refers to the initial years of operation of a wind farm, within which the OE) is responsible for wind turbine O&M linked to an initial warranty – began on 20 April 2010 and ended on 19 December 2014.

At this point, E.ON was faced with the decision of how much responsibility to take on regarding O&M of the wind farm. E.ON made the ambitious choice to adopt the self-perform strategy, whereby the organisation takes full responsibility for all O&M, using directly employed staff with minimal specialised third-party support.

The main driver for such a hands-on approach to O&M is the potential for achieving a long-term reduction in the levelised cost of energy (LCoE) through greater control of long-term costs and risks and increased yield through improved operational performance. Full control of operations allows a strategy to be implemented that is driven by the long-term integrity of the assets and maximising profit.

E.ON had valuable experience to draw on, having already operated the Scroby Sands Offshore Wind Farm with involvement in turbine spares management and maintenance for three years, followed by one year of full self-perform strategy. Nevertheless, self-perform is a significant undertaking.

The major elements of an O&M strategy are shown in Figure 2. When an owner adopts a self-perform approach, each of these elements must be either taken in-house or sub-contracted to a third party.

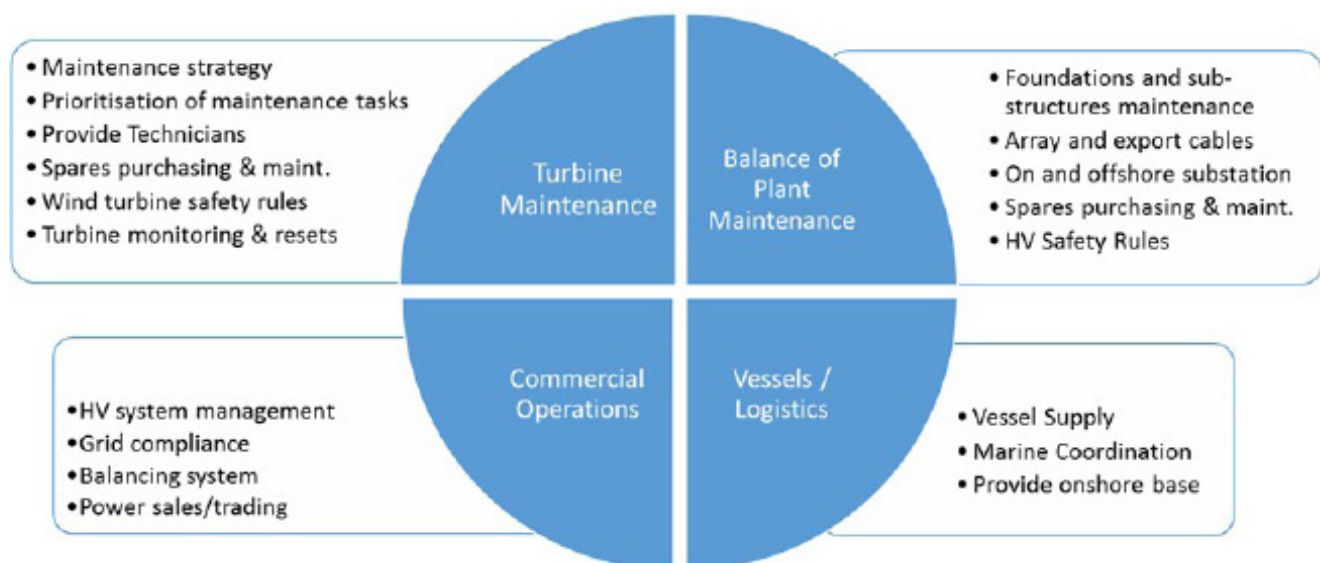


Figure 2: Elements of an offshore wind farm O&M strategy

The approach adopted

Corporate drivers

The corporate drivers of the self-perform approach are:

- Control: to provide full control over the costs and the maintenance strategy.
- Organisational experience: at a corporate level, E.ON was already implementing a self-perform strategy at a number of onshore wind farms, as well as at Scroby Sands.
- Performance: the team was keen to benchmark performance using production-based availability, as opposed to time-based availability with contractually permissible events.
- On-site synergies: able to manage the site team more flexibly across the high voltage (HV), Balance of Plant (BoP) and turbine maintenance areas.
- Off-site synergies: better sharing of knowledge between project partners including vessel fleet and supply chain to drive improvements in in-house O&M knowledge and capability.
- Improving opportunities: exploiting synergies between different E.ON projects.

Scope of O&M responsibility

Table 1 outlines the scope of the tasks that E.ON had responsibility for before and after the transition to the self-perform strategy:

Operations and Maintenance Task	In Warranty	Post-Warranty Self-Perform
Commercial Operations	E.ON	E.ON
Turbine Maintenance		
• All except wind turbine safety rules	OEM	E.ON
• Wind turbine safety rules	E.ON	E.ON
Balance of Plant maintenance	E.ON	E.ON
Vessels / logistics		
• All except jack-up vessel contracting	E.ON	E.ON
• Jack-up vessel contracting	OEM	E.ON

Table 1: Scope of O&M responsibilities pre-and post-warranty

It is immediately apparent from this responsibility matrix that E.ON took an active role in the O&M of Robin Rigg throughout the warranty period from the beginning of the operational life of the wind farm.

The key differences introduced with self-perform were that E.ON took responsibility for wind turbine maintenance and jack-up vessel contracting, which both previously rested with the OEM.

Strategic elements of the self-perform strategy

E.ON outlined the following areas as the key project components implemented to facilitate the self-perform strategy:

- *Investing in infrastructure*

Prior to operation of the wind farm, E.ON committed significant investment to infrastructure. The key investments included a comprehensive O&M base, major port upgrades and crew transfer vessels (CTVs).

During the warranty period, E.ON worked closely with the OEM to improve such facilities as warehouse equipment, quayside facilities and office space and ensure that they were suitable for service teams.

Having this infrastructure in place and fully operational laid the foundation for a smooth transition to a self-perform strategy.

- *The role of the central control room*

E.ON has a centralised wind control room which provides 24/7 support to its operational wind farms. This was used for the Robin Rigg project during the warranty period as a monitoring service out of normal site operational hours to monitor HV systems, report turbine downtime and provide grid control and balancing services.

This approach provided E.ON with full control of offshore access, marine coordination and logistics, thus making the transition to in-house maintenance easier as the offshore logistics platform was essentially already there.

This continued once the site came out of warranty and grew in service scope to include full 24/7 turbine monitoring.

- *Applying approaches proven in the thermal power generation sector*

Wind Turbine Safety Rules (WTSR) are an industry standard safe system of work to control access and work on wind turbine mechanical systems and low voltage equipment (<1000V).

In the warranty contract, E.ON specified that it would implement these WTSR which provided valuable transparency on all planning and coordination of activity throughout the warranty period.

E.ON was responsible for interviewing and authorising all technicians who worked at the site, receiving and reviewing all Approved Work Procedures (AWPs), risk assessments and method statements prepared by the OEM and releasing the wind turbine plant to the OEM when maintenance was required. This facilitated a close working relationship between E.ON and the OEM during the warranty period and significant knowledge transfer.

Unlike a thermal plant, two forms of safety rules are employed on wind farms generally and, in E.ON's case, these are the Electrical and Mechanical Rules (High Voltage) and the WTSR.

Having both sets of rules under E.ON's single 'umbrella' presented a clear advantage, in that the control of works was overseen by one organisation.

E.ON also implemented three key software systems prior to the start of initial operations:

- a Computerised Maintenance Management System;
- an electronic 'shift-log' to record events;
- a proven Plant Information (PI) data historian to capture, store and analyse Supervisory Control and Data Acquisition (SCADA) and other data from the wind farm linked to SpheriCAL, an advanced condition monitoring system which was piloted at Robin Rigg during the warranty phase.

Finally, E.ON adopted the concept of a 'morning meeting', when an early-day project-specific daily meeting informs a later site meeting. This approach is common on thermal power plants and E.ON adapted this to suit the working arrangements of an offshore wind farm.

This proved to be a key mechanism for sharing information during the initial warranty period and prepared E.ON for taking on full responsibility for O&M.

- *Directly employing an active and knowledgeable team*

The importance of an active and knowledgeable team when implementing a successful in-house O&M strategy was made apparent by the inclusion of permanent E.ON staff during the warranty period.

Following the transition to self-perform, E.ON retained all 10 incumbent OEM offshore technicians, plus two onshore maintenance support staff who had been working on the site, enabling significant knowledge transfer and a seamless handover of turbine maintenance.

The transfer of staff from the OEM to E.ON fell under the Transfer of Undertakings (Protection of Employment) (TUPE) Regulations and support was provided by HR professionals from E.ON and the OEM to ensure a smooth transition.

E.ON provided facilities for the OEM's team to use and created an open plan office environment and a shared local operational control room to deliver turbine monitoring, marine coordination, emergency response and monitoring of the HV Systems.

E.ON also ensured that the working hours and shift patterns of the E.ON support staff matched those of the OEM's team, thus improving teamwork and facilitating joint decision-making. This enhanced the potential for knowledge sharing and joint working which brought benefits during the warranty period, but was also a critical success factor when the decision was made to implement a self-perform strategy.

Figure 3 shows the organisational chart pre- and post-warranty, illustrating where E.ON employees took on active roles during the initial five years of operations:

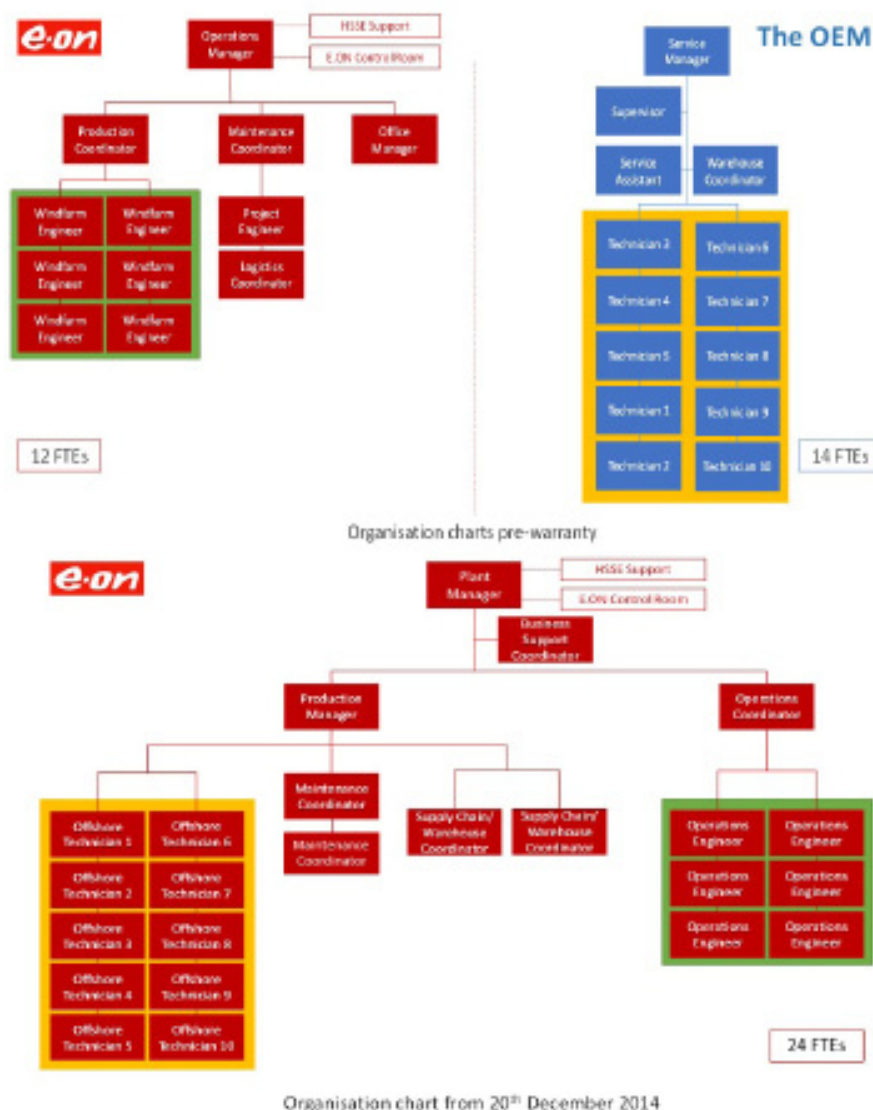


Figure 3: E.ON organisational charts for Robin Rigg, pre-and post-warranty

The results

At the time of the case study interviews, Robin Rigg had more than six months of self-perform operation experience to draw on and significant benefits and lessons learned are already beginning to emerge.

Self-perform in action: overcoming pitch ram issues

The self-perform approach and subsequent results can be demonstrated by the way in which E.ON dealt with ongoing pitch ram issues at the Robin Rigg Offshore Wind Farm.



A pitch ram is the component responsible for manipulating the pitch of a wind turbine blade. Within the warranty period, E.ON staff at the Robin Rigg site became aware the pitch rams were displaying an unexpectedly high failure rate and the replacement procedure was restricted by a wind speed limit of 8 m/s.

During the warranty period, E.ON challenged the OEM to review the component reliability and replacement procedure. However, there were few contractual drivers for a proactive strategy and the operational priorities of the OEM resulted in a 'run to fail' strategy being adopted for this component. Any attempted replacements were regularly delayed due to the low wind speed limit and most downtime was considered contractually permissible by the OEM.

Once the service and warranty period ended, E.ON implemented a targeted programme of proactive inspections using Non-Destructive Testing (NDT) methods and engaged with the component sub-supplier. E.ON also reviewed the health and safety procedures associated with the tasks and identified improved methods of working.

Key benefits

- *Control and ownership of the maintenance strategy*

The self-perform approach has enabled a more dynamic and proactive strategy with improved information on the condition of the assets, allowing prioritisation of maintenance tasks and faster reaction to incidents and component failures.

Contractual arrangements for the scheduling of planned annual service caused inefficient use of weather windows to carry out minor upgrades instead of necessary corrective maintenance.

There were also no direct contractual targets relating to power production, which is now possible through a self-perform approach.

“Ownership of all operations and maintenance
has enabled the team to work dynamically and prioritise tasks more effectively.”

Robin Rigg Production Manager

Under self-perform, the maintenance strategy has evolved towards a more proactive approach with the successful implementation of faster, more extensive root cause analysis.

While in warranty, any failed components would be sent offsite with little feedback to E.ON staff. There was also a long time lag for the limited root cause investigations undertaken due to a longer supply chain. Now, any component can be sent to a central department at E.ON for analysis with tangible benefits.

A good example is the maintenance of generator bearings. These are now stripped down by E.ON and subjected to a deeper root cause analysis, and this approach has led to the implementation of improved alarms in SpheriCAL, E.ON's advanced condition monitoring system.

There was a generally good level of reliability of the turbines during the warranty phase resulting in contractual time-based availability targets often being met. However, there was a lack of drivers to deliver performance above the guaranteed level.

Potential performance improvements could be gained through a reduction on permissible 'wait on weather' downtime or minimising lost production, and it is these pockets of value that E.ON hopes to unlock through self-perform as well as improving the management of long-term asset risks.

- *Improved staff satisfaction and working environment*

E.ON has been able to cultivate a more engaging working environment and provide a direct link between turbine technicians and E.ON management. This gives technicians a more effective 'voice', potentially increasing job satisfaction.

Many of the OEM turbine technicians were employed by E.ON following the transition to self-perform. These employees have expressed that they feel they have much more of a voice within the overall operation of the wind farm and can now communicate directly with site managers. They also feel they have increased career development opportunities local to their homes that did not exist previously. The transition has enabled E.ON to implement a more appealing working environment with less report writing and more attractive working hours.

"Previously I was required to cover a wide range of operational tasks. I now have the support of a wider on-site team which allows me to manage my workload more efficiently and effectively"

Robin Rigg Maintenance Coordinator

- *Enhanced supply chain engagement*

Direct communication with component suppliers has opened up following the transition to self-perform. The example given on page 8 regarding pitch ram malfunctions demonstrates how supply chain interaction has improved.

There is a sense that, within warranty, the component manufacturers were not always getting rapid feedback and had no direct contact with technicians and site staff. Now suppliers are better informed about procedures and uses of the components. This facilitates valuable design and procedural improvements.

- *Enhanced O&M knowledge and capability*

One of the key advantages of the self-perform approach has been the significant transfer of knowledge to E.ON from all stakeholders, including the OEM, component manufacturers, technicians and vessel operators. While in warranty, there was very limited communication between OEM technicians and E.ON, or between component manufacturers and wind farm owners. This created barriers to capturing and learning from experience in the field.

Self-perform has enabled E.ON to develop in-house O&M knowledge and capability and respond quickly and effectively to operational experience leading to enhanced documentation, procedures and health and safety. There have also been changes made to the annual turbine service procedure to introduce some additional measures to manage long-term risks. The entire team is now aligned to exactly the same performance drivers to maximise wind farm output.

- *Improved health and safety*

Robin Rigg operated using E.ON's in-house Wind Turbine Safety Rules. Consequentially, E.ON commanded significant control and transparency on all operations at Robin Rigg. This allowed E.ON to enforce a very high standard of health and safety (H&S).

In addition to the pitch ram example given on page 8, E.ON has also customised the annual service. It is now a more comprehensive check-up of the turbines with a focus on preventative maintenance to address potential risks in advance. Furthermore, failed components can be kept on site to allow the team to learn from experiences in the field and mitigate associated H&S risks.

"We now have greater control over health and safety and have the power to enforce our high standards. E.ON's Authorised Technician approval process under the Wind Turbine Safety Rules has always been an excellent example of this but now we also have our own in-house Authorising Engineer."

Robin Rigg Production Manager

Lessons learned

- *Technical documentation*

Access to technical documentation has been one of the more challenging aspects of self-perform. E.ON is addressing this by writing its own set of maintenance procedures which is also providing opportunities to review and improve maintenance practices. This has taken a great investment of time, but E.ON believes it will provide a significant long-term advantage.

As part of the end of warranty close out, E.ON continues to seek access to OEM technical documentation. Access to OEM documentation is critical, however there is a reluctance in the industry to make this available to owners.

A lesson identified was that access to documentation should be addressed early in any transfer of control discussions: tactically, the use of escrow arrangements could have made the process more efficient.

- *Management of data*

Access to data and data management systems has caused issues for implementation of the self-perform strategy. E.ON secured early access to SCADA data by implementing its own server to host an independent data historian based on the widely used OSI-soft PI software from the start of operations.

It was expressed that a lot of time would have been saved if E.ON had established clear ownership of all data in the contracts for the Robin Rigg project, especially condition monitoring data. Accessing such data became complicated when new contracts were being negotiated.

“Fundamentally, it is the underlying data that is critical.”

Robin Rigg Production Manager

In terms of data management systems, system implementation was highlighted as just as critical to success as the choice of which IT system to invest in.

The OEM had put a computerised maintenance management system in place to enable simple, fast and effective access to data and to improve planning and reporting. Both the OEM and E.ON's team were familiar with the system and its operation. The same system was then implemented by E.ON when self-perform was implemented at Robin Rigg, but it quickly became apparent that the system's functionality did not meet the requirements of the site management.

This particular example demonstrates that, while IT systems are an important aspect, those responsible for the procurement and maintenance of such systems must take future requirements into consideration. In the case of wind farm maintenance, access to the underlying data, such as failure data, hours worked, tools and components used, is critical.

The OEM boasts a wealth of experience in supporting SCADA systems and interrogating SCADA data for interaction with, and understanding of, the health of wind turbines. A potential area for improvement at E.ON would be the development of a dedicated in-house SCADA support team.

- *Understand the scope*

While much of the ground work for a self-perform style approach was laid during the original contract negotiation and early operational period, the move to self-perform was still a significant project.

The requirements to consider TUPE and new HR contracts and to set up an 'on-boarding' process to ensure payroll, IT logins, medicals, training records and PPE provision are established on day one makes it difficult to fully appreciate the scale of the effort required as it involved many different corporate departments.

During the transition to the self-perform approach at Robin Rigg, the existing O&M team was also delivering end of warranty inspections, a significant major retrofitting campaign for the foundations and coordinating daily maintenance, all of which made the project extremely challenging.

It is necessary to ensure that the key teams across the corporate structure are aware of all the tasks and their inter-relations, as well as the need to keep current operational activities on track while making this transition.

The early involvement of the E.ON team clearly assisted with this.

- *Timing of transition*

Given the comprehensive scope involved in taking O&M in-house, planning and scheduling of the transition is critical. While some preparation was already underway, the final decision to implement self-perform was made twelve months prior to the end of the warranty.

Furthermore, the time of year is an important factor. Robin Rigg implemented the transition six days before Christmas, which added to the challenge as it coincided with the OEM's leave year end and the end of E.ON's financial year, placing additional tasks on the site-based and remote support teams.

Consequently, many of the transferring OEM staff were using up annual leave throughout this month. This lack of resource added one more element of complexity to the already formidable task of taking ownership of all O&M activities.

- *Stock and procurement*

Access to stock was identified as another challenge of the self-perform strategy.

One of the aspects of O&M that has changed radically with the move to self-perform is the spare parts supply chain. Previously, the OEM sourced all parts from Denmark but now the supply chain is shorter and more indigenous. This benefits the wider UK economy but has caused challenges for the team at Robin Rigg.

Previously, the team had access to the OEM's stock warehouses, sharing of spares across OEM-maintained wind farms with similar turbines and a comprehensive vendor list. It was expressed that supply chain mapping is necessary to improve the supply of components and provide competition and diversity.

Procurement readiness for self-perform is an area where the E.ON team believe they can improve further to avoid significant delays and act quickly to avoid lost production.

Cost implications

A key objective of any O&M strategy is to reduce operating expenditure (OPEX). While there will inevitably be an initial one-off investment of resources in setting up a self-perform operation, E.ON believes that the long-term LCoE will improve as a result of implementing proactive approaches and managing through-life risks more effectively.

Initial analysis by E.ON reveals that costs appear to have fallen in a sustainable manner, partly in exchange for taking responsibility for managing more risk in-house. In addition to the removal of any mark-up that the OEM may have taken, cost savings have been made in the following areas:

- Jack-up vessels: a significant cost driver for operating an offshore wind farm is the management of jack-up vessels. These particular costs have been lower than expected for Robin Rigg in the first six months of self-perform due to relatively low necessity for jack-up interventions and this is the main reason for the initial low OPEX results. Managing major interventions and mobilising jack-ups is a significant risk for the self-perform approach. However, E.ON is spreading this risk across a whole offshore fleet, and foresees the development of a larger and more liquid Irish Sea offshore market.
- Centralised control room: during warranty, control room tasks were shared and sometimes duplicated between E.ON's central and local control rooms and an OEM facility in Barcelona. Now all control room operations are managed and coordinated from the single E.ON central control room, with support from the local control room.
- Leaner management: a significant amount of contract management and administration has been removed by implementing the self-perform strategy. Furthermore, E.ON has been able to implement protocols that allow more technical faults to be addressed by way of automatic resets, consequently reducing the number of technician transfers to turbines.
- Streamlining of availability reporting: during warranty, the OEM collected all the SCADA data on a monthly basis, with the time-based availability warranty calculation subsequently duplicated by E.ON with contractual permissible events. Now these tasks are eliminated and E.ON can focus on the more informative and representative production-based availability
- E.ON only pays for spare parts and sub-contract services that are required and takes the risk on these costs. It is assumed that the OEM warranty and maintenance contract would have costed these risks. Many items, which were previously shipped from Europe, are now sourced locally and nationally.

Self-perform will deliver increased ownership and transparency of O&M costs, which is also one of the key drivers of the entire self-perform philosophy at E.ON. This information allows decisions to be based on owner value and profit, as opposed to focussing on minimising OEM costs without considering the implications on production or long-term impacts on the asset integrity.

The real long-term cost of self-perform at Robin Rigg remains uncertain. For now, the project is well into a knowledge transfer and training phase and the staff expect to see this investment in people, plant and processes paying off over the life of the asset.

“A higher level of control over our own assets allows us to increase our assets’ performance and manage O&M costs in the long-term.”

Robin Rigg Operations Coordinator

De-risking the concept of in-house maintenance

Wind farm owners taking full ownership of O&M is relatively new, but is emerging as an increasingly common trend.

The actions taken by Robin Rigg may go some way to demonstrate how potential risks have been managed by the owners:

- E.ON managed to maintain the same personnel and suppliers before and after the transition
- E.ON have made significant progress in obtaining all of the OEM technical documentation
- E.ON has managed to acquire the technical data required to operate the wind farm
- According to site-based technicians and managers, the day-to-day operations remain similar, but there are benefits from working as part of a single, wider team

“The risks associated with wind farm maintenance are always present, but now we are more aware of them”

Robin Rigg Production Manager

Recommended reading

Wind Turbine Safety Rules, Renewable UK, April 2015, available online at <http://www.renewableuk.com/en/utilities/document-summary.cfm?docid=1F3A938E-2A3B-4E08-8FEEE76FF2F523C9>, last retrieved on 30 March 2016

Interviewees' biographies

Tim Morgan, Robin Rigg Plant Manager

Tim has worked in the wind industry since 2004 and is now Plant Manager for E.ON at the Robin Rigg Offshore Wind Farm.

Tim leads a team of 24 staff and is responsible for all aspects of O&M. Prior to his current role, Tim has worked within E.ON's asset management function leading on asset integrity, strategy and risk and also managed a portfolio of E.ON's onshore wind farms.

Paul Hendren, Production Manager

Paul is Production Manager at Robin Rigg and has worked at the site since 2008, with responsibility for wind turbines and balance of plant maintenance.

With a previous background in the power industry gained at combined heat and power (CHP) plants, Paul leads the maintenance team and is responsible for ensuring maintenance requirements are understood and delivered along with leading on the assessment and management of engineering risks.

David Mitchell, Operations Coordinator

Dave has worked in offshore wind since 2007 and is Operations Coordinator at Robin Rigg.

Dave was one of the first to join the O&M team at Robin Rigg and now coordinates the day-to-day operational activities at the site, the operational control room and site safety rules, including operational arrangements for the offshore transmission assets. Prior to working in offshore wind, Dave worked with the British Antarctic Survey to construct and manage Antarctic bases.

Wayne Rayson, Maintenance Coordinator

Wayne is responsible for coordinating and delivering maintenance requirements for the wind turbines at Robin Rigg.

Wayne has been involved in O&M at Robin Rigg since 2007 where he worked as a technician and supervisor for the OEM before transferring into the E.ON organisation in December 2014. Wayne manages a team of technicians who deliver planned and reactive turbine maintenance and supports the day to day scheduling of work at site alongside the coordination of the long-term maintenance plan.

Author Profile



Dr Conaill Soraghan is a Renewable Technology Engineer with ORE Catapult.

He has a background in applied mathematics and completed a PhD in wind turbine design.

Conaill's main area of expertise is the management and optimisation of operational assets: he has extensive experience of the design and development of benchmarking systems and data/knowledge-sharing for the offshore wind industry.

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