Offshore Technology/Operation & Maintenance – accessibility

Søren Vestergaard
Elsam Engineering
Kraftværksvej 53
DK-7000 Fredericia
tel: +45 79233041, email: sve@elsam-eng.com

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Planning of offshore wind farm operation

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The plans for larger offshore wind farms are getting closer to realisation, thus it might be time to do something more about accessibility. Experience from Horns Rev shows that accessibility can have a huge influence on availability.

The need to access offshore installations has been present in the oil and gas industries for many years and also in connection with maintenance of offshore lighthouses and buoys. However, an offshore wind farm is a different sort of offshore installation, and the needs for access have a different pattern.

As long as the newest turbines are still placed off shore, a certain amount of access-availability will be required. This need for access will drive the development of new methods, but will they be ready in time? It is not only a question of technique; the new methods also have to fit into the total organisation and logistics used for operation of the offshore wind farm. Flexibility is a key word in operation of offshore windfarms.

Another important issue is safety. Although most of the new methods need some kind of certification or approval, a lot of time can be saved if the regulations are incorporated into the method from the beginning. The approving authorities are often left behind as well as the intended users. A lot of problems can be avoided if they are approached from the beginning.

Instead of looking at the technology available on the market today, each project should be carefully studied to establish the optimum operating conditions, and the access and operation solutions must be chosen on the basis of these findings.

1. Introduction

The Horns Rev offshore wind farm was the first wind farm built as part of the Danish Government's offshore wind energy programme. It was built by the Danish utility group Elsam as a multi-contract project; Vestas supplied 80 V80/2MW wind turbines. The last turbine was connected to the grid in December 2002. After dealing with numerous problems on all wind turbines, Vestas decided to bring all nacelles ashore for retrofit in the summer of 2004. The wind farm is now in full operation.

The wind farm is situated on a natural reef called Horns Rev in the North Sea 14 to 20 km from the shore at the westernmost point of Denmark. From the nearest harbour, Esbjerg, it takes 1-2 hours to reach the wind farm by boat, and from Esbjerg Airport it takes 15 minutes by helicopter. The helicopter can land on the substation, but the transfer to the turbines is by means of hoist from the helicopter while it is hovering above the nacelle of the wind turbine.

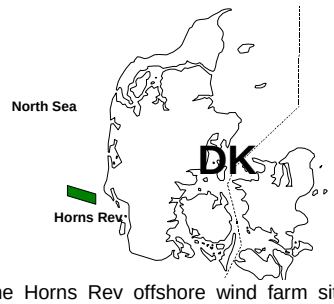

Figure 1. The Horns Rev offshore wind farm situated between 14 and 20 km into the North Sea

The installed power is 160 MW from 80 wind turbines in an almost square pattern. The turbines are arranged along 10 lines each consisting of eight turbines. Pairs of lines form 32 MW clusters. Each cluster is connected to the offshore transformer substation where the 33/150 kV transformer is located. The principle is illustrated in figure 2.

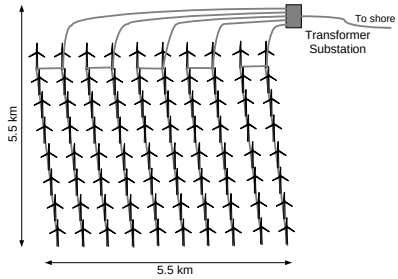

Figure 2. Connection of the turbines to the offshore transformer substation

From the substation, a submarine cable leads to shore where it is terminated in an existing substation.

All power cables have integrated optic fibres for the remote control system.

2. Operation and maintenance

2.1 Horns Rev setup

From the very beginning Elsam has had an interest in acquiring knowledge of operation and maintenance of offshore wind farms. Therefore the operation of the wind farm is handled in close cooperation with Vestas, who has granted a 5-year guarantee, provided that they have a warranty and maintenance contract for this 5-year period.

Very early in the process, the transport to the site was considered a challenge, and before Vestas was selected as contractor for the wind turbines, Elsam started the planning and contracting for helicopter and boat transport of persons to the wind farm. The responsibility is now split so that Elsam shall provide all necessary transport of persons up to a certain level. Beyond that Vestas shall handle transport of persons as well as transport of larger goods.

2.2 Focus areas

As owner, the focus will always be on the total economy of the plant and the return on investment. After installation, the main drive is to keep the O&M costs down and keep the production as high as possible.

The production is dependent on the wind and availability of the turbines. If the turbine is not available when there is wind, production will be lost. On the other hand, when there is no wind, the turbine does not need to be available. This sounds very simple and straightforward, but when it has to be incorporated into daily planning, reality is much more complicated.

A high availability can be reached by having a large O&M organisation on high alert, but this is also very costly. The resources should be kept at a level, where the cost of providing service and alertness is lower than the gained extra production.

The challenge is to translate the owner's interests into practical, safe and useable instructions on how to operate and maintain the wind farm from day to day.

2.3 Costs

O&M costs should be kept as low as possible, but not so low, that the turbines are not available when there is wind. With the increasing size of the turbines, focus on the single turbine will rise, since loss of production will have higher value than O&M costs for the same amount of human resources pr. turbine.

Transport is another large cost in connection with offshore wind farms. Besides the helicopter hoist on Horns Rev all offshore wind farms are

serviced by boat, and the transfer of personnel is very much the same. Many new ideas have been presented to improve accessibility, but so far none of them has resulted in a major increase in accessibility, so the basis for comparison of the wind farms is very good.

The market situation is a major factor in the pricing of a vessel, and a lot of existing vessels have been used for the service so far, since they are cheaper than a purpose-built vessel. As experience increases, a lot of minor improvements have been made, and a better basis for construction of vessels specific for service of wind farms is now available. It is not easy to measure the savings directly on the accessibility, but it is possible to obtain better utilisation of the vessel, smoother operation and less friction, when the vessel is designed for the job. In the long run this will lead to increased production.

3. Transport

The turbines on Horns Rev are all equipped with a helihoist platform at the rear end of the nacelle. For service visits, personnel access the turbine via this platform from a helicopter. The turbines can also be accessed by boat, and there is a lift in all towers.

Since the construction period and until the end of the retrofit programme called “Horns Rev Completion”, there has been an almost constant need for access and transport to the wind turbines. The transport has primarily been by boat, since the helicopter can only carry 5 passengers at a time, and the need was much higher than that. The helicopter was utilized as much as possible, especially in the winter period, where boat transport was impossible for up to several weeks at a time.

3.1 Helicopter

Helicopter operation and passenger transport by plane in general is very regulated, and the limits set up in the international regulations for passenger traffic are very restrictive. Also the opening hours of the airport and working hour regulations for pilot and crew put certain limits on the operation, but these factors can all be foreseen and dealt with. The weather also influences the operation, since lightning, ice, fog and very high wind can prevent the operation. But when all conditions are present, the operation is very gentle for the passenger, and there a no special requirements for the passenger in connection with transfer from helicopter to the wind turbine. Experience from Horns Rev shows that this form of transport has an availability of around 90%, with the weather as the main obstacle.

3.2 Boat access

Boat operation is not as regulated as helicopter operation. In Denmark the conditions of this form of transport is laid down mainly by the operators under consideration of maritime safety regulations and safety in general.

On Horns Rev the main factor reducing the availability of boat transport is the weather. Experience shows an accessibility around 65% annually with a lot of variations over the year.

The sparse weather windows and the variation of their duration put much more strain on the ability of the operators to utilise the weather windows when they are there. On top of that the need for a large staff to utilise the rare weather windows also leads to larger losses due to waiting time caused by bad weather.

The transfer itself from the vessel to the wind turbine and back again involves active participation of the passenger, who has to coordinate his step from the boat to the wind turbine and back again. Also the ability of the captain to read the waves and position the vessel properly very much influences the success of the operation.

When all aspects are considered the transfer of persons from boat can be carried out in a safe and efficient way, but there are a lot of parameters, which influence the operation.

4. Planning of operation

To ensure that a proper transport setup can be established from the beginning, planning of an operation will always be based on the knowledge available at the time of planning. It is difficult to set a standard for the transport setup, since so many parameters influence the opera-

tion. The setup will have to be adjusted to the exact conditions at the specific site.

The access to offshore wind turbines requires a very different setup than is the case for onshore wind farms. There are a lot more logistics involved, many of them known from the offshore oil and gas industry. But the operational pattern of a wind farm with multiple individual production units differs a lot from that of single or few large oil and gas production units, where each component can stop the whole operation. If one WTG stops the rest carries on, meaning that the consequence is a lot less for the wind farm than for an oil and gas production unit. On the other hand, if oil and gas production is stopped, the energy resources stay in the ground to be utilised when production can start again. For a wind turbine the energy resources are wasted while the wind turbine is stopped.
Although experience from the oil and gas industry must be utilised, it is important to keep the above differences in mind.

5. Evaluation of operation

After some time of operation a lot of lessons are learned, and a lot of these will lead to modification of vessels and gears and to adjustment of procedures.
It is very important that the planning phase involves considerations about evaluation of the operations, and also that some flexibility is incorporated into the contracts in order to make room for optimisation based on lessons learned.

The evaluation can be done in many ways. Some issues are very obvious, but often a thorough logging of key parameters is needed to quantify lessons learned and to prioritize the issues found. The choice of parameters to be measured should be made very carefully, since the focus on details without looking at the complete economy can lead to sub-optimisation of the operation, which will not necessarily be in the owner's overall interest.

The daily or short-term logging and evaluation must be adapted to the specific organisation, not only the organisation of the owner, but also the organisation put up by the operator, which in many cases will be the different wind turbine manufacturers.

Different traditions, methods and IT solutions will require that the solution cannot be the same for all wind farms.