leanwind

Logistic Efficiencies And Naval architecture for Wind Installations with Novel Developments

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Definitions

Acronym	Description
BIMCO	Baltic International Marine Council
CESA	Community of European Shipyards Association
DECC	Department of Energy & Climate Change
EWEA	European Wind Energy Association
FID	Final Investment Decision
HLV	Heavy Lift Vessel
HSC	High Speed Craft
IACS	International Association of Classification Societies.
IMO	International Maritime Organisation
LCOE	Levelized cost of electricity
MCA	Maritime and Coastguard Agency
MODU	Mobile Offshore Drilling Units
NDE	Non-destructive examination / inspection
O&M	Operations & Maintenance
OCV	Offshore Construction Vessel
OEM	Orignal Equipment Manufacturer
OMS	Offshore Marine Services
OSC	Offshore Service Craft
SCV	Small Commercial Vessel
SOLAS	Safety of Life at Sea
TAS	Turbine Access Systems
TOC	Transfer of class between IACS member societies
WFSV	Wind Farm Service Vessels
WP	Work Package
WTG	Wind Turbine Generator
WTIV	Wind turbine installation and/or heavy lift maintenance vessel

Executive Summary

Electricity generated from offshore wind remains at an uneconomic level in comparison with that from conventional fuel sources in most parts of the world. Significantly increased costs have been incurred by the wind industry in the move from onshore development, with the associated ease of access and installation, to offshore sites. Now these are being further increased by the progression from inshore into deeper waters in search of greater resource and by the pressures of coastal development. This is driving a need for cost reduction.

Due to the relatively early state of the sector, there remain significant cost savings to be made through learning and technological innovation. “LEANWIND” (Logistic Efficiencies and Naval architecture for Wind Installations with Novel Developments) is an EU project under funded FP7 that aims to provide cost reductions across the offshore wind farm lifecycle and supply chain. The Lean aspect of the project aims to characterise the processes involved in the industry, identify value creating steps and reduce waste, thereby maximising value to the client. Technological improvements will be used to reduce the waste in the process.

One significant area of cost is in the installation and commissioning phase which was estimated at around £400 million, out of a total project capital cost of £1500 million for a typical Round 3 500MW wind farm in the Crown Estate's Guide to an Offshore Wind Farm [1].

The wind farm installation phase requires a number of vessel types including, but not restricted to, accommodation vessels, cable laying vessels, construction support vessels, diving support vessels, heavy lift vessels, jack up barge or vessel, multi-purpose project vessels, multi-purpose cargo vessels, service crew vessels, safety and standby emergency evacuation and response vessels, survey vessels and tugboats. While many do not necessarily require technological innovation to be effective for the industry, the increasing installation volumes, turbine size, water depth and distance from shore means that the anticipated shortage of supply can be fulfilled by vessels developed considering cost efficiencies for the industry. Confidence in terms of financial support for offshore wind and future substructure design would encourage their construction.

The industry has predominantly been reliant on jack-up vessels (or liftboats) for installation and large maintenance actions such as gearbox replacement. These barges and vessels have been increasingly adapted to become specific for the market and are now seeing investment by wind farm developers and OEM. However, the number of capable jack-up installation vessels required for the hundreds of 5-6MW turbines in the next generation of offshore wind farm developments is estimated to outstrip supply by 2020. This has been identified as an area that would benefit from technological innovation where potential cost reductions are closely linked to

- reduction of the time needed for the various installation operations
- extension of the weather windows in which the operations are feasible

Innovations to reduce total install time will not only reduce cost to the individual wind projects but also eases market demand on the more capable installation vessels. The cost reductions could be achieved by

- Decreasing use of offshore lifts requiring an increased amount of onshore pre-assembly
- Decrease operating constraints due to meteorological conditions
  - Improved vessel design for less restrictive weather limitations
    - Increased maximum jacking sea state
    - Increased max crane operating wind speed
  - Improved weather prediction
    - Improved weather monitoring and decision support system
  - Increased loading capability for cranes and components being lifted to increase number of usable weather windows
- Decreased transit time
  - Increased number of turbines loaded per trip
    - Increased deck payload
    - Increased useable deck area
  - Increased transit speed
- Decreased offshore operation duration
  - Increased jacking speed
  - Decreased leg-preload duration (by using 4- or 6-legs vessels)
- The use of component feeder vessels
- The use floating installation vessels

O&M activity accounts for approximately one quarter of the life-time cost of an offshore wind farm. As part of this, service vessels are required to transfer wind turbine maintenance crew to perform duties on the turbines with significant regularity. At current levels, a 1GW farm with 200 turbines rated at 5MW is expected to require around 3000 maintenance visits per year, with a disproportionate number of visits being required in the winter when the environmental conditions incur more unplanned maintenance. Delays in carrying out unplanned maintenance, when a fault has occurred and the turbine may no longer be operational, incur significant penalties in lost electricity generation and revenue. This is loss is also more pronounced in the winter as the potential resource is greater. Innovations in condition monitoring and turbine design are being made to reduce visits, but even at the target of six per year a significant number of transfers remain.

Approximately 110 service vessels with wind experience are available in the market and demand is expected to exceed supply by 2017. By 2022 approximately 426 vessels are expected to be required to deliver maintenance crews to site [2]. To reduce lost revenue, access in sea states higher than the current typical limit of 1.5m significant wave height and 12m/s wind speed is considered necessary; vessels and access systems capable of transferring personnel in 3m is desired. A large number of current service vessels are not suitable for these conditions and in the UK are restricted to 60Nm from safe haven, rendering them unusable for farms to be located further from shore. For these sites duration of transit must also be reconciled against the length of the maintenance crews' working day.

Farm operators desire vessels whose characteristics produce fast transfer speeds, with large deck area, are fuel efficient and have a comfortable ride as sea sickness is a significant contributor to lost time. The transfer of technicians from vessel to turbine is also easier and safer when there is little vessel motion when station keeping. Both aspects are dictated by the working environment such as significant wave height, spectral shape, current conditions etc. together with hull form, weight distribution, presence of ride control systems and the expertise of the captain. In some cases the resulting design requirements may be in conflict, such as with longer sleeker hull forms which are faster and more efficient but more exposed to waves on the beam.

Technological innovations in the transfer of personnel from vessel to turbine have sought to improve accessibility. The bump and jump method, based upon a bow fender design creating a high friction force between bow and boat landing, remains the preferred access method but is limited to a 1.5m Hs. Active and passive crew transfer access systems have been developed to compensate for motion in more severe sea states. These remain unpopular due to their high cost and weight which is typically located towards the bow and may require additional hull strengthening.

With increasing farm size and distance from shore, purpose built wind farm maintenance vessels that are able to undertake lifting activities for component replacement will be developed. These may also act as a mother-ship providing accommodation and spare part storage functions, with smaller service vessels transferring crew to turbines in the farm. Uncertainty remains over the detailed functionality of the mothership and the safe and reliable transfer of personnel from crew boat to the mothership. Concepts including lift and stowage of the service vessels on the mothership are also being proposed.

Service vessel designs may also have recently been limited by the regulations resulting from SOLAS and the International Load Line Convention definition of a “Passenger"; vessels carrying more than 12 passengers must be in possession of a Passenger Ship Safety Certificate which incurs additional safety equipment and operational activities such as safety drills. Vessels with a load line length below 24m and fewer than 12 passengers are able to avoid the more stringent regulations under the Load Line Convention and most of SOLAS, therefore incurring less cost in the fit-out and operation of the vessel.

The main challenges for service vessels remain

- Reducing motion when transferring to increase accessibility in larger sea states
- Balancing fuel efficiency against transit speed
- Reduce motion which incurs sea sickness due to its detrimental effect on maintenance crew operational efficiency
- Establishing optimum vessel size and hull form type for varying distances from shore

The purpose of this report is to highlight the challenges in the industry regarding installation and maintenance and these will form the basis for the remaining activities in work package 3. Solutions for these challenges will be sought through vessel and equipment design, analysis, simulation and physical test. The following stage of this project will refine the design requirements, such as maximum metocean conditions for operations, which will be used to create the designs. These will be considered in light of economic and technical factors and the lean principles on which the project is based. Design stages will follow and activities will include

- Global structural analysis for a number of loading conditions to verify the structural integrity of the vessel hulls
- Performance assessment of DP systems in terms of the increased functionality of vessels in being able to maintain station when undertaking installation and maintenance tasks
- Vessel motion will be assessed via seakeeping and manoeuvring calculations; essential in the assessment of comfort and wind turbine access on service vessels

Marine operations and equipment functionality also require consideration to verify the design. This workpackage will also therefore consider the modelling of

- Seabed/spudcan interaction
- Motions minimization/compensation equipment
- Floating offload/loadout
- Jacking equipment
- Advanced personal transfer equipment

The six designs and assessment techniques will be the functional results of the project. In addition, the parameters which are key to installation and maintenance vessel design, layout, crane operations and access systems will be disseminated by the project.

Vessels perform a transportation function for the industry and can be optimised appropriately but the industry must be capable of sustaining their use to justify investment in their bespoke design. Identifying cost reduction through reduced operational time also requires a collaborative approach on farm design and operation. The cheapest foundation to design and construct may not be the cheapest to install due to sensitivity to precision in the installation, the weight or volume of the structure. This is accommodated in this project through interacting on foundation design in WP2, O&M procedures in WP4 and the economic and market assessment in WP8.

1. References

[1] Crown Estate, "Offshore Wind Cost Reduction Pathways," 2012

[2] Navigan Consulting, Inc., "Global Offshore Wind Shipping Opportunity," Danish Shipowners' Association, London, 2010

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