OFFSHORE WIND PLANT BALANCE-OF-STATION COST DRIVERS AND SENSITIVITIES

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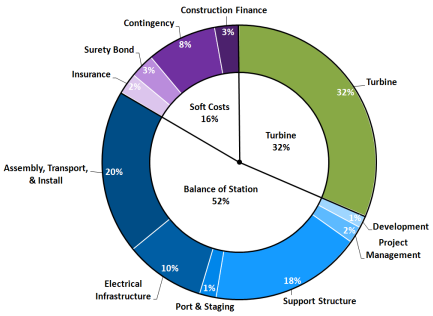
Introduction



Source: Tegen, S.; Hand, M.; Maples, B.; Lantz, E.; Schwabe, P.; Smith, A. (2012). 2010 Cost of Wind Energy Review. 111 pp.; NREL Report No. TP-5000-52920.

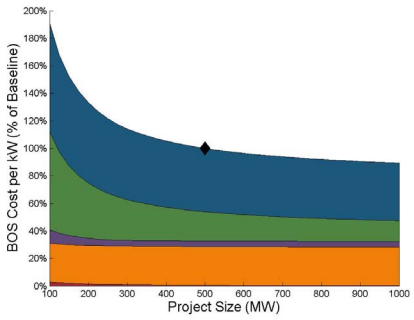
- With estimates of balance-of-station (BOS) costs for offshore wind plants upwards of half of total project investment cost, there is an increasing focus on identifying BOS cost drivers and sensitivities.
- The National Renewable Energy Laboratory (NREL) has developed a new offshore wind plant BOS cost model based on data provided by GL Garrad Hassan America, Inc. (GL GH) to explore these drivers and sensitivities.
- This model demonstrates how various factors such as turbine size and vessel rates can affect BOS costs for offshore wind projects.
- Results of these analyses are based on typical values and ranges for near-term U.S. offshore wind projects in the mid-Atlantic region.
- To represent the impact of altering a single variable, all analyses use common baseline project parameters (see Table 1) while the variable under investigation is changed.
- Because of the high level of variability in project parameters and uncertainty of site-specific elements, the results of these sensitivity analyses should be taken as representative only.

Table 1: Common baseline project parameters

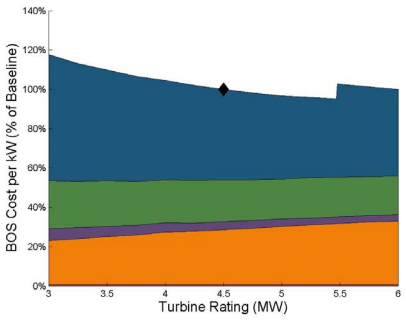
Project Size (MW)	500
Turbine Rating (MW)	4.5
Rotor Diameter (m)	126
Hub Height (m)	90
Distance to Shore (km)	30
Water Depth (m)	15
Foundation	Monopile
Array Spacing (rotor diameters)	8x8
Array Voltage (kV)	33
Transmission Voltage (kV)	220
IEC Wind Turbine Class	II

Sensitivities

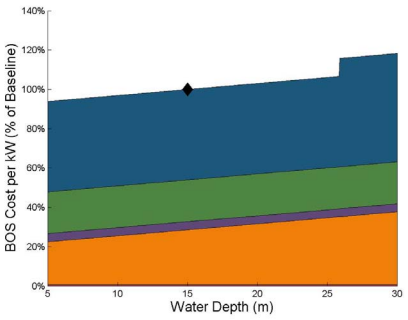
1. Sensitivity to Project Size



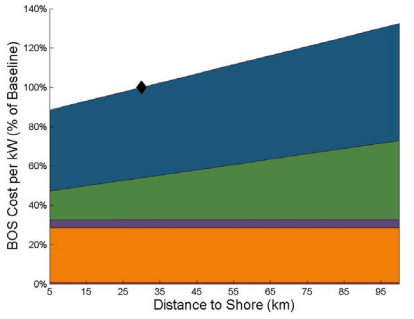
2. Sensitivity to Turbine Size



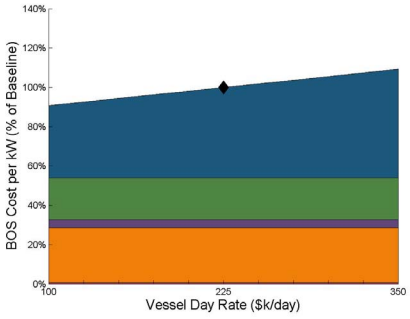
3. Sensitivity to Water Depth

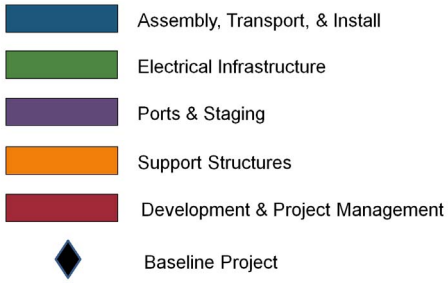


4. Sensitivity to Distance to Shore



5. Sensitivity to Installation Vessel Rate





Conclusions

1 • Total balance-of-station costs are reduced with larger project size. This effect is largely associated with fixed costs such as vessel mobilization, export cable landfall operations, and others being distributed over many megawatts. Further reductions come from increased order sizes that reduce per item costs.

• The electrical costs represent a significant percentage of project costs at low project sizes. At larger project sizes, the support structure and assembly, transport, and install costs dominate.

2 • The total balance-of-station cost is generally reduced as turbine size increases. Monopile support structure costs increase as the turbine rating increases, but the cost increase is outweighed by the reduction in electrical infrastructure and assembly, transport, and install costs.

• The step change increase in assembly, transport, and install cost at larger turbine sizes is associated with the need to change to a larger class of vessels which is needed to handle the increased monopile size required for the higher loads associated with larger turbines.

3 • Water depth shows no impact to electrical costs. However it does impact support structure costs, which leads to increased total BOS cost.

• At shallow water depths, the assembly, transport, and install costs are unaffected by water depth. As the water depth increases, the monopile gets substantially heavier, which triggers a step change in costs due to the need to use a larger and more expensive class of installation vessels.

4 • Distance to shore is typically a result of permitting, wind resource, and other non-cost-related factors. However, as distance to shore increases, BOS costs can rise significantly because of the high costs of the long electrical cabling needed to connect the offshore wind project to the land-based grid.

• For projects sited farther from shore, the assembly, transport, and install costs increase as a result of transporting the turbines and foundations over greater distances.

5 • Variation of installation vessel day rates alone can alter the assembly, transport, and install costs as well as total BOS costs quite substantially.

• Yet-unverified U.S. installation vessel costs and the exceptionally up-and-down history of European installation vessel costs lead to highly variable assembly, transport, & install costs.

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