



## Nearshore Versus Offshore: Comparative Cost and Competitive Advantages

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# Nearshore Versus Offshore: Comparative Cost and Competitive Advantages

By Henrik Klinge Jacobsen, Pablo Hevia-Koch and Christoph Wolter

## BACKGROUND

Currently there exist high expectations for the development of wind energy, particularly in Europe, out of which offshore wind turbine developments will be central as tools to achieve current energy targets. The choice between nearshore and (far)-offshore is particularly relevant, both because of increased public resistance due to visual disamenities produced by nearshore projects, and because of the potential cost reduction benefits attained by building wind farms closer to the shore.

Based on this need, an analysis of the differences between costs and cost drivers for both offshore and nearshore is needed, as well as an exploration towards other possible factors that might affect the relative advantage of nearshore compared to offshore projects. We compare Danish nearshore sites with further ashore wind potentials in Denmark and elsewhere. Costs for nearshore are expected to be lower due to fewer costs of connection, foundation, and to some extent, operation and maintenance. These lower costs must be balanced by the less favourable wind conditions and the costs associated with public resistance. Carefully selecting the nearshore sites with low resistance and low cost characteristics can hopefully reduce the cost of expanding the offshore wind capacity in Denmark where there is a considerable amount of coast line compared to the area of the country.

## METHODS

We define nearshore wind as turbines that are up to 15 km off the coast. The distance is not the only important cost driver, but it is the attribute related both to cost advantages for nearshore development and disadvantages arising from public preferences against close to shore wind turbines. We begin by analysing the main cost drivers for offshore wind turbine projects, disaggregating by variables including site conditions (wind potentials, distance to shore, depth of sea bed) and construction variables (size of wind turbines, capacity, foundation). Then we compare the influence of the most important drivers for both offshore and nearshore projects. Based on some Danish nearshore sites we examine the cost ranges and compare to the cost range from comparable further ashore sites in Denmark.

To quantify the potential cost advantages, we use one international source (EEA, 2009) that provides scaling factors based on only distance to shore and water depth. We then recalculate and calibrate based on investment data from one Danish wind farm.

## FINDINGS

Denmark is probably positioned in the low end of the international average cost for off-shore wind development. This is evident from a comparison of levelised cost of offshore wind energy (LCOE) including projections from major agencies and associations in the wind sector. In Figure 1 we compare cost levels across the projections of several reports. The wideness of the cost range for each source reflects both the uncertainty in technology development and the underlying difference in cost driving characteristics within the area examined (country/region). The Danish Energy Agency numbers and forecasts are at the lowest level compared to the levels provided by other sources. Therefore, we must expect that the cost benefits from moving wind farms from average off-shore to nearshore locations in Denmark is less than for most other countries (in line with the generally shallow seabed conditions in Denmark).

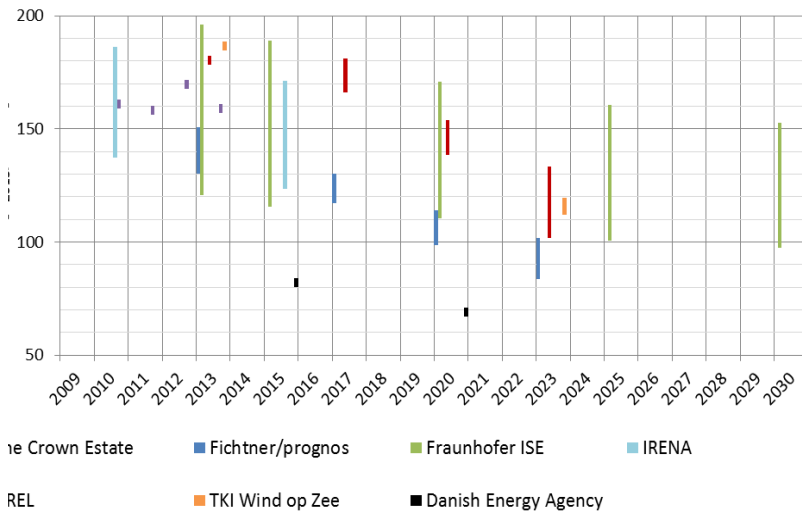
The cost projections in Figure 1 assume a considerable cost reduction over time, but it is

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Water depth\ Distance from shore	4 km	8 km	10 km	12 km	15 km	20 km	25 km
5m							
10m	0.967	0.974	0.978	0.982	0.988	0.998	1.008
15m	1.000	1.008	1.012	1.016	1.022	1.033	1.043
20m	1.034	1.042	1.046	1.050	1.056	1.067	1.078
25m	1.067	1.075	1.080	1.084	1.090	1.102	1.113
30m	1.124	1.133	1.137	1.141	1.148	1.160	1.172
35m	1.237	1.247	1.252	1.257	1.264	1.277	1.290

**Table 1 Investment cost scaling factors used for DK comparison**

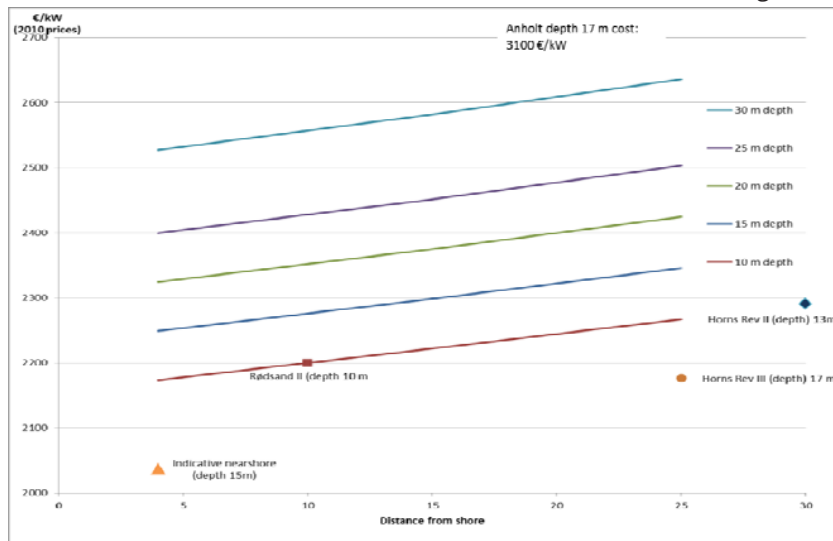
Source: Calculated based on EEA, 2009 (Table 6.4)



**Figure 1 Comparison of levelised cost estimates and ranges for offshore wind in the literature**

seabed characteristic differences and connection costs seems to dominate the generalizable cost drivers. The connection costs for example vary more among nearshore Danish sites than between average nearshore and average offshore DK sites.

However, we illustrate the potential cost advantage based on one of the international sources of cost drivers (EEA, 2009). We calibrate the scaling factors from Table 1 to one particular Danish wind



**Figure 2 Investment cost illustration for DK in 2010 with indicative benefit (Based on investment cost for Rødsand II and EEA scaling factors in Table 1)**

The illustration for potential benefits in DK clearly shows that the main cost benefit will be achieved if it is possible to reduce the water depth by locating the wind farms closer to shore (moving left and down in the figure). If water depth is not reduced, then the cost reduction of moving from a location similar to Horns Rev III to a location just 4-5km from shore will be only 4% (just moving left). If conditions regarding water depth like Horns Rev III (approx. 17m) are very scarce, the relevant comparison might be between average water depths of 25m versus water depths similar to some DK nearshore sites, of around 15m. The benefit in this case will be around 10% reduction of CAPEX

**CONCLUSIONS**

Nearshore wind potentials exist in Denmark, and they have potentially lower costs than further offshore, but the cost advantage is probably lower than in other countries, because offshore costs are comparatively lower in Denmark due to shallow waters. The nearshore potentials are smaller, and

not clear whether this is expected to cover mainly the far off-shore projects in deeper waters. If cost decreases are expected to be dominated by foundation technology improvement and installation cost reductions, then the nearshore projects may benefit less and thus the relative cost advantage of nearshore wind will decline over time.

The ability to generalise the cost curves from a Danish sample of nearshore wind farm sites, was investigated but it is very difficult to characterise other potential sites in DK depending on the few cost drivers that can be extracted from existing developments/projects. The historical data are covering many years and a tremendous development in turbine size and technology. The amount of local conditions affecting the optimal farm layout,

seabed characteristic differences and connection costs seems to dominate the generalizable cost drivers. The connection costs for example vary more among nearshore Danish sites than between average nearshore and average offshore DK sites.

However, we illustrate the potential cost advantage based on one of the international sources of cost drivers (EEA, 2009). We calibrate the scaling factors from Table 1 to one particular Danish wind farm development (Rødsand II, 2010) and then compare to other Danish wind farm developments.

The shares of cost components are different for near-shore and far offshore wind farms, but the cost drivers are basically the same. Connection cabling, as well as installation (and mostly foundations) represent a smaller cost share for nearshore wind, but due to the more varying local conditions for connection, the distance from shore is less important as cost driver compared to the depth. The sea depth and wind conditions are the main drivers, similar to far offshore, and the turbines/steel costs are providing similar cost impacts for the two categories. We therefore chose to illustrate a potential cost advantage based on two cost drivers only as given in Table 1.

possible wind farm sizing is also limited for some sites in Denmark. However, there are still potentials with lower costs than further ashore sites. It is difficult to identify one main contribution as e.g. more shallow water as the source of expected lower costs based on a small sample of data examined for Denmark. Significant cost advantages are however only expected if water depth is considerably lower than at more offshore sites.

An illustrative calculation of benefits indicates that cost could be only 4% lower nearshore if no reduction in water depth is achieved. Compared to this, moving from 25 km distance at the same time as reducing water depth from 25m to 15m may provide cost reductions of around 10%.

Finally, the smaller possible size of the projects may facilitate more competition, especially from domestic developers, but it may also lead to less participation from the global offshore developers that exploit economies of scale in wind farms. If dominated by the first, this produces a more competitive environment for the bidding process of the smaller nearshore projects that may allow new entrants into the offshore development and eventually pushes for lower prices.

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