European Offshore Wind Cost Reductions & Implications for North America

July 2017

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To: Clients and Colleagues
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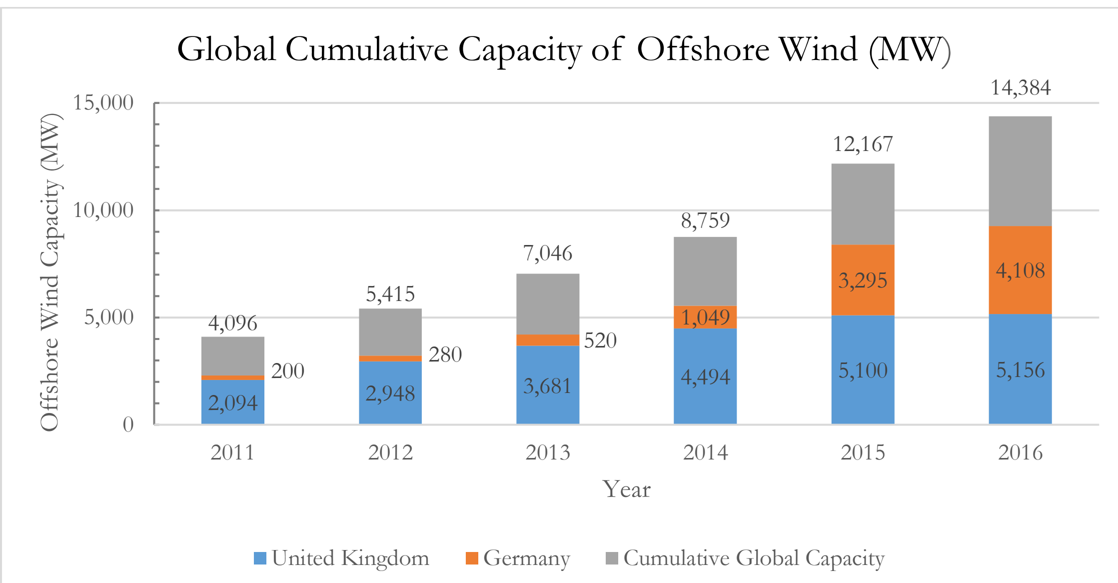
The cumulative capacity of global offshore wind (OSW) has grown at a dramatic rate in recent years, increasing by 25-40% annually since 2011 (see Figure 1 below).[1] Due to increasing industry maturity and the development of a specialized supply chain to support the industry, realization of economies of scale, and other factors, the levelized cost of energy from OSW has decreased significantly, which is an encouraging sign for development of this industry in North America.

Figure 1: UK and Germany Drive Increases in Global Installed OSW Capacity



Source: Global Wind Energy Council

This report illustrates how European OSW projects have realized dramatic cost reductions, and how the emerging US OSW industry can benefit from this experience. The European OSW industry started over twenty years ago, and currently has over 12,000 MW in commercial operation,[2] while the US only installed its first 30 MW project late last year. With an installed fleet of 3,589 OSW turbines and larger turbines being offered by OSW turbine manufacturers,

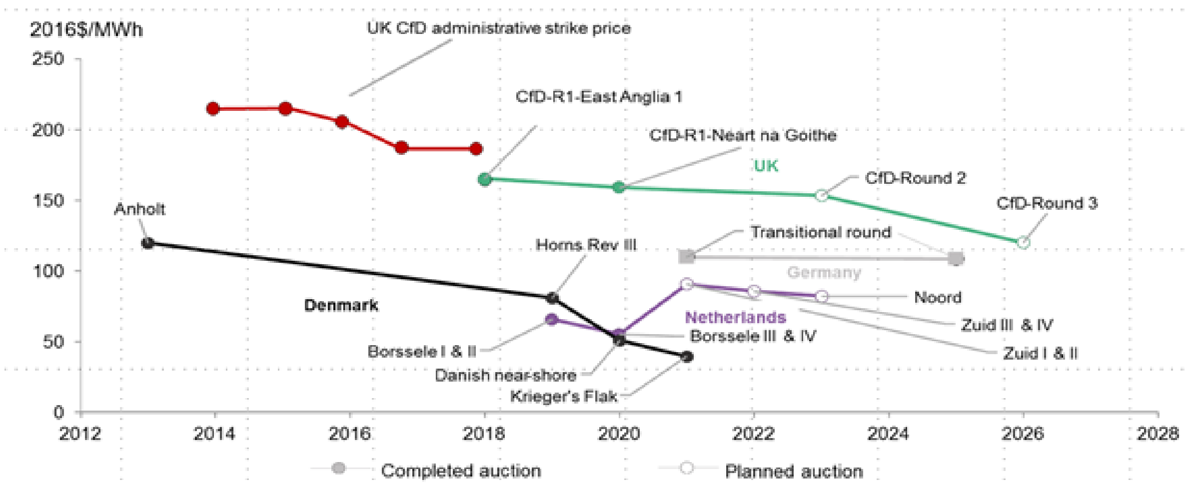
[1] Global Wind Energy Council, 2016
[2] ibid

European projects are offering prices, before consideration of transmission costs, that are competitive with forecast wholesale market prices, promising a market that is sustainable and not dependent on government policy support.

EUROPEAN LEARNING CURVE

Figure 2 shows progressive reductions in levelized cost of energy (LCOE) in European OSW projects, based on commissioning year.[3] Note that the UK LCOE includes transmission costs, which is not the case for the other countries shown, explaining the higher LCOEs for UK projects.

Figure 2: European wind project LCOE by Commissioning Year



Source: Bloomberg New Energy Finance, 2016

With over 5,000 MW in commercial operation, the UK has successfully established an OSW industry and realized significant cost reductions from the development of that industry. In the UK, projects reaching their Final Investment Decision (FID) from 2012-2014 had an average LCOE of $157/MWh[4], whereas projects reaching FID in 2015-2016 averaged $126/MWh[5][6] This cost-reduction surpassed the country's goal of reaching $130/MWh (£100/MWh) by 2020.

Recent European projects have been able to offer notably low prices, reaping the benefits of the development of a specialized supply chain, improvements in technology, growing investor confidence, and a new generation of turbines (6-9 MW). A few of these successes are detailed below in Table 1, which includes projects in the Netherlands and Denmark. In some circumstances, it is cheaper to generate wind offshore than onshore, which is a milestone in the evolution of the industry.

[3] Bloomberg New Energy Finance, 2016
[4] Some locations differ in LCOE calculations depending on whether or not they include transmission costs. The UK includes transmission costs in these calculations.
[5] KPMG, Cost Reduction Monitoring Framework, 2016
[6] July 2017 GBP/USD conversion rate of 1.30 used for this report.

Table 1: Major 2016 Projects and LCOE (USD/MWh)

Project (Developer)	Country	MW	Date Tendered	In-Service Date	LCOE ($USD)[7]
Borssele 1 and 2 (DONG Energy)	Netherlands	700 MW	Jun. 2016	2021	$82/MWh
Danish nearshore (Vattenfall)	Denmark	350 MW	Sep. 2016	2020	$73/MWh
Kriegers Flak (Vattenfall)	Denmark	600 MW	Nov. 2016	2021	$57/MWh
Borssele 3 and 4 (Shell, Van Oord, Eneco, Mitsubishi)	Netherlands	700 MW	Dec. 2016	2021	$62/MWh

Source: Global Wind Energy Council, Global Wind Report 2016

EUROPEAN OFFSHORE WIND COST-DRIVERS

Many developers have given considerable credit for the maturation of the OSW industry to the UK "FID Enabling for Renewables" program, which awarded contracts for difference (i.e., developers realized a fixed price and received supplemental payments when the market price was less than the guaranteed price) to five developers.[8]

Key cost reductions included better financing terms for developers, supplier cost cuts to respond to increased competition, and technological improvements, particularly increased turbine and rotor sizes that are capable of producing more MWh/MW.

A 2014 survey of European OSW executives showed optimism that costs would fall in coming years.[9] The survey showed that the 200 executives expect the cost of constructing OSW farms to fall from 4 million/MW in 2014 to $3.6 million/MW for projects beginning in 2018 and $3.1 million/MW for projects beginning in 2023.

International Renewable Energy Agency (IRENA) projects global offshore LCOEs to fall by 35% by 2025, relative to 2015 costs.[10] Figure 3 gives a current breakdown of OSW cost components.

The four areas of the supply chain with the most significant projected cost reductions are equipment installation (expected to fall 6.6% in 5 years), foundation manufacturing (6.1%), turbine tower production (5.4 %), and blades (4.5%). There was less optimism that grid connection costs could account for significant cost reductions, with a 3.8% cost reduction anticipated. The top drivers identified to result in these capital cost reductions include economies of scale (71% believe it is a strong driver), deployment of higher-capacity turbines (68%), innovation in installation process (65%), a more experienced workforce (56%), and the emergence of dedicated OSW installation vessels (47%).

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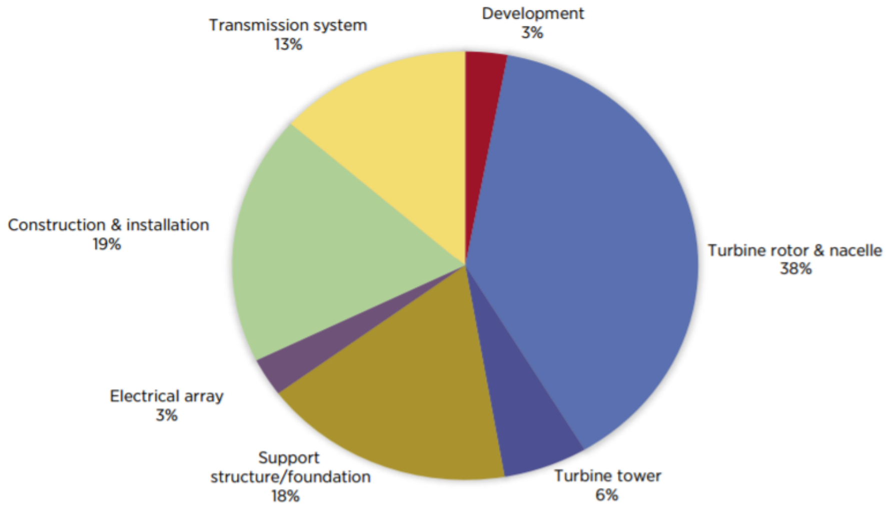
[7] July 2017 EUR/USD conversion rate of 1.14 used for this report

[8] KPMG, Cost Reduction Monitoring Framework, 2016

[9] Clean Energy Pipeline, Offshore Wind Project Cost Outlook, 2014

[10] IRENA, The Power to Change: Solar and Wind Cost Reduction Potential to 2025, 2016

Figure 3: Breakdown of OSW Capital Costs (2016)



Source: IRENA Renewable Cost Database and IRENA, 2016

As indicated by Figure 3, the cost of the turbine and turbine tower account for more than 40% of the total capital cost of an OSW project, so reductions in this area would have a significant effect on project costs. The top drivers of cost reductions in turbine and turbine tower production include realization of economies of scale including deployment of higher capacity turbines, technology innovation, cost reductions from development of industry supply chain, and new market entrants increasing competition.

Most executives agreed that further geographic concentration of the supply chain will reduce OSW costs, as this decreases transportation costs and fosters better communication between supply chain members.[11] This "clustering" strategy also allows for more robust project management and top-to-bottom collaboration on wind energy projects.

The respondents also provided input on government strategies for fostering innovation and investment in OSW. The top strategy, creating certainty in wind subsidy policies to encourage private sector investment, was rated "very effective" by 69% of those surveyed.[12] "If economies of scale are to have a major impact on cost reductions", states the Clean Energy Pipeline, "it is vital that governments across Europe provide clear long-term support for the offshore industry to encourage additional companies across the supply chain to invest."[9] Other strategies that were rated either "effective" or "very effective" included subsidizing wind pilot projects that deploy innovative technologies, encouraging the development of OSW hubs, giving direct grants to early-stage OSW technology companies, and funding R&D programs.

Offshore Wind Transmission Costs Falling

As overall costs of OSW fall, transmission becomes a larger proportion of total costs. Transmission accounted for about 8% of total OSW costs in 2006, but is projected to rise to 12-15% by 2020.

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[11] ibid
[12] ibid

A recent report examining per-MWh transmission tariff reductions in the United Kingdom from 2006 to 2020 concluded that tariffs have been and will continue to be in the $13-$16/MWh range, despite transmission distance increasing by nearly a factor of nine from 2006-2020.[13] This implies a reduction of 70% in dollar per-MWh per mile costs relative to projects that reached a final investment decision from 2006-2008.

There are three main reasons for these cost reductions. First, lower revenues relative to asset value (suggesting lower effective financing costs including possibly longer amortization periods for debt) for offshore transmission owners will lead to a 25% reduction in transmission tariffs. Second, higher wind farm capacity factors will enable a 30% cost reduction. Finally, increasing cable voltages from 132-150kV to 220kV created savings of 12-28% from economies of scale in two sample projects.[14] Beyond 2020, there is the potential for transmission costs to fall another 23%, with the help of technical advances in employing lightweight offshore substations and using transmission cables with large-conductors dynamically-rated at 275 kV.[15]

Developers can realize numerous benefits when they work together in a coordinated approach to develop transmission infrastructure, including cost reductions. Compared to an individual approach, coordination allows fewer asset installations, fewer landings, and overall cost savings in the range of 8-16%.[16] Other benefits include fewer environmental disturbances and reduced permitting complexity.

CONCLUSION AND TAKEAWAYS

Significant cost reductions are occurring in the European OSW industry, as it benefits from construction experience, development of the supply chain, and economies of scale. Technological improvements, including a new generation of turbines, which can produce up to 9 MW supports these cost reductions. Investor confidence is growing as the industry matures with new projects considered less risky. This is a positive sign for continued strong investment.

As the OSW industry continues to mature in Europe, other regions including North America, will be able to apply Europe's experience in reducing costs to boost their own nascent industries. Some of these cost reductions are readily achievable (e.g., utilization of larger turbines), while others require investment and maturation of the industry (e.g., development of the industry supply chain). The key to such development will be supportive government policies that provide long-term visibility regarding market development for industry participants to make the required investments. Thus, while the OSW industry in Europe is several steps ahead of other industries, it has paved the way for other regions to follow.

Power Advisory would welcome the opportunity to assist clients in assessing offshore wind opportunities in the United States, including the implications of European OSW cost reductions on the trajectory of the nascent North American market.

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[13] Offshore Wind Programme Board, Transmission Costs for Offshore Wind, 2016
[14] ibid
[15] ibid
[16] The Crown Estate and National Grid, Offshore Transmission Network Feasibility Study, 2011