McKinsey&Company

MAY 2017

© seanstein

Sustainability & Resource Productivity

Winds of change? Why offshore wind might be the next big thing

Falling costs and rising acceptance are promising signs, but the industry needs to keep improving.

Arnout de Pee, Florian Küster, and Andreas Schlosser

The landscapes of Rembrandt glow with the great painter's rendering of light. And they are distinctive for another reason: windmills are everywhere. As far back as the 13th century, the Dutch used windmills to drain their land and power their economy. And now, 800 years later, the Netherlands is again in the vanguard of what could be the next big thing, not only in wind power but also in the global energy system as a whole: offshore wind.

In December, the Netherlands approved a bid for its cheapest offshore project yet—€54.50 per megawatt-hour, for a site about 15 miles off the coast. Just five months before, the winning bid for the same site was €72.70. Denmark has gone even further, with an auction in November 2016 seeing a then record-winning bid of €49.90 per megawatt-hour, half the level of 2014.

Europe, which has provided considerable economic and regulatory support, accounts for more than 90 percent of global capacity. As a result, Europe now has a maturing supply chain, a high level of expertise, and strong competition; it is possible that offshore wind could be competitive with other sources within a decade. By 2026, the Dutch government expects that its offshore auctions will feature no subsidies at all. But it might be even sooner: in the April 2017 German auction, the average winning bid for the projects was far below expectations, and even less than the Danish record set only six months before. Some of the bids were won at the wholesale electricity price, meaning no subsidy is required.

Prices and costs

The industry still has a way to go compared with current costs: the levelized cost of electricity (or LCOE, a metric that incorporates total lifetime costs and expected production) for an offshore park installed in 2016 is expected to be €120 to €130 per megawatt-hour, about 40 percent more than onshore wind in comparable regions and 20 percent more than solar photovoltaics (PVs). Conventional sources, such as coal and gas, are currently even cheaper in many locations.

The technology thus still comes at a premium. Costs are higher because building at sea requires more materials for foundations and piles, while rough weather conditions make installation and maintenance expensive. Offshore wind parks also require expensive connectors to the inland transmission network.

While prices for all renewables will continue to drop, offshore wind is at an earlier stage of development, so its prices can be expected to fall further, faster, thus improving its competitive position. According to McKinsey research, when different wind farms are made comparable by normalizing for water depth, site preparation, subsidies, and other factors, this is already happening (exhibit).

One caveat: these are prices, not actual costs. Until the parks are actually built and running, it is impossible to know if they can be profitable at these prices. But companies would not be competing so fiercely—the Dutch auction saw 38 bids—if they didn't think they could be.

Offshore wind has a number of advantages that can help to compensate for its higher costs. Specifically, it can be sited near densely populated coastal areas, where land can be costly, and its higher wind speeds produce more power per unit of capacity. Offshore also complements solar PV, because it produces well in winter when load is highest, creating a stable production profile, day in and day out, throughout the year. Offshore wind produces at 35 to 55 percent of capacity, versus 10 to 20 percent in the Northern Hemisphere for solar PV. Finally, the not-in-my-backyard (NIMBY) effect is considerably less when the nearest turbine is miles away at sea. However, when offshore parks are not placed far enough offshore, NIMBY can become an issue, with complaints of visual or horizon pollution.

Factors outside the industry's control, including low interest rates and low steel prices, have played a major role in cutting costs. But so has better technology, especially the trends toward larger turbines and greater durability. Larger turbines harvest more of the wind, which make them more efficient. For many years, 3- to 4-megawatt turbines were standard; now 8- to 10-megawatt models are common, and by 2024, 13- to 15-megawatt models will likely hit the market. This reduces the cost per megawatt. Even as turbines have become larger, they have also become better. In the 1990s, the expected lifetime of offshore wind parks was only 15 years; now it is closer to 25 years, and new sites project an operational lifetime of 30 years.

One final piece of good news: as investors get more comfortable with offshore wind, financing risk premiums will come down.

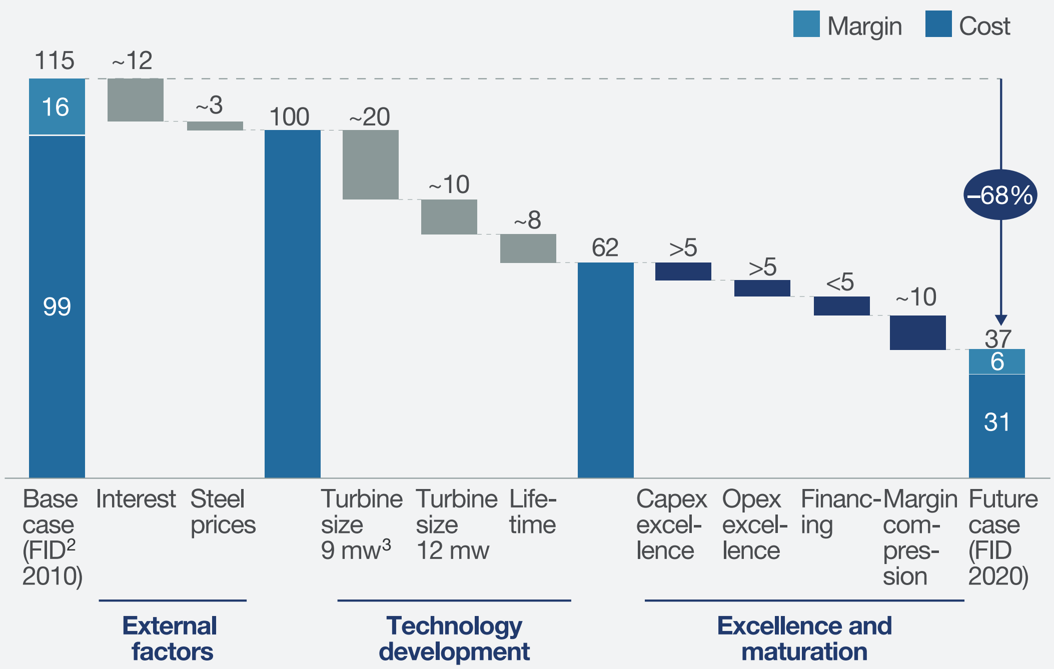
Room for improvement

The offshore wind industry is still in the process of growing up and becoming more professional. There are a limited number of fit-for-purpose suppliers and vessels, for example, and owners, contractors, and subcontractors are still learning how to work together. There aren't that many industry

Exhibit

Cost declines in offshore wind are being driven by external factors, technology development, and excellence.

Potential levelized-cost-of-electricity path, €/mWh,[1] normalized



[1]Megawatt-hour.
[2]Final investment decision.
[3]Megawatts.

Source: Jens Hobohm, et al., *Cost reduction potentials of offshore wind power in Germany,* a joint report from the Fichtner and Prognos, 2013, prognos.com; *Cost reduction options for offshore wind in the Netherlands FID 2010-2020,* TKI Wind op Zee (TKI Offshore Wind), October 2015, tki-windopzee.nl; McKinsey analysis

McKinsey&Company

professionals who are experienced at completing offshore wind projects, and as parks get bigger, the need for such expertise is greater.

Scale itself will help. With more offshore farms being built, the economics of scale are beginning to emerge, in both logistics and along the supply chain, including such things as sharing crew transfer vessels, helicopters, and coordinating jack-up barges across assets and operators for major component replacements.

For offshore wind to fulfill its considerable potential, it needs to raise its game everywhere. The most promising opportunities are in design, procurement, and execution; operations; and innovative financing.

Engineering, procurement, and construction

Value-focused design involves working with all stakeholders, internal and external, to systematically identify technical improvements and value-creation opportunities. For example, the developer and supplier can get together to define the minimum technical solutions, ruthlessly eliminating high-cost, low-value specifications. Design optimization is another possibility. The standardization of components and designs across a single offshore wind site, or a fleet of them, reduces the costs of construction, installation, follow-up engineering, and debugging. Manufacturers can then use modular techniques to adapt to specific situations in a cost-efficient way.

Contracting and procurement could add up to 5 to 10 percent in cost savings. Contracting strategy begins with understanding exactly what is expected of the contractor with respect to technical delivery and added value, the complexity of engineering, and fit with the design requirements. Based on a rigorous risk assessment, the developer seeks the best delivery model and pricing structure and optimizes the contract terms to be consistent with this strategy. By brainstorming with the candidate contractors, then assessing their risk profiles, one onshore wind company saved at least 15 percent on the final proposals.

Applying procurement-excellence tools, such as clean-sheet costing, and creating a clear "package procurement" road map, can help to find the right price for the right product. At several companies, this rigorous purchasing approach has translated into 15 to 20 percent price reductions in the procurement of turbines.

By their nature, offshore wind platforms are costly to build, so improving project execution offers another avenue to cut costs, by 3 to 5 percent. Integrated performance management ensures that data is collected and shared throughout the project—from the owner to all the suppliers and all the subcontractors. Lean construction comprises a set of principles, operating practices, and methods that improve execution while minimizing waste. In offshore wind, examples include reducing delays in preparing foundations and increasing standardization in the assembly of components.

Operations and maintenance

Offshore wind developers vary widely in their operations and maintenance performance. The best drive down costs while maintaining high availability and safety standards; the rest tend to focus on availability and do not pay enough attention to costs. We estimate that for many projects, improved operations could translate into savings of as much as €10 per megawatt-hour in LCOE. Improved operations start with the relentless application of advanced analytics to improve predictive maintenance, condition monitoring, and component replacement.

Second, operators should establish flexible work contracts for offshore sites that are difficult to access, share technicians across sites, and find the right balance between internal and external technicians to contain labor costs while maintaining quality. Size and proximity to other parks does matter. Building new vessel-logistics concepts such as service-operation vessels, and sharing technicians and fleet with other sites (as done in the offshore oil and gas sector) adds a third opportunity to reduce costs.

Financing

McKinsey analysis shows that a one-percentage-point decrease in the cost of capital brings a 5 to

10 percent improvement in LCOE for renewables. To realize this advantage requires investors having a thorough understanding of the real risk profile that offshore wind assets have compared with other renewable or infrastructure assets.

Another way to reduce financing costs is to make the sector more attractive to a broader group of investors. Offshore wind investments are relatively "chunky," requiring hundreds of millions of euros per park, and "illiquid," meaning they are difficult to sell without incurring high transaction costs. To overcome these challenges, other asset classes have devised alternative structures, such as publicly traded or private YieldCos; these have had their challenges but can still be attractive. The industry could also consider new structures, combining features such as publicly listed versus private structures, single asset versus broader portfolios, and single-technology focus versus cross technology.

Reasons for optimism

The world's first wind farm began operating in 1991: the Vindeby project featured 0.45-megawatt turbines. As of 2017, there is more than 14 gigawatts of cumulative installed capacity worldwide.

Other markets have taken note of Europe's progress and are putting into place supportive regulation. China has made offshore wind part of its five-year energy plan. Korea, Poland, Taiwan, and a number of other countries are also considering offshore wind as part of their future energy mix. For example, a major project off the northeast coast of the United States is in the works.

Although in some areas of the world the LCOE of offshore wind may never become at par with, say, solar PV, the value it can bring—as less-intermittent baseload power generation near urban demand centers, offsetting supply deficits from solar PV in winter—can make it a valuable addition to the energy mix.

These brighter prospects have also led to increased interest from oil and gas companies, which are increasing their exposure to the sector. Offshore is a natural fit with their expertise in engineering and in executing complex energy projects in offshore locations.

Offshore's considerable potential would be further enhanced if floating wind platforms could become cost competitive. Fixed-foundation wind parks have to be sited in relatively shallow waters; floating ones could be placed in deeper areas, farther from land, and could open additional markets. There is considerable research going on, with the first floating wind farm being built off the coast of Scotland.

Fast growth, increased investment, bigger parks, falling costs, and new technologies and markets: these are the trends that are defining the offshore sector. Put it all together, and it is fair to conclude that the wind is at the industry's back. ■

Arnout de Pee is a partner in McKinsey's Amsterdam office, **Florian Küster** is a consultant in the Hamburg office, and **Andreas Schlosser** is an associate partner in the Munich office.

The authors wish to thank Nikki Oude Elferink, Marte Guldemond, Jan Koeleman, Florian Kühn, Johannes Lüneborg, Nico Schnackenberg, and Marco Weber for their contributions to this article.