LCOE in the US Offshore Wind Market

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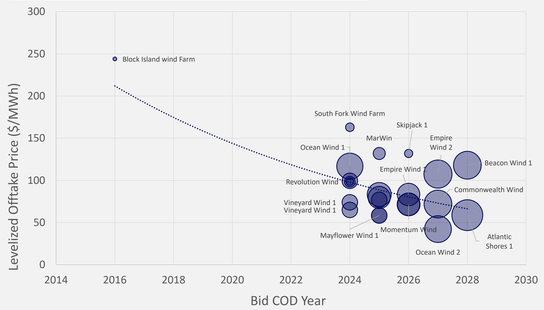
Background

Offshore wind (OSW) costs in the US market have evolved from early projections predominantly based on European markets, to relatively certain estimates as early mover projects mature. But future forecasts remain challenging to predict. Innovation, project scaling, competition, the recent Inflation Reduction Act (IRA), and a maturing US OSW market offer downward cost pressures, however, recent supply chain challenges and macroeconomic pressures drive external headwinds across the energy sector.

This poster highlights the key drivers that will determine the Levelized Cost of Energy (LCOE) trajectory of the US OSW market and how they will impact the industry over the coming years.

Levelized Offtake Price Trend, US Northeast



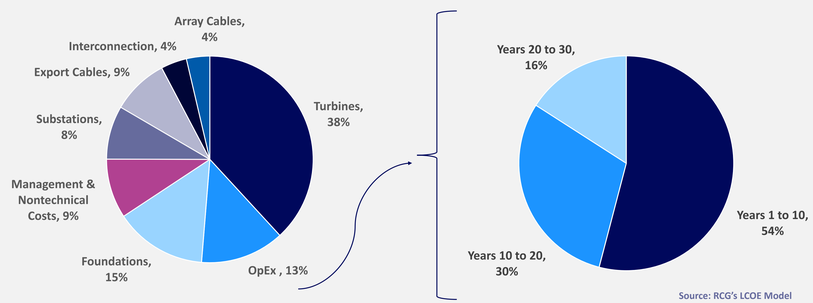
Bubble size represents project size (MW)

Source: DOE Offshore Wind Market Report: 2022 Edition

Downward LCOE Pressures

1. **Larger Turbines –** In RCG's experience, larger turbines do not lead to savings via reduced turbine supply costs directly, but rather via downstream balance of plant (BOP) savings and improved performance. Turbine size has historically improved LCOEs in three ways. Firstly, it has improved capacity factors through reduced wakes and higher hub heights. Secondly, it has enabled downstream CapEx savings due to reduced number of BOP assets to install. Thirdly, it has driven OpEx declines on a per-MW basis given the fewer number of units to maintain.
2. **Technology Innovation –** In addition to larger and more efficient turbines, innovations in foundation design, transmission and cable technology, operations and maintenance (O&M), and installation techniques have culminated in cost savings and operational improvements that drive down LCOE. Key cost-reducing innovations expected in the future include improvements in HVDC technology (larger scale, higher voltages), higher voltage array cables, and several areas of innovation in floating foundation and electrical system design and manufacturing.
3. **Project Scale –** Greater economies of scale help reduce costs by diluting fixed costs, improving purchasing power during procurement, and improving execution efficiency. These forces are particularly important in the US market due to the high degree of fixed costs from international vessel mobilization and lump sum contributions to local supply chains.
4. **Competition for Offtake –** Competition among developers and between supply chain partners is a key underlying force driving CapEx and bid price declines globally. High competition drives cost innovation and puts pressure on developers and suppliers to maximize design and supply chain efficiency.
5. **IRA Incentives –** The IRA offers several incentives that will benefit the offshore wind industry. Key subsidies include the 30% Investment Tax Credit (plus available 10% adders for domestic content, energy communities, and low-income communities), advanced manufacturing credits for manufacturers for turbine components and OSW vessels. These incentives will uplift developer returns and bring down costs faced by ratepayers but are not expected to directly reduce the unsubsidized technical LCOE of US OSW. Indirectly, however, the IRA's acceleration of project and supply chain growth will bring down OSW's LCOE as the market continues to mature.
6. **Market maturation –** Early movers in the US OSW industry have faced higher costs while they navigate the technical, regulatory, and commercial novelty of the US market. Future projects can leverage these investments and find efficiencies in procurement and contracting approaches to speed up project development and bring down costs. Specifically, we expect reductions in the levels of port investments, international vessel mobilizations, project management and DevEx costs, shipping costs, and premiums charged by OEMs.

Discounted Cost Profile, US Offshore Wind



Source: RCG's LCOE Model

Conclusions

As downward and upward cost pressures continue to shape the market, there remains substantial room for long-term LCOE declines in the US offshore wind sector. Many of the cost headwinds are a product of near-term market forces, whereas the downward cost pressures promise to reduce LCOEs for decades to come.

- **Recently**, projects have observed CapEx increases, with sites in mature development most exposed market volatilities–offtake prices are set while costs and contracts are not yet secured. Further, first-mover offshore wind projects in the US have seen unpredictable budget fluctuations to due to a lack of fixed designs or contracts.
- **Near term**, strong competition in the Northeast, IRA incentives, and lessons-learned from first-movers promise competitive offtake prices in the coming few years. But rapid demand growth plus the uncertain trajectory of macroeconomic forces are expected to put pressure on LCOEs for CODs in the mid-late 2020s until market volatilities subside.
- **Medium term**, US OSW LCOEs are dominated by three forces:
  - Whether or not macroeconomic volatilities subside
  - The growth of the global and US OSW supply chain
  - Key technical innovations expected in turbines and HVDC systems.

  Regardless of market conditions, the IRA promises to lower costs to ratepayers while driving domestic investments in the OSW industry.
- **Long term**, technical innovations, policy incentives, and market maturity suggest competitive OSW prices across the US East Coast. Prospects for continued LCOE declines nationally are partially offset by two key upward cost pressures: (1) the move to deeper water and/or lower wind-resource offshore wind sites, and (2) growing interconnection and grid upgrade challenges, increasingly supported by state-led initiatives.

The core strategy to ensure the lowest possible LCOE from OSW remains the same: set clear long-term targets and policies, foster competition among developers and down supply chains, and maximize project size and deployment. The coming few years remain uncertain as market conditions find a new normal, but in all, long term tail winds and strong ambitions paint a promising picture for the LCOE future of US offshore wind.

Why LCOE?

***What is LCOE*:** the present value of lifetime costs divided by the present value of lifetime energy production. In other words – the average net present cost of electricity generation over a plant's lifetime.

***Why LCOE is a valuable tool*:** LCOE is an effective tool for communicating normalized lifetime costs across different projects and technologies. It enables developers, investors, and governments to scrutinize the forces driving offshore wind costs achieved in recent years and expectations for the future buildout of the US market. It lets us cut through commercial differences between markets that otherwise make it difficult to compare across technologies, offtake mechanisms, and complex financial environments.

$$LCOE = NPV\left(\frac{Sum\ of\ lifetime\ costs}{Sum\ of\ lifetime\ energy}\right)$$

$$LCOE = NPV\left(\frac{DevEx, CapEx, OpEx, AbEx}{Lifetime\ generation}\right)$$

$$NPV_{AEP} = \frac{AEP_0}{(1+.06)^0} + \frac{AEP_1}{(1+.06)^1} + \cdots + \frac{AEP_t}{(1+.06)^t}$$

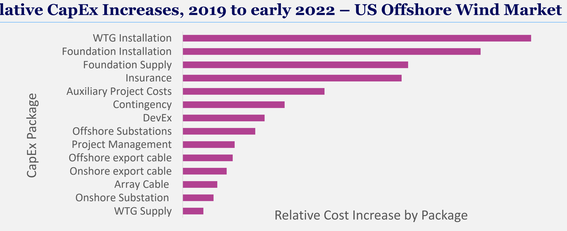
$$NPV_{AEP} = \frac{AEP_0}{1} + \frac{AEP_1}{1.06} + \cdots + \frac{AEP_{30}}{5.74}$$

Strengths	Weaknesses
+ Ability to 'normalise' projects and technologies	- Can be misinterpreted or falsely conflated with offtake prices
+ Widely accepted internationally and easy to communicate	- Results are only as strong as the underlying assumptions
+ Considers full lifecycle costs and energy generation	- Excludes detailed financing and commercial considerations
+ Efficient to estimate – not reliant on detailed financial modelling	- Best for high level assessments – challenging for detailed optimization

Cost Headwinds

1. **Immature Project Budgets – *historical* –** Early estimates of US OSW costs were based on projects that lacked a detailed design and executed contracts, leading to high uncertainty. Because these early estimates were largely based on European norms, they tended to underestimate actual costs observed in the market as project plans refined. Therefore, CapEx appeared to be "going up" simply due to project maturation. With projects now reaching FID, future estimates will be based on higher certainty values informed binding contract offers. This knowledge will be increasingly baked into future auctions and may lead to cost conservatism as many past auctions took place before developers had a firm sense of US market costs.
2. **Recent Market Volatilities – *short term* –** The supply chain and inflationary crisis that has unfolded due to Covid-19 and the geopolitical tensions between the US, China, Russia and Europe has put pressure on offshore wind capex costs. A key underlying feature of these costs increases is volatility in raw materials (commodities) prices, which have now fallen from observed highpoints. Some vendors have reported component cost increases of 10-25% which are passed onto customers. Over the past twelve months, these forces have led to CapEx increases for projects in mature development (in late-stage contract negotiations).
3. **Demand Outpacing Supply – *medium term* –** A surge in demand for renewable energy globally has exacerbated pinch points in the OSW market, especially given economy-wide supply chain disruptions. This high demand has caused vendors to increase fees, and/or reduce or remove contractual commitments once considered standard in the industry. Rapid global OSW growth is expected to drive up demand for turbines, cables, vessels, and foundations by up to 300%+ above current global levels. Investments in fabrication facilities and vessels will be critical to meet demand and ensure competition among suppliers. OEMs may be in strong negotiating positions with multiple projects vying for production slots. This demand, the investments needed to scale production, and the "big three" OEMs' recent financial struggles may lead to elevated contract prices or eroding of TSA protections over the coming years.
4. **Rising Interest Rates – *medium term* –** In addition to cost and energy generation, discount rates are a critical determinant of LCOE. Commercial scale OSW is financed by a combination of debt and equity investments, each of which are sensitive to the broader financial environment. Rising interest rates may increase the cost of debt for OSW developers looking to secure project finance or corporate loans. Fortunately, the US financial sector has been eager to deploy capital for OSW, but, a 1% increase in discount rates results in a roughly 10% increase in LCOE, so the potential impacts remain high from rising capital costs.
5. **Site Location – *long term* –** LCOE is inherently location-specific. The trajectory of OSW LCOE in the US will be ultimately a function of which lease areas are developed when. As early lease areas are built out, new projects will shift further offshore (within the Northeast) and towards other regions. Many of these new regions (West Coast, Carolinas, Gulf of Mexico, Gulf of Maine, etc.) show lower wind speeds and/or deeper waters, placing upward pressures on LCOE.
6. **Onshore Grid – *long term* –** As OSW market penetration grows, available coastal grid capacity will be consumed by early-movers. Long term LCOEs will depend on state and power market plans for the grid upgrades necessary to accept GWs of OSW power. Developers are expected to bear some share of these costs, though exact investments are unknown and vary by market structure.

Relative CapEx Increases, 2019 to early 2022 – US Offshore Wind Market



Source: RCG's Experience

References

1. US Department of Energy, Offshore Wind Market Report: 2022 Edition
2. RCG US market experience
3. RCG's LENS ™ Offshore wind LCOE model

Contact Information

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