Status of US Offshore Wind Projects: A 2023 Scorecard

by

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December 2023

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Introduction

The Biden administration has made offshore wind a centerpiece of its plan to achieve net zero greenhouse gas emissions by 2050. In March 2021 it set a target of having 30 GW (30,000 MW) of offshore wind in operation by 2030[1] with a pathway to 110 GW by 2050. To provide financial incentives to attract developers, a series federal tax credits were enacted, culminating with the passage of the Inflation Reduction Act (IRA)[2] in 2022 which provided Investment Tax Credits of up to 50% of the capital cost of a project.

In response seven northeast states have committed to goals totaling over 42 GW (42,730 MW) [3] by 2040. This includes New Jersey (11,000 MW by 2040), New York (9,000 MW by 2035), Massachusetts (5,600 MW by 2030), Rhode Island (1,430 MW), Connecticut (2,000 MW by 2030), Maryland (8,500 MW) and Virginia (5,200 MW). In support of those goals, the various states have enacted legislation which provides for subsidized guaranteed rates for offshore wind to be paid to developers over a contract period (typically 20 years).

These guaranteed offtake prices for payment for MWHs produced are set forth in contracts or orders from state public utility commissions and generally increase over the term of the contract at a fixed annual escalation rate of 1-3%.

Beginning in 2017, those seven states have awarded contracts for more than 20 GW of offshore wind projects to be built in lease areas offshore in the nearby Atlantic Ocean. Most of these projects were procured in competitive solicitations in which price was one consideration along with commitments to in-state economic development.

Offshore wind requires substantial upfront capital investment and so these projects are very sensitive to interest rates, inflation and supply chain support which can affect construction costs and schedules and financing terms. The favorable macroeconomic environment in 2018-2021 led developers to sign contracts at increasingly lower subsidized prices in the expectation that capital costs would be below $4000/MW[4] and that developers could finance these costs and still meet investment targets of 10-12% for their Internal Rate of Return (IRR)[5]. Those projections have proven extremely optimistic as higher inflation, rising interest rates and supply chain issues have driven capital costs up by more than 50% to $6000/MW[6] over the period 2021-2023 and has adversely affected many of the projects. This is now threatening to derail the goals of the states and the Biden White House for offshore wind.

Table 1 below provides the status of all the projects proposed and approved to date across the seven states, along with their builders, their proposed dates and the Levelized Cost of Energy (LCOE) embodied in their state approved contacts for power.

TABLE 1 -STATUS Of US OFFSHORE WIND PROJECTS
(December 2023)

Project	Capacity (MW)	Builders	State	Award Date	Commercial Operation	Estimated LCOE ($/MWH)	Notes
Block Island Wind	30	Orsted	RI	2010	2016	$ 244.00	(a)
CVOW	12	Dominion Energy	VA	2018	2020	$ 780.00	(b)
Vineyard Wind 1	400	Avangrid/CIP	MA	2019	2024	$ 93.00	(c)
Vineyard Wind 2	400	Avangrid/CIP	MA	2019	2024	$ 83.00	(d)
South Fork Wind	132	Orsted/Eversource	NY	2017	2024	$ 180.00	(e)
Revolution Wind 1	704	Orsted/Eversource	CT/RI	2018	2026	$ 98.73	(f)
Coastal Virginia Offshore Wind	2587	Dominion Energy	VA	2022	2026	$ 77.00	(g)
Skipjack Wind 1	120	Orsted	MD	2017	2025	$ 157.43	(h)
Skipjack Wind 2	846	Orsted	MD	2021	2026	$ 103.54	(i)
Marwin 1	248	US Wind	MD	2021	2026	$ 157.43	(h)
Momentum Wind	809	US Wind	MD	2021	2028	$ 94.36	(j)
Atlantic Shores Wind 1	1510	Shell/EDF	NJ	2021	2028	$ 106.18	(k)
Attentive Energy 1	1400	Total Energies/Rise/Corio	NY	2023	2030	$ 145.07	(l)
Community Offshore Wind	1300	National Grid/RWE	NY	2023	2030	$ 145.07	(l)
Excelsior Wind	1300	CIP	NY	2023	2030	$ 145.07	(l)
Empire Wind 1	816	Equinor/BP	NY	2019	2026	$ 118.38	(m)
Sunrise Wind 1	924	Orsted	NY	2019	2026	$ 110.37	(n)
Beacon Wind 1	1230	Equinor/BP	NY	2021	2027	$ 118.00	(o)
Empire Wind 2	1260	Equinor/BP	NY	2021	2028	$ 107.50	(p)
Southcoast Wind 1	404	Shell/EDF/ENGIE	MA	2020	2028	$ 88.13	(q)
Southcoast Wind 2	400	Shell/EDF/ENGIE	MA	2020	2029	$ 88.13	(q)
Ocean Wind 1	1100	Orsted	NJ	2019	2026	$ 116.75	(r)
Ocean Wind 2	1148	Orsted	NJ	2021	2029	$ 98.40	(r)
Commonwealth Wind	1223	Avangrid	MA	2021	2027	$ 98.40	(s)
Park City Wind	804	Avangrid	CT	2019	2025	$ 79.80	(t)
Revolution Wind 2	884	Orsted/Eversource	RI	2023	2030	??	(u)
Total	21,991				Source: Whitestrand Consulting LLC		

Operating	42 MW	FID Pending	7533 MW
Under Construction	932 MW	On Hold	4230 MW
Final Investment Decision (FID) Taken	3291 MW	Cancelled	5963 MW

Notes

(a) Pilot Demonstration Project
(b) Regulated Utility Pilot Demonstration Project
(c) $74 PPA (2017$) escalated @ 2.5%/yr plus estimated market value of NE-ISO capacity payments
(d) $65 PPA (2017$) escalated @ 2.5%/yr plus estimated market value of NE-ISO capacity payments
(e) Blended $137 PPA (2017$) escalated @ 2%/yr
(f) RI PPA $98.425 for 400 MW; CT PPA $99 for 200MW and $98.25 for 104 MW
(g) Regulated Utility Project LCOE Net of PTC and REC credits
(h) $131.9 PPA (2012$) escalated @ 1%/yr
(i) $71.61 PPA (2012$) escalated @ 2%/yr
(j) $54.17 PPA (2012$) escalated @ 3%/yr
(k) $86.62 OREC (2028$) escalated @ 2.5%/yr
(l) Price subject to adjustment for inflation and interconnection costs
(m) PSC denied requested 35% PPA increase to $159.64
(n) PSC denied requested 27% PPA increase to $139.99
(o) PSC denied requested 62% PPA increase to $190.82
(p) PSC denied requested 66% PPA increase to $177.84
(q) Projects cancelled with $60 million penalty
(r) Projects cancelled with potential forfeiture of $300 milion guarantees
(s) Project cancelled with $48 million penalty
(t) Project cancelled with $16 million penalty
(u) Rhode Island Energy rejected propsed PPA as being too expensive for ratepayers

Levelized Cost of Energy (LCOE)

A key parameter for any commercial energy project is its Levelized Cost of Energy (LCOE)[*] which is a useful metric for comparing the cost of different projects within or across technologies and time frames. Table 1 above shows the estimated LCOE for the US offshore wind projects that have been awarded contracts by the various states from 2017-2023.

These values are based on prices per megawatt-hour (MWH) for power produced and included in contracts for Offshore Renewable Energy Certificates (ORECs) or in Power Purchase Agreements (PPAs). Thus they are the primary source of revenue for the developer and determine the projected Internal Rate Of Return (IRR) for the project given its cost structure (equity, debt, O&M, etc.). This is the primary metric when making a Final Investment Decision (FID) on whether to proceed with a project from the planning/permitting stage to construction.

The LCOE values shown have been adjusted in some cases for additional revenues available to the project from sale of capacity or tax credits not embedded in the OREC or PPA prices.

In general, the OREC or PPA contracts require the return of revenue received from the sale of energy, capacity or Renewable Energy Certificated (RECs) in wholesale markets conducted by regional transmission system operators such as PJM, NYISO or the NEISO. Thus, they represent an offset to the LCOE contract prices to the ratepayer or consumer and have been estimated to have a market value of $50-60/MWH over the period 2026-2050. The difference between the LCOE in Table 1 and this market price represents the degree to which the project is being subsidized by ratepayers.

The following is a discussion of the projects in each of the categories in Table 1.

Operating (42 MW)

The only projects currently in commercial operation are the two small pilot demonstration projects – Block Island Wind (30 MW) and the Coastal Virginia Pilot project (12 MW). Both employ small 6 MW wind turbines and have been in operation since 2010 and 2016 respectively.

Their LOCE costs are much higher than feasible for any commercial offshore wind project but were considered acceptable due to their small size and their status as R&D projects, meant to gather experience in development, construction and operation of offshore wind facilities.

The Block Island windfarm has operated at about 41% capacity factor[7], below projections for large scale projects which are expected to deliver the equivalent of

[*] LCOE is calculated based on the Net Present Value (NPV) of the OREC or PPA revenues over the 20 year term of the contract divided by the NPV of the ORECs generated over the same period.

45-47% of rated full power. The project experienced several months of unplanned downtime in the summer of 2021 due to turbine blade stress fatigue and erosion exposing undersea cables.

The two turbine Virginia pilot project has operated at a 46% capacity factor since it began operating in 2021[8].

These very small pilot projects have proven relatively successful this far but, given their size and number, it is not clear how much they have in fact demonstrated that is relevant to the to the much larger turbines and sizes of wind farms being constructed or proposed.

Under Construction (932 MW)

As of the end of 2023 two projects were in active construction and nearing commercial operation. The Southfork Wind project has recently begun transmitting power to the NY grid from the initial turbine and offshore substation while the remaining units are completed. Thus it marks a key milestone in the progress of US offshore wind. At 132 MW (12 11MW turbines) it is a relatively small commitment with favorable economics for Orsted and Eversource, the project developers. With an estimated LCOE of $180/WMH[9] and access to the ITC of at least 30%, the developers are likely to achieve their expected returns within a relatively short period.

The larger 800 MW Vineyard Wind project is being developed for MA by a partnership of Avangrid and Copenhagen Infrastructure Partners (CIP). It is also nearing commercial operation which is expected in early 2024. This project has a much lower LCOE[10] which is comparable to prices for projects (Commonwealth and Park City) which Avangrid has cancelled due to cost concerns.

Presumably the Vineyard partners have secured more favorable financing terms which have allowed them to proceed here. Recently, they announced deals with for debt and tax equity financing that have made $3.5 billion available from large US banks[11]. In addition to the guaranteed PPA pricing, they also can retain revenues from sales of capacity to the NE-ISO grid operator. Although the resulting LCOE of $83-94/MWH appears to be below the minimum required to support a positive investment decision, there may be additional factors, including the desire to show a commitment to US offshore wind, in anticipation of much larger and financially more lucrative future projects, that may have contributed to the partners' decision to proceed.

Final Investment Decision (FID) Taken (3291 MW)

Only two additional projects have reached favorable decisions to proceed with investments on the part of the investors who are now committed to procurement of materials and services required to begin construction in 2024.

In October, Orsted and Eversource announced a favorable FID for the Revolution Wind 1 project to provide 400 MW to RI and 304 MW to CT beginning in 2026. This

project has an LCOE of $98.73[13] which also appears below the minimum currently required by investors. It is expected that the project will qualify for a 40% ITC which will add the equivalent of about $36/MWH to the LCOE value. On this basis, the project may marginally meet required investment criteria and in any event was sufficient to reach a favorable FID outcome.

The largest US facility under development is the Coastal Virginia Offshore Wind (CVOW) project. This involves 176 14.7 MW turbines capable of generating 2587 MW of power. Not only is it the largest, but the project is also unique in being developed as a regulated utility generating asset. The utility involved, Dominion Energy, has received approval from the VA State Corporation Commission (SCC) to pass costs through to state ratepayers while receiving return of 9.7% on prudently incurred capital investment.

Being a regulated project, CVOW is also the most transparent in revealing construction and operating costs which must be reviewed and approved by the SCC. The most current filing[14] indicates that Dominion projects a capital cost of $9.8 billion or about $3.8 million/MW. Based on this value and including forecast operating expense, Dominion has estimated the LOCE at $77/MWH. This value is net of the Production Tax Credit (PTC) and credit for sale of RECs which will be passed through to ratepayers. The value of these additional elements is estimated to be about $30/MWH so the all-in LCOE is about $107/MWH.

Like any utility project, costs may increase and still be passed through if deemed prudently incurred. The SCC has agreed that ratepayers will share increased capital costs up to $10.8 billion ($4.2 million/MW). Increases above that level would be borne solely by Dominion up to $13.7 billion ($5.3 million/MW) at which point the project would be reviewed again by the SCC. In addition, the project cost is capped by statute at $125/MWH in 2018$ or about $152/MWH in 2023.

In support of the project, Dominion has contracted for the construction of *Charybdis*, a Wind Turbine Installation Vessel (WTIV) to be built as the first such ship to be in compliance with the Jones Act which requires all vessels involved in moving material and passengers between US points to be US built and crewed by American citizens or residents. In addition to using *Charybdis* in its own project, Dominion has contracted it for use by other developers in US projects. Completion of the ship has been delayed, complicating supply chain issues for those projects while raising costs and has been cited as a factor in decisions deferring or cancelling some projects.

The conventional wisdom is that competitive bidding for projects by non-utility companies which are exposed to market economics produces lower costs to ratepayers. Given the comparison of CVOW costs and LCOE to that of other US projects being undertaken by experienced European developers, it appears that, at least in the case of Dominion Energy, the regulated model is proving superior. Much remains to be seen, however, if CVOW can be built as proposed.

FID Pending (7533 MW)

With the recent selection of projects by NY's Energy Research & Development Authority (NYSERDA), there are eight projects which are proceeding pending a final investment decision. The Marwin (248 MW) and Skipjack 1 projects were awarded ORECs in 2017[15] at an LCOE of $157.43. Skipjack Wind 2 (846 MW) and Momentum Wind (809 MW) in MD and the Atlantic Shores 1 (1510 MW) project in NJ received approved PPA or OREC prices in 2021[16]. These prices now appear to be below values required to support a favorable FID given their stage of development and cost increases from 2021-2023. In the case of Atlantic Shores 1[17], project developer Shell has indicated that a minimum short-term IRR of 6-8%[18] would be required for offshore wind projects to reach a favorable FID. Given current cost levels and financing conditions, an estimated 50% increase in its approved OREC pricing would be required to meet that hurdle rate.

The developers of these projects will in all likelihood try to negotiate higher LCOE prices or, failing that, seek to re-bid the projects into new procurements, if permitted by state authorities. FIDs for these projects are expected in 2024.

The remaining three projects comprise 4000 MW of awards announced by NYSERDA in November 2023[19]. While they have not yet received approval by the NY Public Service Commission (PSC), NYSERDA has indicated that the average OREC price of the chosen projects is $145.07/MWH. Under conditions of the procurement, this price is subject to adjustment to reflect inflation from award until approval of the project's Construction and Operations Plan (COP) by the Federal Bureau of Ocean Energy Management (BOEM) according to a set formula for material, labor and commodity indices[20]. The price may also be adjusted upward to reflect interconnection costs which will be passed through to ratepayers. It is likely therefore that the final LCOE will be in the range $150-160/WMH or higher. This in effect establishes a new benchmark for additional solicitations and awards to be announced in 2024.

On Hold (4230 MW)

Four projects (Beacon, Sunrise and Empire Wind 1 & 2) comprising 4230 MW that received NY PSC approval in 2019-2021 requested increases in their approved OREC prices in 2023[21], claiming that increased costs due to unforeseen higher inflation and interest rates and supply chain problems made the agreed prices of $107-118/MWH no longer viable. The proposed increases ranged from $140-190, or 27-66% higher than approved. In October the PSC denied these requests[22] on the basis that approval would be unfair to other developers who have had no opportunity to bid against the proposed adjusted pricing.

In response to the PSC ruling, NYSERDA has announced an expedited procurement for new capacity with bids due in January and selections in February 2024[23]. It is expected that Ortsed and Equinor/BP will submit new bids for their approved contracts. The short time frame will also allow additional bidders who failed to receive awards in the 2022 solicitation to bid into this new round as well.

Cancelled (5963 MW)

In 2023 six projects totaling more than 5000 MW were outright cancelled by the developers. As indicated on Table 1 their LCOEs averaged about $95/MWH. All were awarded in 2019-2020 and have been impacted by adverse macroeconomic developments and supply chain issues which have rendered them not investable at those approved OREC or PPA prices. Shell/EDF and Avangrid incurred cancellation charges of $16-60 million to vacate their contracts in MA and CT[24].

The most surprising and unexpected cancellation decision occurred on October 31 when Orsted announced[25] it was pulling the plug on its Ocean Wind projects in NJ. This decision followed a successful effort in June to secure an additional 18% ITC for Ocean Wind 1 (worth $1.2 billion) which was to have gone to offset rates[26]. The additional ITC was the equivalent of $23/MWH in LCOE revenue and 2-3% additional IRR. Despite this, Orsted indicated that supply chain issues, including delays on the availability of the *Charybdis* WTIV to support the Ocean Wind 1 construction schedule made the project no longer viable. They also cited failure to qualify for an additional 10% bonus ITC as a factor in the decision.

Just one month prior to the decision, Orsted was required to post $200 million in escrow for support of the Paulsboro, NJ wind manufacturing facility and a further $100 million completion guarantee. These monies were a condition of Orsted receiving the additional ITC money and subject to forfeiture in the event Orsted cancelled. The issue may now be the subject of litigation[27].

In July, Rhode Island Energy announced[28] that it was rejecting a proposal from Orsted/Eversource to build the 884 MW Revolution Wind 2 project. The proposed PPA cost was deemed "too expensive for customers to bear" and not in alignment with existing offshore wind PPAs. While the proposed pricing has not been disclosed, the fact that no negotiated PPA was achieved indicates that it was substantially higher than any existing LCOE, and well over $100/MWH.

Transmission Upgrade Costs

It is recognized that bringing large amounts of offshore wind power onto the grid will require major new installation and upgrades of both offshore and onshore transmission facilities including undersea high voltage cables, offshore and onshore substations and AC/DC converters, switchyards and underground and overhead lines through existing or new rights of way.

The initial offshore wind projects have been approved using radial connections between the offshore turbines and substations and an onshore Point of Interconnection (POI) and substation which transmits the energy into the grid for distribution to load centers. It has been acknowledged[29] that such a radial connection scheme involving many dispersed POIs is not optimal in terms of cost, reliability or environmental impact. State and regional transmission system operators in PJM, NY and NE have advocated integrated solutions up to and including the development of offshore transmission system "backbones" that would interconnect multiple offshore

wind farms with each other and with a limited number of onshore POIs capable of receiving large amounts of offshore wind.

Thus far in 2023, little actual progress has been made on such integrated solutions and all of the projects approved to date involve radial connections each with its own POI. The cost of these interconnections as well as gaining approval from the regional system operator is the responsibility of the project developer who will pass on some or all of the cost involved to ratepayers. In the case of Atlantic Shores 1, the added LCOE for the transmission system interconnection and upgrade has been estimated at $8/MWH or the equivalent of about $500 million in cost or $0.33 million/MW. This would be passed through to ratepayers as an addition to the approved OREC price, raising it to $114/MWH.

The cost in $/MW is expected to increase substantially with greater amounts of power and integration which would require new substations and lines and upgrading of existing lines and onshore infrastructure. On Long Island the construction of a new 20 mile 375 KV line to bring 3 MW of offshore wind power from the east end to the grid has been estimated at $3.3 billion[31] or $1.1 million/MW. Bids in NJ to accommodate 6400 MW of power through a single POI averaged $1.3 million/MW[32]. Studies of multi-state integrated offshore transmission systems along the Pacific coast range from $10 billion for 7.2 MW ($1.4 million/MW) to $42 billion for 25.8 MW ($1.6 million/MW)[33]. The cost of a similar offshore wind transmission backbone in the Netherlands has been estimated at $37.5 billion to accommodate 22 GW of power ($1.8 million/MW)[34].

Apart from the costs of upgrading and expanding the transmission system to accommodate the various state goals for offshore wind, the planning and approval process for executing those changes and allocating the costs fairly is fraught with potential delay from state and Federal regulatory agencies as well as resistance from various stakeholder interests who may object on economic or environmental grounds leading to litigation resulting in schedule and cost impacts which will prevent these targets from being realized.

Summary

For the nascent US offshore wind industry, 2023 has administered a dose of sobering reality. The heady days of 2019-2021, in which near zero interest rates and inflation, easy financing with political and public support, resulted in falling prices on contracts awarded for thousands of MW of offshore wind across the northeast. Despite the boost to such projects injected with the extra tax credits provided with the Inflation Reduction Act of 2022, more than 10,000 MW or half of these projects have been cancelled or stalled. Aside from Dominion's regulated project, developers have committed to construct only 1636 MW of capacity to come online well before end of the decade.

Table 2 below summarizes the goals and current status of projects by state showing those committed (in operation, under construction or having reached favorable FID) together with procurements for new capacity announced thus far for 2024.

Table 2 - Status of State Offshore Wind Projects

	Committed (MW)	Announced 2024 Procurements (Maximum MW)	Goal (MW)
Massachusetts	800	3,600	5,600
Connecticut	304	1,200	2,000
Rhode Island	430	1,200	1,430
New York	132	4,000	9,000
New Jersey	-	4,000	11,000
Maryland	-	NA	8,500
Virginia	2,599	NA	5,200
Total	4,275	14,000	42,730

As indicated, the ambitious goals of the seven Atlantic coast states remain just that, but it is clear that the goalposts have moved further out with much higher costs. The year 2024 will determine whether these aspirations for offshore wind can be met or will stall even further. We will have a clearer picture early in the year when NJ and NY reach decisions on up to 8000 MW of new or re-bid awards in January or February. Based on the prices in the most recent NY awards the LCOE for these new contracts are expected to be in the range of $150-160/MWH or higher after inflation adjustments up to 15% are applied.

As noted, the levelized value of the wholesale market price of power over the period 2026-2050 is estimated to be about $50-60/MWH[30]. Thus, the rate subsidy needed for these new awards could be $100/MWH or more. At that price, to get to the goal of 42.7 MW, the total rate subsidy would top $350 billion. Associated transmission system upgrades will add another $150 billion, so the total added cost of offshore wind in electric rates in the seven mid-Atlantic and northeast states could exceed a half trillion dollars and, based on results for NJ, raise average rates by more than 65% across the region[35].

With a growing public awareness of the rate impact of offshore wind and opposition being led by shore communities to the economic and environmental impact of offshore wind, it remains to be seen whether state leaders can muster the political will and support to bring these goals any closer to reality. Early in 2024 we may not have a final answer but we will have a good indication of which way the wind is blowing.

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The Author

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Mr. O'Donnell holds an M.S. in Nuclear Engineering from Columbia University and has been a licensed Professional Engineer in NJ. He is also a registered Enrolled Agent, authorized to represent individual and business entities before the IRS on tax matters.