



RENEW
Northeast

Offshore Wind Capital Costs for ORTP Calculation: A Proposed Amendment

Abby Krich and Alex Worsley, Boreas Renewables LLC
NEPOOL Markets Committee
September 8-10, 2020



www.renew-ne.org
Follow us: [@Renew_NE](https://twitter.com/Renew_NE)



About RENEW



The comments expressed herein represent the views of RENEW and not necessarily those of any particular member of RENEW.

Background: How We Got Here

- ISO has proposed to use \$5,876/kW (2019\$) for the overnight capital cost for Offshore Wind, which RENEW believes is far outside the range of reasonableness

	ISO	RENEW	Links
MC June 10	Proposed range of \$5,500-6,000/kW for the Offshore Wind Capital Costs	Met with ISO after MC and highlighted several publicly available reports which showed lower capital costs	June 10 CEA Materials
MC July 14-15	Refined estimate to \$5,876/kW	Presented findings of PPA analysis that showed implied capital costs for local projects of between \$2,300-3,700/kW (2019\$), in addition to more publicly available data that supports capital costs in this lower range	July 14-15 CEA Materials RENEW PPA Presentation
MC August 11-13	Released ORTP models with a more detailed cost breakdown. The preliminary ORTP calculated for OSW was \$58.88-59.05/kW-mo	Presented memo with more publicly available data and line item feedback on several elements of the capital cost assumption to support a lower cost	August 11-13 CEA Materials RENEW Memo RENEW PPA Model

Summary of RENEW's Concerns and Proposed Amendment

- ISO has proposed to use \$5,876/kW (2019\$) for the overnight capital cost for Offshore Wind, resulting in an ORTP of \$32.31-32.51/kW-mo
- RENEW believes that this capital cost assumption is significantly higher than commercial expectations
 - Based on RENEW's PPA analysis of current executed offshore wind contracts in NE and publicly available data from a wide range of sources
- ISO used a bottom up methodology for determining the capital cost assumption, but has not presented cost-based benchmarking that supports any element of that analysis or the final capital cost assumption
- RENEW is proposing an amendment to the final ORTP value based on a lower capital cost assumption (\$2,900/kW, 2019\$), bringing the final ORTP from \$32.31-31.51/kW-mo to **\$(3.92)-(3.71)/kW-mo**

Why RENEW Believes ISO's Capital Cost Assumption is High – Top Down Benchmarking

RENEW has primarily looked to two top-down methodologies for benchmarking ISO's capital cost assumption.

1. Literature Review

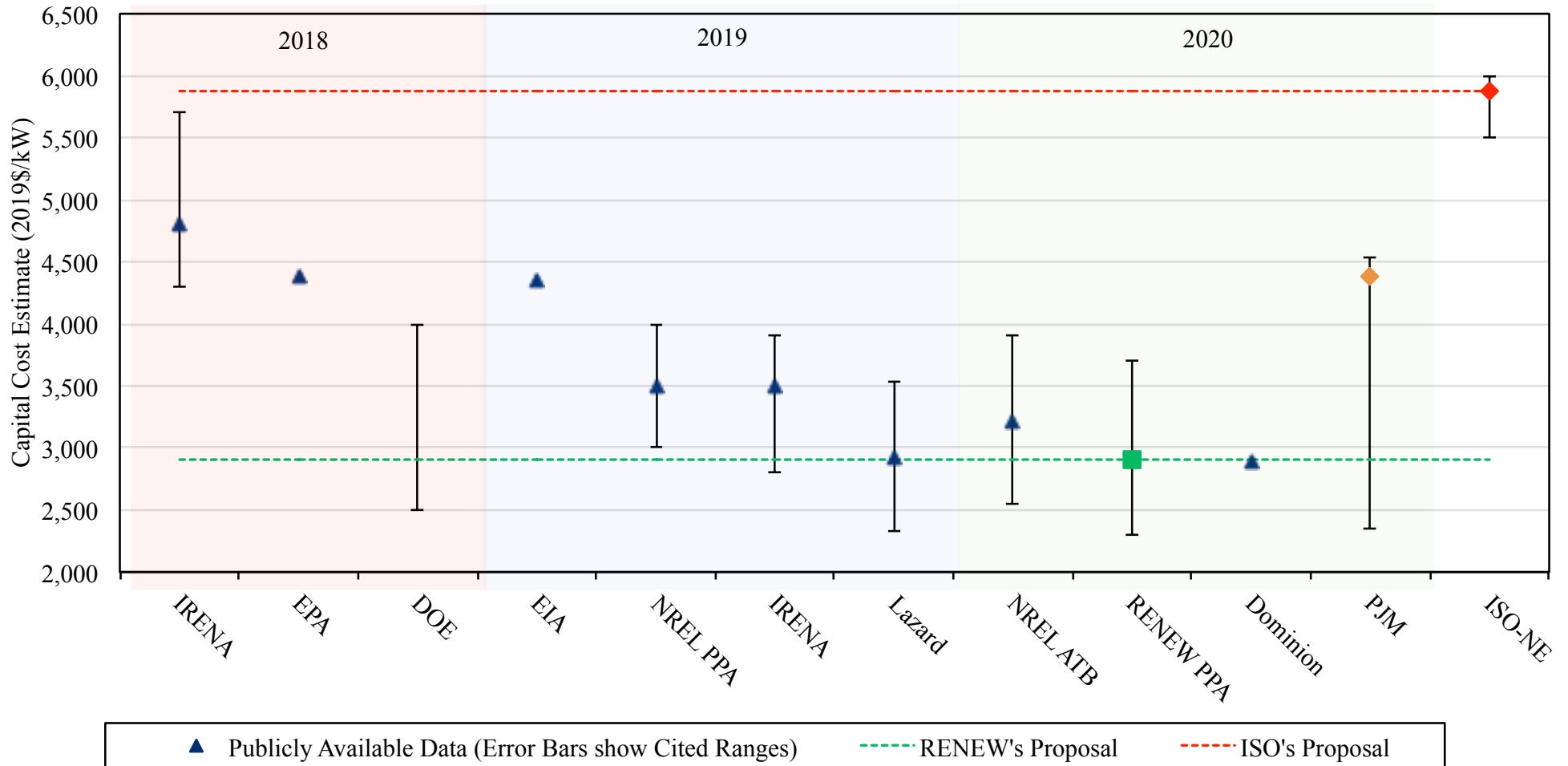
- RENEW has looked at a wide range of sources to gauge industry expectations for capital costs both globally and in the United States (NREL, Lazard, DOE, IRENA, EPA, EIA, Dominion, and PJM)
- While any one of these numbers should not be explicitly used in ISO's calculations, they provide a benchmark for the reasonable range of where the final value should land

2. PPA Analysis

- RENEW conducted its own research into capital cost assumptions current NE developers are using by looking at their executed PPA contract prices
- There is uncertainty in the analysis, but RENEW utilized what we believe to be reasonably conservative assumptions and sensitivities in a fully transparent analysis and has received no feedback regarding any inappropriate assumptions

A Review of the Publicly Available Data Regarding Offshore Wind Capital Costs

Publicly Available Offshore Wind Capital Cost Estimates



*Shaded bands indicate the year of the most current data used in the study

A Review of the Publicly Available Data Regarding Offshore Wind Capital Costs

	Source	Year Published	Representative Value (2019\$/kW)	Range (2019\$/kW)	Link
1.	IRENA: Renewable Power Generation Costs in 2018	2019	\$4,800	\$4,300-5,700	https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf
2.	EPA: IPM Platform 2018 Reference Case	2018	\$4,375	N/A	https://www.epa.gov/airmarkets/documentation-ipm-platform-v6-november-2018-reference-case-all-chapters
3.	DOE: 2018 Offshore Wind Technologies Market Report	2018	N/A	\$2,500 – 4,000	https://www.energy.gov/sites/prod/files/2019/09/f66/2018%20Offshore%20Wind%20Technologies%20Market%20Report.pdf
4.	EIA: AEO2020 Cost of New Generating Technologies	2019	\$4,356	N/A	https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf
5.	NREL Vineyard Wind PPA Analysis	2019	\$3,500	\$3,000-4,000	https://www.nrel.gov/docs/fy19osti/72981.pdf
6.	IRENA: Renewable Power Generation Costs in 2019	2019	\$3,500	\$2,800 – 3,900	https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019
7.	Lazard: 2019 Levelized Cost of Energy	2019	\$2,925	\$2,330 – 3,530	https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf
8.	NREL: 2020 Annual Technology Baseline	2020	\$3,213	\$2,541 – 3,900	https://atb.nrel.gov/electricity/2020/data.php
9.	RENEW PPA Analysis	2020	\$2,905	\$2,300 – 3,700	https://www.iso-ne.com/static-assets/documents/2020/07/a5_b_ii_renew_northeast_offshore_wind_capital_costs_and_rec_price_assumptions_for_orpt_calculation_rev1.pdf
10.	Dominion IRP	2020	\$2,894	N/A	https://www.dominionenergy.com/library/domcom/media/about-us/making-energy/2020-va-integrated-resource-plan.pdf?modified=20200501191108
11.	PJM: Recalculation of the Default MOPR Floor Offer Prices	2020	\$4,375	\$2,350 – 6,323	https://www.pjm.com/-/media/committees-groups/committees/mic/2020/20200228-mopr/20200228-item-03a-pjm-preliminary-cone-values.ashx
12.	ISO-NE	2020	\$5,876	\$5,500 – 6,000	https://www.iso-ne.com/static-assets/documents/2020/07/a5_b_i_cea_mm_presentation_cone_orpt.pptx

*Notes on the values presented in this table are included on the next slide

Notes on the Table of Publicly Available Data Regarding Offshore Wind Capital Costs

1. **IRENA**, Renewable Power Generation Costs in 2018: Of the European projects commissioned in 2018 that were 400 MW or larger (the largest one being around 550 MW) the capital cost range was \$4,300 - \$5,700/kW with a simple average of \$4,800 (2018\$). This comes from Figure 3.3 of the report.
2. **EPA**, IPM Platform 2018 Reference Case: As part of the EPA's Power Sector Modeling Platform v6 for 2018, the developed capital cost assumption for offshore wind with a vintage of 2025 was \$4,122/kW (2016\$) for a 600 MW project as seen in Table 4-16.
3. **DOE**, 2018 Offshore Wind Market Technologies Report: Citing reported project data, DOE suggested that they expect to see the gradual decline of CapEx costs to a range of \$2,500-4,000/kW between the years 2020-2030.
4. **U.S. Energy Information Administration**, Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2020: Table 1 shows the base overnight cost of \$4,356/kW (2019\$) for a 400 MW project that is not among the first four OSW units. Table 2 shows the regional adjustment of 1.0 for OSW in ISO-NE.
5. **NREL PPA**, The Vineyard Wind Power Purchase Agreement: Insights for Estimating Costs of U.S. Offshore Wind Projects: After the PPA price between the Massachusetts electric distribution companies and Vineyard Wind was published, NREL endeavored to calculate an implied LCOE for the project. As part of this calculation they estimated capital costs for the 800 MW project to be \$3,500/kW citing Bloomberg New Energy Finance and studied this number with a sensitivity of \pm \$500/kW.
6. **IRENA**, Renewable Power Generation Costs in 2019: Of the European projects commissioned in 2019 that were 400 MW or larger (the largest one being about 600 MW) the capital cost range was \$2800 - \$3900/kW with a simple average of \$3,500 (2019\$). This comes from Table 4-4 of the report.
7. **Lazard's** Levelized Cost of Energy Analysis – Version 13.0, November 2019: Slide 2, note 2 gives a capital cost range of \$2,330 - \$3,530/kW. Slide 10 note 1 gives an estimated midpoint capital cost of \$2,925/kW. Slide 17 shows the project size is 210 – 385 MW and includes a CapEx range of \$2,350 - \$3,550/kW due to rounding to the nearest \$50/kW).
8. **NREL, 2020 ATB**: National Renewable Energy Laboratory's 2020 Annual Technology Baseline (ATB): Offshore Wind Classes 1-7 are for fixed-bottom turbines with a capital cost range of \$2,491 to \$3,824/kW (2018\$) for the sum of the overnight capital cost (which excludes grid connection costs) and the grid connection cost for a 600 MW project with a 2025 COD. Class 6 is closest to the hypothetical ORTP project, with a moderate/expected cost of \$3,150/kW. Only Class 7 has a higher expected cost of \$3,152/kW.
9. **RENEW PPA**: Daymark Implied Offshore Wind CapEx Calculation. Summary presented to the NEPOOL Markets Committee at its July 14-15, 2020 meeting (agenda item 5.b.ii), spreadsheet with calculation details posted with the materials for the August 11-13, 2020 Markets Committee meeting (agenda item 4.a.iv).
10. **Dominion IRP**: The 2020 Integrated Resource Plan of Virginia Electric and Power Company, Case No. PUR-2020-00035, May 1, 2020, Appendix 5N lists an overnight installed cost of \$2,952/kW (2020\$) for three projects, each 852 MW, to reach COD in 2026 and 2027 (per Appendix 3B).
11. **PJM** presentation to the Market Implementation Committee, February 28, 2020, "Preliminary Default MOPR Floor Offer Prices for New Generation Capacity Resources", slide 4 gives an assumed capital cost of \$4,375/kW for a 400 MW project. Slide 14 lists the capital costs in each of the sources reviewed by PJM, ranging from \$2,350 - \$6,323/kW. PJM selected the second highest cost among the sources reviewed that represented a fixed-bottom turbine rather than a floating turbine (of the values reviewed by PJM, those above \$4,529/kW were for turbines on floating platforms and have therefore been excluded from the range shown in this presentation).

Note: All costs have been adjusted to 2019\$ using a 2% annual inflation index.

Why RENEW Believes ISO's Capital Cost Assumption is High – Bottom Up Benchmarking

- Interconnection Cost - \$70 million
 - This does not align with cost estimates in completed ISO-NE interconnection studies for projects almost identical to the proposed project
 - QP618 interconnection cost was estimated to be \$15.5 million (800 MW of offshore wind interconnecting to Brayton Point)
 - The average interconnection cost for the 13 offshore wind projects studied by ISO-NE is \$35.5 million
 - Only 3 out of 13 projects had interconnection costs of \$70 million or more.
 - Choosing the highest costs for projects studied by ISO-NE is not representative of what developers will typically face and should not be used in the determination of an ORTP
- The only detail ISO has provided on the remaining line item costs can be found on the following slide, where RENEW highlights what they believe to be more realistic estimates. These estimates were used to determine an adjusted capital cost which anchors RENEW's proposed amendment for the final ORTP for offshore wind.

RENEW's Proposed Amendment

- We believe \$2,900/kW is a more reasonable assumption for capital costs for offshore wind, based on the following bottom-up values:

	ISO's Estimate (2019\$)	RENEW's Proposed Adjustment (2019\$)
EPC Costs		
Offshore Substation Platform	465,000,000	226,480,000
Install Submarine Export Cabling	583,000,000	283,960,000
Construct Landfall Transition Box	134,000,000	65,270,000
Interarray Cabling	288,000,000	140,270,000
Major Equipment	2,333,000,000	1,160,000,000
Project Contingency	380,300,000	187,600,000
Total EPC	4,183,300,000	2,063,580,000
Non-EPC Costs		
Owner's Development Costs (Services)	217,000,000	107,040,000
Owner's Contingency	21,700,000	10,700,000
Electrical Interconnection	70,000,000	35,500,000
Financing Fees (4% of costs financed through debt)	167,332,000	82,540,000
Working Capital (1% of EPC)	41,833,000	20,640,000
Total Non-EPC	517,865,000	256,420,000
Total Cost (2019\$)	4,701,165,000	2,320,000,000
Total Cost (2019\$/kW)	5,876	2,900

RENEW's Proposed Amendment

- Using these costs in ISO's DCF model results in a calculated ORTP of $\$(3.92)-(3.72)/\text{kW-mo}$, resulting in an actual ORTP of $\$0.00/\text{kW-mo}$
- RENEW believes these values accurately capture commercial expectations for offshore wind capital costs and set appropriate expectations for offshore wind's participation in the FCM

	FRM Sunset & ISO ESI	FRM Sunset & NEPOOL ESI	FRM & No ESI
ISO's ORTP (2019\$/kW-mo)	\$32.308	\$32.358	\$32.515
RENEW's Proposed ORTP (2019\$/kW-mo)	$\$(3.916)$	$\$(3.865)$	$\$(3.708)$

RENEW's Proposed Amendment: Sample Redline

NEPOOL ESI and FRM Sunset

III.A.21.1.1. Offer Review Trigger Prices for the Forward Capacity Auction.

For resources other than New Import Capacity Resources, the Offer Review Trigger Prices for the ~~twelfth Forward Capacity Auction (for the~~ Capacity Commitment Period beginning on June 1, ~~2025~~2021) shall be as follows:

Generating Capacity Resources	
Technology Type	Offer Review Trigger Price (\$/kW-month)
Simple Cycle <u>e</u> Combustion t <u>T</u> urbine	\$6.3546 <u>503</u>
e <u>C</u> ombined e <u>C</u> ycle g <u>G</u> as t <u>T</u> urbine	\$9.1087 <u>856</u>
e <u>O</u> n- s <u>S</u> hore w <u>W</u> ind	\$0.000 <u>11.025</u>
<u>Offshore Wind</u>	<u>\$0.000</u>
<u>Energy Storage Device – Lithium Ion Battery</u>	<u>\$5.778</u>
<u>Photovoltaic Solar</u>	<u>\$11.014</u>



ISO's proposed changes are marked in blue.
RENEW's proposed changes are marked in red.

Questions?

Abby Krich

President, Boreas Renewables, LLC

krich@boreasrenewables.com

Alex Worsley

Boreas Renewables, LLC

worsley@boreasrenewables.com