APPUI EXTERNE RELATIF À L'A/O 2023-01 : APPEL D'OFFRES POUR L'ACQUISITION DE 1500 MW D'ÉNERGIE ÉOLIENNE

RAPPORT DU CONSULTANT MERRIMACK ENERGY GROUP INC.

FINAL REPORT OF Merrimack Energy Group, Inc.

12/7/2023

Benchmarking the Cost of Supplying Electricity from Wind Energy Resources Relative to Hydro-Quebec's 2023 Wind Call for Tenders

prepared by

MERRIMACK ENERGY GROUP, INC.
WWW.MERRIMACKENERGY.COM

Table of Contents

1. Executive Summary

Merrimack Energy Group, Inc. ("Merrimack Energy") was retained by Hydro-Quebec to undertake a benchmark cost assessment of the comparative costs of wind generated electricity resources in the Northeast United States ("US") and eastern Canadian markets relative to the costs of the proposals submitted to and selected by Hydro-Quebec in its distribution activities under its most recent 2023 Call for Tenders (A/O 2023-01) for Electricity Produced from Wind Sources ("2023 Wind Call for Tenders").

Hydro-Quebec is required, based on regulations, to demonstrate to the Régie de l'énergie du Quebec ("Regie") that the contract pricing from the Call for Tenders is competitive and represents lowest reasonable cost when compared with market options in neighboring markets as part of the contract approval process by the Regie.

This report serves as the benchmark assessment for calculating the competitive cost of wind generated electricity resources in neighboring markets to Quebec. Merrimack Energy completed a similar benchmark report for Hydro-Quebec in 2022, which was completed and submitted to Hydro-Quebec in February 2023 ("2022 Benchmark Report"). The results of the 2022 Benchmark Report were used to assess the competitive costs of proposals associated with the December 2021 Call for Tenders.[1] This report focuses entirely on our assessment of wind project costs in neighboring markets to Quebec.[2]

In the 2022 Benchmark Report, Merrimack Energy noted the significant increases in market prices experienced by most renewable resources, including wind project costs in 2021 and 2022, over the time period consistent with the submission of proposals into the 2021 Call for Tenders in mid-2022. Due to the volatility in market prices, Merrimack Energy has focused its efforts on the development of benchmark prices for wind resources that correspond as closely as possible to the timing for submission of proposals into Hydro-Quebec's 2023 Wind Call for Tenders, which is September 12, 2023.

To develop benchmark costs for the wind resources identified above, Merrimack Energy has utilized publicly available reports, generic market information based

---

[1] The December 2021 Call for Tenders included the 300 MW Renewable Energy Call for Tenders (A/O 2021-0) and the 480 MW Renewable Energy Call for Tenders (A/O 2021-01)

[2] This report provides an estimate of the benchmark costs for wind resources located in neighboring Northeast markets. For purposes of undertaking the competitive analysis of resources selected from Hydro-Quebec's 2023 Wind Call for Tenders, Merrimack Energy will add the transmission costs to deliver the power into Quebec from neighboring markets in the next phase of this assessment.

on projects proposed, and our knowledge of market trends for wind resources based on real-time market involvement as Independent Evaluator or Independent Monitor in a number of power procurement processes. This information has been used to develop estimates of the cost of power for wind resources in Northeast US markets and eastern Canadian markets.

For the 2022 Benchmark Report, Merrimack Energy prepared a sample of proposals based on contract prices or unit costs but also developed a sample of proposal costs based on capital costs for specific resource types and then calculated annualized costs using a capital cost recovery factor plus O&M costs divided by the capacity factor[3] of the resource technology for the applicable markets. For this 2023 Benchmark Report, Merrimack Energy intends to focus on updates to wind project costs since completion of the 2022 Benchmark Report but will apply the same methodology as noted above. Merrimack Energy's methodology is designed to calculate the Levelized Cost of Energy ("LCOE")[4] for wind resources as the initial calculation and then calculate the real levelized cost of energy consistent with Hydro-Quebec's input assumptions and methodology for evaluating proposals received through its 2023 Wind Call for Tenders. For projects in the United States, Merrimack Energy initially calculated the LCOE and real levelized cost[5] values in US dollars and then converted the cost streams to Canadian dollars, using Hydro-Quebec's projected exchange rates for Canadian and US dollars.

Table ES-1 provides a summary of the levelized cost of wind energy and real levelized benchmark costs in US and Canadian dollars for the wind resources considered and evaluated. As noted in this table, Merrimack Energy has provided a range of costs due to market volatility and increases in the cost of constructing wind projects. Merrimack Energy was able to compile a significant amount of data on US wind resource costs but was not able to find much real time data for eastern Canadian markets. As a result, the cost calculations rely heavily on US data and associated calculations of costs in northeast US markets. Merrimack Energy intends to expand our database of wind project costs from the 2022 Benchmark Report as a starting point. This report provides additional recent

[3] Use of capacity factors for generation resources in specific markets is important to appropriately evaluate the costs of these resources. For example, the levelized cost of solar PV projects would likely be much lower in western and southern US markets given the higher capacity factors of solar resources relative to the northeast where capacity factors for solar resources are much lower.
[4] The LCOE is a measurement used to assess and compare alternative methods of generating electricity. The LCOE of an energy-generating asset can be thought of as the average total cost of building and operating the asset per unit of total electricity generated over an assumed lifetime of the asset. The LCOE can be calculated by first taking the net present value of the total cost of building and operating the power generating asset. This number is then divided by the net present value of total electricity generation over its lifetime.
[5] Real levelized cost is based on the determination of the initial year price escalated by inflation that results in the same net present value of the stream of dollars generated by the LCOE calculation.

information on wind project costs and a detailed description regarding the basis for calculation of benchmark costs for wind resources.[6]

Table ES - 1: Summary of LCOE and Real Levelized Cost Calculations ($/MWh US and Cn$)

Resource Cost Assessment	Levelized Cost of Energy ($/MWh US$)	Levelized Cost of Energy ($/MWh Cn$)	Real Levelized Cost of Energy (2023 $/MWh US$)	Real Levelized Cost of Energy (2023 $/MWh Cn$)
Wind				
Capital Cost - $2,000/kW	$74.95	$97.43	$55.56	$72.23
Capital Cost - $2,250/kW	$82.21	$106.87	$60.95	$79.23
Capital Cost - $2,500/kW	$89.46	$116.30	$66.34	$86.24
New England LCOE	$76.77 - $81.77	$99.80-$106.30	$56.92 - $60.63	$74.00 - $78.82
New York LCOE	$76.77 - $94.40	$99.80-$122.72	$56.92 - $70.01	$74.00 - $91.01

In conclusion, Merrimack Energy believes that the range of real levelized costs noted in the last Column above are a reasonable starting point for assessing the benchmark costs of wind projects in neighboring power markets. The higher real levelized costs (in Cn$) of $86.24/MWh based on capital costs for new wind projects in the Northeast US represents a reasonable value for the LCOE in neighboring markets without the inclusion of production tax credit benefits.[7] Merrimack Energy believes the lower capital cost cases identified do not reflect current market conditions in the Northeast and the high capital cost case is more consistent with actual wind market costs in the Northeast. Merrimack Energy also believes the lower LCOE's for New England and New York, which are representative of Power Purchase Agreements ("PPAs"), compare favorably to LCOE values which represent proposals that have included all or a portion of tax benefits in their pricing. These values compare to the LCOE that would be derived

[6] For purposes of calculating the LCOE's for the three Capital Cost cases, Merrimack Energy relied upon inputs developed by the National Renewable Energy Laboratory ("NREL") for the discount rate (Weighted Average Cost of Capital or WACC) and the Capital Cost Recovery Factor as contained in the financial assumptions for the 2023 Electricity Annual Technology Baseline ("ATB"). Merrimack Energy relied upon the assumptions from NREL's Market Case from the 2022 Baseline Report for calculations of LCOEs for wind for the 2022 Benchmark Report and utilized the Market Case assumptions from the 2023 ATB for this report. As we will discuss later in the report, the 2023 ATB uses higher values for the WACC and the Capital Cost Recovery Factor, calculates the LCOE based on those assumptions and subtracts the value of Production Tax Credits ("PTC") of $17.62/MWh in US$. In addition, LCOE values for the Capital Cost cases assume a 2027 in-service date for these estimates and a 30-year contract term.

[7] Hydro-Quebec's 2023 Wind Call for Tenders requires bidders to submit proposals with the price of electricity it is offering without anticipating obtaining financial assistance. The 2023 Wind Call for Tenders document includes a description of the treatment of incentives should an incentive bonus be available. Given the Call for Tenders requirements, Merrimack Energy is also calculating the real levelized cost of energy with the exclusion of tax credit benefits, which results in a higher real levelized cost of energy. The first three rows of Table ES-1 reflect the levelized and real levelized costs excluding the benefits of tax credits.

based on subtracting the full value of tax credits (i.e., $17.62/MWh US$) from the LCOE calculated with no tax credit benefits included of $89.46/MWh US$, which would result in an LCOE of $71.84/MWh US$.[8]

2. INTRODUCTION

2.1 BACKGROUND & OBJECTIVE

Merrimack Energy Group, Inc. ("Merrimack Energy") was retained by Hydro-Quebec to undertake a benchmark cost assessment of the comparative costs of wind energy resources in the Northeast United States ("US") and eastern Canadian markets relative to the costs of the proposals submitted to and selected by Hydro-Quebec in its distribution activities under its most recent 2023 Call for Tenders for Electricity Produced from Wind Sources (A/O 2023-01), herein referred to as the 2023 Wind Call for Tenders. Hydro-Quebec issued this Call for Tenders on March 31, 2023. This Call for Tenders aims to acquire a block of wind energy with a targeted capacity of 1,500 MW from projects connected to the Hydro-Quebec integrated Network in the Eligible Zones identified in the Call for Tenders in order to meet the long-term electricity needs of Quebec markets. The Call for Tenders arises from the adoption by the Government of Quebec of Decree No. 285-2023. The guaranteed start dates for eligible electricity deliveries are December 1, 2027, December 1, 2028 and December 1, 2029. Bids were due on September 12, 2023.

The bidders can choose the duration of the contract, which must not be less than 20 years and must not be more than 30 years from the start of the electricity deliveries. A bidder may propose a project combining a wind farm with guaranteed power provided by an energy storage system ("ESS"). The ESS must be available every hour during the winter period, i.e., from December 1 of one year to March 31 of the following year. The energy associated with the guaranteed power must be able to be delivered for a minimum of 100 hours during this period. The ESS must at least be able to be used over a period of four consecutive hours.

Hydro-Quebec is required, based on regulations, to demonstrate to the Régie de l'énergie du Quebec ("Regie") that the contract pricing from the Call for Tenders is competitive and represents lowest reasonable cost when compared with

[8] Since the pricing for wind projects in New England and New York are based on PPA agreement there is no data available regarding the amount of the tax credit benefits flowed through in the prices proposed.

market options in neighboring markets as part of the contract approval process by the Regie. For this assignment, Merrimack Energy is required to provide two deliverables.

For the first deliverable, Merrimack Energy is required to update its 2022 Benchmark Study for Hydro-Quebec associated with benchmark costs for wind generated electricity as well as wind combined with energy storage costs,[9] if applicable, for wind projects located in the Northeast United States and eastern Canada. Merrimack Energy will present the comparison in Canadian dollars and in 2023 constant dollar prices. In addition, the results obtained should be adjusted to reflect Quebec's business, economic, and regulatory context, and document the main characteristics that differentiate North American Call for Tenders (or Request for Proposals) to those in the Quebec market.

Deliverable 2 requires Merrimack Energy to conduct a comparative cost assessment of the winning bids selected by Hydro-Quebec in its 2023 Wind Call for Tenders (A/O 2023-01) issued on March 31, 2023, relative to benchmark resources potentially available in northeast power markets, including the cost of transporting the power to Quebec and factoring in the Quebec business, economic and regulatory context. Hydro-Quebec wishes to obtain an assessment of the anticipated real unit cost (in real levelized $/MWh in Cn$) per originating renewable energy source as the basis for comparison.

Under its regulations, the Regie requires that Hydro-Quebec undertake a comparative analysis of the cost of power for similar products from neighboring Northeast power markets. The "similar products" standard is important to define in undertaking the benchmark study and can be identified to reflect project technology, size, product specifications, contract term, timing for the Call for Tenders and project in-service date. For example, as will be described in this report, a similar product standard should include size of the resource, timing of the solicitation process for Hydro-Quebec, and commercial operation date of the project, if possible. Based on continuing recent dramatic changes in electric power project costs resulting from such factors as: (1) supply chain constraints affecting the availability and cost of generating equipment; (2) project input commodity costs for a wide range of raw materials; required in the production process such as steel, copper, cement, etc.; (3) inflationary trends affecting labor and other costs; (4) increases in interest rates in the US and other markets which affects the cost of borrowing to construct such projects; (5) worldwide competition for renewable resources; (6) exchange rate impacts; (7) legislative and regulatory initiatives to increase subsidies for renewable projects; and (8)

[9] There were no wind combined with energy storage projects bid into the Call for Tenders. As a result, Merrimack Energy did not prepare benchmark cost assessments for wind combined with energy storage projects.

increasing interconnection and network upgrade costs, it is important that the cost of benchmark resources should be assessed in conjunction with Hydro-Quebec's timing for its Call for Tenders in which bids were due in September 2023 and projects are expected to come on-line in between December 1, 2027 and December 1, 2029.[10]

The timing for the comparative assessment based on September 2023 cost information presents unique challenges for collecting primary data for each market as the basis for comparison. For example, it is difficult to obtain data from publicly available studies without significant lags in data availability. However, some recent studies are now capturing some of the price increases for renewable resources dating back to the initiation of price increases beginning in 2021 and continuing through 2022 and into 2023. However, some studies completed in 2021 still show a projected decline in renewable project costs from 2021 and beyond based on a continued improvement in technology, essentially treating the recent cost increases as a temporary blip in the market. While that outcome may be the case over the long run, at this point in time it is difficult to assess when the cost factors driving the increases in wind and other renewable project costs will converge with increases in technology and the impacts from increases in tax incentives to stabilize and drive costs backs down. While the long-term cost trends may revert back to declining costs for a number of resources as several analysts predict, for the appropriate comparison of market costs to the costs of resources selected by Hydro Quebec through its March 2023 Call for Tenders for Electricity Produced from Wind Sources, it is required that consistent and reasonable information that reflect market conditions at that point in time when bids were submitted, evaluated, and selected should be utilized as the basis for comparison. Merrimack Energy will therefore present information on wind project costs in regional markets based on recent market activity as the basis for comparison.

As Independent Evaluator or Independent Monitor for a large number of Request for Proposal processes for renewable resources and energy storage projects in many regions of the United States, Merrimack Energy can attest to the significant volatility in project pricing for most renewable resources and storage projects (including wind and wind and storage) and the implications on power procurement activities, which have been driven by multiple factors as described above. Section 3 of this report will provide in more detail a description of the factors that have driven increases in wind power project costs and their implications on current and near-term future power markets.

---

[10] For this benchmark assessment, Merrimack Energy has calculated the real levelized benchmark costs based on a 2027 Commercial Operation Date ("COD").

Given the mandate of the Regie, Hydro-Quebec requires that the Merrimack Energy limit its analysis to the North American market, ideally the eastern Canadian provinces and northeastern US regions/markets. In undertaking the assessment in previous benchmarking studies for Hydro-Quebec in its distribution activities[11], Merrimack Energy also considered project size, location, technology, generation profile and capacity factors based on location. As an example of the importance of these factors in the analysis, it is often the case that the levelized cost of wind or other renewable energy projects based on contract pricing can differ due to different capacity factors for wind resources than would be realized in the US Northeast or eastern Canada, capital and operating costs for similar projects, and interconnection costs based on project location. Given the potential for very different Levelized Cost of Energy ("LCOE") values for projects in different markets based on localized factors, Merrimack Energy also proposes to use the capital costs of wind projects in Northeast markets as a starting point for assessing levelized cost or as verification of the levelized contract costs as an appropriate methodology.

The analysis undertaken by Merrimack Energy is intended to validate whether or not the costs of the wind projects selected by Hydro-Quebec for contract execution are competitive to similar resource options in other neighboring markets. [12].

2.2 Methodology for Preparing Benchmark Costs in Neighboring Markets

The methodology and workplan proposed by Merrimack Energy is generally consistent with the methodology used by Merrimack Energy in the previous Benchmark studies (including the recent 2022 report entitled "Benchmarking the Cost of Supplying Electricity from Renewable Energy Sources Relative to Hydro-Quebec's December 2021 Call for Tenders)[13] prepared for Hydro-Quebec in its distribution activities, including presenting cost estimates in constant Canadian dollars.[14]. However, Merrimack Energy will assess any updated wind project cost

[11] Merrimack Energy prepared and submitted at least seven reports on the competitive cost of electricity associated with Hydro-Quebec Call for Tenders between 2004 to 2015.

[12] For purposes of this analysis, Merrimack Energy will provide a range of costs for wind project based on several data sources, if possible, as representative of the most competitive projects which reflects a reasonable sample from which to compare the prices of the wind projects selected by Hydro-Quebec from the Call for Tenders processes.

[13] Hydro-Quebec also asked Merrimack Energy to prepare an assessment presenting the current pricing trends for wind-generated electricity as well as expectations for wind prices going forward as part of Hydro-Quebec's consideration of the potential for pricing associated with wind contract extensions.

[14] This methodology is often referred to as real levelized cost analysis, which is, in simple terms, the initial year cost of a project (i.e., 2027 if the project is expected to come on-line in 2027) which, when escalated by inflation results in the same Net Present Value ("NPV") as the cost stream proposed by the bidder. If the offer was submitted as a fixed price for the contract term, the Net Present Value of that cost stream could be compared to an "alternative" cost stream that calculates the initial year price escalated by inflation that results in the same NPV. The real

information developed in regional markets to update recent information provided. For example, in New York both developers of off-shore wind and on-shore renewable projects with executed contracts with the New York State Energy Research and Development Authority ("NYSERDA") for Renewable Energy Certificates ("RECs") filed petitions on June 7, 2023 requesting that the New York Public Service Commission authorize financial relief to renewable energy generators that have entered into contracts for Clean Energy Standard (CES) Tier 1 Renewable Energy Certificates (REC) and/or Offshore Wind Renewable Energy Credit (OREC) contracts with NYSERDA. NYSERDA awarded the Tier 1 REC, Tier 4 REC, and OREC contracts to the project developers among the Petitioners at the conclusion of competitive procurement processes conducted between 2017 and 2022. The current regulatory proceeding in New York highlights concern over the potential cost increases in these contracts and associated increases in rates, fairness of the increases and the implication on procurement processes, and concern over project failure if cost increases are not allowed, and the resulting impact on New York's clean energy goals.[15] Merrimack Energy will provide additional information from this proceeding that identifies potential cost increases for on-shore and off-shore[16] wind and other renewable projects, as well as recent information associated with interconnection queues and costs in New York and New England in a subsequent section of this report.

The methodology proposed by Merrimack Energy is designed to assess the competitive cost of long-term power from the winning bids from Hydro-Quebec's 2023 Wind Call for Tenders with general industry cost data as well as a sample of other similar project types proposed and under development in neighboring North American markets on a real levelized cost basis over consistent contract terms (e.g., 20 - 30-year contract terms for wind). The subsequent analysis will also include the cost of transmission from neighboring Northeast markets assuming the power would be purchased in the neighboring market and delivered to Quebec. In addition, Merrimack Energy will strive to use publicly available data inputs for each market as a primary source of data if available. If publicly available sources of data are not readily available, Merrimack Energy will attempt to correlate data in other markets with the data in question for the local markets and apply trends

levelized cost approach is effective for comparing costs of projects with different contract start dates and contract terms.

[15] The regulatory proceedings include "Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard" (Case 15-E-0302) and "In the Matter of Offshore Wind Energy" (Case 18-E-0071).

[16] While Merrimack Energy does not intend to include off-shore wind projects as part of the benchmark study, it is important to understand the factors affecting the cost of off-shore wind, many of which also affect the costs of on-shore wind projects including turbine cost and availability, raw material costs for wind projects, interest rates, interconnection and network upgrade costs, and supply chain considerations.

in costs to develop capital cost and other cost inputs and assumptions and apply the expected cost changes over time.

Merrimack Energy intends to supplement this information with information included in publicly available power project cost studies and competitive procurement processes,[17] and will also attempt to compile information on contracts for projects in each market or reported levelized cost information from recent studies for applicable markets.

Merrimack Energy has found in preparing such benchmark studies that use of only levelized cost of energy studies can be misleading based on differences in location, capacity factor, project size, contract term, and market cost structure. When capital cost information is available, Merrimack Energy will calculate the annualized costs associated with the amortization of the capital costs and add estimates of O&M costs and transmission costs for delivering the power from the select market into Quebec, assuming Hydro-Quebec could procure similar resources in other northeast markets and deliver the power to Quebec. Merrimack Energy would then rely upon data from other Call for Tenders or Requests for Proposals as a check on the reasonableness of the comparative costs generated. As we did in previous benchmark reports, Merrimack Energy will compare the costs of renewable or other projects bid into Hydro-Quebec's Call for Tenders with similar resources in New Brunswick, Ontario, Nova Scotia, New York and New England. Merrimack Energy will also address other factors in preparing the sample costs including tax credits and incentives in the US and Canada, capacity factor differences, and local conditions for adjusting benchmark costs.[18] We intend to conduct a similar assessment for this assignment.

As a starting point, Merrimack Energy has initially focused on developing a reasonable sample of similar projects as required based on the resource types selected by Hydro-Quebec in neighboring northeast markets. For developing the sample of project costs, Merrimack Energy has focused on cost information for recent projects (i.e., 2023 project costs) given the market volatility consistent with the timing of submission of proposals in response to Hydro-Quebec's 2023 Wind Call for Tenders. To develop the sample, Merrimack Energy has reviewed recent studies on renewable project costs, public information from trade associations and local sources regarding specific project costs, results from any local Call for Tenders ("CFTs") or Request for Proposals ("RFPs), regulatory filings and approvals

[17] Data from competitive procurement processes is generally confidential but average costs can be calculated without identifying project names or the specific procurement processes.
[18] In previous Call for Tenders, Hydro-Quebec in its distribution activities generally conducted a procurement process designed to procure a targeted resource (i.e., wind only, or biomass only). As a result, Merrimack Energy's previous benchmark studies focused on one specific resource type for comparison purposes. The technologies and resource types are much broader for this assessment.

for contracts submitted, and similar information. In addition, Merrimack Energy utilized bid data from recent RFPs to validate cost information as required. For example, while Merrimack Energy expects the capital cost and operating cost of renewable projects to be somewhat similar within the applicable North American markets, unit costs could vary much more dramatically between different markets based on local conditions. As an example, while we would expect that capital and operating costs for wind projects would not vary dramatically for projects in high-cost markets such as California or the northeast US (i.e., New England and New York), given that these markets are high-cost markets with labor markets dominated by requirements for union labor. These differences will definitely affect unit costs in the different markets, while capital costs would likely be similar.

The next step in the process for developing a sample of similar projects is to assess the implications of other factors which could influence the costs of different projects by region. This could include implications of tax credits in the US relative to Canada, labor costs and requirements, local or regional content requirements, initiatives to benefit local communities and First Nations in Quebec, cost of transmission between regions, project sizes as noted previously, expected capacity factors for projects in different markets, and other unique requirements in the various markets which could impact project cost comparisons. Our objective would be to control these factors as much as possible in preparing a sample of project costs as the basis for comparison. Table 1 below presents Merrimack Energy's perspective for how each of these factors may influence costs in each region relative to Quebec.[19]

Table 1: Cost Factor Considerations in Northeast U.S. and Eastern Canada

Factor	Considerations	Implications on Cost Comparisons
Climate	All Northeast markets would likely experience similar impacts regarding shorter project construction timeframes, capacity factors, peak period requirements and cost implications.	From a wind perspective, projects would appear to be smaller in the Northeast US and some other Canadian markets than the experience in Quebec. Larger wind projects would have some economies of scale. Limited land availability and reasonable access could impact the ability to construct large scale projects in the Northeast US. For this factor, we are generally assuming no significant difference or cost impact.
Labor costs	Labor costs are likely higher in all Northeast US and Canadian markets considered due to union labor requirements.	US markets may experience higher labor costs based on market structure and competition but no major differences. Differences are generally associated with comparison to other markets in the US such as Southwest or Southeast markets where

[19] Table 1 above was prepared originally for Merrimack Energy's 2022 Benchmark Study for Hydro-Quebec. It has been updated slightly and is included in this report as well.

		non-union labor is allowed and cost of construction and operations is lower. Merrimack Energy would expect that labor costs would not vary significantly between Quebec and other northeast markets.
Regional Market	Studies reviewed indicate that the cost of wind projects in Ontario are much higher than in the US. Certainly, tax credits can be one factor but it appears that market inefficiencies and regulatory issues could also have an impact.	For wind, we have assumed that all regional markets are similar with the exception of Ontario that appears to be a higher cost market for wind. As will be discussed later in this report, it also appears that the recent solicitation in Nova Scotia resulted in fairly low prices for wind projects selected. However, we would expect such power to be utilized in Nova Scotia and would not be available for export to Quebec at the contract price.
Local Sourcing Requirements	In several Call for Tenders, Hydro-Quebec has included a local or regional content requirement that bidders had to meet regarding the sourcing of inputs, equipment and labor.	Merrimack Energy would expect that local and regional requirements would result in higher costs for projects, particularly in cases where equipment is in short supply and supply chain issues are present. Assume 5% cost disadvantage.
Involvement of Local Communities and First Nations	Merrimack Energy consulted to Hydro-Quebec on Call for Tenders which allocated capacity to local communities and First Nations. As we recall, the project costs were more diverse but that on the whole project costs were generally higher for those projects associated with local communities and First Nations. Nova Scotia's 2022 RFP apparently included involvement of First Nations organizations in the projects, which may contribute to lower costs resulting from tax benefits or lower cost of capital.	As Merrimack Energy recalls from previous Hydro-Quebec Call for Tenders that involved local communities there was a range of costs, some higher and lower than broader Call for Tenders. Slightly higher costs are likely to result due to the additional requirements which may limit market participation.
Topography	For Northeast US markets for wind, the best projects are generally in mountainous areas away from population centers. The topography likely results in higher cost construction in these areas.	Due to the topography overall in the Northeast, we would expect that costs for construction and operations would be higher due to the topography relative to other markets such as Texas and the Southwest US with mesas and flat lands that are conducive to wind project development at a lower cost and the benefits associated with a large amount of available land for project development. One of the other important issues associated with topography in northeast US and Canadian markets is the cost of constructing transmission facilities to connect the projects to the utility system.
Tax Credits	US markets for wind, solar and other renewables as well solar combined with storage have enjoyed Production Tax Credits and Investment Tax Credits for a	In the US, the rules and regulations for accessibility to the available tax credits under the Inflation Reduction Act are still being developed. While we have recently

	number of years. The recent Inflation Reduction Act has extended and expanded tax credits for renewables and has also added an investment tax credit for standalone storage. US projects have had an advantage over Canadian projects which have not had tax credits but that may be changing given recent discussions in Canada about adopting tax credits for renewable resources.	seen in trade publications that tax credits are being considered in Canada, we are not certain of the potential impacts. The tax benefits associated with renewable energy projects depend on how competitive the market is and what percentage of the tax credits are passed along to utility customers or retained by the project developer or tax equity participants.
Limited Interconnection capacity	This is an issue that every region generally experiences. In the Northeast US, the presence of large offshore wind contracts could absorb much of the available interconnection capacity and result in significant costs for system expansion. The most economic wind projects in New England and New York are in the northern tier areas where system access may be limited	Merrimack Energy expects no difference because all regions are likely affected by interconnection constraints. Major cost differences are primarily dependent on project location within the transmission system.
Scale of the projects	There are generally smaller scale wind projects in the Northeast markets for the most part with the possible exception of Quebec and Ontario. New York has also experienced a limited number of larger projects for wind, but not of the level consistently seen in other states or Provinces	The scale of projects is generally affected by the available land for such projects and the topography that supports the highest levels of output for the technology.

As noted above, in developing Merrimack Energy's benchmark reports for previous Hydro-Quebec Call for Tenders, Merrimack Energy not only prepared a sample of proposals based on unit costs but also developed a sample of proposals based on capital costs and then calculated annualized costs using a capital cost recovery factor that reflected the market cost of capital initially for consistency purposes. Merrimack Energy's methodology is designed to calculate the LCOE[20] for each resource type as the initial calculation and then calculate the real levelized cost of energy consistent with Hydro-Quebec's methodology. For US projects, Merrimack Energy will initially calculate the LCOE and real levelized cost[21] values in US dollars and then convert to Canadian dollars using Hydro-Quebec's projected exchange rates for Canadian and US dollars. We intend to also include such costs for the purpose of preparing the project cost sample for this assignment.

[20] The LCOE is a measurement used to assess and compare alternative methods of generating electricity. The LCOE of an energy-generating asset can be thought of as the average total cost of building and operating the asset per unit of total electricity generated over an assumed lifetime of the asset. The LCOE can be calculated by first taking the net present value of the total cost of building and operating the power generating asset. This number is then divided by the net present value of total electricity generation over its lifetime.
[21] Real levelized cost is based on the determination of the initial year price escalated by inflation that results in the same net present value of the stream of dollars generated by the LCOE calculation.

In terms of developing the database for projects in other regional markets there are additional issues to keep in mind that could affect the evaluation. First of all, it is challenging for consultants to gain access to the results of Request for Proposals and Call for Tenders, particularly recent solicitations in neighboring markets consistent within the timeframe for Hydro-Quebec's Call for Tenders, since the data is generally confidential. A second factor of importance to consider, especially at this time in the renewable energy industry, is the implications of supply chain constraints, inflationary factors, and legislative and regulatory policy changes. It has been our experience that costs for wind, storage and solar resources have increased significantly since the middle of 2021. As Independent Evaluator, we are seeing project developers request higher pricing for their proposals during contract negotiations (or even after contracts have been executed and approved by regulatory agencies) as well as proposing indexed pricing, either for submitting proposals or as part of the contract negotiation process. Many projects are having challenges securing wind, storage and solar equipment in the current market, which is delaying the expected Commercial Operation Date ("COD") of the project and driving up costs. Combined with these issues is the recent increase in interest rates which are also driving up bidder costs and associated pricing due to increased financing costs.[22] As a result, one of our objectives has been to place similar resources on an equal basis when developing a benchmark analysis of pricing of these resources.[23] For this process, we also intend to rely upon actual proposals in other regions of the US and adjust the local market costs based on historical relationships to costs in the northeast markets as another data point for comparison. We have seen many cases in which government or other publicly available studies addressing pricing of various electric generation resources are out of date the minute they are released because the market has changed, and the study has not included the impacts of market volatility or pertinent changing market conditions. For a number of years costs for solar, wind and storage equipment and resource costs were flat or declining. However, that is not currently the case as virtually all factors are leading to an increase in cost of these resources.[24] The market is currently in an increasing cost state and one has to tread lightly regarding the reliance on

[22] Merrimack Energy has also seen delays in project development being affected by transmission constraints and interconnection challenges. However, these issues are consistent in all markets considered.

[23] Another trend we have observed is that mature projects that have been in the development process for some time will generally submit lower price bids while projects in the early stages of development are offering higher prices generally. It is our understanding that financial entities are concerned about multiple project risks associated with equipment procurement and costs, permitting, interconnection access and costs, and cost and availability of transformers and other equipment and as a result are requiring project sponsors to incorporate a risk premium in their pricing.

[24] Sellers are generally the beneficiary of declining cost markets since the seller will submit its proposal based on its expectations of equipment and EPC costs but may enjoy the benefits associated with continued cost declines once the seller executes contracts for such equipment.

such studies, although recent studies could add value as a starting point for incorporating adjustments in cost as Merrimack Energy has attempted in this report.

Finally, it is important to note that the recent passage of the Inflation Reduction Act ("IRA") in the United States is anticipated to have an offsetting cost impact for US projects based on the potential for higher tax incentives and other benefits which could potentially lower the cost of these resources for future projects. However, the details underlying this legislation, while evolving consistently are still not definitive and are creating some uncertainty on the part of developers. While the details are being worked out, the message we are hearing from bidders in power procurement solicitations is that there is still quite a bit of uncertainty how the rules regarding tax credits will be implemented.[25] Merrimack Energy will also address these implications once more market information becomes available. Table 2 presents a comparison of the recent tax credits in the US for wind, storage and hybrid resources compared to the proposed tax credits expected to be implemented through the Inflation Reduction Act.

Table 2: U.S. Renewable Energy Tax Credits Before and After Passage of IRA[26]

Tax Incentives by Resource Type	Previous Tax Incentives in the United States for Renewable Resources	New Tax Incentives from the Inflation Reduction Act
Wind	Up to $26/MWh US$ Production Tax Credit ("PTC") depending on the in-service date.	Projects will be able to choose the ITC or PTC. Both credits come with potential adders for meeting certain domestic requirements (labor and domestic content), located in energy communities, or for being a low-income property.[27] ITC could range from 24% up to 40% if special adders are reached. PTC starts at $26/MWh in US$ in 2024 and escalates by inflation each year.
Storage	No tax benefits	Standalone storage will be eligible for a 30% ITC and up to 40% with additional incentives including location, US equipment, and labor requirements.
Hybrid	Battery systems that are charged by a renewable energy system more than 75%	It appears that hybrid projects can receive tax credits for both the renewable system and the

[25] Merrimack Energy's experience in recent Request for Proposals is that pricing for renewable and storage resources are not yet declining with the passage of the IRA but are still increasing slightly.
[26] All costs reported in Table 2 are in US$.
[27] Labor requirements entail certain prevailing wage and apprenticeship conditions being met. To qualify for the domestic content bonus, all steel or iron used must be produced in the US and a "required percentage" of the total costs of manufactured products (including components) of the facility need to be mined, produced, or manufactured in the United States. An "Energy Community" is defined in the legislation as applying to a brownfield site or an area that has had energy production facilities closed and has an unemployment rate at or above the national average. Projects sited in an energy community are eligible for a 10 percentage point increase in value of the ITC (e.g., an additional 10% for a 30% ITC equals 40%) or a 10 percent increase in the value of the PTC.

	of the time are eligible for the ITC. Battery Systems that are charged by a renewable energy system 75% to 99.9% of the time are eligible for that portion of the value of the ITC.	storage component as well based on the individual benefits for each technology as provided through the IRA.

3. Current Conditions in Renewable Energy Markets in North America

3.1 Power Markets in the Northeast US and Eastern Canada

For the comparative analysis of costs of wind generated electricity, Merrimack Energy's objective is to update the database of generating resource options for wind projects in both the northeast US and eastern Canadian markets from the 2022 Benchmark Report. In the Northeast US this includes the New York ISO ("NYISO) and ISO New England (ISO-NE), the entities that operate the power market in New York and New England, respectively.

For eastern Canadian Markets, Merrimack Energy has assessed the Ontario, New Brunswick and Nova Scotia markets. While all three regions have experienced an increase in renewable generation, there is little available recent data on the cost of generating electricity from renewable resources in these three regions compared to the US. There does not appear to be much recent publicly available cost information and limited results from recent solicitations. Merrimack Energy has been able to find some cost information from specific wind projects over the past three to four years but we could find no information regarding the recent implications of increases in costs for wind generation resources. Merrimack Energy is providing the information we have gathered below in an attempt to inform our view of the cost of different renewable resources.

3.2 Market Costs & Structure in New York and New England

The Northeast US markets have a number of similarities regarding market structure, resource mix, procurement initiatives, and underlying resource characteristics. For example, both New England and New York wholesale electric markets are operated by an Independent System Operator ("ISO") – ISO New England and the New York ISO respectively. Both markets have a generation mix primarily dependent on natural gas, with renewable resources a small but growing component. Both regions can be classified as high-cost markets and regional areas with a heavy presence of union labor. Both regions have similar resource plans with a projected significant reliance on offshore wind to make up an increasing portion of the generation mix in each region going forward. Given the climate in each region, the capacity factors for wind and solar are lower than many other regions of the US. These factors will affect the levelized cost of energy calculations, which will reflect levels of output for wind projects.

From a policy perspective, both New York and Massachusetts (largest New England state) have common goals regarding reliance on renewable resources and emission reduction targets. For example, New York is pursuing a goal of 70% renewable energy by 2030 and the elimination of emissions from the state's electrical system by 2040. One of the major differences between Massachusetts and New York, however, involves how each of the states is addressing proposals for increases in contract pricing for large scale off-shore wind and other renewable energy projects.

S&P Global Market Intelligence prepared a series of articles on each ISO in the US, including articles on ISO-New England and NYISO in May of 2023 that provided a high-level review of generation activities in each region.

NYISO Market Information

For NYISO, the above S&P Global Market Intelligence article indicates that the NYISO will see the start of operations of the largest offshore wind facility in the US in 2023, the 132 MW South Fork Offshore Wind Project, being developed by Orsted and Eversource Energy. This project is one of several projects anticipated to start operations in 2023. Legislation approved in New York in 2019 targets the development of 9 GW of offshore wind resources by 2035. The ISO's only major planned power plant retirement is tied to the offshore wind target and the developers of the proposed project acquired a major gas facility in New York City with the objective of closing the facility down to repurpose the site as a converter station to interconnect their planned 1,230 MW Beacon Offshore Wind project beginning in the late 2020's.[28]

The report also includes a list of NYISO's current capacity, scheduled additions, and scheduled retirements. Table 3 contains the existing capacity by type, scheduled additions and proposed retirements.

[28] Equinor ASA and BP PLC acquired the Astoria Gas Turbine facility and retired the facility because it was at odds with the New York 2019 clean energy law and repurposed the converter station to interconnect their planed 1,230 MW Beacon Offshore Wind project.

Table 3: NYISO Capacity Mix and Scheduled Changes

Plant Type	2022 Capacity (MW)	Scheduled Additions (MW)[29]	Scheduled Retirements (MW)
Solar	1,289	1,986	0
Wind	2,145	984	0
Energy Storage	91	174	0
Oil	3,912	3	0
Biomass	470	2	0
Natural Gas	26,831	3	541
Other	10,064	0	0
Total	44,803	3,151	541

The report notes that to hit New York's goal of 70% renewable energy by 2030, the NYISO forecasts it will need 20,000 MW of new renewable capacity in operation. To hit the 2040 goal to eliminate emissions from the state's electric sector will require total installed capacity in the system to triple, bringing online at least 95,000 MW of new generation through new projects or modifications to existing plants. Overall, in 2023, the New York grid is scheduled to add 3,151 MW of capacity as listed in Table 3. Over the last five years, 2,600 MW of renewable and gas-fired generation have come online and 4,800 MW, including two nuclear units, have been deactivated. The report also notes that the NYISO also faces an interconnection backlog, with 475 active projects in the queue, nearly four times more than in 2018, when it had 120 projects in the queue.

The report also identifies the projects expected to come online in 2023. These are listed in Table 4.

Table 4: Larger Scale Renewable Projects Expected Online in 2023 in New York

Project Name	Developer	Type	Project Size (MW)
Big Tree Solar Project	ConnectGen	Solar	175
Franklin Solar Project	National Grid Renewables	Solar	150
Empire Solar Project	AES Corp	Solar	125
High River Energy Center	NextEra	Solar	90
Baron Winds Project	RWE	Wind	122
Eight Point Wind Project	NextEra	Wind	102
Deer River Wind Farm	Avangrid	Wind	101
South Fork	Orsted and Eversource	Wind	132

NYSERDA is the primary procurement entity for offshore wind and renewable resources in New York. NYSERDA's webpage contains a list of the Offshore Wind and Renewable RFPs NYSERDA has initiated and completed. NYSERDA issued a

[29] Scheduled additions exclude capacity in announced status, as well as select plants in early development stage with 200 MW and above capacity where the latest data is not available.

Request for Proposals to procure at least 2,000 MW of offshore wind resources on July 27, 2022. Proposals were due on January 26, 2023. Also, NYSERDA issued a Large-Scale Renewable RFP on September 21, 2022, seeking to procure approximately 4.5 million Tier 1 Renewable Energy Certificates ("RECS") from eligible facilities that enter commercial operations on or before May 31, 2025. To date, we have not seen any information about the results from these solicitations.

ISO-NE Market Information

According to the S&P Global Market Intelligence Report, in 2023 ISO New England expects to add 1,376 MW of new generating capacity, nearly all of which is renewable. New England is expected to retire only small amounts of the existing generation. The expected additions to capacity include 872 MW of solar, 170 MW of energy storage, and 126 MW of wind.

The report also noted that over the past decade, about 7,000 MW of mainly coal, oil and nuclear generating capacity has been retired or announced for retirement. Another 5,000 MW of coal and oil-fired capacity is at risk of retirement. These coal and oil resources have played a critical role in recent winters when gas supplies are constrained according to ISO-NE.

ISO-NE has also documented the change in resources in its interconnection queue. In June 2017, it said its queue was approximately 13,250 MW of generation capacity, about half of which was gas. In January 2023, the queue was 31,840 MW, about half of which was wind, with most of that offshore wind and most of the offshore wind supplying Massachusetts. ISO-NE also identified seven major transmission projects under development to bring power into New England load centers.

Similar to New York, New England intends to rely heavily on offshore wind as the primary long-term resource supply for the region. However, recently the progress for projects selected from RFPs in Massachusetts and Rhode Island has been hindered by high costs for projects that exceed contract pricing approved in several contracts. Two examples identified in a July 20, 2023 article in Utility Dive as well as recent information regarding other contracts in Massachusetts and Connecticut discussed in a October 4, 2023 article in Utility Diver provide an update on the status of offshore wind contracts in New England:

- The termination by Avangrid of their agreement with Eversource Energy, National Grid and Unitil for the company's proposed 1,223 MW offshore wind farm named Commonwealth Wind. Avangrid had requested that the Massachusetts Department of Public Utilities ("DPU") approve an increase in pricing citing higher interest rates, increased cost of capital, inflation,

supply chain constraints and associated price increases. The DPU sided with the utilities who refused to renegotiate the contract that was already approved by the DPU. Avangrid was required to pay the utilities $48 million in penalties if terminated;
- Rhode Island also announced that it would not move forward with a long-term PPA with Orsted and Eversource for their joint offshore wind project, the 884 MW Revolution Wind 2, calling it too expensive;
- It was announced in the October 4, 2023 Utility Dive report that Avangrid has filed settlements with Connecticut electric distributors, Eversource Energy, and United Illuminating that, if approved, would cancel the power purchase agreements for the 804 MW offshore Park City Wind project;
- Massachusetts regulators approved the termination of PPAs tied to the 1,200 MW SouthCoast Wind project, an offshore development by Shell New Energies and Ocean Winds North America at a termination cost of $60 million US$.

The project developers indicated that they would compete in the next offshore wind solicitation in Massachusetts, issued in 2023. Bids for Massachusetts fourth offshore wind solicitation are due January 31, 2024. Massachusetts is aiming to procure up to 3,600 MW via this solicitation.

As illustrated in Table 5, all states in New England, with the exception of Vermont, have targeted offshore wind to play a key role in meeting clean energy and decarbonization goals. Several states have offshore wind procurement targets which are key for meeting regional carbon emission reduction targets of 80% below 1990 levels by 2050.

Table 5: Clean Energy and Emissions Reduction Goals by State

State	Amount of CO2 Emission Reductions Targeted	Targeted Resources	Procurement to Date[30]
Massachusetts	MA statewide GHG emission limit – Net-Zero by 2050; MA Clean Energy Standard – 80% by 2050.	5,600 MW of offshore wind by 2027	3,241 MW of offshore wind contracted for including: (1) Vineyard Wind – 800 MW; (2) SouthCoast Wind – 804 MW; (3) Commonwealth Wind –

[30] Vineyard Wind was contracted in 2018 from the first Massachusetts Offshore Wind RFP. SouthCoast Wind was contracted in 2019 from the second Massachusetts Offshore Wind RFP. Commonwealth Wind and SouthCoast Wind residual were contracted in 2022 from the Third Massachusetts Offshore Wind RFP. The contracts for SouthCoast Wind and Commonwealth Wind have been terminated due to the fact that the original terms of the contracts are no longer viable because of inflation, rising interest rates, supply chain disruptions, and the impacts from the war in Ukraine. The project developers are expected to bid the projects into the May 2023 Massachusetts fourth offshore wind solicitation seeking to procure up to 3,600 MW.

			1,232 MW; and (4) SouthCoast Wind Residual – 405 MW
Vermont	VT Renewable Energy Requirement – 90% by 2050		
Maine	ME Renewable Energy Requirement – 100% by 2050; ME Emission goal – Carbon-Neutral by 2045	3,000 MW of offshore wind by 2040 based on a July 2023 procurement law.	11 MW as a demonstration project via a single floating turbine
Connecticut	CT Zero-Carbon Electricity Goal – 100% by 2040	2,000 MW of offshore wind by 2030	Connecticut has two active offshore wind projects in development: (1) Revolution Wind – 704 MW[31]; and (2) Park City Wind (804 MW)
Rhode Island	RI Renewable Energy Goal – 100% clean energy resources by 2033	1,030 MW of offshore wind	Rhode Island has procured 430 MW of offshore wind including: (1) Block Island Wind Farm – 30 MW (operational); (2) Revolution Wind – 400 MW.[32]

The third Massachusetts offshore wind RFP was subject to a price cap of $77.76/MWh nominal levelized (US$) as approved by the Massachusetts Department of Public Utilities. As noted above with regard to the discussion on Massachusetts, only one offshore wind project, the Vineyard Wind 800 MW project, is moving forward with a 2023 COD date.

While the Massachusetts DPU has rejected proposed price increases for offshore wind projects, New York is moving in a different direction. In New York, the Alliance for Clean Energy New York (ACE-NY)[33], Sunrise Wind LLC, Empire Offshore Wind LLC and Beacon Wind LLC (Empire/Beacon Wind), and Clean Path New York each filed petitions on or around June 7, 2023 in Case 15-E-0302 and Case 18-E-0071 requesting that the New York Public Service Commission (Commission) authorize financial relief to renewable energy generators that have entered into Clean Energy Standard (CES) Tier 1 Renewable Energy Certificates (REC) and/or Offshore Wind Renewable Energy Credit (OREC) contracts with NYSERDA.

[31] Revolution Wind is a 704 MW joint procurement with Rhode Island. Revolution Wind was contracted in 2018 and Park City Wind in 2019. Both have a COD date of 2025.

[32] Rhode Island Energy announced in July 2023 that it would not move forward with a long-term PPA with Orsted and Eversource for their joint offshore wind project, the 884 MW Revolution Wind 2 project, due to the expensive nature of the project.

[33] ACE NY petitioned on behalf of 86 Tier 1 projects in the NYSERD portfolio, which total 7.54 GW or 10% of statewide load.

The Petitions requested that the Commission authorize NYSERDA to modify the terms of existing and effective contracts that were executed following conventional procurement processes. Each Petition requests a one-time inflation adjustment mechanism as compensation for the effects of inflation and unexpected levels of competition for raw materials and equipment manufacturing capacity that the Petitioners claim have rendered contracted clean energy project development economically infeasible.[34] The offshore wind developers Empire/Beacon Wind and Sunrise Wind also requested incremental interconnection cost adjustments. Empire/Beacon Wind also requested a Consumer Price Index adjustment and extension of its contract term from 25 to 30 years. All Petitions requested that these cost adjustments be reflected in increases to the REC or OREC strike prices.

NYSERDA filed comments and a study in response to the petition by the above noted parties. NYSERDA noted that the three petitioners cited similar megatrends, including unforeseen inflation and supply chain bottlenecks, as the primary drivers of eroding renewable energy project economics and the underlying justification of the Petitions. The Petitioners claim that if the Commission were to provide no price adjustment, NYSERDA-awarded projects that are under development would not be economically viable and would be unable to proceed to construction and operation under their existing contract pricing. ACE NY contends that without a price adjustment, projects would be forced to cancel their existing contracts and either terminate development altogether or seek new contracts with higher pricing, either with NYSERDA or elsewhere. ACE NY further predicts that those projects that are able to successfully rebid into future NYSERDA solicitations would reach commercial operations much later than would occur without an adjustment. The offshore wind project sponsors also contend that without incorporating inflation and interconnection cost adjustment mechanisms into the OREC Agreement, Sunrise Wind (and others) believe it would not be able to obtain a final investment decision allowing it to fully construct the project. Sunrise contends that this would likely result in the project being delayed for several years and in higher eventual prices for replacement ORECs.

[34] NYSERDA's comments describe the proposed adjustments for each Petitioner. ACE NY, which addresses solar and onshore wind projects selected by NYSERDA, proposes price adjustment mechanisms for solar and onshore wind projects based on changes in technology-specific indices and interest rates. These proposed adjustments result in a significantly greater price adjustment than those that would result if the inflation adjustment formula in the 20222 Tier 1 solicitation, RESRFP22-1 (22T1) were applied. ACE NY wind price adjustment components include: PPI Industry Data for Electric Power and specialty transformer mfg; PPI Industry Data for Steel product mfg from purchased steel; PPI Industry Data for turbine and turbine generator set units mfg; PPI Industry Data for non-residential building construction; and PPI Industry Data for Cement and concrete product manufacturing.

NYSERDA conducted its own review and retained Industrial Economics (IEc) to also conduct a review of key factors affecting cost increases.[35] IEc identified the following conclusions from its report:

- Forecasts indicate that inflation will moderate, but remain positive over the next 10 years;
- Supply chain constraints threaten the financial viability of renewable energy projects;
- Renewable energy project costs will remain above pre-2022 levels until sometime during the 2025 – 2030 period, with the exact year dependent on the technology type. The onshore wind industry is expected to recover faster, with project costs returning to 2021 levels as early as 2025. Though technology and efficiency gains are lowering costs for offshore wind development over the long term, recent press reports and industry analysis provide strong evidence that supply of key components will not keep pace with global demand for offshore wind generation, which will increase costs in the sector through 2030.

NYSERDA conducted an analysis based on the Petitioners requests as well as an analysis of alternative price adjustments based on inflation formulas from the 2022 Renewable RFP. Based on the information presented in the Petitions, NYSERDA calculated the impact on strike prices of implementing the requested relief proposed based on the latest publicly available data for each applicable index. In addition, NYSERDA also considered the potential impacts of no price adjustments being provided.

NYSERDA noted that "if the renewable energy projects that are the subject of the Petitions are not economically viable under current conditions, providing no price adjustment whatsoever would result in a large amount of renewable energy generation needing to be re-procured in future solicitations (either from existing projects re-bidding or from new projects). This would significantly slow progress toward meeting the clean energy targets due to project delays, cancellations, and increased uncertainty, even if existing projects elect to re-bid into future solicitations. NYSERDA also believes that these dynamics create the risk of further increasing costs to projects and to ratepayers. In addition, the delays and cancellations would result in missed opportunities for reliability and resiliency benefits associated with new renewable energy generation, prolong the State's reliance on harmful fossil fuels for energy production, delay delivery of associated

[35] IEc defined the purpose of its report to inform NYSERDA's recommendations concerning the Commission's response to the Petitioners. The report provided an historical assessment of inflation and inflation forecasts between 2016 and the present, summarizes available forecasts of inflation over the next 10 years, and reviews petitions for inflationary relief in other jurisdictions.

economic benefits of such projects and hurt New York's ability to tap the scarce Offshore wind supply chain."

As noted above, NYSERDA conducted its analysis of cost increases based on the pricing formulas included in the 2022 Renewable RFP[36] (referred to as 22T1) as well as the results based on ACE NY's proposed adjustments based on its Petition. Table 6 below presents a summary of the results for the original strike price[37] from the wind projects selected in each renewable energy solicitation conducted by NYSERDA dating back to 2017 as well as the results based on ACE NY's requested adjustments and the results based on adjustments using the 2022 Renewable RFP adjustment mechanisms allowed.

Table 6: Tier 1 Estimated Levelized Adjustment Strike Prices (US$)

RFP	Technology	Number of Projects	Original Strike Price ($/MWh)	Petitioners Requested Adjustment ($/MWh)	22T1 Adjustment ($/MWh)
RESRFP17-1	Wind	2	$66.49	$118.09	$82.66
RESRFP18-1	Wind	2	$67.12	$112.48	$80.56
RESRFP19-1	Wind	1	$71.59	$113.89	$86.24
Portfolio (weighted Ave)					
	Wind	5	$67.63	$115.66[38]	$82.72

As Table 6 illustrates, the proposed adjustment mechanism of ACE NY would lead pricing for wind projects to exceed $100/MWh (US$) while adjustments based on the NYSERDA 2022 Renewable RFP would result in prices at nearly $83/MWh (US$).[39] While Merrimack Energy has not focused on offshore wind as part of our benchmark assessment on which to compare the bids submitted into Hydro-Quebec's 2023 Wind Call for Tenders relative to prices in neighboring northeast markets, Table 7 includes comparable pricing for offshore wind based on the Petitioner proposals.

[36] Proposers were allowed to submit an Inflation Risk Adjusted Bid Proposal where the Index REC Strike Price or Fixed REC Price would be subject to a one-time adjustment to reflect changes to a pre-determined price index. The New York Tier 1 RESRFP22-1 Proposer's Webinar on NYSERDA's website for the RFPs provides a good description and example of the pricing structure options for bid pricing.

[37] NYSERDA defines the Strike Price to represent the all-in cost per MWh to develop a large-scale renewable energy project competitively bid to NYSERDA. The 2022 Renewable Energy RFP was the first RFP to allow bidders to offer either a fixed strike price or a strike price based on an index formula specified in the RFP. The 22T1 case applies this formula for calculating the results based on actual inflation values.

[38] NYSERDA noted in its comments that of the difference between the original strike price and the Adjusted Strike Price, inflation adjustments account for $40.48/MWh (US$) while interest rate assumptions account for $7.55/MWh US$).

[39] As will be addressed later in this report, the New York State Public Service Commission denied the petitions filed by renewable energy developers on October 12, 2023.

Table 7: Offshore Wind Estimated Levelized Adjusted Strike Prices (US$)

Project	Original Strike Price ($/MWh)	Adjusted Strike Price ($/MWh)	NY3 Adjustment Strike Price ($/MWh)
Sunrise Wind	$110.37	$139.99	$138.22
Empire Wind 1	$118.38	$159.64	$148.26
Empire Wind 2	$107.50	$177.84	$147.79
Beacon Wind	$118.00	$190.82	$162.23
Portfolio Weighted Average	$113.40	$167.25	$149.14

As the data illustrates, offshore wind prices would increase dramatically from already high levels.

NYSERDA's comments identified a number of issues for the Commission to consider in its ruling on the petitions. NYSERDA also noted that Clean Path New York also submitted a petition to request an adjustment to the agreed upon generation strike price commensurate with the adjustment granted to ACE NY, when applicable.[40]

3.3 Market Structure in Eastern Canadian Power Markets

Merrimack Energy's goal regarding cost data in eastern Canadian markets is to collect and utilize data available for project costs in the three eastern Canadian markets of Ontario, New Brunswick and Nova Scotia. The market structure and role of renewables differ by market, with Ontario having a more complex market structure than either of the smaller systems of New Brunswick and Nova Scotia

A March 2021 report by the Canadian Energy Regulator (CER) entitled *"Canada's Renewable Power: Recent and Near-Term Developments"* provides a review of recent developments for renewable energy by Province. The Report notes that between 2010 and 2017, Ontario added a net 7,152 MW of renewable capacity, comprised primarily in wind (3,668 MW) and solar (2,299 MW). Between 2017 and 2023, Ontario is projected to add 466 MW of new net renewable capacity. The projected increases in wind and solar are offset by decreases in Biomass/Geothermal capacity. The report identified recent and future wind (5 projects), solar (1 project) and hydro (1 project) projects added between 2017 and 2021.

[40] As Merrimack Energy will discuss later in this report, in October, 2023, the New York Public Service Commission denied the Petitions for price increases filed.

A recent report by the Independent Electricity System Operator ("IESO") in Ontario entitled *"Resource Eligibility Interim Report"*, October 7, 2022 noted that the 2022 Annual Acquisition Report ("AAR") identified a need for 2,500 MW of capacity starting in 2025 and continuing beyond. The report notes that to address this need, the IESO has developed three procurements (Same Technology Upgrades, Expedited LT 1, and LT 1) with a target of approximately 4,000 MW of capacity. The IESO has identified significant reliability risks as a result of potential project delays, given the current global supply chain and project development issues. The higher procurement target mitigates against this risk of not having enough resources to meet planning standards and ensure that the system is ready for future growth. This target will also help the IESO manage operability risks stemming from integrating new technologies onto the system. The procurement amounts and timelines are listed in Table 8. It is Merrimack Energy's understanding that the proposal deadline for the IESO LT1 RFP is December 12, 2023.

Table 8: Power Procurement Processes in Ontario

Procurement Mechanism	Capacity Target (MW)	Eligibility	Procurement Materials Posted	Proposals Due	Contract Award
Same Technology Upgrades	300	Facility improvements managed through contract amendments	Nov 1, 2022	Dec 20, 2022	Q1 2023
Expedited Long Term 1	1,500	On-site expansions and new greenfield resources	Nov 1, 2022	Dec 20, 2022	Feb 2023
Long Term 1	2,200	On-site expansions and new greenfield resources	Jan 31, 2023	Q2 2023	No later than Oct 2023
Total	4,000				

The CER report notes that approximately one-third of New Brunswick's electricity is generated by renewable sources with hydro the largest source followed by wind and biomass. New Brunswick is reported to have 294 MW of wind and 127 MW of biomass capacity. New Brunswick is projected to add 35 MW of wind by 2023 from 2017 with no change in biomass capacity. Utility solar capacity is currently miniscule in New Brunswick.

Although approximately 36% of Nova Scotia's generating capacity is comprised of renewable resources, only about 26% of its electricity generation is provided by renewables. Nova Scotia generates over 50% of its energy from coal. Renewable energy generation in Nova Scotia is growing, led primarily by wind. Hydro, tidal and biomass also contribute to total generation. Solar is near 0%. Nova Scotia's legislated renewable energy target requires 40% of electricity to be generated from renewable sources by the end of 2020. In 2021, legislation was passed setting an 80% renewable target by 2030. The Province of Nova Scotia issued a Request for Proposals for new large wind and solar projects capable of supplying 10% of the province's electricity from renewable sources in January 2022. Nova Scotia selected five wind projects that are expected to generate 372 MW or 1,373 gigawatt hours per year of electricity at an average cost of energy of $53.17/MWh.

4. Calculation of Benchmark Costs for Renewable Resources

Section 4 of this report discusses general trends in wind resource costs at a high level. This Section also describes in detail the calculation of benchmark costs for wind resources, including wind resources in northeast US and eastern Canadian markets for the purpose of comparing against the pricing of the wind bids selected by Hydro Quebec through the recent 2023 Wind Call for Tenders. For purposes of developing benchmark cost estimates, Merrimack Energy initially focuses on wind energy cost information for the US Northeast markets based on the greater availability of data and information. Following the compilation and calculation of cost and other data for Northeast US markets, Merrimack Energy provides the comparative cost information for eastern Canadian markets that we have been able to gather for comparison purposes.

4.1 Calculation of Wind Benchmark Costs

4.1.1 Background to the Calculation of Wind Benchmark Costs by Market

There are a number of factors that influence the cost of wind-generated electric power and other renewable resources by market area. These include the capital cost of the project, the cost of financing the project, operation and maintenance costs, and other administrative costs (e.g., property taxes, insurance, administration costs, and land lease costs, if applicable). For wind resources, the wind regime at the site, the size of the wind farm, configuration of the turbines, and the presence of government incentives such as production tax credits (US), accelerated depreciation and state subsidy programs also influence the levelized cost of energy.

The strength of the wind resource (i.e., wind regime), including wind speed and wind speed distribution over the course of the year, and the matching of the wind resource to the wind turbine power curve, is also a major determinant of project cost. These factors determine the generation profile and project output and the associated capacity factor of the wind system. Since most of the costs associated with a wind generation facility are fixed costs, the higher the capacity factor, the lower the per-unit cost.

However, since the cost of wind generation is highly site specific, it is very difficult to consistently and equitably compare the economics of various projects since each project has a unique set of local conditions. Unlike other generation technologies, such as combined cycle or combustion turbine facilities that generally have a standard design and fairly consistent cost characteristics, the economics of wind generation can vary considerably by area or market regions.

4.1.2 Sources of Data for Evaluation of Wind Benchmark Costs

Merrimack Energy has focused its efforts on developing a database of information on wind resource costs in the US and Canada, with a focus on compiling data in the regions of the Northeast US and eastern Canada, where available. As noted, since bids were submitted into Hydro-Quebec's 2023 Wind Call for Tenders in September 2023 and therefore pricing submitted by bidders would reflect the changes in project costs experienced in the market in Q1 to Q3 of 2023, our objective was to develop benchmark costs for the same period as the bids received by Hydro-Quebec. While ideally collection of primary real time data based on contracts executed at the same time or solicitations for bids in these regions at the same time would be preferred, it is very challenging to collect such data. However, we have attempted to compile secondary data sources, such as reports, which include cost trends or to correlate the cost of wind in the northeast markets during the same base period to cost changes in other markets where more recent data is available and extrapolate the change in costs to projects in the northeast markets as an example.

The development of benchmark costs for wind projects defined in this assessment for each market will be supported by the following sources of information:

1. Recent reports, studies, and trade press articles in the US and Canada which focus on trends in wind-generated electricity costs and may include regional wind prices. Examples of reports include: (1) *"LevelTen Energy Q1, 2021 through Q3, 2023 PPA Price Index Executive Summary for North America"*[41]; (2) *"US Department of Energy Land-Based Wind Market Report: 2023 Edition"*; (3) "NREL Annual Technology Baseline: The 2023 Electricity

[41] LevelTen makes Executive Summaries for their quarterly reports available free of charge but require a substantial fee to purchase the quarterly report which provides details by region.

Update"; and (4) CohnReznick Capital Solar and Wind Market Cost of Energy Analysis, February 2023";[42]
2. Pricing for wind projects bid into recent Request for Proposal processes where available;[43]
3. Studies which provide estimated installed costs or levelized costs for wind projects;
4. Prices for projects recently built or under construction if reported in publicly available sources.

The type of data collected will also have to be scrutinized to ensure the characteristics of wind projects in various regions of the US and Canada are appropriately applied. As an example, while relying on reported LCOE data for wind may seem straightforward, it is important to note that projects may vary significantly in terms of capacity factor, regional labor costs, regulations, and terrain for these projects compared to other regions of North America. For example, data has shown that the capacity factor for wind projects located in the northeast is generally lower than in more wind-friendly regions such as Texas, and the Pacific northwest.

Due to these factors Merrimack Energy has also prepared estimates of levelized costs of wind by assessing the capital costs or Engineering, Procurement and Construction ("EPC") costs for wind projects by calculating the annualized costs based on a capital cost recovery factor or fixed charge rate and adding fixed operations and maintenance costs ("FOM"), and other administration and operations costs combined with an expected capacity factor to derive an estimate of the LCOE for wind in the northeast US and eastern Canada. Merrimack Energy will therefore attempt to update information provided on wind project costs from our 2022 Benchmark Report by also identifying trends in wind project costs that can inform our assessment of costs for wind energy in the northeast US and eastern Canada based on North American trends for wind costs.

As we did for the 2022 Benchmark Report, for this assessment, Merrimack Energy will undertake multiple approaches for calculating the LCOE of wind projects in the northeast and will test the results against data from recent RFPs or Call for Tenders. Merrimack Energy would prefer to rely on publicly available data and "test" the accuracy and reasonableness of the data based on actual bids submitted into recent solicitation processes which reflect summer 2023 pricing trends. However, there is generally a lack of publicly available data for project

[42] Merrimack Energy relied upon an earlier version of these reports in preparation of the 2022 Benchmark Report for Hydro-Quebec.
[43] The specific projects and exact references are confidential.

capital costs and LCOE's for summer 2023, particularly for the Northeast US, which has not seen a reasonable number of recent on-shore wind projects during the timeframe in question.[44]

4.1.3 Data on Wind Costs Reported in Recent Studies or Trade Articles for Recent Cost Trends for Wind-Generated Electricity

An article on wind project cost increases by IHS Markit, a part of S&P Global, issued on January 31, 2022[45] identified the major drivers of cost increases for wind projects based on discussions with Original Equipment Manufacturers ("OEM"). The article notes that the cost of onshore wind fell 40% in the latter half of the 2010's; however, prices are now on the rise, and that trajectory is set to continue, as cost increases and COVID induced bottlenecks snarl supply chains. For example, Vestas indicated it expected costs to continue to rise through 2022 and beyond because the company expected an increased impact from cost inflation related to raw materials, wind turbine components and energy prices. GE Renewables, the second largest turbine equipment supplier, also expected prices to continue to rise.

The article also noted that the cost increases behind the price hike span materials, freight, labor needs coming out of the pandemic, and geopolitical risk. Rising material costs for aluminum, copper, fiber glass resins, and more have played a prominent role. Higher raw material prices are resulting in higher costs for all critical components including towers, blades, power electronics, and foundations. The top of the material cost list is the increase in steel prices, which accounts for a significant portion of wind project costs. In addition, increasing transportation and logistics costs are expected to continue to affect the wind power industry throughout 2022.

Other articles by Reuters Events have confirmed the reasons for the increases in wind project costs citing inflationary pressures, supply chain constraints and grid connection delays along with increases in the price of steel and other commodity costs as reasons for the increase. The article provided a summary of the results of a survey of project developers in which 75% of developers said that procurement

---

[44] New York (NYISO) and New England (ISO-NE) have focused their attention on offshore wind procurement. New York State Energy Research and Development Authority ("NYSERDA") has held annual procurements for renewable resources, but maintains confidentiality of the data. The focus in ISO-NE and the New England states has generally been on offshore wind with limited recent solicitation activity. For example, as will be discussed Merrimack Energy has relied upon LevelTen data to observe trends in wind and solar pricing, However, while Level Ten reports pricing by ISO market in the US (i.e., PJM, MISO, ERCOT, SPP, and CAISO), there is little to no data directly available for ISO-NE and NYISO.

[45] HIS Markit, "North America Wind Capital Cost and LCOE Outlook", January 2022.

and supply chain challenges drove Power Purchase Agreement ("PPA") price volatility.

LevelTen Energy (Q1, 2021 through Q3, 2023) PPA Price Index Executive Summary North America

Each quarter, the LevelTen Energy PPA price Index[46] reports the prices that wind and solar project developers have offered for power purchase agreements (PPAs) available on the LevelTen Energy Marketplace, a large collection of PPA pricing offers. The offers underlying the index are from projects that are currently under development and posted by developers to the LevelTen Energy Marketplace, which provides a look at actual PPA price offers.[47] The Quarterly Executive Summaries are available publicly, but the full report has to be purchased separately at a hefty price. Merrimack Energy has accessed only the publicly available data beginning with the Q1 2021 report through the Q3 2023 Executive Summary to inform our own knowledge of market price changes. Merrimack Energy views this period (Q1 2021 – Q3 2023) as the period where project developers first began to raise concerns regarding cost increases for solar, wind and storage projects in power procurement solicitations, up through Q3 2023 which coincides with the receipt of tenders for Hydro-Quebec's 2023 Wind Call for Tenders.

Merrimack Energy began its review of the LevelTen Energy PPA price index for Q1 2021 and compiled the price trends through Q3 2023. For wind projects on a US national level, wind prices have experienced an upward trend every quarter since Q1 2021, nearly doubling over that timeframe. Table 9 presents the quarterly index for wind on a US national level.

Table 9: Quarterly Changes in Wind PPA Prices (US$)

Period of Analysis (Quarter)	Index Price for Wind ($/MWh)
Q1 2021	$30.74
Q2 2021	$33.34

[46] Merrimack Energy has seen the LevelTen Energy PPA Price Index referenced in several articles and reports dealing with price increases for wind and solar projects.

[47] LevelTen Energy noted that price data is aggregated and reported in percentile buckets (e.g., P25 refers to the most competitive 25th percentile offer price). Indices calculated and presented by LevelTen in their quarterly publicly available reports are calculated at the 25th percentile and are averages of the individual P25 ISO components. Data are based on PPA prices that assume financial settlement in the real time wholesale energy market by ISO (i.e., PJM, MISO, ERCOT, SPP, and CAISO with no or little data available or reported for ISO-NE and NYISO). All prices are hub settled with bundled project RECs included. Prices were offered across a range of project contract start dates with contract tenors ranging from 10 – 15 years.

Q3 2021	$36.14
Q4 2021	$38.36
Q1 2022	$43.51
Q2 2022	$44.59
Q3 2022	$49.66
Q4 2022	$48.71
Q1 2023	$51.12
Q2 2023	$58.00
Q3 2023	$57.51[48]

As Merrimack Energy noted in its 2022 Benchmark Report, the index price for wind increased from $30.74/MWh (US$) in Q1 2021 to $49.66/MWh (US$) for Q3 2022, the timing for submission of proposals into Hydro-Quebec's December 2021 Calls for Tenders. As the data above illustrates, the quarterly index price for wind projects since that time has increased by $7.85/MWh (US$) or by 15.8% over the past 4 quarters, starting with Q3, 2022 to Q3 2023, which corresponds with the submission of proposals into Hydro-Quebec's 2023 Wind Call for Tenders on September 12, 2023.[49]

In the Executive Summary to the Q1 2023 LevelTen report, LevelTen provides supporting information underlying the results of its survey, including the following points:

- Volatility in the banking sector and the continuation of rising capital costs are contributing to a degree of financial uncertainty around renewable investments and throughout the cleantech space more broadly;
- The US Federal Reserve's campaign of ongoing interest rate hikes is pushing up capital costs for a renewable development sector that has grown accustomed to cheap and abundant capital for most of its recent history, and developers are responding by increasing PPA prices to account for economic headwinds both existing and prospective;

Wood Mackenzie Global Onshore Wind Energy Report

Wood Mackenzie released a report in early 2023 entitled Global Onshore Wind Energy: 5 Key Things to Look for in 2023, January 2023. The report provides Wood Mackenzie's insight on recent trends in wind project pricing. The report concluded that "western onshore wind markets will continue to grapple with supply chain challenges and capex increases in 2023. Wind turbine manufacturers and their suppliers will experience a challenging year, despite sustained efforts to increase

[48] While the LevelTen index illustrates a slight decrease in wind prices from Q2 2023 to Q3 2023, LevelTen noted that the decrease in the index was attributed to declining wind prices in the Southwest Power Pool (SPP). LevelTen also noted that wind prices in other regions were stable for Q3.
[49] In total, wind project costs based on the LevelTen index have increased by $26.77/MWh (US$) from Q1 2021 to Q3 2023.

prices in light of global supply chain challenges. Still a return to profitability is imminent due to unprecedented positive renewable energy policy momentum in the world's largest markets. Many markets will react to increasing capex with a reset in power purchase agreement (PPA) prices, a lift in auction price caps and increased commercial and industrial (C&I) PPA pricing, driven by solid demand from C&I off-takers to meet environmental sustainability goals." Some of the key points raised in the report with regard to pricing included the following:

- A perfect storm hit the Original Equipment Manufacturers (OEMs) with impacts lasting into early 2023. The reasons for these struggles are multi-faceted but are primarily tied to supply chain issues, raw material inflation, dramatic increases in specialized logistics costs, and a backlog of unfavorably priced supply contracts;
- Capex increases will ultimately propel prices up. Western turbine OEMs have been raising turbine prices in reaction to sustained supply chain and profitably challenges. The rise in prices has led to a drop in new orders but it will ultimately drive wind energy offtake agreement power prices higher in the long term;
- Strong demand from C&I off-takers will prompt a price premium. Renewable energy PPAs allow commercial and industrial customers to meet environmental sustainably goals. Wind PPAs have also been widely used to save costs by hedging against volatile and historically high wholesale power pricing. Increased demand from the C&I sector will drive PPA prices up in reaction to turbine price hikes;
- We forecast that wind LCOEs will increase in the near term and stabilize. Capex increases will inflate LCOE in the near term before moving back to long-term cost reduction driven by technology advances and the deployment of 5 MW+ wind turbines in global markets. These LCOE levels will manifest in higher offtake prices.

Merrimack Energy's own experience in the market matches closely with the cost trends reported by LevelTen Energy regarding the recent cost increases and the medium-term trends expected by Wood Mackenzie.

US Department of Energy (DOE) Land-Based Wind Market Report: 2023 Edition

The *"US DOE Land-Based Wind Market Report: 2023 Edition"* only provides data up to 2022 but does include pricing and other information by region in the United States. This report contains significant details on project costs and other information regarding wind projects, including data by region and ISO. While the report does provide some information for ISO-NE and NYISO, the data is limited based on limited development activity.

Provided below is a summary of the conclusions from the report pertaining primarily to cost and pricing trends for wind resources.

- Wind turbine prices continued to increase in 2022. The LevelTen PPA price index confirms rising PPA prices and regional variation;
- Just four turbine manufacturers, led by GE, supplied all the US utility scale wind power capacity in 2022;
- At the end of 2022, there were 300 GW of wind capacity seeking interconnection. NYISO is among the regions of the US with the greatest quantity of wind in their queues;
- Hybrid wind plants that pair wind with storage and other resources saw limited growth in 2022 with just one new project completed.;

CohnReznick Capital Solar & Wind Market Cost of Energy Analysis – February 2023

CohnReznick Capital report provides data for wind and solar costs based on its Market Cost of Energy ("MCOE") analysis as opposed to LCOE values.[50] The analysis analyzes six US market regions: CAISO, the Southwest, ERCOT, PJM, combined MISO/SPP and the Southeast (solar only). New England and New York are not included. The July 2022 study of Solar and Wind Costs completed by CohnReznick noted that across regions, the MCOE of wind costs ranged from $37/MWh (US$) to $60/MWh (US$) for PJM with an average of $47/MWh (US$) while for CAISO, the MCOE for wind was the same as PJM. The February 2023 report projected that the wind MCOE in the same markets ranged from a low of $39/MWh to $66/MWh (US$) for PJM and $73/MWh (US$) for CAISO. The study also notes that inflation and higher CAPEX have caused an increase in February 2023 prices compared to the 2022 report. The 2023 study also projects wind MCOE to remain generally the same from 2023 through 2029. The report projects that wind CAPEX increases 10% each year over the 2023 – 2029 period over its 2022 forecast. This is due to an increase in raw materials prices and commercialization costs of new turbine designs. Turbine OEMs have increased prices by 30+% over the 2020 lows in all western markets leading to an overall expected increase in turbine costs.

[50] The CohnResnick report states that the Market Cost of Energy ("MCOE") represents a year-1 $/MWh contracted offtake rate with a creditworthy off taker on a 15-year bundled (energy + capacity + RECs) utility scale PPA with 2% escalation. The report notes that LCOE measures the average net present cost of energy generation for a power plant over its lifetime. MCOE utilizes a market-based approach to determine the PPA price required to reach specific investor returns.

The CohnReznick study also includes forecasts of MCOE values from 2023 to 2029 for the above regions. The report also identifies the underlying assumptions for the forecast.[51]

4.1.4 Assessment of Recent Prices for Wind Projects

Merrimack Energy's assessment of the benchmark cost for wind projects in the Northeast US and eastern Canada will start with the results from Merrimack Energy's 2022 Benchmark Report submitted to Hydro Quebec in February, 2023. Merrimack Energy is also considering the following cost information in informing our assessment of benchmark costs for wind:

1. Assessment of recent information regarding publicly available data for recent wind project costs in the Northeast US and eastern Canada;
2. Review and analysis of the NYSERDA assessment of cost increases addressed in its comments associated with the Petition for cost increases for renewable resources and offshore wind projects in New York;
3. Inclusion of increases in wind costs based on the LevelTen data relative to Merrimack Energy's estimated cost for wind power in the Northeast US based on data from previous solicitations;
4. Information contained in articles, studies, and reports regarding recent and projected changes in costs for wind power in North America.

Merrimack Energy will use this information as the basis for calculating the real levelized cost in Canadian dollars for which to compare against the bids submitted in response to Hydro-Quebec's 2023 Call for Tenders.

Information on Recent Project Costs

Merrimack Energy has conducted a Google search of recent wind projects identified in New England, New York and eastern Canada to determine if any updated cost information is reported. Unfortunately, we found no additional information for wind projects in eastern Canada and limited information from New England and New York.

One project identified is the proposed 1,000 MW King Pine Wind project located in northern Maine. The wind project and an associated transmission build-out was selected by the Maine Public Utilities Commission in October 2022. The wind project would be developed by Longroad Energy while LS Power would develop the 345 kV transmission line project. The transmission project will be designed to connect renewable energy projects located in Northern Maine with the New

[51] It appears that the assumptions underlying the forecast of the MCOE needed to determine the PPA price required to reach specific returns may be based on previous US tax incentives.

England grid. It is estimated that the transmission line project will cost $2.78 billion (US$), while Longroad has reported that the cost of the wind project only will cost about $2 billion or ($2,000/kW US$). The project was approved by the Maine Public Utilities Commission in February 2023. It has been reported in the press that the Massachusetts Department of Energy Resources is interested in requiring the Massachusetts utilities to enter into long term contracts for up to 40% of the generation project's electric generation and up to 40% of the Transmission project's transmission service payments for 20 years or less. The estimated net cost of the two projects is $1.7 billion (US$) over 30 years for ratemaking purposes.

In its 2022 Benchmark Report, Merrimack Energy observed proposed prices for wind projects in New England in the 2017 timeframe and for New York in the 2020 timeframe. The average prices Merrimack Energy observed at that time was approximately $50/MWh (US$) to $55/MWh (US$). If these prices remained flat into 2021 and experienced the same level of increase as experienced nationally based on LevelTen data as well as our own experience observing price increases for projects in recent solicitations, Q3 2022 prices would be approximately $68.92/MWh (US$) to $73.92/MWh (US$) or more (i.e., $55/MWh (US$) + $18.92/MWh (US$) or $73.92/MWh US$)). The recent LevelTen indices for wind illustrate a further $7.85/MWh (in US dollars) increase from Q3 2022 to Q3 2023. If this increase over the previous four quarters was also applied to our previous estimate, current wind prices in New England would be in the $76.77/MWh (US$) to $81.77/MWh (US$) range.

A third data point is the assessment provided by NYSERDA in response to the Petition of suppliers to seek and increase in contract prices. As noted in Table 7, only 5 wind projects were subject to the proposed increases in contract prices, with the final wind project included on the list selected in NYSERDA's 2019 Renewable RFP. While the weighted average wind strike price in the period including and prior to the 2019 Renewable RFP was $67.63/MWh (US$), the estimated prices based on the proposed indices would range from $82.72/MWh (US$) under NYSERDA's proposal to $115.66/MWh (US$) under ACE NY's proposal. Alternatively, assuming the increase in the LevelTen index between Q1 2021 and Q3 2023 was applied to the weighted average original Wind Strike Price of $67.63/MWh (US$) from Table 6, the current price would be $94.40/MWh (US$),[52] which is within the range of the proposed adjusted wind prices in New York noted in Table 6. Prices would be projected to range from $82.72/MWh (US$) under NYSERDA's 22T1 Adjustment case and the Petitioner's Requested Adjustment which would bring the price for wind to $115.66/MWh (US$). Merrimack Energy

[52] The high-end wind price reflects the strike price of $67.63/MWh (US$) plus the increase in the LevelTen index from Q1 2021 to Q3 2023 of $26.77/MWh (US$), or $94.40/MWh (US$).

has included a range for wind prices in New York from a low of $76.77/MWh (US$), consistent with the New England prices, to a high of $94.40/MWh (US$)

On October 12, 2023, the New York State Public Service Commission denied petitions filed for amendments to renewable energy contracts that would result in increased contract prices, citing that the contract amendments would cost billions of dollars and were not in the best interests of ratepayers. The Commission stated that the decision reaffirms that competitive procurement is the best and most efficient way to help New York reach its's goal of having at least 70% of its electric load served by renewable energy by 2030, development of 9,000 MW of offshore wind energy by 2035 and meeting state-wide demand with zero-emission resources by 2040.

Finally, Merrimack Energy has served as Independent Evaluator for several recent power procurement solicitations in which bidders submitted pricing for both PPAs and Build Own Transfer options. We have also served as IE over multiple solicitations in which the same project proposals have been submitted. Merrimack Energy has observed significant increases in prices, including pricing, which reflects recent interconnection studies that illustrate higher interconnection and network upgrade costs. As a result, the increase in wind project costs as well as interconnection and network upgrade costs lead Merrimack to conclude that the high end of our capital cost range for wind projects has a higher probability of occurrence than our view in the 2022 Benchmark study. Even the estimate provided by Longroad of $2,000/kW (US$) for the King Pine project would need to be adjusted because of the economies of scale associated with such a large project and the fact that there are no network upgrade costs included in this estimate since a separate transmission project will be required, which is not included in the project cost estimate.

4.1.5 Methodology and Assumptions for Estimating Wind Generation Costs

Merrimack is proposing to undertake an assessment of wind generation costs in the Northeast US based on estimating the expected installed cost for wind projects and calculating the nominal levelized and real levelized cost of wind energy based on a capital cost recovery methodology. The LCOEs for the capital cost cases identified will calculated based on a 30-year contract term beginning in 2027. The general assumptions for the analysis of wind generation project costs in the Northeast US were derived from other studies and reports[53] as well as

[53] Merrimack Energy has relied upon inputs developed by the National Renewable Energy Laboratory ("NREL") as contained in its financial assumptions for the 2022 and 2023 Electricity Annual Technology Baseline ("ATB"). Merrimack Energy relied upon the input assumptions from NREL's Market Case from the 2022 ATB for estimates

information gathered by Merrimack Energy through regular involvement in the renewable energy market throughout the US. To calculate the levelized cost of wind power, Merrimack Energy has relied upon the following formula for calculating the levelized cost of wind power Levelized Cost of Energy = ((Installed Capital Cost x Capital Cost Recovery Factor by resource) + Operating Costs)/Annual Energy Generation, with the Capital Cost Recovery Factor ("CRF" or alternatively Fixed Charge Rate) based on the 2023 NREL ATB Market Case reported value of 8.9%, which represents the annualized revenue requirements recovered for the return on and of investment. NREL reported a Weighted Average Cost of Capital ("WACC") of 8.02% and a 30-year life for evaluating wind project costs[54]. The WACC incorporates in the inputs the interest rate, rate of return on equity, debt percent and equity percent. Both the WACC and CRF inputs are derived from the NREL *Annual Technology Baseline ("ATB"): The July 2023 Electricity Update.*

The Northeast US is generally marked as a high-cost region for developing, constructing and operating renewable energy projects, including wind. The region generally faces higher labor costs, higher costs of developing and constructing projects in challenging locations, higher taxes and operating costs overall. As the data from the various reports have noted, New England and New York have limited data on recent projects, but the available data does indicate the installed costs of wind projects in these regions is certainly higher than the national average.

Based on recent data we have witnessed across the country, the installed costs of wind projects in areas of the country that have typically enjoyed lower capital costs than the Northeast have increased substantially, to the point we are seeing costs for projects submitted and/or contracted to be in excess of $2,000 per kW installed (US$)[55]. This is up from $1,300/kW (US$) a few years ago for the same project. Since the most recent installed costs reported for a wind project in New England was approximately $2,500/kW (US$), Merrimack Energy would expect a reasonable level for costs for wind projects in the Northeast US to be at the high-end of the range at approximately $2,500/kw (US$).[56] Based on recent increases

of wind LCOEs for Merrimack Energy's 2022 Benchmark Report. Merrimack Energy is also utilizing the NREL assumptions from the Market Case from the 2023 ATB for development of LCOE estimates for this report as well.

[54] NREL has utilized higher values for the discount rate and Capital Recovery Factor for a wind project in the 2023 ATB Market Case. NREL has calculated the LCOE based on calculation of the LCOE for wind without inclusion of the impacts of the Production Tax Credits and then adjusts the LCOE by subtracting the estimated Production Tax Credit benefit of $17.62/MWh (US$) from the LCOE calculated without tax benefits.

[55] Merrimack Energy recently reviewed proposals for wind projects in a region in the US where wind is a predominant resource where capital costs for such projects exceeded the mid-point cost of $2,250/kW (US$).

[56] Note that all data assumptions included in the tables for each technology are presented initially in US$ for the purposes of calculating the levelized cost of each technology. Merrimack Energy will also present the results in levelized costs in Cn$ as well as presenting real levelized costs in both US$ and Cn$.

in wind project capital costs, Merrimack Energy views the low end of the range of capital costs to be very optimistic while the high end of the range is more representative of project costs for wind in the Northeast US based on continuation of recent market cost trends.

The US Department of Energy (DOE) (Land Based Wind Market Report 2022) estimated O&M costs to average about $21/kW-year (US$) for projects that have entered service since 2010. According to DOE, O&M costs represent about 50% of all total operating costs, which according to DOE is estimated to be about $44/kW-year (US$). There are a number of other costs that should also be included in operating costs such as insurance, property taxes, capital expenditures, etc. We have seen estimates of total operating costs to range from about $35/kW-year (US$) to over $50/kW-year (US$). The July 2023 NREL ATB calculates a Fixed O&M rate of $29.57/kW-year (US$) in 2023 for wind projects; however, this O&M estimate is much lower than what Merrimack Energy has seen in the market. The 2022 NREL ATB estimate of $42.19/kW-year is, in our view, a more accurate estimate of the fixed O&M plus other administrative costs for wind projects. Merrimack Energy is therefore using an operating cost consistent with the NREL value of $42.19/kW-year (US$) from its 2022 ATB Report starting in 2027 and escalating annually by inflation.

The cost components aggregated in the fixed O&M cost includes:

- Administrative Fees
- Administrative Labor
- Insurance
- Land Lease Payments
- Legal Fees
- Operating Labor
- Other
- Property Taxes
- Site Security
- Taxes
- Project Management
- Blades
- Gearboxes
- Generators
- General Maintenance
- Scheduled Maintenance over Technical Life
- Unscheduled Maintenance over Technical Life
- Transformers
- Turbines

- Annualized present value of large component replacement over technical life

Another major factor is the capacity factor for wind in each of the markets. For projects in the Northeast, Merrimack Energy has observed capacity factors from below 30% up to around 40%. Based on projects observed the average has been around 35%. The assumptions utilized in the assessment of levelized costs based on recovery of capital costs plus operating costs are presented in Table 10.

Table 10: Input Assumptions and Cost Parameters for Wind Projects

Parameter	Assumption
Capital Cost ($/kW) (US$)	$2,000 to $2,500[57]
Fixed O&M plus Operating Costs ($/kW-year) (US$)	$42.19
Capacity Factor (%)	35%
Project Size (MW)	100 MW
Discount Rate (%)	8.02%
Capital Cost Recovery Factor (%)	8.9%
Inflation Rate (%)	2.10%
Contract Term	30 years

Based on these assumptions, Merrimack Energy has calculated the LCOE of wind projects in the Northeast US to range from $74.95/MWh (US$) based on a low-end capital cost of $2,000/kW (US$) installed to $89.46/MWh (US$) based on a high-end capital cost of $2,500/kW (US$). Based on the capital cost assumptions noted above, the real levelized cost of energy ranges from $55.56/MWh (US$) (assuming a capital cost of $2,000/kW in US$) to $66.34/MWh (US$) (assuming a capital cost of $2,500/kW in (US$). If these values are converted to Canadian dollars the real levelized cost in (Cn$ 2023$) would be $72.23/MWh (Cn$) assuming a capital cost of $2,000/kW (US$) and $86.24/MWh (Cn$) assuming a capital cost of $2,500/kW (US$). This is generally consistent with the cost increases reported by LevelTen and applied to costs for comparable markets and recent prices for projects in New England and New York.

57 Merrimack Energy also calculated the LCOE values for wind based on a capital cost of $2,250/kW (US$) to represent a mid-point in the cost range given the variability of capital costs for wind projects and timing of the Hydro-Quebec Call for Tenders.

5. Summary and Conclusions for the Northeast US Market

This section of the report provides a summary of the LCOE values and real levelized costs (in both US$ and Canadian dollars) for the wind benchmark resource options identified in Section 4 of this report.[58] Table 11 presents the high-level levelized cost estimates at several capital cost quantities as well as for New England and New York project cost estimates.

Table 11: Summary of LCOE and Real Levelized Cost Calculations for Wind Projects in the Northeast

Resource Cost Assessment	Levelized Cost of Energy ($/MWh US$)	Levelized Cost of Energy ($/MWh Cn$)	Real Levelized Cost of Energy (2023 $/MWh US$)	Real Levelized Cost of Energy (2023 $/MWh Cn$)
Wind				
Capital Cost - $2,000/kW	$74.95	$97.43	$55.56	$72.23
Capital Cost - $2,250/kW	$82.21	$106.87	$60.95	$79.23
Capital Cost - $2,500/kW[59]	$89.46	$116.30	$66.34	$86.24
New England LCOE	$76.77 - $81.77	$99.80-$106.30	$56.92-$60.63	$74.00-$78.82
New York LCOE	$76.77 - $94.40	$99.80-$122.72	$56.92-$70.01	$74.00-$91.01

In conclusion, Merrimack Energy believes that the range of real levelized costs noted in the last Column above are a reasonable starting point for assessing the benchmark costs of wind projects in neighboring power markets. The higher real levelized costs (in Cn$) of $86.24/MWh based on capital costs for new wind projects in the Northeast US represents a reasonable value for the LCOE in neighboring markets without the inclusion of production tax credit benefits. Merrimack Energy believes the lower capital cost cases identified do not reflect current market conditions in the Northeast and the high capital cost case is more consistent with actual wind market costs in the Northeast. Merrimack Energy also believes the lower LCOE's for New England and New York, which are representative of Power Purchase Agreements ("PPAs") compare favorably to

---

[58] The levelized cost of energy is calculated based on the contract term assumed with each contract beginning in 2027. The real levelized cost of energy is calculated back to a 2023 base period.

[59] The LCOE values contained in this table based on the capital cost cases reflects the LCOEs without the inclusion of tax incentive benefits to conform with Hydro-Quebec's requirements that bidders should submit price proposals without any incentives included.

LCOE values which represent proposals that have included all or a portion of tax benefits in their pricing. These values compare to the LCOE that would be derived based on subtracting the full value of tax credits (i.e., $17.62/MWh US$) from the LCOE calculated with no tax credit benefits included of $89.46/MWh US$, which would result in an LCOE of $71.84/MWh US$.[60]

6. Forecast of Renewable Energy Prices

Merrimack Energy was also asked to provide a forecast of wind resource costs going forward. While most studies and forecasts of renewable resource costs project continued declines in cost, particularly for wind, solar, and energy storage resources due to expected continued improvements in resource technologies, Merrimack Energy is not as optimistic regarding the timing or magnitude of cost declines. In our view, we believe the recent trends and market conditions associated with increases in wind and storage costs could remain for several more years due to regulatory policy and shortages of raw material inputs combined with a growing demand for these resources to meet aggressive clean energy targets in many developed countries as many areas of the world focus on reducing overall emissions by adding more renewable resources. Both Wood Mackenzie and CohnReznick project that wind costs will remain steady for the foreseeable future. Both reports expect that wind capex will continue to increase.

Another factor which could place upward pressure on wind project pricing over the next few years is the continued financial issues facing major OEM's, including Siemens Gamesa. As an example, Siemens Gamesa has experienced a recent decline in in its stock price due to deeper than expected problems at its wind turbine division which revolve around quality problems at Siemens Gamesa's two most recent onshore wind turbine platforms related to rotor blade main bearing problems, which could cost several billion dollars to fix. This could also affect the company's competitiveness and ability to meet new orders for equipment.

Merrimack Energy is more optimistic about the potential for wind project costs to decrease in the future assuming input costs decline such as steel and the like. Unlike the solar and storage markets, wind turbine manufacturers are largely based in the US, Canada and Europe which should reduce the risk of supply disruption. However,

[60] Since the pricing for wind projects in New England and New York are based on PPA agreement there is no data available regarding the amount of the tax credit benefits flowed through in the prices proposed.

Another factor influencing costs for all resources is the costs required to upgrade transmission systems to allow more generation to be delivered to load centers. Our experience is that transmission interconnection queues in most power markets have a very large number of projects looking to secure interconnection agreements to allow the projects to move forward in the development process. However, recent experience with regard to network upgrade costs to construct transmission facilities illustrates that such costs are also increasing and the timing for completing such facilities on the part of utilities and ISOs is increasing as well.

In conclusion, Merrimack Energy feels that there are a number of factors in the power market that will likely keep wind energy prices higher than projected, including a significant increase in demand for such facilities to meet projected load growth, to replace retiring coal and gas units, and meet emission reduction targets.

7. References

NREL (National Renewable Energy Laboratory). 2023. *2023 Annual Technology Baseline*. Golden, CO: National Renewable Energy Laboratory. https://atb.nrel.gov/.

EIA (Energy Information Administration). *Annual Energy Outlook 2022*. Washington, D.C.: U.S. Energy Information Administration, March 2022. https://www.eia.gov/outlooks/aeo/.

LevelTen Energy. 2021. *2021 PPA Price Index*. Seattle, Washington: LevelTen Energy. http://www.leveltenenergy.com/resources.

LevelTen Energy. 2022. *2022 PPA Price Index*. Seattle, Washington: LevelTen Energy. http://www.leveltenenergy.com/resources.

Penrod, E. (2022, October 18). *PPA prices jump 9.6% in Q3 as growing demand hits supply chain, transmission roadblocks: LevelTen*. Utility Dive. https://www.utilitydive.com/news/ppa-prices-supply-chain-interconnection-levelten/634320/?utm_source=Sailthru&utm_medium=email&utm_campaign=Issue:%202022-10-20%20Utility%20Dive%20Renewable%20Energy%20%5Bissue:45418%5D&utm_term=Utility%20Dive:%20Renewable%20Energy

Weaver, J. F. (2022, August 25). *To PTC or ITC, that is the financial question*. Pv Magazine USA. https://pv-magazine-usa.com/2022/08/25/to-ptc-or-itc-that-is-the-financial-question/

American Clean Power Association (ACP). 2022. *Clean Power Annual Market Report 2021*. Washington, D.C.: American Clean Power Association. https://cleanpower.org/market-report-2021/

CohnReznick Capital (2022, July). *Capital Solar & Wind Market Cost of Energy Analysis*.

Bolinger, M., & Wiser, R. (2022, August). *Land-Based Wind Market Report*. Electricity Markets and Policy Group; Lawrence Berkeley National Laboratory for Department of Energy. https://emp.lbl.gov/wind-technologies-market-report

The International Renewable Energy Agency (2016). *The Power to Change: Solar and Wind Cost Reduction Potential to 2025.*

International Energy Agency (2021). *Renewables 2021 Analysis and Forecast to 2026.*

Kessler, R. (2022, May 4). "*Destroying clean energy.*" Recharge | Latest Renewable Energy News. https://www.rechargenews.com/solar/destroying-clean-energy-industry-decries-potential-new-us-solar-tariffs-as-impacting-jobs-and-climate/2-1-1212019

Potomac Economics. (2022, May). *2021 State of the Market Report for the New York ISO Markets*. NYISO Market Monitoring Unit.

HIS Markit (2022, January). *North America Wind Capital Cost and LCOE Outlook*.
The International Renewable Energy Agency (2016). *The Power to Change: Solar and Wind Cost Reduction Potential to 2025.*

Johnson, E. (2022). *New England Power System Outlook*. CBIA 2022 Energy & Environment Conference.

Canadian Energy Regulator (2022, March). *Canada's Renewable Power: Recent and Near-Term Developments*.

Canadian Energy Regulator (2022, May 24). *Canada's Energy Future*.

Independent Electricity System Operator (2022, October 7). *Resource Eligibility Interim Report*.

National Renewable Energy Laboratory (2022 September). *US Solar Photovoltaic System and Energy Storage Cost Benchmarks with Minimum Sustainable Price Analysis Q1 2022.*

Montanes, C. C., Gorman, W., Mills, A., & Kim, J. H. (2022, June). *Keep it short: Exploring the impacts of configuration choices on the recent economics of solar-plus-battery and wind-plus-battery hybrid energy plants*. Journal of Energy Storage, 50.

Marsh, J. (2019, August 29). *AC vs. DC solar battery coupling: What you need to know*. EnergySage. https://news.energysage.com/ac-vs-dc-solar-battery-coupling-what-you-need-to-know/

Fitch Solutions (2022, June). *Cost of Biomass Poewr Generation Stagnates, with Downward Pressure for the Future*.

Natural gas generator construction cost U.S. (n.d.). Statista. Retrieved November, 2022, from https://www.statista.com/statistics/557322/installed-natural-gas-generator-construction-cost-in-the-us-by-type/

Rosa, J. D. (2022, August 25). *Natural gas power plants generate record electricity levels in July*. Talk Business & Politics. https://talkbusiness.net/2022/08/natural-gas-power-plants-generate-record-electricity-levels-in-july/

Ding, D., Pollan, S., & Yang, Z. (2021). *Evaluating Market Conditions for Renewable Natural Gas and Clean Hydrogen*.

Investor, I. (2022, October 4). *Renewable natural gas: Attracting significant capital*. Seeking Alpha. https://seekingalpha.com/article/4544525-renewable-natural-gas-attracting-significant-capital

ICF. (2019). *Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment*. American Gas Foundation.

Smith, S. (2022, August 17). *N.S. selects five wind projects to produce electricity from renewable sources*. CBC. https://www.cbc.ca/news/canada/nova-scotia/n-s-selects-five-projects-largest-ever-wind-procurement-1.6553677

Canada's Nova Scotia province approves 372 MW of onshore wind projects. (2022, August 22). Enerdata. https://www.enerdata.net/publications/daily-energy-news/canadas-nova-scotia-province-approves-372-mw-onshore-wind-projects.html