STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

CASE 18-E-0071 – In the Matter of Offshore Wind Energy

COMMENTS OF DEEPWATER WIND, LLC.

June 4, 2018

Deepwater Wind, LLC ("Deepwater Wind") respectfully submits the following comments in response to the *Notice Soliciting Comments* ("Notice") filed by the Department of Public Service Staff ("DPS" or "Staff") pursuant to the State Administrative Procedures Act and published in the New York State Register on April 4, 2018.[1] The Notice solicits comments from stakeholders in response to the Straw Proposal concerning the OREC funding mechanism as outlined by Staff.

Deepwater Wind submits these comments as the only company to have developed, financed, constructed and operated an offshore wind farm in America. Our Block Island Wind Farm was not only the first constructed in the U.S., but also the first offshore wind farm to complete a tax equity financing anywhere in the world. Deepwater Wind is honored to have been selected by the Long Island Power Authority to develop New York's first offshore wind farm. Our South Fork Wind Farm will serve Long Island's south fork beginning in 2022, making it the first utility-scale project in America. Deepwater Wind has been awarded ORECs from the Maryland PSC for our Skipjack Wind Farm, located within our Delaware Wind Energy Area, making it the first in the mid-Atlantic region. And just last month, our Revolution Wind Farm was selected by the State of Rhode Island in the joint MA/RI procurement, and will achieve commercial operations in 2023.

We applaud Governor Cuomo, who has made New York a national leader in stimulating private investment in renewable energy, creating 21st century jobs across the state while reducing greenhouse gas and other harmful emissions. The New York Green Bank, NY-Sun Program, Clean Energy Standard, and other initiatives have proven track records of success as executed by the New York Public Service Commission ("PSC" or "Commission"), Staff, and the New York State Energy Research and Development Authority ("NYSERDA"). Given this Administration's record of success, the Governor's laudable goal of 2,400 MW of offshore wind energy by 2030 can be obtained and will position New York's clean energy economy on the global stage.

We strongly support the Administration's commitment to purchase 800 MW between two solicitations in 2018 and 2019, which sends a signal to both developers and the global supply

[1] CASE 18-E-0071 - In the Matter of Offshore Wind Energy

chain for offshore wind that New York will strongly compete for the economic, social, and environmental benefits of offshore wind.

The greatest cost in the development of an offshore wind farm is the cost of capital, and the most significant driver of the cost of capital is the risk associated with revenue. Therefore, the terms of a procurement mechanism, solicitation and award should be defined with the purpose of increasing investor confidence, decreasing risk and reducing capital costs, and thus minimizing ratepayer costs. Deepwater Wind offers the following comments to that effect.

Comments

1. **Deepwater Wind supports the comments of the New York Offshore Wind Alliance with additional comments herein.**

Deepwater Wind is a founding member of the New York Offshore Wind Alliance (NYOWA), which has been able to unify the interests of industry, the environment, and labor to advance offshore wind energy in New York. Thus, NYOWA's comments reflect comprehensive guidance on achieving the Governor's offshore wind goal in New York. Deepwater Wind supports NYOWA's comments and supplements them with additional comments below.

2. **The Commission should authorize and encourage the procurement of offshore wind as soon as practicable to capitalize on the federal Investment Tax Credit.**

The federal Investment Tax Credit ("ITC") applicable to wind energy projects is declining. Projects that demonstrate commencement of construction in 2018 are eligible to receive an 18% ITC and those that do so in 2019 are eligible to receive a 12% ITC. Absent a change in federal law, projects that commence construction after 2019 will not receive an ITC.

Qualifying to receive the investment tax credit has a material impact on the price that an offshore wind farm can offer the ratepayers of New York. Therefore, we urge the Commission to proceed with a procurement that will allow developers to qualify their projects for the ITC.

To qualify for the 2019 ITC using the IRS's "safe harbor" method for establishing commencement of construction[2], developers must purchase equipment constituting at least 5% of the qualifying cost of the project by 12/31/19 and take delivery of the same shortly thereafter. While not all developers may rely on the safe harbor method, providing them the ability to do so will ensure New York's ratepayers have access to the greatest selection of offers and the ability to choose from more competitive bids.

We urge the Commission and NYSERDA to implement a schedule that allows for a fully-approved, un-appealable agreement not later than August of 2019. Based on our experience in

[2] Title 26 Internal Revenue Code USC § 48

qualifying the South Fork and Skipjack projects for the 2018 ITC, Deepwater Wind estimates that vendors will require contracts to be completed and payments made by August 2019 in order to satisfy the requirements outlined by the IRS through its released guidance to safe harbor a new project for the 2019 ITC. If the Commission does not authorize the solicitation of offshore wind that allows developers to qualify for the 2019 ITC, ratepayers would likely have to pay prices more than 10% higher than if projects did qualify for the 2019 ITC. It is important to emphasize this is the last opportunity to reduce costs from tax credits. Following 2019, the ITC is fully eliminated.

3. **The Commission should require careful consideration of the financial feasibility of proposed projects in all procurement decisions.**

As detailed in Comment 2 above, qualifying for the ITC, and completing a Tax Equity Financing to monetize the same, has a material impact on the economics of an offshore wind project. Indeed, it affects the very feasibility of an offshore wind project.

At the time of this submission, only one offshore wind project – the Block Island Wind Farm – has ever completed a Tax Equity Financing. The market for tax equity is much smaller than that of the market for project debt, especially for an ITC-based Tax Equity Financing, which requires the Tax Equity Investor have the need to offset a large tax obligation in a single year. To the best of our knowledge, at the time of this submission, the largest ITC-based Tax Equity Financing ever completed was for a value of approximately $350 million. We estimate that an 800 MW offshore wind project would require a Tax Equity Financing of up to $600 million – nearly double the size the largest ever completed. For this reason, we believe that smaller projects are more likely to be successful in completing a Tax Equity Financing.

Accordingly, we urge the commission to require careful consideration of a proposed project's ability to successfully complete a tax equity financing, and to encourage selection of projects that are more likely to do so.

4. **The Commission should authorize and encourage a schedule of annual procurements, as certainty of demand will help to achieve offshore wind goals at a lower cost and with the most economic development.**

We urge the Commission to authorize and encourage regularly-scheduled, predictable solicitations for offshore wind. Doing so will facilitate the development of a local supply chain and drive down costs. Two recent studies prepared by the University of Delaware's Special Initiative on Offshore Wind have demonstrated that a commitment to a pipeline of 2,000 MW or more of offshore wind can be expected to result in cost reductions of approximately 50%. In their Massachusetts cost study, the University of Delaware projected similar cost reductions. These costs are achieved through the technological innovation, along with local supply chain development and lower cost of capital that accompanies a commitment to a pipeline of 2,000

MW, which could be achieved through a predictable schedule of procurements. Such a commitment, as seen in the State of Massachusetts, will attract adept competitors that compete to drive the price lower.

In addition to cost savings, commitments to sustained, predictable offshore wind procurements will also maximize New York's opportunities to capitalize on growing jobs and supply chain components in New York. The Commonwealth of Massachusetts, and States of New Jersey, Connecticut and Rhode Island are all moving forward with offshore wind procurements in 2018, offering a time-advantage to establish supply chain providers and jobs. A predictable schedule of procurements will enhance the position of New York in capturing jobs and economic benefits within the state, ensuring the success of the Governor's goal. With its dense coastal population and skilled workforce, New York is a natural home for these jobs, and, with a compelling impetus to invest in the required port upgrades, manufacturing facilities and workforce education, New York can ensure that it captures a plurality of future jobs and economic development while still providing cost effective power.

5. **The Commission should require that the first round procurement consider how its initial decision will impact the cost-effectiveness of the State's 2,400 MW goal.**

New York's initial 800 MW procurement constitutes one third of the Governor's 2030 goal and will have a material impact on the cost of future offshore wind projects serving New York. In the attached independent analysis, The Brattle Group considered the cost effectiveness of New York's procurement of offshore wind of 2,400 MW by comparing procurement options of either (i) three projects sized 800 MW each, or (ii) six projects sized 400 MW each. Despite the economies of scale of larger projects, Brattle estimates that ratepayers would save up to $541 million in ratepayer costs if awards in New York were granted in 400 MW increments rather than 800 MW increments. The most significant reason for this conclusion is the ability to take advantage of supply chain and technology learning curves expected to occur until 2030 as the industry in the US rapidly matures. Brattle's analysis suggests that procurements in 400 MW increments would better take advantage of swiftly declining costs for the benefit of ratepayers, and still achieve the Governor's goal of 2,400 MW by 2030. Accordingly, we urge the commission to require that the round 1 procurement decision consider not only which bid resulted in the least cost in round 1, but also which allows New York to procure all 2,400 MW at the lowest total cost.

6. **The Commission should authorize and encourage selection of multiple projects in the initial round of procurement.**

Selecting multiple projects in the initial round of procurement can provide a lower cost for procuring the full 2,400 MW, yield more economic development in New York and mitigate the risks associated with a single project.

Selecting multiple projects will create on-going competition in supply chains that can result in lower costs for ratepayers in future procurements, as detailed in Comment 5 above and the attached Brattle memo.

In their attached memo, Brattle estimates that having multiple, smaller, concurrent projects would drive accelerated learning in supply chains which would firmly establish lower cost development, building and operations of offshore wind projects in New York. Rather than creating an overwhelming and short-lived economic impact, which would result in premium prices and boom-and-bust cycles, local suppliers would greater benefit from longer-term investment activity, which would in turn better attract supply chain components from outside of New York because costs to relocate into the state would see higher long-term economic development.

Additionally, Brattle cites the ability to spread project execution risk across multiple projects will ultimately increase likelihood of achieving Governor Cuomo's 2030 goal, as also addressed in Comment 3, above.

We note that, at the time of this submission, there have been two competitive processes for the procurement of offshore wind in America: (1) Maryland PSC Docket 9431; and (2) the recent joint procurement by Rhode Island and Massachusetts. In both cases, the selection committees chose to proceed with multiple projects. According to MD PSC Order 88192, which authorized two projects to receive ORECs:

> *As noted by several intervenors, the benefit of competition (albeit one of many benefits we realized in this case) is that we are presented with two options: move forward incrementally through the approval of one, smaller project; or, move forward on an "all-in" basis and authorize incentives for both projects.*
>
> *Put simply, we chose the latter. We found it especially compelling to consider the concept of risk when reaching our decision. There are obvious financial risks to our ratepayers associated with the chosen approach, and equally obvious ways to mitigate them (which we have done)…*
>
> *… we have considered exhaustively the issues of whether the offshore wind projects have not only demonstrated a likelihood to produce positive net economic, environmental, and health benefits to the State, but also whether such benefits will truly come to pass.*

Conclusion

Deepwater Wind appreciates the opportunity to provide input and looks forward to working with the Commission, Staff, NYSERDA, and stakeholders in this process. Staff and NYSERDA have given extensive consideration to achieving Governor Cuomo's ambitious goals. Given its successful experience in developing, financing, constructing, and operating the only offshore wind farm in the United States, Deepwater Wind respectfully urges the Commission to adopt the comments of NYOWA and the comments set forth herein.

Appendix – The Brattle Group Memo

THE Brattle GROUP

DRAFT MEMORANDUM

TO: Clint Plummer, *Deepwater Wind*

FROM: Jurgen Weiss, Principal, *The Brattle Group*[1]

SUBJ: Analysis of Sizing and Timing of Offshore Wind Procurements on Portfolio Cost for New York

DATE: June 1, 2018

I. Summary

In this memo, we provide some thoughts about the optimal timing and sizing of offshore wind procurements in light of the offshore wind industry still is a relatively young technology that is undergoing rapid cost declines, especially in the US. While the exact development of the costs for procuring offshore wind as a function of the size and timing of individual procurements over time is difficult to predict, it is likely that learning across New York, the U.S. Atlantic coast and global offshore wind procurement will have an impact on the overall costs of the procurements of offshore wind in New York and consequently on New York ratepayers.

We built a simple model to examine how costs would differ under a range of reasonable assumptions about the pacing of procurements outside of New York and different rates of cost reductions occurring over time, as a function of the non-US build-out of offshore wind, primarily in Europe, and learning that occurs from the development of an offshore wind industry on the Eastern Seaboard of the United States. Our analysis shows that since early projects are likely to create significant learning benefits, more frequent smaller procurements likely lead to lower average costs than less frequent larger procurements. This results from the fact that an initial large procurement of 800 MW at this very early phase of U.S. offshore market development would remove a third of the overall targeted procurement from taking advantage of expected learning benefits that will occur both from the first set of New York projects themselves and from learning that will likely continue both in other U.S. states and in the rest of the world.

Cost savings from smaller 400 MW rather than larger 800 MW procurements could be significant, in particular if actual learning rates exceed those typically expected in the offshore wind industry. This may be an important insight given that there are many offshore wind farms

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1 This memo was prepared for Deepwater Wind. All results and any errors are the responsibility of the authors and do not represent the opinion of The Brattle Group or its clients.

sized in the range of 400 MW, suggesting that such a level of procurement may not be too small to take advantage of most project level economies of scale. These savings assume that projects with COD in or before 2023 having passed a certain threshold of advancement will still benefit from a 12% Investment Tax Credit whereas later projects are assumed not to and therefore could be larger if projects with COD in 2023 meet the requires safe harbor provisions. We also provide some economic bases for the argument that procuring in more frequent and smaller increments over time may make it more likely that the U.S. East Coast, including New York, will capture a more significant portion of the offshore wind value chain. Finally, we provide some arguments for and against splitting individual larger procurements into smaller increments. We note that if larger procurements involve multiple awards economies of scale at the project level will likely need to be traded off against the loss of opportunities for learning from experimentation and potentially higher project level risks.

II. Background

The offshore wind industry still is a relatively young technology that is undergoing rapid cost declines, especially in the US.. The vast majority of offshore wind projects to date have been developed in Europe. The scale of individual turbines and projects has been increasing and project costs have been decreasing. The decrease in costs is likely the result of a combination of scale economies and various learning effects observed more generally with new technologies. It is therefore widely expected that there is significant additional cost reduction potential for offshore wind projects, particularly in the United States, where to-date only a single (small) offshore wind project, the 30 MW Block Island wind farm in Rhode Island, is operational.

Since there are several states along the Eastern Atlantic coast exploring or implementing offshore wind procurement, it is important to consider how the sizing and timing of procurements, including in particular the New York procurement of 2,400 MW by 2030,[2] can be structured in a way to maximize the benefits to consumers from learning and scaling the offshore wind industry. A related issue to consider is that local economic impacts of an emerging offshore wind industry will likely also depend on how offshore wind is being deployed over time. Offshore wind will have a more positive impact on the local economies in the Northeast to the extent it leads to the emergence of stable local supply chains for labor and various offshore wind components. Finally, when individual procurements exceed a certain size, there are important trade-offs between procuring fewer larger projects or more smaller projects. In the rest of this memo, we explore these issues and provide some recommendations.

[2] NYSERDA, New York State Offshore Wind Master Plan: Charting a Course to 2,400 MW of Offshore Wind Energy.

III. Learning Rates for Offshore Wind - Evidence

Given the relative "youth" of the offshore wind industry and technology, learning is expected to provide a significant opportunity for cost reductions over the coming decades. The cost declines that occur through learning are typically represented through "learning rates" or "progress rates". These rates capture the expected cost decline (in percent) for each doubling of cumulatively installed capacity. Learning rates have been estimated for offshore wind as a whole as well as for various components. These estimates of learning rates differ significantly, but generally range from 5-10% overall, with component learning rates as high as 38%.[3] One of the studies cited separates the overall learning curve into two components, a "learning-by-doing" rate of 1% and a "learning by research" rate of 4.9%.[4]

A complicating factor in assessing how learning would affect the timing (and sizing) of offshore procurement in New York is that one needs to determine how much learning is expected to occur "by-doing" in New York and the broader Northeast versus elsewhere, but benefitting deployments in New York. Examples of such transferable learning could be the move towards larger turbine sizes, the development of specialized vessels for offshore wind installations, or the idea of creating centralized maintenance platforms in the middle of clustered offshore wind farms. The estimated rate of "learning by research" is one way to separate out the effects of deployment in the Northeast from learning related cost-reductions that happen over time independent of installations in the Northeast. Whether those cost reductions are due to pure R&D efforts, as a "learning by research" rate implies, or through learning by doing in the context of installations that happen outside the Northeast/New York is hard to estimate reliably, given the still limited amount of data available. But it is likely that a two-factor learning model that includes both learning by doing in New York and more broadly the Northeastern United States and learning that occurs elsewhere but is transferrable and results in lower installed costs in New York more accurately represents the evolution of costs than a one-factor learning model. Put simply, there are benefits to spacing deployment over a longer period of time since later installations not only benefit from learning by doing in New York/Northeast but also from learning over time that happens elsewhere.

3 See Rubin et al., A review of learning rates for electricity supply technologies, Energy Policy 86 (2015) 198–218, p.206. While one study analyzing offshore wind projects through 2012 found no evidence of either scale or learning effects in the offshore wind industry, the authors caution that this does not mean such effects would not materialize over time (See David Dismukes and Gregory Upton Jr., Economies of Scale, Learning Effects and Offshore Wind Development Costs, March 16, 2015 (Preprint submitted to Renewable Energy).

4 Ibid, citing Jamasb, T., 2007. Technical change theory and learning curves: Patterns of progress in electricity generation technologies. Energy J. 28, 51–72. That paper cites a single-factor learning rate of 8.3% and a learning rate of 1% for learning-by-doing in a two factor learning curve model.

IV. Learning Rates Applied to New York Procurements

To provide some insights into the implications of learning (by doing and by other means) we developed a simple three-factor learning model for offshore wind and show how various types of deployment over time affect costs under different assumptions about learning rates. We also needed to consider economies of scale at the project level. In other words, if economies of scale are present, then the timing and scaling of procurement requires a trade-off between fewer larger-scale procurements and more frequent smaller procurements.

The evidence on economies of scale for offshore project is somewhat mixed, but there is a trend towards somewhat larger "average" projects. For example, in 2016, the average size of a wind park installed in Europe was 380 MW, up 12% from the previous year.[5] However, there is significant variation among wind farms. For example, the range of proposed sizes of offshore wind parks in the most recent auction in Germany was 10 MW to 476 MW, while the previous auction included projects between 40 MW and 900 MW.[6] An evaluation of the auction including interviews with participants conducted by NERA suggests that offshore wind developers do seek larger farms (either achieved as larger single projects or by being clustered with other wind farms) because they expect them to be less costly.[7] This is consistent with the results for the most recent awards in Taiwan for 11 projects totaling 3,836MW, which, with the exception of a single 48MW project, range in size between 294.8MW and 708MW.[8]

To illustrate the impact of various combinations of timing and scaling, we developed a simple 3-factor learning model. Concretely, we allow for different learning rates based on global installations and US East Coast installations over time, the latter representing the combined effects of investments in R&D, increasing turbine sizes, etc. Given the very early stage of the US market, we make one other modification to the standard learning model: We assume that individual projects benefit from past learning rather than from "concurrent learning.[9]"

To illustrate the effect of different sizing/pacing options, we have calculated the total cost and the average capital cost per kW installed of the 2,400 MW target for offshore wind deployment in New York using two different sizing/pacing combinations:

- Option 1: Three procurements of 800 MW each, with CODs in 2023, 2025 and 2027;
- Option 2: Six procurements of 400 MW each, with CODs in 2023, 2025, 2027, 2028, 2029, and 2030.

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5 The European offshore wind industry: Key Trends and Statistics 2016, p.15.

6 Data collected from https://www.4coffshore.com and press releases from Bundesnetzagentur.

7 NERA, Hart am Wind: Einsichten aus der Optionsbewertung zu den Ergebnissen der ersten deutschen Offshore-Wind-Ausschreibung und ihren Auswirkungen, May 2017, p.4 and Appendix 2

8 See https://www.offshorewind.biz/2018/04/30/taiwan-selects-eleven-offshore-wind-projects/

9 Specifically, we apply learning progress with one year lag.

Under each of these options we assume that the projects under the initial procurement will benefit from a 12% investment tax credit by meeting the safe harbor requirements before the expiration of the investment tax credits for offshore wind.[10] We are not assuming that larger procurements would mean a single offshore windfarm of the total procurement size would be built. A large procurement in any given year could also result in several projects being selected and constructed in parallel. We will discuss the trade-offs between procuring fewer larger projects versus more and smaller projects below. To capture global learning effects we assume a build out of offshore wind outside the United States reaching roughly 110 GW by 2030, which assumes annual non-US installations grow by 7% per year on average from 4,334 MW installed in 2017 (and 18,784 MW cumulatively installed by the end of 2017).[11]

To capture learning on the US East Coast, we need to make assumptions about both the size and timing of procurements and resulting installations in states other than New York. Table 1 shows our assumed build-out pattern in places other than New York. Our modeled installations by 2030 are broadly in line with recent forecasts about global installations.[12]

Table 1: Assumed Sizing and Time Pattern of Offshore Wind Installations outside New York

Annual Installatons	<2018	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Non-US	18,784	4,500	4,815	5,152	5,513	5,899	6,311	6,753	7,226	7,732	8,273	8,852	9,472	10,135	109,417
NJ	-	-	-	-	-	-	437.5	437.5	437.5	437.5	437.5	437.5	437.5	437.5	3,500
RI	30	-	-	-	-	-	400	-	-	-	-	-	-	-	430
CT	-	-	-	-	-	-	-	250	-	250	-	-	-	-	500
NY	[redacted]														2,490
MA	-	-	-	-	-	-	800	-	-	800	-	-	-	-	1,600
Maryland	-	-	-	-	-	368	-	-	251	-	-	251	-	-	870
Rest of East Coast	-	-	-	-	-	-	-	100	100	100	100	100	100	100	700

Sources and Notes: All dates are assumed Commercial Operating Dates (COD). New Jersey target based on [insert]. MA target based on H.4568: An Act to promote energy diversity; NY target based on New York State Offshore Wind Master Plan: Charting a Course to 2,400 MW of Offshore Wind Energy, plus 90 MW assumed to be contracted by LIPA. RI based on announcement on 5/23/18 that Deepwater is entering negotiations to build a 400MW plant to serve RI; MD build out based on awarded OREC contracts and discussions with developers; global installation assumptions based on GWEC Global Wind Report, April 2018.

Our assumptions about the build out pattern and sizing of procurements in other parts of the East Coast are based on a mix of legal or announced targets and other publicly available information

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10 https://www.grantthornton.com/library/newsletters/tax/2017/hot-topics/January-17/safe-harbor-guidance-deadlines-Section-45-48.aspx

11 Based on Actual and Forecast through 2030 in Global Wind Energy Council (GWEC), Global Wind Report, April 2018.

12 See Global Wind Energy Council (GWEC), Global Wind Report, April 2018. See also Bloomberg New Energy Finance, Global Offshore Wind Market Set to Grow Sixfold by 2030, January 8, 2018 (https://about.bnef.com/blog/global-offshore-wind-market-set-to-grow-sixfold-by-2030/, accessed May 19, 2018), which projects a global offshore wind capacity of 114.9GW by 2030, somewhat lower than the approximately 120 GW projected by GWEC

about various projects.[13] Given the rapid evolution of the offshore wind market in various markets, these forecasts are highly uncertain, but help illustrate the interaction between global and US experience (in states other than New York) and the cost of timing and sizing New York procurements.

To understand how different assumptions about learning rates and time trends affect total and average costs of New York offshore wind procurements, we first constructed default assumptions global and US East Coast learning rates as well as an independent time trend (designed to reflect learning by R&D, turbine size increases etc.) to approximately match the reported overall learning rates of about 10% as well as the component learning rates discussed above. To calibrate our learning rate assumptions, we assumed the New York installation path under Option 2 (400 MW per year starting in 2023), but tested the sensitivity of our results to using New York build out Options 1 and found only relatively small differences. We found that a time trend of 0.5% cost decline per year combined with a 1% global learning rate and a 1.5% US learning rate (representing a less mature industry and therefore the ability to "catch up" with Europe through faster learning early) results in approximately the same total cost reduction by 2030 that would be achieved assuming a single 10% learning rate, namely an approximately 22% decline in installed cost by 2030. Recognizing that, especially given the relative immaturity of the US offshore wind market, but also given estimates of the potential for further cost reductions overall, costs may fall significantly faster, we also used alternative learning rate assumptions that result in approximately twice the cost reductions by 2030.

Table 2 below shows the total and average installed costs for the two modeled New York build out options under several combinations of learning rate assumptions. The different learning rate scenarios we model result in cost reductions in the US by 2030 between roughly 25% and 50%, broadly in line with forecasts made by various studies. For example, Wind Europe projects decreases in the levelized cost of energy (LCOE) for offshore wind in Europe to levels in the range of €45-65/MWh by 2030, corresponding to a price decline of more than 50% relative to 2015.[14] Assuming that U.S. costs will converge with European costs by 2030, but are currently above European costs, this suggests that the potential for cost declines through a combination of learning factors may well exceed 50% between 2018 and 2030.

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13 Outside New York, targets have been established in Massachusetts (1,600 MW) and New Jersey (3,500 MW). Rhode Island and Connecticut projects are based on discussions with developers. Maryland assumptions are based on publicly announced contracts and targeted operations dates. Since other states on the East Coast, notably North Carolina, Virginia and Georgia, are also somewhat actively exploring offshore wind development, we have assumed a base level of developments in these other states.

14 Unleashing Europe's offshore wind potential: A new resource assessment, Wind Europe, June 2017, Box 1, p.25.

As can be seen from Table 2, the savings from procuring more often in smaller increments rather than two 1,200 MW increments (Option 1) are significant under all of our cost decline scenarios. Costs are lowest under the assumption that six procurements of 400 MW each are used to meet New York's 2,400 MW target. Intuitively, this result is driven by the fact that US-learning would be expected to be strongest at the beginning. Since learning rates are based on doubling cumulatively installed capacity, there is a strong doubling effect for the first projects given the very low starting point of only 30 MW installed. Procuring 800 MW initially would allow benefitting some from the still existing Investment Tax Credit, but would also mean that a third of the total New York target cannot benefit from the early and significant learning that is expected to occur as the East Coast ramps up its offshore wind industry and the rest of the world continues to provide learning opportunities. By contrast, multiple procurements at a smaller scale, such as 400 MW, a sixth of the New York offshore wind target and very typical for a single offshore wind farm in Europe, would allow incorporating the benefits from learning into more projects down the road. Assuming current (2018) capital cost of $5,000/KW,[15] the savings from more frequent smaller procurements rather than larger procurements could be significant and shown in Table 2 below for various assumed learning rates. Table 2 shows the range of potential savings from six 400 MW procurements over three 800 MW procurements for various assumed learning rates. They range from - $89 million (undiscounted) assuming learning leads to cost declines in line with expectations about general cost declines, but could be as high as $541 million assuming learning occurs at roughly twice the rate implied by the offshore wind learning literature, but in line with other estimates of costs by 2030 such as the Wind Europe estimates cited above. These savings estimates do incorporate the ITC, which is assumed to be available to any project with COD of 2023 or earlier, assumed to be contracted in time to meet the safe harbor conditions required to qualify. The savings would be larger if the early projects do not qualify for the ITC.

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15 We use an estimate of the capital cost as the metric for evaluating potential cost savings since the New York target is expressed in terms of procured capacity. This is not to imply that we assume learning will only manifest itself through a lower cost of the "physical capital". Rather, capital cost should be interpreted as a proxy for the total cost of offshore wind expressed per unit of capacity. It is therefore comparable to other measures of cost such as LCOE.

Table 2: Cost Impacts of Sizing/Timing of New York Procurement under different cost decline assumptions

		Learning Scenarios				
	Time Trend	3.0%	2.0%	1.0%	1.0%	0.5%
	Global Learning Rate	3.0%	2.0%	2.0%	1.5%	1.0%
	US East Cost Learning Rate	4.0%	3.0%	3.0%	2.0%	2.0%
	Implied Cost Reduction by 2030	54%	*42%*	34%	27%	*22%*
Option 1	**Total Cost of 2,400 MW ($ million)**	**$ 6,915**	**$ 8,027**	**$ 8,614**	**$ 9,250**	**$ 9,650**
*3*800MW*	*Average Cost ($/kW)*	*$ 2,881*	*$ 3,344*	*$ 3,589*	*$ 3,854*	*$ 4,021*
Option 2	**Total Cost of 2,400 MW ($ million)**	**$ 6,374**	**$ 7,632**	**$ 8,352**	**$ 9,060**	**$ 9,561**
*6*400MW*	*Average Cost ($/kW)*	*$ 2,656*	*$ 3,180*	*$ 3,480*	*$ 3,775*	*$ 3,984*
	Cost Savings ($ million)					
	Option 2 versus Option 1	$ 541	$ 395	$ 262	$ 190	$ 89

Notes: Total and average costs are undiscounted.

V. Supply Chain Effects

There are several other reasons why a more even and gradual procurement may have economic benefits. While we have not formally analyzed their effect, they are discussed here at a high level to illustrate how and why they might be relevant.

In general, these benefits are related to the supply chain for offshore wind. For example, large procurements could overwhelm existing local (and perhaps even international) supply chains temporarily and lead to higher cost due to suppliers (labor and capital goods) being able to require premium payments.[16] Second and perhaps more importantly, the likelihood of the development of local supply chains increases with the stability and predictability of future demand. Put differently, if New York procured all 2,400 MW through a single procurement, with little hope of additional procurements down the road, turbine suppliers may be reluctant to invest in local manufacturing since the sunk cost of the investment in local facilities with a capacity high enough to meet the one-time local demand would likely not be economical. If, on the other hand, there were a steady demand for 400 MW over a six-procurement period, building local turbine manufacturing facilities with 400 MW annual production capacity may indeed make economic sense. Even if manufacturing of major equipment (such as turbines) may not locate close by because of the need for a larger market than the one expected to develop on

[16] A similar concern has been raised in the context of Taiwan's ambitious procurement targets, which comprise building 6 GW of offshore wind capacity from a base of zero by 2030, a pace three times as fast as the UK's. (https://www.greentechmedia.com/articles/read/taiwan-adds-to-offshore-winds-eastern-promise#gs.=AgoJ8g, accessed May 19, 2018)

the Atlantic Sea Board, other smaller elements of the supply chain could be local and sustain themselves with slower but steady demand. This principle certainly applies at the regional level for the development of a regional supply chain, but it may also apply to some extent locally, *i.e.* at the state level. At a minimum, it suggests that procurement efforts in the Northeast should be coordinated among procuring states to avoid boom-bust cycles in procurement, with the goal of attracting larger portions of the offshore wind supply chain, perhaps at a somewhat smaller level than would be needed to meet the goals of a small number of large procurements.

VI. Procurement Size and Number of Projects per Procurement

Finally, we provide some thoughts concerning the trade-off, for any given procurement round, between procuring fewer larger or more smaller projects. The primary advantage of procuring fewer larger projects is the opportunity to take advantage of project-level (as opposed to industry-level) economies of scale. For example, a larger order of turbines, blades or foundations may result in a lower purchase price (due to bargaining power or due to savings in contracting and other transaction costs). Similarly, costs can be reduced if some fixed costs of building or operating offshore wind farms can be spread over a larger project, for example the cost of maintenance vessels or maintenance crews. For some such costs, further cost savings may be limited once offshore wind farms reach a minimum scale. Other cost savings may also be realized across wind farms if costs can be shared among multiple wind farms. Again, maintenance vessels may be one example, ports could be another.

On the other hand, especially while the offshore wind industry is still maturing, there are likely benefits from procuring offshore wind power from more, but smaller wind farms. While smaller wind farms may not result in the same economies of scale, they provide potential learning as well as risk diversification benefits, which could result in either project level cost savings or in reducing the overall costs of meeting an offshore wind procurement goal such as New York's.

A potential learning benefit could result from observing different approaches being used for projects that are being developed more or less in parallel. The differences can encompass all aspects of developing, building and operating an offshore wind project. If, in an extreme case, only one project is built in a given procurement round, there is no opportunity to learn from any differences in approach that are being used. Put differently, one can only observe what happens and not what works better than something else. While we have not attempted to quantify this effect, it seems that learning could be accelerated by being able to observe different concurrent methods for developing, building and operating offshore wind projects.

A second potential benefit of spreading procurement across more and smaller projects is a certain amount of risk diversification, both for the state and for other stakeholders such as potential project investors.

The relative magnitude of these benefits would have to be estimated, which is beyond the scope of this memo, but they suggest that for each procurement there are both benefits and costs of choosing fewer (and perhaps only one) larger projects versus procuring more smaller projects.