STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF

CHAMPLAIN WIND, LLC	)	SITE LOCATION OF DEVELOPMENT ACT
CARROLL PLT./KOSSUTH TWP.	)	NATURAL RESOURCES PROTECTION ACT
PENOBSCOT/WASHINGTON COUNTY	)	PUBLIC HEARING
#L-25800-24-25800-TE-B-N	)	

Pre-Filed Testimony of Abigail Krich by Intervenor Conservation Law Foundation

Below is the pre-filed testimony of Abigail Krich with respect to the above-referenced licensing application. Ms. Krich's testimony addresses the following criteria relevant to the Department's review of this project: The expedited wind energy development's purpose and the context of the proposed activity. 35-A M.R.S.A § 3452(3)(D).

Introduction

My name is Abigail Krich. I am President of Boreas Renewables, a consulting company serving renewable energy developers, owners, and operators as well as the industry advocacy group Renewable Energy New England. Boreas helps developers navigate their way through the interconnection process, participate in the Forward Capacity Market, and register to sell into the New England wholesale electricity markets. Boreas works with owners and operators to understand how existing and upcoming market rules and compliance requirements factor into their day-to-day operations. As indicated on my Curriculum Vitae, attached to this testimony, I hold a Master's of Engineering Degree in Electrical and Computer Engineering with a focus on power systems from Cornell University as well as a B.S. in Biological and Environmental Engineering, Environmental Option, from Cornell University. I have worked in the renewable energy industry in varying capacities since 2003.

Summary

The purpose of my testimony is to highlight the positive economic and environmental impacts of wind energy, and the Bowers Wind Project in Maine.

- Electrical generation and consumer demand for electricity must be balanced at all times as there is very little electrical storage available. Therefore, when wind energy is produced, it must displace energy that would have been produced by another source.
- Wind has almost no marginal cost for producing electricity once it is built so it typically acts as a price-taker in the wholesale electricity markets. Price-taking energy, like wind, displaces more expensive energy in the markets, keeping power prices low.
- The 2011 Economic Study by the Independent System Operator of New England (ISO-NE) estimates that these savings could amount to approximately $108 per Megawatt hour of wind energy. With Bowers Wind's production estimates, this would result in $17 million in annual savings.
- Fossil fuels produce the majority of electricity in New England and represent over 70% of the electrical generating capacity in the region.[1] Wind energy primarily displaces natural gas and oil and will displace increasing amounts of coal electricity as more wind is installed.
- ISO-NE has stated that "the region's growing dependence on natural gas for power generation is a rapidly-escalating strategic risk for the region." Wind energy provides needed fuel diversity and a hedge against natural gas price volatility and supply disruptions.
- The New England Wind Integration Study (NEWIS), performed by ISO New England, found that no additional power plants would be needed to balance the additional variations expected from up to 12,000 MW of wind energy in New England. This is equivalent to approximately 24% of the

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[1] *2012 Regional System Plan*, ISO New England Inc., Nov 2, 2012. Section 7.1.

annual regional demand for electricity being met by wind energy. For comparison, wind accounts for nearly 2% of the electricity generated in New England to date in 2013.[2]

- NEWIS found that up to 12,000 MW of wind could be integrated without the need for additional electrical storage. It also found that if 20% of New England's electricity were supplied by wind it would reduce the region's electricity-related CO_2 emissions by 25%, SO_x emissions by 6%, and NO_x emissions by 26%.

Generation, Load, and the Grid

Electrical generators produce power that is fed into the transmission system, also known as the grid. Consumers of electricity, known as load, take power from the grid. The grid is composed of transmission and distribution lines that connect and transmit electricity between all of the generators and load on the system.

With the exception of northern Maine which is electrically connected to New Brunswick rather than southern Maine, all of the generators and load in New England are tied together electrically by the grid. Because all of New England is connected, the electrical performance in one part of the system affects all areas of the system. It also allows the six New England states to participate in a single market for wholesale electricity that serves the needs of the entire region. A wind energy plant in Maine competes with every other electric generator in the region. Because wind power has no marginal costs, its bid to supply electricity will be at the lowest cost, thereby reducing prices for Maine rate payers as well as those in the rest of New England. The

2 *ISO New England Weekly Market Performance Reports*, Week Ending March 3, 2013. http://iso-ne.com/markets/mkt_anlys_rpts/wkly_mktops_rpts/index.html

New England electrical system serves approximately 14 million people with over 300 generators and is connected by over 8,000 miles of high voltage transmission lines.[3]

Load Must Equal Generation

The high voltage transmission lines, the backbones of the New England grid, and the wholesale power that flows over them are managed by the Independent System Operator of New England (ISO-NE). To operate reliably, the amount of power being put into the grid by generators and the amount of power being taken from the grid by load must be balanced at all times.

Because the load in New England is constantly fluctuating, the fleet of generators must match their production to the load fluctuation in order to produce exactly the amount of power that is being consumed at any point in time. ISO-NE manages the process of telling generators when to turn on or off and how much electricity to produce . They manage the wholesale markets and determine which generators are needed and when they are needed based on a load forecast, economics, and physical reliability constraints.

Variations in Load

There are annual variations in load which mean that some generators are only used during certain parts of the year, typically in the summer when New England load is at its highest. There are daily variations in load that must be matched by turning some generators on and off during the day (called unit commitment) and having other generators ramp their output up or down over the course of the day to match the trends in load (called load following). There are also second-to-second and minute-to-minute variations in load that cannot be predicted but must be matched

[3] *ISO New England Regional System Plan* 2010 (RSP10) at page 15-16. Regional System Plans are released annually and are available at http://iso-ne.com/trans/rsp/index.html.

by generation. A select number of generators receive automated signals from ISO-NE to balance those very quick variations (called regulation).

ISO-NE also needs to maintain a specified level of reserve generation at all times to be able to respond to errors inherent in the load forecast. If the load is higher than expected, these reserves are dispatched (instructed to produce power) to make up the difference. If load is lower than expected, ISO-NE tells generators to reduce their output or even turn off.

ISO-NE is not concerned with the precise amount of power each individual load is consuming. They do not dispatch individual generators to follow the patterns of individual loads. The load patterns of an individual house would look very erratic with huge shifts from one moment to the next as lights and appliances are switched on and off. ISO-NE only needs to pay attention to the system load and make sure the generation fleet as a whole balances the system load. Because the 14 million people being served by ISO-NE do not turn their lights and appliances on and off in synch with each other, a graph of the total system load appears smoother than the load of an individual house. Wind energy, as described next, is very similar in this respect.

Wind Power Variability Decreases as Installed Wind Increases

Wind power output varies primarily with wind speed. Because wind speed is constantly changing, there is inherent variation in the power output from wind plants. Wind speeds vary from one location to another across the region. Even within an individual wind plant there will be variations in the wind speeds from one wind turbine to another and some wind turbines may be increasing power production when other turbines in the same project are decreasing. From one wind plant to another, this spatial variation effect is even stronger and the output from one plant to another correlates more weakly the further apart they are.[4]

An empirical study of long-term high resolution wind speed data performed by the US Department of Energy's National Renewable Energy Laboratory's National Wind Technology Center showed that "despite their close proximity, instantaneous outputs from individual turbines of a large wind farm are not synchronized. Physical separations and differences of local terrains cause wind speeds at each turbine to vary."[5] Further, "as more and more wind generating plants over a wider area are integrated into the grid, spatial diversity of the wind resources will make the overall wind power much less volatile than the output from any individual wind farm."[6]

New England Can Feasibly Integrate 12,000 MW of Wind Energy

ISO-NE released NEWIS in December 2010.[7] This two-year effort looked into the operational impacts of integrating substantial amounts of wind generation into the New England system. It studied a number of scenarios ranging from approximately 2.5% to 24% of annual electricity demand being met by wind energy (1,140 MW to 12,000 MW installed wind).[8] These study levels do not represent an expectation for the amount of wind that will be installed within New England, but they are useful for answering a number of hypothetical questions relevant to the long-term system planning process over a range of potential future scenarios. For comparison, wind currently produces between 1% and 2% of New England's electricity.

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[4] Wan, Y. (2005), *Primer on Wind Power for Utility Applications*, 45 pp.; NREL Report No. TP-500-36230. http://www.nrel.gov/docs/fy06osti/36230.pdf . (Wan) at page 15.
[5] Wan at page 13.
[6] Wan at page 16.
[7] *Final Report: New England Wind Integration Study*, Prepared for ISO New England, Prepared by GE Energy Applications and Systems Engineering, EnerNex Corporation, and AWS Truepower. December 5, 2010. Available at http://iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/reports/2010/newis_report.pdf
[8] In February 2011, wind produced 1% of the total electricity generated in New England. In the state of Maine that figure rises to an impressive 7.9%. *See* U.S. EIA, *Electric Power Monthly*, May 2011 Edition, Tables 1.6.A and 1.17.A.

The NEWIS results showed that, with the current fleet of existing generation and demand response resources, New England could feasibly integrate even the highest levels of wind energy studied. Even when looking at 12,000 MW of wind energy on the system, no additional generators would be needed to balance the variations in wind energy output. The study assumed that there would be no major attrition of existing generators or demand-side resources and that these existing resources would remain available to provide system flexibility.[9]

Due to the variable nature of wind, many people expect that electrical storage is needed in order to "smooth out" wind power generation to make it look like the output from many conventional generators. Except in the case of small island systems such as Hawaii, this is generally not the case. In New England we have a number of pumped-storage hydro facilities that are used for electricity market arbitrage. When electricity prices are low, these facilities consume electricity by pumping water uphill to a storage reservoir. When electricity prices are high, these facilities produce electricity by running that same water downhill and through a turbine. This is the only large-scale electricity storage that exists in New England today.

If electricity storage were an essential part of operating a power system with significant amounts of wind energy, one would expect that pumped-storage hydro utilization would increase with increasing amounts of wind energy. Quite the opposite, the NEWIS study showed relatively little increase in the use of existing pumped-storage hydro. NEWIS found that the required balancing of net load (load minus wind generation) was provided adequately by the flexibility of the existing generation fleet. Further, the wind generation had the effect of

[9] NEWIS page 205.

reducing the price differential between on-peak and off-peak pricing, reducing the opportunities for market arbitrage.[10]

Wind Operates as a Price-Taker in Wholesale Markets, Driving Down Costs

ISO-NE operates competitive wholesale electricity markets that select which producers of electricity can meet the regional demand at the least cost. This is done through an auction process in which ISO-NE stacks up all of the offers to supply electricity from lowest cost to highest cost (called a supply curve). The price at which the vertical line that represents the demand for electricity crosses the supply curve is the auction clearing price. All supply offers at or below that price "clear" in the auction and are asked to produce their offered power. The highest priced offer that is selected by ISO-NE sets the price that all generators are paid for their electricity. This process is depicted graphically in Figure 1, where the three vertical blue lines represent light load, moderate load, and peak load as might be experienced in the middle of the night, in the morning hours, and on a summer afternoon.

[10] NEWIS page 33.

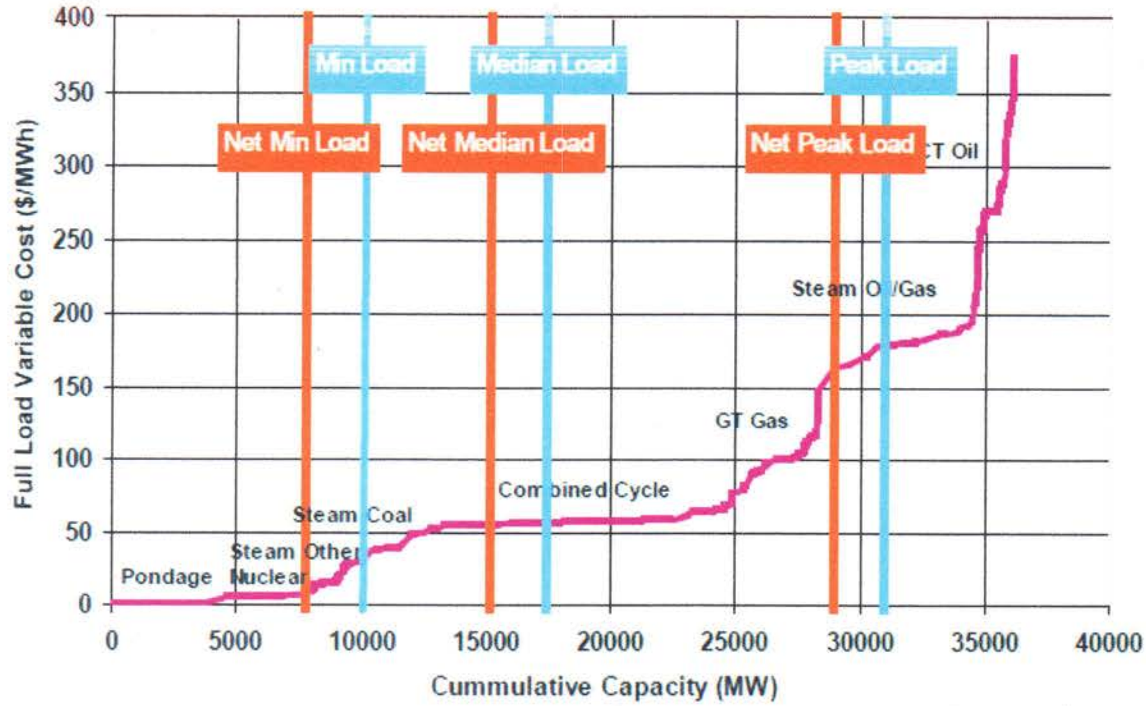

Figure 1 – Representative ISO-NE supply curve for the year 2020 assuming 100% of the region's conventional generation is available. Regional electricity demand levels (load) and demand minus wind generation (net load) levels are represented by the blue and orange lines respectively, showing example marginal fuel type and cost.

Generators bid their variable cost of producing energy (fuel cost, variable operations and maintenance, and emissions cost) into the auction. Capital costs and other fixed costs are not considered in these offers. Hydro power and nuclear power have very low variable costs to produce electricity so they represent the bottom of the supply curve. At the other end of the supply curve, the oil-fired combustion turbines represent the highest-cost resource type represented. The costs depicted in Figure 1 assume relatively low natural gas fuel prices, but in reality can vary widely as fuel costs fluctuate.

Since wind energy does not have a fuel cost and has minimal operations and maintenance costs,[11] its variable cost of providing energy is lower than that of any electrical power plant that must purchase fuel to produce electricity. For this reason, wind typically operates as a "price-taker" in the wholesale energy markets, bidding in the equivalent of $0/MWh to produce energy.

When demand for electricity is low, ISO is generally able to meet the demand with all low-cost generators, as represented by the blue line labeled "min load". When demand is high or many of the low cost generators are not available, ISO has to reach higher up the supply curve to meet the demand, resulting in higher electricity prices as represented by the blue line labeled "peak load".

Subject to available transmission capacity, price-taking energy like wind will always clear in the market and displaces the need to purchase energy from the most expensive generators. Adding zero-cost energy offers like wind to the bottom of the supply curve shifts the supply curve to the right, which has the same effect as reducing the demand for electricity. This effect can be visualized by shifting the demand from the blue to the orange vertical lines. As the vertical demand line shifts to the left, the energy clearing price is reduced and it costs less to provide electricity to the region. This shift also avoids using more carbon intensive fuels from less efficient generators.

Natural Gas Price Volatility Drives Energy Market Volatility

Wholesale electricity prices in New England are driven primarily by natural gas prices, with natural gas producing 51% of the electricity generated in the region and setting the

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[11] Average wind O&M costs are equivalent to $0.01/kWh. 2009 *Wind Technologies Market Report*, U.S. Department of Energy, Energy Efficiency & Renewable Energy. August 2010. Page 54. Available at: http://www1.eere.energy.gov/windandhydro/pdfs/2009_wind_technologies_market_report.pdf&id=4381

wholesale price of electricity 76% of the time over the past year.[12] Volatility in the gas market is consequently the primary driver of volatility in the electricity market, as can be seen clearly in Figure 2.

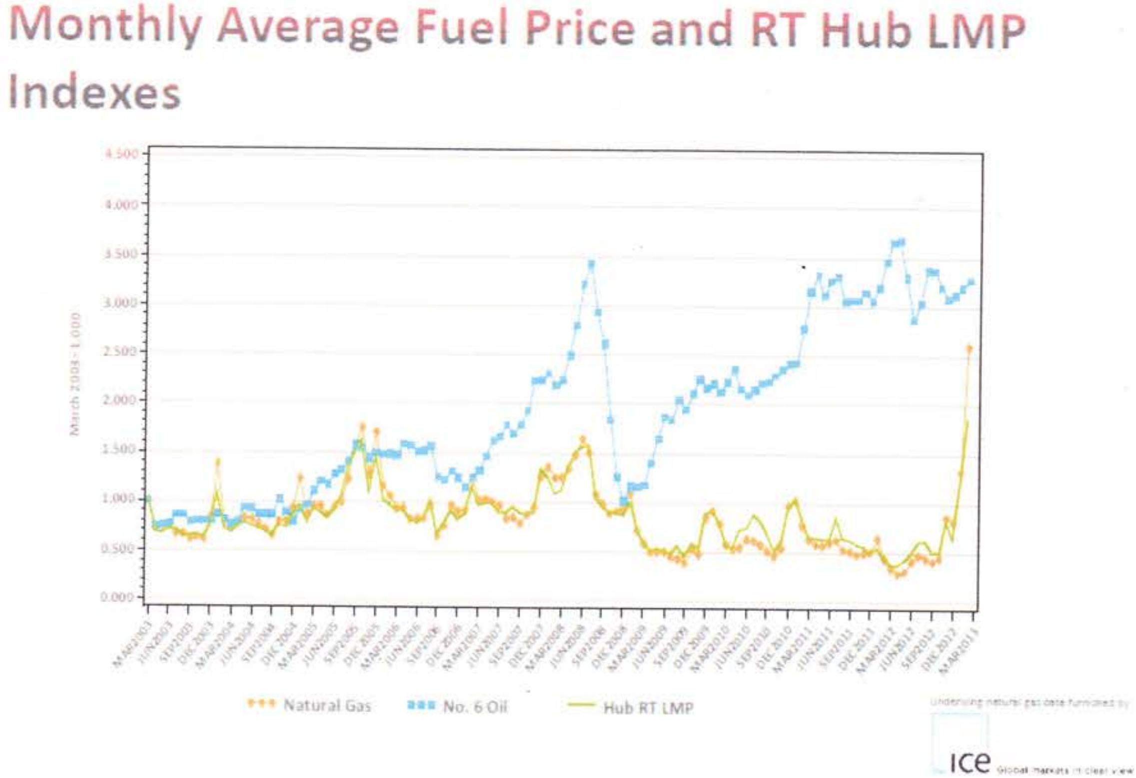

Figure 2 Natural gas and wholesale electricity prices in New England are linked and volatile. Source: ISO New England Chief Operating Officer Report, March 1, 2013.

As an indication of how volatile the electricity markets have been due to gas price fluctuations, Maine reached its all-time low monthly-average real-time electricity price of $0.0294/kWh in February 2012 with natural gas prices of around $3/MMBtu. One year later, in February 2013, the average real-time price in Maine was nearly three and a half times higher,

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[12] *ISO New England Weekly Market Performance Reports*, Week Ending March 3, 2013. http://iso-ne.com/markets/mkt_anlys_rpts/wkly_mktops_rpts/index.html

$0.102/kWh. This was within one percent of its all-time record high, driven by regional gas prices of $21/MMBtu.[13]

Price Stability and Savings from Long Term Contracts for Wind Energy

Not all energy is purchased in wholesale markets. Much of it is purchased through bilateral contracts or power purchase agreements that may or may not be below market rates. Because wind energy projects are capital intensive, they typically look for long-term energy contracts to guarantee energy payment levels.

In 2009 the Maine Public Utilities Commission approved a twenty-year contract between Central Maine Power and Bangor-Hydro-Electric Company and First Wind's Rollins Wind Project in Penobscot County. This contract specified that the energy would be sold at a specified discount from the actual market price with a floor price of $0.055 - $0.065/kWh and a cap of $0.110/kWh. Rollins Wind was the only project selected out of this competitive process.

NSTAR selected First Wind's Bull Hill Wind project in Hancock County in response to their 2010 Request for Proposals for long-term renewable energy contracts. Pricing details were kept confidential, but speculation in the media has been that the fixed-price 15-year contract was for less than $0.10/kWh. Bull Hill was one of three projects selected in this competitive process, proving First Wind's track-record for developing wind farms in Maine that are competitively priced and save ratepayers money.

Whether these long-term contracts end up being above or below market rates depends on fuel prices over time. What they do provide is certainty. Unlike wind, a fossil fuel power plant cannot guarantee its fuel prices one year into the future, let alone ten to twenty years into the future, so it cannot lock in a power sale price to guarantee stable pricing for consumers.

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13 ISO-NE COO Report March 1, 2013

Compared with the market prices that Maine saw for electricity in the early part of 2013, long-term wind energy contracts provide measurable savings to consumers in addition to providing a hedge against price volatility.

All energy purchased through these types of bilateral contracts still needs to be accounted for by ISO-NE and is generally entered into the wholesale market as a price-taker. Therefore, regardless of the long-term contract price, wind energy can still suppress market prices for the energy that has not been purchased through contract. In this way, long-term contracts for wind can also reduce overall regional energy prices indirectly.

Wind Energy Has Been Shown To Reduce Electricity Prices

The experience Texas has had with wind energy serves as a model for what Maine might expect. Wind development in Texas has predominantly occurred in the western part of the state while the major load centers are in the eastern part of the state. Due to transmission constraints for power flows between the western and eastern parts of the state, the western regions have become export constrained. This is not entirely dissimilar from the situation Maine is in with the rest of New England. Maine is also export constrained at times and holds the potential for the majority of on-shore wind development in New England.

In January 2011, the Public Utilities Commission of Texas released a report to the Texas Legislature on the scope of competition in electric markets in Texas.[14] The report finds from Texas's operational experience that balancing energy market prices "are typically lower in the West zone because the West zone is export constrained and prices within that zone are affected by the large amount of low-cost wind energy."[15]

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[14] *Scope of Competition in Electric Markets in Texas*, Report to the 82nd Texas Legislature. Public Utilities Commission of Texas, January 2011. http://www.puc.state.tx.us/electric/reports/scope/index.cfm

[15] *Scope of Competition* at page 53.

We have already seen a similar impact of wind energy on pricing in Maine. On May 25, 2011, First Wind announced a Power Purchase Agreement (PPA) with New Brunswick Power to sell the energy from their Mars Hill project for four years. New Brunswick Power had won the opportunity to provide standard offer service to all customer classes in Northern Maine earlier that year by offering a reduction in electricity prices of 10 to 21%. The use of locally-produced wind power as one of the energy sources being used was cited as one reason for the decrease in Northern Maine consumers' energy bills.

In 2011 ISO-NE elected to perform an economic study looking at the near-term potential for wind energy development in Maine and the rest of New England to reduce the cost of electricity. The study found that if the region's wind capacity increases from 892 MW, approximately what will be installed by the end of 2013, to 3,926 MW, approximately what would be needed to meet the New England states' combined 2021 Renewable Portfolio Standard targets, the savings would be enormous. ISO-NE estimated that Load Serving Entity Energy Expense, roughly what consumers pay in the wholesale energy market, would decrease by $996 million per year. That's a 12.7% decrease and is equivalent to $328,000 in annual savings for each additional MW of wind that is installed. That works out to $108 in savings for every MWh produced from the additional installed wind. First Wind estimates that the Bowers Wind project will produce approximately 157,000 MWh annually,[16] which according to the ISO-NE figures could result in savings to load of approximately $17 million per year.

The economic study also found that the transmission system in the region of Maine north of Orrington, where the Bowers Wind project is being proposed, could accommodate over 1,000

[16] First Wind Submits New, Smaller Bowers Wind Project Proposal. October 31, 2012. http://www.firstwind.com/sites/default/files/Bowers%20Endorsement%20Release_FINAL_103112.pdf

MW of wind without increased curtailment of the energy from those projects. This represents a roughly four-fold increase over the wind capacity installed there today.[17]

The Need For New Electric Generation Capacity

Although New England has about 2,000 MW more electrical capacity than what ISO-NE predicts will be required to meet load growth over the next ten years,[18] the region will need additional capacity to replace unit retirements. ISO-NE has identified nearly 8,300 MW of oil- and coal-fired generators that are at least 40-years old and could be at risk of retirement by the end of the decade.[19] If all of this generation is replaced with natural gas, that will exacerbate the region's dependence on this single fuel source, increasing both economic and reliability risks to the region. Adding more wind power to Maine's electrical capacity will counter the region's overdependence on natural gas.

New England Needs Fuel Diversity

In its recent Winter Operations Summary, ISO-NE detailed its "immediate and growing" economic and reliability concerns due to the region's increasing reliance on natural gas-fired electrical generation. The report speaks about natural gas and oil fired generation "causing persistent reliability concerns" due to fuel-supply uncertainty and states that "the region's growing dependence on natural gas for power generation is a rapidly-escalating strategic risk for the region."

Natural gas price indices rose to $35/MMBtu in January, causing Maine wholesale

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17 GridView *Results for 2011 Economic Study Request*, presented to the ISO-NE Planning Advisory Committee at its January 17, 2013 meeting. http://iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2013/jan172013/index.html

18 RSP12 page 51

19 *Strategic Transmission Analysis: Generation Retirements Study*, Presented by ISO-NE to the Planning Advisory Committee December 13, 2012.

electricity market prices to rise to 222% of what they were in January 2012. In February the effect was even more pronounced as prices increased to 348% of what they were in February 2012.

The constraints on the natural gas system that lead to higher prices and reliability concerns become most pronounced during the winter period due to increased use of natural gas for heating. This is also when wind energy production in New England is known to peak. On February 9, 2013, as winter storm Nemo caused over 6,000 MW of generation outages across the region, wind generators in New England averaged 385 MW output, a roughly 50% capacity factor. This is in comparison to about 2,000 MW of gas-fired generators that ISO called upon that day that reported they were unavailable because they could not procure gas. Had more wind been installed in New England, there would have been less pressure on the natural gas system that day.

The Winter Operations Summary was a clarion call for increased fuel diversity to relieve the strain put on natural gas supplies. Renewable resources, wind energy in particular, are the most viable and likely generation type to fill that need in the coming years. Besides natural gas and renewable resources, it is unlikely that significant levels of other types of generation will be built in New England in the near future. Wind energy, because of its economics and its winter-peaking nature is a nearly ideal energy source for relieving the region's natural gas concerns.

Fossil Fuels Produce The Majority of Electricity in New England

Fossil fuels produced 58% of the electric energy used in New England in 2011, compared with 68% nationally.[20] While New England's energy mix and emissions are relatively cleaner than the national average, the majority of our power is still being produced by carbon-emitting fossil fuels.

[20] RSP12 page 120.

Though the rest of the nation has long-since almost completely stopped generating electricity from oil, New England is unique. Generators fueled primarily by oil make up 22% of New England's capacity mix, compared with 5% nationally.[21] As recently as 2000, oil-fired units were responsible for 22.0% of the annual electricity produced in New England due to the price of oil being lower than natural gas.[22]

Because the price of oil has been substantially higher than the price of natural gas since early 2009, oil-fired units have rarely cleared in the energy market auctions and have produced less than 1% of the electricity in New England over the last four years.[23] The region has seen a significant reduction in power plant emissions in this time due to the limited oil generation. However, for the first time in years, the price of natural gas exceeded the price of oil in New England in February 2013 leading to a brief up-tick in oil generation.

The ISO New England Regional System Plan 2005 states: "An increasing energy use and rising natural gas prices relative to oil prices will tend to increase generating plant production by oil units, resulting in higher total air emissions in New England... Conservation efforts and renewable resources will reduce emissions and encourage greater fuel diversity."[24]

Wind Energy Displaces Fossil Fuel Energy

As discussed above, generation must always match load and each type of resource is another tool in ISO-NE's toolkit to maintain this balance. Wind energy is not an exception. When wind energy is produced and fed onto the grid it must displace energy that would have been produced by another generator. Because ISO-NE uses economics to determine which

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[21] RSP12 page 119. This does not account for dual-fuel units that burn either natural gas or oil, which represent an additional 23% of New England's capacity mix according to RSP 12.
[22] RSP11 page 9.
[23] RSP10, RSP 11, RSP 12.
[24] RSP05. page 20.

plants should produce power, wind energy will displace the most expensive energy that can be backed down without violating reliability standards. NEWIS found that wind in New England would primarily displace energy from natural gas combined cycle generation, as this is typically the most expensive and flexible power being generated. With increasing quantities of wind installed, NEWIS also showed limited but increasing displacement of coal energy. Although there is very little generation from oil at this time in New England, the wind scenarios in NEWIS all appear to displace the little oil generation that there would have been.[25]

Figure 3 and Figure 4 show the simulated dispatch for one peak-load week with and without wind generation. The lightest blue color represents peaking oil-fired steam turbines. There is a fair amount of energy produced by the oil peakers in the no-wind simulation, but this is almost entirely eliminated in the 20% wind simulation.

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[25] NEWIS at pages 221, 262, 294, 297, 302, 303, 304, 306, 307 and *Overview of ISO New England and Near Final Results of the New England Wind Integration Study*, Bill Henson, ISO-NE. NEWEEP Wind Integration Webinar, October 26, 2010. Slide 27. Available at: http://www.windpoweringamerica.gov/newengland/filter_detail.asp?itemid=2837

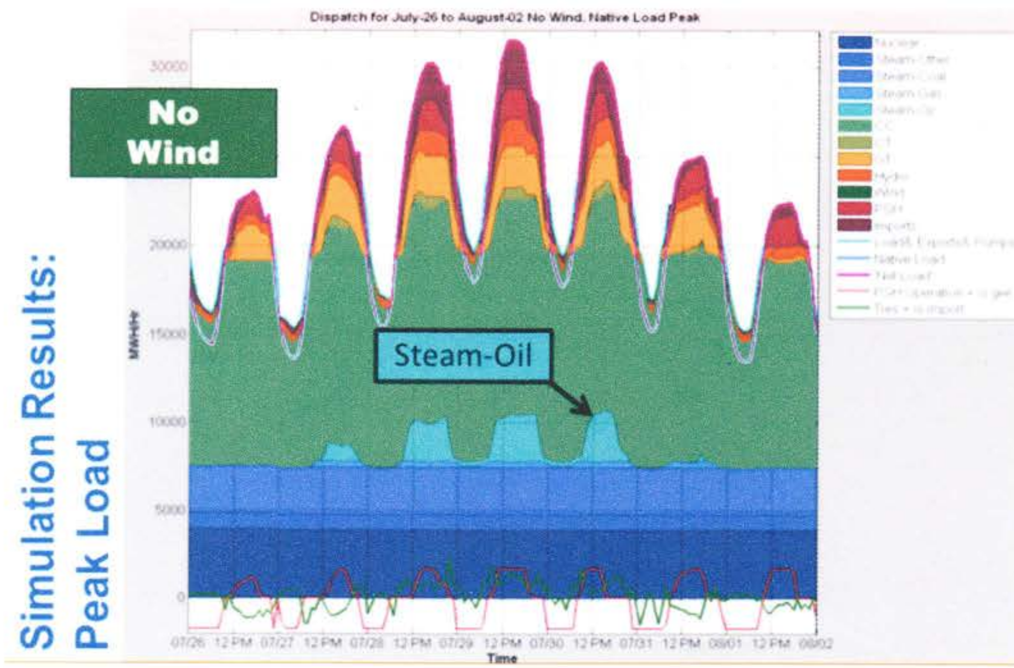


Figure 3 NEWIS dispatch simulation results for a peak load week with no wind[26]

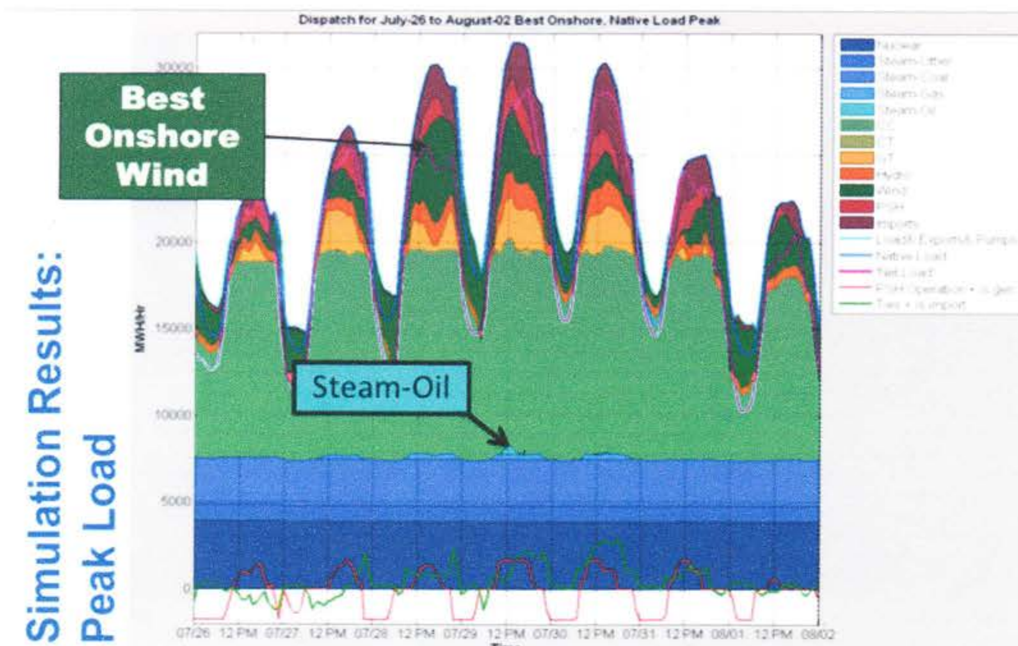
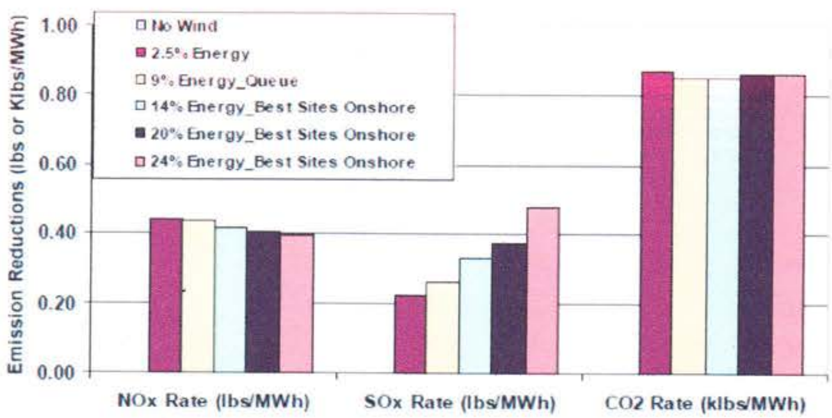


Figure 4 NEWIS dispatch simulation results for a peak load week with 20% wind generation, "Best Onshore Wind" scenario[27]

[26] *Overview of ISO New England and Near Final Results of the New England Wind Integration Study*, Bill Henson, ISO-NE. NEWEEP Wind Integration Webinar, October 26, 2010. Slide 27. Available at: http://www.windpoweringamerica.gov/newengland/filter_detail.asp?itemid=2837 . (NEWEEP) slide 23.

Wind Energy Leads to Increasing Emissions Reductions

With 20% of New England's energy provided by wind power, NEWIS found NO_X emissions would be reduced by approximately 26%, SO_X emissions reduced by 6%, and CO_2 emissions reduced by 25%.[28] As shown in Figure 5, at low levels of wind penetration wind would offset carbon dioxide emissions in proportion with the wind levels. As wind penetration levels rise, the carbon dioxide emission reductions actually grow faster than the wind levels.[29]



Wind Penetration (Energy)	CO2 Reduction
2.5%	2.5%
9%	9%
14%	17%
20%	25%
24%	30%

Figure 5 - Emission reductions found in the NEWIS for the "Best Sites Onshore" scenarios at varying wind penetration levels

This is consistent with an independent scientific study performed by the National Academy of Science. This 2007 report estimated that onshore wind energy development would contribute about 1.2% to 4.5% of U.S. electricity generation in 2020. Based on this projection, the study gave a potential range of CO_2 emissions reductions from electricity generation of 3.8% to 7.1%.[30]

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[27] NEWEEP slide 24.
[28] NEWIS page 26.
[29] NEWEEP slide 28.
[30] *Environmental Impacts of Wind-Energy Projects*, Committee on Environmental Impacts of Wind Energy Projects, National Research Council of the National Academies, 2007. Pages 64-65. Available at: http://books.nap.edu/catalog.php?record_id=11935

Conclusions

- Wind energy in Maine has positive economic and environmental impacts.
- Electrical generation and load must be balanced at all times. When wind energy is produced, it must displace energy that would have been produced by another source.
- Wind has almost no marginal cost for producing electricity once it is built so it typically acts as a price-taker in the wholesale electricity markets.
- Price-taking energy, like wind, displaces more expensive energy in the markets, keeping power prices low.
- The 2011 Economic Study by the Independent System Operator of New England (ISO-NE) estimates that these savings could amount to approximately $108 per Megawatt hour of wind energy. With Bowers Wind's production estimates, this would result in $17 million in annual savings.
- NEWIS found that up to 12,000 MW of wind could be integrated without the need for additional electrical storage.
- NEWIS also found that no additional power plants would be needed to balance the additional variations expected from up to 12,000 MW of wind energy in New England.
- Fossil fuels produce the majority of electricity in New England. Wind would primarily displace natural gas and oil and increasing amounts of coal electricity as more wind is installed.
- ISO-NE has stated that "the region's growing dependence on natural gas for power generation is a rapidly-escalating strategic risk for the region." Wind energy provides needed fuel diversity and a hedge against natural gas price volatility and supply disruptions.

- The New England Wind Integration Study (NEWIS) found that if 20% of New England's electricity were supplied by wind it would reduce the region's electricity-related CO_2 emissions by 25%, SO_x emissions by 6%, and NO_x emissions by 26%.

Dated: March 13, 2013

Abigail Krich

STATE OF MASSACHUSETTS
COUNTY OF MIDDLESEX

The above-named Abigail Krich has made oath and personally attested to me that the foregoing is true and accurate to the best of her knowledge and belief.

Dated: March 13th, 2013

Notary Public
My Commission Expires:

SITA SHRESTHA
Notary Public, Commonwealth of Massachusetts
My Commission Expires March 24, 2017