In its June 29, 2016 Comments to LUPC (“ISO Comments”), ISO-New England (ISO-NE) identifies constraints that exist in the Maine transmission system and the need for upgrades to accommodate new generation. Although constraints exist, there are a number of reasons why the existing transmission system should be able to accommodate the Bryant Mountain project.\(^1\)

The map included as Exhibit A identifies Maine’s major interfaces and the key constraint areas identified by ISO-NE in its comments. This map was included in a December 18, 2014 report that ISO New England presented to the ISO-NE Planning Advisory Committee, *Strategic Transmission Analysis: Wind Integration Study: Maine and Northern Vermont Updates* (“2014 ISO Study”). The key interfaces are the Orrington-South interface in northern Maine, the Surowiec-South interface in southern Maine, and the Maine-New Hampshire interface at the Maine and New Hampshire border. They are depicted by the green-dashed lines on Exhibit A. There are several more localized constraint areas, shown in purple dashed lines on Exhibit A. They include the Keene Road, Wyman Hydro, and Rumford export areas. The most constrained area is north of the Orrington-South interface and, in particular, north of Keene Road. ISO-NE notes in its comments that the major constraint that affects new wind generation is located in northern Maine. (ISO Comments at pp. 2-3.)

The northern Maine constraint identified by ISO-NE does not affect the Bryant Mountain project, which is located south of Rumford and therefore is not affected by the constraints in the system to the north.

The Bryant Mountain project is subject to the Surowiec-South and Maine-New Hampshire interfaces and constraints that might exist in those locations but, as discussed below, ISO-NE has studied those constraints and the impact they might have on wind generation and concluded they are minimal. In the March 28, 2016 report by ISO-NE and presented to the ISO-NE Planning Advisory Committee Meeting, *2015 Economic Study Strategic Transmission Analysis – Onshore Wind Integration Draft Results* (“ISO Economic Study”), it was determined that Maine Interface Upgrades would produce: **“Little to no savings: Infrequent interface constraints and small amounts of bottled-in energy.”**\(^2\) Meaning that because wind generation is not constrained for significant amounts of time, there would be minimal economic benefit to

---

\(^1\) As discussed in my initial June 29, 2016 Letter that was Exhibit B to EverPower’s pre-filed testimony, the project will undergo a multi-year system impact study at ISO-NE that will identify any specific upgrades required as part of the project interconnecting with the electrical grid. The costs of those upgrades will be paid for by the generator.

\(^2\) A complete copy of the ISO Economic Study is included as Exhibit C. This reference is on slide 14 associated with dispatch scenarios 1,2,3 and 4, which are existing generation plus generation north of Surowiec interface 453, 623, 857, 1149MW.
implementing upgrades to reduce or eliminate those constraints. Further, upgrades associated
with projects as required by ISO-NE studies actually often increase transmission capacity and
reduce congestion on the system.

When ISO-NE discusses capacity of the existing transmission system, typically it is
evaluating the ability of the system to operate during periods of peak demand. Wind resources
typically do not operate at maximum capacity during periods of peak demand. For example,
wind projects have a lower output during the summer, when demand in New England peaks.
Therefore, the potential constraints identified by ISO-NE, which occur during periods of peak
demand, typically do not limit operation of wind power projects. This is evident in Exhibit B,
which includes several slides from the ISO Economic Study. Slide 61 depicts flows across the
Maine-New Hampshire interface and shows that during 2015 that interface was not constrained
for wind or any other resources. Similarly, Slide 53 depicts flows across the Surowiec-South
interface and shows that during 2015 that interface was not constrained for wind or other
resources. It is possible those interfaces could be constrained during periods of higher demand
not experienced in 2015, and ISO-NE specifically evaluated the potential for constraints at those
interfaces under several hypothetical scenarios. The ISO Economic Study evaluated several
scenarios, including a scenario in which all of the wind that was in the ISO-NE queue as of April
1, 2015 (identified as Scenario 6 on Slide 8 of Exhibit B, and which includes approximately
3,727 MW of wind power in addition to the 453 MW of wind power that was then in service in
Maine) was operating. Under this scenario, there would be significant constraints at the
Orrington-South interface, but no constraints at the Maine-New Hampshire interface, and
minimal constraints at the Surowiec South interface. Exhibit B Slide 15. This study takes into
account the variable nature of wind generation and aligns it with load as well as price signals
which encourage other generators to operate, and as such it provides a more complete picture of
the impact that existing transmission constraints might have on operation of existing and new
wind resources.

In short, although there are constraints in the existing system, the Bryant Mountain
project is not located in the areas of most significant constraints. Additionally, the constraints do
not significantly affect wind resources, which do not operate during periods of time of maximum
constraint in the system.

It has also been noted that there is a significant volume of wind generation proposed in
the ISO-NE generation interconnection queue. Not all projects in the interconnection queue
proceed to the next phase of study or are ever built. For example,3 since 1996, less than 5,000
MW out of a total of 65,000 MW of proposed interconnections (including Elective Transmission
Upgrades, which may only be elimination of congestion bottle necks vs. actual new generation)
proceeded to the stage of filing an Interconnection Application. (The information from 1996-

---

3 Based on the ISO New England Generator Interconnection Queue as of 7/28/2016
2004 is limited and it is likely the number of proposed interconnections is even higher.) In recent months, there have been a number of market signals (for example, Massachusetts, Rhode Island and Connecticut have issued a joint request for clean energy and transmission to deliver that clean energy) that have promoted competing applications of renewable generation into the ISO-NE queue, much of which will never come to completion. As reflected in the ISO Comments, the majority of proposed wind development in Maine is in northern Maine, Aroostook County. (ISO Comments at 3.) There is only minimal new generation proposed in Oxford County (63 MW, which includes the 40 MW Bryant Mountain project).

Jeffrey H Fenn P.E.
Director Electrical Engineering
EXHIBIT A
Strategic Transmission Analysis: Wind Integration Study: Maine and Northern Vermont Updates

Planning Advisory Committee

Stan Doe
Manager, Transmission Strategy
Maine’s Major Interfaces and Relationship to Wind Resources
EXHIBIT B
2015 Economic Study
Strategic Transmission Analysis – Onshore Wind Integration
Draft Results

Planning Advisory Committee Meeting

Jessica Lau and Wayne Coste

System Planning
2015 Historical Interface Flow (MW)
Maine – New Hampshire (1,900 MW limit)
2015 Historical Interface Flow (MW)

Surowiec South (1,500 MW limit)

Surowiec South Interface Duration Curve: Net Flow MWs
January - December 2015
## Wind Scenarios

### New England Wind Nameplate (MW)

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Maine</th>
<th>Outside of Maine</th>
<th>New England Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>453</td>
<td>426</td>
<td>878</td>
</tr>
<tr>
<td><strong>2</strong> RENEW Sensitivity 1 (Less Wind) *</td>
<td>623</td>
<td>426</td>
<td>1,049</td>
</tr>
<tr>
<td><strong>3</strong> Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>857</td>
<td>489</td>
<td>1,345</td>
</tr>
<tr>
<td><strong>4</strong> RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>1,149</td>
<td>426</td>
<td>1,575</td>
</tr>
<tr>
<td><strong>5</strong> RENEW Sensitivity 2 (More Wind)*</td>
<td>2,084</td>
<td>426</td>
<td>2,510</td>
</tr>
<tr>
<td><strong>5_{NB}</strong> RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>2,084</td>
<td>426</td>
<td>2,510</td>
</tr>
<tr>
<td><strong>6</strong> All Future Queue Wind in New England (as of 4/1/15)</td>
<td>3,727</td>
<td>678</td>
<td>4,405</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding

*Outside Maine, assumed only "existing wind" as of 4/1/15
## Percent of Time Interface is at Limit (% of Year)

*Orrington South is the most limited and leads to minimal congestion at Surowiec South and ME-NH*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Orrington South Export Limit</th>
<th>Surowiec South Export Limit</th>
<th>ME-NH Export Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre- Upgrades (1,325 MW)</td>
<td>Post- Upgrades (1,650 MW)</td>
<td></td>
</tr>
<tr>
<td>1. Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. RENEW Sensitivity 1 (Less Wind) *</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5. RENEW Sensitivity 2 (More Wind)*</td>
<td>43</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>5\textsubscript{NB} RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>83</td>
<td>57</td>
<td>0</td>
</tr>
<tr>
<td>6. All Future Queue Wind in New England (as of 4/1/15)</td>
<td>69</td>
<td>52</td>
<td>0</td>
</tr>
</tbody>
</table>

*Outside Maine, assumed only "existing wind" as of 4/1/15*
2015 Economic Study
Strategic Transmission Analysis –
Onshore Wind Integration
Draft Results

Planning Advisory Committee Meeting

Jessica Lau and Wayne Coste
SYSTEM PLANNING
Outline

• Overview
• Background and Assumptions
• Study Results
• Appendix
  I. Scenarios
  II. Generation by Resource Type Metrics
  III. Air Emissions Metrics
  IV. Bottled-In Energy Metrics
  V. Interface Flow Metrics
  VI. LMP Metrics
  VII. Modeling Assumptions
Overview

• The ISO is performing three 2015 Economic Studies
  – Keene Road area wind development and analysis of local interface constraints (request by SunEdison)
  – Offshore Wind Deployment (request by Massachusetts Clean Energy Center)
  – Maine Upgrades Identified in ISO-NE’s Strategic Transmission Analysis for Wind Integration – Onshore Wind (request by RENEW Northeast)

• Today the ISO is seeking PAC input on the draft results of the Strategic Transmission Analysis – Onshore Wind
  – Estimate extent that transmission constraints are binding
  – Measure the economic benefits of relieving those transmission system constraints

• This analysis includes future resources in some scenarios, but may not account for all the necessary transmission facilities associated with the interconnection of the resource
  – All future constraints may not be captured in this analysis

• Final study results and report will be completed after consultation with the PAC
  – The results may be used to inform the region on the needs for future transmission upgrades in the Maine area
Background

• The Onshore Wind – Strategic Transmission Analysis scope of work and assumptions were developed with PAC input at the May and June 2015 meetings
  – Scope of Work
  – Study Assumptions
  – Stakeholder Comments on Scope of Work
Background

Strategic Transmission Analysis

2012-2014

• ISO-NE conducted the Strategic Transmission Analysis for Wind Integration (STA-WI)
  • Designed to understand transmission constraints in Maine affecting wind resources in northern New England
  • Focused on potential upgrades that would not require major new transmission construction

2016

• ISO-NE will conduct an updated Strategic Transmission Analysis for Maine as discussed in 3/28/2016 PAC agenda item 2.0
  • The Maine transmission topology has changed
  • Some upgrades identified in the previous study have been implemented
  • Some upgrades are no longer appropriate for current system
Background

2015 Economic Study of Strategic Transmission Analysis – Onshore Wind

**Study Objective:** Evaluate the impact of increasing transfer capability along the Maine corridor

- The effect of increasing transfer limits of major ME interfaces
  - Were identified in the Strategic Transmission Analysis – Wind Integration
  - Higher ME interface limits are not directly attributable to specific transmission upgrades

- Pre-contingency thermal limits are respected in the Gridview software
  - Operation of wind resources can be constrained by local thermal limits

- Other local constraints are not modeled
  - Local, voltage and stability constraints
    - E.g. Keene Road, Wyman and Rumford areas
  - Could constrain the operation of impacted resources
Key Study Assumptions

Study Year 2021

- System Characteristics
  - 2015 CELT loads, EE & PV Forecast
  - FCA #9 resources with a Capacity Supply Obligation (CSO) and 2015 CELT resources without a CSO
  - NREL wind hourly profiles
  - Hourly imports and exports available for dispatch
  - 2015 EIA Annual Energy Outlook Fuel Forecast

<table>
<thead>
<tr>
<th>ME Interface Export Limit</th>
<th>Pre-Upgrades Cases (MW)</th>
<th>Post-Upgrades Cases (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keene Road, Wyman, Rumford</td>
<td>Unconstrained</td>
<td>Unconstrained</td>
</tr>
<tr>
<td>Orrington South</td>
<td>1,325</td>
<td>1,650</td>
</tr>
<tr>
<td>Surowiec South</td>
<td>1,500</td>
<td>2,100</td>
</tr>
<tr>
<td>Maine – New Hampshire</td>
<td>1,900</td>
<td>2,300</td>
</tr>
</tbody>
</table>
# Wind Scenarios

## New England Wind Nameplate (MW)

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Maine</th>
<th>Outside of Maine</th>
<th>New England Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>453</td>
<td>426</td>
</tr>
<tr>
<td>2</td>
<td>RENEW Sensitivity 1 (Less Wind) *</td>
<td>623</td>
<td>426</td>
</tr>
<tr>
<td>3</td>
<td>Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>857</td>
<td>489</td>
</tr>
<tr>
<td>4</td>
<td>RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>1,149</td>
<td>426</td>
</tr>
<tr>
<td>5</td>
<td>RENEW Sensitivity 2 (More Wind)*</td>
<td>2,084</td>
<td>426</td>
</tr>
<tr>
<td>5_{NB}</td>
<td>RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>2,084</td>
<td>426</td>
</tr>
<tr>
<td>6</td>
<td>All Future Queue Wind in New England (as of 4/1/15)</td>
<td>3,727</td>
<td>678</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding

*Outside Maine, assumed only "existing wind" as of 4/1/15
Wind Scenarios

Maine Wind Nameplate (MW)

Note: Values may not sum to total due to rounding

Slides 25-27 detail each wind asset and nameplate capacity by scenario
DRAFT STUDY RESULTS
Summary of Draft Results

Study Year 2021

• For 453 MW to 1,149 MW of total wind integration in Maine
  – $0M to $5M production cost savings due to increasing Maine corridor interfaces
  – Orrington South interface becomes more constrained as more wind resources are added

• With 2,084 MW to 3,727 MW of total wind integration in Maine
  – $31M to $75M production cost savings result from increasing the Maine interface transfer limit constraints
  – Orrington South interface is the major constraint
    • Most wind resources are located north of Orrington South
    • Affects the ability to transport economically dispatched resources to South of Orrington (including New Brunswick imports)
  – Relieving the Maine corridor results in the North-South interface becoming increasingly constrained

• Reminder that the above calculations are associated only with the changes in transfer capabilities on the major interfaces
  – Bottled-in energy was observed due to both interface and local thermal constraints
  – Study does not reflect influence of future interconnections on local system constraints
## Production Cost Savings due to ME Interface Upgrades ($M/Year)

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Production Cost</th>
<th>Case Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
</tr>
<tr>
<td>1 Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>3,668</td>
<td>3,667</td>
</tr>
<tr>
<td>2 RENEW Sensitivity 1 (Less Wind) *</td>
<td>3,639</td>
<td>3,638</td>
</tr>
<tr>
<td>3 Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>3,593</td>
<td>3,592</td>
</tr>
<tr>
<td>4 RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>3,563</td>
<td>3,559</td>
</tr>
<tr>
<td>5 RENEW Sensitivity 2 (More Wind)*</td>
<td>3,458</td>
<td>3,427</td>
</tr>
<tr>
<td>5\textsubscript{NB} RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>3,338</td>
<td>3,261</td>
</tr>
<tr>
<td>6 All Future Queue Wind in New England (as of 4/1/15)</td>
<td>3,351</td>
<td>3,276</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding

*Outside Maine, assumed only "existing wind" as of 4/1/15
Production Cost Savings ($M/Year) vs. New England Wind Nameplate (MW)

- 878 MW, $0M
- 1,049 MW, $1M
- 1,345 MW, $1M
- 1,575 MW, $5M
- 2,510 MW, $31M
- 4,405 MW, $75M

Note: New Brunswick sensitivity (1,000 MW of NB imports available for dispatch) is excluded in this graph.
## Load Serving Entity (LSE) Expense Savings due to ME Interface Upgrades ($M/Year)

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>LSE Expense</th>
<th>LSE Expense Savings</th>
<th>Cases Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
<td></td>
</tr>
<tr>
<td>1  Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>7,246</td>
<td>7,245</td>
<td>1</td>
</tr>
<tr>
<td>2  RENEW Sensitivity 1 (Less Wind) *</td>
<td>7,217</td>
<td>7,215</td>
<td>1</td>
</tr>
<tr>
<td>3  Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>7,178</td>
<td>7,177</td>
<td>1</td>
</tr>
<tr>
<td>4  RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>7,167</td>
<td>7,165</td>
<td>2</td>
</tr>
<tr>
<td>5  RENEW Sensitivity 2 (More Wind)*</td>
<td>7,093</td>
<td>7,054</td>
<td>39</td>
</tr>
<tr>
<td>5_{NB} RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>7,002</td>
<td>6,922</td>
<td>80</td>
</tr>
<tr>
<td>6  All Future Queue Wind in New England (as of 4/1/15)</td>
<td>6,959</td>
<td>6,883</td>
<td>76</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding
*Outside Maine, assumed only "existing wind" as of 4/1/15

Little to no savings: Infrequent interface constraints and small amounts of bottled-in energy

When > 2,084 MW of Maine Wind: LSE expense savings are realized from relaxing interfaces and releasing bottled-in energy
Percent of Time Interface is at Limit (% of Year)

*Orrington South is the most limited and leads to minimal congestion at Surowiec South and ME-NH*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Orrington South Export Limit</th>
<th>Surowiec South Export Limit</th>
<th>ME-NH Export Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades (1,325 MW)</td>
<td>Post-Upgrades (1,650 MW)</td>
<td>Pre-Upgrades (1,500 MW)</td>
</tr>
<tr>
<td>1  Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2  RENEW Sensitivity 1 (Less Wind) *</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3  Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>8</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4  RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>13</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>5  RENEW Sensitivity 2 (More Wind)*</td>
<td>43</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>5_{NB} RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>83</td>
<td>57</td>
<td>12</td>
</tr>
<tr>
<td>6  All Future Queue Wind in New England (as of 4/1/15)</td>
<td>69</td>
<td>52</td>
<td>11</td>
</tr>
</tbody>
</table>

*Outside Maine, assumed only "existing wind" as of 4/1/15*
**Percent of Time Interface is at Limit (% of Year), Cont.**

*North – South Interface*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>North-South Export Limit (2,675 MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrade</td>
</tr>
<tr>
<td>1  Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>0</td>
</tr>
<tr>
<td>2  RENEW Sensitivity 1 (Less Wind) *</td>
<td>1</td>
</tr>
<tr>
<td>3  Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>2</td>
</tr>
<tr>
<td>4  RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>2</td>
</tr>
<tr>
<td>5  RENEW Sensitivity 2 (More Wind)*</td>
<td>3</td>
</tr>
<tr>
<td>5\textsubscript{NB} RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>4</td>
</tr>
<tr>
<td>6  All Future Queue Wind in New England (as of 4/1/15)</td>
<td>6</td>
</tr>
</tbody>
</table>

*Outside Maine, assumed only "existing wind" as of 4/1/15

When there is >2,084 MW of wind nameplate in Maine, the North-South interface begins to experience more congestion.
Maine Bottled-In Energy (GWh)

*Operation of some wind resources were constrained by local thermal limits. This cannot be relieved by increasing Maine corridor transfer capability.*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Wind ($0 Threshold Price)</th>
<th>Hydro ($5 Threshold Price)</th>
<th>NB Import ($10 Threshold Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
<td>Pre-Upgrades</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
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<td>92</td>
<td>91</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>97</td>
<td>92</td>
<td>17</td>
</tr>
<tr>
<td>5_{NB}</td>
<td>92</td>
<td>89</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>1,641</td>
<td>941</td>
<td>362</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding

*Outside Maine, assumed only "existing wind" as of 4/1/15*
Maine Bottled-In Energy (GWh)

Pre-Upgrades (approximately represented by shape size in subarea)

Scale
- 100 GWh
- 1,000 GWh

- Green: Wind
- Blue: Hydro
- Orange: NB Import

1
2
3
4
5
5_{NB}
6

18
## CO₂ Systemwide Reductions due to ME Interface Upgrades (kton**) 

Changes (%) in CO₂ emissions are small relative to systemwide emissions of 32,000 kton/year

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>CO₂ Reduction</th>
<th>Cases Show</th>
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<tr>
<td></td>
<td>kton</td>
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<tr>
<td>2</td>
<td>RENEW Sensitivity 1 (Less Wind) *</td>
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<td>Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
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<td>4</td>
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<td>5_NB</td>
<td>RENEW Sensitivity 2 (More Wind)* and 1,000 MW of of NB imports available for dispatch</td>
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<td>6</td>
<td>All Future Queue Wind in New England (as of 4/1/15)</td>
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Note: Values may not sum to total due to rounding

*Outside Maine, assumed only "existing wind" as of 4/1/15

**1 kton = 1,000 short ton = 2,000,000 lb
2015 Economic Study: Next Steps

• Review stakeholder comments and continue stakeholder discussions at future PAC meetings
• Develop report summarizing the Onshore Wind – Strategic Transmission Analysis Study
Questions
APPENDICES

I – Scenarios
II – Generation by Resource Type Metrics
III – Air Emissions Metrics
IV – Bottled-In Energy Metrics
V – Interface Flow Metrics
VI – LMP Metrics
VII – Modeling Assumptions
APPENDIX I

Scenarios
## Table of Scenarios

### Cases

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Pre-Upgrades</th>
<th>Post-Upgrades</th>
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<td>1 Existing Wind in New England (In-Service as of 4/1/15) *</td>
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<td>5\textsubscript{NB} RENEW Sensitivity 2 (More Wind) * and 1,000 MW of of NB imports available for dispatch</td>
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<td>Post-F</td>
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*Outside Maine, assumed only "existing wind" as of 4/1/15*
### Wind Units by Scenario and Subarea (1/3)

**BHE (MW)**

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<th>Area</th>
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<th>2 RENEW Sensitivity 1 (Less Wind)</th>
<th>3 Proposed Wind in New England with I.3.9 (as of 4/1/15)</th>
<th>4 RENEW Basecase - STA-WI Studied Wind (as of 10/1/13)</th>
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<th>5$_{NB}$ Sensitivity 2 (More Wind) and 1,000 MW of NB imports available for dispatch</th>
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## Wind Units by Scenario and Subarea (2/3)

**ME (MW)**

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<th>Area</th>
<th>Name</th>
<th>1 Existing Wind in New England (In-service 4/1/15)</th>
<th>2 RENEW Sensitivity 1 (Less Wind)</th>
<th>3 Proposed Wind in New England with I.3.9 (as of 4/1/15)</th>
<th>4 RENEW Basecase - STA-WI Studied Wind (as of 10/1/13)</th>
<th>5 RENEW Sensitivity 2 (More Wind)</th>
<th>6 All Queue Wind in New England (as of 4/1/15)</th>
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<tr>
<td>ME</td>
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<td>10.5</td>
<td>10.5</td>
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Wind Units by Scenario and Subarea (3/3)

**BST, CMA/NEMA, NH, RI, SEMA, VT, WMA (MW)**

<table>
<thead>
<tr>
<th>Area</th>
<th>Name</th>
<th>1 Existing Wind in New England (In-service 4/1/15)</th>
<th>2 RENEW Sensitivity 1 (Less Wind)</th>
<th>3 Proposed Wind in New England with I.3.9 (as of 4/1/15)</th>
<th>4 RENEW Basecase - STA-WI Studied Wind (as of 10/1/13)</th>
<th>5 RENEW Sensitivity 2 (More Wind)</th>
<th>5(_{NB}) Sensitivity 2 (More Wind) and 1,000 MW of NB imports available for dispatch</th>
<th>6 All Queue Wind in New England (as of 4/1/15)</th>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.0</td>
</tr>
<tr>
<td>WMA</td>
<td>Berkshire East Wind</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>WMA</td>
<td>WND_MISC_WMA</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Outside Maine Total</strong></td>
<td>425.6</td>
<td>425.6</td>
<td>488.5</td>
<td>425.6</td>
<td>425.6</td>
<td>425.6</td>
<td>425.6</td>
<td>678.4</td>
</tr>
</tbody>
</table>
Maine Interface Upgrades

• Conceptual transmission upgrades
  – Used upgraded interface limits identified in the 2012-2014 Strategic Transmission Analysis – Wind Integration
  – Specific upgrades to accomplish changes are not defined

• Maine stability / voltage interface limit increases
  – Orrington-South
    • 2021 limit is 1,325 MW
    • 2021 plus upgrades limit is 1,650 MW
  – Surowiec-South
    • 2021 limit is 1,500 MW
    • 2021 plus upgrades limit is 2,100 MW
  – ME-NH
    • 2021 limit is 1,900 MW
    • 2021 plus upgrades limit is 2,300 MW
Scenario Specific

New Brunswick Imports

• Cases 1, 2, 3, 4, 5, and 6
  – Daily diurnal curves
  – Historical monthly maximum imports for 2013-2014

• Sensitivity case \(5_{NB}\) evaluate the impact of additional New Brunswick imports
  – Assumed 1,000 MW of available imports for dispatch ($10/MWh threshold price)
APPENDIX II

Generation by Resource Type Metrics
# Maine Generation (GWh)

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Wind ($0 Threshold Price)</th>
<th>Hydro ($5 Threshold Price)</th>
<th>NB Import ($10 Threshold Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
<td>Pre-Upgrades</td>
</tr>
<tr>
<td>1</td>
<td>1,454</td>
<td>1,454</td>
<td>2,060</td>
</tr>
<tr>
<td>2</td>
<td>2,025</td>
<td>2,025</td>
<td>2,060</td>
</tr>
<tr>
<td>3</td>
<td>2,793</td>
<td>2,793</td>
<td>2,060</td>
</tr>
<tr>
<td>4</td>
<td>3,634</td>
<td>3,635</td>
<td>2,060</td>
</tr>
<tr>
<td>5</td>
<td>6,615</td>
<td>6,620</td>
<td>2,042</td>
</tr>
<tr>
<td>5_{NB}</td>
<td>6,620</td>
<td>6,623</td>
<td>2,046</td>
</tr>
<tr>
<td>6</td>
<td>10,058</td>
<td>10,758</td>
<td>1,698</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding

*Outside Maine, assumed only "existing wind" as of 4/1/15
Maine Generation (GWh)

Pre-Upgrades (approximately represented by shape size in subarea)

Scale
- 100 GWh
- 1,000 GWh

Wind
Hydro
NB
Import
Annual Generation by Resource Type

Graph

Annual Generation (GWh)

Coal
Oil
Wind
Gas
Ties
Solar
Hydro
Nuclear
Other Renewables
EE, DR, RTEG
### Annual Generation by Resource Type (GWH)

**Table**

<table>
<thead>
<tr>
<th>Cases</th>
<th>EE, DR, RTEG</th>
<th>Other Renewables</th>
<th>Nuclear</th>
<th>Hydro</th>
<th>Solar</th>
<th>Ties</th>
<th>Gas</th>
<th>Wind</th>
<th>Oil</th>
<th>Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1 (Pre-E)</td>
<td>14,238</td>
<td>5,307</td>
<td>29,754</td>
<td>6,631</td>
<td>2,990</td>
<td>20,371</td>
<td>66,852</td>
<td>2,735</td>
<td>405</td>
<td>938</td>
</tr>
<tr>
<td>Post-1 (Post-E)</td>
<td>14,238</td>
<td>5,308</td>
<td>29,754</td>
<td>6,631</td>
<td>2,990</td>
<td>20,371</td>
<td>66,853</td>
<td>2,735</td>
<td>403</td>
<td>938</td>
</tr>
<tr>
<td>Pre-2 (Pre-Less)</td>
<td>14,238</td>
<td>5,279</td>
<td>29,754</td>
<td>6,625</td>
<td>2,990</td>
<td>20,362</td>
<td>66,325</td>
<td>3,324</td>
<td>405</td>
<td>919</td>
</tr>
<tr>
<td>Post-2 (Post-Less)</td>
<td>14,238</td>
<td>5,289</td>
<td>29,754</td>
<td>6,626</td>
<td>2,990</td>
<td>20,371</td>
<td>66,309</td>
<td>3,324</td>
<td>402</td>
<td>919</td>
</tr>
<tr>
<td>Pre-3 (Pre-P)</td>
<td>14,238</td>
<td>5,242</td>
<td>29,754</td>
<td>6,614</td>
<td>2,990</td>
<td>20,344</td>
<td>65,438</td>
<td>4,264</td>
<td>403</td>
<td>936</td>
</tr>
<tr>
<td>Post-3 (Post-P)</td>
<td>14,238</td>
<td>5,256</td>
<td>29,754</td>
<td>6,615</td>
<td>2,990</td>
<td>20,363</td>
<td>65,401</td>
<td>4,264</td>
<td>405</td>
<td>935</td>
</tr>
<tr>
<td>Pre-4 (Pre-Base)</td>
<td>14,238</td>
<td>5,179</td>
<td>29,754</td>
<td>6,611</td>
<td>2,990</td>
<td>20,308</td>
<td>64,951</td>
<td>4,933</td>
<td>407</td>
<td>850</td>
</tr>
<tr>
<td>Post-4 (Post-Base)</td>
<td>14,238</td>
<td>5,199</td>
<td>29,754</td>
<td>6,609</td>
<td>2,990</td>
<td>20,364</td>
<td>64,874</td>
<td>4,934</td>
<td>402</td>
<td>858</td>
</tr>
<tr>
<td>Pre-5 (Pre-More)</td>
<td>14,238</td>
<td>5,041</td>
<td>29,754</td>
<td>6,572</td>
<td>2,990</td>
<td>19,664</td>
<td>62,806</td>
<td>7,914</td>
<td>400</td>
<td>840</td>
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<tr>
<td>Post-5 (Post-More)</td>
<td>14,238</td>
<td>5,079</td>
<td>29,754</td>
<td>6,550</td>
<td>2,990</td>
<td>20,167</td>
<td>62,350</td>
<td>7,920</td>
<td>386</td>
<td>786</td>
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<tr>
<td>Pre-5NB (Pre-More-NB)</td>
<td>14,238</td>
<td>4,844</td>
<td>29,754</td>
<td>6,563</td>
<td>2,990</td>
<td>22,100</td>
<td>60,570</td>
<td>7,920</td>
<td>400</td>
<td>842</td>
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<tr>
<td>Post-5NB (Post-More-NB)</td>
<td>14,238</td>
<td>4,889</td>
<td>29,754</td>
<td>6,521</td>
<td>2,990</td>
<td>23,502</td>
<td>59,270</td>
<td>7,922</td>
<td>381</td>
<td>753</td>
</tr>
<tr>
<td>Pre-6 (Pre-F)</td>
<td>14,238</td>
<td>4,871</td>
<td>29,754</td>
<td>6,153</td>
<td>2,989</td>
<td>18,179</td>
<td>60,551</td>
<td>12,207</td>
<td>413</td>
<td>843</td>
</tr>
<tr>
<td>Post-6 (Post-F)</td>
<td>14,238</td>
<td>4,864</td>
<td>29,754</td>
<td>6,190</td>
<td>2,990</td>
<td>18,784</td>
<td>59,369</td>
<td>12,907</td>
<td>378</td>
<td>724</td>
</tr>
</tbody>
</table>
### Annual Generation by Resource Type (GWH)

**Table - Effect of Relaxing Maine Interfaces (Post minus Pre)**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Resource Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EE, DR, RTEG</td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td>2</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
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<td>4</td>
<td>0.0</td>
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<tr>
<td>5</td>
<td>0.0</td>
</tr>
<tr>
<td>5\text{NB}</td>
<td>0.0</td>
</tr>
<tr>
<td>6</td>
<td>0.0</td>
</tr>
</tbody>
</table>
APPENDIX III

Air Emissions Metrics
## CO₂ Systemwide Emission Reductions due to ME Interface Upgrades (k short ton**)

*Changes (%) in emissions are small relative to systemwide emissions*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>CO₂ Emissions (kton)</th>
<th>CO₂ Reduction</th>
<th>% of 32,000 kton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
<td>kton</td>
</tr>
<tr>
<td>1 Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>31,775</td>
<td>31,775</td>
<td>1</td>
</tr>
<tr>
<td>2 RENEW Sensitivity 1 (Less Wind) *</td>
<td>31,483</td>
<td>31,485</td>
<td>-3</td>
</tr>
<tr>
<td>3 Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>31,047</td>
<td>31,054</td>
<td>-7</td>
</tr>
<tr>
<td>4 RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>30,633</td>
<td>30,631</td>
<td>3</td>
</tr>
<tr>
<td>5 RENEW Sensitivity 2 (More Wind)*</td>
<td>29,462</td>
<td>29,246</td>
<td>216</td>
</tr>
<tr>
<td>5NB RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>28,190</td>
<td>27,572</td>
<td>618</td>
</tr>
<tr>
<td>6 All Future Queue Wind in New England (as of 4/1/15)</td>
<td>28,250</td>
<td>27,549</td>
<td>701</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding

*Outside Maine, assumed only "existing wind" as of 4/1/15

**1 kton = 1,000 short ton = 2,000,000 lb
SO₂ Systemwide Emission Reductions due to ME Interface Upgrades (short ton**)  
*Changes (%) in emissions are small relative to systemwide emissions*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>SO₂ Emissions (ton)</th>
<th>SO₂ Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
</tr>
<tr>
<td>1 Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>3,054</td>
<td>3,050</td>
</tr>
<tr>
<td>2 RENEW Sensitivity 1 (Less Wind) *</td>
<td>3,020</td>
<td>3,014</td>
</tr>
<tr>
<td>3 Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>3,010</td>
<td>3,016</td>
</tr>
<tr>
<td>4 RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>2,923</td>
<td>2,901</td>
</tr>
<tr>
<td>5 RENEW Sensitivity 2 (More Wind)*</td>
<td>2,864</td>
<td>2,737</td>
</tr>
<tr>
<td>5₉₅ RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>2,817</td>
<td>2,614</td>
</tr>
<tr>
<td>6 All Future Queue Wind in New England (as of 4/1/15)</td>
<td>2,801</td>
<td>2,536</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding  
*Outside Maine, assumed only "existing wind" as of 4/1/15  
**1 short ton = 2,000 lb
NO$_x$ Systemwide Emission Reductions due to ME Interface Upgrades (short ton**)  
*Changes (%) in emissions are small relative to systemwide emissions*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>NO$_x$ Emissions (ton)</th>
<th>NO$_x$ Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
</tr>
<tr>
<td>1. Existing Wind in New England (In-Service as of 4/1/15) *</td>
<td>9,284</td>
<td>9,283</td>
</tr>
<tr>
<td>2. RENEW Sensitivity 1 (Less Wind) *</td>
<td>9,199</td>
<td>9,199</td>
</tr>
<tr>
<td>3. Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
<td>9,121</td>
<td>9,132</td>
</tr>
<tr>
<td>4. RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
<td>8,921</td>
<td>8,935</td>
</tr>
<tr>
<td>5. RENEW Sensitivity 2 (More Wind)*</td>
<td>8,632</td>
<td>8,535</td>
</tr>
<tr>
<td>5$_{NB}$. RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
<td>8,314</td>
<td>8,108</td>
</tr>
<tr>
<td>6. All Future Queue Wind in New England (as of 4/1/15)</td>
<td>8,346</td>
<td>8,037</td>
</tr>
</tbody>
</table>

Note: Values may not sum to total due to rounding  
*Outside Maine, assumed only "existing wind" as of 4/1/15  
**1 short ton = 2,000 lb
APPENDIX IV

Bottled-in Energy
## Bottled-In Energy (GWh)

*BHE - RSP Subarea*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Wind ($0 Threshold Price)</th>
<th>Hydro ($5 Threshold Price)</th>
<th>NB Import ($10 Threshold Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
<td>Pre-Upgrades</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>5_{NB}</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1,529</td>
<td>836</td>
<td>250</td>
</tr>
</tbody>
</table>

*Outside Maine, assumed only "existing wind" as of 4/1/15*
## Bottled-In Energy (GWh)

**ME - RSP Subarea**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Wind ($0 Threshold Price)</th>
<th>Hydro ($5 Threshold Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
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<tr>
<td>4</td>
<td>92</td>
<td>91</td>
</tr>
<tr>
<td>5</td>
<td>97</td>
<td>92</td>
</tr>
<tr>
<td>5\text{NB}</td>
<td>92</td>
<td>89</td>
</tr>
<tr>
<td>6</td>
<td>1,641</td>
<td>941</td>
</tr>
</tbody>
</table>

*Outside Maine, assumed only "existing wind" as of 4/1/15*
# Bottled-In Energy (GWh)

**SME - RSP Subarea**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Wind ($0 Threshold Price)</th>
<th>Hydro ($5 Threshold Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
<td>Post-Upgrades</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
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<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$5_{NB}$</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Outside Maine, assumed only "existing wind" as of 4/1/15*
APPENDIX V

Interface Flow Metrics
• Historical
• Draft Study Results
2015 Historical Interface Flow (MW)

Orrington South (1,325 MW limit)

Orrington South Interface Duration Curve: Net Flow MWs
January - December 2015
As export limit increases (with Existing Wind [1]), Orrington South becomes **less constrained**

Pre-Existing: Orrington South constrained 1% of time
Post-Existing: Orrington South constrained 0% of time
Interface: Orrington South – Less Wind

*Duration Curve*

As export limit increases (with Less Wind [2]), Orrington South becomes **less constrained**

Pre-Less: Orrington South constrained 6% of time
Post-Less: Orrington South constrained 0% of time
As export limit increases (with Proposed Wind [3]), Orrington South becomes **less constrained**

Pre-Proposed: Orrington South constrained 8% of time
Post-Proposed: Orrington South constrained 0% of time
Interface: Orrington South – Basecase Wind

Duration Curve

As export limit increases (with Basecase Wind [4]), Orrington South becomes less constrained.

Pre-Basecase: Orrington South constrained 13% of time
Post-Basecase: Orrington South constrained 0% of time
Interface: Orrington South – More Wind

Duration Curve

As export limit increases (with More Wind [5]), Orrington South becomes more constrained.

Pre-More: Orrington South constrained 43% of time
Post-More: Orrington South constrained 19% of time
Interface: Orrington South – More Wind with NB at 1000 MW

Duration Curve

As export limit increases (with More Wind and 1,000 MW of available New Brunswick import 24x7 [\text{NB}])), Orrington South becomes more constrained.

Pre-More-NB: Orrington South constrained 83% of time
Post-More-NB: Orrington South constrained 57% of time
Interface: Orrington South – Future Wind

*Duration Curve*

As export limit increases (with Future Wind [6]), Orrington South becomes **more constrained**

Pre-F: Orrington South constrained 69% of time
Post-F: Orrington South constrained 52% of time
2015 Historical Interface Flow (MW)

Surowiec South (1,500 MW limit)
Interface: Surowiec South – Existing Wind

*Duration Curve*

No change in percent of time Surowiec South is constrained.
Interface: Surowiec South – Less Wind

*Duration Curve*

No change in percent of time Surowiec South is constrained.
Interface: Surowiec South – Proposed Wind

Duration Curve

As export limit increases (with Proposed Wind [3]), Surowiec South becomes less constrained.

Pre-Proposed: Orrington South constrained 1% of time
Post-Proposed: Orrington South constrained 0% of time
As export limit increases (with Basecase Wind [4]), Surowiec South becomes less constrained.

Pre-Proposed: Orrington South constrained 4% of time
Post-Proposed: Orrington South constrained 0% of time
Interface: Surowiec South – More Wind

*Duration Curve*

As export limit increases (with More Wind [5]), Surowiec South becomes **less constrained**.

Pre-More: Surowiec South constrained 11% of time
Post-More: Surowiec South constrained 0% of time
Interface: Surowiec South – More Wind with NB at 1000 MW

Duration Curve

As export limit increases (with More Wind and 1,000 MW of available New Brunswick import 24x7 $S_{NB}$), Surowiec South has increased and unconstrained interface flow at 2,100 MW limit.

Pre-More-NB: Surowiec South constrained 12% of time
Post-More-NB: Surowiec South constrained 0% of time
Interface: Surowiec South – Future Wind

Duration Curve

As export limit increases (with Future Wind [6]), Surowiec South has increased and unconstrained interface flow at 2,100 MW limit

Pre-F: Surowiec South constrained 11% of time
Post-F: Surowiec South constrained 0% of time
2015 Historical Interface Flow (MW)
Maine – New Hampshire (1,900 MW limit)

Maine-New Hampshire Interface Duration Curve: Net Flow MWs
January - December 2015

Number of Hours

Hourly Flow - Positive power flowing into NH (MW)

-1250 -750 250 750 1250 1750

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000 7500 8000 8500
Interface: ME-NH – Existing Wind

*Duration Curve*

No change in percent of time Maine – New Hampshire is constrained.
Interface: ME-NH – Less Wind

*Duration Curve*

No change in percent of time Maine – New Hampshire is constrained.
Interface: ME-NH – Proposed Wind

*Duration Curve*

No change in percent of time Maine – New Hampshire is constrained.
Interface: ME-NH – Basecase Wind

*Duration Curve*

No change in percent of time Maine – New Hampshire is constrained.
As export limit increases (with More Wind [5]), ME-NH is has increased flow but is not constrained at 2,300 MW limit.
Interface: ME-NH – More Wind with NB at 1000 MW

Duration Curve

As export limit increases (with More Wind and 1,000 MW of available New Brunswick import 24x7 [5_{NB}]), ME-NH is has increased flow but is not constrained at 2,300 MW limit.
As export limit increases (with Future Wind [6]), ME-NH has increased flow but is not constrained at 2,300 MW limit.
2015 Historical Interface Flow (MW)
North – South (2,675 MW limit)
Interface: North-South – Existing Wind

*Duration Curve*

No change in percent of time (0%) North – South is constrained.
Interface: North-South – Less Wind

Duration Curve

No change in percent of time (1%) North – South is constrained.
Interface: North-South – Proposed Wind

Duration Curve

No change in percent of time (2%) North – South is constrained.
As the Maine corridor export limit increases (with Basecase Wind [4]), the North-South interfaces becomes more constrained at 2,675 MW limit.

Pre-Base: North-South constrained 2% of time
Post-Base: North-South constrained 3% of time
Interface: North-South – More Wind

As the Maine corridor export limit increases (with More Wind [5]), the North-South interfaces becomes **more constrained** at 2,675 MW limit.

- Pre-More: North- South constrained 3% of time
- Post-More: North- South constrained 9% of time
Interface: North-South – More Wind with NB at 1000 MW

*Duration Curve*

As the Maine corridor export limit increases (with More Wind and 1,000 MW of available New Brunswick import 24x7 \(S_{NB}\)), the North-South interfaces becomes more constrained at 2,675 MW limit.

Pre-More: North- South constrained 4% of time
Post-More: North- South constrained 13% of time
As the Maine corridor export limit increases (with Future Wind [6]), the North-South interfaces becomes more constrained at 2,675 MW limit.

Pre-More: North-South constrained 6% of time
Post-More: North-South constrained 17% of time
APPENDIX VI

LMP Metrics
Summary

LMP Metrics

• LMP duration curves allow the effect of the three classes of study resources to be seen
  – At $0/MWh wind-on-wind competition spills wind
  – At $5/MWh hydro is spilled
  – At $10/MWh imports are curtailed
New England LMP – weighted by load ($/MWh)

Graph

LMP ($/MWh)

- Pre-Upgrades
- Post-Upgrades

1 (Existing) 2 (Less) 3 (Proposed) 4 (Base) 5 (More) 5NB (More-NB) 6 (Future)
# New England LMP – weighted by load ($/MWh)

**Table**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>LMP ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Upgrades</td>
</tr>
<tr>
<td>1</td>
<td>Existing Wind in New England (In-Service as of 4/1/15) *</td>
</tr>
<tr>
<td>2</td>
<td>RENEW Sensitivity 1 (Less Wind) *</td>
</tr>
<tr>
<td>3</td>
<td>Proposed Wind in New England with I.3.9 approval (as of 4/1/15)</td>
</tr>
<tr>
<td>4</td>
<td>RENEW Basecase – STA-WI Studied Wind (as of 10/1/13) *</td>
</tr>
<tr>
<td>5</td>
<td>RENEW Sensitivity 2 (More Wind)*</td>
</tr>
<tr>
<td>5_{NB}</td>
<td>RENEW Sensitivity 2 (More Wind)* and 1,000 MW of NB imports available for dispatch</td>
</tr>
<tr>
<td>6</td>
<td>All Future Queue Wind in New England Wind (as of 4/1/15)</td>
</tr>
</tbody>
</table>

*Outside Maine, assumed only "existing wind" as of 4/1/15
LMP: New England – Existing Wind

Duration Curve

New England LMP unaffected by increased Maine interface limits
LMP: New England – Less Wind

*Duration Curve*

New England LMP unaffected by increased Maine interface limits
LMP: New England – Proposed Wind

Duration Curve

New England LMP unaffected by increased Maine interface limits
LMP: New England – Basecase Wind

Duration Curve

New England LMP unaffected by increased Maine interface limits
LMP: New England – More Wind

Duration Curve

2,2510 MW of New England wind nameplate [5] and unconstrained energy lowers LMPs.
LMP: New England – More Wind with NB at 1000 MW

*Duration Curve*

2,2510 MW of New England wind nameplate $[5_{NB}]$, available New Brunswick imports of 1,000 MW 24/7, and unconstrained energy lowers LMPs

**Graph:**
- Pre-More-NB
- Post-More-NB

**Axes:**
- Y-axis: LMP ($/MWh$)
- X-axis: Time (0% to 100%)

**Legend:**
- Blue line: Pre-More-NB
- Orange line: Post-More-NB
LMP: New England – Future Wind

Duration Curve

4,405 MW of New England wind nameplate [6] and unconstrained energy lowers LMPs.
LMP: BHE – Existing Wind

Duration Curve

New England LMP unaffected by increased Maine interface limits
LMP: BHE – Less Wind

*Duration Curve*

As Maine corridor export limit increases (with Less Wind [2]), Orrington South becomes less constrained (from 6% to 0%). Imports ($10 threshold price) and >$10 resources are not constrained by Orrington South.

Imports set LMP at $10
LMP: BHE – Proposed Wind

*Duration Curve*

As Maine corridor export limit increases (with Proposed Wind [3]), Orrington South becomes less constrained (from 8% to 0%). Imports ($10 threshold price) and >$10 resources are not constrained by Orrington South.

Imports set LMP at $10
As Maine corridor export limit increases (with Basecase Wind [4]), Orrington South becomes less constrained (from 13% to 0%). Imports ($10 threshold price) and >$10 resources are not constrained by Orrington South.
LMP: BHE – More Wind

Duration Curve

As Maine corridor export limit increases (with More Wind [5]), Orrington South becomes less constrained (from 43% to 19%). Imports ($10 threshold price) and >$10 resources are not constrained by Orrington South.

Imports set LMP at $10
LMP: BHE – More Wind with NB at 1000 MW

*Duration Curve*

As Maine corridor export limit increases (with More Wind and available NB at 1000 MW 24x7 [$S_{NB}$]), Orrington South becomes less constrained (from 83% to 57%). Imports ($10 threshold price) and >$10 resources are not constrained by Orrington South.

Imports set LMP at $10
LMP: BHE – Future Wind

Duration Curve

Wind-on-wind competition at $0 LMP

Imports set LMP at $10
LMP: ME – Existing Wind

Duration Curve

ME RSP subarea LMP unaffected by increased Maine interface limits
**LMP: ME – Less Wind**

*Duration Curve*

- ME RSP subarea LMP unaffected by increased Maine interface limits
LMP: ME – Proposed Wind

*Duration Curve*

ME RSP subarea LMP unaffected by increased Maine interface limits
LMP: ME – Basecase Wind

*Duration Curve*

ME RSP subarea LMP unaffected by increased Maine interface limits
LMP: ME – More Wind

Duration Curve

Previously constrained areas (lower) LMP rise to unconstrained New England-wide LMP (higher)
LMP: ME – More Wind with NB at 1000 MW

Duration Curve

Previously constrained areas (lower)
LMP rise to unconstrained New England-wide LMP (higher)
Previously constrained areas (lower)
LMP rise to unconstrained New England-wide LMP (higher)
LMP: SME – Existing Wind

*Duration Curve*

SME RSP subarea LMP unaffected by increased Maine interface limits

- **Pre-E**
- **Post-E**
LMP: SME – Less Wind

*Duration Curve*

SME RSP subarea LMP unaffected by increased Maine interface limits
LMP: SME – Proposed Wind

Duration Curve

SME RSP subarea LMP unaffected by increased Maine interface limits
LMP: SME – Basecase Wind

*Duration Curve*

- **SME RSP subarea LMP unaffected by increased Maine interface limits**

**Graph Details:**
- **Y-axis:** LMP ($/MWh)
- **X-axis:** Time
- **Lines:**
  - **Pre-Base**
  - **Post-Base**
LMP: SME -- More Wind

*Duration Curve*

Unconstrained energy lowers LMPs
LMP: SME – More Wind with NB at 1000 MW

Duration Curve

Unconstrained energy lowers LMPs

LMP ($/MWh)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Time

Pre-More-NB

Post-More-NB
LMP: SME – Future Wind

*Duration Curve*

Unconstrained energy lowers LMPs
APPENDIX VII

Modeling Assumptions
Base Economic Evaluation Model

• System conditions consistent with FCA 9 (2018 / 2019) timeframe
  – Resources
  – Transmission capability
  – Demand

• Other economic assumptions
  – Fuel costs
  – Generator availability
Load: New England Peak Load Forecast

Effect of Behind-the-Meter PV and Passive DR

Summer 50/50 Peak Loads

- CELT/Gross
- Gross - PV
- Gross - PV - Passive DR

Summer Peak Load (MW)
Fuel Price Forecast: EIA’s 2015 AEO Base

2015 Annual Energy Outlook
Reference New England Fuel Prices

Fuel Cost (2013 $/MBtu)

- Coal
- Natural Gas
- Distillate Fuel Oil
- Residual Fuel Oil
- Biomass
- Nuclear
Resource Assumptions

Overview

• Resources include
  – Cleared in Forward Capacity Auction #9
  – 2015 CELT resources
  – Other energy only resources
  – Wind in each study are specified by the economic study request
    • Wind resource production modeled based on 2012 NREL data

• Demand resources
  – Energy efficiency (EE) and photovoltaic (PV) – including forecasts
  – Active demand resources (DR)
  – Hourly profile based on 2006 weather (consistent with wind and PV data)
Resource Assumptions

Overview (Cont.)

• Dispatch threshold price
  1) Wind ($0/MWh)
  2) Hydro ($5/MWh)
  3) Imports ($10/MWh)
*Note: Production cost is zero for these resources. An LMP below the threshold price will result in a resource self curtailing.

• Resources modeled as hourly profiles
  – EE, DR, RTEG
  – PV, wind,
  – Hydro
  – Imports

• Wind profiles based on 2012 NREL data
  – Capacity factors range is from 31% to 41%
Resource Assumptions

Thermal Units

- Points of interconnection for resources based on ISO-NE TPL case*
- Existing thermal units
  - Simulation study production cost parameters: Heat rate curve, Start-up cost, No-load cost and etc.
  - Primary and secondary fuel definition are based on 2015 CELT
- Operational limits
  - Minimum up time, Minimum down time and Start up time
  - Ramp rate limits
- Energy limits: assume no energy limits
- Future thermal units
  - Production cost parameters based on: unit type, technology and rating

Resource Assumptions

Thermal Units (Cont.)

• Combined cycle units
  – Individual machines from a combined cycle plant are modeled as a single generator at one of the machine’s buses

• Outages
  – Thermal units derated to reflect the forced outages using Equivalent Forced Outage Rate (EFOR)
  – Planned maintenance schedule will be developed and held constant across cases
Resource Assumptions

*Hydro Units*

- Hydro units modeled using
  - Hourly energy generation profiles
  - Peak shaving bias
  - Used in previous economic studies

- Hydro units are assumed to have no maintenance outage
Resource Assumptions

Pumped Storage Units

• Modeled in peak shaving mode
  – Pumping during off-peak hours
  – Generating during on-peak hours

• Pumped storage physical parameters
  – Minimum pond size
  – Maximum pond size
  – Plant capacity factor
  – Based on assumptions used in previous studies
Resource Assumptions

Photovoltaic

• 2015 PV Forecast used for simulation year 2021
• Represented by a time stamped, chronological hourly solar PV profile
• National Renewable Energy Laboratory (NREL) has developed a simulated solar PV dataset based on 2006 weather
  – New England specific
  – Profiles by RSP area available
• Consistent with methodology used for wind profile
Resource Assumptions

Demand Resources

• Active DR, EE and RTEG are modeled explicitly
  – Hourly profile for each category of demand side resource
  – FCA amounts used through capacity commitment periods

• Forecasts
  – The latest EE forecast through the year 2024 is reflected
  – Active DR and RTEG are held constant for years beyond capacity commitment period (same as other FCM resources)
Resource Assumptions

Demand Resources (Cont.)

- Hourly profiles are used to explicitly reflect energy efficiency (EE), active demand resources (DR) and real-time emergency generation (RTEG).
Operating Reserve Modeling

• Operating reserve requirement is determined in real time
  – Based on the first and second largest system contingencies
  – Resource profiles (hydro / wind / interchange etc) excluded

• Current operating reserve requirements
  – 125% of the first contingency in ten minutes split between
    • Ten-Minute Spinning Reserve (TMSR) = 50%
    • Ten-Minute Non-Spinning Reserve (TMNSR) = 50%
  – Thirty-Minute Operation Reserve (TMOR) not modeled
    • Assumed to be adequate
    • Provided by hydro, pumped storage and quick-start resources
    • Reasonable assumption except, possibly, at times of peak loads
Network Modeling

• Modeling of transmission network
  – ISO-NE TPL case*
  – Detailed modeling in ISO-NE region only
  – Representation for neighboring systems
    • Detailed network modeling not required for NY, NB and HQ
    • Base flows based on historical line flows

Network Modeling (cont)

• Modeling of internal interface limits
  – The latest ISO-NE estimated internal interface limit values reflected

• Modeling of transmission line
  – All 230 kV and 345kV circuits ISO-NE region are monitored for thermal overloads
    • Nearly 300 branches monitored for thermal overloads
    • Includes transformers that step up to 230 kV and above
  – Generator step-up (GSU) transformers are excluded
    • Ensure a generating plant output is not limited by GSU modeling

• Monitoring of transmission line
  – 115 kV and above lines in areas of concern as appropriate
    • Maine for
      – Strategic Transmission Analysis – Wind Integration study
      – Keene Road study
    • SEMA / RI for off-shore wind study
Imports and Exports Modeling

• Hourly imports and exports over the following external interconnections are modeled based on average 2012, 2013 and 2014 historical interchange values*
  – New York AC
  – NNC
  – Cross Sound Cable
  – Highgate
  – HQ Phase II

• New Brunswick modeled as historical monthly maximum imports from 2013 and 2014

*The same approach used in previous economic studies for representing import/export assumptions
Imports and Exports Modeling

New England to New York - AC Interface

Average Interchange - New York AC
Averaged Diurnal Profiles: 2012 - 2014

Note: positive values represent imports; negative values represent exports.
Imports and Exports Modeling

_Average Interchange - NNC_

Averaged Diurnal Profiles: 2012 - 2014

Note: positive values represent imports; negative values represent exports.
Imports and Exports Modeling

New England to New York – Cross Sound Cable

Average Interchange - Cross Sound Cable
Averaged Diurnal Profiles: 2012 - 2014

Flow (MW)

Note: positive values represent imports; negative values represent exports.
Imports and Exports Modeling
Quebec to New England: Highgate

Average Interchange - Highgate
Averaged Diurnal Profiles: 2012 - 2014

Flow (MW)

Note: positive values represent imports; negative values represent exports.
Imports and Exports Modeling
Quebec to New England: HQ Phase II

Average Interchange - HQ Phase II
Averaged Diurnal Profiles: 2012 - 2014

Note: positive values represent imports; negative values represent exports.
Imports and Exports Modeling
New Brunswick to New England

Interchange - New Brunswick
Diurnal Profile Showing Max Import of 2013 - 2014

Note: positive values represent imports; negative values represent exports.
Questions
Wind Turbine Impacts On Residential Property Values

Ben Hoen
Lawrence Berkeley National Laboratory

AWEA Northeast Summit
July 20, 2016
Four Major US Studies Were Released Since 2009

Large Scale US Studies Investigating Property Value Impacts Near Operating Turbines

<table>
<thead>
<tr>
<th>Study</th>
<th>Authors</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Wide Study</td>
<td>LBNL</td>
<td>December 2009</td>
</tr>
<tr>
<td>US Wide Study</td>
<td>LBNL</td>
<td>August 2013</td>
</tr>
<tr>
<td>RI Based Study</td>
<td>U of RI</td>
<td>December 2013</td>
</tr>
<tr>
<td>MA Based Study</td>
<td>UConn/LBNL</td>
<td>January 2014</td>
</tr>
</tbody>
</table>
US Based Study #1: LBNL 2009

Summary

- 7,489 sales w/in 10 miles of 11 facilities
- 125 post-construction sales within 1 mile
- Rural settings with large (50+ turbines) wind facilities
Summary

- 51,276 total sales, 9 states, 67 facilities
- 376 post-construction sales within 1 mile
- Rural settings, large (50+ turbines) facilities
RI Based Study: URI 2013

Summary

- 48,554 total sales, 10 facilities
- 412 post-construction sales within 1 mile
- Mostly urban settings, small facilities
MA Based Study: UConn/LBNL 2014

Summary
• 312,677 total sales, 26 facilities
• 1,503 post-construction sales w/in 1 mile
• Urban settings, mostly small facilities
• First study to test wind turbine and other environmental amenities/disamenities together

Received the Marc Louargand Award for the Best Research Paper by a Practicing Real Estate Professional presented at the 2014 ARES Annual Meeting
MA Based Study Results
We Compared Impacts Across Amenities and Disamenities

Although the study found the effects from a variety of negative features …and positive features…the study found no net effects due to the arrival of turbines”. (p. 1)
Four Large Scale US Studies = Four Distinct Research Efforts
But The Same Results

No Evidence of Property Value Impacts of Operating Turbines

Combined almost 2,500 transactions within 1 mile of operating turbines

- 2013 LBNL US Study
- 2009 LBNL US Study
- URI RI Study
- UConn/LBNL MA Study
Why Has Consistent Evidence Of Impacts Failed To Emerge In US?
School District Revenue Is Significant

Estimated effect of wind farm on annual school district budget equates to a present value of:

- $60-80 Thousand per MW!
- $6-8 Million for 100 MW!
Total Economic Effects Can Be Very Large

Estimated the 23 largest wind facilities in Illinois equates to a present value of:

$0.9 Million per MW!

$90 Million for 100 MW!
Wind Counties Can Have Lower Taxes And Higher School Quality

“...property tax rates have fallen and public school quality has improved in those counties where wind farms have been built.” (p. 800)

Kahn (2013): Statistical analysis of West Texas county tax rates, school expenditures and teacher-student ratios
Multiple Surveys Have Found High Levels Of Support Near Turbines

Support & Opposition Near Existing Turbines

- Supportive
- Neutral/No Opinion
- Opposed

Data from various states and regions in the US, including NY (2014), PA (2011), TX (2010), and others.
Buyers Could Be Sorting Themselves Into Supporters And Objectors

When consumers are mobile, over time they will sort themselves such that those living in a community with become more supportive of that community over time.

Tiebout, 1956
This Theory Is Supported By Results From 2016 Survey Of 1700 Residents Near Turbines

Moved In Before Construction

Moved In After Construction

Homes within 1 mile of a turbine

\( n = 500 \)

Preliminary LBNL Results Do Not Cite

21% 52% 10% 59%
Overall Conclusions

- Consistent property value impacts have failed to emerge near turbines in US
- Reasons for this include:
  - Significant compensation for schools and local economies
  - Relatively high levels of support for turbines
  - Sorting over time to more supportive communities
- As turbines get quieter, if compensation schemes are consistently applied, and if the community is regularly involved in the development process adverse effects are likely to continue to be elusive.

LBNL Survey Results Will Shed More Light On Levels Of Support, Opposition & Annoyance Near US Turbines
Thank You & Questions?

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References (Not Including Slide 79)


Energy Markets and Policy Group • Energy Analysis and Environmental Impacts Department
Harry Benson, Senior, Director of Development, EverPower Maine LLC
EverPower Overview

- EverPower was founded in 2002 by CEO, Jim Spencer and acquired by Terra Firma in 2009
- Since acquisition, Terra Firma has committed $660m of equity to its investment and the business has been transformed from a development-only player to an owner-operator of wind generation assets with the ambition of growing the business to be a scale player
- EverPower currently has 750+ MW of operational capacity and has a substantial pipeline of near and mid-term projects
- The organizational capabilities have been built to accommodate such growth and the business now has over 50 employees between its office in New York and its corporate headquarters in Pittsburgh, Pennsylvania
- The company has a real time commercial operations center to manage the power contracts and delivery optimization.
- The company has expertise in development, project finance, wind resource analysis, construction management and operations

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Key Events</th>
<th>Installed Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Everpower founded to compete in renewable solar energy and wind development</td>
<td>-</td>
</tr>
<tr>
<td>2009</td>
<td>First wind farm (Krayn) goes operational</td>
<td>63</td>
</tr>
<tr>
<td>2011</td>
<td>Howard Wind Farm (NY) goes operational</td>
<td>114</td>
</tr>
<tr>
<td>2012</td>
<td>Acquisition of Alta VI (Mustang Hills - 150 MW) Highland North, Twin Ridges and Patton go operational</td>
<td>512</td>
</tr>
<tr>
<td>2014+</td>
<td>Acquisition of Big Sky Wind Farm. EverPower is a premier owner and operator of renewable generating assets, with over 2.3 GW of development assets</td>
<td>752+</td>
</tr>
</tbody>
</table>

Year End Installed Capacity (MW)

- EverPower is a fast-growing, onshore wind developer that focuses on strategic project development and operation in California and the Northeast markets of the United States
<table>
<thead>
<tr>
<th>Project</th>
<th>State</th>
<th>Status</th>
<th>COD</th>
<th>Capacity</th>
<th>Ownership</th>
<th>Asset History</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highland</td>
<td>PA</td>
<td>Operating</td>
<td>2009</td>
<td>62.5 MW</td>
<td>100%</td>
<td>Organic Development</td>
<td>Nordex</td>
</tr>
<tr>
<td>Howard</td>
<td>NY</td>
<td>Operating</td>
<td>2011</td>
<td>51.3 MW</td>
<td>100%</td>
<td>Organic Development</td>
<td>RePower</td>
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<tr>
<td>Highland North</td>
<td>PA</td>
<td>Operating</td>
<td>2012</td>
<td>75.0 MW</td>
<td>100%</td>
<td>Organic Development</td>
<td>Nordex</td>
</tr>
<tr>
<td>Mustang Hills</td>
<td>CA</td>
<td>Operating</td>
<td>2012</td>
<td>150.0 MW</td>
<td>100%</td>
<td>Acquisition – Operating</td>
<td>Vestas</td>
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<tr>
<td>Patton</td>
<td>PA</td>
<td>Operating</td>
<td>2012</td>
<td>30.0 MW</td>
<td>100%</td>
<td>Acquisition – Development</td>
<td>Gamesa</td>
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<tr>
<td>Twin Ridges</td>
<td>PA</td>
<td>Operating</td>
<td>2012</td>
<td>139.4 MW</td>
<td>100%</td>
<td>Organic Development</td>
<td>RePower</td>
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<tr>
<td>Howard Expansion</td>
<td>NY</td>
<td>Operating</td>
<td>2012</td>
<td>4.1 MW</td>
<td>100%</td>
<td>Organic Development</td>
<td>Repower</td>
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<tr>
<td>Big Sky</td>
<td>IL</td>
<td>Operating</td>
<td>2011</td>
<td>239.4 MW</td>
<td>100%</td>
<td>Acquisition – Operating</td>
<td>Suzlon</td>
</tr>
</tbody>
</table>

Source: EverPower management
Proposed Bryant Mountain Wind Farm

Existing Spruce Mountain Wind Farm

Bryant Mountain
# BRYANT MOUNTAIN WIND FARM

## Project Overview

<table>
<thead>
<tr>
<th></th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>Oxford County, Maine</td>
</tr>
<tr>
<td><strong>Power Region</strong></td>
<td>NE ISO</td>
</tr>
<tr>
<td><strong>Targeted Permitting, COD</strong></td>
<td>2019</td>
</tr>
<tr>
<td><strong>Nameplate Capacity</strong></td>
<td>40 MW</td>
</tr>
<tr>
<td><strong>Wind Speed</strong></td>
<td>Class III A site</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Bryant and Chamberlain Mtns.</td>
</tr>
<tr>
<td><strong>Interconnection</strong></td>
<td>115kV line to south</td>
</tr>
<tr>
<td><strong>Turbine Viability</strong></td>
<td>Vestas, GE, Gamesa</td>
</tr>
</tbody>
</table>

Source: EverPower management
Importance of Keeping Milton Expedited

• Zoning sends an important message
• Developer will not go forward under these circumstances
• This would be a clear signal from LUPC
We strive to be a **good neighbor in the communities** in which we operate by working together with local stakeholders from early in the development process right on through the operational life of our wind farms. -EverPower

• More than $500 million was spent in Maine on wind power projects
• Construction of 18 projects (does not include Bryant) would result in $1.28 billion in spending in Maine over 12 years

Project Benefits

• Construction and Operation Benefits
  – $104 million investment
  – Capital expenditure of $80 million
  – Estimated $13.1 million in construction wages (primary workers and secondary workers)
  – Estimated $900,000 in annual wages operation
  – Local spending during construction over $23 million
  – Local spending during operation estimated to be $1.5 million annually

Source: Job and Economic Development Impact (JEDI) Model
Additional Economic Benefits

- Taxes and Community Benefits
- Estimated annual taxes of more than $320,000
- Work to keep the money local
- Minimum of $48,000 annually in community benefit agreement for local use
- $40-50,000 annually to local fund to be administered by the community
  - ATV or snowmobile club projects
  - Ball club equipment and uniforms or travel
  - Road improvements
  - Many, many, many other possibilities
- Exploring conservation opportunities in the area
- Over $400,000 in annual payments out to over 28 local landowners
  - Turbine payments, neighbor agreements
  - Upfront payments for easements and option payments
  - Spent locally
Environmental Benefits

• Contribution towards wind energy goals
  – 2000 MW by 2015
  – 3000 MW by 2020 (300 MW Offshore)

• Project expected to result in annual displacement of:
  – 14 tons of NO$_x$
  – 29.1 tons of SO$_x$
  – 67,697.3 tons of CO$_2$

Source: yourstory.com
Site Selection Process

- Economically viable/competitive
- Must be compatible with community values
- Permittable site
Site Selection Process

• Overall Economics of the project
  – Competitive Business Environment- New England PPAs
  – Cheap prices for electricity
    • Evolution of Turbine Technology
    • Long generator lead lines
    • Blending with Hydro
Wind Resource

The wind resource of Bryant Mountain is competitive. It is in the range to warrant a Class IEC Class III wind turbine.
Site Turbine Selection Process

Wind Speed

Shear

Turbulence
# Turbine Class

From IEC 61400-1, Edition 2

<table>
<thead>
<tr>
<th>WTGS class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
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<td>$V_{\text{ref}}$ (m/s)</td>
<td>50</td>
<td>42.5</td>
<td>37.5</td>
<td>30</td>
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<tr>
<td>$V_{\text{ave}}$ (m/s)</td>
<td>10</td>
<td>8.5</td>
<td>7.5</td>
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<table>
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<th>A</th>
<th>$I_{15}$ (--)</th>
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<tr>
<td>B</td>
<td>$I_{15}$ (--)</td>
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<td>0.16</td>
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<td>a</td>
<td>3</td>
<td>3</td>
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</tbody>
</table>

Values to be specified by the designer

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**Figure 2:** Parameters of Wind turbine classes defined in IEC 61400-1 Ed. 2.

- 300-400 W/m²
- 6.4-7.0 m/s

$m/s = mph$

- 10 m/s = 22.4 mph
- 8.5 m/s = 19 mph
- 7.5 m/s = 16.8 mph
- 6 m/s = 13.4 mph
Site Selection Process

• Available Land
• Construction Cost
• Suitable Transmission
  – Bryant Mountain is NE ISO queue #555 for the 115 line to the south.
  – NE ISO says 2 years to study
  – Jeff Fenn of SGC’s feasibility analysis, says yes it is.
Proximity to Residents

- Population Density and Setbacks-
  - One residence within 4,000 feet
  - Talking to everyone within one mile of the project
  - We will comply with the 42 dBA Standard for DEP permit (Spruce Mtn was 45dBA)
    - One within 4000 feet, most outside of that.
    - Turbine technology is improving in this area
  - Shadow flicker assessment will be conducted for DEP permit
  - Property values-
    - Neighbor agreements if within a mile
    - Ben Hoen studies
Wind Turbine Impacts On Residential Property Values

Ben Hoen
Lawrence Berkeley National Laboratory

AWEA Northeast Summit
July 20, 2016
Site Selection Process- Permittable

- Outstanding and Significant Scenic Resources
- Habitat and Wildlife
- Location within Expedited
Conclusions

• Bryant Mountain Wind Farm is needed for Maine to meet its wind energy goals. Good sites are very far and few between. When you find a good site, it needs to be realized.
• Bryant Mountain satisfies the siting criteria for successful wind development
• We would like LUPC to maintain the current zoning so that we can:
  – Reach out to all local landowners and towns and determine if project is compatible with the needs of the community
  – Develop appropriate community benefits packages the meet the community’s needs
  – Conduct all wildlife and resource value studies to determine whether there are site specific consideration that make development inappropriate
Conclusions

• If in two-three years, the site remains viable, we would submit an application to DEP
• There would be a complete and robust review process with opportunity for:
  – Public input
  – Agency input

That would ensure that the project is permitted only if the site is, in fact, appropriate for wind development.
Thank you!

- Thanks to the Commissioners and Staff, local governments, landowners for their time and effort on this matter

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www.everpower.com
Milton Township

Substantive Review of Petition to Remove Milton Township from Expedited Permitting Area

Joy Prescott, Stantec Consulting
1 Project Context and Location
Project Location
2 DEP Permitting Process
Expedited Permitting Area: Wind Power is an Allowed Use

35% of LUPC allows wind power

Wind Power as Allowed Use, 12/31/15

27% of LUPC allows wind power

Wind Power as Allowed Use, 8/9/16
Review Process

**Review by state agencies and third-party reviewers**
- Evaluate whether project meets standards
- LUPC must certify project meets standards
- Work with developer to address issues

**Multiple points for public input**
- Developer holds 1+ public info meeting
- Public can request public hearing
- DEP holds 2 public meetings (if no hearing)
- Written comments can be submitted to DEP
### DEP must evaluate 32 standards before issuing a permit for a wind project

<table>
<thead>
<tr>
<th>Site Law Standards for all Large Projects</th>
<th>Additional Standards for Wind Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project Description</td>
<td>26. Shadow Flicker</td>
</tr>
<tr>
<td>2. Title, Right, and Interest</td>
<td>27. Public Safety</td>
</tr>
<tr>
<td>4. Technical Capacity</td>
<td>29. Decommissioning</td>
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<tr>
<td>6. Visual Quality *</td>
<td>31. LUPC Certification</td>
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<tr>
<td>7. Wildlife, Wetlands, and Fisheries</td>
<td>32. Best Practical Mitigation</td>
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<td>8. Historic Resources</td>
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<td>9. Unusual Natural Areas</td>
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<td>10. Buffers</td>
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<td>11. Soils</td>
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<td>12. Stormwater</td>
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<td>13. Urban Impaired Streams</td>
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<td>14. Basic Standards</td>
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<td>15. Groundwater</td>
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<td>16. Water Supply</td>
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<td>17. Wastewater</td>
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<td>18. Solid Waste</td>
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<td>19. Flooding</td>
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<td>20. Blasting</td>
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<td>21. Air Emissions</td>
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<td>22. Odors</td>
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<td>23. Water Vapor</td>
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<td>24. Sunlight</td>
<td></td>
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<tr>
<td>25. Notices</td>
<td></td>
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</tbody>
</table>

* Noise and Visual Impact are evaluated under both Site Law and wind-specific standards
3 Consistency with CLUP
**Location of Development**

**GOAL:** Guide the location of new development in order to protect and conserve forest, recreational, plant or animal habitat and other natural resources, to ensure the compatibility of land uses with one another and to allow for a reasonable range of development opportunities important to the people of Maine, including property owners and residents of the unorganized and deorganized townships.

**Milton is located on periphery of LUPC jurisdiction**
- Surrounded by 4 organized towns
- Most areas within 10 miles are in organized towns

**LUPC Policies**
- “guide development to areas near existing towns and communities”
- “energy facilities are best located in areas on the edge of the jurisdiction with good existing road access but low natural-resource values”
Economic Development

Wind is compatible with forest management
• Provide value to forest landowners
• Provide benefits to Oxford County, including $320k+/year in taxes, $48k+/year for community benefits to the host community, and $50k/year to fund local projects.

LUPC Policies
• “encourage forest … and other resource-based industries”
• “encourage economic development in those areas identified as most appropriate for future growth”

GOAL: Encourage economic development that is connected to local economies, utilizes services and infrastructure efficiently, is compatible with natural resources and surrounding uses, particularly natural resource-based uses, and does not diminish the jurisdiction’s principal values.
Energy Resources

Renewable energy provides benefits to Maine
• Existing capacity built thru small-medium projects
• Resource-based economic development consistent with state energy policies

LUPC Policies
• “support indigenous, renewable energy resources”
• “accommodate energy generation installations that are consistent with state energy policies”
• “new renewable energy projects displace ... fossil fuels and carry benefits”

GOAL: Provide for the environmentally sound and socially beneficial utilization of indigenous energy resources where there are not overriding public values that require protection.
Scenic and Recreation

Resources located outside Milton
- Limited recreational opportunities within Milton
- No lakes or ponds within Milton
- Nearest scenic resource in LUPC is in Albany
- Detailed survey of resources conducted as part of permit application to DEP

LUPC Policies
- “encourage patterns of grown to minimize impacts on natural values and scenic character”
- “identify and protect areas that possess scenic features and values of state or national significance”

GOAL: Protect the high-value scenic resources of the jurisdiction by fitting proposed land uses harmoniously into the natural environment.

GOAL: Conserve the natural resources that are fundamental to maintaining the recreational environment that enhances diverse, abundant recreational opportunities.
Wildlife

Few wildlife resources
• No Critical Habitat (eagle, salmon, lynx)
• No rare or exemplary natural community or ecosystem
• No mapped Significant Vernal Pools
• No high elevation areas

• Potential impacts to wildlife habitat will be identified during on-site surveys

GOAL: Conserve and protect the aesthetic, ecological, recreational, scientific, cultural and economic values of wildlife, plant and fisheries resources.
Wildlife

Proximity to bat hibernaculum
• Hibernaculum 2.5 miles from nearest turbine
• Species most at risk from turbine collision do not use hibernaculum

Low risk of fatality to bats from turbines
• Existing bat fatality is very low in Maine
• Curtailment significantly reduces mortality

GOAL: Conserve and protect the aesthetic, ecological, recreational, scientific, cultural and economic values of wildlife, plant and fisheries resources.
3 Ability to Meet State Goals
Projects like Milton are key for Maine to meet its wind energy goals.
Wildlife and Siting

**Wind Power and Wildlife in Maine:**

A State-wide Geographic Analysis of High-Value Wildlife Resources and Wind Power Classes

**Susan Gallo, Wildlife Biologist**

Maine Audubon, December 2013
Wildlife and Siting

Project meets recommendations from MAS report

1. The project is located in the expedited wind permitting area away from known and valuable wildlife resources.

2. Everpower is committed to minimizing and avoiding impacts to wildlife resources.

3. Milton does not include any high elevation sites (>2,700’), any modelled Bicknell’s Thrush habitat, or areas designated as Critical Summits.

4. Milton is not located within 2 miles of the coast.
Conclusion

• Milton is appropriate for wind power development

• Project would provide economic development for Milton and Oxford County

• Project must meet 32 standards before DEP can issue permit

Wind development should continue to be identified as an allowed use in Milton Township
August 10, 2016

It is very upsetting to hear Woodstock residents talk about the Milton Twp Wind project. I see the Spruce Mountain Wind Farm from my property and I do not receive any benefits from them. All I want is the same opportunity as they have.

Deana Buck