From:	Warman-Gold, Gae on behalf of Johnson, Eric
To:	Beyer, Stacie R
Cc:	Giaimo, Michael; "Ferdinand, Bill"
Subject:	ISO Materials
Date:	Friday, August 19, 2016 12:40:50 PM
Attachments:	awea_iso_paradise_final.pdf awea_iso_mcbride_final.pdf

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Hello! Per today's discussion, attached please find presentations given by Theodore Paradise and Alan McBride at the July 2016 AWEA Conference in Portland, ME. In addition, here is the link to the following capacity market and renewable energy material:

The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future

Please let us know if you have any further questions.

Best,

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JULY 19, 2016 | PORTLAND, MAINE

The Emerging Landscape: Working to Improve Interconnection Challenges

AWEA Wind Energy Summit

Al McBride

DIRECTOR TRANSMISSION STRATEGY & SERVICES

What's Affecting the Interconnection Process in Backlogged Areas?

- With the exception of Northern and Western Maine, the interconnection queue in Southern New England is processing well without significant backlogs or delays
- Significant backlog of most wind generation proposals in Northern and Western Maine
- Three primary drivers of the interconnection queue backlog in Maine
  - Issues with inverter-based generators
  - Characteristics of the Maine system
  - Requests far beyond the capability of the existing Maine system

The ISO Is Continually Working to Improve the Interconnection Queue Backlog in Maine

1. FERC approved updates to the New England interconnection procedures to address inverter-based issues

2. 2016 Maine Resource Integration Study

3. 2016 Survey of approaches to clustering interconnection projects

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Earlier This Year, FERC Approved Interconnection Procedures Updates to Address Inverter–based Issues

- The objective of the changes is to make inverter-based generator projects more "study-ready"
  - Based on experienced gained studying projects in the New England queue
  - Based on observations of best practices in other areas
  - Leveraging the capabilities of generation technology
- These changes seek to improve curtailment and performance issues in system operations for inverter-based generators
- Also, these rules meet modeling and performance requirements being introduced by new NERC standards

Recently Approved Rule Changes Are Far-Reaching

- Rule changes include reactive performance requirements for wind generators
- Define data requirements for inverter-based generators
  - Complete project descriptions
  - PSCAD models
  - Standardized models
- Clarify application of material modification
  - Project models can be "trued-up" if the system impact study has not yet started
- Include optional alternative scope of a Feasibility Study
  - To perform targeted analysis of stability and PSCAD issues, if appropriate

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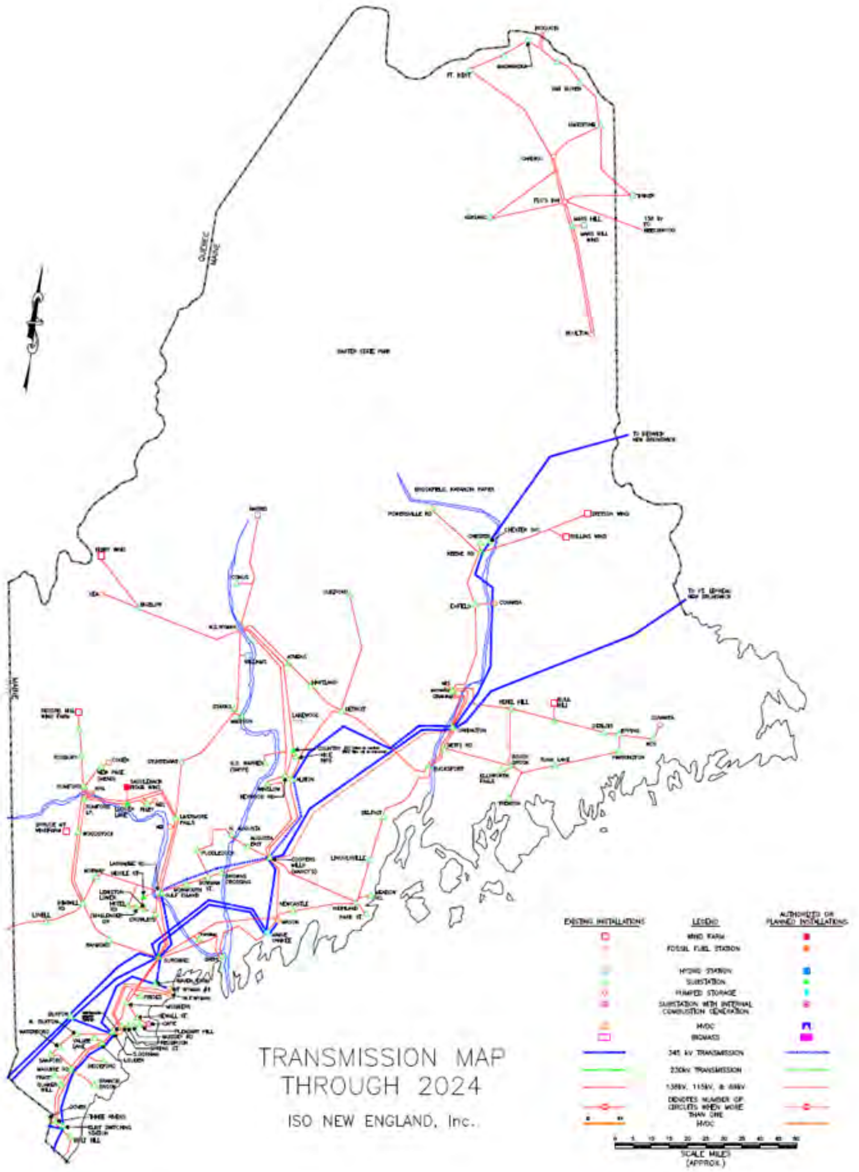
Study Objectives

- Identify transmission infrastructure that can be added to interconnect requested generation in Maine
  - MW quantity of generation that could interconnect
  - Order of magnitude cost of the transmission infrastructure
  - Expected time to construct



The Existing Maine System

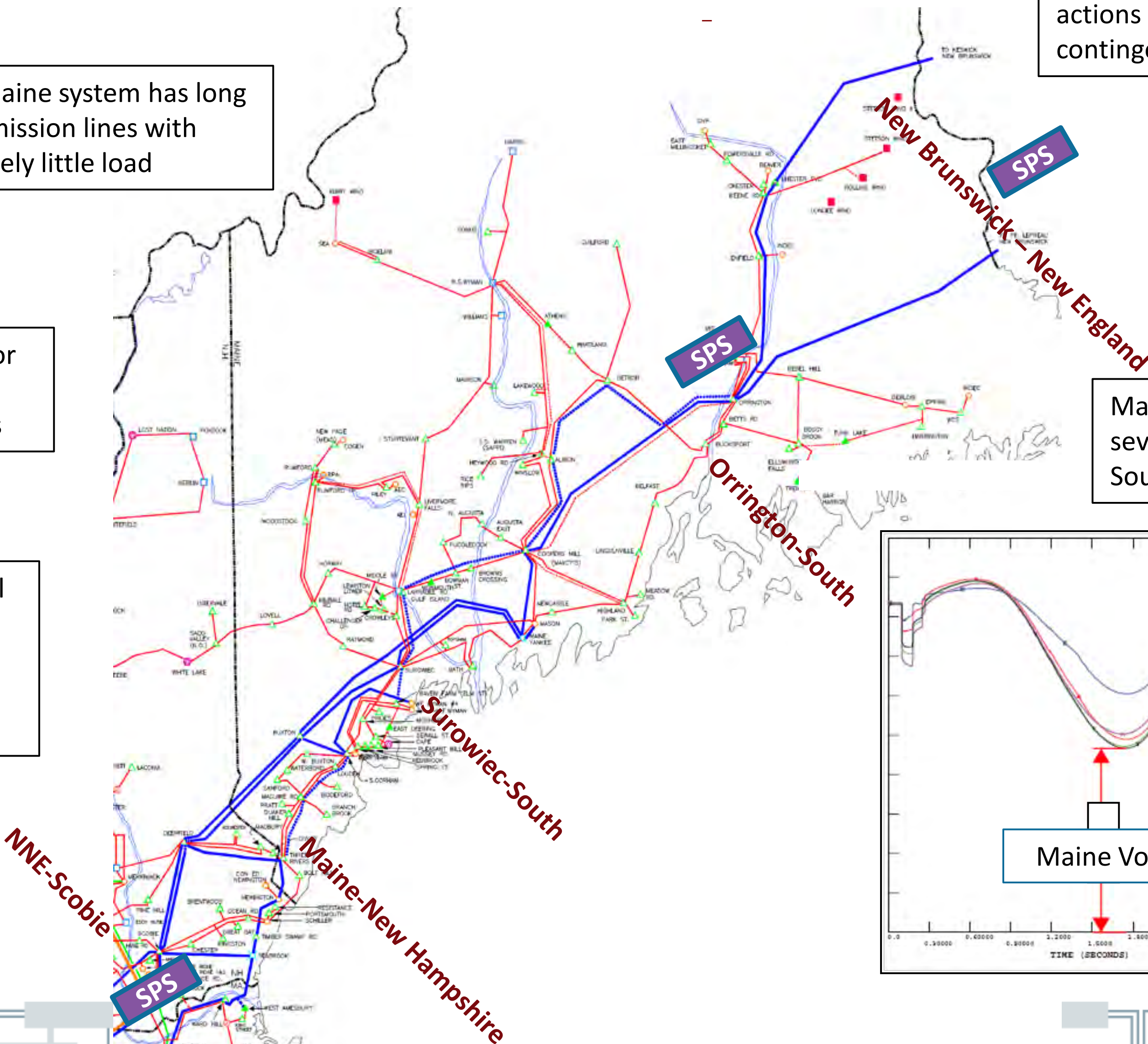
The Maine system has long transmission lines with relatively little load

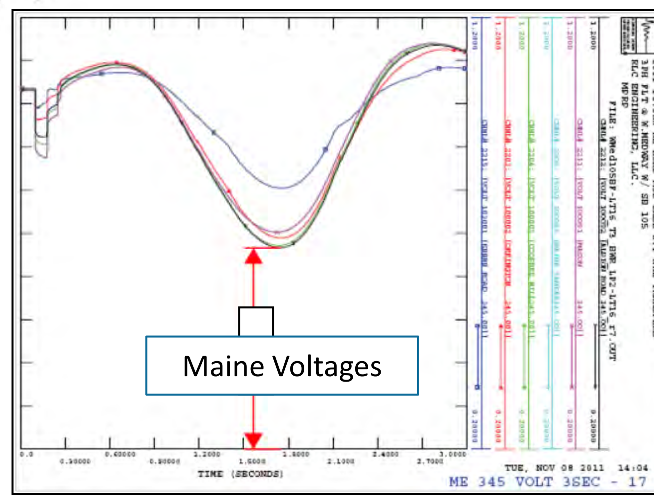
Multiple Major Interfaces to manage flows

Multiple Local Interfaces to manage local constraints (Not Shown)

Three existing Special Protection Systems (SPS) associated with actions to reduce flows under contingency conditions

Maine corridor experiences severe voltage sags for faults in Southern New England





Study Will Consider New Transmission in Maine

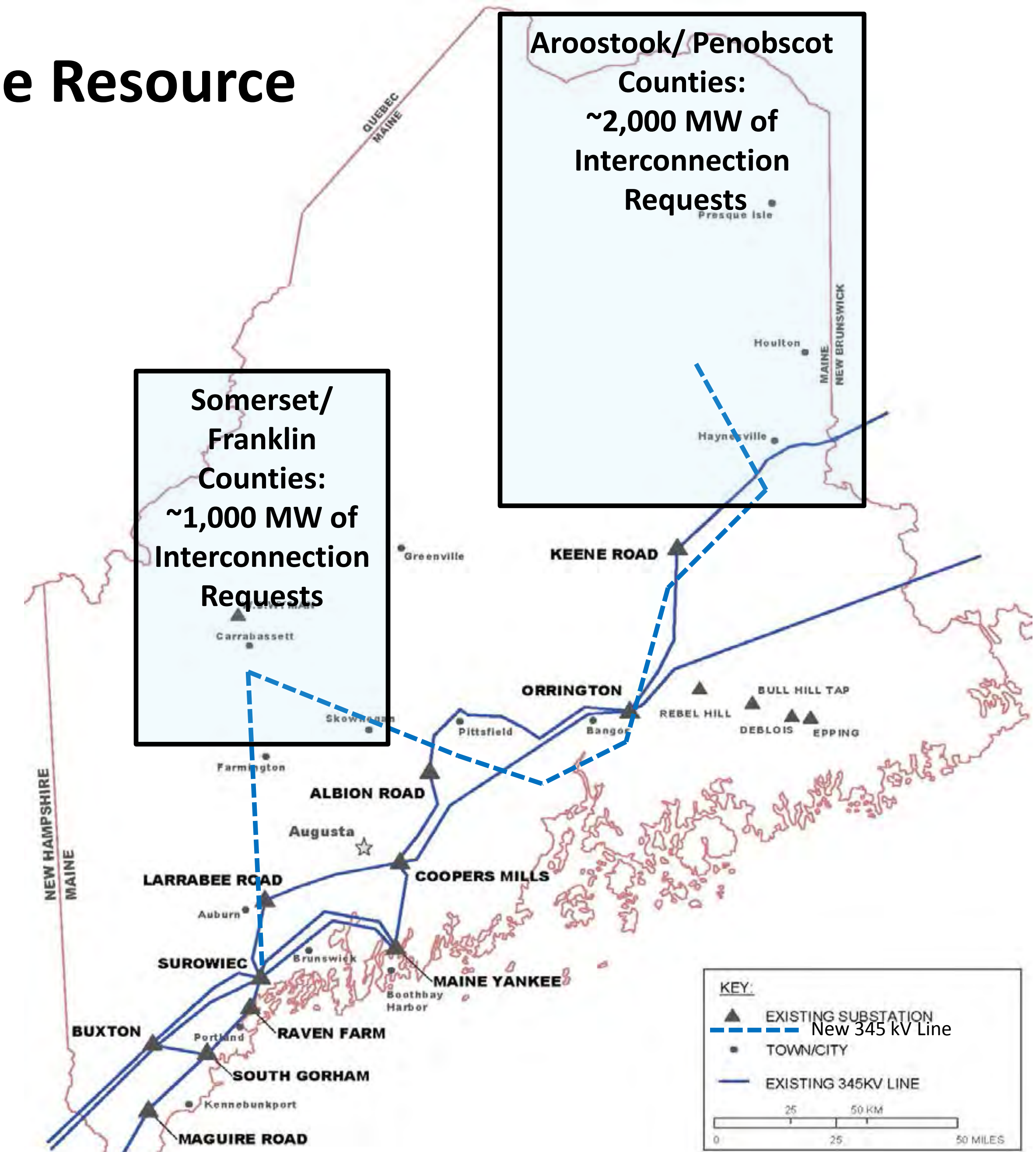
- The 2016 Maine Resource Integration study will focus on the addition of new 345 kV AC transmission circuits
  - The study will also attempt to identify whether there is an identifiable point where HVDC becomes an appropriate alternative to continuing to add AC transmission to the existing system

- Connecting to the areas with the largest quantity of requested new generation interconnections

Proposed Wind Development Proposals in ISO Generator Interconnection Queue (as of June 1, 2016)		
County	Interconnection Requests	Total MWs
Aroostook	9	1,971
Franklin	5	575
Hancock	3	373
Oxford	4	63
Penobscot	5	52
Penobscot/Washington	1	53
Somerset	4	350
Washington	2	194
Total	33	3,631

Scope of 2016 Maine Resource Integration Study

- Analysis of new 345 kV transmission in parallel with the existing network
- Evaluations will include interconnecting with, or bypassing, existing lines and substations



The ISO Is Continually Working to Improve the Interconnection Queue Backlog in Maine

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Stakeholder Discussions Focusing on Cluster Studies

- The ISO has conducted a survey of clustering methodologies used in different regions
- The ISO has been in discussion with regional stakeholders and these discussions will continue
- In response to the backlog of interconnection requests in Maine and following stakeholder discussions, the ISO will present a interconnection clustering strawman proposal this fall

Southern New England Off-Shore Wind

- Near demand and close to Hub
- Recent upgrades made to local systems with additional transmission planned
- Robust transmission system in southern part of the region can allow wind power to flow throughout system
- Relatively easier and better performing interconnections than wind in northern parts of region

Proximity to load and existing infrastructure provide great potential

Closing Thoughts

- The interconnection queue process in Southern New England is working well because resources are seeking to connect close to load and to robust portions of the regional transmission network
- The backlog of wind generation proposals in Northern and Western Maine is the result of resources seeking to connect to weak areas of the network, far from the load
- ISO New England and regional stakeholders are working on backlog issue:
  - Recently approved rule changes will help address inverter-based issues
  - Maine Resource Integration Study will provide guidance on potential needs to help expedite study process
  - Survey of approaches to clustering interconnection projects may prove insightful in making additional interconnection enhancements

Questions

Public Policy Choices, Transmission Challenges, and Emerging Areas of Opportunity

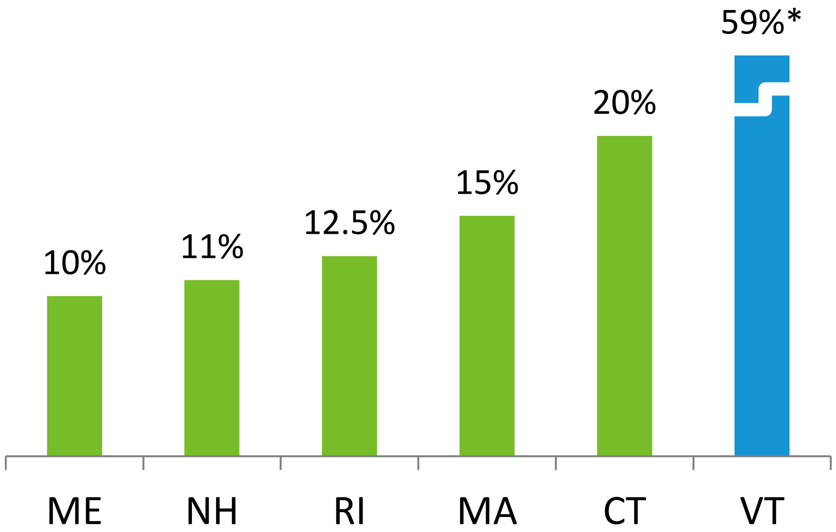
AWEA Wind Energy Summit

Northeast Transmission Panel

Theodore Paradise, Esq.

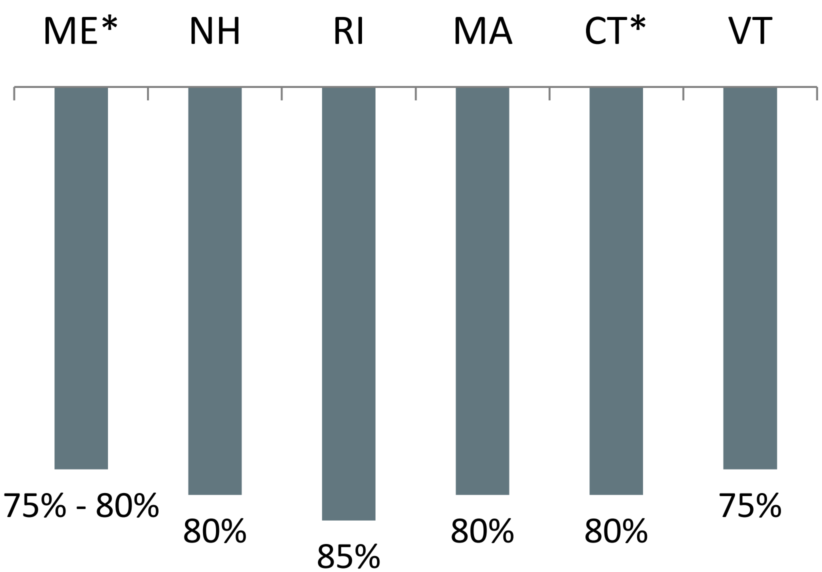
ASSISTANT GENERAL COUNSEL, OPERATIONS & PLANNING

States Have Set Goals to *Increase* Renewable Energy and *Reduce* Greenhouse Gas Emissions



State Renewable Portfolio Standard (RPS) for Class I or New Renewable Energy by 2020

Percent Reduction of Greenhouse Gas (GHG) Emissions Below 1990 Levels* by 2050 (economy wide)



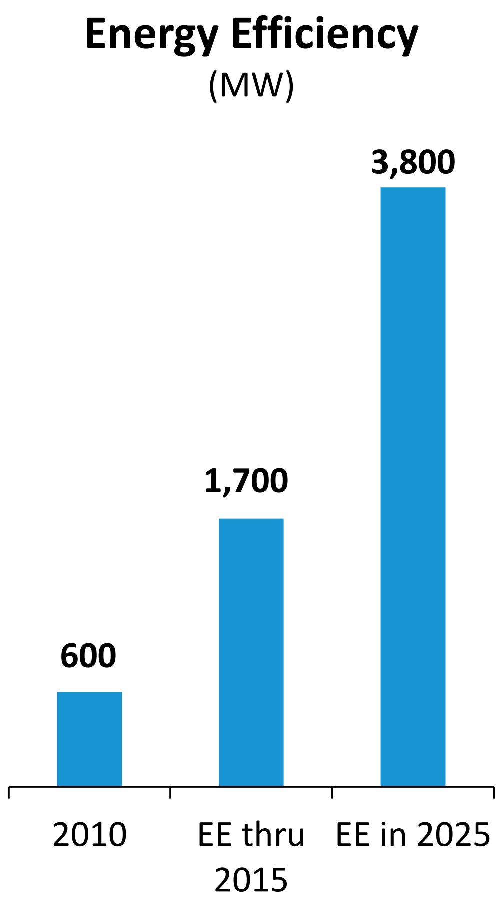
* Vermont's standard recognizes all forms of renewable energy, and is unique in classifying large-scale hydro as renewable.

* Connecticut's goal is tied to 2001 levels. Maine's goal is tied to 2003 levels.

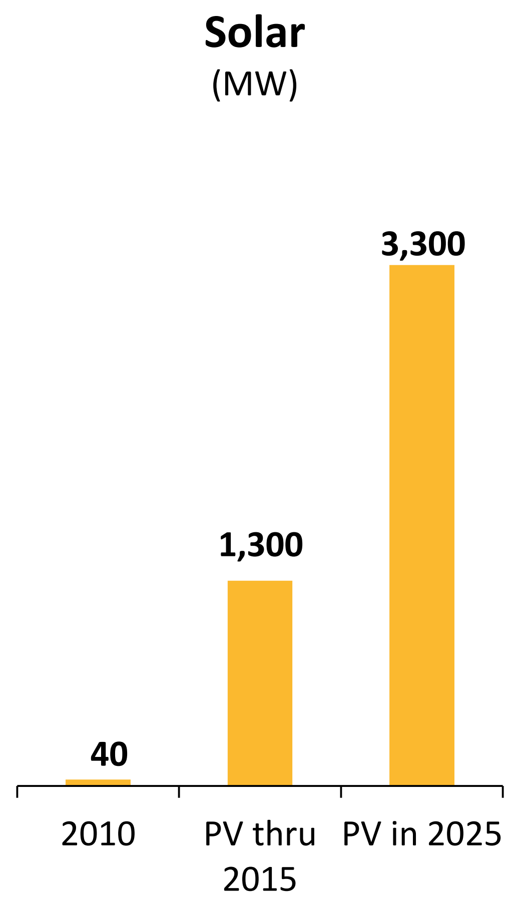
New England Has Been Planning with Public Policy

New England state Energy Efficiency (EE) programs are reducing both seasonal peak demand and annual energy requirements – *initial forecast published in 2012*

Behind-the-Meter solar PV resources are putting downward pressure on both seasonal peak demand and annual energy requirements – *initial forecast published in 2014*



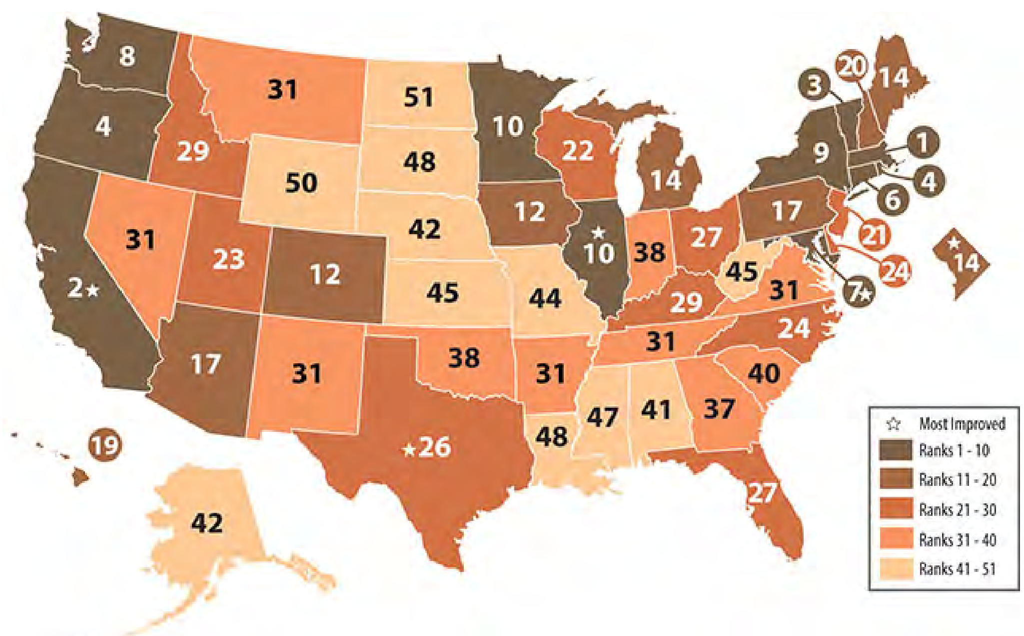
2016 CELT Report, EE through 2015 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2025 includes an ISO-NE forecast of incremental EE beyond the FCM.



Final 2016 ISO-NE PV Forecast, AC nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter."

Energy Efficiency Is a Priority for State Policymakers

2015 State Energy-Efficiency Scorecard



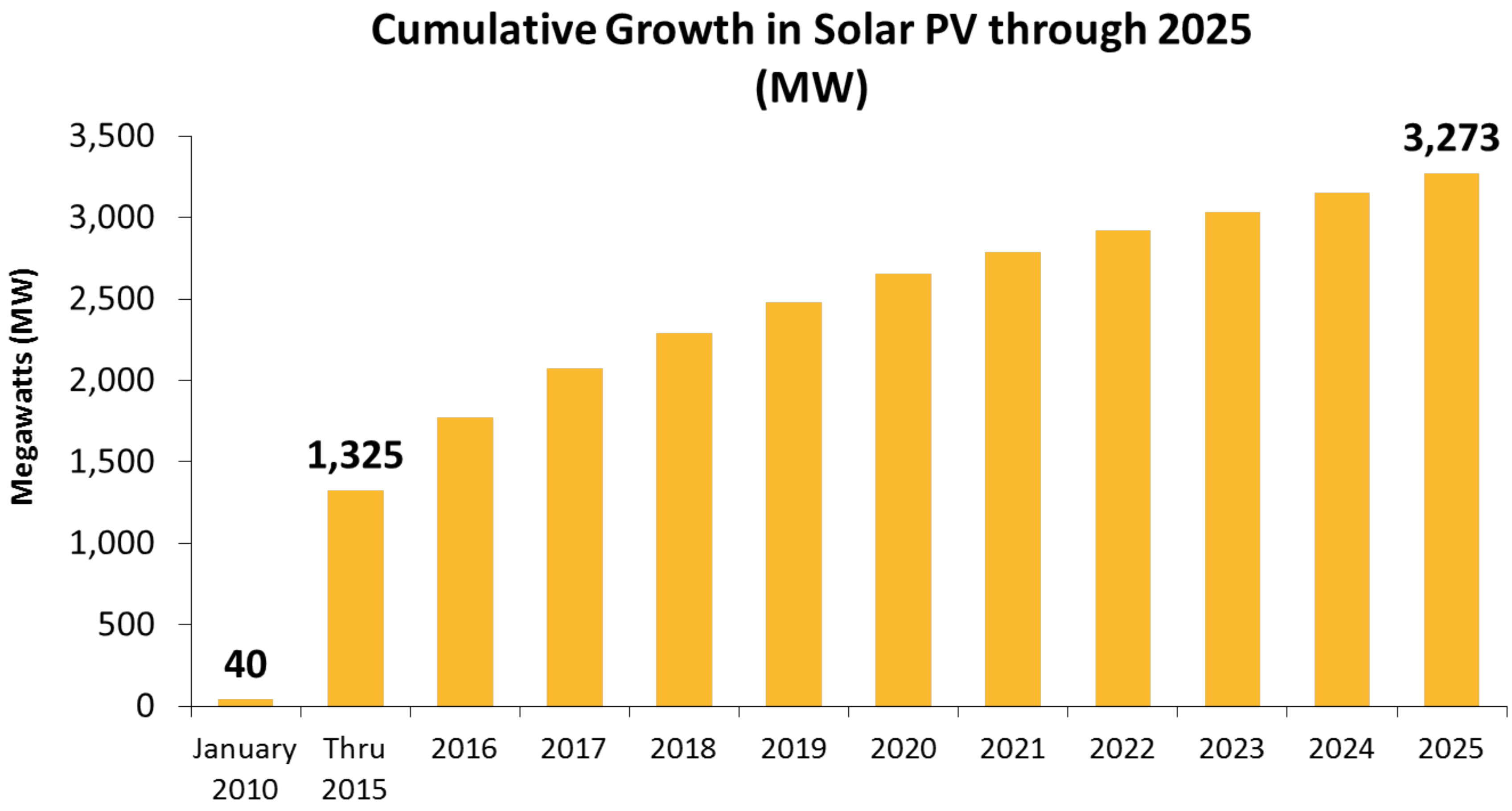
Source: American Council for an Energy-Efficient Economy

Ranking of state EE efforts by the *American Council for an Energy-Efficient Economy*:

– Massachusetts	1
– Vermont	3
– Rhode Island	4
– Connecticut	6
– Maine	14
– New Hampshire	20

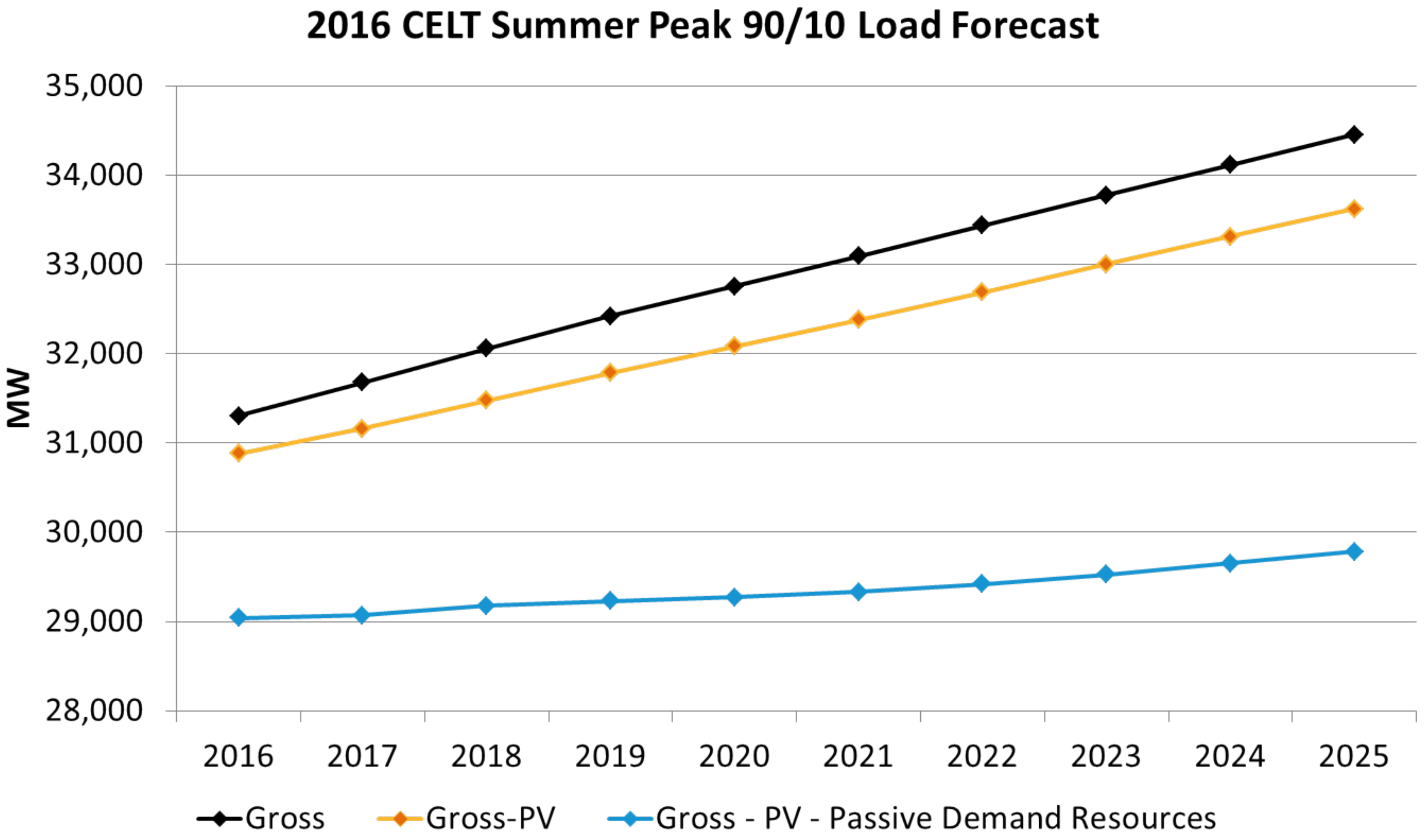
- Billions spent over the past few years and more on the horizon
  - Nearly $4 billion invested from 2009 to 2014
  - ISO estimates $6.6 billion to be invested in EE from 2020 to 2025

ISO New England Forecasts Strong Growth in Solar PV



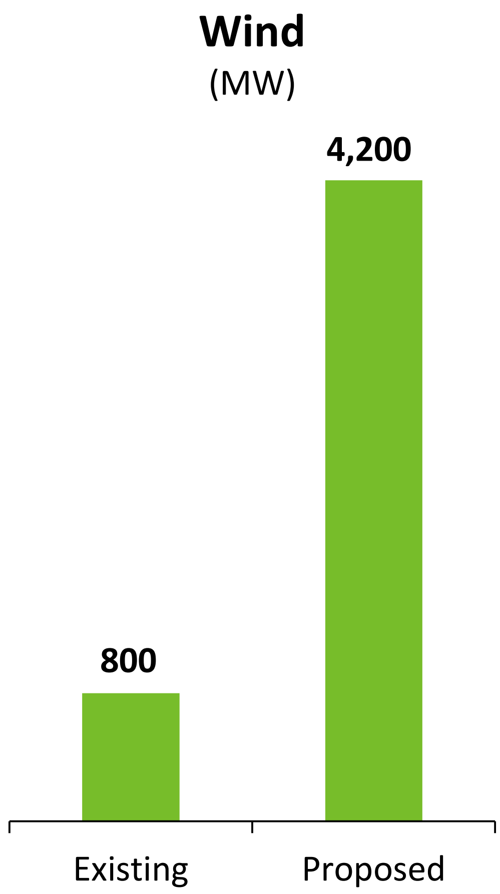
Note: This chart reflects the ISO's projections for nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter." Source: Final 2016 ISO-NE PV Forecast (April 2016); MW values are AC nameplate.

Today, Energy Efficiency and Solar Are Key Factors in Reducing Forecasted Peak Demand Growth



Wind Power Has Emerged in New England, With Significantly More Interest from Developers

- The renewable portfolio standards and public policies have helped stimulate wind development
  - Three-State RFP includes transmission element that can help realize region's wind potential and meet policy goals
- Over 800 MW of large scale wind have begun commercial operations over the past few years
- The ISO has implemented wind power forecasting and enhanced opportunities for wind resources to offer into the energy market

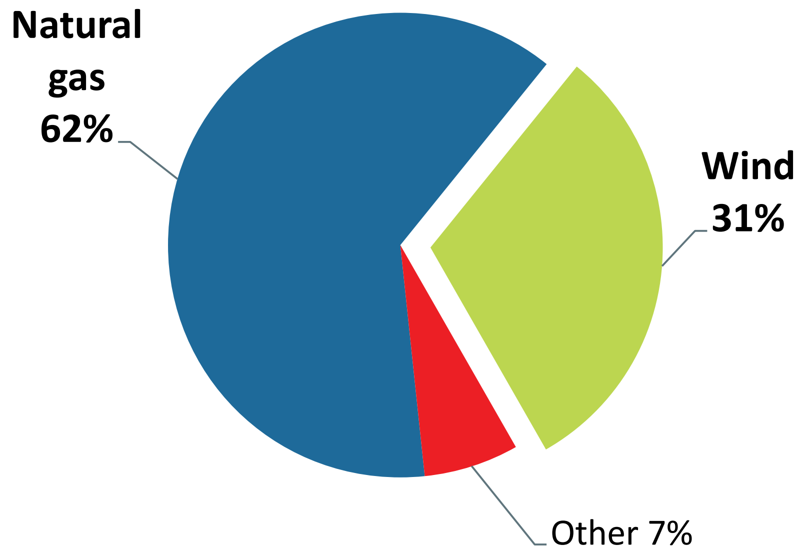


Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue; megawatts (MW).

Infrastructure Will Be Needed to Deliver Energy from Proposed Resources

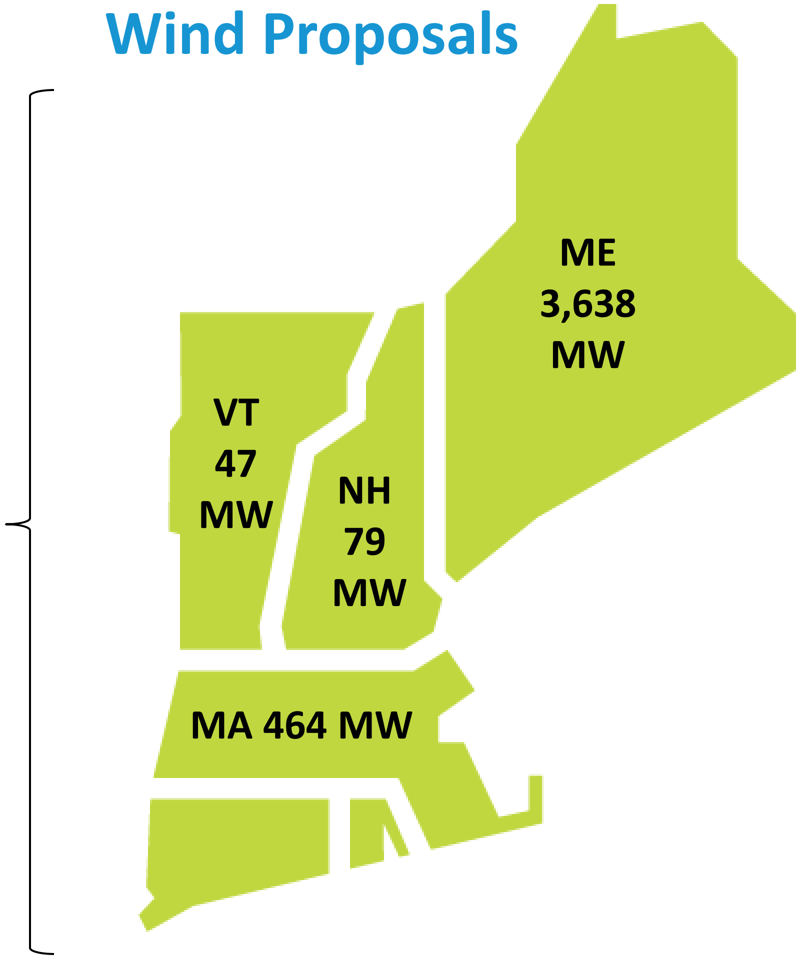
All Proposed Generation

Developers are proposing to build 13,700 MW of generation, including 8,600 MW of gas-fired generation and more than 4,200 MW of wind



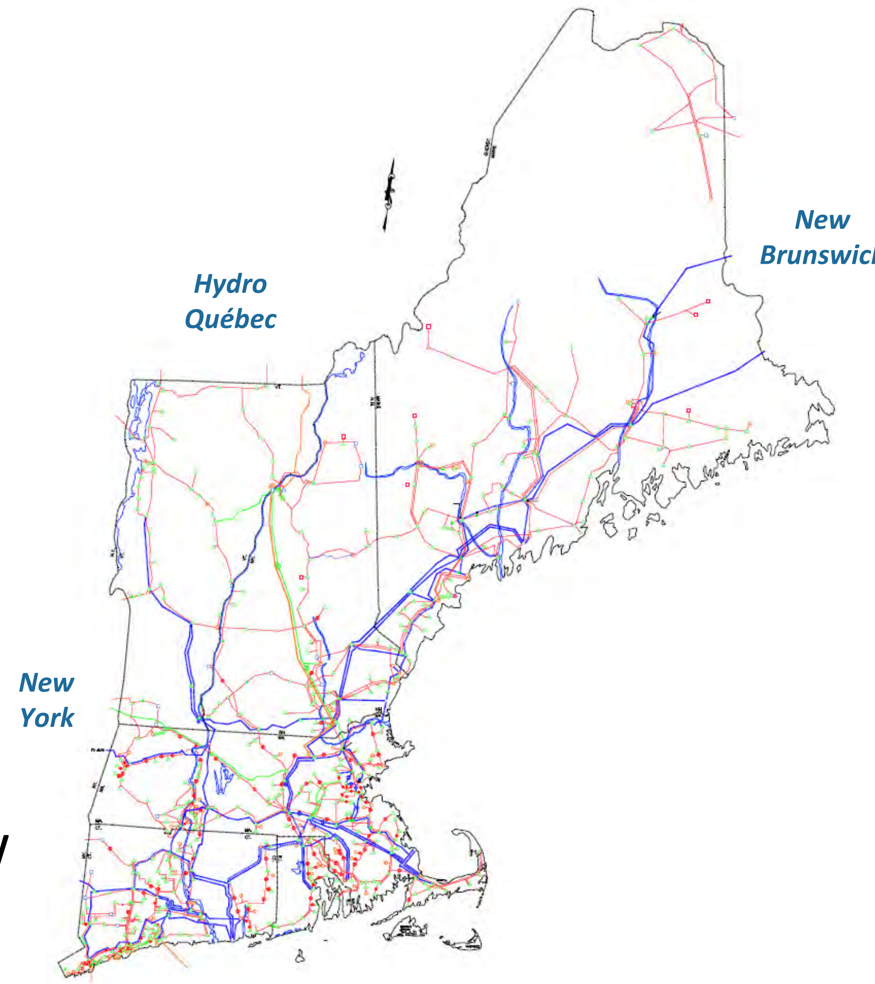
Source: ISO Generator Interconnection Queue (May 2016)
FERC Jurisdictional Proposals Only

Wind Proposals



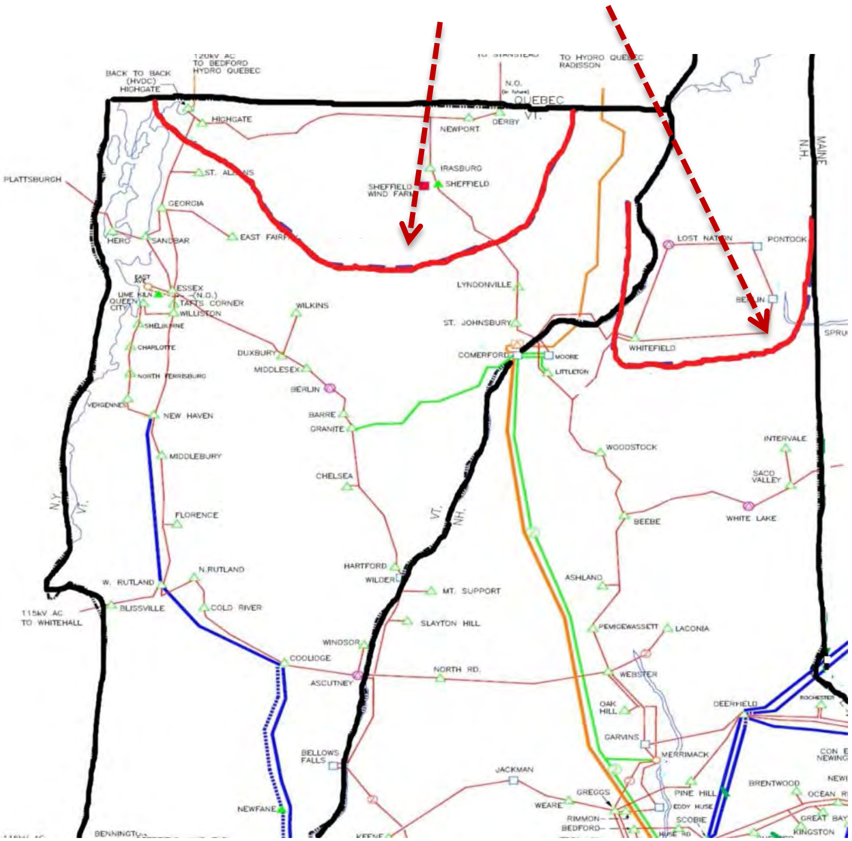
New England's Transmission Grid Is the Interstate Highway System for Electricity

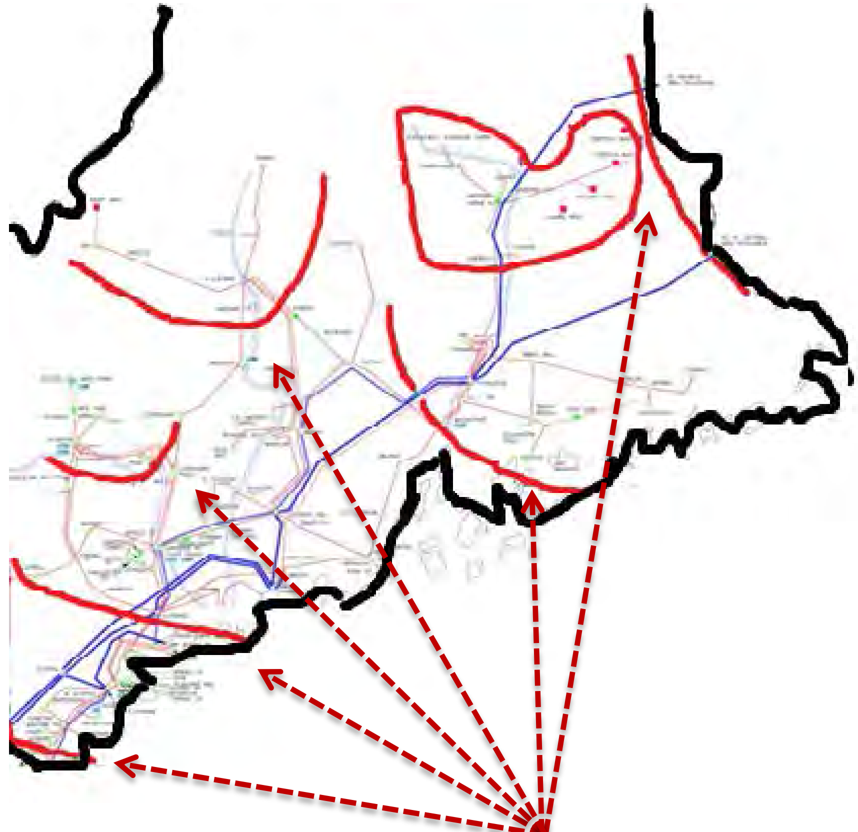
- 8,600 miles of high-voltage transmission lines (≥115 kV)
- Wind generators have connected and are seeking to connect to remote areas that are electrically weak
- Developers have proposed multiple transmission projects to access renewables
- The system is more heavily built out in central and southern New England because that is where the load is concentrated



Transmission Constraints in Northern New England

Constraints in VT & NH





Constraints in Maine

Challenges for *On-Shore* Wind in Northern New England

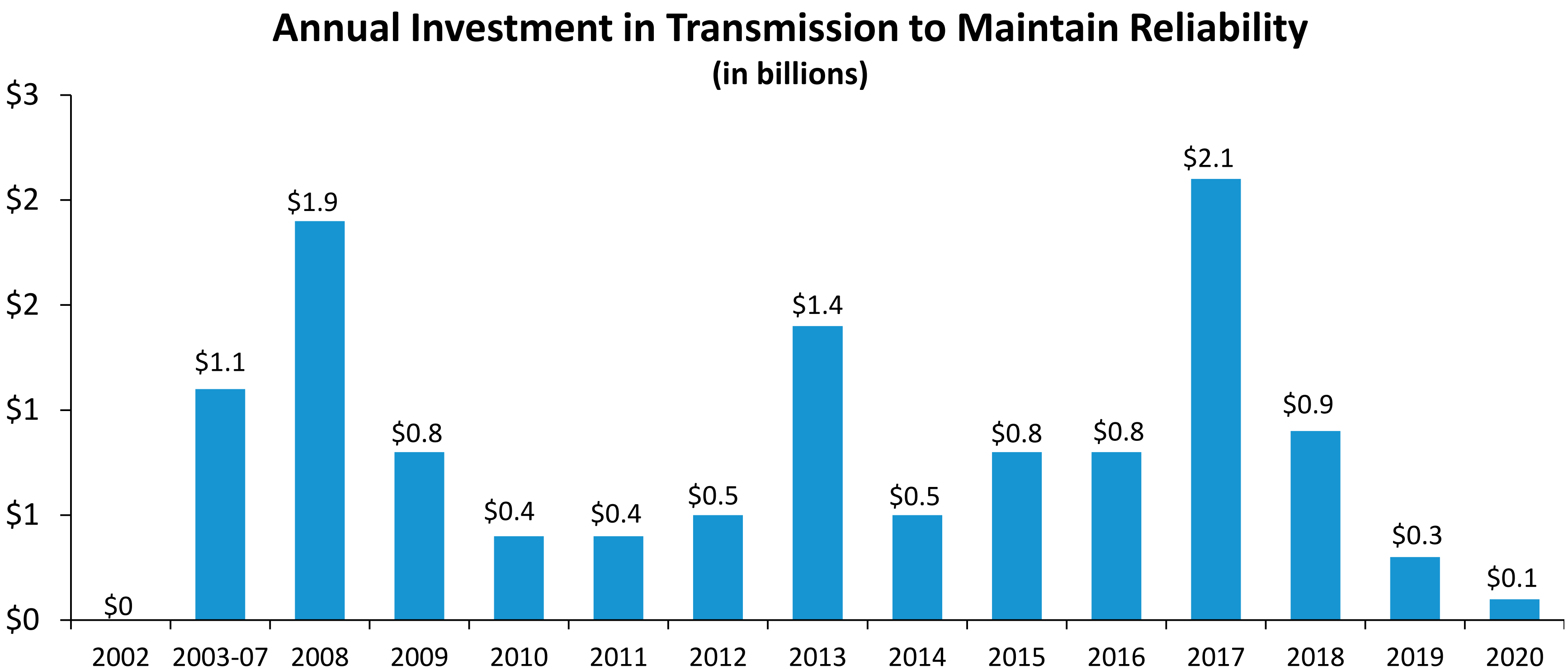
- Wind technology provides limited transmission system support
  - Although technologies are improving, unlike some other conventional generating technologies, wind does not provide significant system voltage/reactive or stability support
- Connecting in a marginal manner to weak parts of the system, often where there are local and regional constraints
  - Poor voltage and stability performance
  - Extremely high reactive power losses
- First-in wind generators have exhausted limited existing system margins, resulting in more significant system upgrades for subsequent generators
- Wind interconnecting as an energy resource, competing for transmission use, based on bid price
  - In some areas of the system, wind competes with wind and other renewable resources, sometimes with the same owner

Transmission Upgrades in New England

	Generally Funded by Entity Proposing Project	Funded by Region, Localized Costs Excluded
Generation Interconnection	100%	
Elective Transmission	100%	
Merchant Transmission	100%	
Local Benefit Upgrades/ Localized Costs	100%	
Regional Benefit Upgrades (Reliability & Market Efficiency)		100%

- As a result of FERC Order 1000, public policy-related projects are subject to a 70%-30% default cost allocation
  - 70% of the cost allocated throughout the region, each state's share is proportionate to the state's share of regional network load
  - 30% to the load in each state in proportion to the state's share of the public policy planning need that gives rise to the project

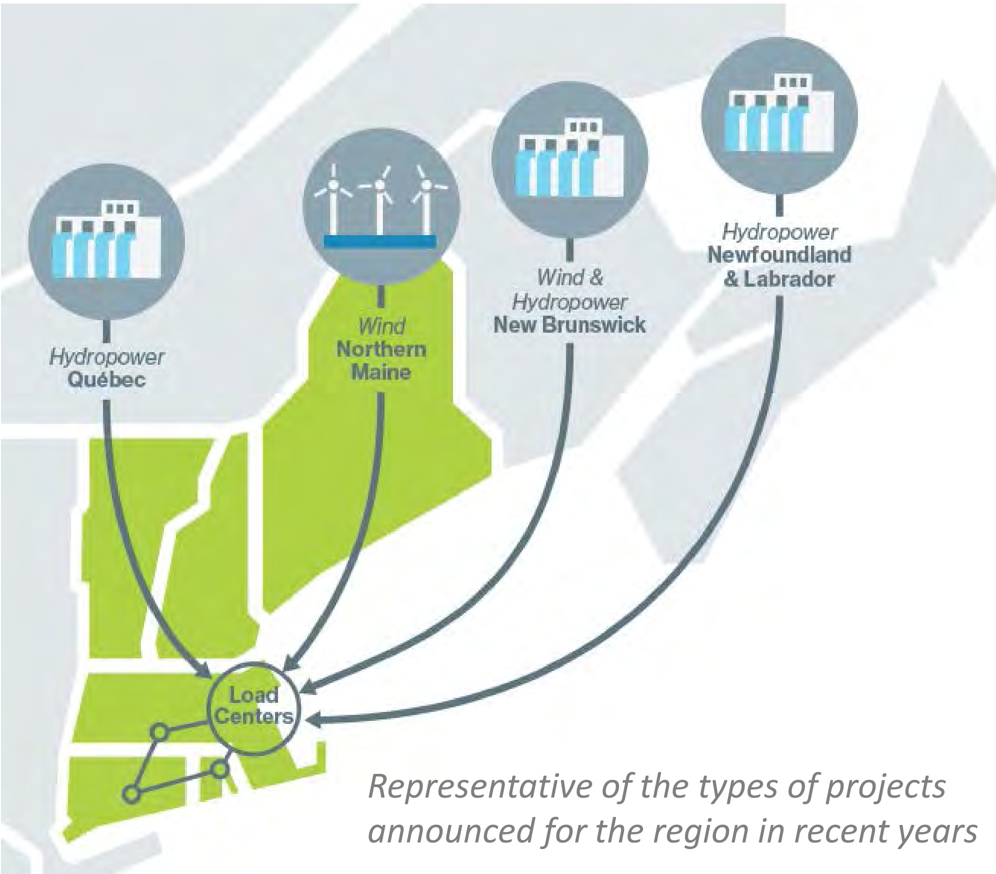
Region Has Made Major Investments in Transmission Infrastructure to Ensure a Reliable Electric Grid



Cumulative Investment through March 2016	$7.86 billion
Estimated Future Investment through 2020	$4.17 billion

Source: ISO New England RSP Transmission Project Listing, March 2016
Estimated future investment includes projects under construction, planned and proposed

Transmission Developers Are Proposing to Move Renewable Energy to New England Load Centers



Representative of the types of projects announced for the region in recent years

- As of **May 1, 2016**, fourteen elective transmission projects had been proposed in the ISO Interconnection Queue, totaling more than **9,000 MW** of potential transfer capability
  - Primarily large-scale **hydro** resources from eastern Canada and **wind** resources from northern New England
- These projects seek to address public policy goals, not reliability needs

Source: ISO Interconnection Queue (May 2016)
http://www.iso-ne.com/system-planning/transmission-planning/interconnection-request-queue

New England States Have Several Initiatives to Develop Energy Infrastructure

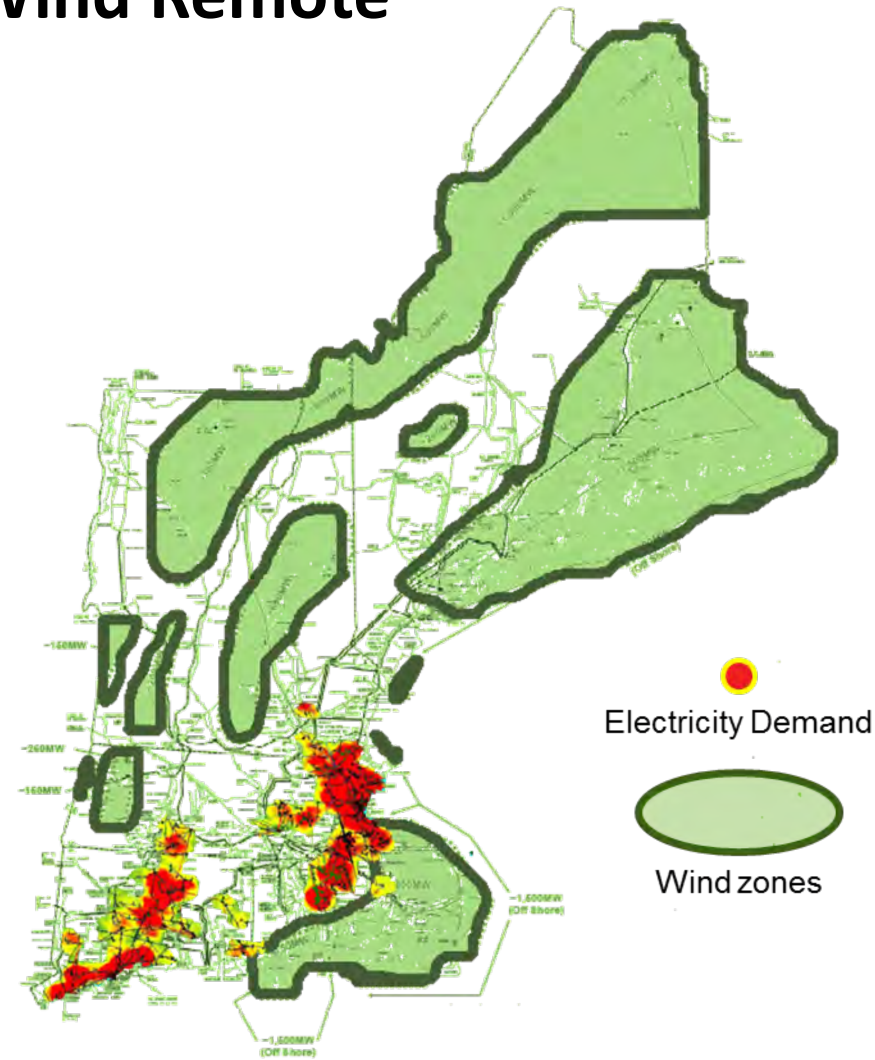
- 2016: Massachusetts, Connecticut and Rhode Island plan to select projects among the responses to their RFP for clean energy and transmission
- 2015: Region's governors meet to discuss their continued work on energy infrastructure challenges at regional energy forum
- 2014: Governors, through NESCOE, request ISO technical support and tariff filings at FERC to support their objectives to expand energy infrastructure
- 2013: Region's governors announce the need for strategic investments in energy resources and infrastructure

ISO Actions to Implement Order 1000, and Next Steps

- The transmission planning process has been revised to comply with FERC Order 1000
- The public policy transmission portion of Order 1000 will begin in January 2017 to provide sufficient time for the ISO and the states to prepare for the new process, including the three southern states finalization of an RFP for clean energy resources
- New, clean energy resources procured through the three-state RFP, in combination with ongoing development of state-sponsored Energy Efficiency programs and incentives for the development of solar PV, may meet or exceed the New England states' Renewable Portfolio Standards

Some Off-Shore Wind Is Near Demand and Transmission; On-Shore Is Wind Remote

- Population and electricity demand are concentrated in southern New England
- On-shore wind resources do not overlap with high energy demand areas
- New transmission is needed to fully realize on-shore and off-shore wind from northern New England



Distances to New England Hub

- Greater distances require greater investment to get power to region's electric hub
- Off-shore wind resources in southern New England have shorter distances than resources in northern New England to get power to load

Southern New England Off-Shore Wind

- Recently announced retirements offer reasonable interconnection spots for offshore wind in southern part of region
- Robust transmission system in southern New England can allow wind power to flow throughout the system

Closing Thoughts

- New England has abundant on- and off-shore wind potential
- Significant transmission investment would be needed to interconnect large-scale wind power in northern New England
- Connecting wind near strong parts of the power system can help reduce transmission bottlenecks
- Potential offshore wind in southern New England is well positioned to tie into a strong part of the transmission system that is near demand
- State public policy initiatives and FERC Order 1000 have the potential to stimulate investment in infrastructure to integrate wind power resources

Questions

memo

To: NECPUC, NESCOE and NEPOOL

From: ISO New England

Date: October 30, 2015

Subject: Revised ISO New England Discussion Paper

In June, ISO New England released a draft discussion paper titled, "The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future." The draft informed discussions with the New England Conference of Public Utilities Commissioners (NECPUC), the New England States Committee on Electricity (NESCOE), and the New England Power Pool (NEPOOL). The ISO accepted comments on the draft discussion paper and incorporated stakeholder feedback into a revised version of the paper.

The following substantive changes are reflected in the revised version:

- Shifted the terminology away from the word "subsidized" and toward "state-supported" or "state-sponsored" when referring to renewable resources
- Made clear that the paper is not intended to address other factors that have an impact on wholesale electric energy prices (e.g., low natural gas prices)
- Noted that other factors in addition to diminishing energy market revenues drive generator retirements (e.g., environmental requirements, aging equipment)
- Noted that wind does not yet have a significant impact on energy market prices because of its modest levels of penetration
- Added a more in-depth discussion of "Pay for Performance" and its importance in a world with high renewable energy penetration
- Added hydro to the discussion on renewables since state-sponsored hydro would have similar effects on wholesale market revenues, even though the New England states apply different treatment to hydro as a renewable resource
- Noted, in the discussion on the 200 MW exemption from the Offer Review Trigger Price (ORTP) for renewable resources, that in order to be treated as a capacity resource, a project would need to meet deliverability requirements, which could increase the cost of the project (and affect its ability to clear the auction)

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- Added a discussion on the potential impacts to merchant storage resources as more renewable energy is brought onto the system, and the economic inter-relationship between merchant and state-sponsored storage

- Added Pilgrim Nuclear Power Station to the discussion of generator retirements driven by low energy market margins (both historical and expected)

Thank you to all who provided feedback on the discussion paper. The ISO is open to any additional comments you may have.

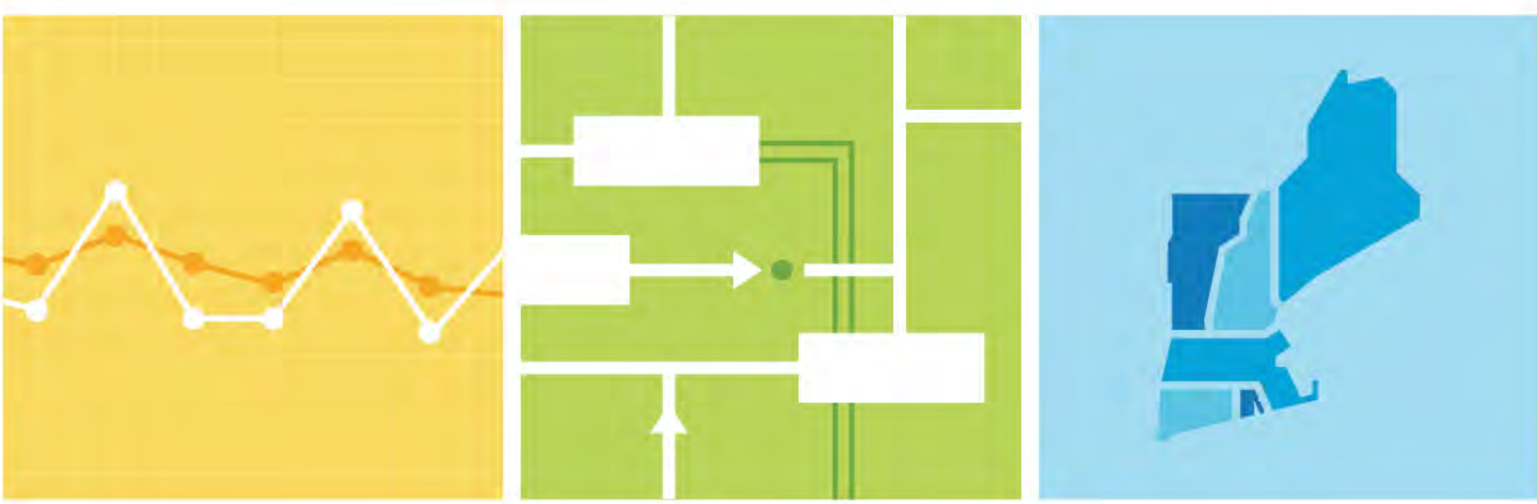
ISO New England

ISO new england

The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future

Revised Discussion Paper

OCTOBER 2015



The Importance of a Performance-Based Capacity Market to Ensure Reliability as the Grid Adapts to a Renewable Energy Future

Revised Discussion Paper

October 2015

Introduction

New England has small, but rapidly growing levels of renewable energy resources—notably wind power and solar power. This growth is being spurred by state and federal policies that seek to introduce cleaner, lower-carbon-emitting resources into the energy mix.[1] In New England, the states desire to see these policies influence the design and outcomes of the wholesale electricity markets.

Because the resources the states are supporting have no fuel costs, they are generally dispatched ahead of conventional generation, such as gas-, coal-, and oil-fired resources with fuel costs which are included in their offers to sell electricity into New England's wholesale electric energy market. These renewable resources are expected to put downward pressure on energy market prices, but this action is not without consequences: a decrease in electricity prices will put upward pressure on prices in the capacity market. The capacity market will help balance the revenue needs of resources needed for reliability as the energy market provides fewer opportunities for resources to recover their fixed costs.

This paper discusses the quantity of renewable resources coming onto the system and the interaction of related state policies with the region's wholesale electricity markets. The capacity market will play a key role in ensuring that reliability is maintained as increasing levels of renewables are integrated onto the system. Additional renewables are expected to decrease wholesale electric energy prices, which in turn will increase capacity prices to meet resource adequacy needs. The shift in revenues from the energy to the capacity market will also affect the resource mix, putting additional financial pressure on energy-market-dependent resources.

[1] Mechanisms to implement these policies include, but are not limited to: state renewable portfolio standards and similar renewable energy goals; state initiatives to reduce greenhouse gas emissions (e.g., global warming solutions acts) and regional carbon cap-and-trade programs, such as the Regional Greenhouse Gas Initiative; state-sponsored, long-term contracts to develop renewable resources; and federal production and investment tax credits.

The purpose of this paper is to examine how increasing levels of renewable energy resources affect the wholesale electricity markets. This paper is not intended to address other factors that have an effect on wholesale electric energy prices, such as low natural gas prices and emissions policies; however, the market dynamics described in this paper will apply to any market condition that incrementally shifts revenue dependency from the energy to the capacity market.

Renewable Energy in New England

By the end of 2014, 800 MW of wind power (nameplate capacity) had been installed in the region, which produced nearly 1% of the region's electricity that year. By 2015, developers had proposed 4,000 MW of additional wind power.[2] Furthermore, ISO studies have shown that New England has vast wind power potential that could generate nearly a quarter of the region's electricity under high wind penetration scenarios (up to 12,000 MW of onshore and offshore wind power resources).[3]

By the end of 2014, 900 MW of solar photovoltaic (PV) resources (AC nameplate capacity) had been installed in the region, and ISO New England's solar PV forecast projects the region will realize nearly 2,500 MW by 2024.[4]

Capacity and Energy Markets

The capacity market is a forward market intended to ensure New England will have adequate resources to meet all electricity demand plus reserve requirements under most conditions three years in the future. Beginning in June 2018, capacity payments will be based on an individual resource's performance during scarcity conditions (times when the system is unable to meet its energy or reserve requirements), which will allow the capacity market to meet two primary objectives: ensuring resource adequacy and providing appropriate incentives for resource performance. The ISO obtains the resources needed through annual forward capacity auctions. In this auction, bidders reduce their offers by each resource's expected net energy market revenues in the capacity delivery period. The two markets (capacity and energy) are linked; higher energy market net revenue reduces competitive capacity market offers. As such, changes in the fundamentals in one market will affect the other.

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[2] ISO New England Generator Interconnection Queue, June 2015

[3] *New England 2030 Power System Study: Report to the New England Governors*, February 2010; http://www.iso-ne.com/static-assets/documents/committees/comm_wkgrps/prtcpnts_comm/pac/reports/2010/economicstudyreportfinal_022610.pdf

[4] Final 2015 PV Forecast, April 2015; http://www.iso-ne.com/static-assets/documents/2015/05/final_2015_pv_forecast.pdf

"Pay for Performance"

Under the new performance incentives design, known as "Pay for Performance" (PFP), a resource's capacity market revenues comprise two parts – a *base payment* and a *performance payment*. The base payment is determined by the forward capacity auction result. The performance payment is determined by a resource's performance whenever scarcity conditions occur during the capacity commitment period. A resource's performance payment may be a positive or negative adjustment to its base payment, reflecting over- or under-performance during scarcity conditions.

PFP will be an important design element as the power system experiences growth in variable energy resources, such as wind and solar. The bulk power system will experience more frequent and rapid changes in generator output as wind and solar levels change, increasing the need for resources that can come online and ramp quickly. PFP provides strong incentives for the development of such resources.

Interaction of State-Sponsored and Conventional Resources

Stakeholders are asking the ISO what will be the impact of increasing levels of state-sponsored renewable resources (e.g., solar, wind, and hydro) on resources participating in the wholesale market.[5] In particular, we are asked: Will this drive conventional generation out of the market by suppressing energy market prices and thereby making conventional generation uneconomic?

This concern has been raised in the context of specific nuclear unit retirements (e.g., Vermont Yankee) and potential retirements (e.g., other nuclear resources in New England and resources in Illinois and New York).[6] [7] And it is easy to understand why this concern arises: wind, hydro, and solar resources generally produce zero (or even negative) marginal cost energy.

Adding wind, hydro, and solar to the grid is expected to result in lower energy prices when the wind is blowing, the water is flowing, or the sun is shining. This will reduce the inframarginal rents earned by all resources during those hours, and may have significant effects on the net revenues of

[5] The New England states apply different treatment to hydropower as a renewable resource, but for purposes of this paper, hydro has been included in the discussion on renewables since state-sponsored hydro would have similar effects on wholesale market revenues.

[6] http://www.renewableenergyworld.com/rea/news/article/2014/06/old-reactors-v-new-renewables-the-first-nuclear-war-of-the-21st-century

[7] http://www.rochesterhomepage.net/story/d/story/the-future-of-ginna-nuclear-power-plant-uncertain/48117/YHLnyTmFt0StlE4Xth_4VA

baseload resources for which the energy market is the primary revenue source. It may also be expected to increase the price of reserves, and the revenues of flexible, reserve-providing resources.

In New England today, the total resource mix comprises a relatively small percentage of locally produced renewable energy, with a larger percentage of imported Canadian hydro energy. With only 800 MW of wind power on the system, it does not have a large impact on energy prices at this modest level of penetration. But the percentage of wind and other renewables such as hydro and solar is expected to grow substantially over the next decade. This growth in renewables is being driven by both the falling cost of installing these resources (by some estimates wind is already a low-cost provider in certain areas), and by sizeable direct and indirect state support, through incentive mechanisms or direct contracts for the energy output.

For example, in late 2015, Connecticut, Rhode Island and Massachusetts, and certain of their electric distribution companies, plan to issue an RFP to help fulfill these states' clean energy goals. This action is in addition to having instituted Renewable Portfolio Standards (RPSs) and other mechanisms for clean energy over the last fifteen years.

As the penetration of wind and solar resources grows, any price-reducing effects of renewables on electric energy prices will increase. This will in turn increase the financial pressure on energy-market-dependent resources with high capital costs, for example, nuclear, storage (pumped hydro and other emerging forms of storage) and legacy fossil-fueled steam generators (coal and oil). These sorts of projections have caused industry participants to worry about a wave of forthcoming retirements of resources that will harm reserve margins and reliability. These concerns are in addition to other factors that drive generator retirements, including the reductions in energy market revenues due to low gas prices and the increased cost of complying with environmental regulations and maintaining aging equipment.

Some argue that the concern over generator retirements warrants changes to the market designs of the RTOs, or policy changes to prevent these retirements and their associated reliability impacts. These suggestions range from clean energy standards, to carbon taxes, to requiring a "baseload" tranche in the capacity market, to requiring a specific resource mix to ensure fuel diversity, to unit-specific reliability agreements to preserve reliability in the absence of an explicit market mechanism to support these resources.

While policy initiatives like these may be desirable for other reasons, such approaches should not be needed to ensure reliability, or efficient market responses to an increased penetration of renewable resources. The current market design should ensure adequate resources to meet the reliability standards for which the markets are designed, as long as prices in the capacity market are appropriately formed. Appropriate price formation in the capacity market should ensure that the resulting resource mix appropriately complements the capabilities and limitations of the renewable resources entering the market.

The Capacity Market Will Ensure Resource Adequacy

Under the current New England market construct, the capacity market is designed to ensure resource adequacy. The supply in the market is determined by offers from competitive suppliers of both new and existing resources. Demand in the market is determined by an administratively defined downward sloping demand curve, which is calculated to ensure adequate resources to meet expected operating needs. Price and quantity are determined by the intersection of the supply and demand curves, just as in any market.

Two important elements of the capacity market design ensure that the market is "calibrated" to reflect both the region's capacity needs and the price needed to induce new capacity when required. These elements are the Installed Capacity Requirement (ICR) and the Cost of New Entry (CONE). The ICR determines the target amount of resources that the ISO seeks to procure through the capacity market. The CONE calculation is an estimate of the cost of building an efficient new generating resource. These elements are expanded upon below.

ICR and CONE

The ICR is calculated by the ISO's System Planning department. Using system load and outage data, System Planning calculates the expected frequency of outages on the bulk power system due to insufficient available capacity resources. From these calculations, System Planning is able to determine the quantity of resources that should be adequate to ensure that a loss of load does not occur more frequently than once every ten years. The ICR increases as the region's demand for electricity grows over time. Similarly, if the outage rate were to increase for resources unexpectedly forced out of service (i.e., an unplanned outage), the ICR would also increase.

This calculation also takes into account the expected availability of renewable resources (or any variable resource). The less frequently a variable resource is expected to operate during a year, the less the resource contributes to ensuring reliability. Thus, a 100 MW wind resource which operates 20% of the time, when the wind blows, contributes less to meeting capacity needs than a 100 MW combined-cycle generator that operates 80% of the time, and on demand.[8] The total quantity of resources needed should be expected to grow as more variable and renewable resources are added to the system; these resources typically make contributions to reliability that are only a fraction of the value of their nameplate capacity. For this reason, variable resources like wind have their capacity severely discounted when counted toward meeting the ICR.

The second important element used for calibrating the capacity market is the Cost of New Entry (CONE). CONE is an estimate of the competitive offer that would be submitted into the capacity market by a prospective new entrant such that, if the market cleared at that price, it would be just sufficient to induce entry into the market.

CONE is calculated by estimating the total cost of a new resource (including permitting, siting and construction costs, and a competitive return on capital), and then calculating a levelized annual cost for the resource (similar to the mortgage payments on a home). These annual costs are then reduced by any forecast net revenues from the energy and ancillary service markets. The remaining revenue requirement is the Cost of New Entry, which is the amount that the resource would need to earn from the capacity market in order to be induced to enter the market.[9]

The simplest calculation would be for a peaking unit with a relatively low capital cost, but a high marginal cost. Such a unit would be expected to earn essentially no money in the energy market, and only a modest amount in the reserve market, so its capacity market offer would be close to its levelized capital cost. This is the amount that a for-profit developer would require in order to build the resource.

The ICR and CONE are used in determining the precise nature of the sloped demand curve. The sloped demand curve helps to determine the purchase quantity and price in the forward capacity auction, causing the FCA to procure less capacity at high prices and more at low prices. This reflects both the fact that the desired level of reliability changes with the price of reliability and that

[8] The difference between resources that operate on-demand versus those that operate when the wind is blowing (or the sun is shining) is important to reliability, but this paper does not focus on those differences and instead only addresses the differences currently relevant for ICR calculation purposes.

[9] There are additional complexities, like variable revenues from year to year and a whole range of operating and market risks which are not discussed here, but which would be expected to influence an actual resource's offer as well as any calculation of CONE.

elasticity of demand helps to control market power. The ICR determines how far “right” the demand curve is positioned. CONE is used to set the “height” of the demand curve.

The “target” procurement is the ICR at an expected price of CONE.[10] That is, the demand curve is set to procure enough to meet the reliability target assuming that CONE is a reasonable estimate of the price that a new resource would require to enter the market.

Interaction of renewable resources and the FCM

From this discussion, it is straightforward to see how the capacity market would respond to an influx of renewable resources with zero marginal cost energy. This would affect both the amount of capacity installed in the region and CONE, with the change in CONE consistent with expected changes in bidding behavior by market participants. The total amount of capacity (i.e., nameplate capacity) would increase with the addition of more renewables relative to a system populated entirely by conventional resources. The ICR calculation discounts the nameplate value of renewable resources as an input, so this increase would not be directly reflected in the ICR.

As an example, 1,000 MW of additional wind resources might only count 200 MW toward meeting the ICR. The gross capacity required to meet the ICR would therefore rise as the proportion of variable generation increased. It might take five 1,000 MW wind facilities to equal the contribution of one 1,000 MW combined-cycle generator.[11]

The introduction of larger quantities of renewable resources would also be expected to increase both CONE and offers from competitive capacity suppliers. CONE would increase because additional renewable resources, which typically act as price takers in the energy market, would be expected to decrease energy prices and therefore net revenues for all resources in the energy market. This expected reduction would be reflected in reduced net energy market revenues calculated for the hypothetical new entrant as part of the CONE calculation. A reduction in net energy market revenues would increase the amount that a new entrant would require from the capacity market in order to move forward.

What is true for the CONE calculation would also be expected to be true for the offers submitted by capacity resource owners: capacity market offers should rise as energy market revenues decrease.

[10] This is a simplification in that the demand curve is set to procure slightly more than the ICR at CONE to allow for error in the CONE calculation.

[11] This is an illustrative example only.

Both elements of the capacity market that calibrate it to reflect reliability needs and market conditions would reflect the addition of renewable resources (as they have to date). These two elements would ensure that sufficient additional nameplate capacity was built to meet reliability requirements (by discounting the capacity value of variable renewable resources), even with the relatively low capacity value of many renewable resources. These elements also would ensure that the price set by the demand curve at the reliability target is increased to reflect any expected reduction in energy market revenues caused by increased levels of renewable resources.

The capacity market would continue to ensure that the reliability target is met just as it does today. If necessary, the capacity market could set a CONE that reflects new entrant capital costs with no energy market revenue offset because expected energy market net revenues are zero.

The Combined Capacity and Energy Markets Will Shape the Resource Mix

While the capacity market will ensure that the region's reliability target is met, the addition of large quantities of renewable resources that reduce energy market prices will influence the long-run resource mix in New England beyond just the quantity of renewables. It will affect what resources retire and what types of resources get built in the future; not all resource types will be affected equally.

Energy market revenues affect cost recovery and retirements

New England has already experienced a number of retirements of coal, oil, and nuclear units in recent years due to economic, environmental, and other factors. While it is not possible to know if all of these retirements would have occurred with fewer renewables as part of the resource mix, they are certainly indicative of the expected future retirements in New England. They include baseload coal and nuclear units that depend relatively heavily on consistent inframarginal rents in the energy market. Entergy, the owner of the Vermont Yankee and Pilgrim nuclear units, has made clear that low energy market margins (both historical and expected) were the driver for their retirements.[12] While the primary driver in current energy market pricing is the relatively low price of natural gas in New England (during the spring, summer, and fall months), renewable energy will become an ever-more-significant factor since the fuel cost for renewable resources is zero.

[12] *Entergy to Close, Decommission Vermont Yankee*, Entergy press release, August 27, 2013; http://www.entergy.com/News_Room/newsrelease.aspx?NR_ID=2769; *Entergy to Close Pilgrim Nuclear Power Station in Massachusetts No Later than June 1, 2019*, Entergy press release, October 13, 2015; http://www.entergynewsroom.com/latest-news/entergy-close-pilgrim-nuclear-power-station-massachusetts-no-later-than-june2019/

With the expected increased penetration of renewable resources, more such retirements should be expected in the future. For example, at current energy and capacity prices, nuclear units might earn almost ten times more revenue from the energy market than they earn from the capacity market.[13] Modest changes in energy market revenues could have large impacts on the bottom line of a nuclear unit, or baseload coal unit. This may be especially true for nuclear units, which have very high fixed operating costs and typically operate at very high capacity factors.

The economic viability of merchant storage resources may also be affected, since storage resources have high capital and fixed costs and rely on daily energy market price arbitrage to recover those costs.

Renewable resources produce energy whenever the wind is blowing or the sun is shining and, because they are the lowest-cost producers of energy, will typically not modify their production in response to changing demand for electricity. Therefore, renewable resources will tend to displace conventional resources and reduce energy prices during all hours. However, because solar production can only occur during the day and is additive to other renewable resources such as wind and hydro, it is likely that the average price differential between the day (peak demand) and the night (off-peak) will be reduced, therefore reducing the revenue opportunity for merchant storage technologies that depend on buying energy when prices are low (at night) and injecting energy when prices are high (during the day, or during scarcity conditions).

For this reason, merchant storage investors are also likely to become more dependent on capacity market revenues. The introduction of state-supported storage at either the wholesale or retail level will tend to further reduce price differentials between peak and off-peak periods and therefore reduce the economic incentives for investors in merchant storage resources.

Energy market shifts could affect technology types

Lower energy market margins are also likely to shift the new generation mix away from energy-market-dependent resources to capacity-market-dependent resources. In the current environment, that might mean a shift from gas-fired combined-cycle resources toward peaking resources that will tend to raise capacity prices, such as gas-fired combustion turbines and emerging storage technologies. For example, a combined-cycle (CC) resource is currently expected to earn double the net revenues from the energy and ancillary markets when compared to a combustion turbine (CT),

[13] 8760 hours*$65/MWh*.95 capacity factor=$540,930/MW vs. $4.75/kW-mo.*12 months*1000kW/MW=$57,000/MW

but a decrease in available energy revenues may cause combined-cycle generators to become less competitive.[14] This shift is also consistent with the expected increase in reserve market needs as the penetration of variable renewable resources grows.

Generator retirements will affect carbon emissions

The expected future increase in renewable resources, and the consequent reduction in energy prices, will put increased pressure on existing baseload units and any technology that is highly capital intensive or has high fixed costs. This financial pressure will likely cause them to retire sooner than they otherwise would. While this is an expected market response given the changing resource mix and incentives, it will have side effects. In addition to accelerating the retirement of otherwise reliable resources, to the extent that nuclear units are shuttered it will likely result in increased CO_2 emissions as fossil resources fill at least some of the energy gap. This is almost certainly an unintended consequence given that much of the rationale for states to sponsor renewable resources is the reduction of CO_2 emissions.

The Increased Importance of the Capacity Market Will Make the ISO's Execution of Administrative Functions Even More Important

Capacity markets include complex administrative elements to ensure appropriate price formation. They rely on accurate calculations of the cost of new entry, sloped demand curves, the installed capacity requirement, offer review trigger prices, and scrutiny of the prices at which resources seek to exit the market (i.e., delist bids are reviewed and potentially capped by the market monitor). While this overhead is necessary because of administratively-imposed reliability standards and lack of substantial demand-side price response by electricity consumers, the reduction in energy margins and greater reliance on the capacity market to assure resource adequacy will *increase* the importance of these administrative determinations.

If they are allowed to operate as designed, these administrative calculations will be successful in ensuring a reliable system and an orderly transition as the share of renewable energy grows rapidly over the next decades.

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[14] For example: http://www.iso-ne.com/static-assets/documents/committees/comm_wkgrps/mrkts_comm/mrkts/mtrls/2014/mar192014/a02_iso_net_cone_capital_budgeting_model_03_14_14.xlsx. See column "E&AS Offsets."

Some of these functions are relatively new to the market, or will take on greater importance. In particular, getting CONE right and guarding against uneconomic new entry through realistic offer review trigger prices (ORTPs) will be necessary to attract the resources needed to operate reliably.

Cost of New Entry

CONE is a key parameter because, when calculated correctly, it causes the demand curve to induce new entry when quantities fall below the ICR. If CONE is too low, there will be insufficient new entry and the region's reliability targets will not be met. Because of the complexity of the CONE calculation, sensitivity to key assumptions like internal rates of return, and the necessary projections of future energy, capacity and ancillary service market revenues, CONE is particularly vulnerable to miscalculation.

Offer Review Trigger Prices

ORTPs are also important components to a successful capacity market. The ORTP is intended to prevent uneconomic new entry from distorting market prices by setting a price floor below which new entrants must demonstrate their costs or be withdrawn from the capacity auction. Inappropriate entry by uneconomic new resources will lower the capacity price for all existing resources, which in turn will reduce the incentives for new, market-rate resources in the future. Because the volume of new entry needed in any particular year is generally small relative to the total capacity need, even a modest amount of uneconomic new entry could meaningfully depress capacity prices.

Features in FCM that address entry by new renewable resources

To address this, the New England capacity market has two complementary features that address capacity market entry by new, renewable resources: ORTPs designed to prevent uneconomic entry, and a 200 MW per-year exemption from the ORTP for renewable resources. The exemption allows, within limits, the resources being developed in response to state policy to enter the market and count as capacity resources.[15]

The 200 MW limit on the amount of renewable resources that may clear in an auction is intended to ameliorate price suppression concerns given that the combination of load growth and retirement of

[15] To be eligible for treatment as a capacity resource, a project would need to meet deliverability requirements, which could increase the cost of the project and affect its ability to clear in the FCM.

existing resources would have to be less than 200 MW in order to result in suppression of prices when the market is at or near equilibrium. This is appropriate to avoid creating a large quantity of state-backed resources that do not count towards meeting the region's reliability requirements. Ignoring these resources would be costly and inefficient. Allowing unlimited entry by such resources, however, would undermine long-term price expectations and confidence in the capacity market. This would make it more difficult for the market to attract new resources, and would increase the price necessary to attract those that do come forward.

The ORTPs are necessary to ensure that resources that do enter the market, including renewables, do so at a competitive price. This acts as a filter to ensure consistently competitive pricing in the capacity market and provides appropriate long-term price signals to new entrants. If renewables are economic at quantities that exceed the renewables exemption, the ORTPs will allow them to enter the market at a competitive level. If they are not, the ORTPs will ensure that more economically-efficient new entrants clear in the auction.

Calculating class-specific ORTPs is an involved task, but doing these calculations correctly is important to ensure that uneconomic resources do not depress the capacity price and that economic resources are not inappropriately excluded from the market. Either would reduce efficiency and ultimately increase costs to consumers.

While the renewables exemption and ORTPs contribute both to the administrative nature of the capacity market and the difficult set of calculations that must be performed by the ISO for each capacity auction, they have emerged as accommodations to state programs and policies outside the control of the ISO. If government policies were to reduce the emphasis on targeted mechanisms, such as direct contracting and picking specific preferred technologies, and instead focus on broad-based mechanisms such as regional carbon-cap-and-trade markets or other resource-neutral carbon reduction incentives (that can be easily monetized by the wholesale market), these types of administrative safeguards might be relaxed.

The interaction of competitive wholesale electricity market design and state policy objectives requires a delicate balance.

Conclusion

The development of large quantities of state-sponsored renewable resources will present opportunities and challenges for New England.[16] The current markets are equipped to respond appropriately to the entry of these resources, maintaining reliability and market efficiency. However, this new entry will likely drive down energy prices, but lead to an increase in capacity prices. Capacity market revenues will become even more critical to the continued operation of existing resources and the entry of new resources. This entry also will likely incent some existing baseload resources to retire earlier than they otherwise would.

In the medium to long term, the capacity market will enable the region to achieve necessary levels of resource adequacy and resource performance while transitioning toward a system with greater levels of renewable resources. In the near term, the entry and exit of specific resources will continue to be monitored to ensure reliability needs are met.

[16] The introduction of similar quantities of renewable resources because of naturally occurring, private-sector investment (without state support) would have the same effect, but state policies appear to be the primary driver of this type of investment, not private investment.

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August 22, 2016

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106 Hogan Road, Suite 8
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RE: Additional Information regarding the Milton Township bat hibernaculum

Dear Stacie:

As a follow-up to comments from this Department submitted on June 29, 2016, and in response to specific questions in your e-mail dated August 13, 2016 we offer the following information on the Milton Township bat hibernaculum for your consideration. Thank you for the opportunity to provide technical information as the Land Use Planning Commission undergoes a substantive review on a petition for removal of Milton Township from the expedited permitting area for wind energy development.

Significance of the Milton Township hibernaculum: A bat hibernaculum in Milton Township annually supports the largest gathering of overwintering bats known in Maine. All three *Myotis* bats (Little Brown Bat, Northern Long-eared Bat, and Eastern Small-footed Bat) designated as Endangered or Threatened since October 15, 2015 use the site. This location is the only hibernaculum in Maine with documented use by all five cave-dwelling bats that occur in Maine. Tricolored Bats and Big Brown Bats also overwinter in the Milton Township hibernaculum and are both Species of Special Concern.

Only 3 settings in Maine have been documented to support 85 or more wintering bats during the last decade after millions of cave bats died from white nose syndrome (WNS). The Milton Township location consistently supports the most bats overwintering in a Maine cave as well as the greatest numbers of *Myotis* bats now protected under the Maine Endangered Species Act. Numbers of overwintering bats declined at an alarming rate at this site, as well as at the other two large hibernacula in Maine as they have at nearly all caves across eastern North America impacted by WNS.

Bat activity near hibernacula: *Myotis* bats and other species that overwinter in caves do concentrate near hibernacula during the period of fall swarming (primarily September and October) and spring emergence (primarily April and early-May). Seasonal activity patterns and the range of movements from bats using a hibernaculum are among the many facets of little-studied bat biology that are now being researched. Bats equipped with transmitters near a Vermont site have been monitored up to 5 miles from their hibernaculum (David Yates, personal communication to Charles Todd, August 16, 2016). As yet, there are no data to infer that concentrations of cave-dwelling bats are greater during the summer breeding season. Preliminary findings suggest that areas with substantial talus fields, cliffs or rock outcrops may harbor more remnant *Myotis* bats which may use suitable substrates as roosts.

Vulnerability of cave-dwelling bats to wind turbines: In general, "cave bats" are reported less frequently than so-called "tree bats" during efforts to monitor mortality at wind turbines. Some may infer lower vulnerability based on differing migration habits and/or foraging strategies. However, it should be stressed that deaths of Little Brown Bats are reported at most windpower projects in Maine despite a population decline exceeding 90% during the period that most searches have occurred for dead bats at turbines in Maine. In other words, we are left with remnant numbers of several *Myotis* bats for which any and all additional mortality should be avoided or minimized. Little Brown Bats in particular are considered generalists and are known to occupy a variety of habitats across the landscape, making them particularly vulnerable among *Myotis* bats. At one wind project in 2013, a total of 19 bat fatalities was reported, including 10 Little Brown Bats mortalities (extrapolated to an estimate of 26 Little Brown Bat mortalities), during a single monitoring season.

Even a partial recovery of cave bats from WNS impacts will take many decades, and cumulative losses during the life of each project are now a major concern. Monitoring of bat mortality is done by sampling and modelling, and we urge decision makers to disregard simple tallies of dead bats found. Curtailment policies are the best tool currently available to minimize bat mortalities from operation of wind turbines during low wind speeds at night during the season of bat activity in Maine; however, the exact level of curtailment that offers the greatest level of protection to our bats, especially the listed *Myotis* bats, is still being studied. The fate of Little Brown Bats and Northern Long-eared Bats is uncertain and losses that are avoidable may be considered "negligent" take: a prohibition of the Maine Endangered Species Act. To date, wind projects in Maine are not operating at rocky settings favored by Eastern Small-footed Bats.

Continuing use of the Milton Township hibernaculum: There has been some confusion in submissions to LUPC regarding the status of the Milton Township hibernaculum. Since 2008, MDIFW has conducted or coordinated all surveillance of Maine's major bat hibernacula during the period that WNS impacts on cave bats was spreading across the Northeast. We are not aware of any formal surveys conducted during the winters of 2013 – 2014 or 2014 - 2015. In other words, there was no appropriate monitoring conducted for two winters, so references to "no bats found in the Milton Township hibernaculum" is inaccurate.

In February 2016, investigations by MDIFW biologists at the Milton Township hibernaculum revealed the presence of several species of bats, including Little Brown Bats and Northern Long-eared Bats (both listed as Endangered in Maine) and Tri-colored Bats (Special Concern Species in Maine), and an unknown *Myotis*--likely an Eastern Small-footed Bat (Threatened in Maine) that was not identified with certainty but is previously reported here. MDIFW's 2016 findings are significant because they verify the value of this hibernaculum for harboring remnant populations of vulnerable cave bats as well as contributing to the potential recovery of the *Myotis* bats. In general, appropriate safeguards near cave hibernacula are essential to avoid local extirpations of remnant bat populations and possible extinction of species that have been decimated from white nose syndrome mortality.

If Maine's bats are to recover from white nose syndrome, Maine's three major hibernacula will play critical roles in their recovery. Cave-dwelling bats swarm near hibernacula in the fall before dormancy and again in the spring during emergence from overwintering sites. In other words, cave bats have a higher vulnerability near hibernacula than at most other locations on the landscape. Given this, *any* proposed development in proximity to hibernacula, including the hibernaculum in Milton Township, will be thoroughly reviewed by this Agency and recommendations will be evaluated to protect the integrity of the site and the habitat features it represents, for the protection of the animals utilizing this site now and over the life of the project into the future.

If you have any questions or concerns, please feel free to contact me at (207) 287-5254 or at john.perry@maine.gov.

Best regards,

John Perry
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