New England's Exploration of Coordinated Renewable Power Procurement

Renewable Supply Curve Analysis

New England States Committee on Electricity

January 2012

SUMMARY

Renewable Supply Curve Analyses

Potential for Coordinated Procurement: Background

In the fall of 2009, New England Governors adopted the *New England Governors Renewable Energy Blueprint*. The Blueprint identified the significant renewable resources located in & around the region & the potential for New England to coordinate competitive renewable power procurement & better coordinate siting of interstate transmission facilities.

In mid-2010, in response to the New England Governors' request by Resolution, NESCOE provided the Governors a *Report on Coordinated Renewable Procurement*. The Report identified potential coordination mechanisms & preliminary ideas about contractual terms & conditions.

In early 2011, NESCOE collected information in response to a *Request for Information* from renewable project developers. The RFI identified about 4,700 MW of new renewable resource able to serve customers by 2016, 90% of which was wind & 50% of which was located in Maine & transmission proposals that generally corresponded to the generation. NESCOE also formed an Interstate Transmission Siting Collaborative, which is seeking from transmission owners upcoming projects through which to improve coordination.

In mid-2011, the New England Governors expressed, by Resolution, continued interest in exploring the potential for coordinated competitive renewable power procurement as a means to identify those resources able to serve customers at the lowest all-in cost – generation & transmission costs.

Supply Curve Analysis: Background

To provide *directionally indicative* cost analysis in relation to new on- & off-shore wind resources to inform policymakers' decisions about the potential for coordinated competitive renewable power procurement, NESCOE sponsored analyses to:

- Assess **amount** of, **and estimate generation costs for,** wind resources in New England & New York
  - Retained Sustainable Energy Advantage, LLC (SEA)
  - Data availability precluded examination of Canadian resources
    - NESCOE invited the Canadian Electricity Association to provide comparable resource & cost analysis
- Provide **indicative transmission costs** to reach remote wind
  - Retained RLC Engineering

WHAT THIS ANALYSIS IS *NOT*

- **Not a resource plan** or recommendation
- **Not** an indication of **preferred resource type or location**
- ***Not a projection of actual costs*** for specific resources or projects
  - Cost data is *indicative;* usefulness is sense of *relative costs*
  - Use of conservative assumptions suggests that ***actual costs will likely be lower than costs presented in report*** (by up to $68 / MWh)
  - Market conditions & developer decisions will determine actual costs
- **Not a recommendation** to develop any specific resources
- **Not an estimate of benefits** of any particular resource

Why This Analysis is Not a Projection of Actual Costs

Given the **very conservative** base case assumptions, **actual costs** that would emerge from a competitive procurement process **would likely be meaningfully lower** than the base costs considered here.

The magnitude of such reductions could range from $33 to $68 MWh, with the largest reductions occurring at on-shore wind resources that could most greatly benefit from the use of taller towers. The upper bound on the potential cost reduction of $68 per MWh consists of three components: $10 (lower interest rates) + $23 (continuation of federal incentives) + $35 (use of higher hub heights from some on-shore supply blocks).

NESCOE Supply Curve Analyses Material

1. NESCOE Executive Summary
2. NESCOE Supply Curve Analyses Report
3. NESCOE Presentation
4. NESCOE Technical Appendix
5. Generation Presentation – SEA, LLC
6. New England Generation Report – SEA, LLC
7. New York Generation Report – SEA, LLC
8. Transmission Report - RLC Engineering

available at www.nescoe.com

At High Level, Supply Curve Analyses…

- Confirms we have more wind potential than we need to meet RPS goals
- Indicates ***relative* costs** of **on & off shore wind** resources ***based on conservative assumptions* in the years 2016 & 2020** (New York, 2020 only)
  - Actual project costs to be determined by market & will probably be meaningfully lower
- Suggests in 2016, **large on-shore wind in Maine likely to have lowest generation costs** & could meet needs at least cost assuming no material transmission needed to integrate into supply mix
- Suggests **the costs of transmission upgrades** to integrate large, on-shore wind **could accelerate the cost competitiveness of off-shore wind**
  - Off-shore wind could compete with imports as marginal resource by 2020
  - However, technology advances for on-shore wind (*e.g.*, use of taller towers) could preserve cost advantage of on-shore projects
- Highlights the importance of transmission needs & costs & identifies questions regarding preferred level of resource integration

New England Has More Wind Resources That Could Be Developed by 2020 Than It Needs

- **On-shore** potential in New England: 26 TWh/yr
- **Off-shore** potential in New England: 90 TWh/yr
- Potential **imports** from New York: ~2.5 TWh/yr

For comparison, load & Renewable Portfolio Standard Needs in 2020

- Total New England energy demand in 2020 net of energy efficiency & passive DR: ~127 TWh/yr
- Total incremental RPS need in 2020: ~12 TWh/yr

Costs Vary

Integration Level Affects Least Cost Mix

Very wide range of indicative costs under conservative assumptions

- From $95/MWh up to $415/MWh

Relative costs more reliable than absolute costs
Actual costs will be determined by market
&
will likely be meaningfully lower

***If* transmission was unlimited, remote on-shore wind would be cheapest**

- ~50% of 2020 need would come from on-shore wind in Maine

However, new transmission needed for remote wind & cost of integrating transmission affects 'least cost' mix

- Key question: preferred level of wind energy integration

Quick Look at How SEA Built "Supply Curve"

First, Estimated Regional Wind Resource Potential

- Divided total regional wind potential into "supply blocks"

  Within each block, projects have similar characteristics, such as size, wind quality, location, distance to grid

- Determined potential wind energy in each block

- Identified 141 supply blocks in New England

Then, for Each Supply Block…

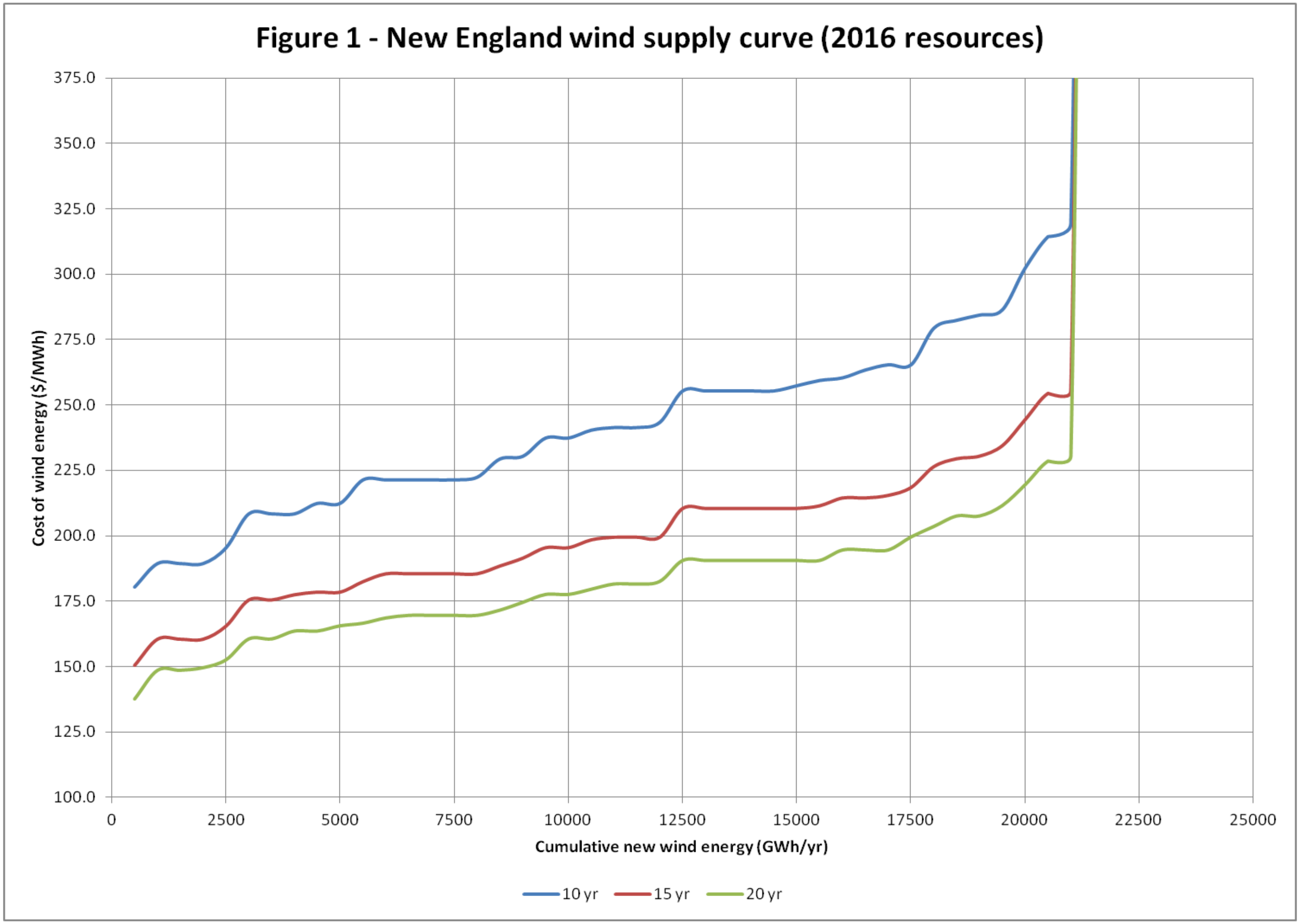
SEA estimated cost of wind resources in dollars per MWh

- Stacked blocks in order of increasing cost
- Plotted cost of energy - in $/MWh - against total amount of energy available at or below that cost
- Result is a *supply curve* showing cost vs. annual energy

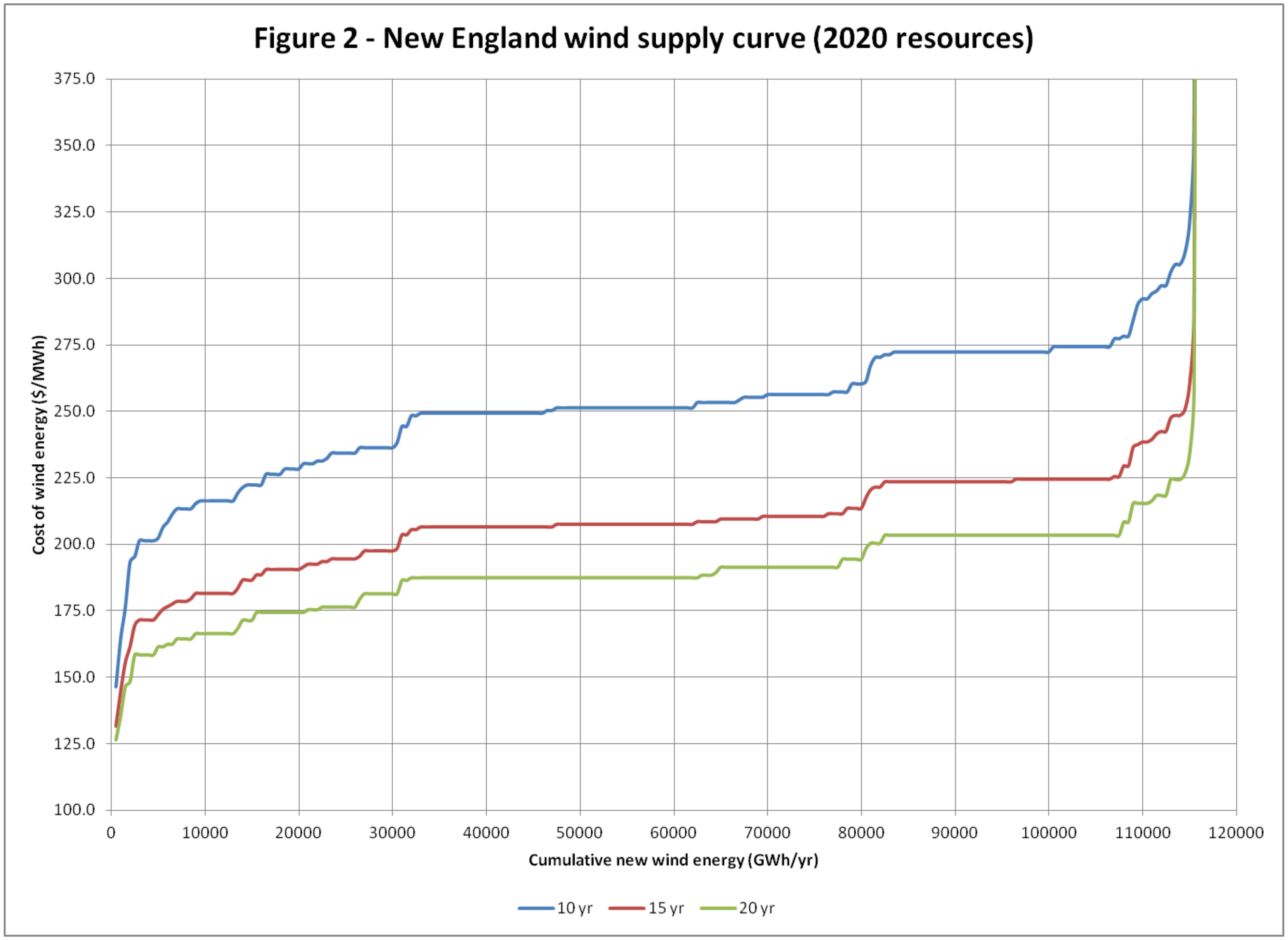
Contract Term Length is a Cost Driver

3 contract terms considered - 10, 15 & 20 years

New England Wind Resources - 2016



New England Wind Resources - 2020



Generation Cost Drivers

The longer the contract, the lower the costs

- 10 year contract: $200/MWh - notional value
- 15 year contract: $165/MWh - 17.5% lower than 10 year term
- 20 year contract: $150/MWh - 25 % lower than 10 year term

For baseline costs, NESCOE used conservative assumptions -

- No more federal financial incentives
- Interest rates reflecting normal economic environment
- Historical hub heights for on-shore wind

Changing *any* of these assumptions to be less conservative could materially decrease costs

Implications of Changing Conservative Assumptions

SEA examined key sensitivities that influence generation costs

- ***If* federal financial incentives** continue?
  then costs would decrease by ~$23/MWh
- ***If* interest rates** remain low?
  then costs would decrease by ~$10/MWh
- *If* on-shore wind projects use **higher hub heights** (consistent with plans for many projects in development)?
  then costs of some blocks would decrease by ~$35/MWh

Total range of potential cost decreases: $33 to $68/MWh

Greatest decrease for on-shore projects that can use taller towers

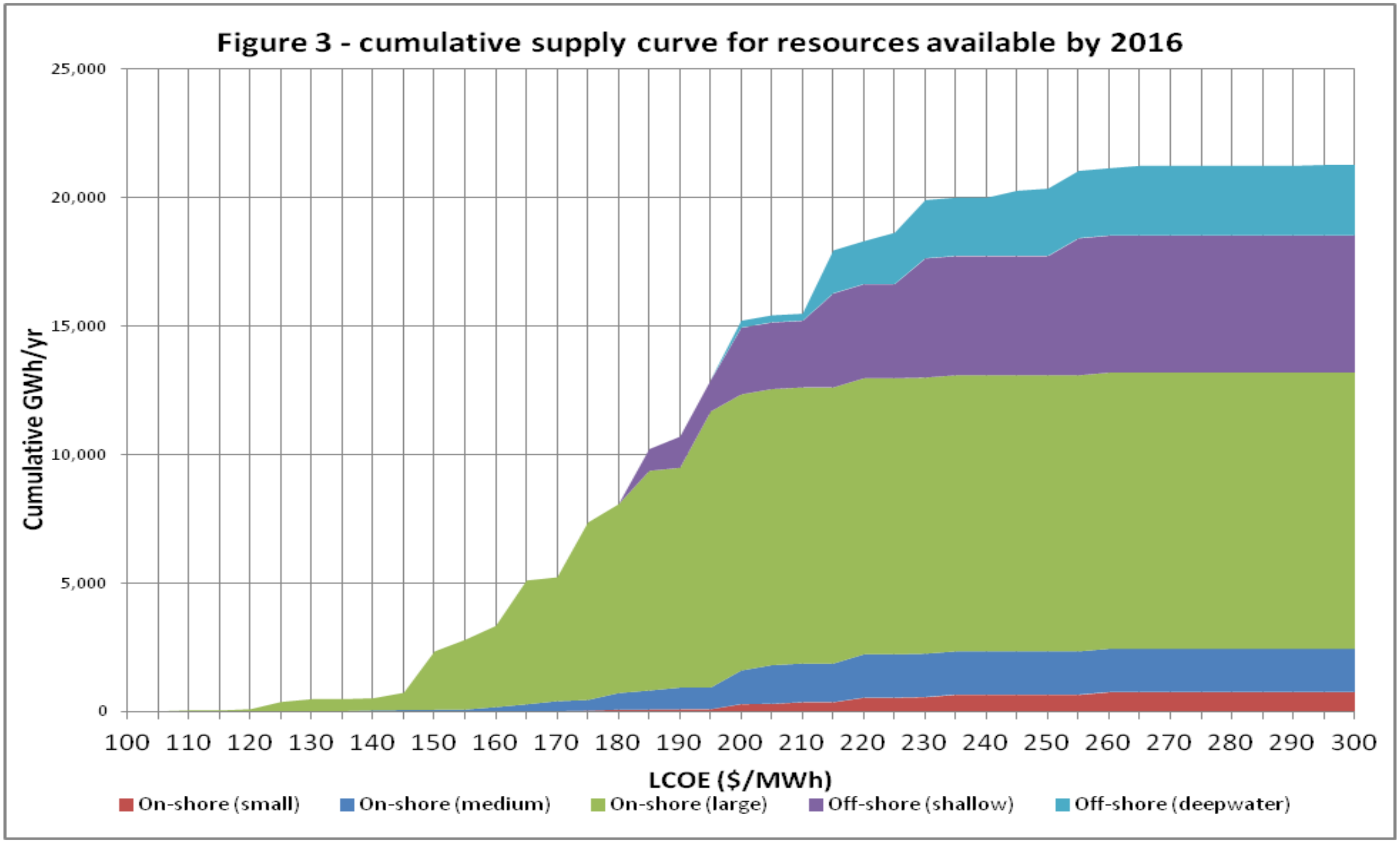
Analyses of Potential Resource Mix

- **Focused on 1 supply curve in 2016 & 2020 at 15 year contract term**

- **Categorized wind potential by project type**
  - On-shore projects: small (10MW), medium (60MW) or large (125MW)
  - Off-shore projects: shallow water or deep water (300MW)

- **Showed relative amounts of each type of wind resource at each price point on supply curve**
  - Example: in 2016, large on-shore wind would supply over 90% of wind energy available at or below $170/MWh
  - Example: in 2020, deep water off-shore wind comprises over 60% of wind energy available at any price

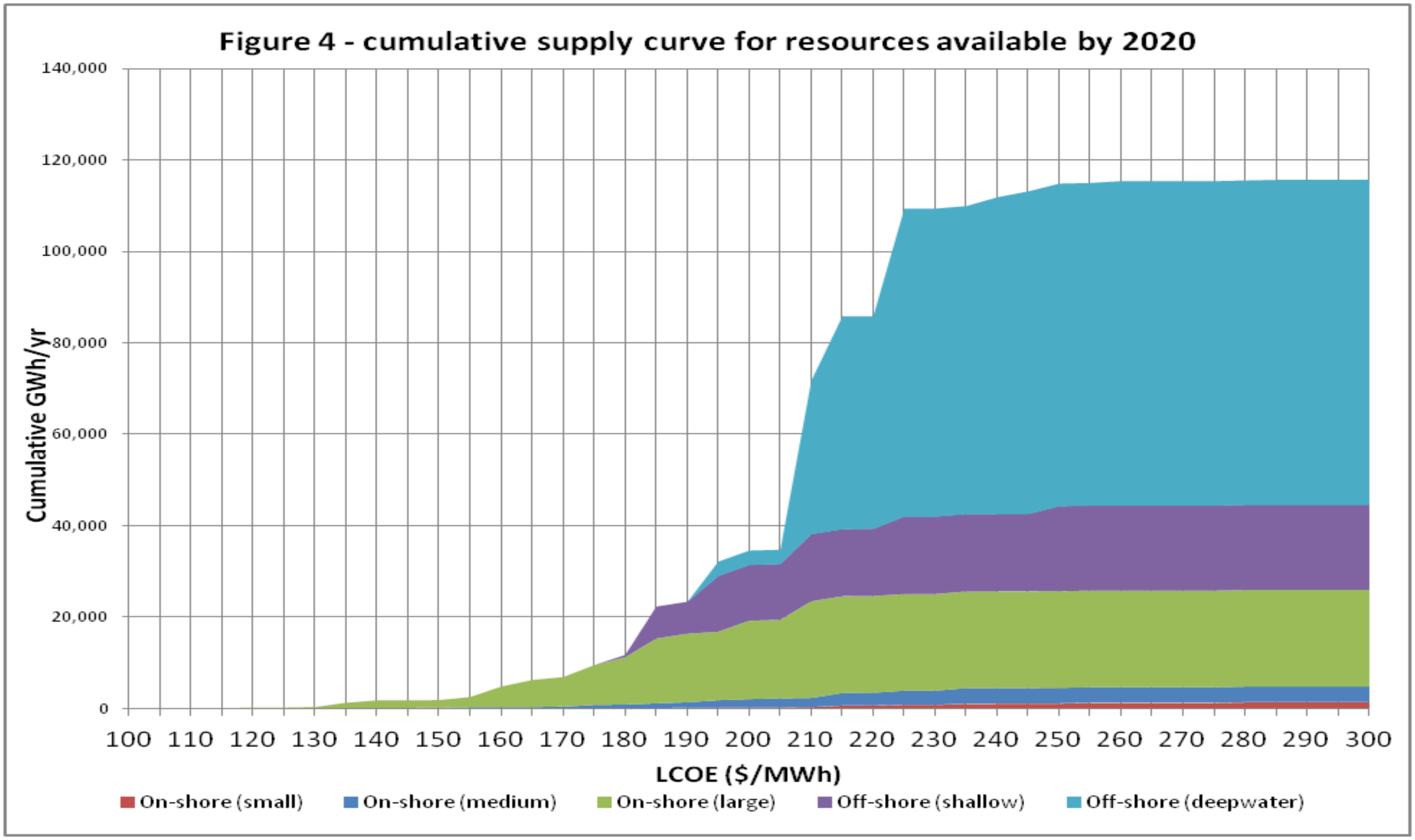
NEW ENGLAND WIND SUPPLY CURVE BY PROJECT TYPES - 2016



<u>Notes</u>

- Resource mix based on generation costs for 15 year contract term, using conservative baseline assumptions
- New England resources only

NEW ENGLAND WIND SUPPLY CURVE BY PROJECT TYPE - 2020

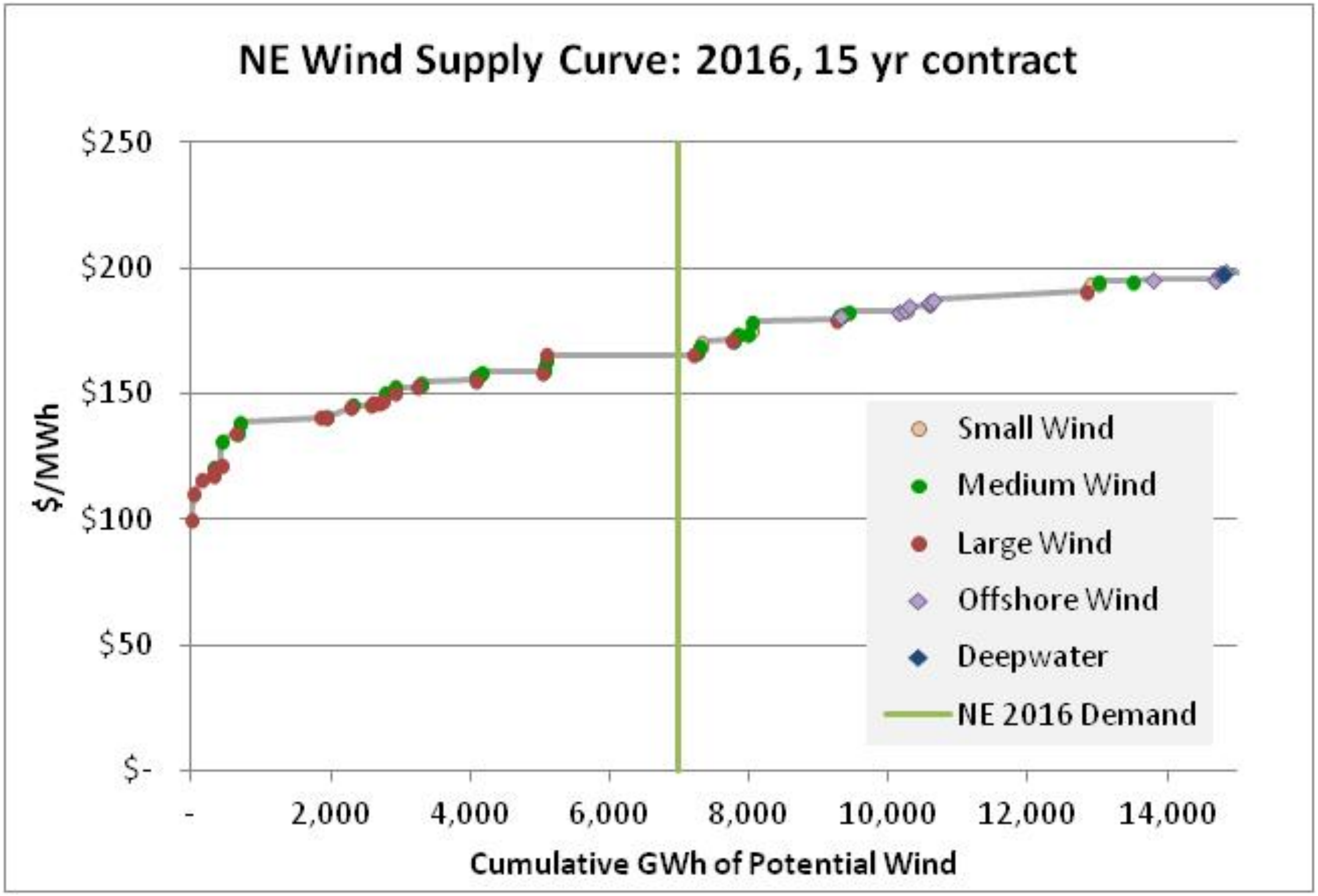


Notes

- Resource mix based on generation costs for 15 year contract term, using conservative baseline assumptions
- New England resources only

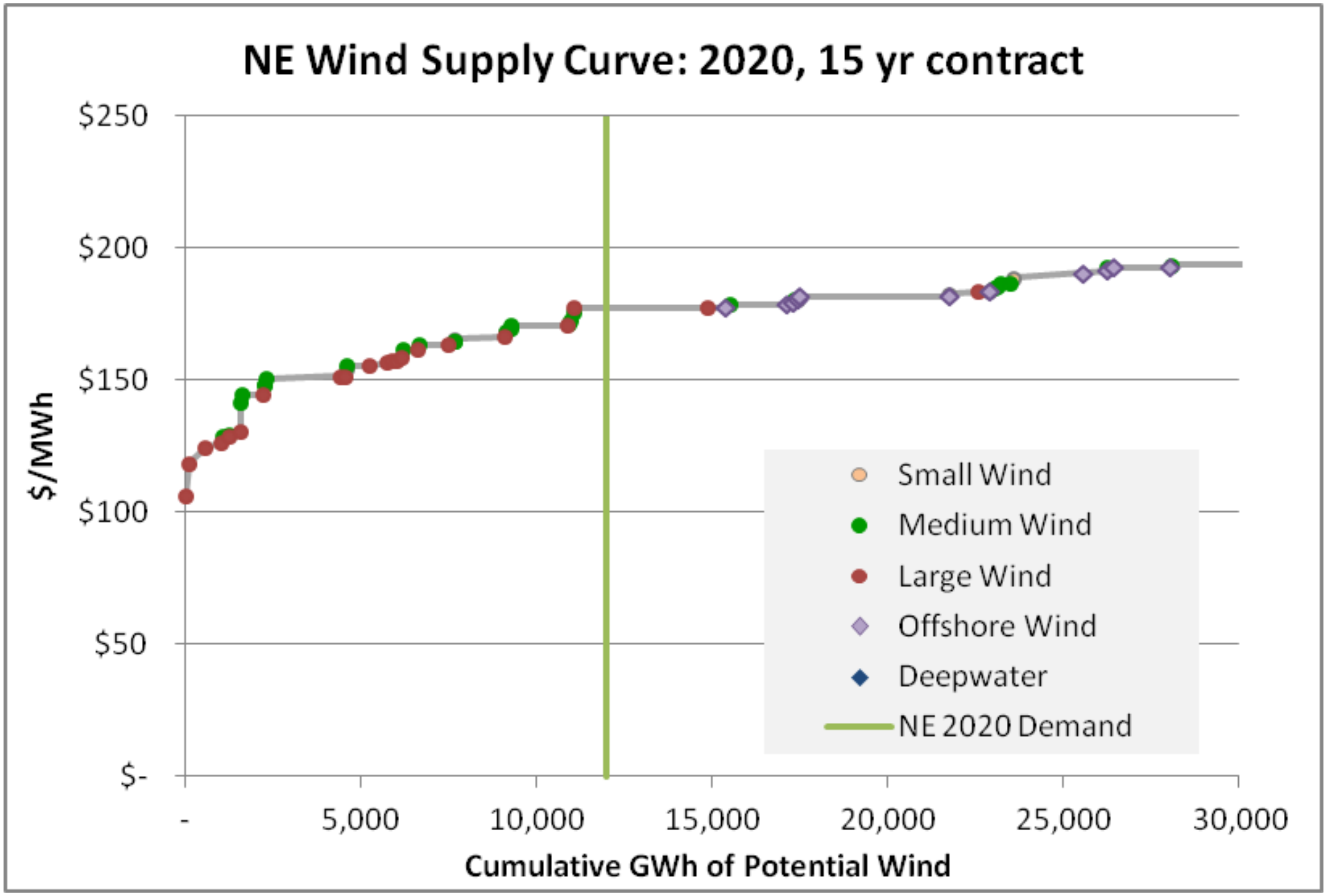
Another View of 2016

Slide, courtesy SEA, LLC; data based on conservative assumptions described on slide 15



Another View of 2020

Slide courtesy SEA, LLC; data based on conservative assumptions described on slide 15



New England Supply Curve by Project Type Through 2016

Through 2016, large (125MW) on-shore wind is the least expensive

- Small (10MW) & medium (60MW) on-shore wind resources make minor contribution to lower-cost supply block
- Off-shore wind resources do not become economically feasible until 10,000 GWh/yr ($185 MWh)

Project Type by 2020

By 2020, off-shore resources could become more economically feasible at the margin

- Off-shore wind 1st appears on supply curve at $180/MWh
- Very large off-shore resources available at ~ $210/MWh
  - Off-shore wind comprises over 68% of regional resources able to be obtained at that price
  - At that price, over 77,000 GWh/year is available
- **In 2020, off-shore resources might compete with imports as marginal supply**
  - Alternately, technology advances for on-shore wind could reduce competitiveness of off-shore resources

Meeting Regional Needs

- **Initially, resource base analysis *only* considered generation-related costs**
  - Included interconnection costs, but *not* transmission network upgrade costs
  - Did not consider potential for imports from New York

- **Subsequently, analyses identified resource mix that meet incremental regional needs at lowest *generation-only* cost**:
  - Expected incremental needs in 2016: 7.5 TWh/yr
  - Expected incremental needs in 2020: 12.25 TWh/yr
  - Also considered potential for imports from New York

- **For 2016 & 2020, analyses characterized selected resource mix by**:
  - Location - state
  - Project type - on-shore vs. off-shore

MEETING REGIONAL NEEDS (1)

	Mix for 2016 (GWh/yr) Only generation costs considered			Mix for 2020 (GWh/yr) Only generation costs considered		
	On-shore	Off-shore	Total	On-shore	Off-shore	Total
CT	0	0	0	0	0	0
MA	346	0	346	936	0	936
ME	5,391	0	5,391	5,743	0	5,743
NH	309	0	309	595	0	595
RI	0	0	0	0	0	0
VT	883	0	883	2,489	0	2,489
New England total	6,929	0	6,929	9,762	0	9,762
NY	571	0	571	2,488	0	2,488
Grand total	7,500	0	7,500	12,250	0	12,250

Notes

- Resource mix based on generation costs for 15 year contract term, using conservative baseline assumptions
- Developable N Y resources in 2016 = 35% of NY resources developable by 2020
  - NY imports constrained to 1000 MW

Transmission Analyses Implications

If *no* additional transmission was required to integrate wind from supply mix –

In 2016, 72% of energy would come from **on-shore wind in Maine**

In 2020, 47% of energy would come from **on-shore wind in Maine**

However, Transmission Analysis Indicates…

- **Significant network upgrades would be required to integrate wind from northern New Hampshire & western Maine**
  - Cost of such upgrades (~$35-45 / MWh) may be material
- **Maximum pace of transmission development in western Maine could limit wind energy from Maine**
  - No more than 3000 GWh/yr in 2016 & 5500 GWh/yr in 2020
- **Transmission development in New Hampshire can match wind supply**

Sensitivity analysis identifies changes in supply mix

- Added 50% of transmission network upgrade cost to remote wind
  - Assumed off-shore wind & imports did not require upgrades
  - As necessary, also constrained total wind generation in Maine

MEETING REGIONAL NEEDS (2)

	Mix for 2016 (GWh/yr) Apply 50% of network upgrade costs to on-shore wind in ME, NH, VT & constrain on-shore wind in ME			Mix for 2020 (GWh/yr) Apply 50% of network upgrade costs to on-shore wind in ME, NH, VT & constrain on-shore wind in ME		
	On-shore	Off-shore	Total	On-shore	Off-shore	Total
CT	0	0	0	0	0	0
MA	360	720	1,080	986	2,683	3,669
ME	2,711	59	2,770	3,949	206	4,155
NH	280	0	280	396	0	396
RI	0	0	0	0	76	76
VT	883	0	883	1,467	0	1,467
New England total	4,233	779	5,012	6,798	2,964	9,762
NY	2,488	0	2,488	2,488	0	2,488
Grand total	6,721	779	7,500	9,286	2,964	12,250

Notes

- Resource mix based on costs for 15 year contract term, conservative baseline assumptions
- Cost of on-shore generation in NH & ME (and VT) increased to reflect 50% of cost of required network upgrades
- On-shore generation in ME constrained to limits indicated by transmission analyses
- NY imports limited to 1000 MW

Impact of Transmission Costs & Limits

Transmission costs & limits show potential shift towards off-shore wind & imports in selected mix

- In **2016, 44% of energy from off-shore wind & imports** in selected mix (vs. 8% in prior table that only looks at generation costs)
- In **2020, 45% of energy from off-shore wind & imports** in selected mix (vs. 20% in prior table that only looks at generation costs)

Shift to Off-Shore Depends on Assumptions

Key assumptions that indicate shift to off-shore wind:

- **Little capacity on existing transmission system for new wind in Maine, New Hampshire or Vermont**
- **Generation cost premium for off-shore wind steadily decreases**
- **On-shore generation costs do not decrease over time (*e.g.*, limited use of and benefit from benefits from taller towers)**
- **Much less transmission required to integrate off-shore wind or imports than remote on-shore generation**
  - Example: off-shore wind connected to coastal generating station could displace fossil generation and contribute to regional goals
  - Example: imports during off-peak hours could displace gas
  - Counterexample: off-peak wind in ME, NH &VT could readily displace off-peak non-renewable generation
- Analysis does not estimate the *benefits* of different mixes

Changing any of these assumptions could materially shift the supply mix with the lowest total cost

Key Question – Integration Level

What is the preferred system integration standard for renewable resources contributing to renewable goals?

The level of integration –

- Determines transmission network upgrades - & costs - required for specific resources
- Determines the ultimate resource mix - different integration standards results in different resource mixes

Some Options

"REC-Only" Integration – new renewable energy only needs to displace non-renewable energy in regional resource mix

- With no deeper network upgrades, market price impact of new resources may be limited
- Renewable developers could voluntarily elect greater integration into commodity markets to capture higher energy prices
- May result in energy market congestion with low priced energy bottled up in Maine & New Hampshire
- May lead to increased uplift as more localized operating reserves could be required
- Will congested renewable energy in Maine & New Hampshire satisfy other states' renewable requirements or objectives?

More Options

- **“REC Plus” Integration options**
  - **Deliver specific percentage of renewable energy throughout region**
    - Could result in greater energy price reductions
    - Could require higher transmission costs than REC-Only Integration
  - **Renewable resources obtain capacity resource status**
    - Could reduce regional capacity prices
    - Could require even higher transmission
- **For any specific project, any particular level of energy integration will have specific costs and benefits that are incremental to a REC Only standard**

Any REC Plus option will likely require significant interconnection queue reform to support coordinated regional procurement

NESCOE appreciates the analysis provided by RLC Engineering, Sustainable Energy Advantage, LLC & in particular appreciates the valuable contribution by Ray Coxe, Ph. D., President, Mosaic Energy Insights, Inc. for his assistance in synthesizing and presenting the analysis in a way that is informative to policymakers.