Executive summary

**Key Points**

- **The region is about to make a major investment decision**
  - There is a great amount at stake with the urgency of the reliability problems for the biggest load center in New England

- **The only perspective that matters should be doing what is best for customers**
  - Both from an overall cost and impact standpoint

- **The SeaLink Plan is clearly the best choice to address the region’s transmission reliability challenges**
  - SeaLink will be more cost-effective for customers than the AC Plan
  - SeaLink will provide customers enhanced reliability more effectively and faster than the AC Plan
  - SeaLink will have less impact on customers’ communities and the environment than the AC Plan
Agenda

• Greater Boston Situation
• SeaLink Overview
• Selection Criteria
• Project Comparison
• Conclusion
It is important to put the Greater Boston region into perspective before addressing this reliability study

**Greater Boston Context**

- **Roughly 6000 MW of peak electrical load – the largest in New England and equivalent to 80% of entire state of CT**
  - Only 2600 MW of generation currently located within zone
  - The fastest growing load center in New England since 2003
- **Over 3 million people live in Greater Boston Study Area**
  - Roughly a third of all New England’s population
  - 8th largest metro area in the United States
- **Greater Boston is the economic driver of New England**
  - Represents more than 40% of New England GDP
  - Headquarters to 11 Fortune 500 Companies
- **Geographically situated in center of New England**
  - Located at North/South electrical interface – primary interface connecting generation in the North to load in the South
Addressing Greater Boston reliability and market issues is an imperative

**Greater Boston Reliability Situation Is Urgent**

- **There are significant reliability issues present today:**
  - Most reliability needs are way past due (2013) but unlikely any solution will be implemented prior to 2018
  - In addition, there are numerous short circuit and stability problems to fix

- **Beyond reliability issues, there is also substantial price separation**
  - FCA 8 results showed NEMA clearing at much higher price than the rest of New England – at an *incremental* cost of over $300 MM to NEMA\(^1\)
  - There is substantial price separation between NEMA and Northern New England when system is stressed on hot and cold days

- **Recent and expected generator retirements compound these issues**
  - Brayton Point, Vermont Yankee retirements
  - Footprint Power delay and Mystic 7 on ISO at-risk of retirement list

---

Note 1 – NEMA cleared at $15/kW-month, ROP cleared at $7.025/kW-month. NEMA LSR 3428 MW.
The Greater Boston Study Needs Report highlights the urgency of the reliability situation in Greater Boston

**ISO-NE Greater Boston Needs Report**

**Reliability Needs (N–1)**

<table>
<thead>
<tr>
<th>Sub-Area</th>
<th>Element ID</th>
<th>Monitor Point</th>
<th>LME Rating/Consequence</th>
<th>LSE Leading for Year</th>
<th>Year of Need</th>
<th>Critical Need Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>N-1-1</td>
<td>11569</td>
<td>3.2</td>
<td>2010</td>
<td>2013</td>
<td>Needed solution in-service before 2013</td>
</tr>
<tr>
<td>B</td>
<td>N-1-2</td>
<td>11569</td>
<td>3.2</td>
<td>2010</td>
<td>2013</td>
<td>Needed solution in-service before 2013</td>
</tr>
<tr>
<td>C</td>
<td>N-1-3</td>
<td>11569</td>
<td>3.2</td>
<td>2010</td>
<td>2013</td>
<td>Needed solution in-service before 2013</td>
</tr>
</tbody>
</table>

This translates to a significant amount of reliability risk until these issues are resolved.
On top of the reliability problems, there are serious capacity issues that compound the problem.

**Greater Boston Rolling Blackout Warning**

Rolling blackouts in Greater Boston? It could happen sooner than you think.

- ISO's warning: if Footprint is delayed past June 2016, the ISO could be forced to use rolling blackouts in NEMA to keep grid operational.
  - “…if the Footprint facility is not available by June 1, 2016, the NEMA/Boston area is expected to face an electric capacity shortage, will not meet federal reliability criteria, and could face controlled blackouts.”
  - “On a hot summer or cold winter day or if other resources fail, the ISO will use controlled power outages, or "rolling blackouts", in the NEMA zone to assure that reliability in the larger region is not threatened.”

Footprint recently requested and received approval from FERC for a one year delay to 2017 leaving the capacity shortage as an open question.

Greater Boston Study based on a set of assumptions

Greater Boston Modeling Assumptions

• AC Plan or SeaLink Plan only designed to meet needs until 2023
  – 8 years remaining (less the time to put any solution in-service)
• Using less than historical peak load growth 1.5% vs. 2.2%
• Generator assumptions:
  – Assumes Mystic 7 in operation until 2023 and Footprint by 2016
  – Does not account for Brayton Point and Vermont Yankee retirements
• Uses substantial amounts of DR and EE\(^1\)
  – 430 MW of Active and Passive DR and 369 MW of new EE
• Does not consider potential impacts of the Governors’ Infrastructure Initiative
  – Could put additional pressure on the North-South interface
  – Most projects would inject to the North of this interface

Notes: 1 – DR – Demand Response, EE – Energy Efficiency
Agenda

• Greater Boston Situation
• **SeaLink Overview**
• Selection Criteria
• Project Comparison
• Conclusion
SeaLink project and background

**Project Overview**

- **SeaLink is a 520 MW High Voltage Direct Current (HVDC) Voltage Source Converting (VSC) project**
  - Project scope includes two 200kV converter stations and 68 miles of buried submarine and land cable
  - Reliability project to meet Greater Boston needs - Open Access Line serving all of New England

- **Advantages of latest generation of HVDC VSC Technology**
  - +/-175 MVAR capability at each converter station
  - Fast Response – capable of ramping up to 1000 MW/sec
  - Bidirectional flow offers operators increased flexibility and control
  - Less than 4% losses for both converter stations and HVDC cable
  - Minimal short circuit contribution
  - Black start capability available
  - Targeted availability of 98-99%
The SeaLink route has been extensively investigated over the past two years and is very constructible

### SeaLink Route Overview

- **68 miles total, 18 miles on land**
  - 11 miles in abandoned rail corridors
- **Several desktop studies, marine and land surveys complete**
- **Cable will be *entirely* buried**
- **No private parcels needed**
- **4 landowners**
  - NHDOT, MassDOT, DCR, MBTA
  - LOI signed with MBTA for 9+ miles
- **NHT has secured site control for both converter station sites**
- **Key letters of support received from:**
  - Host communities
  - State agencies
SeaLink team has already met with most federal, state and local agencies who ultimately are involved in siting/permitting.

### State Agencies (MA)
- Department of Public Utilities
- Energy Facilities Siting Board
- EOEEA
- MA Attorney General Office
- Massachusetts Environmental Policy Act Office
- Coastal Zone Management Program
- Division of Marine Fisheries
- MWRA
- Dept. of Conservation & Recreation
- Historical Commission
- Board of Underwater Archaeological Resources
- MBTA

### State Agencies (NH)
- Public Utilities Commission
- Department of Transportation
- OEP
- NH Department of Environmental Services

### Federal Agencies
- United States Army Corps of Engineers
- National Oceanic and Atmospheric Administration/National Marine Fisheries Service
- United States Coast Guard (Sector Boston and 1st District)
- Environmental Protection Agency
- US Navy Seafloor Cable Protection Office

### Local
- City of Boston
- City of Everett
- City of Revere
- City of Malden
- City of Lynn
- Town of Salisbury
- Town of Saugus
- City of Gloucester
- Town of Seabrook
- Massachusetts Lobsterman Association
- Gloucester Fisheries Commission
- Northern Strand – Bikeway to the Sea
- Seabrook Rails-to-Trails

NHT has maintained a productive dialogue with most state agencies and has received route development feedback.
A comprehensive geophysical survey of the SeaLink marine route was conducted in the summer of 2013

SeaLink Marine Survey Highlights

- Survey was a success:
  - Refined route
  - Achieve ~99% burial
  - Single subsea asset crossing

- Data was leveraged to produce high quality cable install bids

- Gave NHT confidence of SeaLink constructability
  - Vendors concurred
  - Presented results at state interagency meeting

- 50 mile ocean route surveyed plus alternatives and landings
- 300 meter wide survey corridor
- Side scan sonar, multibeam bathymetry, subbottom profiler and magnetometer to investigate route
- Subsurface photos and video taken
- 33 three meter core samples taken as well as benthic samples
SeaLink Marine Survey video highlights the various datasets collected by rendering it in a 3D environment

**SeaLink Marine Survey - Route Video**

Video can be found at: [http://www.sealinkcable.com/content/map.shtml](http://www.sealinkcable.com/content/map.shtml)
In addition, land survey results are encouraging and give us confidence we can successfully execute project

**SeaLink Onshore Survey Work**

<table>
<thead>
<tr>
<th>Onshore Route Survey</th>
<th>Northern Landing</th>
<th>Southern Landing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NH Rail</td>
<td>NH Road</td>
</tr>
<tr>
<td>Geotechnical Assessment¹/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Onshore Utility Data Compilation²/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Beach Landings Survey³/</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Bedrock GPR Survey⁴/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Environmental Contamination Assessment⁵/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Thermal Resistivity Investigation⁶/</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Onshore Archaeology Assessment⁷/</td>
<td>excepting Seabrook Substation</td>
<td>x</td>
</tr>
<tr>
<td>Vernal Pool Assessment⁸/</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

¹/ Desktop and site visit summary memo; no actual field survey performed or data acquired
²/ NH utility data is compiled from town sources, utility sources, GRANIT GIS data; MA utility data is compiled from town sources, utility sources, previously completed existing conditions field surveys, MassGIS data
³/ Beach landings survey performed to date include Salisbury Beach Access 9 (old landing), Revere and Lynn Beach
⁴/ Additional geotechnical investigations required to confirm RFP HDD assumptions at BMH sites.
⁵/ Desktop estimate based on Tetra Tech knowledge of comparable projects in area
⁶/ MA Road and Salisbury BMH investigation occurring 12/15-12/17; no access S.Landing
⁷/ Includes background research and reconnaissance-level survey; no sub-surface testing
⁸/ Field surveys performed

x = completed  O = not yet completed
SeaLink Project Cost Summary (2018 dollars)

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost ($ MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>$257</td>
</tr>
<tr>
<td>Labor &amp; Installation</td>
<td>$208</td>
</tr>
<tr>
<td>Indirects</td>
<td>$19</td>
</tr>
<tr>
<td>AFUDC</td>
<td>$35</td>
</tr>
<tr>
<td>Contingency</td>
<td>$24</td>
</tr>
<tr>
<td><strong>Total Project Cost</strong></td>
<td><strong>$543</strong></td>
</tr>
</tbody>
</table>

To date, NHT is still the only entity who has shared its cost templates with stakeholders.
NHT’s schedule for SeaLink shows an estimated in-service date of November 2018

**SeaLink Project Milestone Schedule**

- Project Initiation: Feb -15
- Initial Engineering: July-15
- Final Engineering: Mar-17
- State / Local Siting: Mar-15
- Environmental Permitting: Mar-15
- Land / ROW Acquisition: Mar-15
- Long Lead Time Equipment Procurement: April-16
- Civil Construction: Aug-16
- Construction Start: Aug -16
- Construction Complete: Jul -18
- **Energize / In-Service**: Nov-18

*SeaLink schedule based on vendor bids, survey work and expected timeframes for permitting and construction*
NHT’s partnership with MMWEC on SeaLink strengthens our overall proposal and value to customers

MMWEC Partnership

- NHT and MMWEC have an equity partnership in SeaLink
  - Similar structure to joint ownership arrangement at Seabrook Substation
- MMWEC is directly impacted by Greater Boston Study in several ways:
  - Represent ~100,000 NEMA customers
  - Reliability and full costs impact MMWEC customers
  - Host of several upgrades – including Wakefield-Woburn line
- MMWEC brings a unique perspective to debate:
  - Adds a consumer focused, non-profit local entity
Given the technology and application, SeaLink provides several other reliability benefits to New England

**Incremental SeaLink Benefits**

- **Adds system robustness by creating a new corridor to move power into heart of the city**
  - Avoids putting more critical assets in same crowded ROW

- **Hardened system less susceptible to risks of extreme weather such as high winds, flooding and ice**

- **Use of offshore and abandoned rail corridor minimizes impact to communities lowering risk of permitting delays**
  - Extensive outreach has also helped build support, which we believe will allow SeaLink to be put into service on schedule

- **Advanced technology increases operational flexibility**

- **Better against risks of generator retirement**
  - Studied by the Greater Boston Working Group
Agenda

• Greater Boston Situation
• SeaLink Overview
• Selection Criteria
• Project Comparison
• Conclusion
Operative Tariff Section Highlights

• Attachment K – Section 4.2 (b)
  - The ISO may form ISO-led targeted study groups to conduct Solutions Studies. Such study groups will include representatives of the proponents of regulated transmission solutions and other interested or affected stakeholders. Through this process, the ISO may identify the most cost-effective and reliable solutions for the region that meet a need identified in a Needs Assessment. These solutions may differ from a transmission solution proposed by a transmission owner.

• Attachment K – Section 7.3 (a)
  - ISO-NE Board of Directors may approve the recommended draft RSP as submitted, modify the RSP or remand all or any portion of it back with guidance for development of a revised recommendation.

The Tariff provides for broad flexibility to ISO and its Board in making transmission project decisions.
The Planning Procedures provide further insight into factors that ISO can consider

**Planning Procedure 4 Guidance**

- Attachment A of Planning Procedure 4 also offers the following *non-exclusive* list of factors that can be considered:
  - Costs of construction including ROW, easements
  - Assessment of schedule or in-service date
  - Relative reliability or operational impacts
  - Costs associated with operation and maintenance
  - Costs of related and long-term congestion impacts, including costs related to outages associated with construction
  - Fit into future expansion plans
  - Consistency with current design and construction practices
Suggested Solution Study Report Factors

- Sections 7.1 and 7.2 provide the following factors that can be considered:
  - Operational Performance
  - Constructability
  - Construction Outage Requirements/Impacts
  - Interface Impacts (Internal/External)
  - Siting Issues such as Environmental Impact or Right-Of-Way Acquisition
  - Expansion Capabilities
  - Lifetime Efficiency/Expectancy
  - Maintenance Requirements
  - Expected In Service Dates
  - Costs (including items that may impact project selection such as: Construction Costs, Outage Costs, Cost of Loss, Net Present Value ("NPV"), etc.)
In practice, ISO-NE has analyzed many of these factors in recent solution studies

### Metrics Used to Evaluate Solutions – Recent Examples

<table>
<thead>
<tr>
<th>Metric</th>
<th>NH-VT</th>
<th>Pittsfield-Greenfield</th>
<th>NEEWS-IRP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Performance (Thermal, Voltage, Short-Circuit, Stability, BPS Testing, etc.)</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Constructability</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Construction Outage Requirements/Impacts</strong></td>
<td>X¹</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Interface Impacts</strong></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Siting Issues (Environmental, ROW, etc.)</strong></td>
<td>X²</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Expansion Capabilities</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Lifetime Efficiency/Expectancy</strong></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Loss Savings</strong></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Maintenance Requirements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replaces old/aging infrastructure</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Expected In-Service Date</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Costs – incl. items that may impact project selection such as construction costs, outage costs, losses, NPV, etc.</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Source: ISO-NE solution study reports for each study. Notes: 1. Excluded generation costs incurred for reliability. 2. VT focused on maximizing use of existing ROW.
Many elected officials and key stakeholders have already provided ISO-NE with written feedback on selection criteria

### Stakeholder Input – Greater Boston

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>All-in costs</th>
<th>In-service date</th>
<th>Comm. &amp; Env. impact</th>
<th>Grid Resiliency</th>
<th>Cost containment</th>
<th>System performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governor Patrick</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Governor Hassan</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>U.S. Senator Shaheen &amp; Ayotte</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Attorney General Coakley</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Mayor Walsh</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mayor Menino</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>NESCOE</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>State Senator Stiles &amp; select reps²</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1 – while there was some variation in terminology, most stakeholders acknowledged congestion during construction and other lifecycle costs should be included. 2 -includes select members of NH Science, Energy & Technology Committee 3 – some stakeholders, subsequent to their letters to ISO, have also supported cost containment.
In conclusion, ISO’s mandate to select the most cost-effective solution cannot be achieved by only analyzing capital costs.

**Selection Criteria Summary**

- **A thoughtful and holistic comparison of alternatives is fully consistent with the Tariff**
  - In fact, it leaves much to ISO-NE and the stakeholders to decide.

- **In practice, ISO-NE often looks at factors beyond just technical capabilities and construction costs**
  - It is more the norm rather than the exception.

- **A variety of key elected officials and other stakeholders have recently supported a broader set of criteria**
  - Many have specifically requested ISO-NE look at these factors prior to a decision.

With so much at stake for Greater Boston, why would ISO-NE not consider a variety of factors to reach the best decision?
Agenda

- Greater Boston Situation
- SeaLink Overview
- Selection Criteria
- **Project Comparison**
- Conclusion
There are two very different ways to address the needs of Greater Boston

**SeaLink Plan and AC Plan Route Comparison**

Note: map highlights only the comparative elements, not the common set of upgrades both plans require. Existing transmission system not overlaid here.
Scobie-Tewksbury is one of the most challenging transmission projects in recent years

Scobie-Tewksbury Overview

- **Route description**
  - 25 miles in length, existing corridor contains (in various points):
    - One 450 kV HVDC line
    - Two 345 kV lines
    - Two 230 kV line
    - Three 115 kV lines

- **Property interest**
  - ~440 parcel owners
  - Easements allow for new transmission within primarily 350 foot corridor

- **Key crossings**
  - I-93, I-495, Merrimack River
Ngrid’s recent MEPA filing highlights extent of reconfiguration required

Scobie-Tewksbury (MA) Overview

**Existing Cross Section**

- Old 397 (345 kV) turned into New 3124 (345 kV) line
- Old N214 line (230 kV) turned into relocated 397 line (345 kV), New structures
- Old L164 line (115 kV) turned into relocated N214 (230 kV), New Structures
- Old Y151 line (115 kV) turned into relocated L164 line (115 kV)
- Y151 line (115 kV) relocated to new position, New Structures

**Proposed Cross Section**

Source: Ngrid MEPA filing, dated November 19, 2014 under Merrimack Valley Reliability Project
Complicating matters, Kinder Morgan’s revised pipeline route now parallels the Scobie-Tewksbury ROW.

**Northeast Energy Direct Project**

- **Project details:**
  - Kinder Morgan developer
  - 36 inch gas pipeline
  - Up to 2.2 billion cubic feet firm capacity

- **Route details**
  - 13.4 miles parallel Scobie-Tewksbury ROW
  - Current proposal is outside of ROW and crosses 6 times
    - Will impact same landowners as overhead line

FERC filing – docket PF14-22-000 by Tennessee Gas Pipeline Company, L.L.C. (Kinder Morgan) made on 12/8/2014
NHT believes Ngrid’s plan will take longer and cost more to minimize extended outages than other available options.

**Scobie-Tewksbury Takeaway**

- **There are three primary options to construct the new 345 kV Scobie-Tewksbury line…**
  - Double circuit an existing line with the new 345 kV line
  - Go outside of the ROW to build the new line
  - Reconfigure the ROW to accommodate the new line
- **And each has tradeoffs…**
  - Double circuiting requires extended outages but minimizes capital
  - Expanding the ROW is likely to be controversial due to increased landowner impact
  - Reconfiguration takes longer and is more expensive
- **Scobie-Tewksbury options involve tradeoffs of capital costs, costs due to longer construction schedules, and congestion costs**
Greater Springfield Reliability Project is likely the best comparable for the Scobie-Tewksbury line

**Project Route Overviews**

- **35 miles of new overhead 345 kV line**

- **Significant reconfiguration**
  - Involved two other 115 kV lines for half of route

- **Constructed in existing ROW, but:**
  - 5.2 miles ROW expansion\(^1\)

- **Line only costs - $478 MM (2017 dollars)**
  - $13.7 MM/mile
  - Another $120 MM\(^3\) spent upgrading existing endpoint substations\(^2\)

Source: NU TCA application (NU-13-TCA-01), February 20, 2013. Notes: 1 – 18 acres of additional ROW/easements needed. 2 – Upgrades to Ludlow and N. Bloomfield substations. 3 - $110 MM in 2013 dollars listed in TCA application
The Greater Springfield Reliability Project took 6 years and $718 MM to fully execute.

### Greater Springfield Cost and Schedule Summary

#### 2.2 Detailed Cost Summary By Project Element

<table>
<thead>
<tr>
<th>Project Element</th>
<th>Material</th>
<th>Labor</th>
<th>Right of Way</th>
<th>Engineering/Permitting/Indirects</th>
<th>Escalation</th>
<th>APUDC</th>
<th>Contingency</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.1 New 345-kV/115-kV lines between Agawam Substation, East Springfield Junction and Fairmont</td>
<td>$30,247</td>
<td>$60,584</td>
<td>$9,199</td>
<td>$27,544</td>
<td>$331</td>
<td>$1,947</td>
<td>$4,554</td>
<td>$140,276</td>
</tr>
<tr>
<td>2.2.2 New 345-kV/115-kV lines between East Springfield Junction and Ludlow</td>
<td>$51,438</td>
<td>$70,577</td>
<td>$6,113</td>
<td>$28,374</td>
<td>$286</td>
<td>$1,845</td>
<td>$6,158</td>
<td>$144,772</td>
</tr>
<tr>
<td>2.2.3 New 345-kV/115-kV lines between CT/MA border and Agawam</td>
<td>$17,024</td>
<td>$37,488</td>
<td>$5,380</td>
<td>$15,461</td>
<td>$143</td>
<td>$1,015</td>
<td>$604</td>
<td>$77,421</td>
</tr>
<tr>
<td>2.2.4 New 345-kV/115-kV lines between North Bloomfield and CT/MA border</td>
<td>$15,068</td>
<td>$41,240</td>
<td>$1,710</td>
<td>$16,530</td>
<td>$181</td>
<td>$2,370</td>
<td>$761</td>
<td>$79,840</td>
</tr>
<tr>
<td>2.2.5 Ludlow Substation</td>
<td>$20,793</td>
<td>$20,550</td>
<td>$1,003</td>
<td>$10,053</td>
<td>$104</td>
<td>$1,079</td>
<td>$2,582</td>
<td>$55,773</td>
</tr>
<tr>
<td>2.2.6 Agawam Substation</td>
<td>$51,010</td>
<td>$27,678</td>
<td>$806</td>
<td>$14,220</td>
<td>$141</td>
<td>$1,364</td>
<td>$1,116</td>
<td>$78,248</td>
</tr>
<tr>
<td>2.2.7 Catwell Switching Station</td>
<td>$5,508</td>
<td>$9,745</td>
<td>$73</td>
<td>$5,568</td>
<td>$376</td>
<td>$440</td>
<td>$23,738</td>
<td></td>
</tr>
<tr>
<td>2.2.8 Fairmont Switching Station</td>
<td>$12,237</td>
<td>$17,563</td>
<td>$881</td>
<td>$9,489</td>
<td>$74</td>
<td>$569</td>
<td>$42,330</td>
<td></td>
</tr>
<tr>
<td>2.2.9 North Bloomfield Substation</td>
<td>$10,309</td>
<td>$10,250</td>
<td>$103</td>
<td>$10,032</td>
<td>$104</td>
<td>$2,048</td>
<td>$4,350</td>
<td>$55,023</td>
</tr>
<tr>
<td>2.2.10 All Other Switching/Substations</td>
<td>$2,666</td>
<td>$8,611</td>
<td>$206</td>
<td>$2,066</td>
<td>$20</td>
<td>$215</td>
<td>$1,842</td>
<td>$14,180</td>
</tr>
<tr>
<td>2.2.11 Virtual Impact Mitigation</td>
<td>$3,750</td>
<td>$3,750</td>
<td>$3,148</td>
<td>$1,377</td>
<td>$13</td>
<td>$64</td>
<td>$10,705</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>185,414</strong></td>
<td><strong>319,323</strong></td>
<td><strong>24,068</strong></td>
<td><strong>145,152</strong></td>
<td><strong>1,863</strong></td>
<td><strong>18,841</strong></td>
<td><strong>23,207</strong></td>
<td><strong>712,107</strong></td>
</tr>
</tbody>
</table>

**Source:** NU TCA application (NU-13-TCA-01), February 20, 2013. Notes: 1 - $442 MM dollars escalated at 2% per year is $478 MM in 2017 dollars 2 - With escalation, substation costs are $120 MM in 2017 dollars.

**Line only costs ($442 MM) – 2013 dollars**

**Endpoint subs upgrades ($111 MM) – 2013 dollars**
Stoughton Cable Project is likely the best comp for the AC Plan underground projects

**Project Route Overviews**

- **17 miles of 345 kV underground AC line**
  - Three 345 kV circuits

- **Route**
  - 10 miles all in same trench
  - First half of route, fairly open

- **Project cost $378 MM (2017 dollars)**
  - $21MM / mile
  - $8.8 MM / circuit mile (with synergies of multi-circuit)

*Source: Nstar TCA application (Nstar-04-TCA-01-Rev 1), September 15, 2005*
The Greater Boston AC Plan is more like Greater Springfield plus Stoughton Cable projects together

### Plan Cost Comparison (2017 dollars)

<table>
<thead>
<tr>
<th>New England Comps</th>
<th>AC Plan – Key Upgrades¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Greater Springfield line</strong></td>
<td></td>
</tr>
<tr>
<td>– 35 miles new 345 kV line, reconfiguration multiple circuits, interconnecting subs work</td>
<td></td>
</tr>
<tr>
<td>– $478MM + $120MM = $598 MM</td>
<td></td>
</tr>
<tr>
<td><strong>Stoughton Cables</strong></td>
<td></td>
</tr>
<tr>
<td>– 17 miles 345 kV underground line, synergies from common trench &amp; install, interconnecting sub work</td>
<td></td>
</tr>
<tr>
<td>– $378 MM</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
<tr>
<td>– $976 MM</td>
<td></td>
</tr>
<tr>
<td><strong>Scobie-Tewksbury line</strong></td>
<td></td>
</tr>
<tr>
<td>– 25 miles new 345 kV line, reconfiguration multiple circuits, interconnecting subs work</td>
<td></td>
</tr>
<tr>
<td>– $106 MM³</td>
<td></td>
</tr>
<tr>
<td><strong>Underground segments²</strong></td>
<td></td>
</tr>
<tr>
<td>– 16 miles 345 kV and 115 kV underground line, <em>no</em> synergies from common trench or install, interconnecting sub work</td>
<td></td>
</tr>
<tr>
<td>– $182 MM</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
<tr>
<td>– $288 MM</td>
<td></td>
</tr>
</tbody>
</table>

Even accounting for differences in projects, the AC Plan cost estimates are *hundreds of millions* below actual comparables

---

Notes: ¹ – Estimates from NU and Ngrid and in 2017 dollars ² – Includes Wakefield-Woburn, 345 kV underground circuit at 8 miles and Mystic-Woburn, 115 kV underground circuit at 8 miles. ³ – Removes Y-151 reconductoring at $16 MM as it is a separate project
When it comes to projected in-service dates, the AC Plan timelines are far shorter than recent comparables.

### Plan Schedule Comparison

#### New England Comps

<table>
<thead>
<tr>
<th>Line Description</th>
<th>Expected Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Springfield line</td>
<td>35 miles new 345 kV line, reconfiguration multiple circuits, interconnecting subs work, 6 years to put into service</td>
</tr>
<tr>
<td>Stoughton Cables</td>
<td>17 miles 345 kV underground line, synergies from common trench &amp; install, interconnecting sub work, 5 years to put into service</td>
</tr>
</tbody>
</table>

#### AC Plan – Key Upgrades

<table>
<thead>
<tr>
<th>Line Description</th>
<th>Expected Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scobie-Tewksbury line</td>
<td>25 miles new 345 kV line, reconfiguration multiple circuits, interconnecting subs work, 2 years (NU) or 3 years (Ngrid)¹</td>
</tr>
<tr>
<td>Underground segments</td>
<td>16 miles 345 kV and 115 kV underground line, no synergies from common trench or install, interconnecting sub work, Wakefield to Woburn, 4 years, Mystic to Woburn, 3 years</td>
</tr>
</tbody>
</table>

Faster in-service dates affect reliability and costs to customers.

---

Notes:
2. RSP project IDs 1552 by December 2018 Wakefield – Woburn (NU), project ID 1356 by December 2017 Mystic – Woburn (NU)
At NHT’s request, The Brattle Group conducted an analysis to evaluate two key cost factors for Greater Boston Study

**Brattle Presentation Overview**

- The Brattle Group conducted a study to evaluate:
  - Congestion during construction
  - The value of speed to put a project into service
- Provided independent perspective on Greater Boston resource issues
- Highlighted WIRES report
  - Broad look at transmission costs/benefits
Brattle’s work show significant costs at stake in addition to capital construction costs

**Brattle Study Results**

**Congestion During Construction**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>$163 MM</td>
</tr>
<tr>
<td>Footprint delayed one year (6/17 vs. 6/16)</td>
<td>$507 MM</td>
</tr>
<tr>
<td>Mystic 7 retires prior to construction complete</td>
<td>$314 MM</td>
</tr>
</tbody>
</table>

**In-service Delay**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year delay</td>
<td>$349 MM</td>
</tr>
<tr>
<td>2 year delay</td>
<td>$698 MM</td>
</tr>
</tbody>
</table>

These costs will ultimately be paid for by customers in New England and must be taken into account in this decision.
When all the factors that matter are taken into account, SeaLink is the more cost-effective project

### Greater Boston Cost Comparisons

<table>
<thead>
<tr>
<th>All numbers in millions</th>
<th>Transmission Owners Estimates(^1)</th>
<th>ISO Cost Consultant Estimates(^1)</th>
<th>New England Average Estimates(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AC Plan</td>
<td>SeaLink Plan</td>
<td>AC Plan</td>
</tr>
<tr>
<td>Construction Cost Estimates</td>
<td>$519</td>
<td>$804</td>
<td>$512</td>
</tr>
</tbody>
</table>

**Estimates of Other Relevant Costs**

- Incremental Higher Cost of Electricity During Construction \(^3\) $163 - $163 - $163 -
- Incremental Cost of Delay Due to Permitting \(^3\) $349 - $349 - $349 -

**Total Customer Cost** $1,031 $804 $1,024 $770 $1,178 $804

Under any of these scenarios, SeaLink is the more cost-effective project for customers

Notes: 1 - Numbers from the ISO-NE Greater Boston Presentation to the Planning Advisory Committee, November 18\(^{th}\). 2 – Numbers derived from NHT analysis of recent comparable New England projects already constructed and in rates. 3 –The Brattle Group’s estimates of these charges.
NHT offers one final, but important note

**Perspective on Cost Estimates**

- **All estimates from NU, Ngrid and NHT that the PAC looked at in November 2014 were cost-of-service**
  - While they should be in a -25% to +50% band, that band is non-binding

- **Not all components that impact a customer’s bill are being taken into account**
  - NHT strongly believes there are hundreds of millions at stake between congestion and speed to put project into service

- **And as of the November PAC meeting, no entity had yet offered a proposal that addresses the cost and schedule risk to customers**
Agenda

- Greater Boston Situation
- SeaLink Overview
- Selection Criteria
- Project Comparison
- Conclusion
Key Points

- The region is about to make a major investment decision
  - There is a great amount at stake with the urgency of the reliability problems for the biggest load center in New England
- The only perspective that matters should be doing what is best for customers
  - Both from an overall cost and impact standpoint
- The SeaLink Plan is clearly the best choice to address the region’s transmission reliability challenges
  - SeaLink will be more cost-effective for customers than the AC Plan
  - SeaLink will provide customers enhanced reliability more effectively and faster than the AC Plan
  - SeaLink will have less impact on customers’ communities and the environment than the AC Plan
And one more thing…
Appendix
In consultation with many agencies and stakeholders, SeaLink team conducted a detailed desktop study of route

- Found very high quality public data along most of the route (side scan sonar/bathymetry, bottom type, sediment samples, seabed photos, backscatter)
- Noted locations of other telecom and gas subsea lines and designed accordingly
- Designed to be consistent with MA Ocean Management Plan & International Cable Protection Committee Engineering Guidelines
Marine survey:
Visual representation of systems deployed offshore
Marine survey select photos

R/V Sea Lion V

The Survey Swath – All Geophysical Data Shown

Multibeam/Side Scan Hybrid

Avoiding a Magnetic Anomaly
Marine survey select photos – (cont.)

*Shipboard Side Scan – Sands and Clays*

*Undocumented Anomaly – Likely a Wreck*

*Undocumented Anomaly – Likely a Sunken Barge*

*Shipboard Subbottom Data*
The success of the TransBay project demonstrates how HVDC can effectively address reliability problems.

**TransBay HVDC cable – San Francisco**

**Key project facts**

- 400MW HVDC cable controlled by CAISO
- 53 miles long
- Voltage Source Converter (VSC) technology
- EPC with Siemens/Prysmian
- 4 years from decision to COD (w/ delays)
- Developed by Babcock & Brown
- In service in 2010, uptime around 99%

- San Francisco very similar to Boston – dense urban environment, limited in-city generation, heavy reliance on transfer capability
- Competed against a set of AC solutions developed by the incumbent utility
- Not least cost, stakeholders (particularly state and city) supportive, AC challenges on siting were significant and benefits were critical including time to install, and creation of new corridor decreasing dependency on existing corridor, thus improving reliability.
- In eyes of CAISO and others, large success
Scobie-Tewksbury Overview

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Ngrid ENF Figure 3 Cross Section Reference</th>
<th>Ngrid ENF Figure 4 Environmental Constraints Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Page 2</td>
<td>Pages 1-3</td>
</tr>
<tr>
<td>2</td>
<td>Page 4</td>
<td>Pages 3-5</td>
</tr>
<tr>
<td>3</td>
<td>Page 6</td>
<td>Pages 5-7</td>
</tr>
<tr>
<td>4</td>
<td>Page 8</td>
<td>Pages 7-8</td>
</tr>
<tr>
<td>5</td>
<td>Page 10</td>
<td>Pages 8-11</td>
</tr>
<tr>
<td>6</td>
<td>Page 12</td>
<td>Pages 11-15</td>
</tr>
<tr>
<td>7</td>
<td>Page 14</td>
<td>Pages 15-19</td>
</tr>
<tr>
<td>8</td>
<td>Page 16</td>
<td>Pages 19-25</td>
</tr>
</tbody>
</table>
### NH/VT Solution Comparison

#### Figure B.1 – NH/VT Solution Study Report – April 2012
Comparison Matrix of Alternative Solutions
For the Central Vermont and Connecticut River Corridor Sub-Area

<table>
<thead>
<tr>
<th>Description</th>
<th>Alternative #1</th>
<th>Alternative #2</th>
<th>Alternative #3</th>
<th>Alternative #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. Rutland to Ascutney 115kV Line Rebuild</td>
<td>West Rutland to Coolidge 115kV Line addition, Coolidge to Ascutney 115kV Line addition</td>
<td>W. Rutland to Coolidge 345kV Line addition, Coolidge to Ascutney 115kV Line addition</td>
<td>West Rutland to Ascutney 115kV Line addition</td>
<td></td>
</tr>
</tbody>
</table>

#### Project Execution Criteria

<table>
<thead>
<tr>
<th></th>
<th>Permitting (e.g. environmental, siting, etc.)</th>
<th>Constructability (e.g. system outages)</th>
<th>Project Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permitting (e.g. environmental, siting, etc.)</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Constructability (e.g. system outages)</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>System Performance</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Longevity (20-yr performance)</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Loss Savings</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>System Operation</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

#### Project Cost Estimates

| Cost Estimates ($M in 2016 dollars) | $254 | $281 | $262 | $269 |

#### Preferred Solution Ranking

| 4 | 3 | 1 | 2 |

**Note:** Scale from 1 to 5, where 1 is the best

Source: Section 7.3.2 and Table 7.6 in the April 2012 New Hampshire / Vermont Solutions Study Report

The April 2012 NH-VT Solutions Study Report discussion on alternative selection:

Four transmission solution alternatives were studied for these two combined sub-areas. The study report concluded that based on the results summarized in Table 7-8, which has been reproduced above, and which provides a summary table of the performance, constructability, and strategic considerations, Alternative #3 was selected as the preferred solution for the Central Vermont and the Connecticut River Corridor combined areas. Alternative #3 consists of: Install a second 330 Coolidge – West Rutland 345 kV line, a second Coolidge-Ascutney line, and rebuild the E149 line.
### NH/VT Solution Comparison (cont.)

#### Figure B.2 – NH/VT Solution Study Report – April 2012

Comparison Matrix of Alternative Solutions

<table>
<thead>
<tr>
<th>New Hampshire Southern Sub Area</th>
<th>Alternative #1</th>
<th>Alternative #4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cost to Construct (SM)</td>
<td>$252</td>
<td>$227</td>
</tr>
<tr>
<td>• MW Loss Reduction (at Peak Load)</td>
<td>0-1</td>
<td>3-4</td>
</tr>
<tr>
<td>• Capability to Expand Proposed Facility</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• State Siting Required (SEC)</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>• Existing Right(s) of Way</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>• Within Existing Property</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>• New Right(s) of Way</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>• New Circuit Miles</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>• Rebuilt Circuit Miles</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>• Expand Existing Substation(s)</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>• Greenfield Substation(s)</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Operations &amp; Maintenance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Construction Outage(s) Impact</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>• Construction Outage(s) Impact to Generation</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>• Time to Construct</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>• Flexibility</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MVAR Margin (QV) to 0.95 pu. V (N-1)</td>
<td>170</td>
<td>140</td>
</tr>
<tr>
<td>• MW Load Growth (PV) to 0.95 pu. V(N-1-1)</td>
<td>480</td>
<td>600</td>
</tr>
<tr>
<td>• Existing MW Load in Area</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>• Existing MVAR Capacitor Installed</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>• MVAR Capacitor Additions</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>• Impact to Circuit Breakers (% Duty)</td>
<td>98% - 63kA</td>
<td>88% - 63kA</td>
</tr>
<tr>
<td>• Converts Substation(s) to BPS</td>
<td>NO</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Note: Letter grading: A=Better B=Good C=Fair D=Poor
Source: Section 7.3.7 and Table 7.11 in the April 2012 New Hampshire / Vermont Solutions Study Report*

The April 2012 NH-VT Solutions Study Report discussion on alternative selection:

Southern New Hampshire was another sub-area of the nine sub-areas studied identified in the April 2012 NH-VT Solutions Study. Both remaining alternatives (alternative 1 and alternative 4) provide active power loss reduction benefits and future margin for load growth. Alternative #1 has poor expansion capability, requires more new line construction, and costs approximately $26 M more. In addition, under Alternative #1, several Scobie Station 115 kV breakers will be over 95% of their breaker duties. Alternative #4 has less impact to the breaker duties. Alternatives #4: New Eagle 345/115 kV autotransformer and certain 115kV upgrades common to both alternatives, was selected as the preferred solution, as it was determined to be less costly than the other alternative, and it was determined to address the needs in the area.
Select examples – ISO-NE Solution Study Reports

**Pittsfield/Greenfield Solution Comparison**

![Comparison Matrix of Alternative Solutions](image)

1. **Total Project Costs**
   - Lower overall cost
   - Estimated installed cost in 2014 dollars
   - Solution A: Berkshire 345kV Ring Bus
   - Solution C: Montague 345kV Ring Bus
   - Solution D: New Irving 115kV Switching Station
   - Solution B: Does not satisfy this objective

2. **Operational Performance Improvements**
   - Improve operational performance and flexibility of the system
   - Solution A
   - Solution B
   - Solution C
   - Solution D

3. **System Capacity Margin**
   - Margin at System Peak
   - Margin at Shoulder Peak
   - Solution A
   - Solution B
   - Solution C
   - Solution D

4. **Expected Early In Service Date**
   - Shorter licensing and permitting time
   - Solution A
   - Solution B
   - Solution C
   - Solution D

5. **Acquisition of new land and ROW**
   - Does not require significant additional land and ROW
   - Solution A
   - Solution B
   - Solution C
   - Solution D

6. **Minimizes transmission line construction**
   - Less new and rebuilt lines
   - Solution A
   - Solution B
   - Solution C
   - Solution D

7. **Replaces old infrastructure**
   - Replaces aging structures and obsolete conductors
   - Solution A
   - Solution B
   - Solution C
   - Solution D

X – Does not satisfy this objective
✓ - Achieves this objective

Source: Sections 5 and 6 of the Pittsfield-Greenfield Solutions Study Report – March 2012

The March 2012 Pittsfield-Greenfield MA Solutions Study Report discussion on alternative selection: Plan D is recommended as the preferred solution. All of the solution alternatives provide for a stronger transmission supply to the Pittsfield-Greenfield area which resolves all thermal and voltage violations identified in the needs assessment report. The most significant factor that led to choosing Plan D was the total overall cost. Plan D is approximately 40% less cost than Plan A, which is the next most cost effective plan. Regarding siting issues, the new transmission facilities recommended for Plan D can be constructed on existing rights-of-way and on land owned by the utility, although expansion of the substation yard at Northfield Mountain may require some land acquisition/easement. Plan D also eliminates the need to rebuild the 1231/1242 lines from Berkshire to Cumberland.
## Select examples – ISO-NE Solution Study Reports

### NEEWS/IRP – Solution Comparison

**Figure B.4 – NEEWS – IRP (2012)**
Comparison Matrix of Alternative Solutions
Sherman Road Sub Area

<table>
<thead>
<tr>
<th>Comparison Factors</th>
<th>Alternative 1 Rebuild Existing Station</th>
<th>Alternative 2 New GIS Station</th>
<th>Alternative 3 New AIS Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost (Conceptual Grade Estimate)</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Ring Bus - $36.0M</td>
<td>Ring Bus - $44.9M</td>
<td>Ring Bus - $36.0M</td>
<td></td>
</tr>
<tr>
<td>Outage Requirements</td>
<td>Very High Requirements</td>
<td>Low Requirements</td>
<td>Low Requirements</td>
</tr>
<tr>
<td>High Risk Outages</td>
<td>Low Risk Outages</td>
<td>Low Risk Outages</td>
<td></td>
</tr>
<tr>
<td>Construction Sequencing</td>
<td>Construction will conflict with other components at West Farnum and Millbury</td>
<td>Minimal conflicts</td>
<td>Minimal conflicts</td>
</tr>
<tr>
<td>Expansion Capabilities</td>
<td>Difficult to Expand: Expansion requires reconfiguring from ring bus to breaker-and-a-half</td>
<td>Easy to expand: Up to 4 Bays</td>
<td>Easy to expand: Up to 4 Bays (after initial 2-bay build-out and removal of existing station)</td>
</tr>
<tr>
<td>Environmental Factors</td>
<td>Low Impact</td>
<td>GIS may not be considered carbon neutral</td>
<td>Medium Impact</td>
</tr>
</tbody>
</table>

**Figure B.5 – NEEWS – IRP (2012)**
Comparison Matrix of Alternative Solutions
RI and MA A Series Sub Area

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option A-1</th>
<th>Option A-2</th>
<th>Option A-3</th>
<th>Option A-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>New 345 kV Line Length (mi.)</td>
<td>37.9</td>
<td>35.6</td>
<td>37.9</td>
<td>46.9</td>
</tr>
<tr>
<td>Est. Upland Forest Cleared (Acres)</td>
<td>149.5</td>
<td>165.9</td>
<td>149.5</td>
<td>149.5</td>
</tr>
<tr>
<td>Est. Wetland Forest Cleared (Acres)</td>
<td>19.2</td>
<td>7.25</td>
<td>19.2</td>
<td>19.2</td>
</tr>
<tr>
<td>Est. Tree Clearing within Mapped Rare, Threatened or Endangered (Listed) Species Habitat (Acres)</td>
<td>1.4 – Upland Forest</td>
<td>2.1 – Forested Wetland</td>
<td>12.4 – Upland Forest</td>
<td>0.6 – Forested Wetland</td>
</tr>
<tr>
<td>Watercourse Crossings (Number)</td>
<td>53</td>
<td>50</td>
<td>53</td>
<td>61</td>
</tr>
<tr>
<td>Parkland Traversed (mi.)</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>3.2</td>
</tr>
<tr>
<td>Residences within 500 ft of route centerline</td>
<td>319</td>
<td>265</td>
<td>319</td>
<td>319</td>
</tr>
</tbody>
</table>

**Substations and Switching Stations**
- New Switching Station (Sherman Road): Yes
- New AIS Station (Usbridge, MA): No
- Wetlands (acres permanently affected): 0.3
- Upland forest (acres permanently affected): 2.7

Source: Table 7-11 from NEEWS: Interstate reliability project – February 2012

**The Feb 2012 NEEWS/IRP Solutions Study Report discussion on alternative selection:**

Based on these factors the A-series options were found to be more cost effective than option C-2.1 for resolving the projected criteria violations. However, the results from Section 7.2 do not provide a preferred alternative amongst the A-series options. The estimated costs of the four A-series options are within 5% of each other. All the A-series options performed well electrically and essentially equally, however, future system expandability and flexibility considerations favor option A-1 over the other A-series options.

An analysis of the natural and human environmental impacts of the four A-series options concluded that option A-1 also represents the best of the four A-series options. Hence, the A-1 option is selected as the preferred alternative by the working group based on the comparisons in Sections 7.3.