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Attachment B-2: ISO-NE's Needs Assessment for 2033

Pictured: Jupiter's Callisto | BESS in Harris County, TX

Prepared For:

Massachusetts Department of Energy Resources

Electric Distribution Companies:

Fitchburg Gas & Electric Light Company d/b/a Unitil

Massachusetts Electric Company and Nantucket Electric Company, each d/b/a National Grid

NSTAR Electric Company d/b/a Eversource Energy

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Boston 2033 Needs Assessment, Revision 2

Planning Advisory Committee

Revision 2 to the February 28, 2024 Presentation

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Purpose

- Present the results of the Boston 2033 Needs Assessment (NA)
- Identify the time sensitive and non-time-sensitive needs in the study area
- Discuss the solutions development process that will be used to address the identified needs

Overview

- Synopsis of Needs Assessment
- Overview of Modeling Assumptions
- Steady-State Assessment Results
  - Peak Load Needs
  - Minimum Load Needs
- Impact of Future LSP and Asset Condition Projects
- Solutions Development
- Summary and Next Steps

SYNOPSIS OF NEEDS ASSESSMENT

Study Objective and Background

- The objective of the Boston 2033 Needs Assessment(NA) is to evaluate the reliability performance of the Pool Transmission Facilities (PTF) and identify reliability-based transmission needs in the Boston study area for the year 2033
  - Steady-state, stability and short circuit analysis was performed
- ISO-NE shared a presentation, a study scope, and study files with PAC previously
  - All materials can be found in the Greater Boston key study area portion of the ISO website
  - Additional details and links are included in Appendix A of this presentation
- ISO-NE expects to post the draft Boston 2033 NA report and study files under the Greater Boston Key Study Area on the ISO-NE external website by March 22, 2024

Overview of Results

- Stability
  - No needs identified
  - All criteria violations occurred in the 2033 Daytime minimum load due to loss of legacy DER. These violations will be further studied in New England 2034 Daytime Minimum Load Needs Assessment
- Short Circuit
  - No needs identified
- Steady State
  - N-1-1 thermal and voltage needs identified
  - A subset of the needs are time-sensitive
  - Remainder of the presentation discusses the steady-state needs

Summary of Steady-state Needs

- No N-0 or N-1 needs were identified
- N-1-1 Peak Load Testing:
  - 15 elements with thermal violations (3 are time-sensitive)
  - 11 buses with low voltage violations (4 are time-sensitive)
  - One N-1-1 contingency pair results in unacceptable loss of load – this need is non-time sensitive
- N-1-1 Minimum Load Testing:
  - 17 buses with high voltage violations (17~~15~~ are time-sensitive)

OVERVIEW OF MODELING ASSUMPTIONS

Scenarios Studied

- Steady-state analysis included three summer peak load scenarios and two minimum load scenarios:
  - 2033 Evening peak (90/10 CELT load with 26% PV)
  - 2033 Daytime peak - low renewables (90/10 CELT load with 40% PV)
  - 2033 Daytime peak - high renewables (90/10 CELT load with 65% PV)
  - 2033 Daytime minimum (Fixed 12,000* MW load with 90% PV)
  - 2033 Nighttime minimum (Fixed 7,680* MW load)
- The following slide shows the net Boston load for each scenario and the range of Boston import transfers for the dispatches evaluated
  - Additional details on the base case assumptions are included in the Needs Assessment report and final study files

*Fixed New England load includes transmission and distribution losses

2033 Net Boston Loads and Transfers

Boston Net Load Levels (Excludes Transmission Losses) and Range of Boston Import Transfers

Load Scenarios →	Peak Load Scenarios			Minimum Load Scenarios	
	2033 Daytime Peak – High Renewables (MW)	2033 Daytime Peak – Low Renewables (MW)	2033 – Evening Peak (MW)	2033 Daytime Minimum (MW)	2033 Nighttime Minimum (MW)
CELT Loads (Excludes Transmission Losses)	6,913	6,914	6,915	NA	NA
Boston share of Fixed New England Load	NA	NA	NA	1,911	1,337
Available ADCR (modeled as negative load)	-76	-76	-76	0	0
Available CELT EE Forecast (modeled as negative load)	-436	-436	-436	0	0
Available CELT PV Forecast for study year (subtracted from gross load as these are load reducers)	-849	-523	-340	-1,176	0
Net load modeled in Boston (Excludes Station Service)	**5,552**	**5,879**	**6,063**	**735**	**1,337**
Range of Boston Import Transfers in Base Cases	**4,541 – 4,833**	**4,905 – 5,211**	**5,096 – 5,387**	**749**	**1,366 – 1,399**

Comparison to Previous Boston Needs Assessment

- The most recent Needs Assessment for the Boston area was the Boston 2028 NA
  - A comparison of the highest and lowest net loads studied in the 2028 assessment and this 2033 assessment are included in Appendix A
- For peak load cases, the projected net load in Boston for 2033 is about 650 MW higher
  - Higher Boston import results in thermal and low voltage violations
- For the minimum load cases, the net load in Boston for 2033 is between 300 MW and 900 MW lower than the lowest load studied in the past
  - Lower net loads in Boston results in high voltage violations

Creation of Time-sensitive Scenarios

- A time-sensitive analysis was performed to determine if the needs are observed within 3 years from the expected date of publication of the final Needs Assessment
  - Expect the final Needs Assessment to be published by April 2024
  - The Solutions Study process as described in Section 4.2 of Attachment K is proposed to be used for all time-sensitive needs
- Time-sensitive analysis was restricted to peak load needs
  - All needs observed under minimum load conditions are observed in the nighttime minimum cases
    - Some needs appeared in daytime minimum case, with magnitude equivalent to nighttime minimum conditions
  - The needs observed at nighttime minimum load levels are deemed to be time-sensitive without further analysis because the nighttime minimum load level is possible under current-day system conditions
- To assess whether any of the needs identified in 2033 were time-sensitive, the following load level was created based on the methodology documented in Section 4.1.8.3 of the Transmission Planning Technical Guide* :
  - 2026 summer peak

* https://www.iso-ne.com/static-assets/documents/2023/09/2023_09_12_pac_transmission_planning_technical_guide_rev8_1.pdf

2026 Net Boston Loads and Transfers

Boston Net Load Levels (Excludes Transmission Losses) and Range of Boston Import Transfers

Load Scenarios →	Peak Load Scenario
	2026 Evening Peak (MW)
CELT Loads (Excludes Transmission Losses)	6,176
Boston share of Fixed New England Load	NA
Available ADCR (modeled as negative load)	-90
Available CELT EE Forecast (modeled as negative load)	-434
Available CELT PV Forecast for study year (subtracted from gross load as these are load reducers)	-199
Net load modeled in Boston (Excludes Station Service)	5,453
Range of Boston Import Transfers in Base Cases	4,605 – 4,752

Comparison of Time-sensitive year cases to Boston 2028 NA

- A comparison of the highest and lowest net loads studied in the 2028 assessment to the 2026 time-sensitive year cases is included in the appendix
- For peak load cases, the projected net load in Boston for 2026 is comparable to the loads studied in the 2028 assessment
  - However, updated TO load distributions and improved DER locational information resulted in variations in how the load is distributed among the various substations within the study area

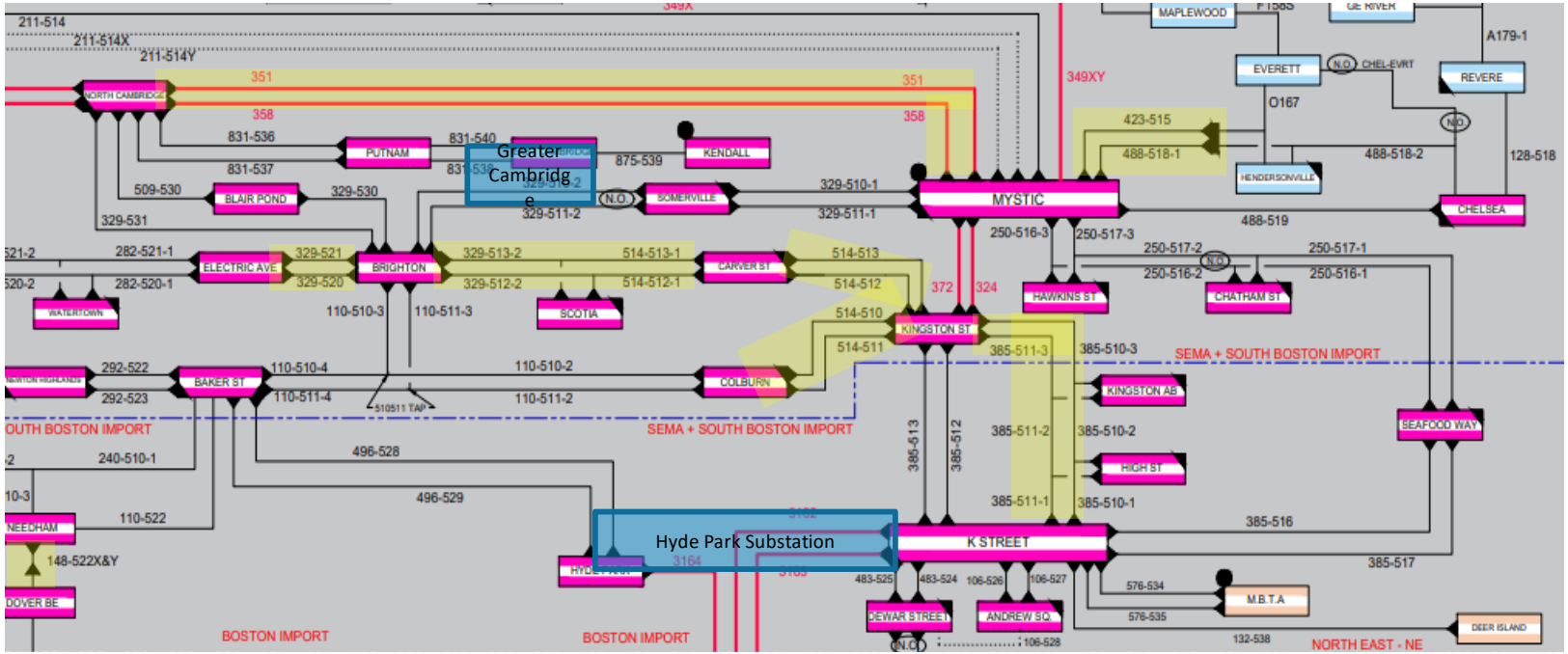
Sensitivity Analysis

- ISO reached out to Eversource and National Grid to identify any asset condition projects that have not yet been added to the Asset Condition List located in the Boston study area that would be in-service by 2033
  - The objective was to conduct sensitivity analysis to identify if any of these potential future projects may alleviate needs in the study area
- Of the list of projects identified by Eversource and National Grid, a few Eversource projects and one National Grid project were deemed to impact ratings or power flows
  - All Eversource projects were instances where pipe-type cables (PTC) in the Boston area are projected to be replaced by XLPE cables
  - The 337 line from Sandy Pond to Tewksbury was identified by National Grid as requiring a complete rebuild
- Additionally, Eversource identified two Local System Plan (LSP) projects that do not yet have PPA approval that may impact the needs in the Boston area
  - As a part of the ISO review, ISO evaluated whether these LSP projects address needs in the study area

List of Asset Condition and LSP Projects Evaluated

- Asset Condition Projects – PTC in the Eversource area
  - North Cambridge – Mystic 345 kV 358/351 lines
  - Needham – Dover 115 kV 148 – 522 XY Line
  - Brighton – Carver 115 kV 329 – 512/513 lines
  - Brighton – Electric Ave. 115 kV 329 – 520/521 lines
  - Kingston – K St. 115 kV 385 – 510/511 lines
  - Mystic – Everett 115 kV 423 – 515 Line
  - Mystic – Chelsea 115 kV 488 – 518 Line
  - Kingston – Colburn 115 kV 514 – 510/511 lines
  - Kingston – Carver 115 kV 514 – 512/513
- Asset Condition Project – Overhead line in National Grid area
  - Sandy Pond – Tewksbury 345 kV – 337 line
- LSP Projects
  - Hyde Park Substation (ES-23-LSP038 on Eversource 2023 LSP)
  - Greater Cambridge Energy Program (ES-23-LSP046 on Eversource 2023 LSP)
- The following slide shows the locations of these projects

Asset Condition and LSP Projects Considered



Asset Condition Projects

Local System Plan Projects

STEADY-STATE ASSESSMENT RESULT

N-1-1 Peak Load Needs

Organization of the Results

- No N-0 or N-1 peak load needs were identified, and the following slides will discuss the N-1-1 peak load needs
- The results are categorized into the following subareas of the Boston study area
  - Boston 345 kV – Includes all 345 kV facilities in the study area and 345 kV connected transformers
  - North Shore 115 kV
  - Downtown Boston 115 kV
- The presentation identifies the facilities with thermal violations and the buses with voltage violations
  - In the case of thermal overloads, the highest loading that is observed in 2033 is also included
  - Detailed results with worst case thermal and voltage violations in 2033 and 2026 (time sensitive year) are provided in Appendix B
- Any needs that are time-sensitive are also identified

Subareas

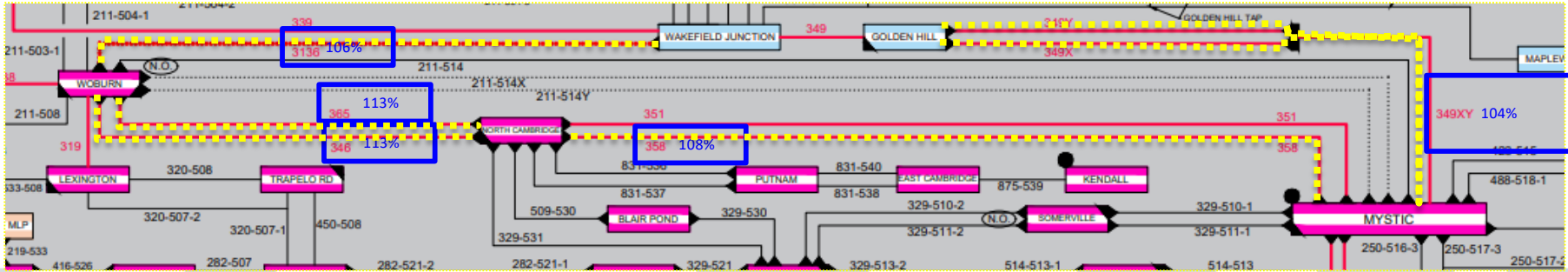
- An approximate geographical map showing the North Shore and Downtown Boston subareas
- The Boston 345 kV subarea is not shown but covers all study area 345 kV facilities including those in the North Shore and Downtown Boston areas

Boston 345 kV – Summary of Needs

- There are eight 345 kV lines and one 345/115 kV transformer with N-1-1 thermal overloads
  - 337 line from Sandy Pond to Tewksbury
  - 3162 line from Stoughton to K Street
  - 338 line from Tewksbury to Woburn
  - 3136 line from Woburn to Wakefield Junction
  - 349 line from Wakefield Junction to Mystic
  - 346 line from Woburn to North Cambridge 345 kV
  - 365 line from Woburn to North Cambridge 345 kV
  - 358 line from North Cambridge to Mystic
  - Sandy Pond T1 345/115 kV Autotransformer
- There were no N-1-1 voltage violations
- All Boston 345 kV needs are non-time sensitive

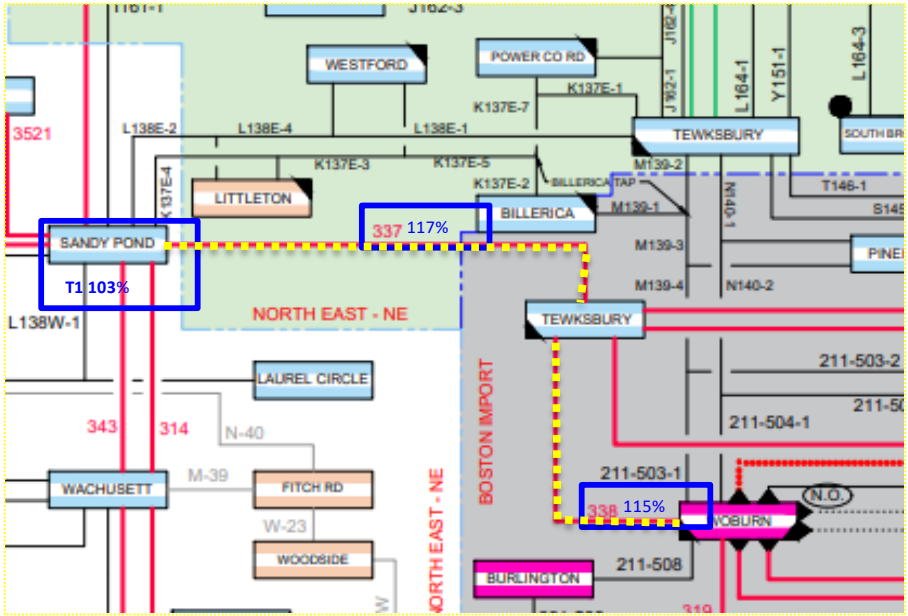
Boston 345 kV – Underground Cables North of Boston

- This category of facilities includes the 346, 365, 349, 358 and 3136 underground cables that are in the northern part of the transmission system serving Boston
  - Worst case thermal violations shown in the diagram
- Highest loadings observed in the high North-South transfer cases in the Evening Peak scenario
  - Additional details on the worst case violations including the contingencies that cause the violations is provided in the CEII Appendix B



Boston 345 kV – Overhead Lines and Transformer North of Boston

- This category of facilities includes the 337 and 338 overhead line and the Sandy Pond T1 345 /115 kV transformer that are in the northern part of the transmission system serving Boston
  - Worst case thermal violations shown in the diagram
- Highest loadings observed in the high North-South transfer cases in the Evening Peak scenario
  - See CEII Appendix B for additional details on worst case violations



Boston 345 kV – Underground Cables South of Boston

- This category of facilities includes the 3162 underground cable that is in the southern part of the transmission system serving Boston
  - Worst case thermal violation is shown in the diagram
- For the 3162 line, the highest loadings observed in the high North-South transfer cases in the evening peak scenario
- See CEII Appendix B for additional details on worst case violations

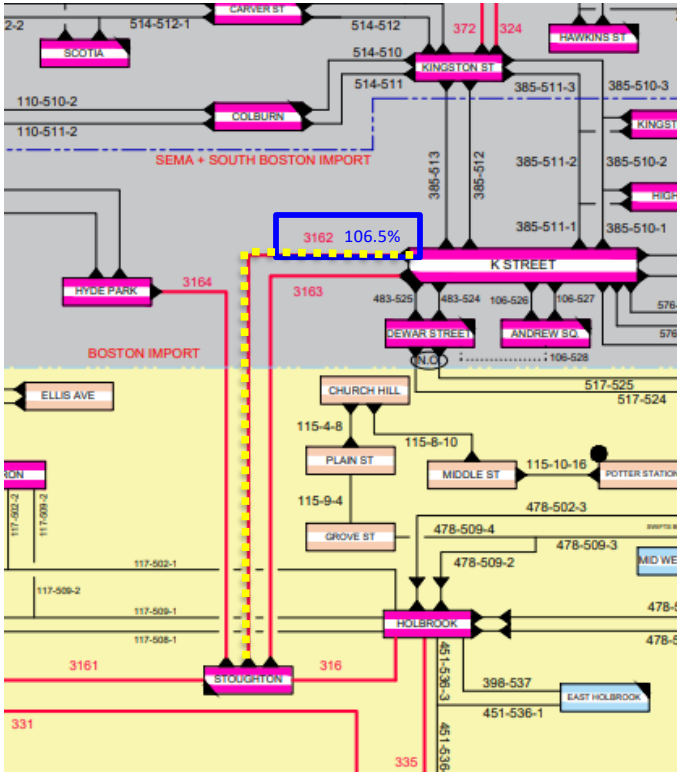


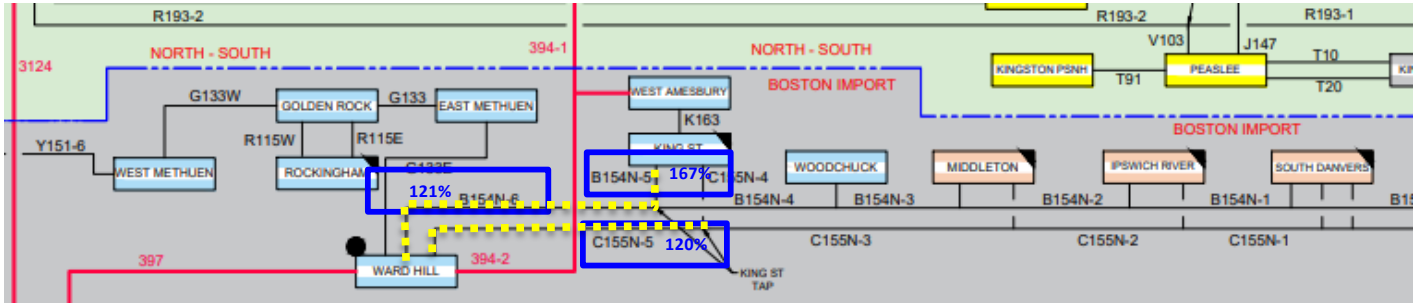
Image replaced to reflect 3163 overload being eliminated

North Shore 115 kV – Summary of Needs

- There are two 115 kV lines with N-1-1 thermal overloads
  - Ward Hill – South Danvers 115 kV B-154N
  - Ward Hill – South Danvers 115 kV C-155N
  - Both needs are time-sensitive
- Nine 115 kV buses with N-1-1 low voltage violations
  - Golden Rock, East Methuen, Ward Hill, King Street, West Amesbury, Woodchuck Hill, Middleton, Ipswich River and South Danvers
  - Four of these low voltage violations are time-sensitive
    - Ward Hill, West Amesbury, King Street, and South Danvers
- The consequential load lost for the loss of two 115 kV PTF lines in the area exceeds 300 MW
  - The consequential load loss is below 300 MW in the time-sensitive year; therefore, the need is non-time sensitive

North Shore 115 kV – Thermal Violations

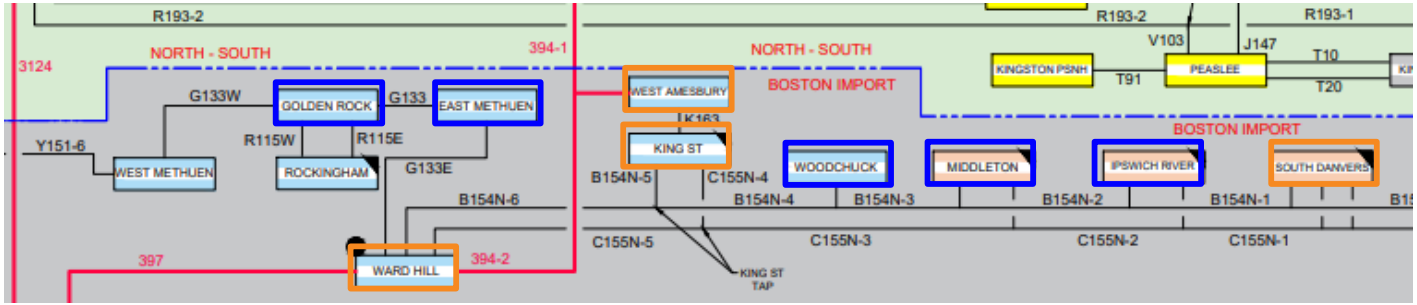
- There are thermal violations on segments of the B154N line and the C155N line in the North shore area
  - Worst case thermal violations in 2033 are shown in the diagram
  - The violations in 2026 are included in Appendix B
- The violations are
  - Observed when North Shore generation is OOS
  - Independent of system transfers (i.e. observed in both the North – South and SEMARI stresses)
  - See CEII Appendix B for additional details on worst case violations



Max LTE Loading

North Shore 115 kV – Voltage Violations

- There are low voltage violations at nine 115 kV buses between Golden Rock and South Danvers in the North shore area in 2033
  - In 2026, low voltage violations are observed at Ward Hill, King Street, West Amesbury, and South Danvers
  - Buses with low violations in 2033 and 2026 are shown in the diagram
    - Worst case violations in 2033 are between 0.822 and 0.895 PU
  - Highest loadings observed in the high North-South transfer cases in the evening peak scenario
    - See CEII Appendix B for additional details on worst case violations



North Shore 115 kV – Consequential Load Loss

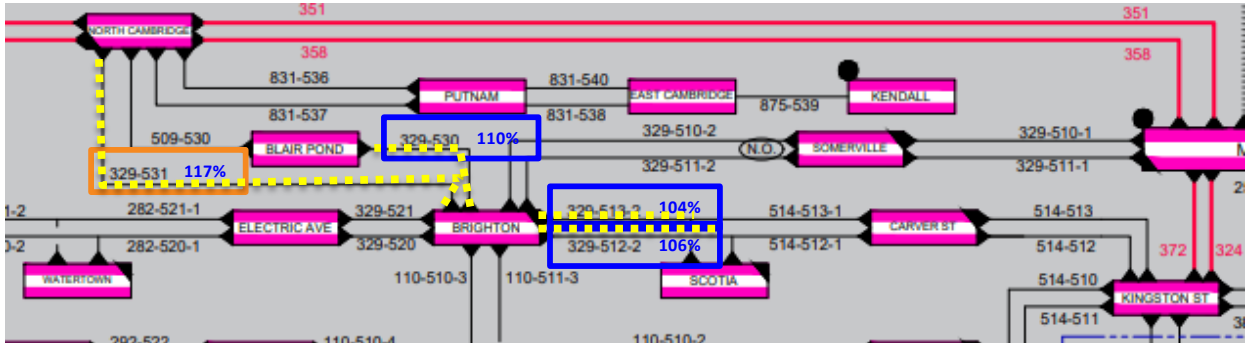
- The loss of two 115 kV lines in the North shore area results in the consequential loss of load at four 115 kV substations
  - Total load lost in 2033 – 330 MW
  - Total load lost in 2026 – 299 MW
- See CEII Appendix B for additional details on the two lines and associated substations

Downtown Boston 115 kV – Summary of Needs

- There are four 115 kV lines with N-1-1 thermal overloads
  - 329-530 line from Brighton to Blair Pond
  - 329-531 line from Brighton to North Cambridge
  - 329-512 line from Brighton to Carver
  - 329-513 line from Brighton to Carver
  - Only the overload on the 329-531 line is time-sensitive
- Two 115 kV buses with N-1-1 low voltage violations
  - Hartwell and Burlington
  - None of these low voltage violations are time-sensitive

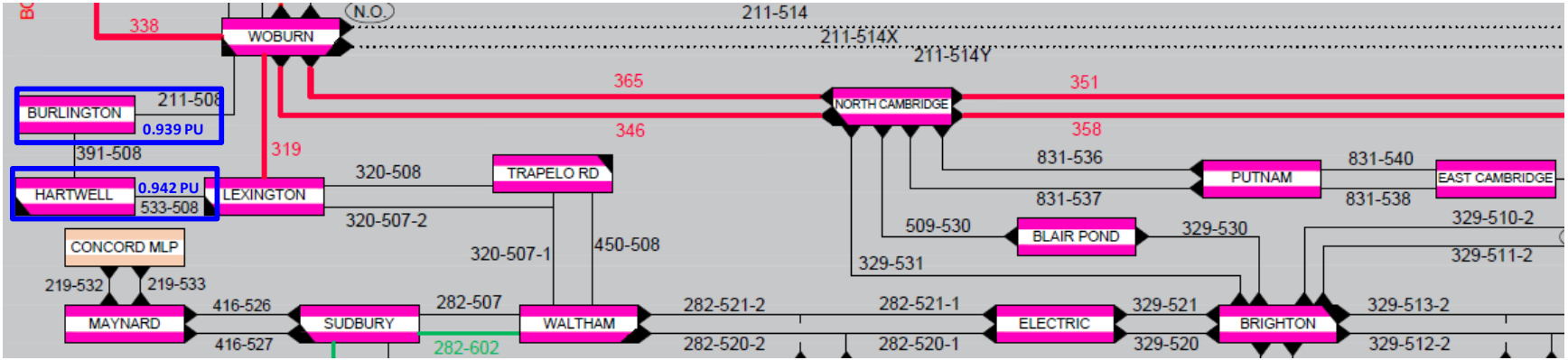
Downtown Boston 115 kV – Thermal Violations

- There are thermal violations on the 329-530 line, 329-531 line and segments of the 329-512 line and 329-513 line in the Downtown Boston area
  - Worst case thermal violations in 2033 are shown in the diagram
- The violations are driven by the local generation dispatch in the vicinity of the overloaded facilities and is generally independent of system transfers



Downtown Boston 115 kV – Voltage Violations

- There are low voltage violations at the Hartwell and Burlington 115 kV substations
  - Worst case voltage violations in 2033 are shown in the diagram
- The violations are driven by the large amount of load at Burlington and Hartwell substations
  - See CEII Appendix B for additional details on worst case violations



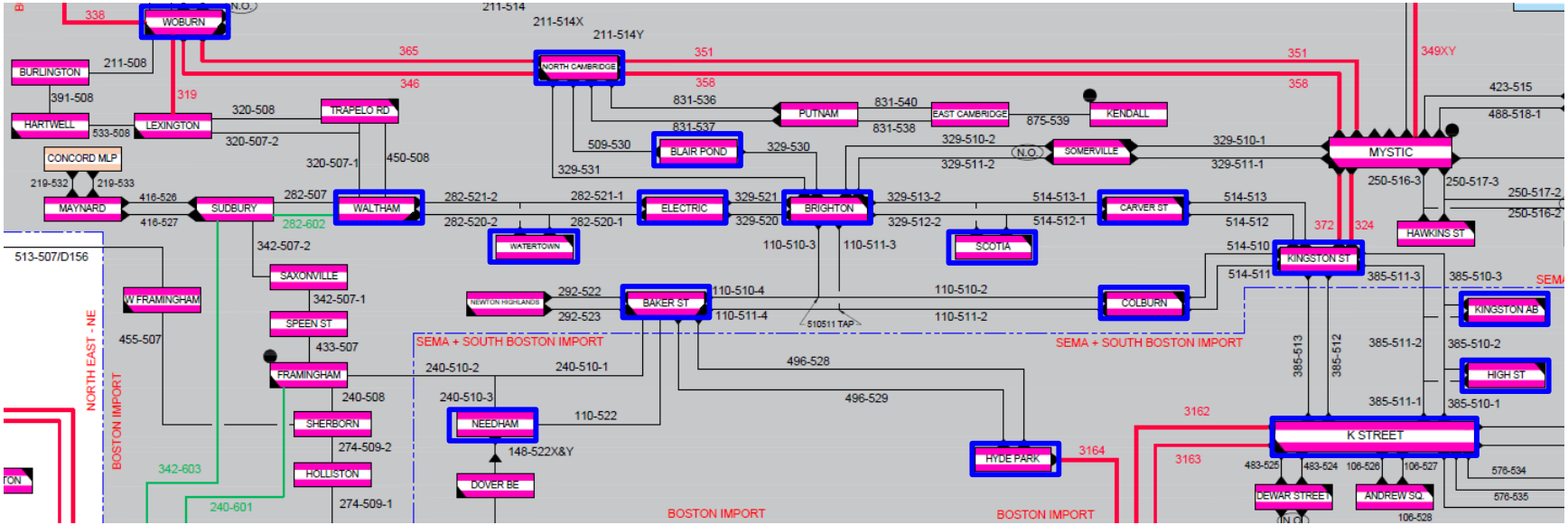
STEADY-STATE ASSESSMENT RESULT

N-1-1 Minimum Load Needs

Summary Results

- No N-0 or N-1 minimum load needs were identified, and the following slides will discuss the N-1-1 minimum load needs
- There are seventeen 115 kV buses with N-1-1 high voltage violations
  - All buses are in the Downtown Boston 115 kV subarea
  - Woburn, Waltham, Watertown, Electric Avenue, Brighton, Blair Pond, North Cambridge, Scotia Street, Carver Street, Baker Street, Needham, Hyde Park, Colburn Street, Kingston Street, Kingston Network Station, High Street and K Street
    - Worst case violations are between 1.050 and 1.067 PU
  - All of these high voltage violations are time-sensitive because the violations are seen in the nighttime minimum cases as well as the daytime minimum case
- The following slide identifies the buses with their highest voltage violations in 2033
  - High voltage violations are seen for contingencies that result in the loss of shunt reactors
  - Additional details on the worst case violations are included in Appendix B

Buses with High Voltage Violations in 2033



115 kV Bus with High Voltage Violations

IMPACT OF FUTURE ASSET CONDITION PROJECTS AND LSP PROJECTS

Results of Sensitivity Analysis

Impact of Asset Condition Projects

- Of the 15 N-1-1 thermal violations identified in 2033, the asset condition projects provided by Eversource and National Grid were evaluated and were found to potentially address the following four lines:
  - 358 line from North Cambridge to Mystic
  - 329-512 line from Brighton to Carver
  - 329-513 line from Brighton to Carver
  - 337 line from Sandy Pond to Tewksbury*
- All four needs that are potentially addressed by the asset condition projects that are not yet added to the Asset Condition List are considered non-time sensitive needs

*Due to an ISO-NE oversight, the asset condition rebuild of the 337 line was not included in the analysis. However, given typical ratings of the upgraded conductor that is being proposed by National Grid, the overload observed in 2033 is likely to be addressed

Impact of LSP Projects

- There are two 115 kV lines with N-1-1 thermal overloads that are potentially addressed by the Greater Cambridge Energy Program
  - 329-530 line from Brighton to Blair Pond
  - 329-531 line from Brighton to North Cambridge
- One of these needs, overloads on the 329-531 line, is considered a time-sensitive need

SOLUTIONS DEVELOPMENT

Tariff Requirements Associated with Time-sensitive Needs

- Under Section 4.1(j) of Attachment K, a time-sensitive need demonstrates reliability criteria violations for system conditions within 3 years after the completion of the relevant Needs Assessment and includes specific provisions that must be met as a part of identifying time-sensitive needs
  - Slides 40 and 41 describe the time-sensitive needs in the study area and an explanation for why the needs are considered time-sensitive and a description of why the reliability need was not identified earlier
  - Slide 42 includes a discussion of non-transmission options that were considered but concluded would not sufficiently address the time-sensitive needs

Summary of Peak Load Time-Sensitive Needs

- There are three 115 kV lines with N-1-1 thermal overloads that are considered time-sensitive
  - Ward Hill – South Danvers 115 kV B-154N
  - Ward Hill – South Danvers 115 kV C-155N
  - 329-531 line from Brighton to North Cambridge
- There are four 115 kV buses with N-1-1 low voltages violations that are considered time-sensitive
  - Ward Hill, King Street, West Amesbury, and South Danvers
- The need-by-date for all peak load time-sensitive is June 1, 2026*
- These needs were not identified in past Needs Assessments; they are being seen now due to updated net load distribution at buses in the vicinity of the thermal and voltage violations, that are driven by:
  - Increased gross load forecasts for stations in the Cambridge and North Shore area based on TO provided load distributions
  - Improved allocation of DERs to load buses based on locational data from distribution companies

* For additional details, see section 4.1.8.4 of the Transmission Planning Technical Guide

Summary of Minimum Load Time-Sensitive Needs

- There are 17 115 kV buses with N-1-1 high voltage violations that are considered time-sensitive
  - Woburn, Waltham, Watertown, Electric Avenue, Brighton, Blair Pond, North Cambridge, Scotia Street, Carver Street, Baker Street, Needham, Hyde Park, Colburn Street, Kingston Street, Kingston Network Station, High Street and K Street
- All time-sensitive needs are observed under night time minimum load conditions that are possible under current day conditions
  - Need-by-date will be date of publication of the Needs Assessment
- These needs were seen in the nighttime minimum load cases used for the Boston 2033 Needs Assessment and were not identified in past Needs Assessments due to:
  - Reduction in net load modeled in the Boston subarea under the nighttime minimum load conditions by 300 MW due to more accurate distribution of loads based on historical data*
  - Also, certain contingencies involving the failure of the circuit breaker to operate while initiated by a RAS were not included in previous Boston area Needs Assessments

* See slide 13 of https://www.iso-ne.com/static-assets/documents/2022/11/a08_transmission_planning_technical_guide_update_rev8_0.pdf

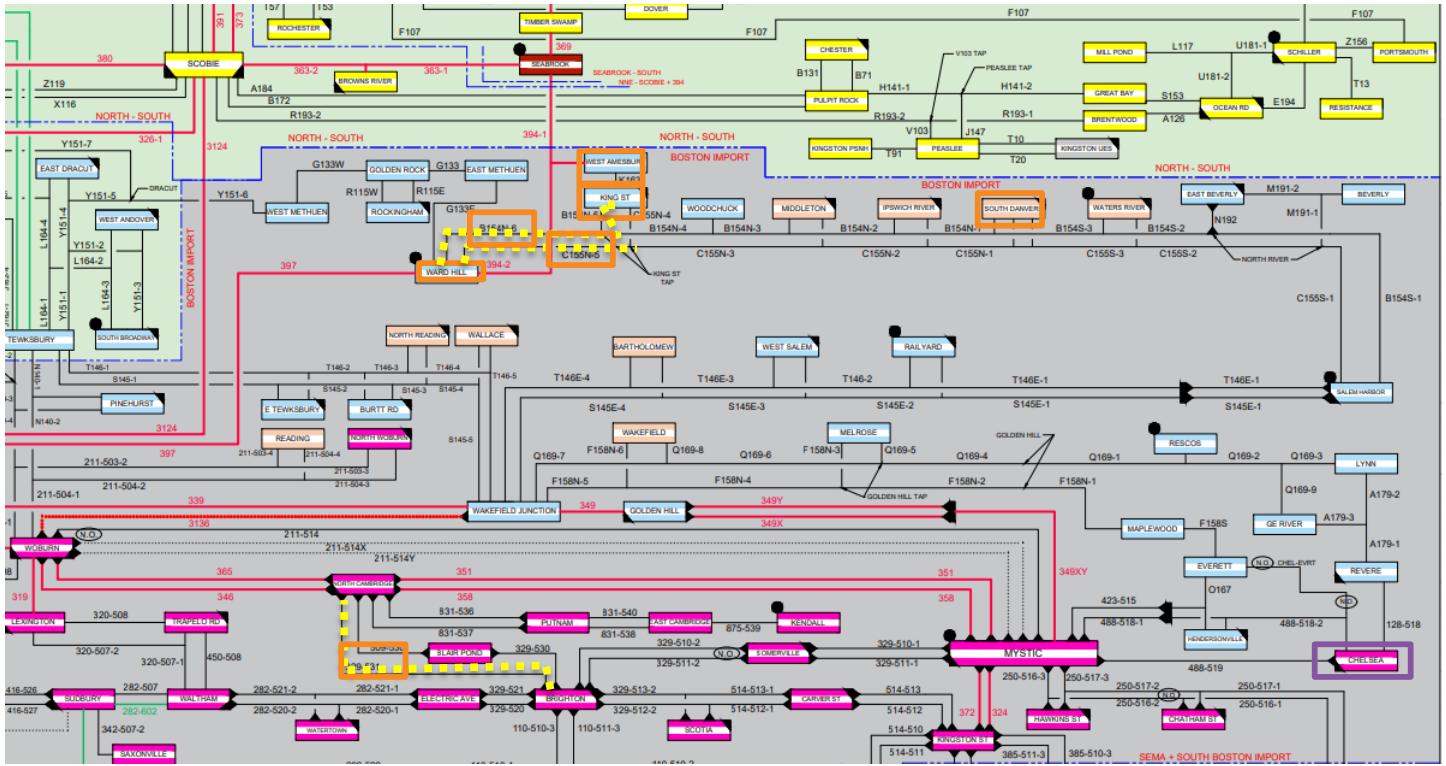
Non-Transmission Options

- Non-transmission options which have already been included in the system models are not adequate to relieve the reliability criteria violations in Boston for the time-sensitive year
  - Demand Resources (DR) through FCA 17, and draft 2023 Energy Efficiency (EE), and draft 2023 Solar Photovoltaic (PV) forecasts were included in the models used to identify needs
  - There were no active DR that cleared FCA 18 in the NEMA/Boston load zone
  - Further, at minimum load any reduction of net load would exacerbate the high voltage violations
- Existing and New Generating Capacity Resources with Forward Capacity Market obligations through FCA 17, and all resources and ETUs with a binding contract as of the start of the Needs Assessment are already considered in the study
  - One new resource, Hecate Energy Eastern Ave Energy Center, a 250 MW Battery Energy Storage System (BESS), cleared FCA 18
  - Note that the results of FCA18 were posted to the ISO website on February 21, 2024 and there was insufficient time to update the complete analysis with this resource
  - During the course of the Needs Assessment, the contracts associated with two offshore wind resources were terminated
  - See next slides for details on the sensitivity analysis that was performed to determine the impact of these changes on the time-sensitive needs

Impact of Hecate Energy Eastern Ave Energy Center

- All the time-sensitive high voltage needs are observed under nighttime minimum load conditions where all study area generation, including BESS, would be offline
- The new resource would not impact those needs and no additional analysis was performed
- All the worst case time-sensitive thermal and low voltage needs are due to high loads in the vicinity of the overloaded facilities and buses with low voltage violations
  - A sensitivity analysis was performed on the worst case dispatches and contingency pairs that cause the time-sensitive thermal and low voltage needs with the new resource online
  - The analysis indicated that the new resource does not impact the time-sensitive needs
  - This was expected based on the relative location of the resource compared to the elements with time-sensitive needs (see next slide for locational information)
- When the non-time-sensitive needs are reassessed at the end of the Solutions Study, this new resource will be included in that assessment

Relative Location of Peak Load Time-Sensitive Needs and Hecate Energy Eastern Ave Energy Center



Time-sensitive violations

Location of new resource

Impact of Off-shore Wind Contract Termination

- During the Needs Assessment, the contracts for the following two off-shore wind projects were terminated
  - Park City Wind
  - Mayflower Wind
- A sensitivity analysis was performed on the 2026 evening peak time-sensitive cases with these two off shore resources offline in addition to the Hecate Energy resource being included
  - There were no changes to the time-sensitive needs in the Boston study area
- When the non-time-sensitive needs are reassessed at the end of the Solutions Study, these two off shore wind resources will be assumed offline

Determination

- Since the needs on slides 40 and 41 have been shown to be time-sensitive, the ISO proposes to use the Solutions Study process as described in Section 4.2 of Attachment K
- Based on the location of the reliability criteria violations, the ISO will work with the following Participating Transmission Owners, as needed
  - Eversource
  - National Grid
- A reassessment of the non-time-sensitive needs will be performed after the conclusion of the Solutions Study
  - This will include the new resource from FCA 18 and reflect the termination of the two offshore wind contracts

SUMMARY AND NEXT STEPS

Summary of Needs

Steady State N-1-1 Needs

	345 kV	North Shore	Downtown Boston 115 kV
2033 Horizon Year	• 9 thermal violations	• 2 thermal violations • 9 low voltages • 1 N-1-1 Load loss above threshold	• 4 thermal violations • 2 low voltage violations • 17 high voltage violations
2026 Time-sensitive Year	• N/A	• 2 thermal violations • 4 low voltages	• 1 thermal violation • 17 high voltage violations

LSP and Asset Condition Projects

- For the LSP project that impacts the time-sensitive need on the 329-531 line, the Solutions Study will explore the status of these projects
- For the asset condition projects that impact the non-time-sensitive needs, the ISO will work with Eversource and National Grid to further understand the status of these projects

Schedule

- Please submit comments on the materials in this presentation to pacmatters@iso-ne.com by March 15, 2024
- The draft Boston 2033 NA is expected to be posted by March 22, 2024
  - Stakeholder feedback on the report will be requested within 15 days of the posting of the draft report
- Complete the Boston 2033 NA and post the final report – Q2 2024
- Initiate the Boston 2033 Solutions Study to address the time-sensitive needs – Q2 2024

Questions

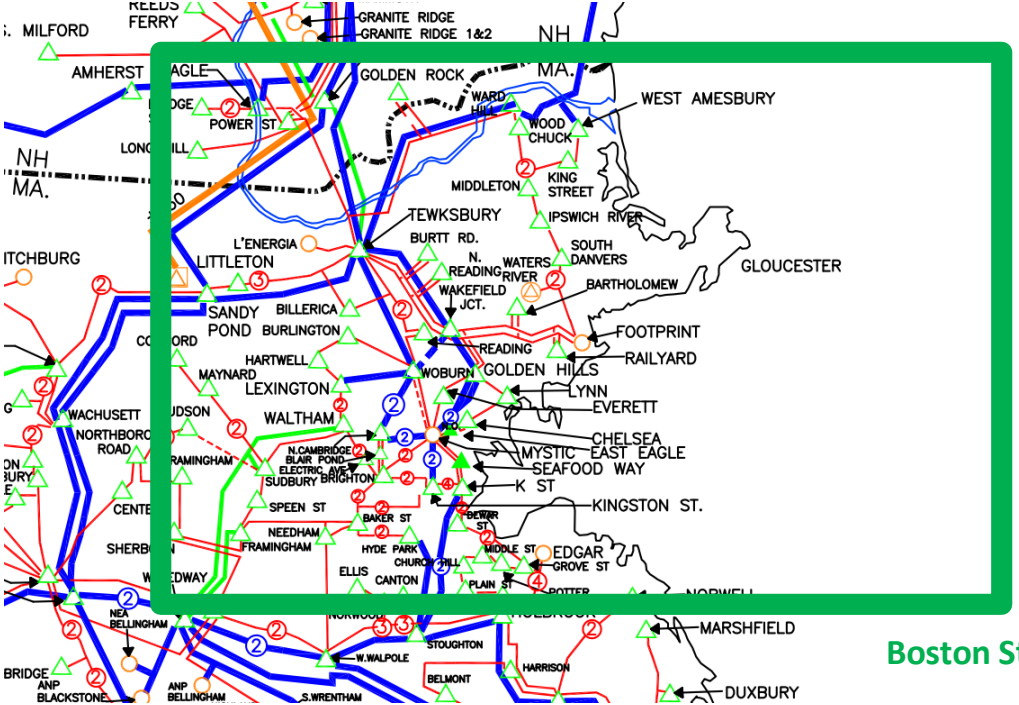
APPENDIX A

Background information

Background

- October 16, 2022: the ISO posted a Notice of Initiation of the Boston Area Needs Assessment (NA)
- December 13, 2022: the ISO presented the Boston 2032 Needs Assessment Scope of Work (SOW) to PAC
- June 12, 2023: the ISO posted the draft Boston 2033 NA SOW and intermediate study files
- August 23, 2023: the ISO posted the final Boston 2033 NA SOW
  - Included changes based on stakeholder comments on the draft Boston 2033 NA SOW
- See the Greater Boston Key Study Area of the ISO external website for applicable final documents

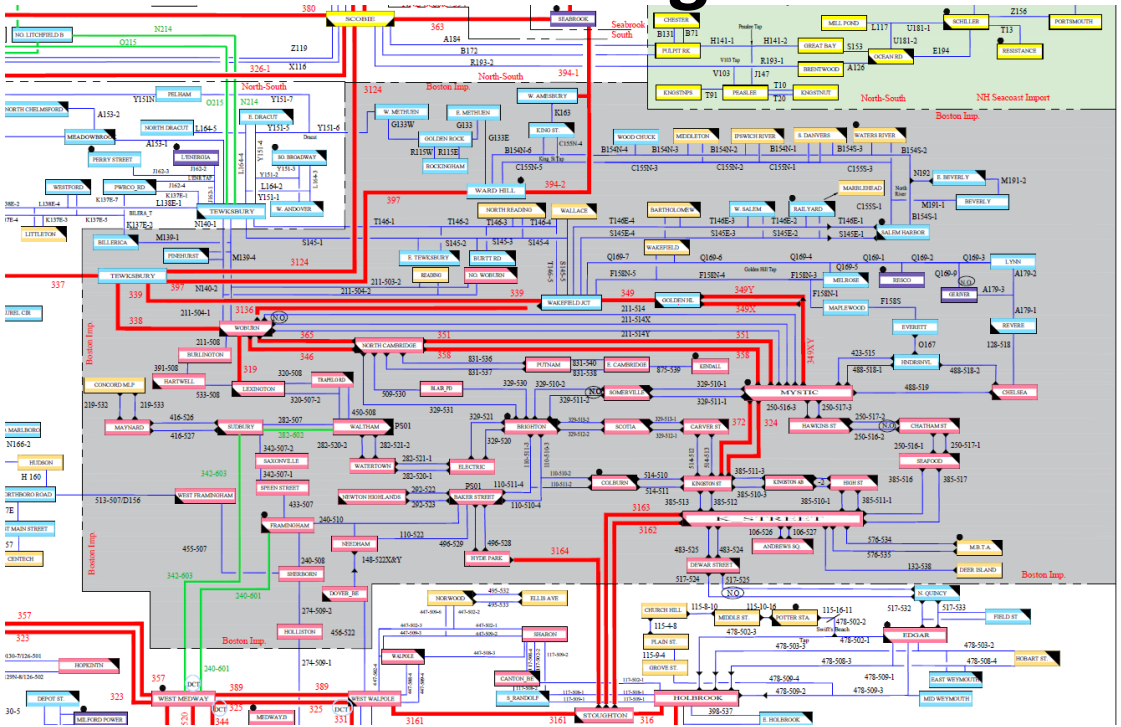
Boston Area Geographical Map



Boston Study Area

The map is shown for reference only and does not include all of the latest topology changes.
This map shows the 115 kV system and above and does not depict the 69 kV system
For a high resolution version of the system diagram, please go to: https://www.iso-ne.com/about/key-stats/maps-and-diagrams

Boston Area One Line Diagram



The diagram is shown for reference only and does not include all of the latest topology changes.
This diagram shows the 115 kV system and above and does not depict the 69 kV system
For a high resolution version of the system diagram, please go to: https://www.iso-ne.com/about/key-stats/maps-and-diagrams

Comparison of Boston 2033 Needs Assessment Loads to Boston 2028 Needs Assessment - Peak

	2026 Evening Peak Boston 2033 NA (Time Sensitive Case – 3 years)	2028 Peak Boston 2028 NA (10 year case)	2033 Evening Peak Boston 2033 NA (10 year case)
CELT Load	6,176	6,699	6,915
Available ADCR (modeled as negative load)	-90	-56	-76
Available CELT EE Forecast for study year (modeled as negative load)	-434	-1,315	-436
Available CELT PV Forecast for study year	-199	-185	-340
Net load modeled in Boston (Excludes Losses and Station Service)	5,453	5,400	6,063
Range of Boston Import (Includes Losses and Station Service)	**4,605 – 4,752**	**4,509 – 4,654**	**5,096 – 5,387**

Comparison of Boston 2033 Needs Assessment Loads to Boston 2028 Needs Assessment - Minimum

	2028 Nighttime Minimum Boston 2028 NA (3 year and 10 year minimum load)	2033 Daytime Minimum Boston 2033 NA (10 year case)	2033 Nighttime Minimum Boston 2028 NA (3 year and 10 year minimum load)
Boston share of Fixed New England Load	1,650	1,911	1,337
Available ADCR (modeled as negative load)	0	0	0
Available CELT EE Forecast for study year (modeled as negative load)	0	0	0
Available CELT PV Forecast for study year	0	-1,176	0
Net load modeled in Boston (Excludes Station Service)	1,650	735	1,337
Range of Boston Import (Includes Losses and Station Service)	**869 – 1,572**	**749**	**1,366 – 1,399**

APPENDIX B - STEADY STATE EXPANDED RESULTS

Appendix B provides additional details on worst case violations, and includes CEII information. It is therefore provided as a separate file.