MARCH 19, 2025 | WEBEX

Connecticut 2034 Needs Assessment

Planning Advisory Committee

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Purpose

- Present the results of the Connecticut 2034 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
  - Minimum Load Needs
  - Peak Load Needs
- Solutions Development
- Summary and Next Steps

SYNOPSIS OF NEEDS ASSESSMENT

Study Objective and Background

- The objective of the Connecticut 2034 Needs Assessment (NA) is to evaluate the reliability performance of the Pool Transmission Facilities (PTF) and identify reliability-based transmission needs in the Connecticut study area for the year 2034
  - Steady-state, stability and short circuit analysis was performed
- ISO-NE posted the final scope of work presentation and intermediate study files on August 20, 2024
  - All materials can be found in the Connecticut 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 Connecticut 2034 NA report and study files under the Connecticut Key Study Area on the ISO-NE external website by March 19, 2025

Overview of Results

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

Summary of Steady State Needs

- Minimum Load Testing:
  - Minimum load needs were noted throughout the state of Connecticut at 115 and 345 kV
    - No N-0 needs identified
    - Eight buses* with N-1 high voltage violations (none are time-sensitive)
    - 50 buses with N-1-1 high voltage violations (48 are time-sensitive)
- Peak Load Testing:
  - Violations were concentrated in the Eastern Connecticut/Southwestern Rhode Island (ECT/SWRI) 115 kV System
    - No N-0 needs were identified
    - N-1 and N-1-1 non-convergence observed (time-sensitive)
    - Five elements with N-1 and N-1-1 thermal violations (all are time-sensitive)
    - 12 buses with N-1 and N-1-1 low voltage violations (all are time-sensitive)

* buses are modeled buses in PSS®E and a single station may be modeled using multiple buses in PSS®E

OVERVIEW OF MODELING ASSUMPTIONS

Scenarios Studied

- Steady-state analysis included one summer peak load scenario and two minimum load scenarios:
  - 2034 Summer Evening peak (92% 90/10 CELT load with 0% PV)
  - 2034 Daytime minimum (Fixed 12,000* MW load with 90% PV)
  - 2034 Nighttime minimum (Fixed 7,680* MW load)
- 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 May 2025
  - The Solutions Study process described in Section 4.2 of Attachment K will be used for all time-sensitive needs

*Fixed New England load includes transmission and distribution losses

Creation of Time Sensitive Scenarios

- Time-sensitive analysis was conducted for both minimum and peak load needs
  - Needs observed under minimum load conditions are observed in the nighttime and daytime scenarios
    - 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
    - Needs observed at daytime minimum load levels were tested for time sensitivity
  - Needs observed under peak load were tested for time sensitivity
- To assess whether any of the needs identified in 2034 were time-sensitive, two load levels were created based on the methodology described in Section 4.1.8.3 of the Transmission Planning Technical Guide* :
  - 2027 Summer Evening Peak
  - 2028 Daytime Minimum

* https://www.iso-ne.com/static-assets/documents/100009/2024_03_21_pac_tptg_rev8.2.pdf

Modeling Changes from Scope of Work

- A major update was made to the minimum load cases to better represent historical minimum load operational conditions in New York
- Adjustments were made near the major tie-lines between CT and NY
  - The NNC cable is a phase-shifter controlled 138 kV tie-line between SWCT and NY. For this line, the VAR flow was aligned to match historical data
  - The 398 line is a 345 kV tie-line connecting WCT and NY. For this line, voltages on the NY side were adjusted to reflect historic minimum load conditions
- For further details on the minimum load changes described above and other changes made to the study files, see the Needs Assessment Report and associated documents

CT Peak Loads Comparison – Current NA versus Relevant Past Study

Connecticut System Load*	2034 Needs Assessment		ECT 2029 Needs Assessment
	2034 Summer Late Evening Peak Load (MW)	2027 Summer Late Evening Peak Load (MW)	2029 Summer Peak Load (MW)
CELT 2024 90/10 Gross Load Forecast	7,069	6,707	7,678
Available FCA 18 ADCR (modeled as negative load)	-129	-129	-104
Available 2024 CELT EE Forecast for study year (modeled as negative load)	-485	-510	-971
Available 2024 CELT DER PV Forecast for study year (Modeled as negative load for the ECT 2029 NA)	0	0	-291
Net load modeled in CT (Excludes Station Service)	**6,455**	**6,068**	**6,312**

* Excludes Transmission Losses and Includes Distribution Losses

ECT/SWRI Pocket Load comparison

- The key criteria violations observed in the ECT/SWRI area were driven by loads at 15 substations
- The following table compares the net load at these substations in the 2034 CT NA versus the ECT 2029 NA

Key Substations in ECT/SWRI Load*	2034 Needs Assessment		ECT 2029 Needs Assessment
	2034 Summer Late Evening Peak Load (MW)	2027 Summer Late Evening Peak Load (MW)	2029 Summer Peak Load (MW)
Net load modeled at Substations (Excludes Station Service)	**300**	**274**	**283**

* Excludes Transmission Losses and Includes Distribution Losses

Summary of Peak Load Comparison

- Net load at key substations in ECT/SWRI in the time-sensitive year (2027) is comparable to the net load studied in the ECT 2029 Needs Assessment
- However, a comparison of system topology shows that a key change is the Wickford Junction substation, which was not included in the ECT 2029 Needs Assessment
  - The Wickford Junction substation was added as a part of a PV Distributed Energy Resource (DER) cluster in Rhode Island, and received PPA approval after the finalization of the ECT 2029 Needs Assessment Scope of Work
  - Additional discussion on the impact of this substation is provided in Appendix B

CT Minimum Load Comparison - Current NA versus Relevant Past Study

Connecticut System Load	CT 2034 Needs Assessment			SWCT 2027 Needs Assessment
	2034 Daytime Minimum (MW)	2028 Daytime Minimum (MW)	2034 Nighttime Minimum (MW)	2027 Minimum Load (MW)
Fixed Connecticut load * **	2,590	2,591	1,721	1,863
Available 2024 CELT DER PV Forecast for study year	-2,519	-1,605	N/A	N/A
Net load modeled in CT (Excludes Station Service and ESS in charging mode)	71	986	1,721	1,863

*Excludes Transmission Losses and Includes Distribution Losses
**Fixed Connecticut load includes impact of EE and Active DR

Summary of Minimum Load Comparison

- The most recent Connecticut-wide minimum load assessment was performed as part of the Southwest Connecticut (SWCT) 2027 Needs Assessment
- For nighttime minimum load conditions, the net CT load modeled in the 2034 Needs Assessment is about 150 MW lower than the lowest nighttime minimum load level studied in the SWCT 2027 NA
  - The decrease is due to changes in load distribution resulting in a slightly lower percentage of the fixed New England load residing in CT in the CT 2034 NA
- Daytime minimum load scenarios were not studied in past Needs Assessments for CT

STEADY-STATE ASSESSMENT RESULTS

Minimum Load

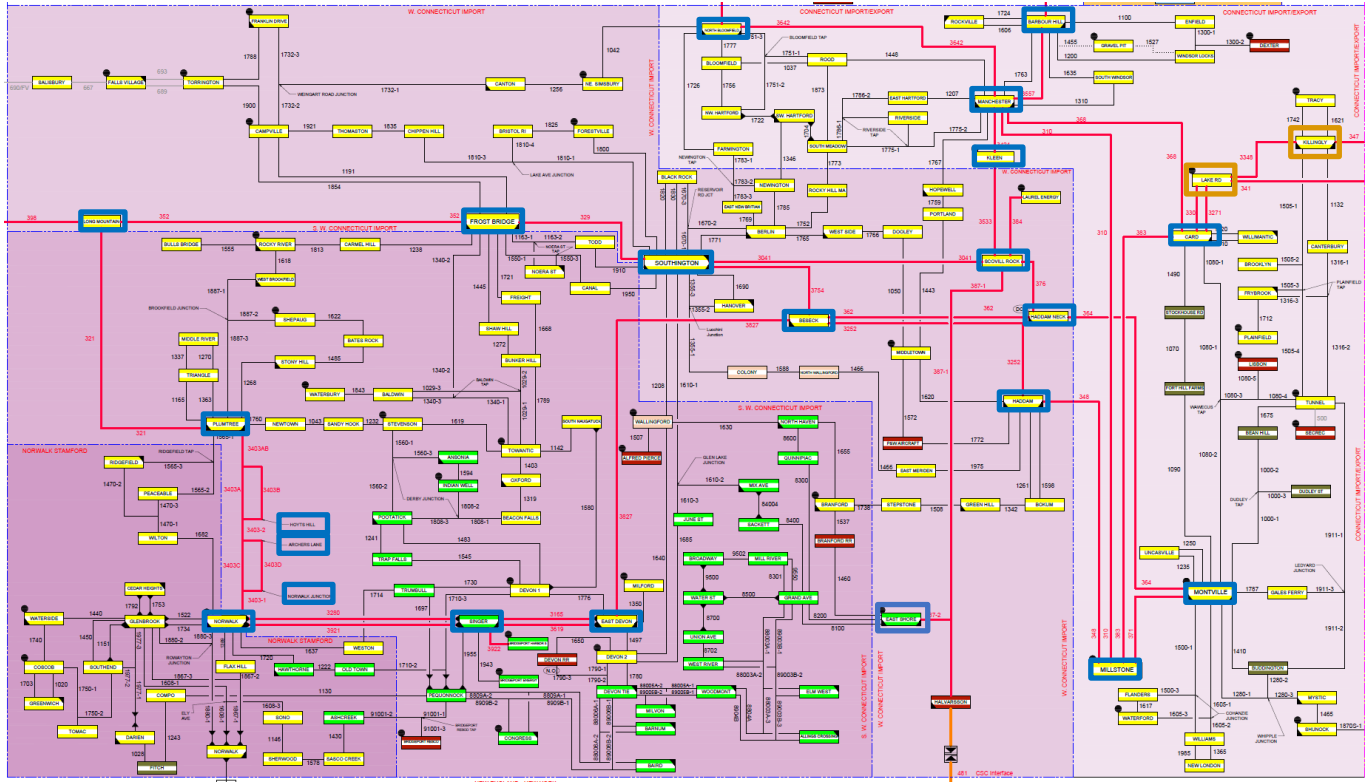
2034 Minimum Load Results

- No N-0 minimum load needs were identified
- N-1 high voltage violations were identified at 8 345 kV buses
  - Worst-case violations are between 1.049 and 1.051 PU
  - Archers Lane, Norwalk Junction, East Devon, Norwalk, Singer, East Shore (x3)
- N-1-1 high voltage violations were identified at 29 345 kV buses
  - Worst-case violations are between 1.052 and 1.063 PU
  - Violations occur at 27 PTF buses in CT and two in Western MA
- N-1-1 high voltage violations were identified at 21 115 kV
  - Worst-case violations are between 1.050 and 1.054 PU
  - Violations occur at buses in SWCT and Central CT near the East Shore substation
- The worst-case high voltage violations are seen for contingencies that result in the loss of certain shunt reactors
  - Additional details on these violations are included in Appendix B

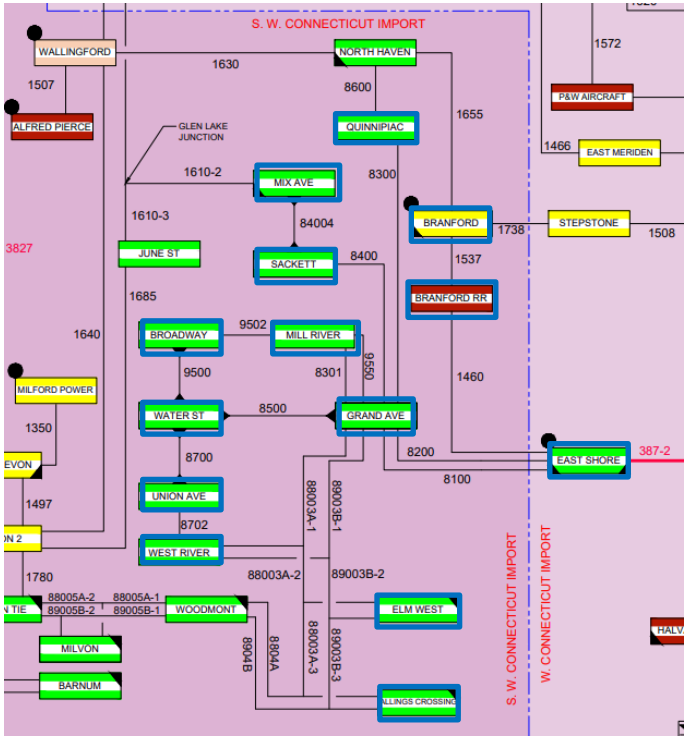
Minimum Load Time-Sensitivity Analysis

- All violations under nighttime minimum load conditions are automatically considered time-sensitive
  - There were no N-1 violations under nighttime minimum load conditions
  - There were 27 345 kV buses and 21 115 kV buses with N-1-1 voltage violations under nighttime conditions. These are time-sensitive
- For violations that only occur under daytime minimum load conditions, time-sensitivity analysis was performed on a 2028 daytime minimum load scenario
  - No high voltage violations were identified under 2028 Daytime Minimum conditions
- There are therefore eight 345 kV buses with non-time-sensitive N-1 high voltage violations, and two 345 kV buses with non-time-sensitive N-1-1 high voltage violations

345 kV Buses with High Voltage Violations



115 kV Buses with High Voltage Violations



115kV Time Sensitive

STEADY-STATE ASSESSMENT RESULTS

Peak Load

Summary of Peak Load Needs

- No N-0 peak load needs were identified
- There is one N-1 contingency that causes non-convergence in multiple dispatches. This contingency simulates the loss of two circuits that share common towers
  - Multiple N-1-1 contingency pairs that result in the loss of the same two circuits also lead to non-convergence in several dispatches
  - Non-convergence was observed in 2027 and 2034
- There are 5 115 kV elements with N-1 and N-1-1 thermal violations and 12 115 kV buses with low voltage violations that are identified as needs*
  - All violations were observed in 2027 and 2034
  - All violations occur near the ECT/SWRI border
- In summary, all the 115 kV needs in ECT/SWRI are time sensitive since they were observed in the time sensitive year (2027)
- The following slides identify the buses with thermal and low voltage violations under peak load conditions
  - Additional details on the worst-case violations, including the N-1 and N-1-1 contingency pairs that cause non-convergence, are included in Appendix B

* There is one element with an N-1-1 thermal overload that is not identified as a need. Additional discussion on this overload is provided on slides 27-29.

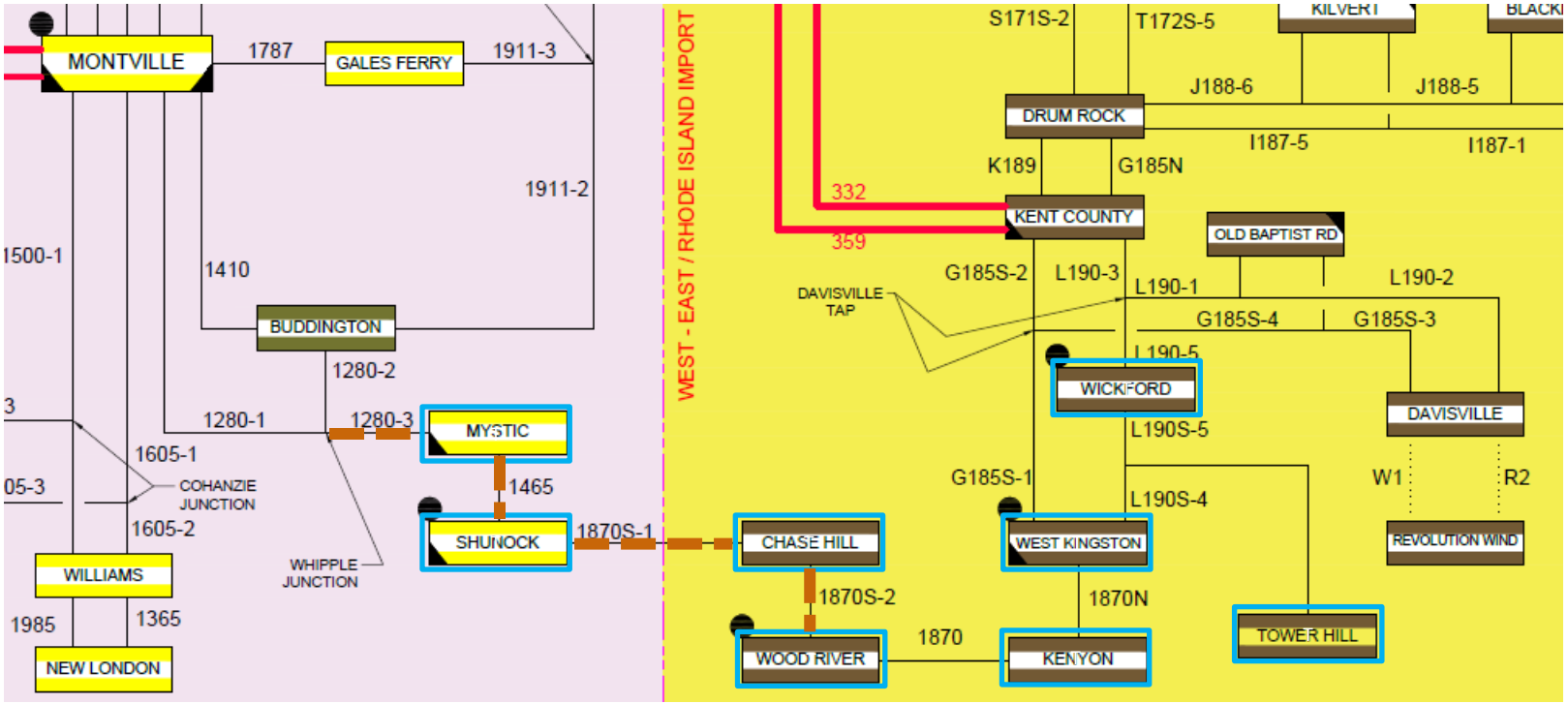
Five Thermal Overloads

Element Description (LTE Rating in MVA)	2034 Worst-Case N-1 Thermal Loading (% LTE)	2034 Worst-Case N-1-1 Thermal Loading (%)	2027 Worst-Case N-1 Thermal Loading (% LTE)	2027 Worst-Case N-1-1 Thermal Loading (% LTE)
Line 1870S Wood River to Chase Hill (218)	126.1	126.5	114.9	114.9
Line 1870S-NEP-1 Chase Hill to ECT/SWRI border (218)	149.7	150.0	133.0	133.0
Line 1870S-1_NU ECT/SWRI border to Shunock (278)	117.4	117.6	104.2	104.2
Line 1465 Shunock to Mystic (278)	114.7	115.1	103.0	103.0
Line 1280-3 Mystic to Whipple Junction (278)	132.1	140.6	119.2	132.4

Twelve Buses with Voltage Violations

Element Description (kV Level)	2034 N-1 Lowest Voltage (p.u.)	2034 N-1-1 Lowest Voltage (p.u)	2027 N-1 Lowest Voltage (p.u)	2027 N-1-1 Lowest Voltage (p.u)
Kenyon (115)	0.608	0.609	0.631	0.630
Tower Hill (115)	0.568	0.569	0.600	0.598
West Kingston (115)	0.584	0.584	0.611	0.609
Wood River (115)	0.638	0.638	0.656	0.655
West Kingston_85 (115)	0.584	0.584	0.611	0.609
West Kingston_90 (115)	0.584	0.584	0.611	0.609
Chase Hill (115)	0.676	0.675	0.688	0.686
Wickford Junction (115)	0.568	0.569	0.600	0.598
Mystic_1280 (115)	0.840	0.835	0.822	0.822
Mystic_1465 (115)	0.840	0.835	0.822	0.822
1465_Mystic_X (115)	0.822	0.817	0.808	0.807
Shunock (115)	0.732	0.730	0.735	0.734

Eastern CT / Southwestern RI Pocket

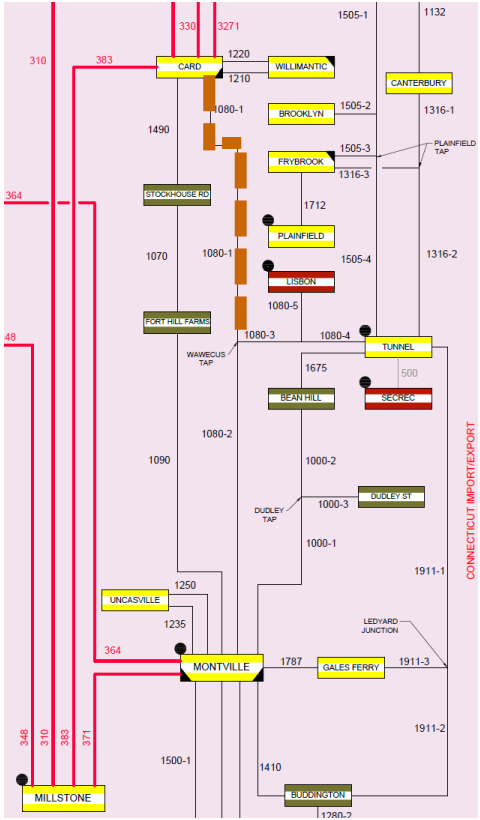


115kV Time Sensitive Voltage Violation

115 kV Time-sensitive overload

Line 1080 Overload

- The CT 2034 Needs Assessment identified an N-1-1 thermal overload on the 1080-1 line between Card and Wawecus Junction Tap
  - Loading in 2034 – 101.5 %
  - Loading in 2027 – 98.4 %
- This overload only shows up for one contingency pair, where the second contingency is a multiple-element contingency (breaker failure)
  - Of the various transmission planning criteria, NERC TPl-001, ISO-NE PP3 and NPCC Directory 1, only Directory 1 requires the evaluation of multi-element contingencies as second contingencies for N-1-1 testing



Non-time-sensitive overload

D1 Study-based Exclusion Process

- With the updated NPCC Regional Reliability Reference Criteria A-10 Classification of Bulk Power System Elements, published in 2020, a study-based exclusion process is available to exclude elements from Directory 1 applicability
  - Prior to this version of the A-10 document, once a bus was identified as a BPS bus, all elements connected to that bus were considered BPS elements and Directory 1 was applicable to these elements
  - This is an optional process to exclude elements from Directory 1 applicability

1080 Line – Candidate Element for D1 Exclusion

- ISO-NE originally planned on performing a comprehensive review of all 115 kV and 230 kV elements in New England for possible exclusion from D1 applicability
  - Due to resource constraints, this comprehensive effort did not occur
- For ongoing and upcoming Needs Assessments, ISO-NE will review the results of the Needs Assessment and make a determination on pursuing the D1 exclusion process
  - The ISO has identified the 1080 line as a candidate element for D1 exclusion and will not be identifying the overload on this line as a need in the CT 2034 NA
  - In parallel with the Solutions Study, the ISO will pursue the D1 study-based exclusion process for the 1080 line

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 32 and 33 describe the time-sensitive needs in the study area, explain why the needs are considered time-sensitive, and describe why the reliability needs were not identified earlier
  - Slide 34 includes a discussion of non-transmission options that were considered, but it was concluded they would not sufficiently address the time-sensitive needs

Summary of Minimum Load Time-Sensitive Needs

- There are 21 115 kV buses with N-1-1 high voltage violations that are considered time-sensitive
  - Branford (x2), East Shore, Grand Avenue, Quinnipiac, Sackett, Mix Avenue, Mill River (x3), Broadway (x2), Water St, West River (x3), Elm West (x2), Allings Crossing (x2), Union Avenue
- There are 27 345 kV buses with N-1-1 high voltages that are considered time-sensitive
  - Ludlow, Agawam, Card Street, Manchester, Barbour Hill, North Bloomfield, Kleen, Scoville Rock, Haddam Neck, Montvillle (x2), Millstone, Haddam, Beseck, Southington, Frost Bridge, Long Mountain, Plumtree, Hoyts Hill, Archers Lane, Norwalk Junction, East Devon, Norwalk, Singer, East Shore (x3)
- All time-sensitive needs are observed under nighttime minimum load conditions that are possible under current day conditions
  - Need-by-date will be date of publication of the Needs Assessment report
- These needs were seen in the nighttime minimum load cases used for the CT 2034 Needs Assessment and were not identified in past Needs Assessments due to:
  - Reduction in net load modeled in the CT subarea under nighttime minimum load conditions by 150 MW due to updated distribution of New England loads resulting in a slightly lower proportion of load in CT*

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

Summary of Peak Load Time-Sensitive Needs

- There were non-convergence scenarios under 2027 peak load conditions
- There are five 115 kV lines with N-1 and N-1-1 thermal overloads that are considered time-sensitive
  - Line 1870S (Wood River to Chase Hill)
  - Line 1870S-NEP-1 (Chase Hill to ECT/SWRI border)
  - Line 1870S-1_NU (ECT/SWRI border to Shunock)
  - Line 1465 (Shunock to Mystic)
  - Line 1280-3 (Mystic to Whipple Junction)
- There are twelve 115 kV buses with N-1 and N-1-1 low voltages violations that are considered time-sensitive
  - Kenyon, Tower Hill, West Kingston (x3), Wood River, Chase Hill, Wickford Junction, Mystic (x3), Shunock
- The need-by-date for all peak load time-sensitive is June 1, 2027*
- These needs are associated with system performance after the addition of the Wickford Junction substation, which was not included in the ECT 2029 Needs Assessment

* For additional details, see section 4.1.8.4 on Peak Load Level Needs in the Transmission Planning Technical Guide

Non-Transmission Options

- Non-transmission options which are already included in the system models are not adequate to relieve the reliability criteria violations in Connecticut for the time-sensitive years
  - Demand Resources (DR) through FCA 18, 2024 Energy Efficiency (EE), and 2024 Solar Photovoltaic (PV) forecasts were included in the models used to identify needs
  - 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 18, and all resources and ETUs with a binding contract as of the start of the Needs Assessment are already considered in the study

Determination

- Since the needs on slides 32 and 33 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
  - Avangrid
  - CMEEC
  - Eversource
  - Rhode Island Energy
- A reassessment of the non-time-sensitive minimum load needs will be performed after the conclusion of the Solutions Study

SUMMARY AND NEXT STEPS

Summary of Needs

	Peak Load	Minimum Load
2034 Horizon Year	• N-1 and N-1-1 non-convergence in ECT/SWRI • Five N-1 and N-1-1 thermal violations • 12 buses with N-1 and N-1-1 low voltage violations	• Eight buses with N-1 high voltage violations • 50 buses with N-1-1 high voltage violations
2027/2028 Time-sensitive Year	• N-1 and N-1-1 non-convergence in ECT/SWRI • Five N-1 and N-1-1 thermal violations • 12 buses with N-1 and N-1-1 low voltage violations	• 48 buses with N-1-1 high voltage violations*

* Note that 48 of the N-1-1 minimum load high voltages that occur in 2034 occur under nighttime minimum load conditions. 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 and the need-by-date will be the publication date of the Needs Assessment report.

Schedule

- Please submit comments on the materials in this presentation to pacmatters@iso-ne.com by April 3, 2025
- The draft Connecticut 2034 NA is expected to be posted by March 19, 2025
  - Stakeholder feedback on the report will be requested within 15 days of the posting of the draft report
- Complete the Connecticut 2034 NA and post the final report – April 2025
- Initiate the Connecticut 2034 Solutions Study to address the time-sensitive needs – Q2 2025

Questions

About the Presenter

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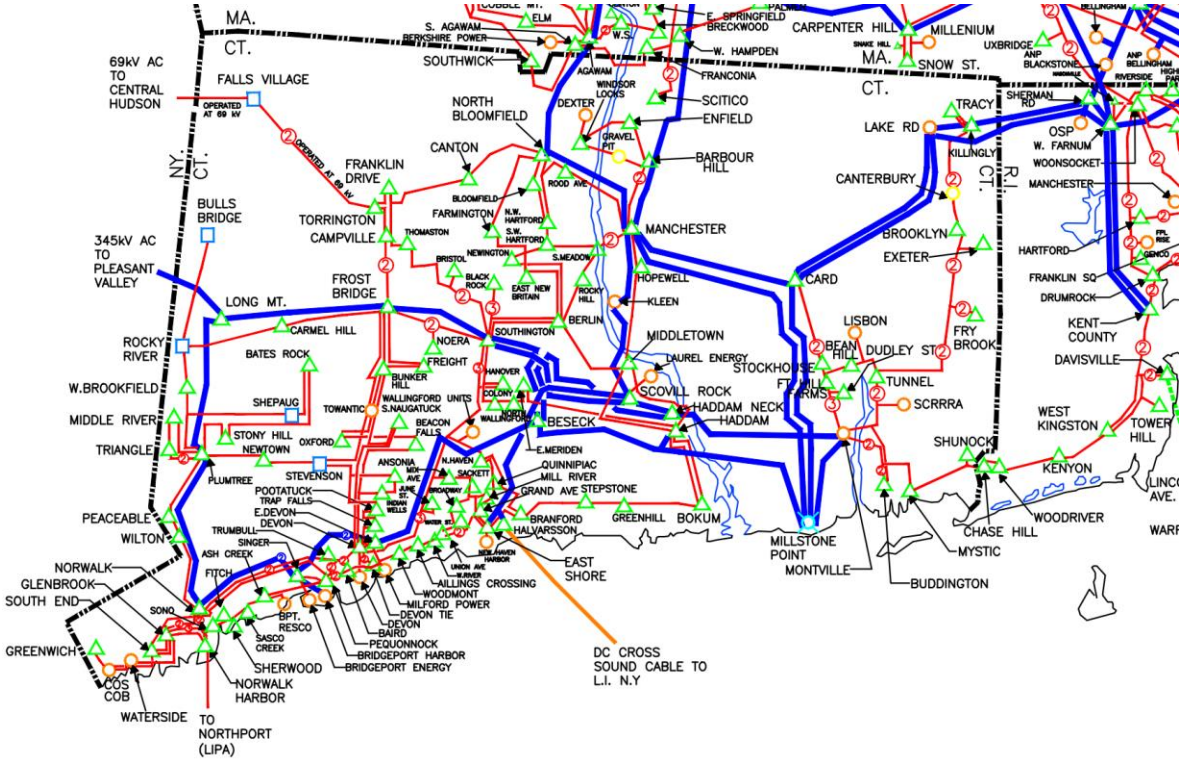
APPENDIX A

Background information

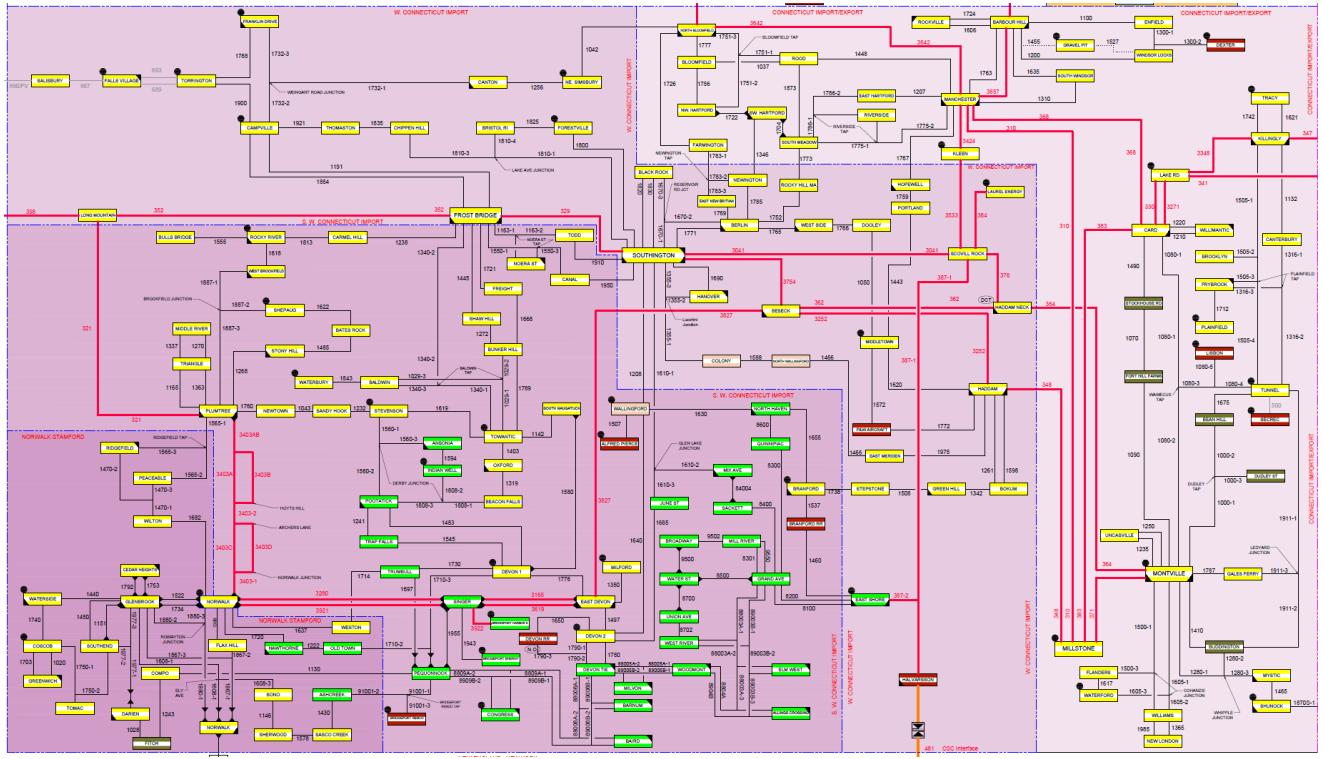
Background

- April 26, 2024: the ISO posted a Notice of Initiation of the Connecticut Needs Assessment (NA)
- July 17, 2024: the ISO presented the draft Connecticut 2034 Needs Assessment Scope of Work (SOW) to PAC
- August 20, 2024: the ISO posted the final Connecticut 2034 NA SOW and intermediate study files
- See the Connecticut Key Study Area of the ISO external website for applicable documents

Connecticut Area Geographical Map



Connecticut Area One Line Diagram



https://www.iso-ne.com/about/key-stats/maps-and-diagrams

APPENDIX B

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