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Greater Boston 2023 Needs Assessment and Solutions Study Status Update

Planning Advisory Committee Meeting

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Purpose

- Present the Greater Boston 2023 Needs Assessment using updated assumptions
- Provide an update on the Greater Boston Solutions Study

Agenda

- Greater Boston 2023 Needs Assessment
  - Objectives and study history
  - Comparison of assumptions to previous work
  - Results
- Solutions Study Update
  - Study history
  - Status
- Next Steps

GREATER BOSTON 2023 NEEDS ASSESSMENT
OBJECTIVES AND STUDY HISTORY

Needs Assessment Objectives

- The objectives of the assessment have remained the same over time
- Identify reliability based transmission needs in the Greater Boston study area while considering
  - Future load growth
  - A range of generation patterns and system stresses
    - One and two unit OOS design cases
    - Retirement cases with an additional unit OOS
  - Adherence to all applicable transmission planning standards
- The previous needs assessment (Greater Boston 2018 Needs Assessment) was limited to steady-state and short-circuit. The current assessment includes Bulk Power System (BPS) stability testing

Geographical Map of the Study Area

- Redacted

Study History

- Eleventh time the Greater Boston study has been to the PAC
  - First trip to the PAC was May 2008 with a presentation of the Needs Assessment Scope of Work
  - Steady state needs were presented in July 2009 (N-1) and in December 2009 (N-1-1) with a Needs Assessment report issued in July 2010
    - Short-circuit needs and critical load level assessment were presented at June 2011 PAC
  - A complete Greater Boston AC preferred solution was presented to PAC in March 2012
    - Agreed to examine a hybrid HVDC / AC alternative (SeaLink) proposal made by New Hampshire Transmission, LLC (NHT)
- Links to all the PAC presentations can be found in Appendix A to this presentation

GREATER BOSTON 2018 AND 2023 NEEDS ASSESSMENT ASSUMPTIONS

Comparison of Needs Assessment Assumptions

2018 versus 2023 Needs Assessment

Load | Generation | Transfers | Misc.

- 2018 Needs Assessment
  - Peak load cases only based on the 2008 CELT 90/10 Summer Forecast
    - 2013 New England peak load of 32,410 MW and Boston area load of 6,460 MW
    - 2018 New England peak load of 33,830 and Boston area load of 6,900 MW
  - Minimum load not studied
  - The NEMA/BOSTON load zone had approximately 300 MW of Passive Demand Side Management and Active Demand Resources through Forward Capacity Auction (FCA) 2

- 2023 Needs Assessment
  - Peak load cases based on the 2013 CELT 90/10 Summer Forecast
    - 2018 New England peak load of 32,615 MW and BOSTON RSP area load of 6,830 MW
    - 2023 New England peak load of 34,460 MW and BOSTON RSP area load of 7,210 MW
  - Minimum load cases with New England load of 8,500 MW
  - The NEMA/BOSTON load zone had approximately 430 MW of Active and Passive DR per of FCA 7
  - Additionally, Future EE was modeled as follows:
    - In 2018 : 124 MW
    - In 2023 : 369 MW

Comparison of Needs Assessment Assumptions

2018 versus 2023 Needs Assessment

Load | **Generation** | Transfers | Misc.

- 2018 Needs Assessment

Major Boston Generating Units > 100 MW	Qualified Capacity (FCA 2)	Com. Oper. Year	Age (yrs)
Mystic 7	566	1975	38
Mystic 8	682	2003	10
Mystic 9	678	2003	10
Salem 1	82	1952	61
Salem 2	80	1952	61
Salem 3	150	1958	55
Salem 4	431	1972	41
Kendall CT	157	2002	11

- 2023 Needs Assessment

Major Boston Generating Units > 100 MW	Qualified Capacity (FCA 7)	Com. Oper. Year	Age (yrs)
Mystic 7	578	1975	38
Mystic 8	691	2003	10
Mystic 9	703	2003	10
Footprint 1	337	2016	NA
Footprint 2	337	2016	NA
Kendall CT	154	2002	11

Comparison of Needs Assessment Assumptions

2018 versus 2023 Needs Assessment

Load | Generation | **Transfers** | Misc.

- 2018 Needs Assessment
  - System Stresses
    - High North / South and high SEMA / RI exports
    - High North / South and low SEMA / RI exports
    - Low North / South and high SEMA / RI exports
  - Boston Imports ranging from 4,565 to 6,023 MW depending on Boston unit dispatch in 2018
  - Fifteen design cases with one and two units OOS
  - Eight retirement cases with Salem Harbor and Mystic 7 additionally OOS
- 2023 Needs Assessment
  - System Stresses
    - High North / South and high SEMA / RI exports
    - High North / South and low SEMA / RI exports
    - Low North / South and high SEMA / RI exports
  - Boston Imports ranging from 3,250 to 5,080 MW depending on Boston unit dispatch in 2023
  - 34 design cases with one and two units OOS
  - 3 retirement cases with Mystic 7 additionally OOS

Comparison of Needs Assessment Assumptions

2018 versus 2023 Needs Assessment

Load | Generation | Transfers | **Misc.**

- 2018 Needs Assessment
  - Transmission projects with Proposed Plan Application approval as of summer 2008
  - The downtown Boston 345 kV and 115 kV cables used a mixture of 1-hour, 4-hour and 12-hour ratings
  - No de-rating performed for companion cable OOS
  - N-1-1 testing included only facilities where both ends were classified as Bulk Power System (BPS) as the first element out of service
- 2023 Needs Assessment
  - Transmission projects with Proposed Plan Application approval as of March 2013
    - Includes some Advanced GBWG solutions
  - The study is now using the 12-hour ratings for the Boston cables as specified in the ISO New England Planning Procedures
  - Derating performed for companion cable OOS
  - N-1-1 testing now includes all PTF facilities over 100 kV

Minimum Load Needs Assessment Assumptions

2023 Needs Assessment Only

- 8500 MW load plus losses in New England
- Load power factor assumptions
  - Boston load (NSTAR Only) = 0.968 p.u. lagging on low side of distribution transformer
  - Other New England loads = 0.998 leading power factor on low side of distribution transformer
- Generation Assumptions:
  - All major Boston generators OOS
  - Pilgrim and Seabrook OOS
  - Low eastern New England generation
  - Pumped hydro units offline
- Stresses
  - Low North – South in all cases
  - Three dispatches tested:
    - Phase 2 OOS high West-East
    - Phase 2 at 500 MW, high West-East
    - Phase 2 at 500 MW, lower West-East
- Contingencies Tested
  - 345 and 115 kV reactors in the Greater Boston area
  - 345/115 kV autotransformers in Greater Boston area
  - Selected overhead lines
- N-1 and N-1-1 testing
  - 25 initial elements OOS

Short-Circuit Needs Assessment Assumptions

2018 and 2023 Needs Assessment

- A short-circuit assessment was conducted to determine the fault current levels and breaker duty for the “as-planned” 2018 Greater Boston transmission system
- The base case included all approved transmission and generation projects
- Assessment was performed using the breaker rating module in Aspen
- Faults were simulated with an assumed pre-fault voltage “Flat” option of :
  - 1.05 p.u. for Public Service of New Hampshire (PSNH) system
  - 1.03 p.u. for NSTAR and National Grid system

Bulk Power System (Stability) Needs Assessment Assumptions

2023 Needs Assessment Only

- Utilized light load cases from the latest ISO database
- Five dispatches at different levels of Boston generation while stressing:
  - Maine interfaces
  - East to West interface
  - SEMA/RI interface
- BPS testing consists of 3-phase bus faults with remote clearing
  - Tested 63 stations throughout new England with the majority of stations being in and around the Greater Boston area

GREATER BOSTON 2018 AND 2023 NEEDS ASSESSMENT RESULTS

Peak Load Steady-State Results

- Results indicate there are numerous thermal overloads and voltage violations for N-0, N-1 and N-1-1 conditions

Thermal Only	N-1	N-1-1
Design	22	59
Additional Retirement Overloads	6	7

- The results are organized into the 8 sub-areas used in the 2018 Needs Assessment
  - The sub-areas are shown on the next page

Eight Greater Boston sub-area used in this study

- Redacted

Thermal Results

- For each thermal violation, the Boston Critical Load Level was determined
  - Used linear regression method to determine a critical load level
    - Assumes uniform load growth on a percentage basis throughout Boston
  - Most restrictive of N-1 or N-1-1 presented
  - Full listing of each element is presented in Appendix B
- The highest 2023 loading also provided

2023 Needs Assessment
345 kV Highest Loading and Critical Load Level Results

Element ID	Highest 2023 % LTE Loading	Boston Load Level
337	118	5702
394	110	6010
358 / 351	155	4197
346 / 365	154	5037

Element ID	Highest 2023 % LTE Loading	Boston Load Level
3162 / 3163	103	6198
326	117	5910
349	103	6180
324 / 372	125	5663

2023 Needs Assessment
Transformer Highest Loading and Critical Load Level Results

Element ID	Highest 2023 % LTE Loading	Boston Load Level
Sandy Pond T1	138	4387
Sandy Pond T2	104	6220
Woburn A	158	4869
Hyde Park A	105	6194
W. Walpole A	102	6285

2023 Needs Assessment
115 kV Critical Load Level Results

Element	Highest 2023 % LTE Loading	Boston Load Level
Y-151	103	6223
G-133	111	5965
391-508	120	5847
533-508	160	5048
211-514	207	3738
282-520 / 521	208	3569
329-510 / 511	144	4739
329-512 / 513	127	5062
385-510 / 511	173	4102
250-516 / 517	150	4395

Element	Highest 2023 % LTE Loading	Boston Load Level
110-510/511	149	4486
329-530 / 531	134	5562
496-528 / 529	111	6021
W23	212	3091
E-157	135	5314
W23W	265	1414
X-24W	184	3235
433-507	134	5399
282-507	110	6010
240-508	100	6288

2023 Needs Assessment
115 kV Critical Load Level Results

Element	Highest 2023 % LTE Loading	Boston Load Level
274-509	104	6157
455-507	137	5247
447-508 / 509	125	5964
146-502	140	5093
148-522XY	110	5999
F-158N	146	5067

Element	Highest 2023 % LTE Loading	Boston Load Level
F-158S	127	5703
Q-169	115	5899
T-146E	125	6184
T-146	109	6010
M-139	126	5438
N-140	113	5874
K-137E	105	6084

Minimum Load Results

- N-1 testing demonstrated no high voltages in the Greater Boston area
- N-1-1 testing demonstrated high voltages on the downtown Boston cable systems:
  - Highest voltage was at K Street at 1.078 p.u.
  - Ten 345 kV voltage violations
  - Twenty-four 115 kV voltage violations

Short-Circuit Results

- Redacted

Bulk Power System (Stability) Results

- Results indicate there are 17 stations that need to be upgraded to BPS
  - Fourteen stations in the Greater Boston Area
  - One each in Southeast Mass, Western Mass and Rhode Island
- BPS classification is due to system separation between Maine and the rest of New England
- The Solutions Study is considering
  - Reducing clearing times
  - Rebuilding the stations to BPS standards
  - Adding a dynamic VAR device to improve overall system performance

SOLUTIONS STUDY UPDATE

Primary Objective of the Solutions Study

- The primary objective of the Greater Boston Working Group is to resolve the needs identified in the 2023 Needs Assessment
- A complete Greater Boston AC preferred solution was presented to PAC in March 2012
  - Agreed to examine a hybrid HVDC / AC alternative (SeaLink) proposal made by New Hampshire Transmission, LLC (NHT)
- SeaLink is a hybrid solution consisting of a subset of the AC plan components and an HVDC submarine cable extending from Seabrook to Boston
  - SeaLink would primarily displace the new 345 kV AC transmission lines north of Boston
  - Includes subset of AC plan components in the south, west and downtown areas

Study Progress Since March 2012 PAC

- Substantial progress evaluating both the AC and the HVDC SeaLink plans has been made
- The peak load steady state portion of the assessment for both plans is complete
  - AC Plan
    - Determined that not all the AC components presented in March 2012 PAC are needed due to assumption changes in 2023 Needs Assessment
    - Considered several AC component alternatives
  - HVDC SeaLink
    - Uses several components from the AC plan

Study Progress Since March 2012 PAC, *cont.*

- Currently conducting for both plans
  - BPS screening
  - Short-circuit assessment
  - Minimum load assessment
- Started a comparative assessment of both plans that may include
  - Costs
  - Operational performance
  - Impact on relevant interfaces
  - Robustness through retirement scenarios
  - Other assessments as needed – congestion during construction or other implementation issues
- Expect to complete the assessment in Q4 this year

NEXT STEPS

Next Steps

- Post draft Greater Boston 2023 Needs Assessment report in Q3 2013 for stakeholder review
- Complete the testing on the AC and SeaLink HVDC plans
- Compare the AC and the SeaLink HVDC plans
- Choose between the AC and SeaLink HVDC plans for Greater Boston
- Present the Greater Boston solutions at PAC and post the draft Solutions Study for stakeholder review in Q4 2013

Questions

APPENDIX A

Links to Past Presentations

Study History

1. Needs Assessment scope presented to PAC in May 2008
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2008/may202008/index.html
2. Initial needs presented to PAC in January 2009
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2009/jan212009/index.html
3. Detailed preliminary needs and Notification of Solution Study discussed at PAC in July 2009
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2009/jul162009/index.html
4. Needs Assessment Status Update in December 2009
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2009/dec162009/index.html

Study History, *cont.*

5. Greater Boston Study Needs Assessment/Solution Study Status Update presented at PAC in December 2010
   - Grouped transmission solution alternatives into three areas
     - North of Boston
     - South of Boston
     - Central Area
   - Identified the preliminary preferred solutions for both the north and south areas
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2010/dec162010/index.html

Study History, *cont.*

6. Greater Boston Study Needs Assessment/Solution Study Status Update presented at PAC in June 2011
   - Completed the "Needs Assessment" phase by presenting short-circuit assessment and critical load level assessment for the Boston Area
   - Discussed the impact of Salem Harbor Non-Price Retirement
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2011/jun302011/index.html

Study History, *cont.*

7. Greater Boston Study Needs Assessment/Solution Study Status Update presented at PAC in January 2012
   - Grouped transmission solution alternatives for the Central Area into the Western Suburbs and Downtown Boston sub-Areas
   - Western Suburbs
     - Presented competing transmission alternatives
     - Provided feasibility, cost, and technical assessment
     - Identified the preliminary preferred solutions
   - Downtown Boston
     - Presented competing transmission alternatives
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2012/jan182012/index.html

Study History, *cont.*

8. Greater Boston Study Needs Assessment / Solution Study Status Update in March 2012
   - Downtown Boston
     - Presented competing transmission alternatives
     - Provided feasibility, cost, and technical assessment
     - Identified the preliminary preferred solutions
   - Presented the complete Greater Boston Solution
   - Agreed to consider an HVDC alternative from Seabrook into Boston
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2012/mar142012/index.html
9. Greater Boston Solution Study Update in February 2013
   - Presented the impact of assumption changes
   - Presented a preliminary transfer assessment based on the set of AC upgrades described in the March 2012 PAC presentation
   - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2013/feb122013/index.html

Study History, *cont.*

10. NSTAR Underground Cable Rating Update
    - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2013/apr242013/index.html

APPENDIX B

Critical Load Level Detailed Results

Redacted