



**Northeast
Utilities**

Northern Pass Transmission Project Proposed Plan Application

NEPOOL Reliability Committee Meeting

November 19, 2013

(Redacted Version)

Agenda

- Northern Pass Transmission Project Status
- Executive Project Summary
- PPA Study Results Summary
- PPA Study Scope of Work
- Project Details
- PPA Study Assumptions
- PJM/NYISO/HQ Study



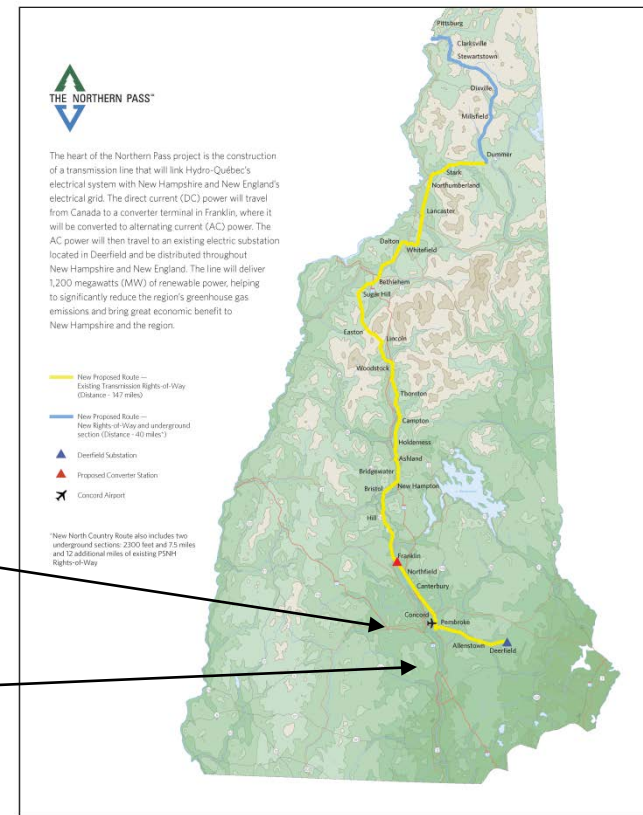
Northern Pass Transmission Project

- The Northern Pass Transmission Project planning is nearing completion, as are studies in support of the Proposed Plan Application (PPA)
- Northern Pass Elective Transmission Upgrade Application filed on October 13, 2010 under ISO-NE's Network Capability Interconnection Standard (NCIS).
- Today's presentation will provide details of the supporting studies that have been completed and their conclusions
 - Transmission upgrades identified through the studies will be reviewed
- NPT has provided updates to the Task Forces in March, September and October of 2012
- The Project expects to complete the Task Force approvals in November 2013 and ask for RC recommendation for an ISO-NE no adverse impact determination at the December 2013 RC meeting



Executive Project Summary

- The Northern Pass Transmission (NPT) Project is a planned High Voltage Direct Current (HVDC) link between Quebec, Canada and Franklin, New Hampshire.
- 1200 MW HVDC terminal at Franklin, NH (two 600 MW, 12-pulse line-commutated converters)
 - Power flows from Quebec to US
- ± 300 kV dc line – bipolar design with metallic return path
 - HQ Des Cantons Substation to the Quebec/US border ~ 47 miles
 - Quebec/US border at Pittsburg, NH to Franklin, NH ~153 miles (~ 8 miles underground)
- Single 345-kV ac transmission line to 345-kV Deerfield Substation ~ 34 miles
- In service date 2017



Study Results Summary

NPT tested for:

- Acceptable system response for system impact study work that includes Steady State (N-1, N-1-1 and BPS testing), Stability (N-1, N-1-1 and BPS testing), Short Circuit. SSTI screening indicated the need for more studies as part of the detailed design studies.
- Additional inter-regional testing that stressed NY and PJM regional transfers conducted to assess potential impacts for temporary loss-of-source in New England.
- Sensitivity stability analysis was completed for line-out and NY import scenarios.



Study Results Summary

NPT tested for:

- Study results from the System Impact Study indicated that Northern Pass Transmission would be able to interconnect with the New England system without a significant adverse impact with the following system upgrades:
 - Loop the 345-kV Buxton to Scobie Pond 391 line into Deerfield.
 - Upgrade 345-kV transmission lines 373 (Deerfield to Scobie Pond) and 391S (Deerfield to Scobie Pond) and line 326 (Scobie Pond to MA border) to increase thermal capabilities.
 - Add reactive compensation at Deerfield (200 Mvar (4 - 50Mvar)) and at Scobie Pond (210 Mvar (3 - 60 Mvar 1-30Mvar)).
 - Add two 345-kV series circuit breakers (9126 & 262) at Scobie Pond
 - Add a +400 Mvar SVC at the 345-kV Deerfield Substation in New Hampshire. 400 Mvar leading, 0 Mvar lagging, made up of 400 Mvar TCR and 400 Mvar MSC
 - Add a +100 Mvar SVC at the 345-kV Franklin Substation in New Hampshire. 100 Mvar leading, 0 Mvar lagging, made up of 100 Mvar TCR and 100 Mvar MSC
 - Franklin HVDC converter controls designed to damp power system oscillations based on frequency deviation measured at Franklin
 - Franklin HVDC 350 Mvar TSC (6 - 50 Mvar, 2 – 25 Mvar)



NPT Project Scope of Work

■ ETU Studies

- 7 (N-1) thermal and voltage Pre- and Post-Project dispatches: 5 peak load, 1 shoulder load and 1 minimum load: 70 contingency events tested.
 - 26 N-1-1 line out cases: selective line out conditions using D1, D2, D3, D5 and D7
- 8 (N-1) transient stability Pre- and Post-Project dispatches: 6 light load, 2 peak load, modified D1: 52 normal and extreme contingency faults tested.
 - Southern New England sensitivities: five 345-kV and five 115-kV extreme contingencies
 - N-1-1 Initial line out base cases include: 345-kV Scobie Pond – Sandy Pond 326 Line, 345-kV Buxton – Deerfield 385 Line, 345-kV Seabrook – Ward Hill 394 Line, 345-kV Scobie- Deerfield 373 line, 345-kV Surowiec – Buxton 374 line, 345-kV Scobie-Amherst 380 line
- Eastern interconnection (PJM, NYISO, HQ, ISO-NE) temporary loss of source stability response
- Short Circuit
- NPCC 115-kV steady-state and stability BPS testing: Garvins, Madbury, Pine Hill Rochester, [Medway, Lexington and Wampanoag stability only]
- SSTI screening analysis: Seabrook, Newington Energy, PSNH Newington, Merrimack, Granite Ridge, Yarmouth 1,2,3 and 4, Cape G4 and G5, Mystic G7 and G8, Schiller 4,5 and 6, Bucksport G4, Westbrook Energy, Maine Independent Station (MIS), and Pt. Lepreau
- Impact for the loss of ROW containing Phase II and NPT lines in Quebec
- Capacitor switching delta-voltage analyses



Project Scope of Work (Continued)

■ ETU Studies

- Franklin converter start-up and shut-down sequence analyses
- Sensitivity to queue generators #387 and #408
- Sensitivity to blocking and mask blocking of NPT
- Sensitivities to New York to New England stresses, including a New England South to North transfer



NPT Project One-Line Diagram

REDACTED



New 345-kV Franklin Station

- 345-kV ac air insulated station with HVdc converter terminal
- 750 Mvar of reactive compensation consisting of harmonic filters, shunt capacitors and reactors, and an +100 Mvar SVC
- An eight 345-kV circuit breaker ring bus configuration

REDACTED



345-kV Deerfield Substation

- Add two new 345-kV bays at the Deerfield Substation
 - Re-terminate the existing 345-kV Buxton – Scobie Pond line 391
 - Connect the new 345-kV Franklin – Deerfield line 3132
 - Add 200 Mvar reactive compensation (capacitive) and + 400 Mvar

REDACTED



345-kV Scobie Pond Substation

- Add 210 Mvar of shunt reactive compensation
- Add a series 345-kV circuit breaker to breaker 9126, and to breaker 262

REDACTED



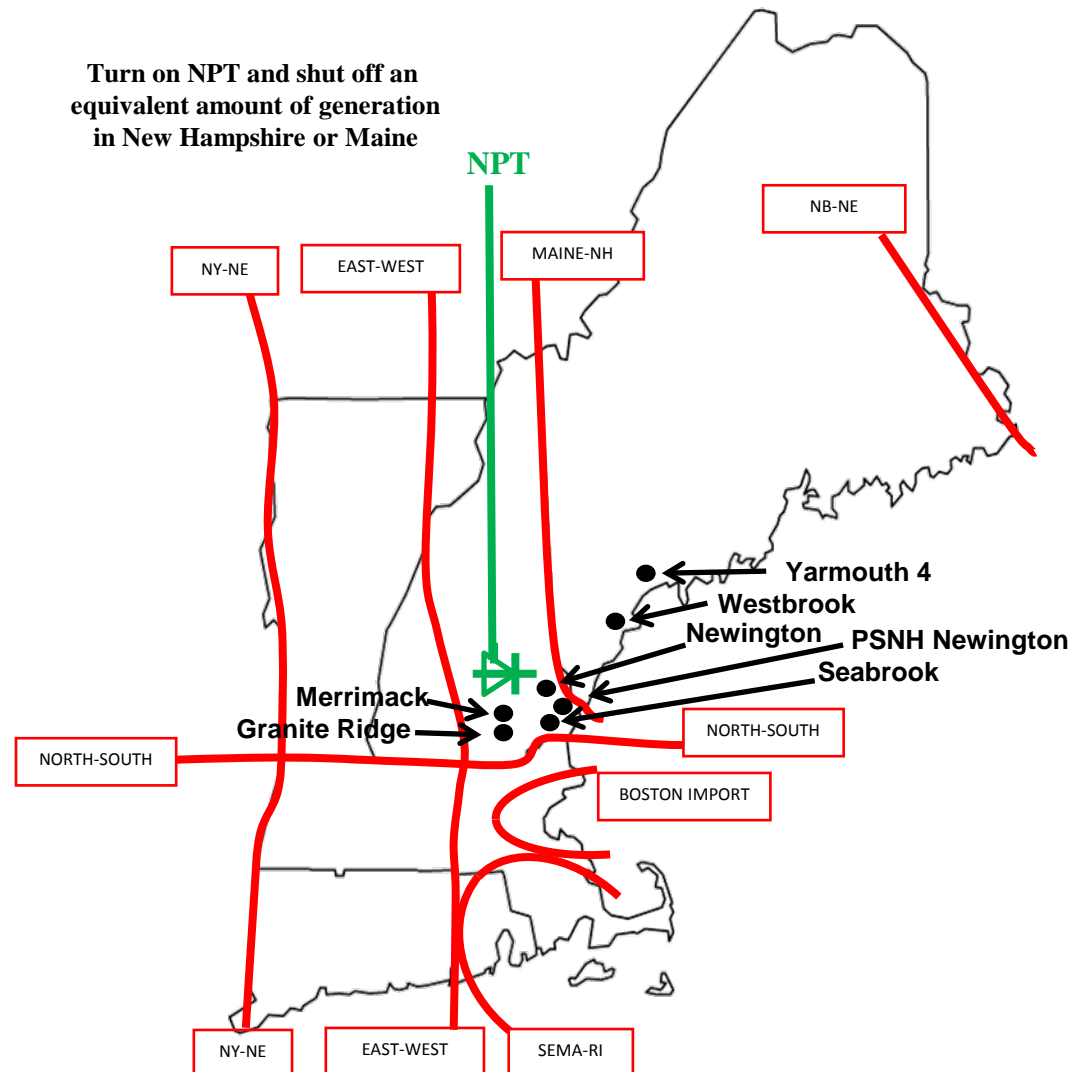
PPA Study Assumptions

2017 New England Load + Transmission Losses + DR (2013 CELT):

- Steady-State Thermal and Voltage Analyses (N-1 and N-1-1)
 - Peak load: 32,210 MW (100% Passive DR, 0% Active DR, 100% 90/10 CELT)
 - Shoulder load: 22,343 MW (75% Passive DR, 0% Active DR, 75% 50/50 CELT)
 - Minimum load: 8,500 MW (0% Passive DR, 0% Active DR)
- Stability Analysis
 - Peak load: 32,210 MW (100% Passive DR, 0% Active DR, 90/10 CELT)
 - Light load: 13,406 MW (45% Passive DR, 0% Active DR, 45% 50/50 CELT)
- Short Circuit Analysis
 - Including assessment of the Seabrook generator circuit breaker
- NPCC Bulk Power System (BPS) Analysis
 - Light Load
 - Peak load
- Sub-synchronous Torsional Interaction (SSTI) Screening



NPT Re-dispatch Resources for Steady State



Base Cases

Sensitivities were performed with New Brunswick power flows at maximum import and export.

Re-dispatch with NPT on against northern New England generation to maintain transfer levels within existing limits including ME-NH.

Different levels of sink for NB, northern New England, Boston/NEMA/SEMA, CT, western New England and NY.

Transfer levels between New York and New England tested high import and export.

Legend

● Generator available for re-dispatch



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Critical Energy Infrastructure has been redacted

Steady-State Dispatch Summary

Generation	Steady-State Base Case												2017 Shoulder Load	2017 Minimum Load		
	2017 Peak Load															
	D1		D2		D3		D4		D5		D6				D7	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post			Pre	Post
Northern Pass	0	1200	0	1200	0	1200	0	1200	0	1200	0	1200	0	1200		
Sandy Pond Ph.2	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	1500	1500	0	0		
MIS	339	339	339	339	0	0	339	339	525	525	169	169	0	0		
Bucksport	269	269	87	87	269	269	87	87	87	87	87	87	21	21		
Western ME Hydro	123	123	150	150	150	150	150	150	184	184	111	111	41	41		
Yarmouth 1-3	178	178	122	122	0	0	122	122	122	122	178	178	50	50		
Yarmouth 4	0	0	633	633	0	0	0	0	633	633	633	0	0	0		
Westbrook 1-3	529	529	529	529	0	0	529	529	174	0	174	174	0	0		
Comerford-Moore	271	271	319	319	168	168	319	319	311	311	0	0	24	24		
Merrimack	476	264	354	476	476	476	476	476	122	122	122	122	476	476		
Granite Ridge	734	734	734	734	734	734	734	734	734	734	487	343	0	0		
Schiller	52	52	52	52	159	159	52	52	159	159	107	107	0	159		
PSNH Newington G1	424	0	424	424	424	0	424	0	424	0	424	0	0	0		
Nwngtn Energy C1, C2, ST	559	0	0	0	559	0	559	0	559	0	0	0	0	0		
Seabrook	1361	1361	1361	0	1361	1143	1361	1143	0	0	1361	1361	1361	0		
VT Yankee	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Bearswamp	590	590	590	590	590	590	590	590	590	590	590	590	-300	-300		
Northeastfield	590	590	590	590	1180	1180	590	590	1180	1180	590	590	0	0		
Stonybrook	478	478	478	478	478	478	478	478	478	478	212	212	0	0		
Millenium	362	362	362	362	362	362	362	362	0	0	362	362	0	0		
Berkshire	274	274	274	274	274	274	274	274	274	274	274	274	0	0		
West Medway Jets	115	115	0	0	115	115	0	0	0	0	0	0	58	58		
Mass Power	285	285	285	285	285	285	285	285	285	285	285	285	0	0		
West Springfield	111	111	226	226	178	178	111	111	111	111	0	0	0	0		
Mystic	1964	1964	1964	1964	2250	2250	1964	1964	1964	1964	0	0	0	0		
Salem Harbor	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

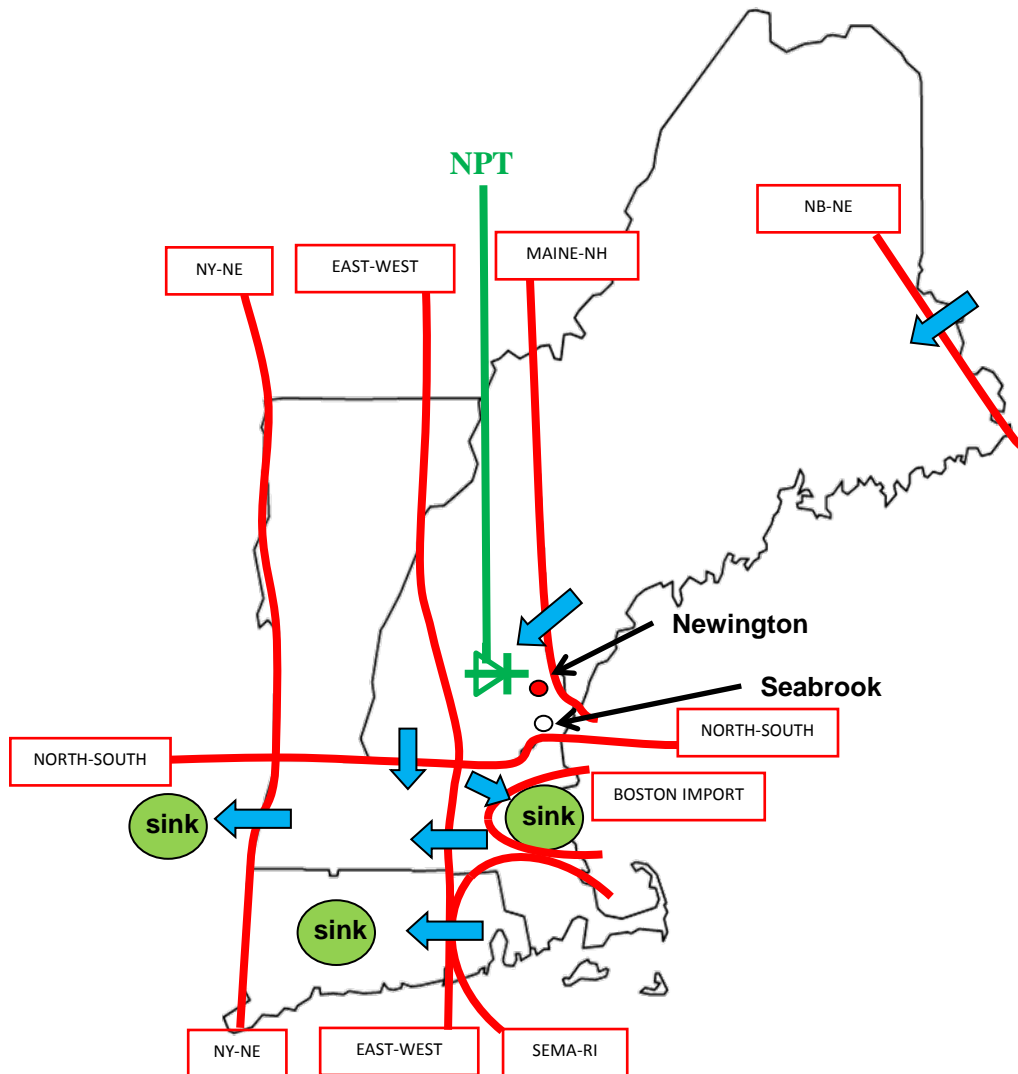


Steady-State Interface Summary

Steady-State Base Case														
Interface	2017 Peak Load										2017 Shoulder Load		2017 Minimum Load	
	D1		D2		D3		D4		D5		D6		D7	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
NB-NE	1003	1003	1003	1003	-300	-300	1004	1004	1003	1003	999	999	523	523
Orrington South	1371	1371	1197	1197	-303	-303	1198	1198	1415	1415	1229	1229	433	433
Surowiec South	1244	1244	1063	1063	-903	-903	1064	1064	1246	1205	1087	1088	168	182
ME-NH	1282	1282	1663	1663	-1588	-1588	1045	1045	1510	1298	1585	966	0	14
Y138 (Saco Valley PAR)	137	137	137	137	117	121	137	137	137	137	124	124	59	61
PV20 (NY-NE)	105	105	105	105	105	105	105	105	105	105	105	105	110	105
NNE Scobie + 394	2747	2873	2555	2385	230	203	2547	2529	1625	1618	2637	2770	1137	1031
North-South	2603	2611	2368	2319	-228	-214	2393	2396	1281	1290	2467	2482	1211	1216
NE East-West	3000	3021	1831	1842	306	331	1376	1397	1758	1766	3295	3296	447	451
Boston Import	4034	4033	4129	4128	3370	3370	4198	4197	4161	4161	3905	3905	1601	1599
NY-NE	-1260	-1277	-1204	-1213	-1203	-1229	1178	1157	-1263	-918	-1207	-1207	1219	1213
LI Cable	0	0	0	0	0	0	-1	-1	0	0	101	101	4	0
Cross Sound Cable	345	345	345	345	345	345	345	345	345	345	345	345	0	0



Steady-State D2

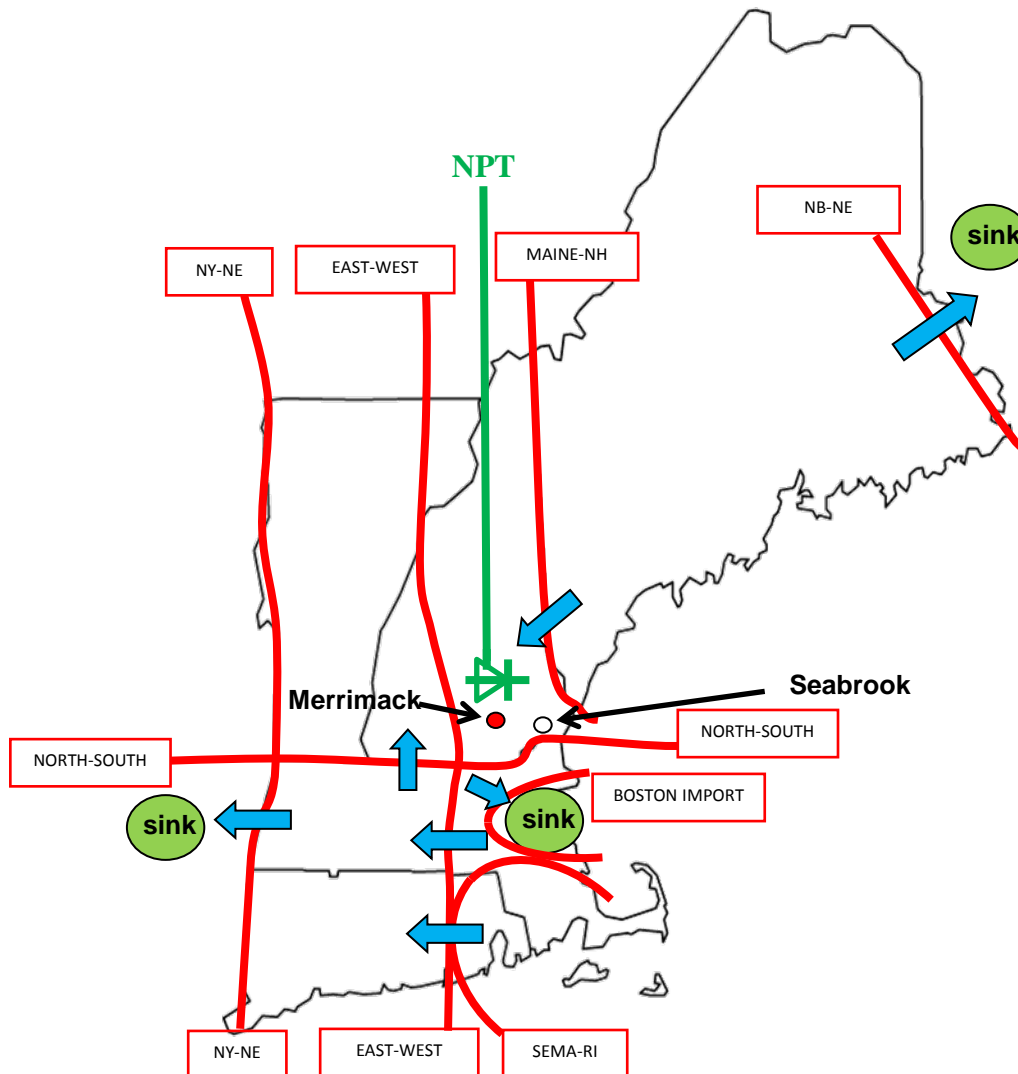


Case D2	
Interfaces	System Conditions
NB-NE = 1003 MW	<ul style="list-style-type: none"> • Peak Load • High ME-NH • High Boston Import • High SEMA-RI Export • NPT dispatched against Seabrook
ME-NH = 1663 MW	
North-South = 2320 MW	
Boston Import = 4127 MW	
SEMA-RI Export = 2992 MW	
East-West = 1842 MW	
NY-NE = -1215 MW	

Legend	
●	Generator turned on in full or partial
○	Generator turned off
◐	Generator turned off in partial



Steady-State D3



Case D3

Interfaces

System Conditions

NB-NE = -300 MW

- **Peak Load**

ME-NH = -1588 MW

- **NE Export to NB**

North-South = -214 MW

- **N.E South-North**

Boston Import = 3370 MW

- **Boston Import**

SEMA-RI Export = 3302 MW

- **SEMA-RI Export**

East-West = 331 MW

- **NPT dispatched against Seabrook**

NY-NE = -1229 MW

- **High NE – NY**

Legend



Generator turned on in full or partial



Generator turned off



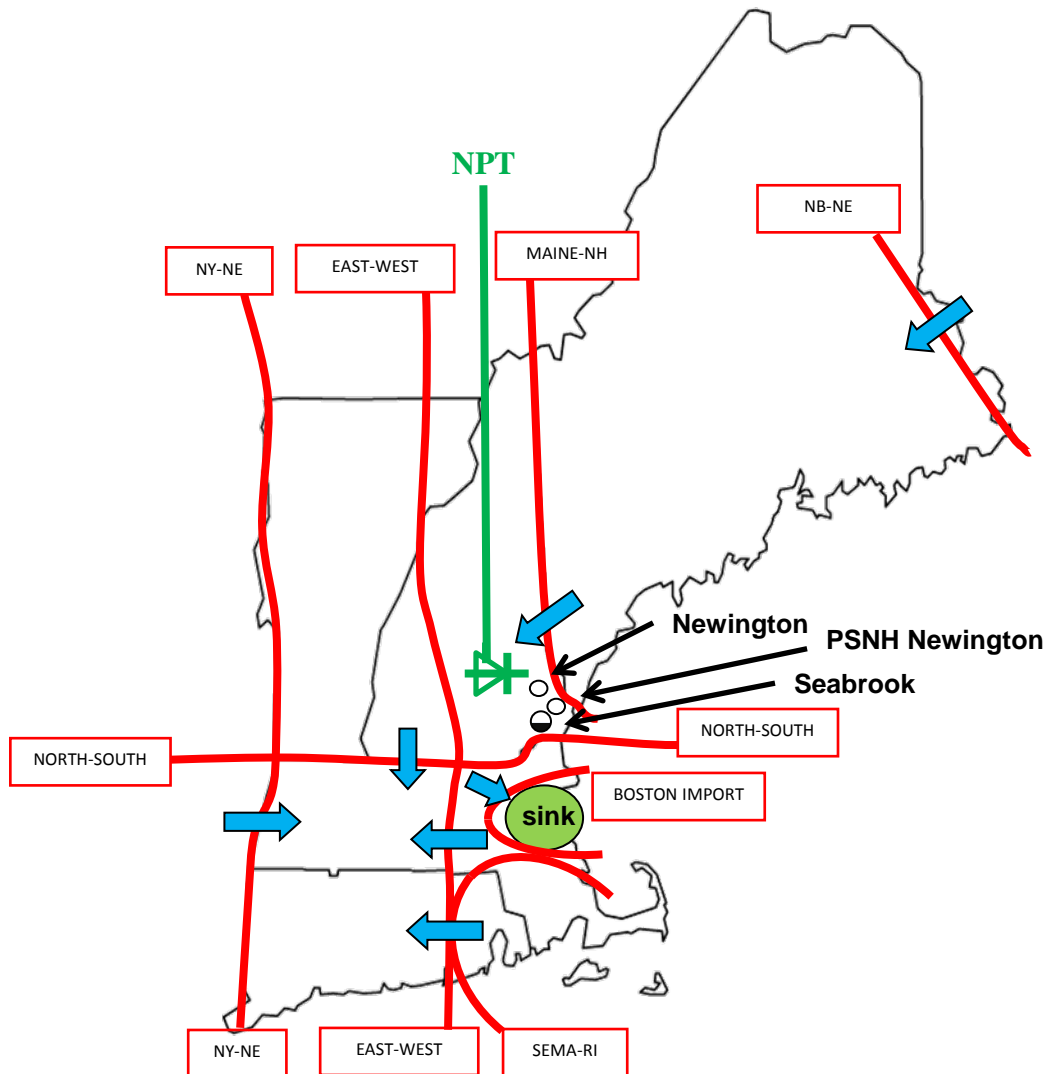
Generator turned off in partial



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Critical Energy Infrastructure has been redacted

Steady-State D4



Case D4

Interfaces

System Conditions

NB-NE = 1004 MW

- **Peak Load**

ME-NH = 1045 MW

- **High North-South**

North-South = 2396 MW

- **High Boston Import**

Boston Import = 4197 MW

SEMA-RI Export = 2605 MW

- **SEMA-RI Export**

East-West = 1397 MW

- **NPT dispatched against Newington**

NY-NE = 1157 MW

- **High NY – NE**

Legend



Generator turned on in full or partial



Generator turned off



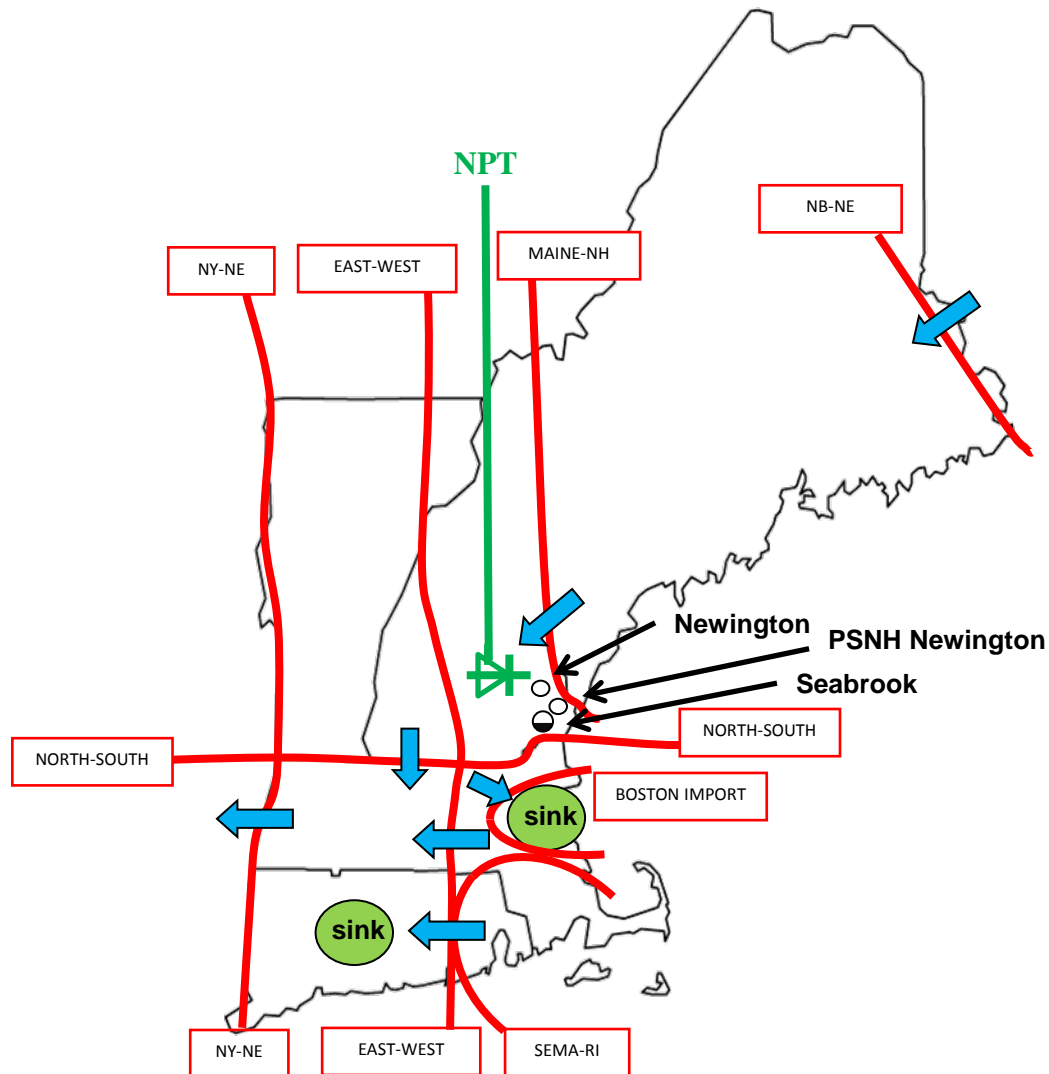
Generator turned off in partial



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Steady-State D5

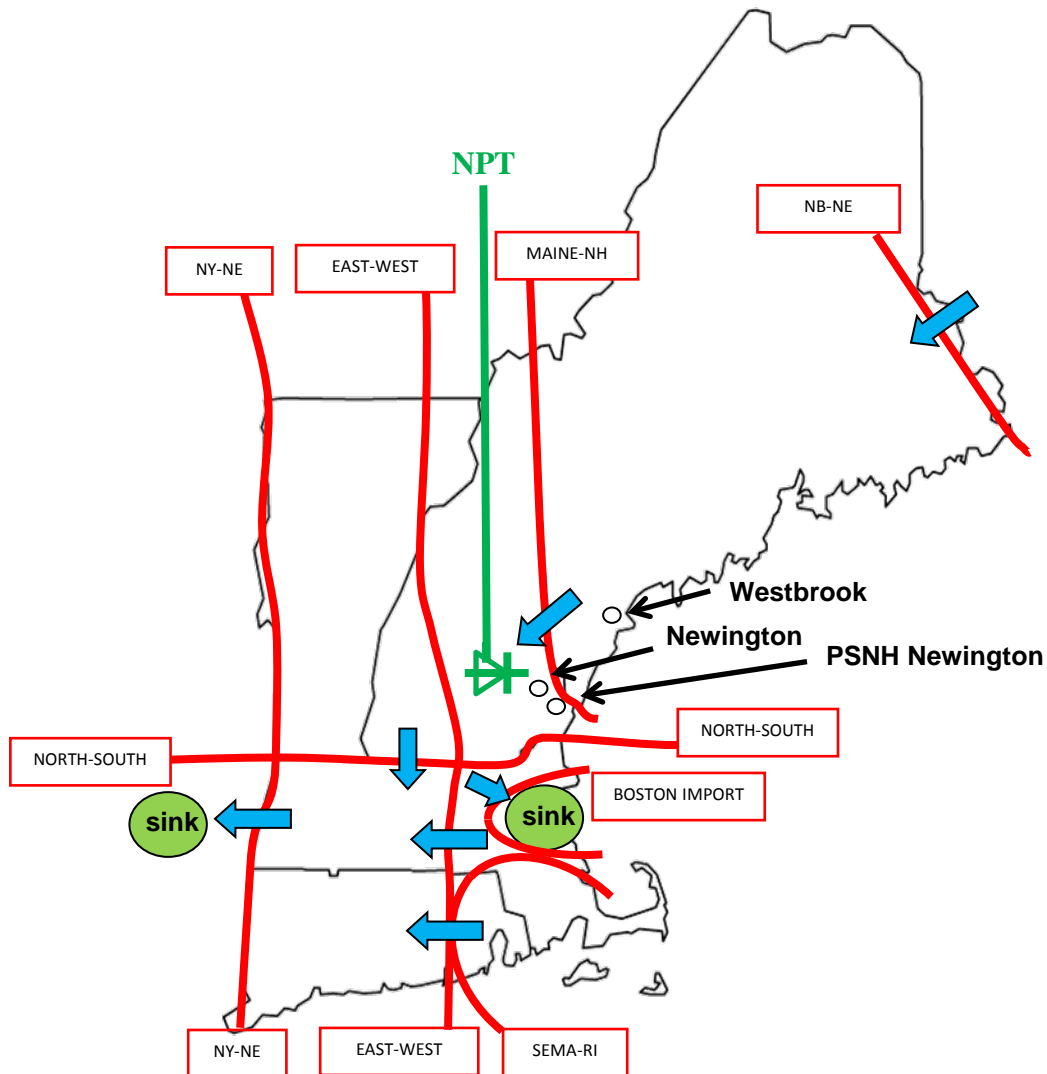


Case D5	
Interfaces	System Conditions
NB-NE = 1003 MW	<ul style="list-style-type: none"> • Peak Load • ME – NH • High Boston Import • High SEMA-RI Export • NPT dispatched against Newington and Westbrook
ME-NH = 1299 MW	
North-South = 1290 MW	
Boston Import = 4160 MW	
SEMA-RI Export = 3970 MW	
East-West = 1767 MW	
NY-NE = -919 MW	

Legend	
●	Generator turned on in full or partial
○	Generator turned off
◐	Generator turned off in partial



Steady-State D6

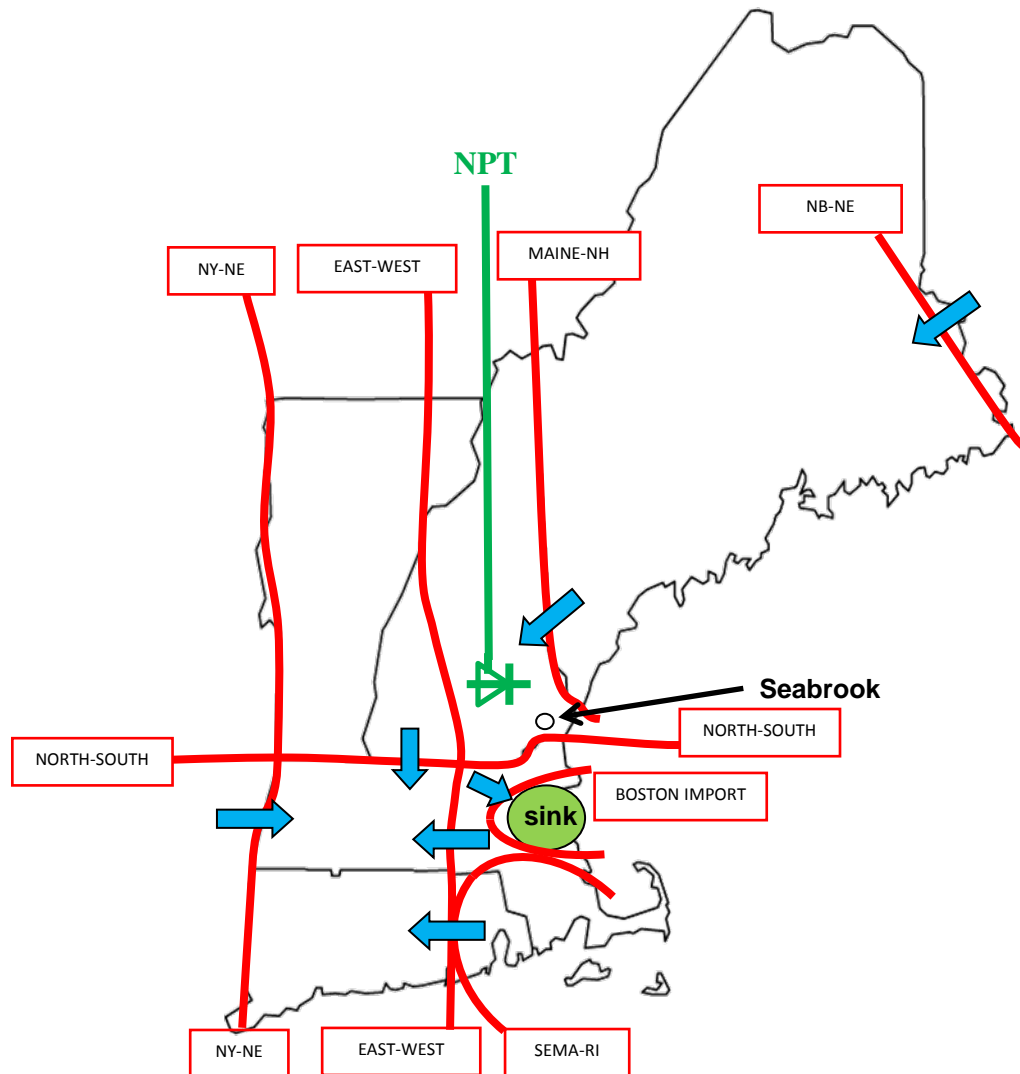


Case D6	
Interfaces	System Conditions
NB-NE = 999 MW	<ul style="list-style-type: none"> Shoulder Load High North-South High Boston Import High SEMA-RI Export NPT dispatched against PSNH Newington and Yarmouth
ME-NH = 966 MW	
North-South = 2482 MW	
Boston Import = 3905 MW	
SEMA-RI Export = 4149 MW	
East-West = 3296 MW	
NY-NE = -1207 MW	

Legend	
●	Generator turned on in full or partial
○	Generator turned off
◐	Generator turned off in partial



Steady-State D7



Case D7

Interfaces	System Conditions
NB-NE = 523 MW	<ul style="list-style-type: none"> Minimum Load Minimum interface flows except NY import
ME-NH = 14 MW	
North-South = 1216 MW	
Boston Import = 1599 MW	<ul style="list-style-type: none"> Light Boston Import
SEMA-RI Export = 1265 MW	<ul style="list-style-type: none"> Lower SEMA-RI Export
East-West = 451 MW	<ul style="list-style-type: none"> NPT dispatched against Seabrook
NY-NE = 1213 MW	

Legend

- Generator turned on in full or partial
- Generator turned off
- ◐ Generator turned off in partial

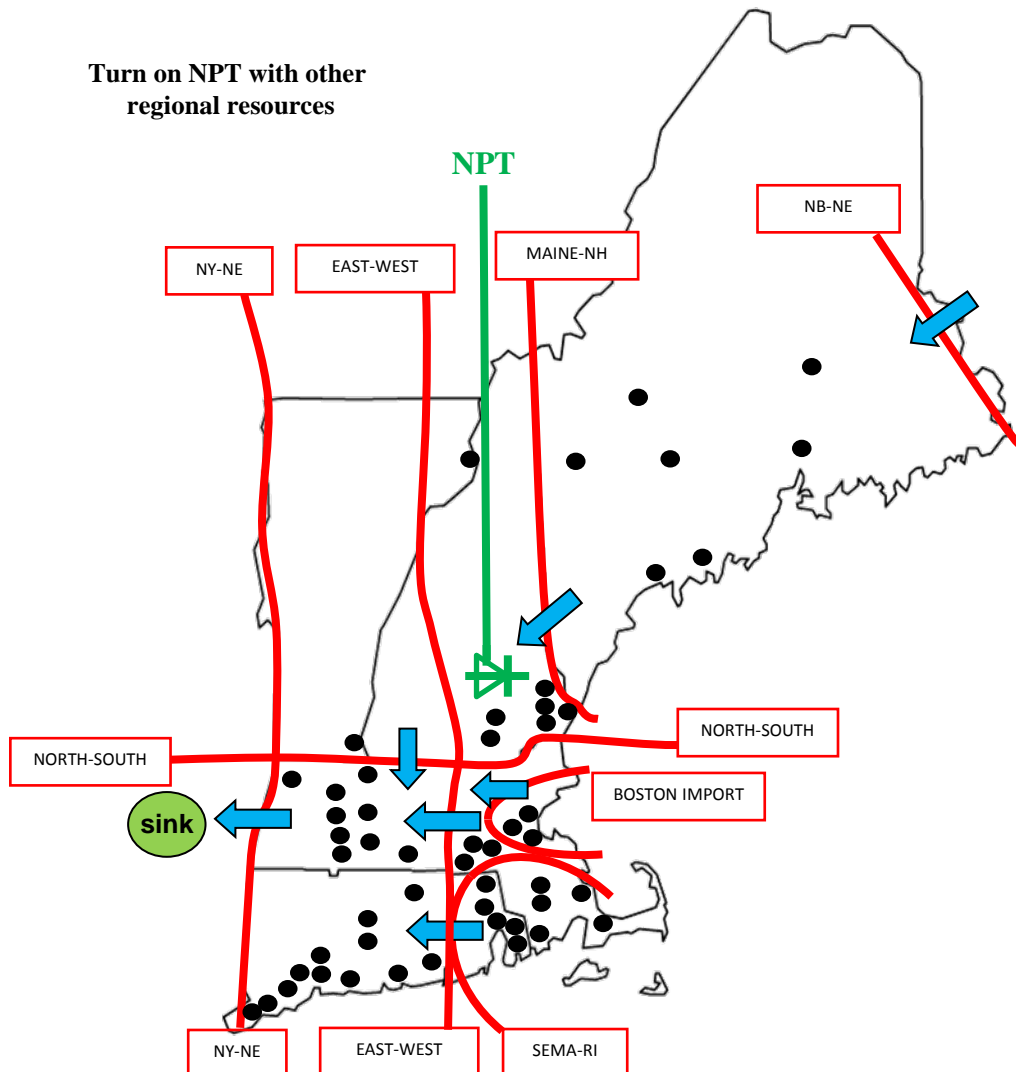


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NPT Dispatch Resources for Transient Stability

Turn on NPT with other regional resources



Base Cases

Sensitivities were performed with New Brunswick power flows at maximum import and export.

NPT dispatched with New England generation to maintain transfer levels within existing limits including ME-NH.

Different levels of sink for northern New England, Boston/NEMA/SEMA, CT and western New England.

Transfer levels between New York and New England tested high import and export.

Legend

● Generator available for dispatch



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Critical Energy Infrastructure has been redacted

Transient Stability Resource Summary

Transient Stability Base Case												
Generation	2017 Light Load						2017 Peak Load		NY-NE 2017 Light Load			
	D1	D2	D3	D4	D5	D6	D7	D8	C1	C2	C3	C4
MIS	0	0	0	0	571	0	571	571	0	0	0	0
BUCKSPORT	289	289	289	211	97	289	33	225	19	289	289	289
STETSON	83	83	83	0	57	83	29	29	0	57	83	83
W_ME_HYDRO	171	171	171	79	171	171	185	185	66	171	171	171
KIBBY-Q197-Q215	0	0	0	0	0	0	181	181	0	25	0	0
RUMFORD_PWR	281	281	281	186	281	281	281	281	0	281	281	281
VERSO_COGEN	163	163	163	109	163	163	163	163	0	163	163	163
YARMOUTH1-3	56	0	125	125	181	56	181	181	0	56	56	0
YARMOUTH4	0	0	0	0	0	0	638	638	0	0	0	0
WESTBROOK	554	0	0	0	0	554	554	554	0	554	554	0
CMRFRD-MOORE	157	157	157	349	157	157	253	348	165	157	70	70
MERRIMACK	0	0	0	502	0	0	501	501	0	0	0	0
GRANITE_RDG	0	0	0	823	0	0	823	823	0	0	0	0
SCHILLER	108	0	161	0	0	161	160	160	161	161	108	108
PSNH_NEWINGTON	0	0	438	0	0	0	438	438	0	0	0	0
NWNTN_ENERGY	572	0	572	0	0	526	278	572	0	572	571	0
SEABROOK	0	1317	0	0	1317	0	0	0	0	0	0	0
VT_YANKEE	0	0	0	0	0	0	0	0	0	0	0	0

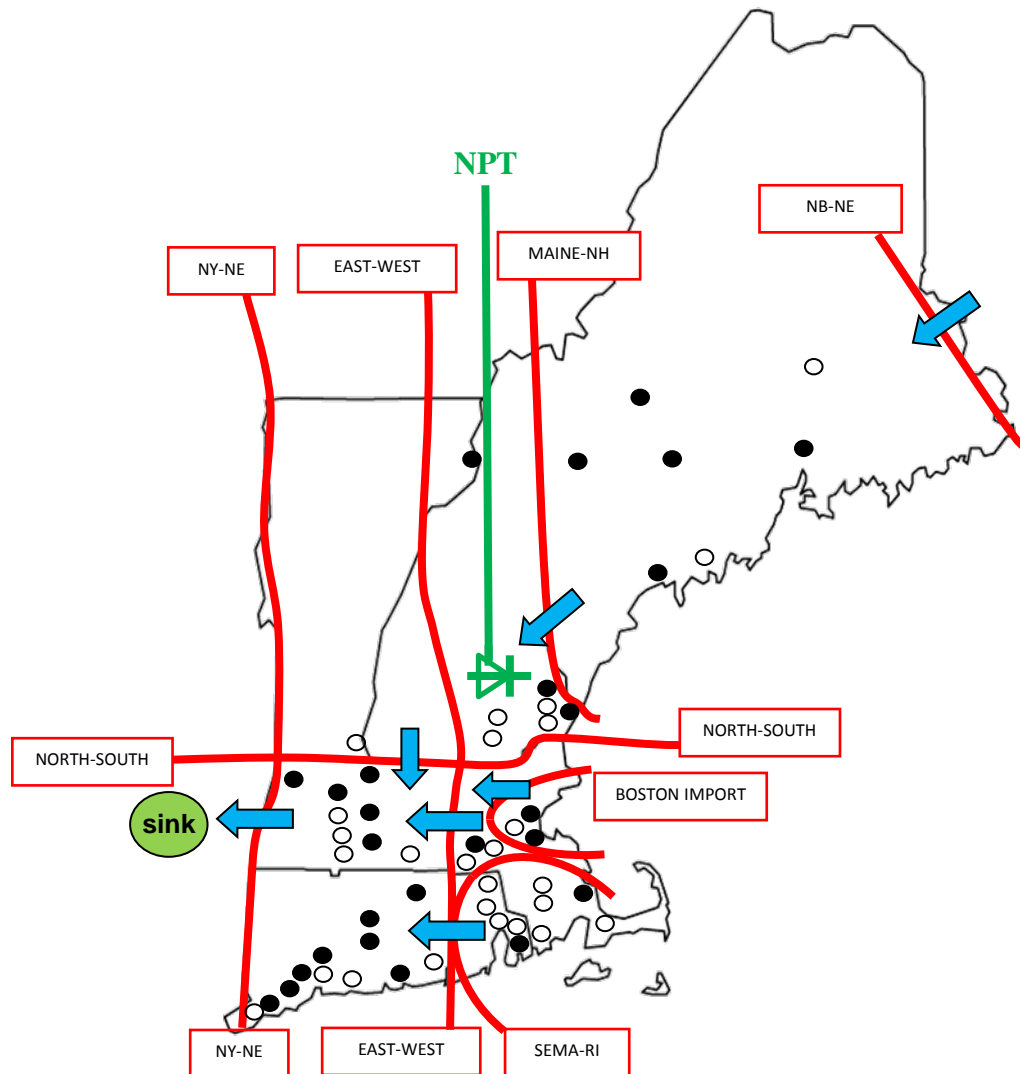


Transient Stability Interface Summary

Transient Stability Base Case												
Interface	2017 Light Load						2017 Peak Load		NY-NE 2017 Light Load			
	D1	D2	D3	D4	D5	D6	D7	D8	C1	C2	C3	C4
Northern Pass	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
NB-NE	1005	1005	1005	1005	-570	1005	1004	-310	-549	1005	1005	1005
Orrington South	1402	1402	1402	1248	185	1406	1427	370	-608	1379	1402	1402
Surowiec South	1606	1605	1605	1233	464	1609	1329	305	-1077	1607	1605	1605
Maine-NH	2004	1363	1523	1170	406	2008	2023	1018	-1293	2006	2003	1404
Saco PAR	67	67	67	67	67	67	90	90	67	67	67	67
Seabrook South	796	1368	935	347	1140	839	918	845	-161	854	939	472
NNE-Scobie+394	3025	3143	3037	1948	2274	3010	2999	2387	-440	3045	3039	1964
N.VT. Import	60	60	60	56	60	60	271	269	67	61	67	68
NE North-South	2623	2638	2633	2705	1707	2639	2653	2058	-1110	2675	2574	1429
NE East-West	3504	3502	3499	3513	3504	3516	3534	3515	-1017	3512	-955	-980
Sandy Pd South	850	745	823	642	351	778	2602	2319	-446	867	1087	640
Boston Import	-16	-13	-16	-19	-16	2021	3427	3426	2408	1510	2426	2233
Tremont East	175	173	173	173	173	177	-687	-686	-990	-989	-987	-986
SEMA Export	442	-242	-242	-264	-232	765	1017	1035	1685	1582	636	700
SEMA-RI Export	1380	1365	1365	1331	2297	3464	3508	4002	3103	2881	-622	391
CT Import	613	599	598	635	603	631	3155	3156	343	2120	128	127
SWCT Import	520	816	816	1059	816	816	2945	2943	836	1138	1185	1184
Norwalk-Stamfd	782	782	782	781	782	782	1274	1274	781	781	781	781
Ny-NE	-1192	-1204	-1201	-1201	-1210	-1193	-1209	-1196	1215	1186	1195	1216
Norwalk-Northpt	201	201	201	201	201	201	0	0	201	201	201	201
Cross Sound Cable	344	344	344	344	344	344	344	344	344	344	344	344



Transient Stability Dispatch - D1

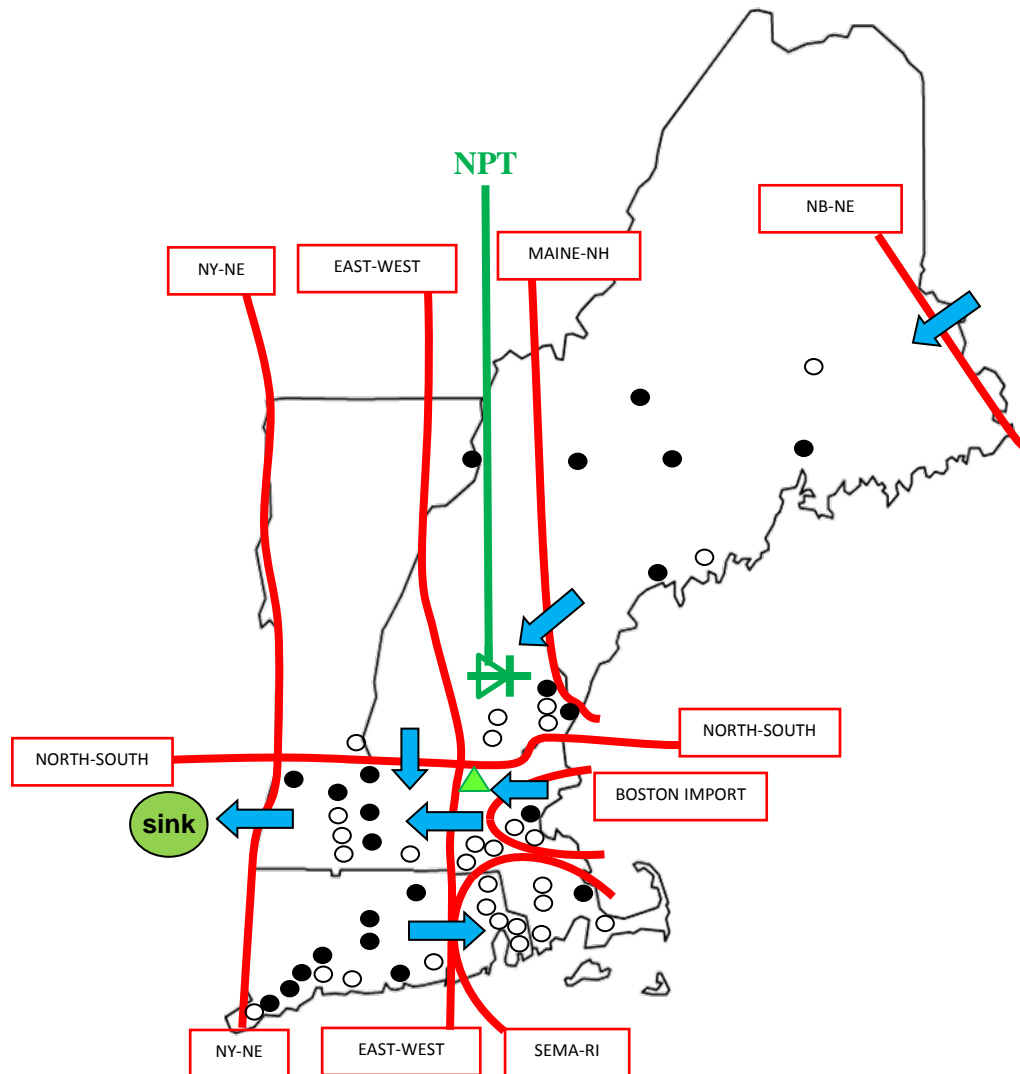


Case D1	
Interfaces	System Conditions
NB-NE = 1005 MW	<ul style="list-style-type: none"> • Light Load • High ME-NH • Boston Export • SEMA-RI Export • High East-West to New York Export
ME-NH = 2004 MW	
NNE-Scobie+394 = 3025 MW	
Boston Import = -16 MW	
SEMA-RI Export = 1380 MW	
East-West = 3507 MW	
NY-NE = -1192 MW	

Legend	
●	Generator turned on in full or partial
○	Generator turned off



Transient Stability Dispatch – Modified D1



Case Modified D1

Interfaces

System Conditions

NB-NE = 1005 MW

ME-NH = 2004 MW

NNE-Scobie+394 = 3015 MW

Boston Import = -16 MW

SEMA-RI Export = -580 MW

East-West = 3516 MW

NY-NE = -1124 MW

- **Light Load**
- **High ME-NH**
- **Boston Export**
- **SEMA-RI Import**
- **High East-West to New York Export**

Legend

● Generator turned on in full or partial

○ Generator turned off

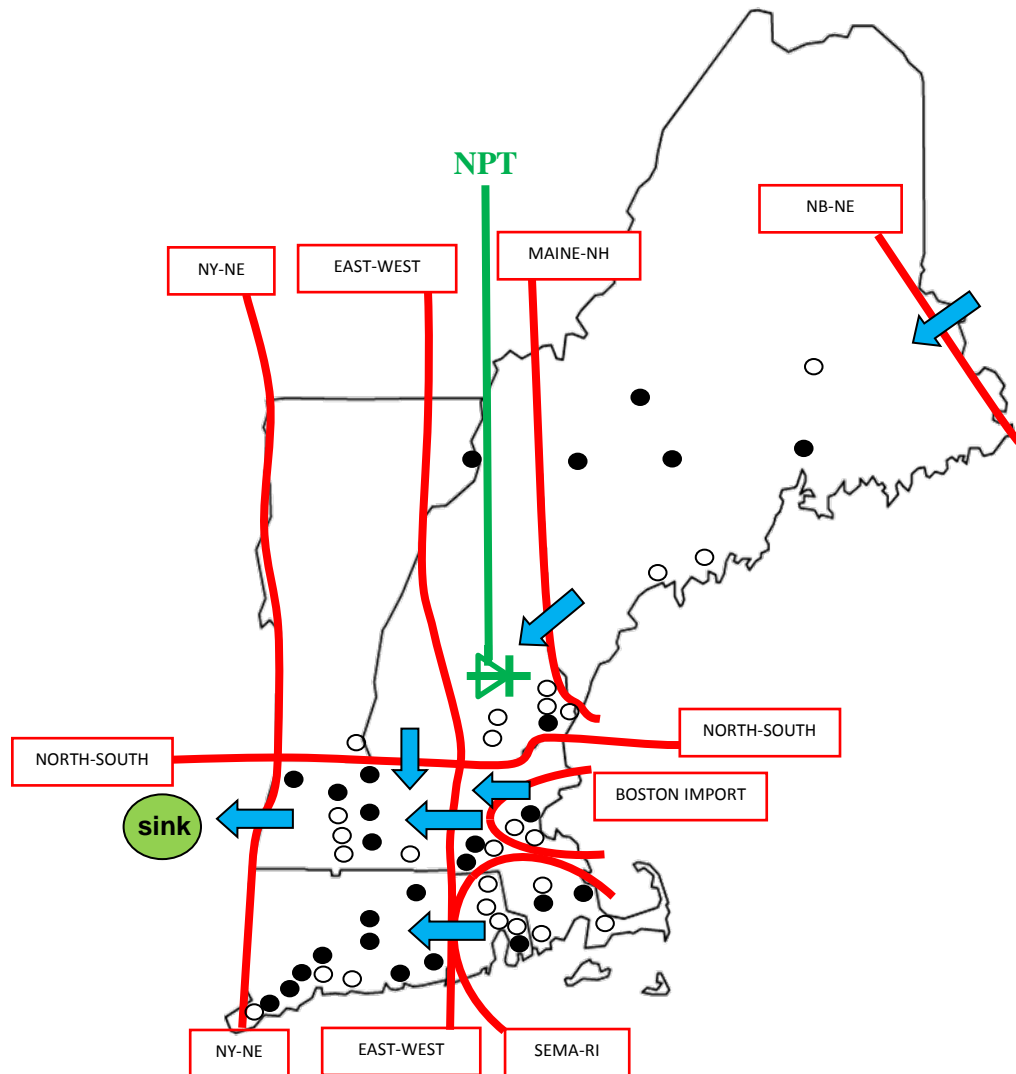
▲ Sandy Pond Phase II on at 2000 MW



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Critical Energy Infrastructure has been redacted

Transient Stability Dispatch – D2



Case D2

Interfaces

NB-NE = 1005 MW

ME-NH = 1363 MW

NNE-Scobie+394 = 3143 MW

Boston Import = -13 MW

SEMA-RI Export = 1365 MW

East-West = 3505 MW

NY-NE = -1204 MW

System Conditions

- **Light Load**
- **High NNE-Scobie +394**
- **SEMA-RI Export**
- **High East-West**
- **High NE to NY Export**

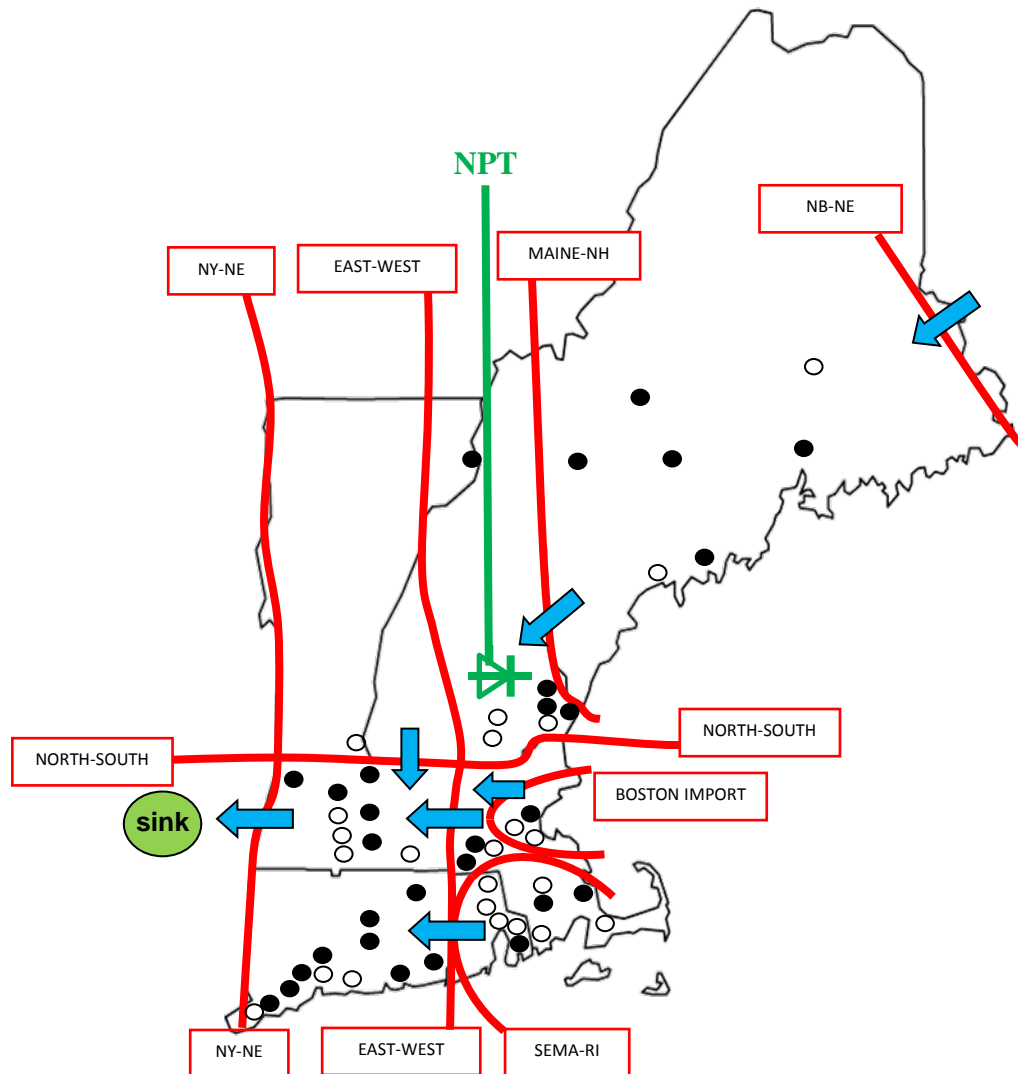
Legend

● Generator turned on in full or partial

○ Generator turned off



Transient Stability Dispatch – D3



Case D3

Interfaces

NB-NE = 1005 MW

ME-NH = 1523 MW

NNE-Scobie+394 = 3037 MW

Boston Import = -16 MW

SEMA-RI Export = 1365 MW

East-West = 3502 MW

NY-NE = -1201 MW

System Conditions

- **Light Load**
- **High NNE-Scobie +394**
- **SEMA-RI Export**
- **High East-West**
- **High NE to New York Export**

Legend

● Generator turned on in full or partial

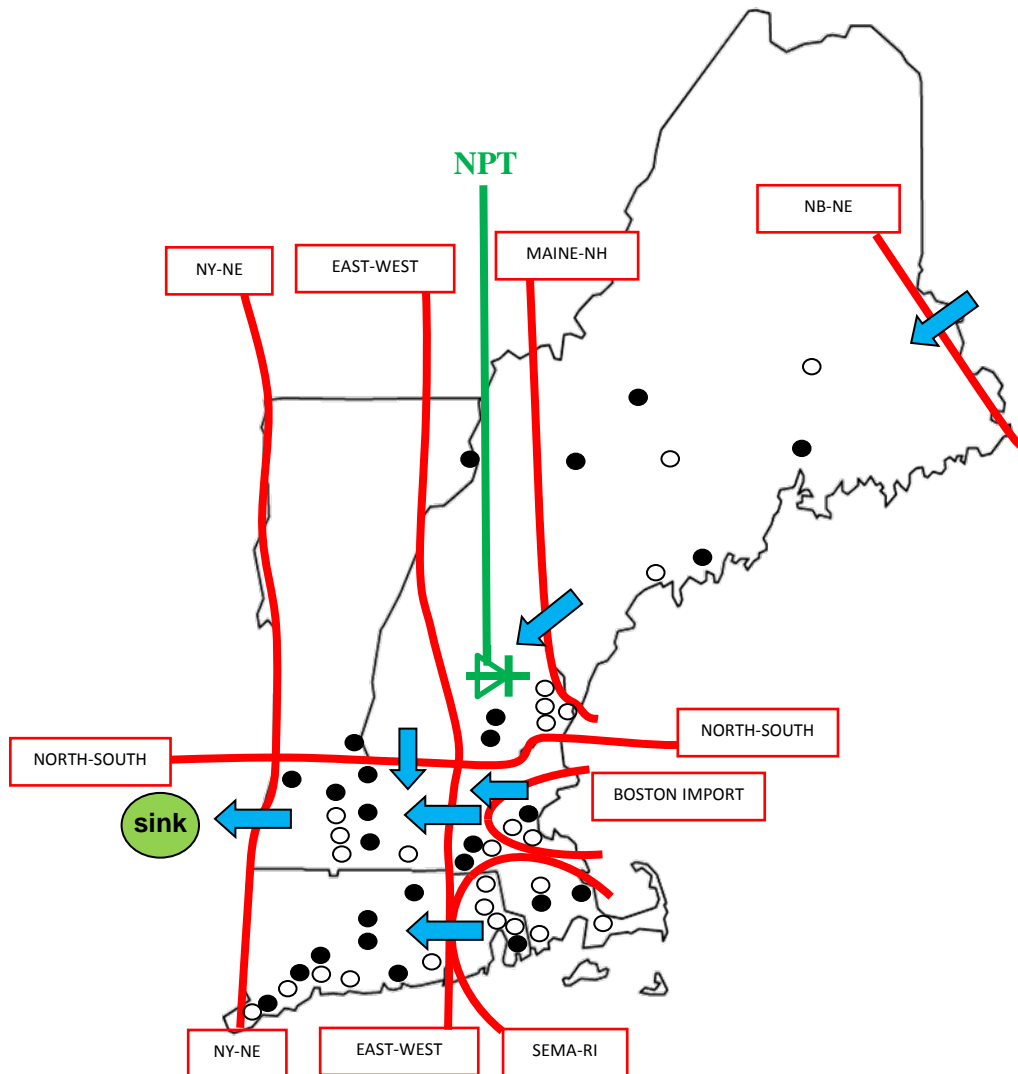
○ Generator turned off



**Northeast
Utilities**

Critical Energy Infrastructure has been redacted

Transient Stability Dispatch – D4



Case D4

Interfaces

System Conditions

NB-NE = 1005 MW

ME-NH = 1170 MW

NNE-Scobie+394 = 1948 MW

Boston Import = -19 MW

SEMA-RI Export = 1331 MW

East-West = 3513 MW

NY-NE = -1201 MW

- **Light Load**
- **High North-South**
- **SEMA-RI Export**
- **High East-West**
- **High NE to New York Export**

Legend

● Generator turned on in full or partial

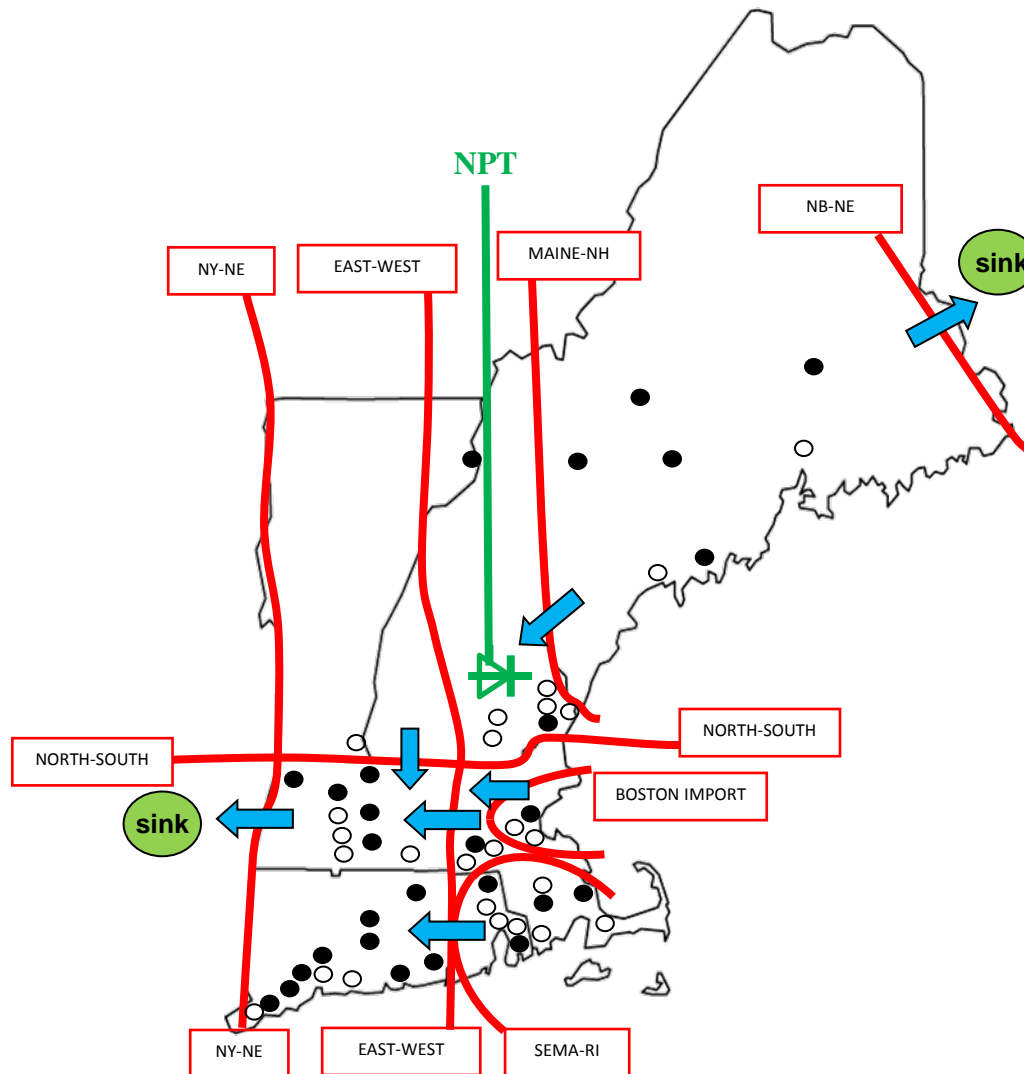
○ Generator turned off



**Northeast
Utilities**

Critical Energy Infrastructure has been redacted

Transient Stability Dispatch – D5



Case D5

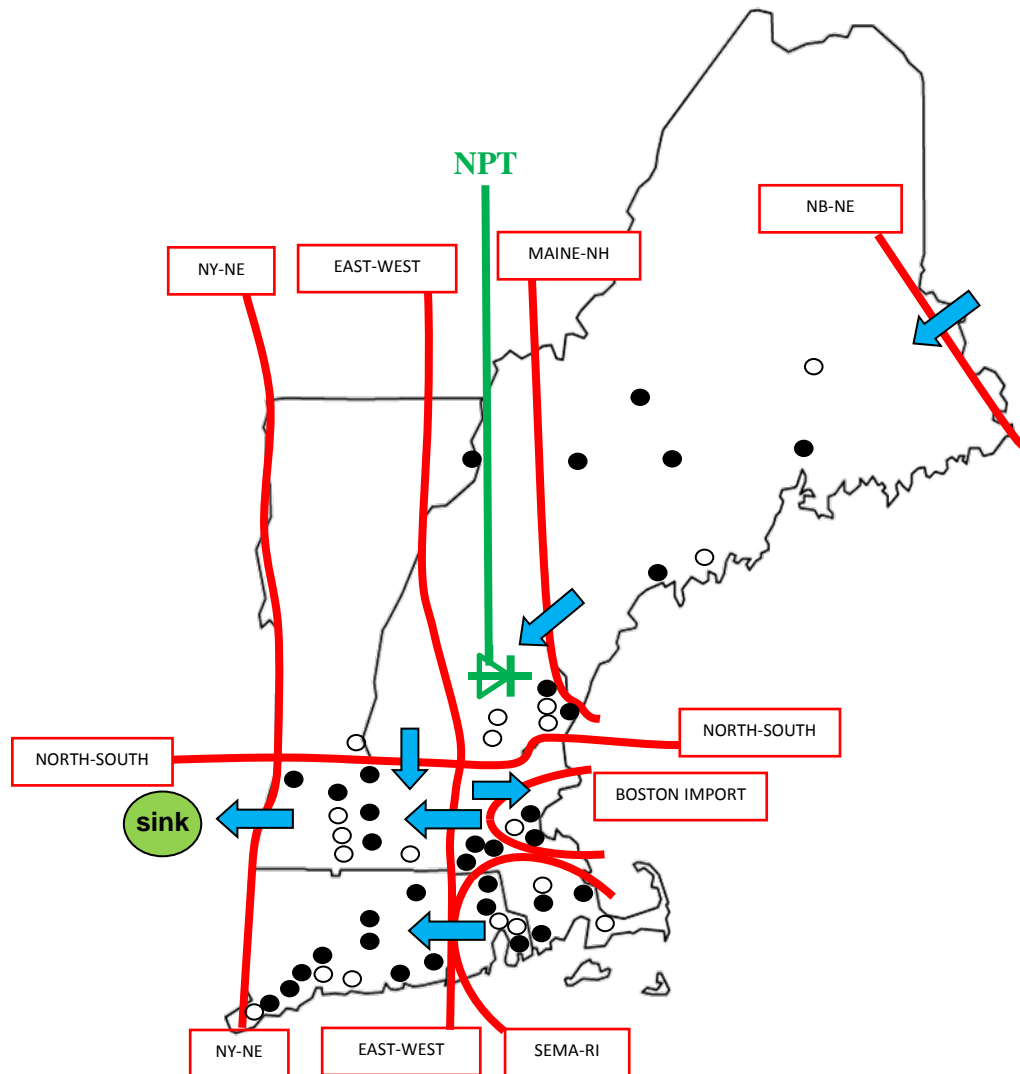
Interfaces	System Conditions
NB-NE = -570 MW	<ul style="list-style-type: none"> • Light Load • NE Export to NB • Boston Export • High SEMA-RI Export • High East – West • High NE to N Y Export
ME-NH = 406 MW	
NNE-Scobie+394 = 2274 MW	
Boston Import = -16 MW	
SEMA-RI Export = 2297 MW	
East-West = 3504 MW	
NY-NE = -1210 MW	

Legend

- Generator turned on in full or partial
- Generator turned off



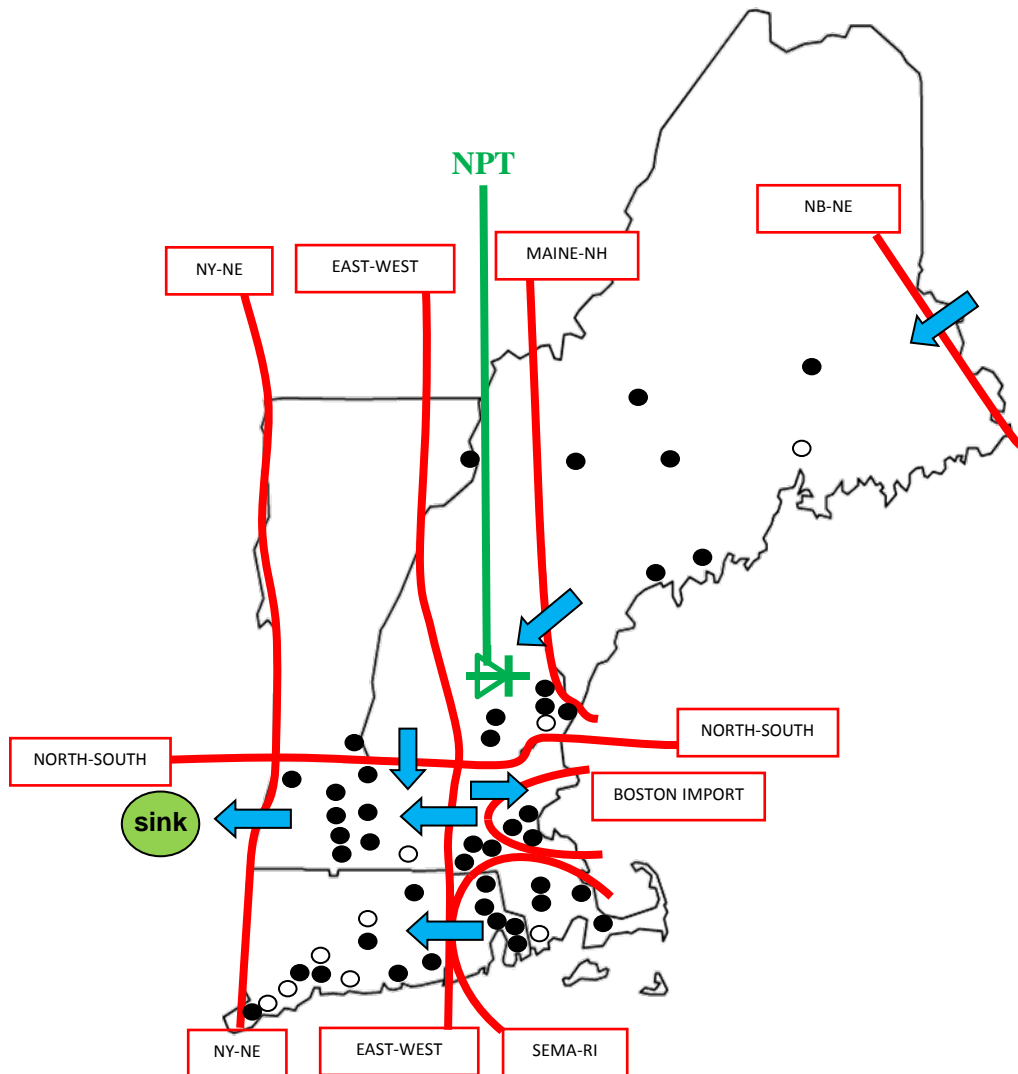
Transient Stability Dispatch – D6



Case D6	
Interfaces	System Conditions
NB-NE = 1005 MW	<ul style="list-style-type: none">• Light Load• High ME-NH• Boston Import• High SEMA-RI Export• High East-West• High NE to NY Export
ME-NH = 2008 MW	
NNE-Scobie+394 = 2638 MW	
Boston Import = 2021 MW	
SEMA-RI Export = 3464 MW	
East-West = 3516 MW	
NY-NE = -1193 MW	
Legend	
●	Generator turned on in full or partial
○	Generator turned off



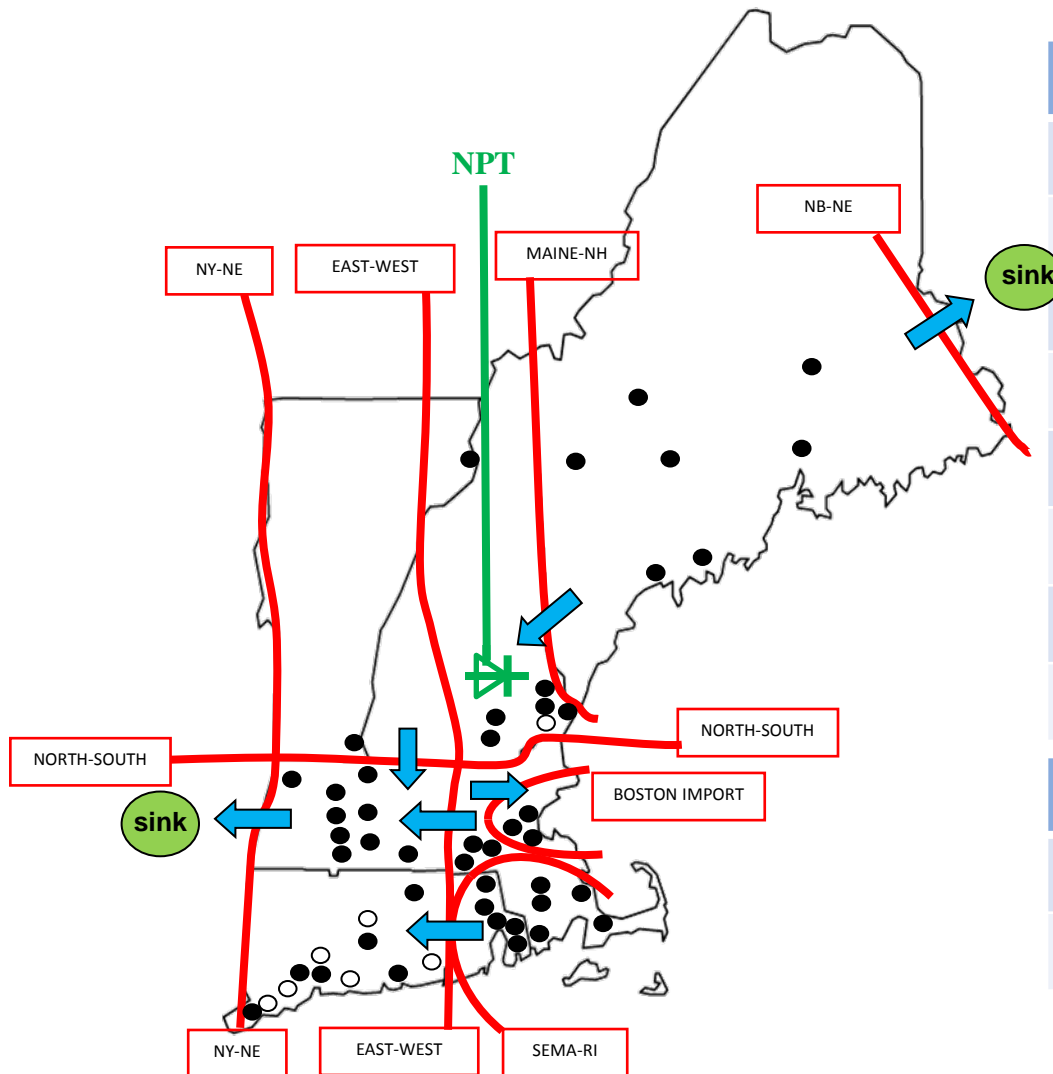
Transient Stability Dispatch – D7



Case D7	
Interfaces	System Conditions
NB-NE = 1004 MW	• Peak Load
ME-NH = 2023 MW	• High ME-NH
NNE-Scobie+394 = 2999 MW	• High NNE-Scobie +394
Boston Import = 3427 MW	• High Boston Import
SEMA-RI Export = 3508 MW	• High/lo SEMA-RI Export
East-West = 3534 MW	• High East - West
NY-NE = -1209 MW	• High NE to NY Export
Legend	
●	Generator turned on in full or partial
○	Generator turned off



Transient Stability Dispatch – D8



Case D8

Interfaces

System Conditions

NB-NE = -310 MW

ME-NH = 1018 MW

NNE-Scobie+394 = 2698 MW

Boston Import = 3426 MW

SEMA-RI Export = 4002 MW

East-West = 3515 MW

NY-NE = -1196 MW

- **Peak Load**
- **NE to NB export**
- **High Boston Import**
- **High SEMA-RI Export**
- **High East - West**
- **High NE to NY Export**

Legend

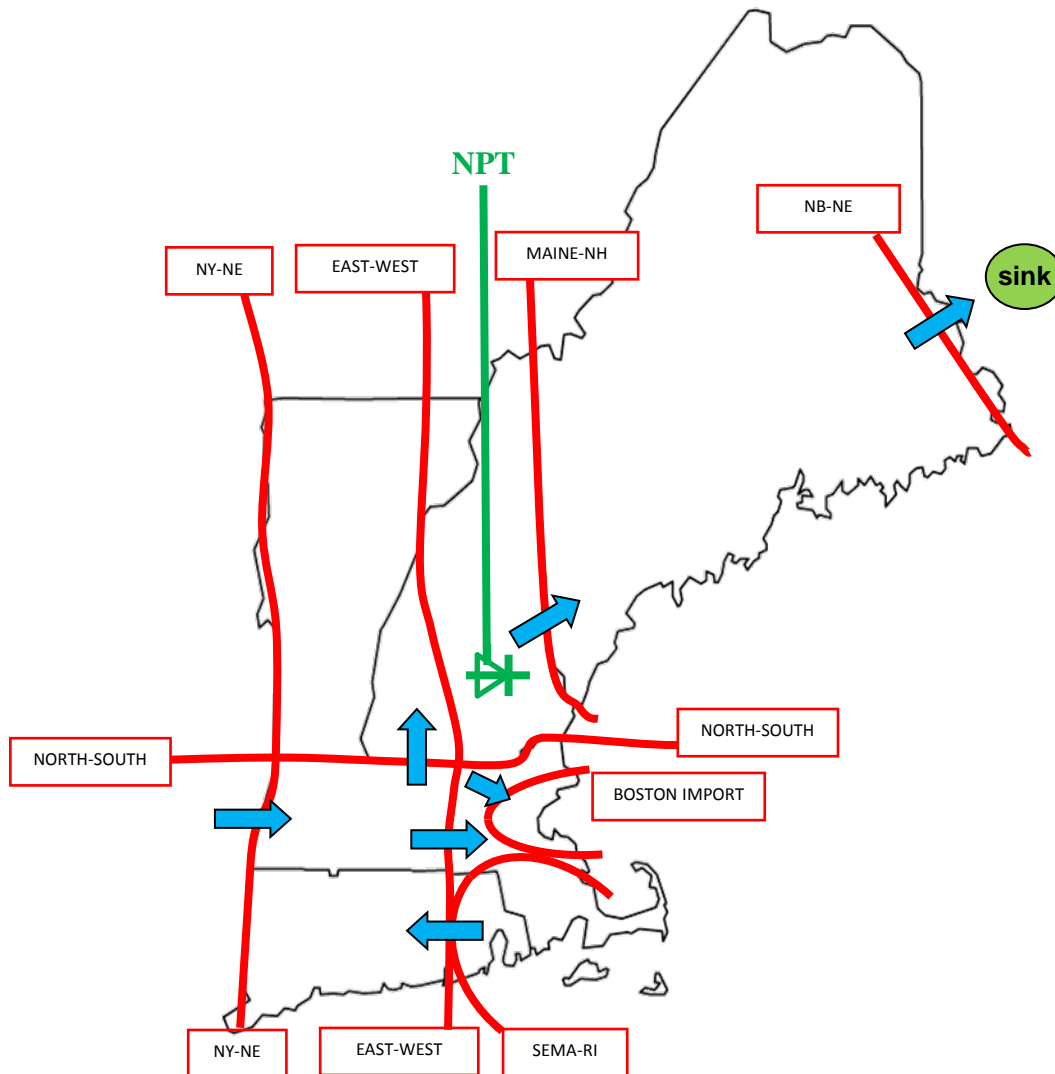
● Generator turned on in full or partial

○ Generator turned off



New York to New England 1200 MW Sensitivities Transient Stability Case C1

PPA Study Assumptions



Case 1		
System Conditions		
NB-NE = -549 MW	South To North	
ME-NH = -1293 MW		
North-South = -1110 MW		
West-East = 1017 MW		
NY-NE = 1215 MW	Northern NE	
Sink		

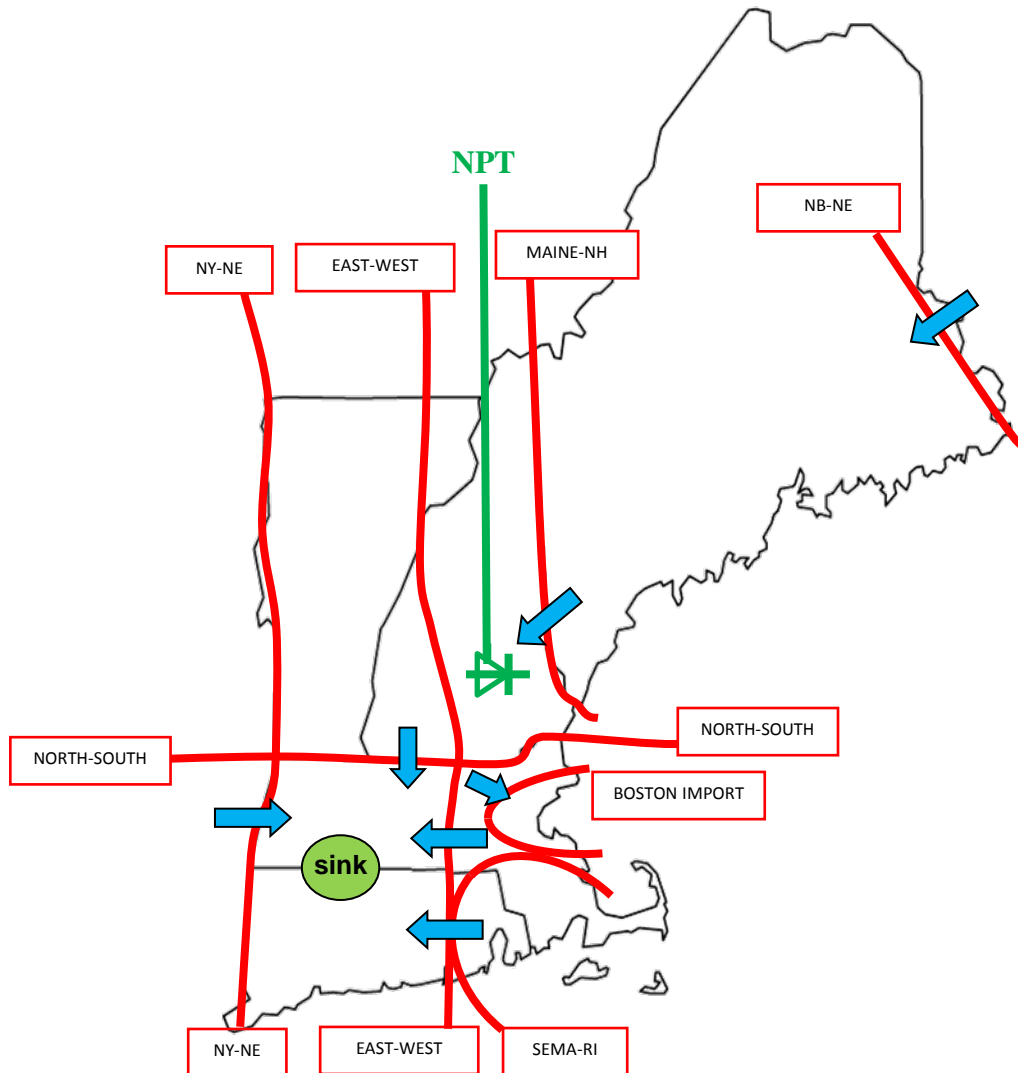


Northeast
Utilities

Critical Energy Infrastructure has been redacted

New York to NE 1200 MW Import Sensitivities Transient Stability Case C2

PPA Study Assumptions



Case 2	
System Conditions	
NB-NE = 1005 MW	North to South
ME-NH = 2006 MW	
NNE-Scobie+394 = 3045 MW	
East-West = 3512 MW	
NY-NE = 1186 MW	
Sink	CT & WMA

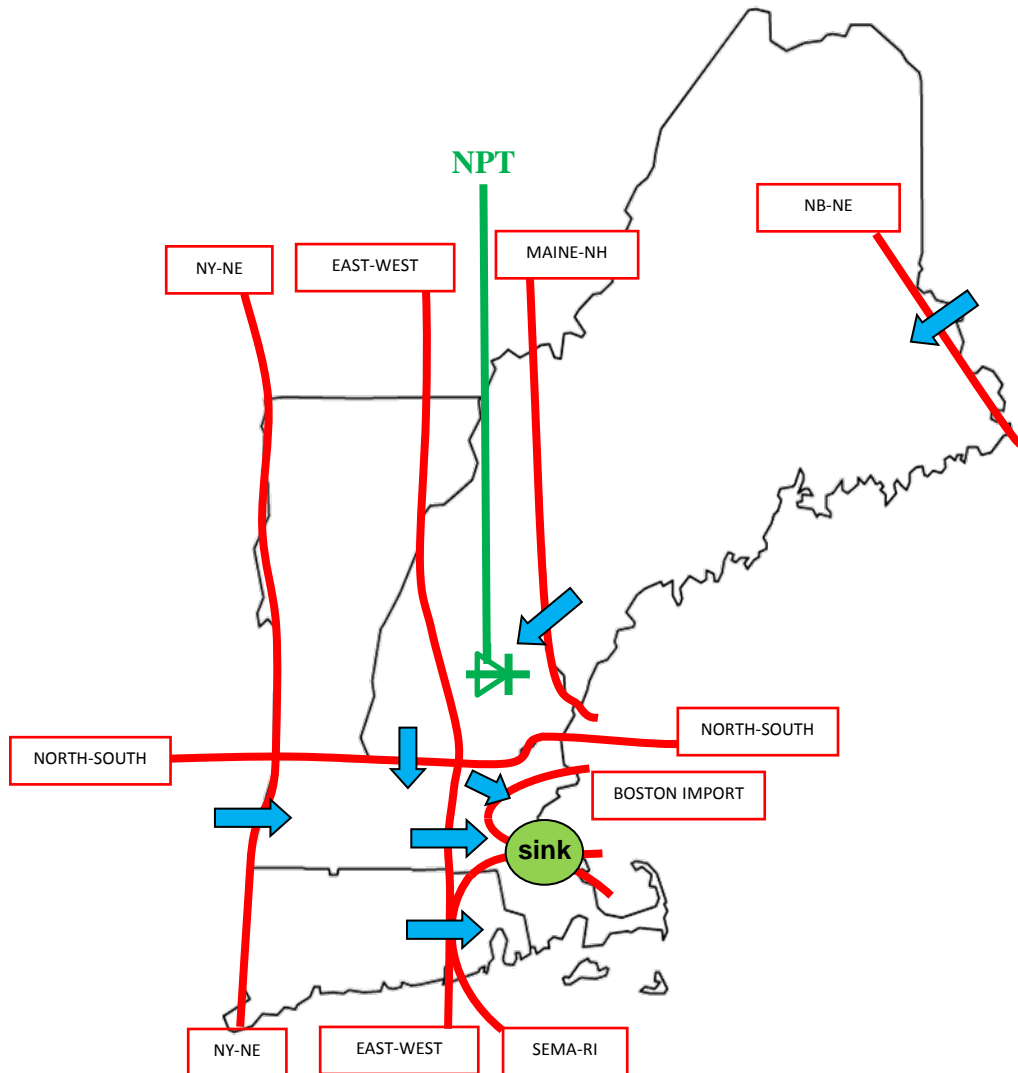


Northeast
Utilities

Critical Energy Infrastructure has been redacted

New York to NE 1200 MW Import Sensitivities Transient Stability Case C3

PPA Study Assumptions



Case 3		
System Conditions		
NB-NE = 1005 MW	North To South	
ME-NH = 2003 MW		
NNE-Scobie+394 = 3045 MW		
West-East = 955 MW		
NY-NE = 1195 MW		
Sink	NEMA & SEMA	

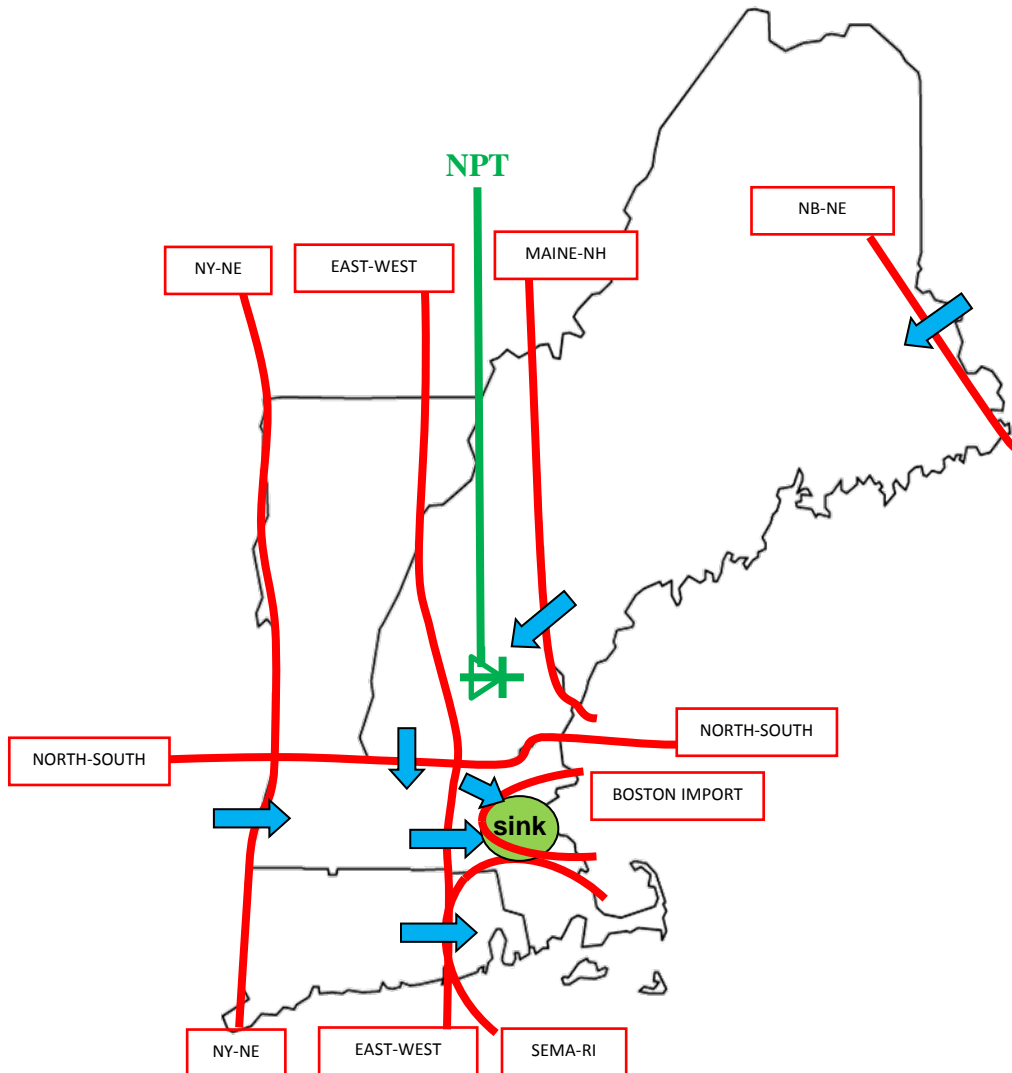


Northeast
Utilities

Critical Energy Infrastructure has been redacted

New York to NE 1200 MW Import Sensitivities Transient Stability Case C4

PPA Study Assumptions



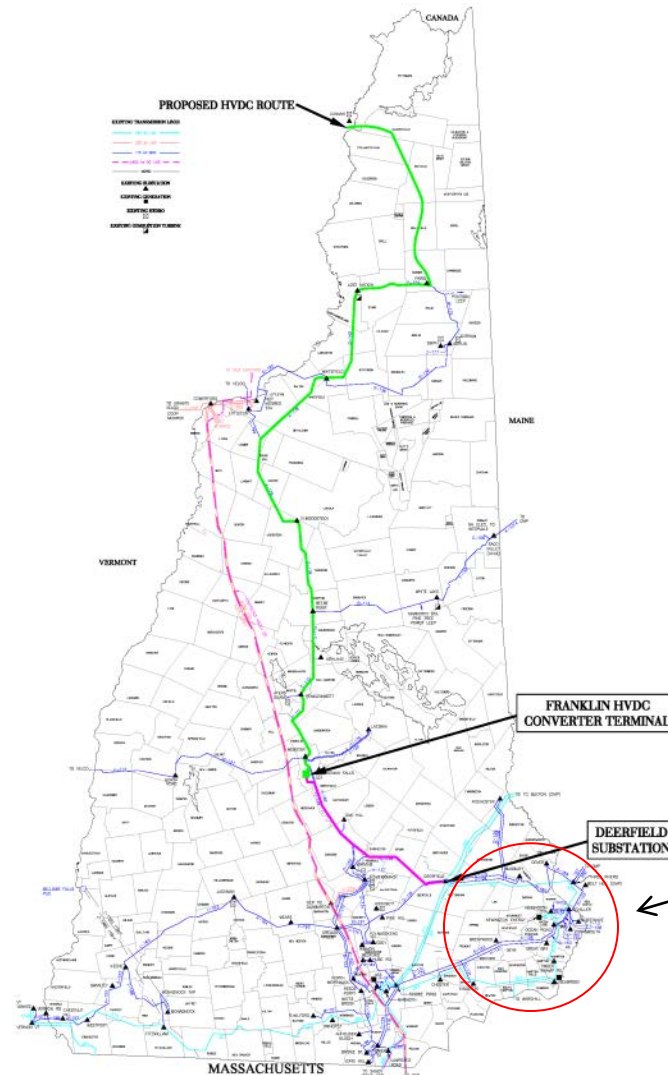
Case 4	
System Conditions	
NB-NE = 1005 MW	North To South
ME-NH = 1404 MW	
NNE-Scobie+394 = 1964 MW	
West-East = 980 MW	
NY-NE = 1216 MW	
Sink	NEMA



Northeast
Utilities

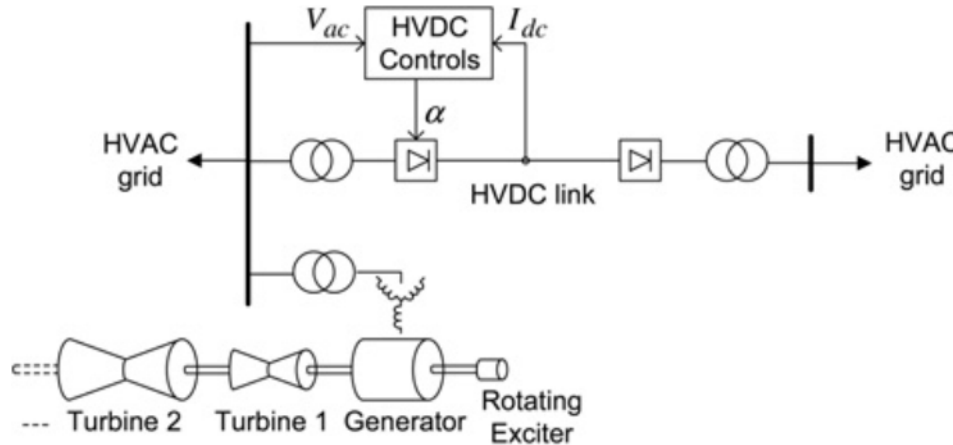
Critical Energy Infrastructure has been redacted

NPT to Address Thermal and Voltage Results



Sub-Synchronous Torsional Interaction (SSTI) Screening

- SSTI screening analysis, Unit Interaction Factor (UIF) based on short-circuit strength, performed in accordance with Electric Power Research Institute (EPRI) guidelines.
- Variations in HVdc terminal DC voltage and current can cause the converter AC current to oscillate that can impact mechanical stresses on electrically connected nearby generators. This phenomenon is called torsional interaction and occurs in the frequency range of 10-40 Hz.



- UIFs calculated for: Seabrook, Newington Energy, PSNH Newington, Merrimack, Granite Ridge, Yarmouth 1,2,3 and 4, Cape G4 and G5, Mystic G7 and G8, Schiller 4,5 and 6, Bucksport G4, Westbrook Energy, Maine Independent Station (MIS), and Pt. Lepreau. As part of the vendor selection process, the detailed SSTI analysis will be completed and if SSTI concerns are identified the project expects to address these by the proper selection of the controller parameters of the HVdc terminal.



HVDC Runback/Re-dispatch Analyses for N-1-1 Conditions

- Dispatches:
 - Peak load D1, D2, D3, D5
 - Minimum load: D7
- Runback levels (i.e. NPT or generation output was reduced to eliminate thermal overloads, total did not exceed 1200 MW)
 - Northern Pass Transmission HVDC 0 – 350 MW
 - Maine Generation 0 – 1143 MW
- Worst case: N-1-1 (N-1 with 394 line OOS followed by Scobie 326 Line/Y151 SPS for N-1-1) thermal overloads on the 230-kV line N214 is eliminated by reducing generation in Maine by 1143 MW and reducing the Franklin HVDC Converter Station by 50 MW.
- **Conclusion:** Runback levels are acceptable and do not violate NPCC or ISO-NE line out re-dispatch criteria (loss of source < 1200 MW).



PPA Study Results

- **Thermal/Voltage:** All power flows demonstrated acceptable steady-state and voltage response under post-contingency conditions with Project upgrades.
- **Stability:** All simulations demonstrated acceptable dynamic responses when compared to pre-Project simulations.
- **NPCC A10 Bulk Power System:** No significant adverse impacts were reported and no new BPS classified stations.
- **Short Circuit:** The results of these analyses showed that the Project will have a minimal impact on the maximum available short circuit current levels in the New England system.
- **Delta V:** The highest percent change in voltage (1.89%) was reported when switching 200 Mvar out of service in one step at the 345-kV Deerfield Substation (does not violate the NU delta voltage criteria of 2.5%).
- **SSTI Screening:** UIFs of potential concern were reported for Seabrook, Newington Energy, PSNH Newington, Granite Ridge, Yarmouth 1,2,3 and 4, Schiller 4, 5 and 6, Bucksport G4, Westbrook Energy, and Maine Independent Station (MIS). These potential concerns will be addressed in the HVdc terminal control system design studies which will demonstrate adequate damping for all potentially impacted generator's torsional frequencies of concern.



Proposed Plan Applications

■ NU-13-T20

Build a new 345-kV Franklin switchyard. Build a 1200 MW Franklin HVDC Converter Station and add 750 Mvar of reactive compensation, and a 100 Mvar SVC. 100 Mvar leading, 0 Mvar lagging, made up of 100 Mvar TCR and 100 Mvar MSC

■ NU-13-T21

Build a new HVDC transmission line from Quebec/US border in Pittsburg, NH to the 345-kV Franklin Switching Station in Franklin, New Hampshire.

■ NU-13-T22

Build a new 345-kV ac overhead transmission line from the 345-kV Franklin Switching Station to the 345-kV Deerfield Substation.

■ NU-13-T23

Modify the 345-kV Deerfield Substation and add 200 Mvar of reactive compensation, and a 400 Mvar SVC. 400 Mvar leading, 0 Mvar lagging, made up of 400 Mvar TCR and 400 Mvar MSC

■ NU-13-T24

Modify the 345-kV Scobie Pond Substation and add 210 Mvar of reactive compensation. (3 – 60 Mvar, 1 – 30 Mvar)

■ NU-13-T25

Re-terminate 345-kV Buxton – Scobie Pond Line 391 into the 345-kV Deerfield Substation and uprate the 391S line section from Deerfield to Scobie.

■ NU-13-T26

Uprate 345-kV transmission line 373 Deerfield – Scobie Pond.

■ NU-13-T27

Uprate 345-kV transmission line 326 section from Scobie Pond to Lawrence Road to NU/NGRID border.



PJM/NYISO/HQ Study

The PJM/NYISO/HQ study sensitivities, which included independent reviews, addressed temporary “loss-of-source” concerns within the northeastern part of the US following contingency events that tripped generation and “blocked” the NPT, Chateauguay, and Sandy Pond HVDC Phase II terminals.

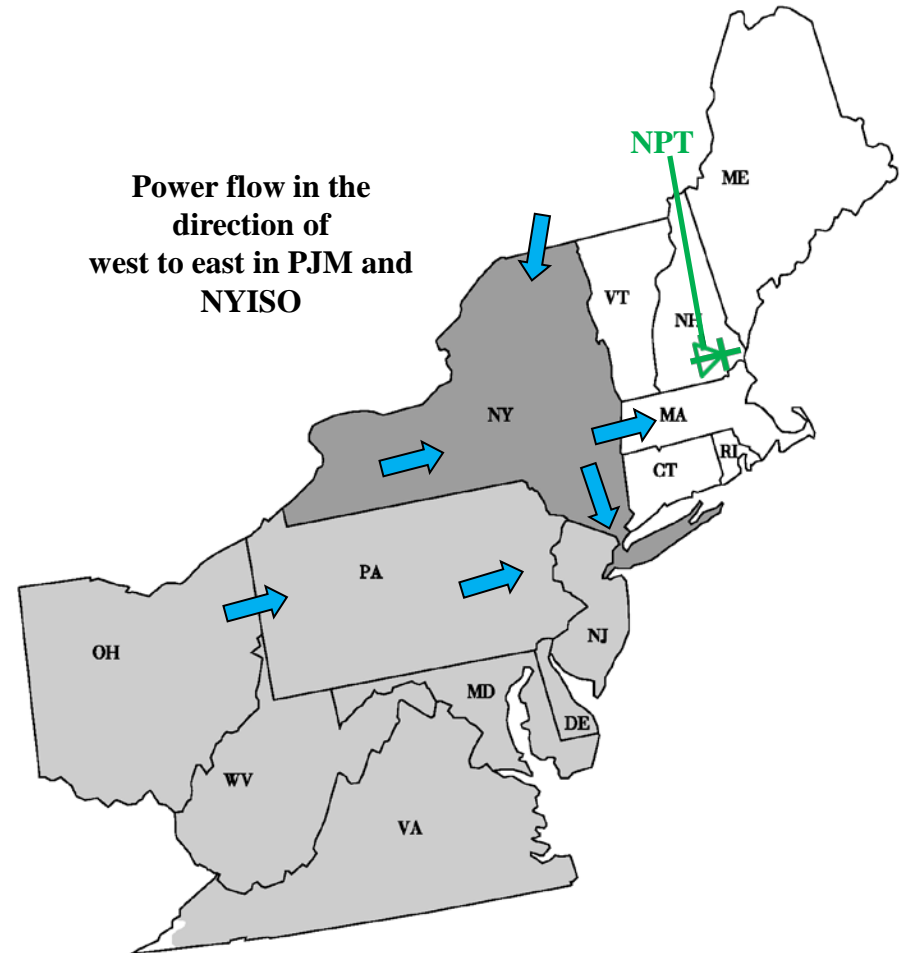
■ Base Case Modeling

- PJM and New York’s West to East Interfaces stressed
- Simulations were performed with maximum synchronous generation in Northern NY and Quebec
- Sensitivities with and without Chateauguay HVDC facility
- Primary New England Interface Levels
 - Northern New England Scobie + 394 Interface at its stability limit of 3100 MW
 - New England East – West Interface at its 3500 MW limit
 - New York–New England Interface at 1200 MW

■ Results indicated no significant adverse impact

- System oscillations were damped with no PJM or NYISO loss of source

**Power flow in the
direction of
west to east in PJM and
NYISO**



Conclusion

- NU believes that NPT does not cause any significant adverse impacts to the New England transmission system or the facilities of a market participant.
- NYISO has given their acceptance to the NPT Project
- PJM is currently reviewing the final test results and is expected to give their acceptance to the NPT Project.
- The Transmission Task Force and the Stability Task Force are expected to recommend that the NEPOOL Reliability Committee vote in favor of the motion to recommend ISO-NE approve the Northern Pass Transmission Proposed Plan Applications (PPAs/I.3.9).

