

2016 Maine Resource Integration Study – Additional Steady State Results

Planning Advisory Committee



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SYSTEM PLANNING

Agenda

- Describe the purpose of the Maine Resource Integration Study
 - Study approach and assumptions
- Review the results from the September 2016 PAC presentation
 - Testing without re-dispatch within Maine
- Present the results of steady state analysis with application of the Network Capability Interconnection Standard (the Minimum Interconnection Standard)
 - Testing that includes re-dispatch within Maine
- Discuss the difficulties associated with additional interconnections north of Orrington

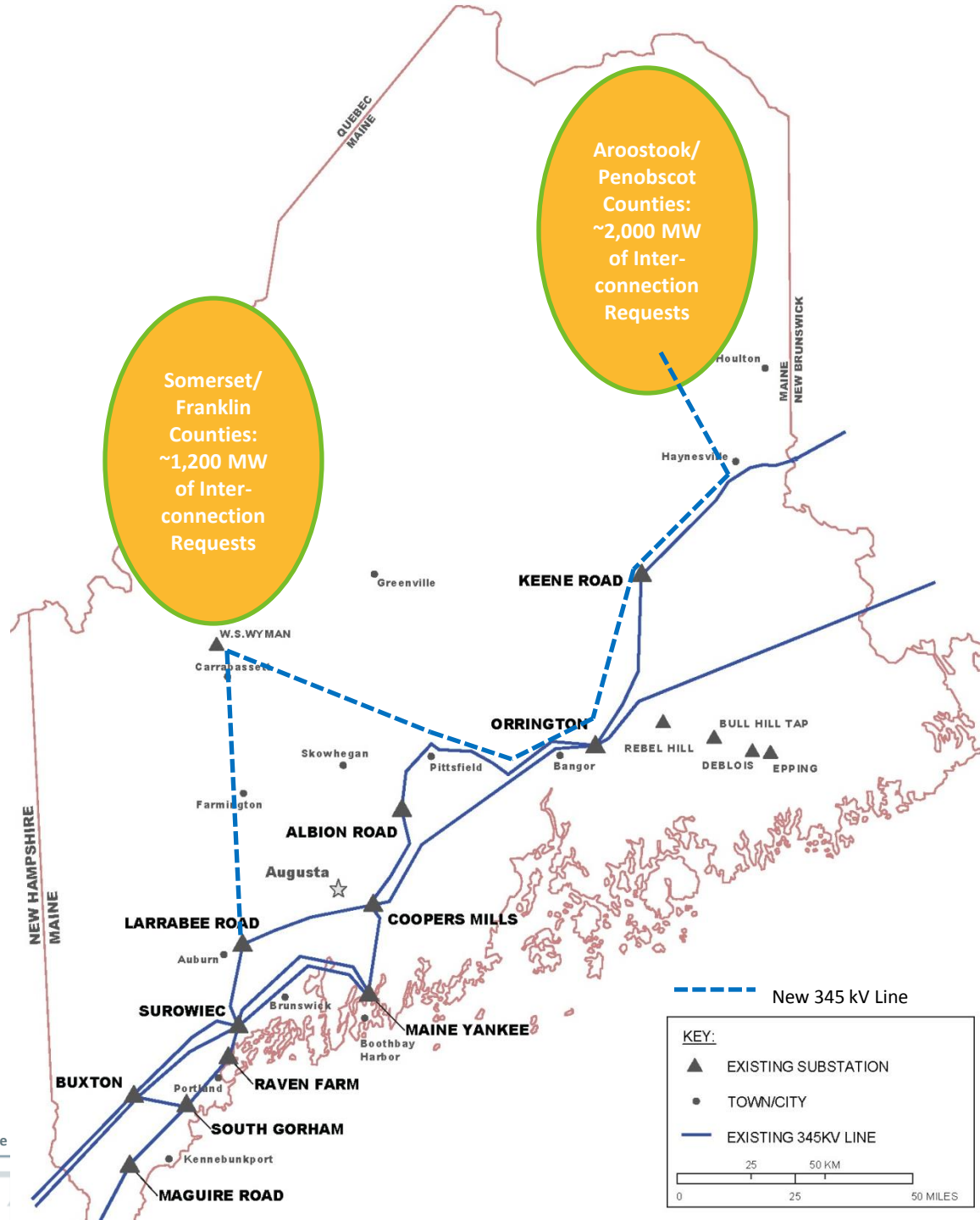
OBJECTIVES OF THE MAINE RESOURCE INTERCONNECTION STUDY

Study Objectives

- Identify potential transmission infrastructure that could be used **to interconnect** queued generation in Maine
 - Quantify generation that could interconnect with new transmission
- The 2016 Maine Resource Integration Study is focused on the assessment of new 345 kV AC transmission circuits that could connect to the areas with the largest quantity of requested new generation interconnections
 - [Scope](#) presented to the March 2016 PAC meeting
 - [Initial Steady State Results](#) presented to the September 2016 PAC meeting
- The study will also attempt to identify whether there is an identifiable point where HVDC becomes an appropriate alternative to continuing to add AC transmission to the existing system

Conceptual Transmission Upgrades

- Analysis of new 345 kV transmission in parallel with the existing network
- Evaluations include interconnecting with, or bypassing, existing lines and substations



Link to Interconnection Queue Clustering

- Discussions regarding the proposed addition of a targeted clustering methodology are taking place at the NEPOOL Transmission Committee
 - September, October and November 2016 Transmission Committee meetings
- The proposed methodology will be triggered when more than one Interconnection Request requires common new transmission line infrastructure to interconnect
- Clustering approach will have two phases
 - Phase 1 will be a Regional Planning Study that is presented to the PAC
 - It is proposed that this Maine Resource Integration Study will be used as the regional study for the first cluster(s)
 - Phase 2 will be a Cluster System Impact Study where more than one project will be studied together and will share the costs for certain upgrades

Study Approach

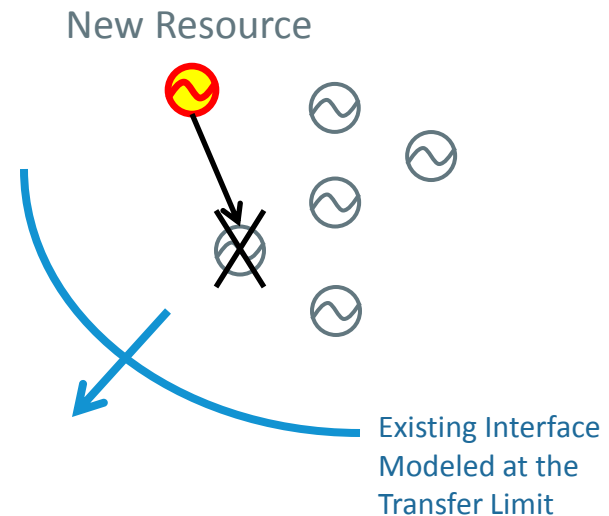
- The Maine Resource Integration Study will identify the infrastructure required **to interconnect** proposed resources
- The study will use the assumptions used in an interconnection System Impact Study
 - The September 2016 PAC presentation provided the results when no re-dispatch within Maine was considered
 - Such results give an indication of the ability to be deliverable and meet the Capacity Capability Interconnection Standard
 - The additional information in this presentation focuses on the results when re-dispatch is considered
 - Consistent with the Network Capability Interconnection Standard (NCIS – sometimes referred to as the minimum interconnection standard)

Network Capability Interconnection Standard (NCIS)

- The conditions used in NCIS System Impact Studies are described in [Planning Procedure 5-6](#)
 - Peak load (mostly for steady state) and light load (mostly for stability) testing
 - Resources are modeled at their nameplate ratings (50 degrees F or 0 degrees F, as appropriate)
 - New Resources may dispatch against existing resources under the Network Capability Interconnection Standard
 - Interfaces modeled at the transfer limit

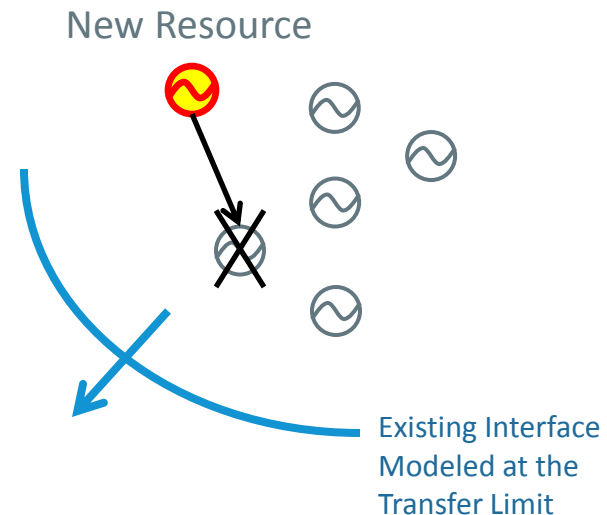
System Impact Studies Ensure No Adverse Impact on Transfer Capability

- New resources may dispatch against existing resources
 - Not required to increase transfer capability
 - Not allowed to degrade transfer capability
- What is the outcome?
 - After the addition of the new resource, more resources will now be competing to use the same transfer capability



Why Ensure No Adverse Impact on Transfer Capability?

- Degrading transfer capability:
 - would mean a reduction in the level of interconnection transmission service than has been previously provided to the existing resources
 - would have additional consequences such as the reduction of upstream import capability from other regions
 - Reduction in tie benefits
 - May not be operable (transfer limit would decrease for an increase of one resource's output)

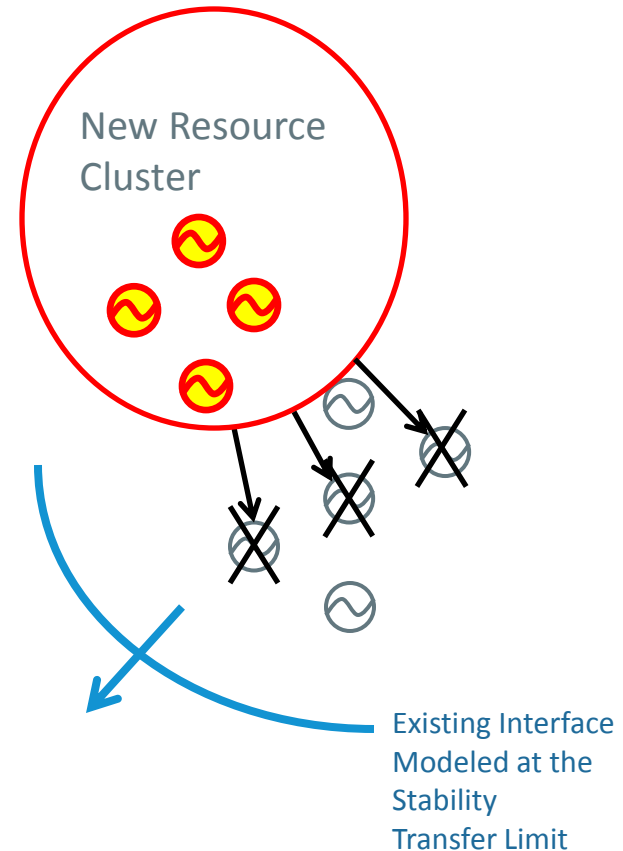


A System Impact Study is Not an Economic Study

- A System Impact Study does not seek to forecast likely patterns of congestion or likely economic dispatch outcomes because such issues are not considered in the provision of interconnection transmission service
 - Under the interconnection procedures, resources request (and the ISO and Transmission Owner provide) interconnection service in the amount of requested nameplate capability
- Even though intermittent resources (such as wind) may not always be running at the full nameplate level, the interconnection service is still provided for the full amount
 - The full interconnection service is used when the resource runs at full output

Implications for Cluster Applications of the Network Capability Interconnection Standard

- For the system to be operable, all possible combinations (up to the interface stability transfer limit) must be feasible
 - This will include scenarios where all of the resources in the cluster are running together at the same time



Testing Performed in the Maine Resource Integration Study

- Steady State Thermal (Northern, Western & Combination)
 - N-1
 - N-1-1
- Steady State Voltage
 - N-1
- Inverter-Based/Weak Grid Issues
 - Reactive Support
 - Low Short Circuit Ratio
- Stability Testing
 - Local and some remote (BPS impact) testing
 - Use real queue generation data to the extent possible

Completed
Analyses

Next
Steps

Steady State

Summer Peak Load Base Case Conditions

Interface Flows (MW)	Generation Dispatch (MW)	
New Brunswick-New England = 1049	Belldune	480
Orrington South = 1359	Mactaquac	290
Surowiec South = 1494	Bayside	170
Maine- New Hampshire = 1922	Coleson Cove	300
	Pt. Lepreau	705
	Mckay Hydro	33
	Jimmy Owl	26
	Stetson	57
	Dundee	33
	Rollins	27
	Passadumkeag	40
	MIS	310
	Oakfield	148
	Pisgah	9
	Bull Hill	34
	Bucksport	0
	Kibby	132
	QP333 Wind	185
	VERSO Cogen AEC	165
	Rumford Power	277
	Newpage Cogen	110
	Record Hill	51
	Sappi Somerset	97
	Westbrook Energy	539
	Yarmouth 4	623

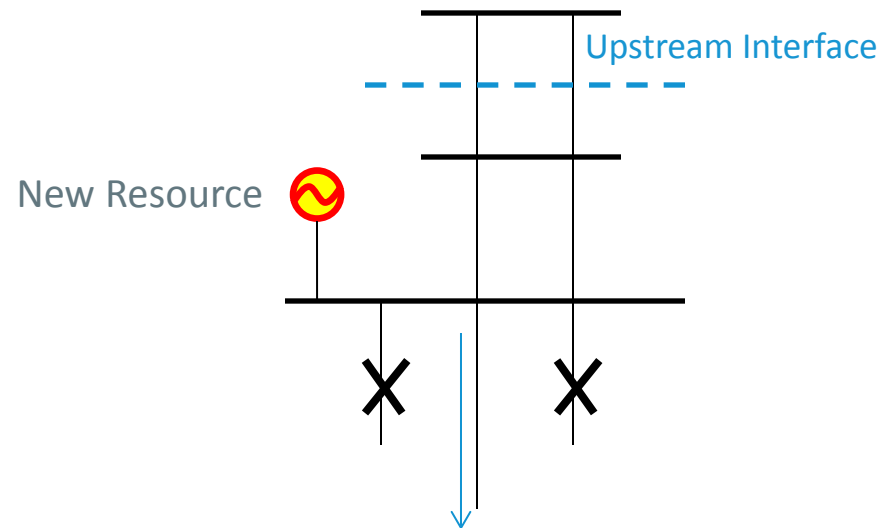
Steady State N-1 & N-1-1 Thermal Testing

- Thermal transfer analysis for each interconnection area:
 - Northern Maine
 - 4 Potential Configurations (with no Western Injection)
 - Western Maine
 - 4 Potential Configurations (with no Northern Injection)
- Thermal transfer analysis for a combination using a configuration from each area
 - With simultaneous injections in both the North and the West
- All N-1 thermal transfer analyses used Short Time Emergency (15 minute) ratings
- N-1-1 limits respect Long Time Emergency (12 hours – Summer) ratings
 - Line Outages – All Maine 345kV Lines

Criteria Note

1,200 MW Back Down Limit in N-1-1 Testing

- Up to 1,200 MW back down allowed between the first and second contingency:
 - New Brunswick (but upstream interfaces should be at-limit initially)
 - Existing Generation
 - New Generation



What is the back down required
To ensure this line is within LTE
Rating after the 2 contingencies?

Criteria Note

Limit of 1,200 MW on a Radial Connection

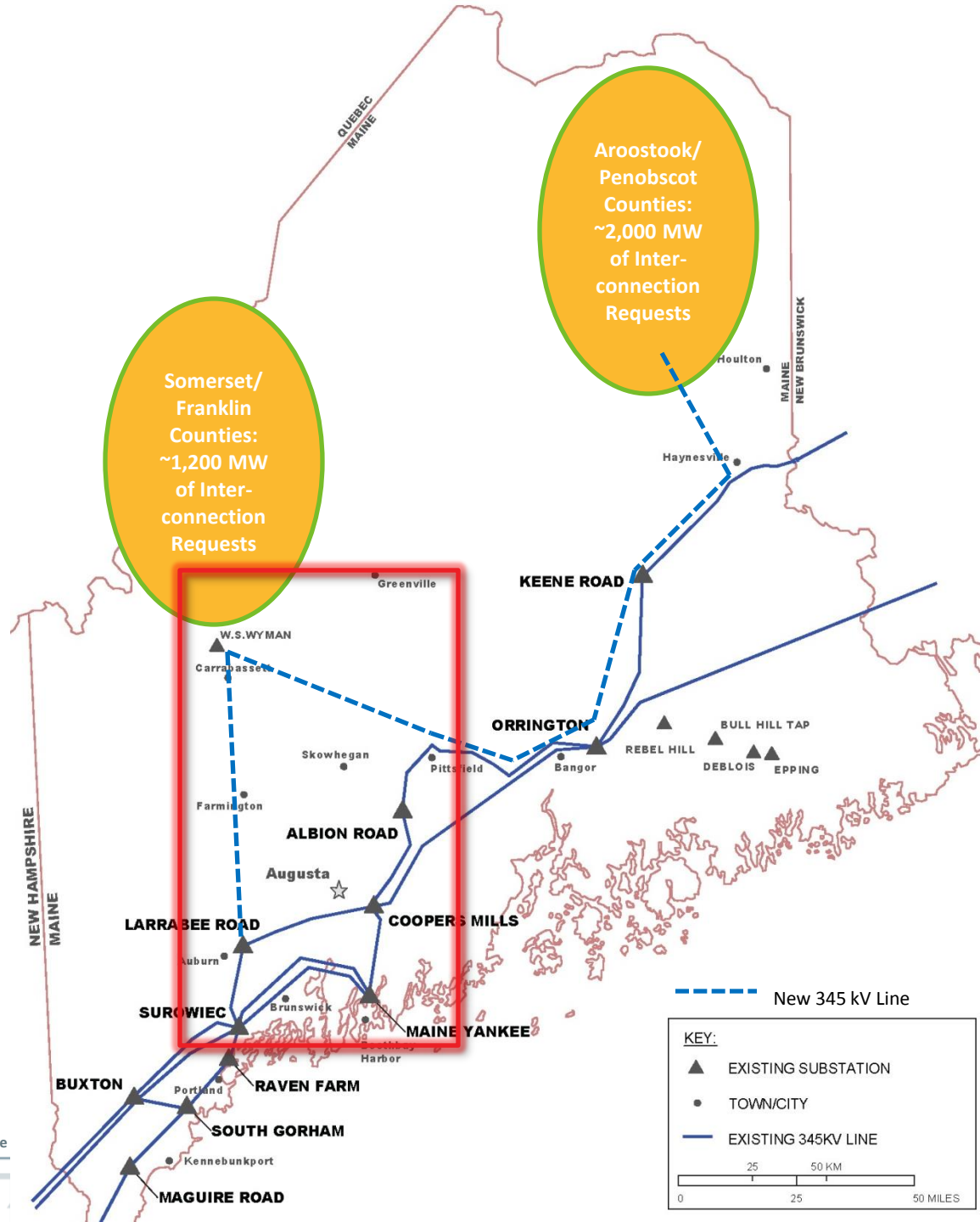
- The quantity of MW that can connect using a radial line is limited to 1,200 MW
 - Loss-of-source limit for Normal Contingencies



STEADY STATE RESULTS WESTERN MAINE

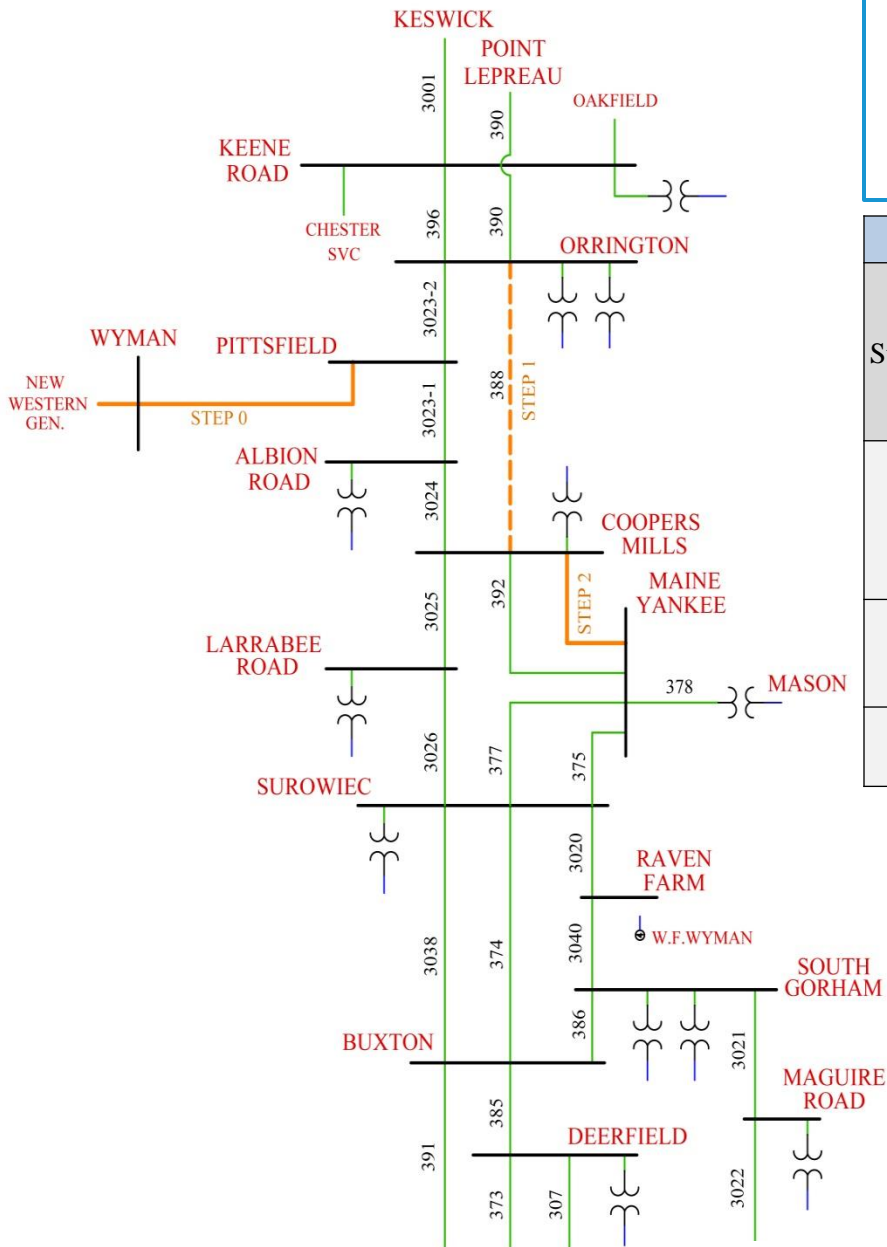
Western Infrastructure Concepts

- 345 kV connections between the Wyman area and Pittsfield and/or Larrabee Road
- No connection proposed to the 115 kV at Wyman



N-1 New Western Gen.

Option 1 – Interconnect at Pittsfield from Wyman Western Gen.



(Pittsfield to Wyman)

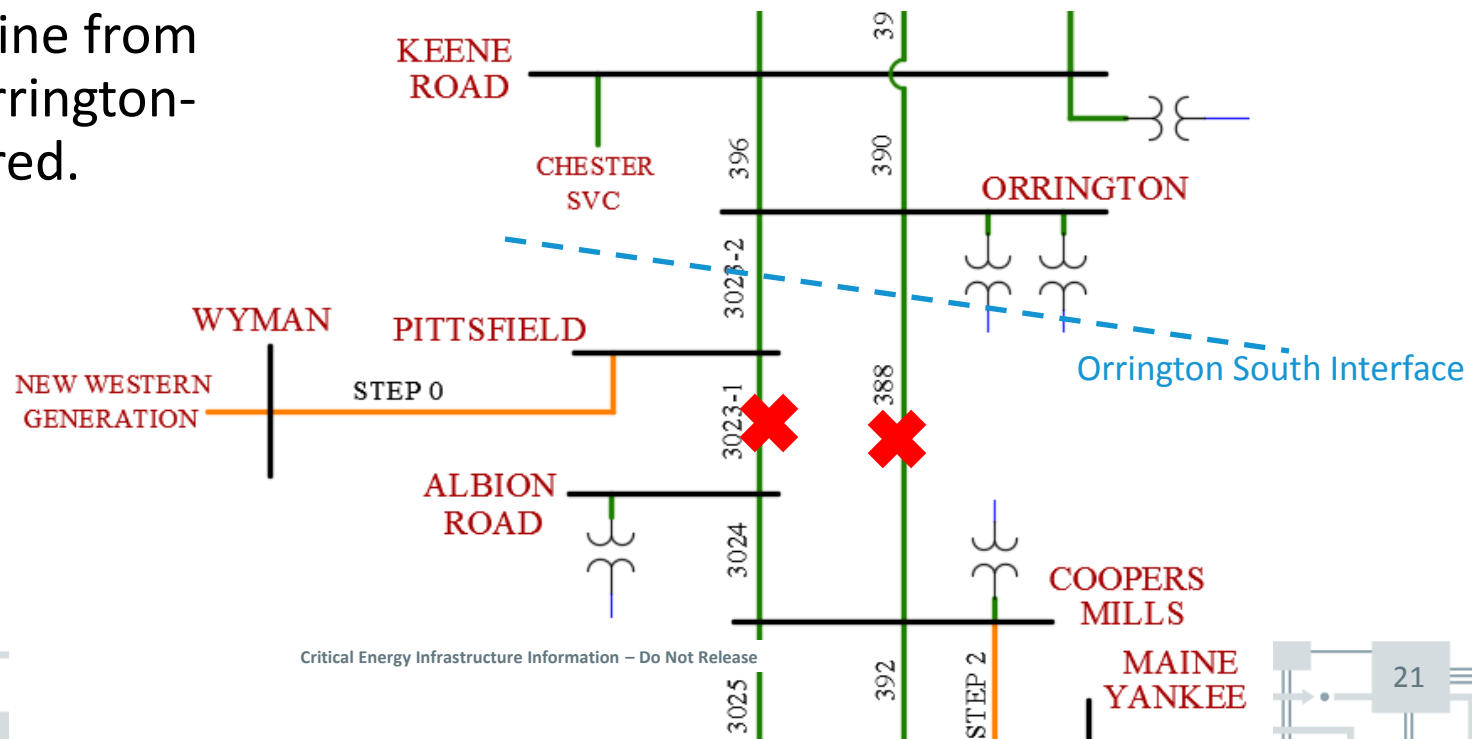
Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	New Line (Pittsfield-Wyman)	S.388 (Orrington-Coopers)	Any Albion Road Stuck Breaker	383
			S.3023-1 (Pittsfield-Albion)	404
1	S.388 (Orrington-Coopers)	S.392 (Coopers-ME Yankee)	S.3025 (Coopers-Larrabee)	433
2	Parallel S.392	S.3038 (Surowiec-Buxton)	S.3040 (S.Gorham-Raven)	1004

*No re-dispatch north of Maine-New Hampshire was conducted for these results

Western N-1-1 Thermal Results – Option 1

The N-1-1 Limit for Western Option 1 is approx 345 MW – additional upgrades defined in the N-1 analysis will not increase this limit. In order to increase this limit another line from Pittsfield or Orrington-South is required.

First Level Outage	Contingency	Monitored Facility	LTE Rating	Option 1
				Pittsfield-Wyman
				Available MW Injection
LN_3023-1	Orrington K390/388 (Several Contingencies)	CMP_65_EM 115 BUCKSPORT 115 1	193	344

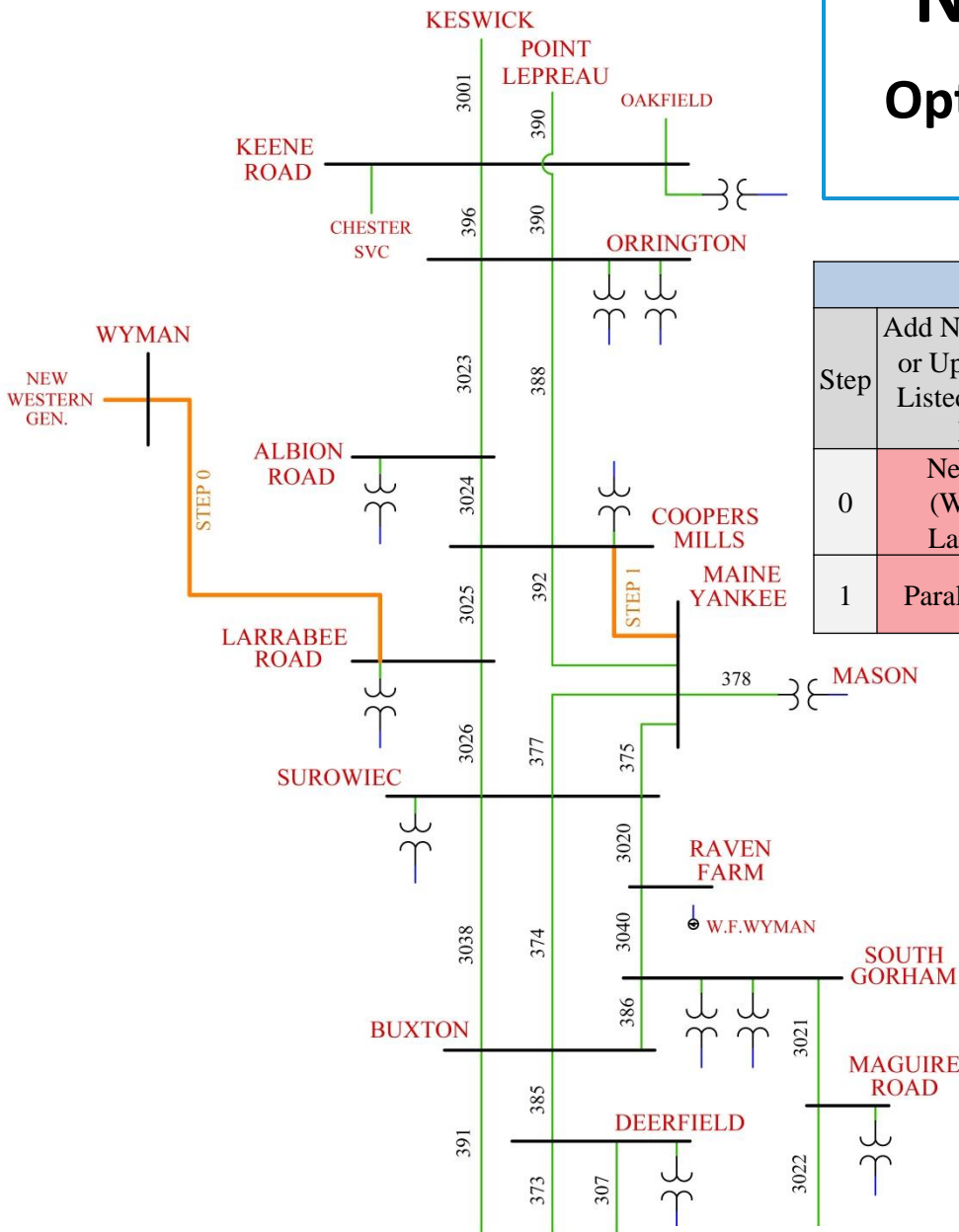


NCIS Re-dispatch Options – Western Option 1

- Re-dispatch options are limited in this case
 - Orrington South required to be at limit in the analysis
 - No nearby 345 kV connected resources
- Western Option 1 will not be considered further as a stand-alone option
- Note that this option appears to be useful when used in combination with other options
 - More described later in this presentation

N-1 New Western Gen.

Option 2a – Interconnect at Larrabee from Wyman Western Gen.



(Wyman to Larrabee)

Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	New Line (Wyman-Larrabee)	S.392 (Coopers-ME Yankee)	S.3026 (Larrabee-Surowiec)	660
1	Parallel S.392	S.3038 (Surowiec-Buxton)	S.3040 (S.Gorham-Raven)	1001

*No re-dispatch north of Maine-New Hampshire was conducted for these results

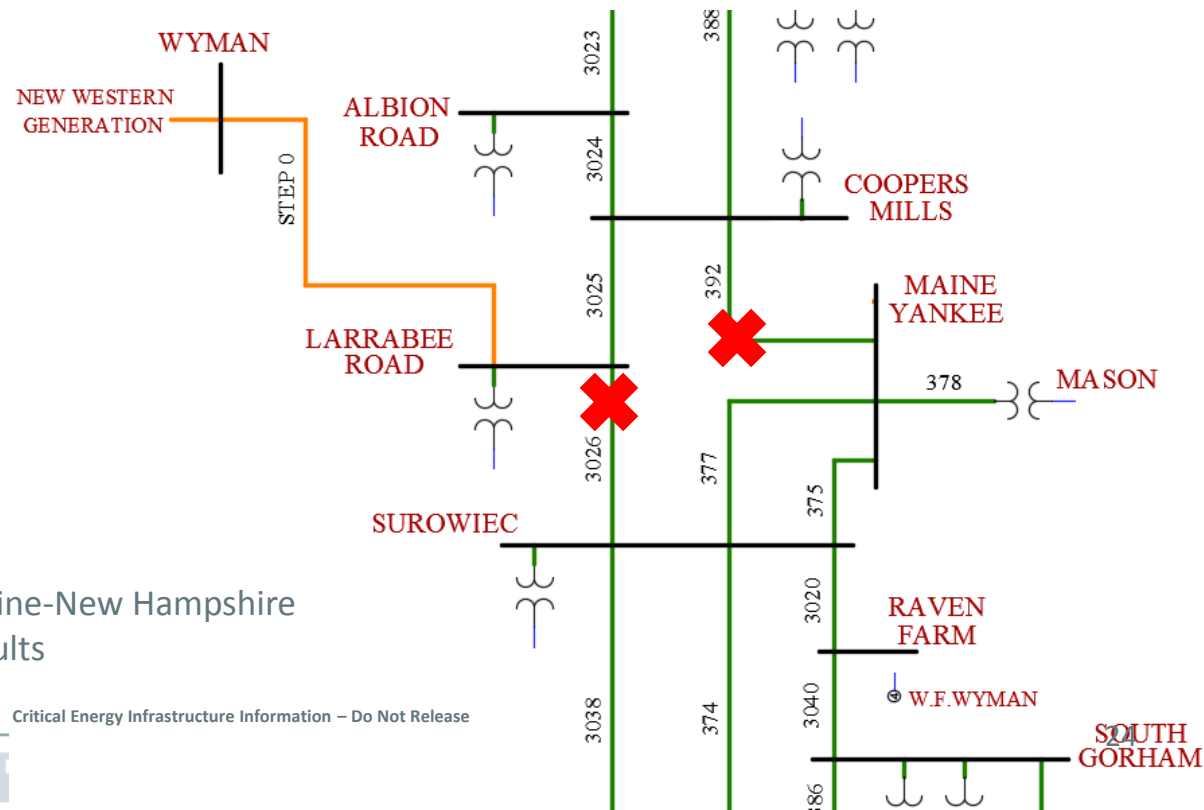
Western N-1-1 Thermal Results – Option 2a

(Step 0 Only)

The N-1-1 Limit for Western Option 2a modeling the addition of the new line from Wyman to Larrabee Road only is 460 MW.

In order to increase the amount of generation to greater than 460 MW a parallel S.392 would need to be added.

First Level Outage	Contingency	Monitored Facility	LTE Rating	Option 2a
				Wyman-Larrabee
				Available MW Injection
LN_3026	LN_392	CROWLEYS 115 SUROWIEC 115 1 <i>(Several Elements Overloaded)</i>	226	460

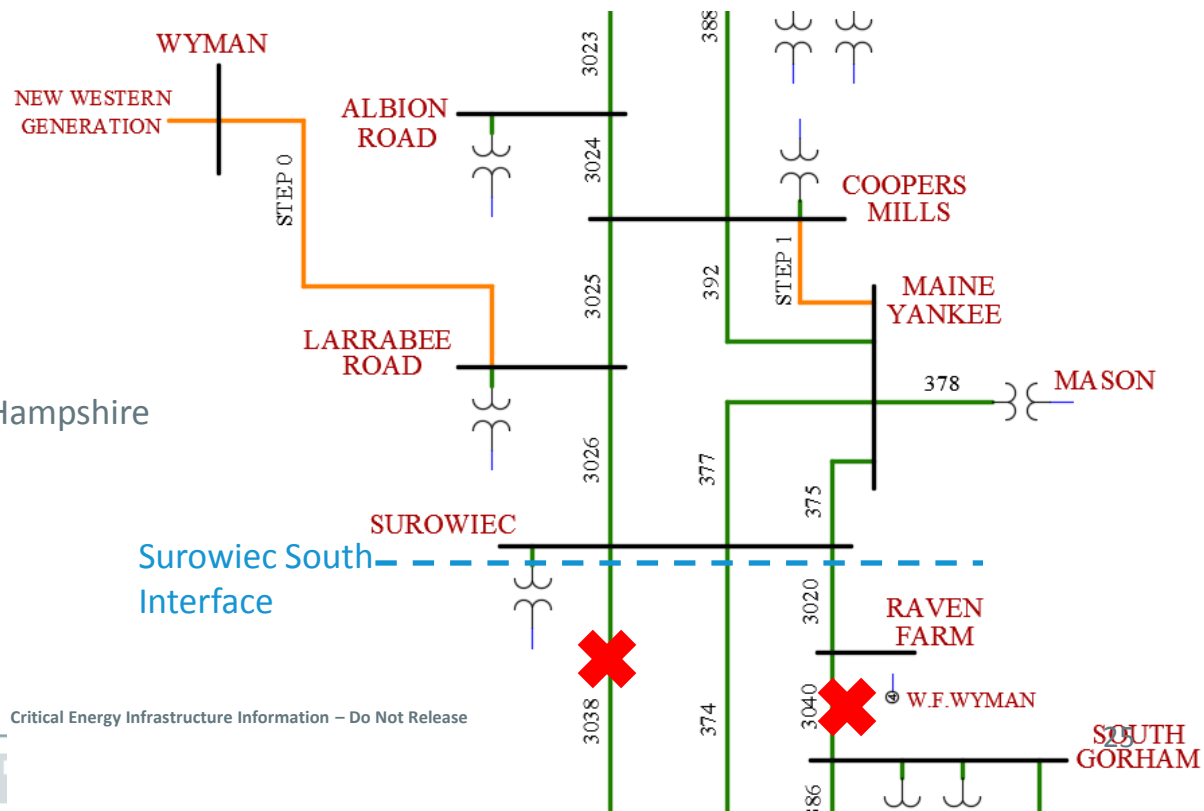


*No re-dispatch north of Maine-New Hampshire was conducted for these results

Western N-1-1 Thermal Results – Option 2a (Step 0 & Step 1 Upgrades)

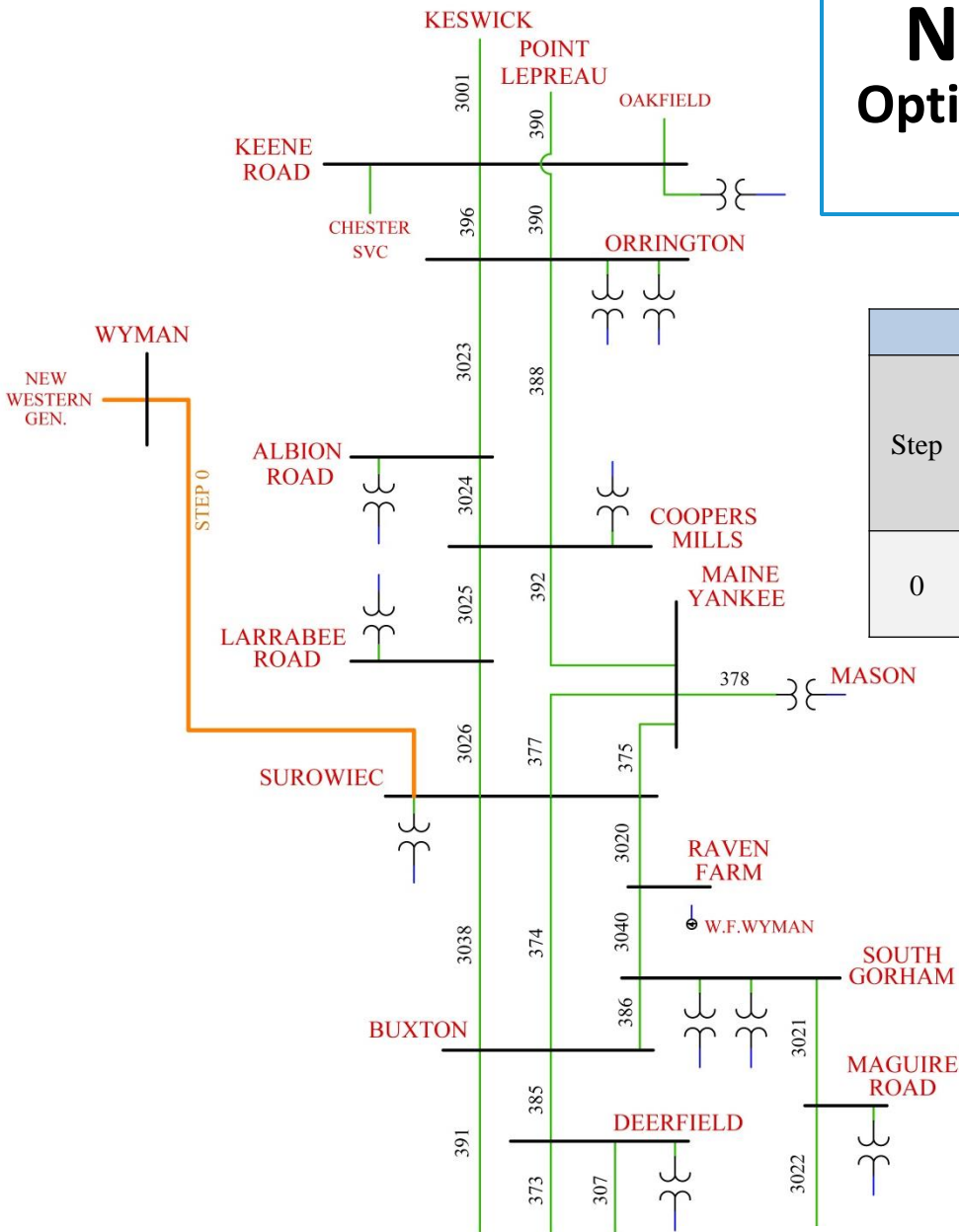
The N-1-1 Limit for Western Option 2a, with the inclusion of a parallel S.392, is increased to 785 MW.

First Level Outage	Contingency	Monitored Facility	LTE Rating	Option 2a
				Wyman-Larrabee
				Available MW Injection
S.374/3038 (Surowiec-Buxton)	S.3040 (S.Gorham-Raven)	S.374/3038 (Surowiec-Buxton)	1429	785



*No re-dispatch north of Maine-New Hampshire was conducted for these results

N-1 New Western Gen.
Option 2b – Interconnect at Surowiec
from Wyman Western Gen.



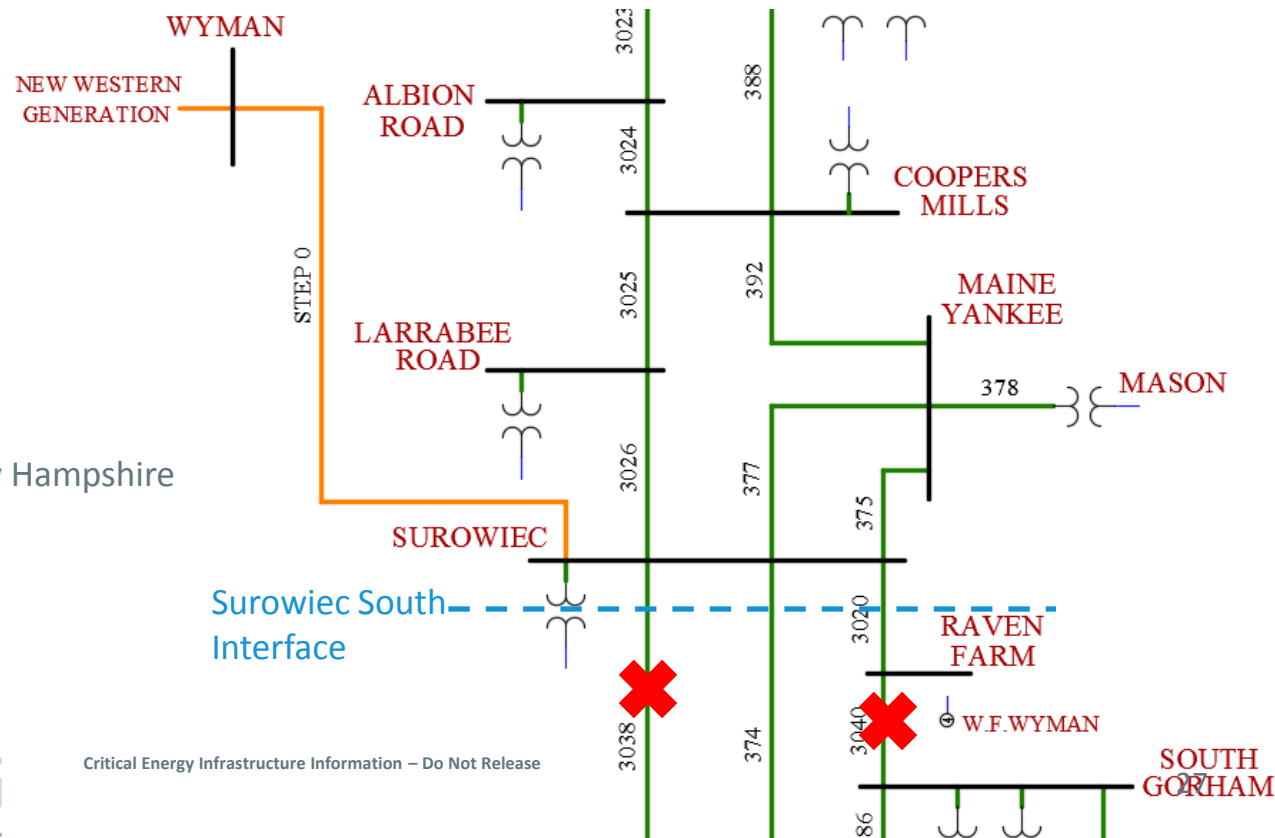
(Wyman to Surowiec)				
Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	New Line (Wyman-Surowiec)	S.374/3038 (Surowiec-Buxton)	S.3040 (S.Gorham-Raven)	984

*No re-dispatch north of Maine-New Hampshire was conducted for these results

Western N-1-1 Thermal Results – Option 2b

The N-1-1 Limit for Western Option 2b is approx 866 MW.

First Level Outage	Contingency	Monitored Facility	LTE Rating	Option 2b
				Wyman-Surowiec
				Available MW Injection
LN_3038	LN_3040	SUROWIEC 345 BUXTON 345 1	1429	866



*No re-dispatch north of Maine-New Hampshire was conducted for these results

NCIS Re-dispatch Options – Western Option 2a & 2b

- Western options 2a (with the parallel new 392 line) & 2b perform similarly well from a thermal perspective – even without re-dispatch
- Note that, without re-dispatch, there would be an increase in Surowiec South transfers
 - Surowiec South was at limit before the addition of the new resources
- For the N-1-1 limits found, a candidate resource to dispatch against is Yarmouth 4 (also known as WF Wyman 4)
 - Yarmouth 4 is connected to the 345 kV system
 - However, Yarmouth 4 is connected to the south of Surowiec South

Investigation of Increasing the Surowiec South Transfer Capability

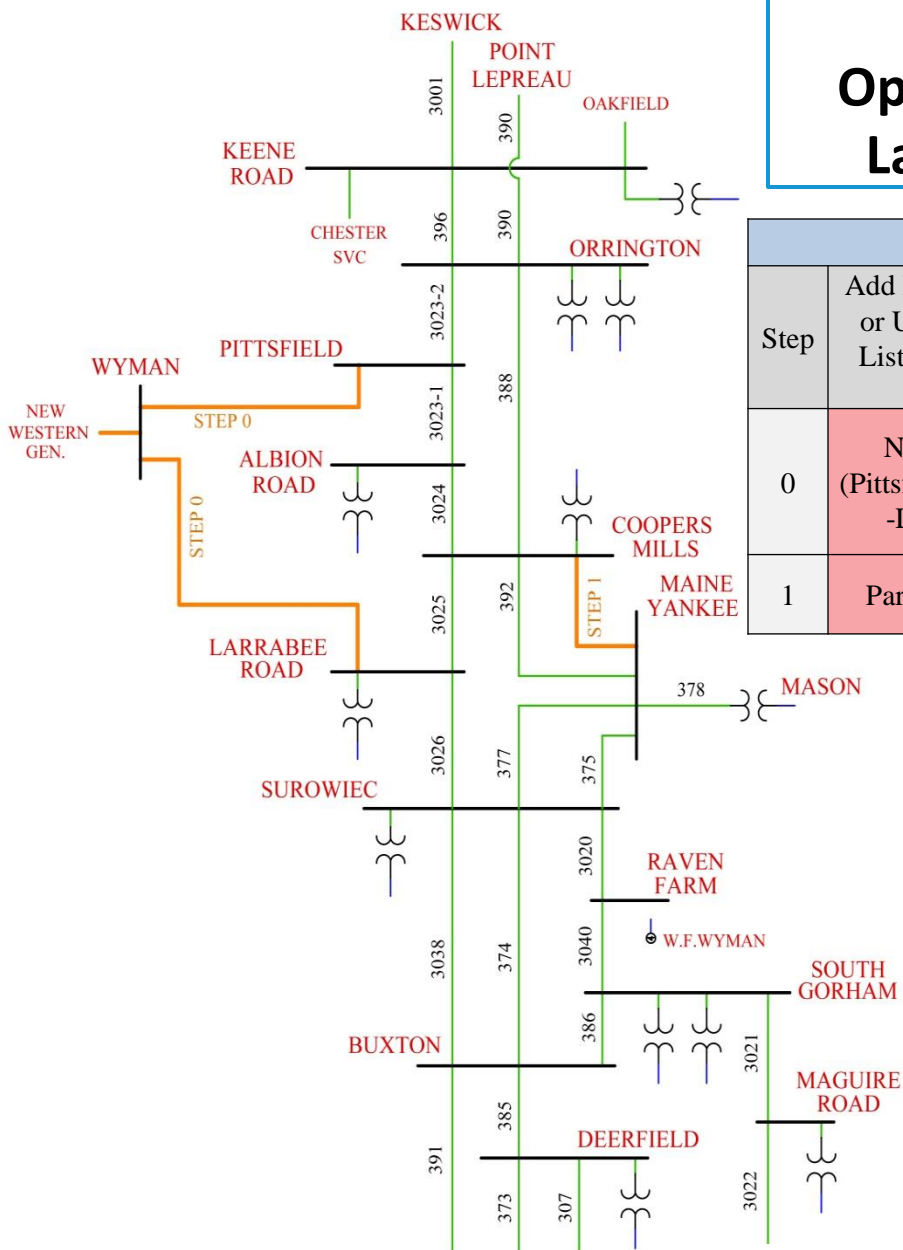
- Investigated increasing Surowiec South from 1,600 MW to 2,200 MW
 - The increased flow was simulated in the study by (partially) dispatching against Yarmouth 4
 - The remaining re-dispatch was performed by turning down existing Western Maine generation when adding the new proposed Western Maine resources
- Note that this increase in Surowiec South will require a significant amount of stability and voltage testing to confirm achievability
- As described later in this presentation, an increase in Surowiec South transfer capability would be used by both Western and Northern Maine proposed resources

NCIS Re-dispatch Results – Western Option 2a & 2b

- When dispatching against Yarmouth 4 and existing Western Maine resources – no N-1 or N-1-1 thermal violations were identified for the addition of up-to 1,200 MW of new resources in Western Maine
 - From a thermal perspective, Western Maine options 2a & 2b can accommodate up-to 1,200 MW
 - **Note that significant stability and voltage testing is still required to demonstrate achievability**
 - **Preliminary stability and voltage testing is showing that very large reactive upgrades (perhaps more than 1,000 MVAR) are required**
 - **A preliminary review of short circuit strength is showing that significant reinforcement could be required, either in the form of synchronous condensers or additional transmission**

N-1 New Western Gen.

Option 3 – Interconnect at Pittsfield and Larrabee from Wyman Western Gen.



(Pittsfield to Wyman to Larrabee)

Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	New Lines (Pittsfield-Wyman-Larrabee)	S.392 (Coopers-ME Yankee)	Larrabee K3025/NEW Stuck Breaker	429
			S.3026 (Larrabee-Surowiec)	624
1	Parallel S.392	S.3038 (Surowiec-Buxton)	S.3040 (S.Gorham-Raven)	996

*No re-dispatch north of Maine-New Hampshire was conducted for these results

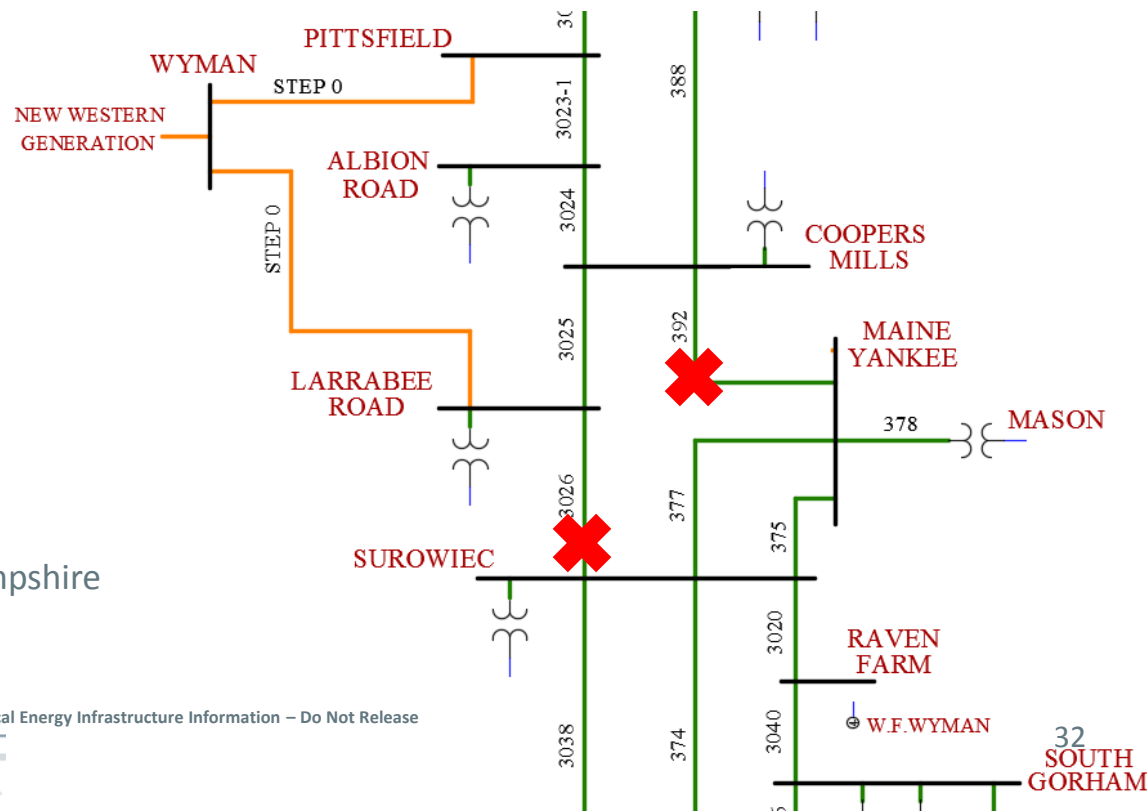
Western N-1-1 Thermal Results – Option 3

(Step 0 Only)

The N-1-1 Limit for Western Option 3 modeling the addition of the new lines from Pittsfield to Wyman to Larrabee Road only is 466 MW.

In order to increase the amount of generation to greater than 446 MW a parallel S.392 would need to be added.

First Level Outage	Contingency	Monitored Facility	LTE Rating	Option 3
				Pitts.-Wyman-Larrabee & Larr.BKR
				Available MW Injection
LN_3026	LN_392	CROWLEYS 115 SUROWIEC 115 1 <i>(Several Elements Overloaded)</i>	226	466



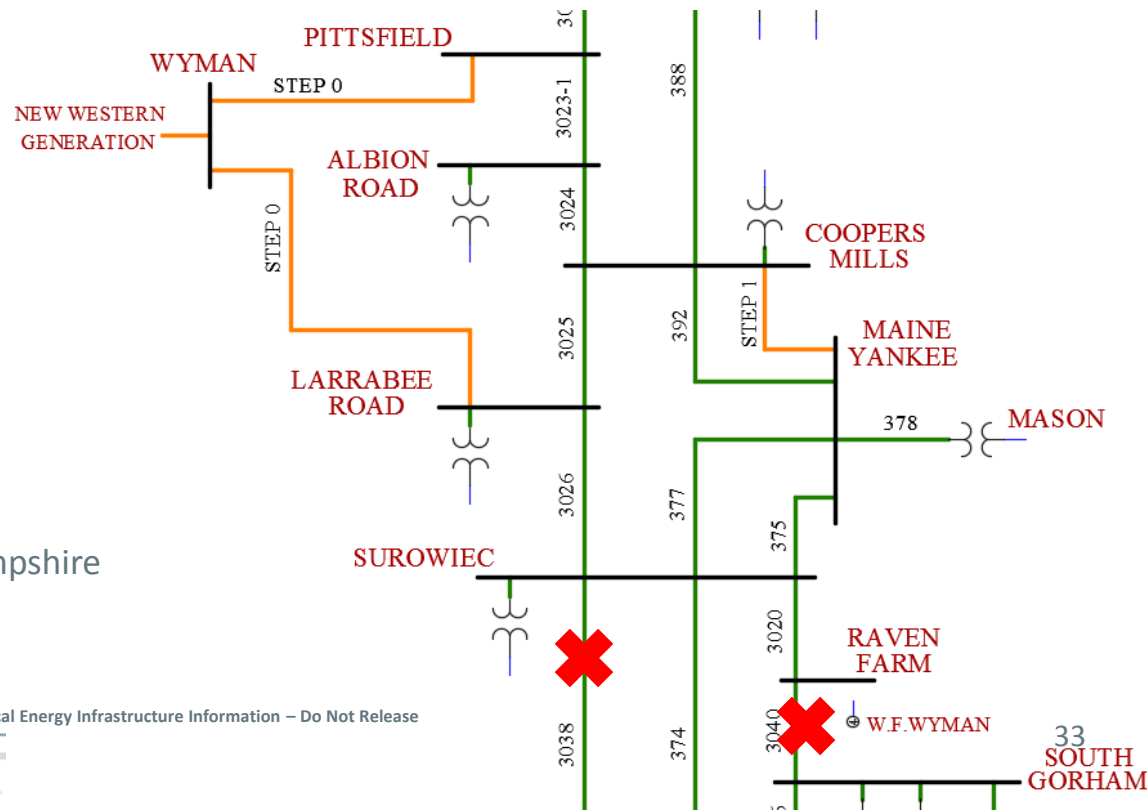
*No re-dispatch north of Maine-New Hampshire was conducted for these results

Western N-1-1 Thermal Results – Option 3

(Step 0 & Step 1 Upgrades)

The N-1-1 Limit for Western Option 3, with the inclusion of a parallel S.392, is increased to 841 MW

First Level Outage	Contingency	Monitored Facility	LTE Rating	Option 3
				Pitts.-Wyman-Larrabee & Larr.BKR
				Available MW Injection
S.374/3038 (Surowiec-Buxton)	S.3040 (S.Gorham-Raven)	S.374/3038 (Surowiec-Buxton)	1429	841



*No re-dispatch north of Maine-New Hampshire was conducted for these results

NCIS Re-dispatch Discussion – Western Option 3

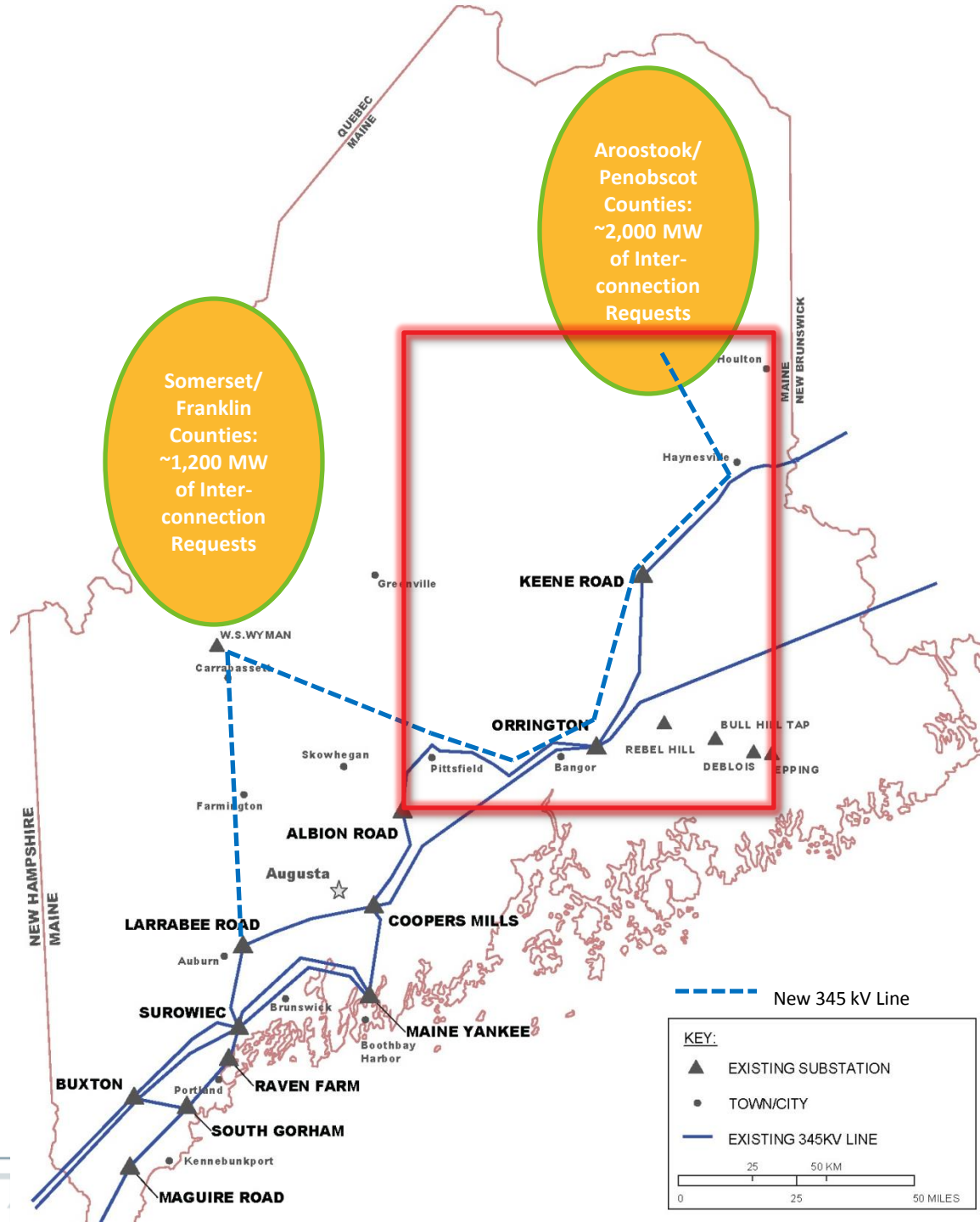
- Western Option 3 provides essentially no incremental benefit in thermal performance over Western Option 2a or 2b
 - The NCIS re-dispatch results are essentially the same
- However, the additional 345 kV transmission connection from the Wyman area to Pittsfield may prove to be required for larger MW additions – to alleviate stability, voltage and/or weak-grid issues

STEADY STATE RESULTS

NORTHERN MAINE

Northern Infrastructure Concepts

- 345 kV connection between the Northern Maine area and Pittsfield

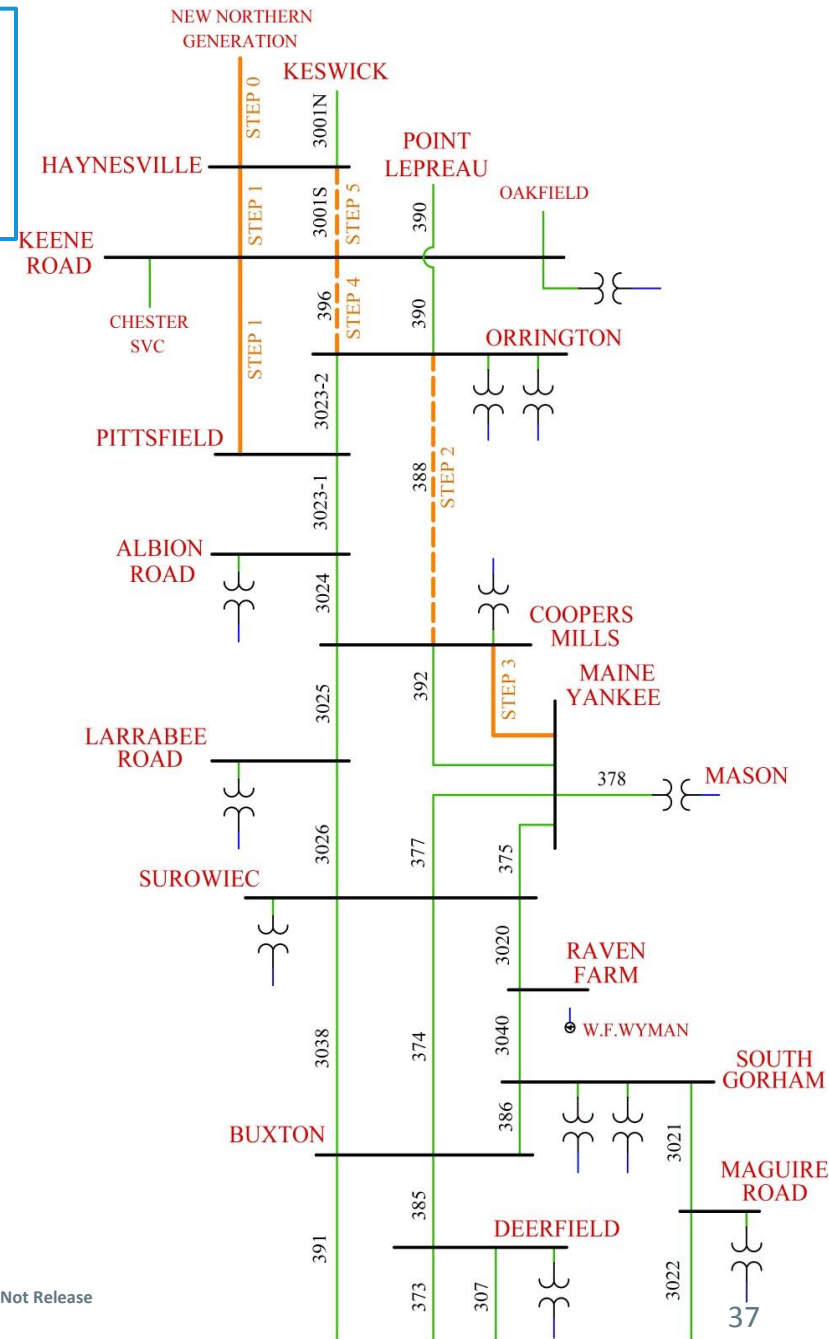


N-1 New Northern Gen.

Option 1 - Interconnect at Haynesville, Keene Road, and Pittsfield

(New Gen. to Haynesville to Keene Road to Pittsfield)				
Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	Add New Connection to Haynesville (S.3001 Interconnection)	S.396 (Orr.-Keene Rd)	Orrington K390-1 Breaker Failure	132
1	New Lines (Pittsfield-Keene Rd & Keene Rd - Haynes.)	S.388 (Orrington-Coopers)	Any Albion Road Stuck Breaker	368
			S.3023-1 (Albion-Pittsfield)	390
2	S.388 (Orrington-Coopers)	S.392 (Coopers-ME Yankee)	S.3025 (Coopers-Larrabee)	422
3	Build Parallel S.392 (Coopers-ME Yankee)	S.396 (Orr.-Keene Rd)	New Line (Pittsfield-Keene Rd)	508
4	S.396 (Orr.-Keene Rd)	S.3001S (Keene Rd-Haynes.)	New Line (Keene Rd-Haynes.)	720
5	S.3001S (Keene Rd-Haynes.)	S.3038/374 (Buxton-Surowiec)	S.3040 (South Gorham-Raven)	992

*No re-dispatch north of Maine-New Hampshire was conducted for these results



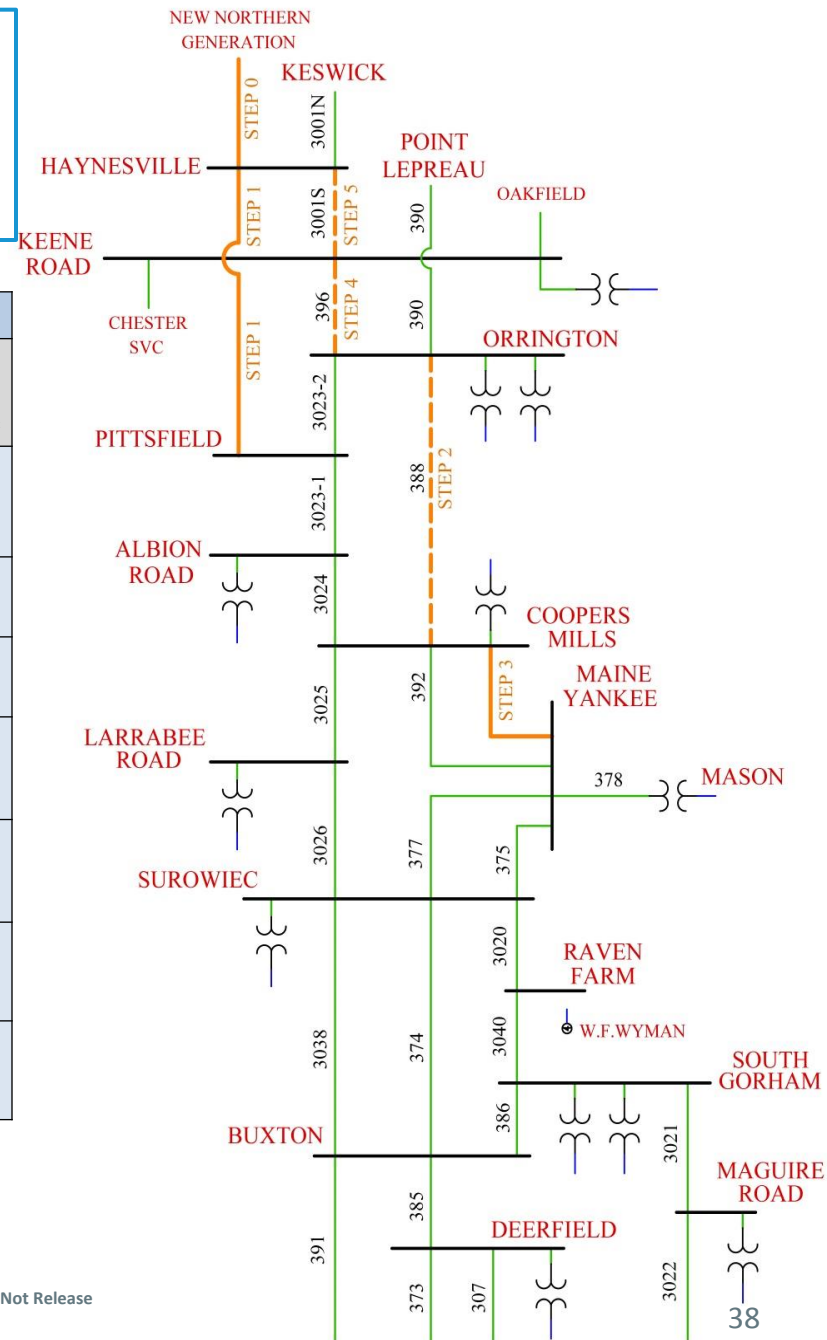
N-1 New Northern Gen.

Option 2 - Interconnect at Haynesville and Pittsfield. Bypass Keene Road.

(New Generation to Haynesville to Pittsfield)

Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	Add New Gen. (Haynesville/S.3001 Interconnection)	S.396 (Orr.-Keene Rd)	Orrington K390-1 Breaker Failure	132
1	New Line (Pittsfield-Haynes.)	S.388 (Orrington-Coopers)	Any Albion Road Stuck Breaker	369
			S.3023-1 (Albion-Pittsfield)	391
2	S.388 (Orrington-Coopers)	S.392 (Coopers-ME Yankee)	S.3025 (Coopers-Larrabee)	422
3	Build Parallel S.392 (Coopers-ME Yankee)	S.396 (Orr.-Keene Rd)	New Line (Pittsfield-Haynes.)	581
4	S.396 (Orr.-Keene Rd)	S.3001S (Keene Rd-Haynes.)	New Line (Pittsfield-Haynes.)	820
5	S.3001S (Keene Rd-Haynes.)	S.3038/374 (Buxton-Surowiec)	S.3040 (South Gorham-Raven)	992

*No re-dispatch north of Maine-New Hampshire was conducted for these results



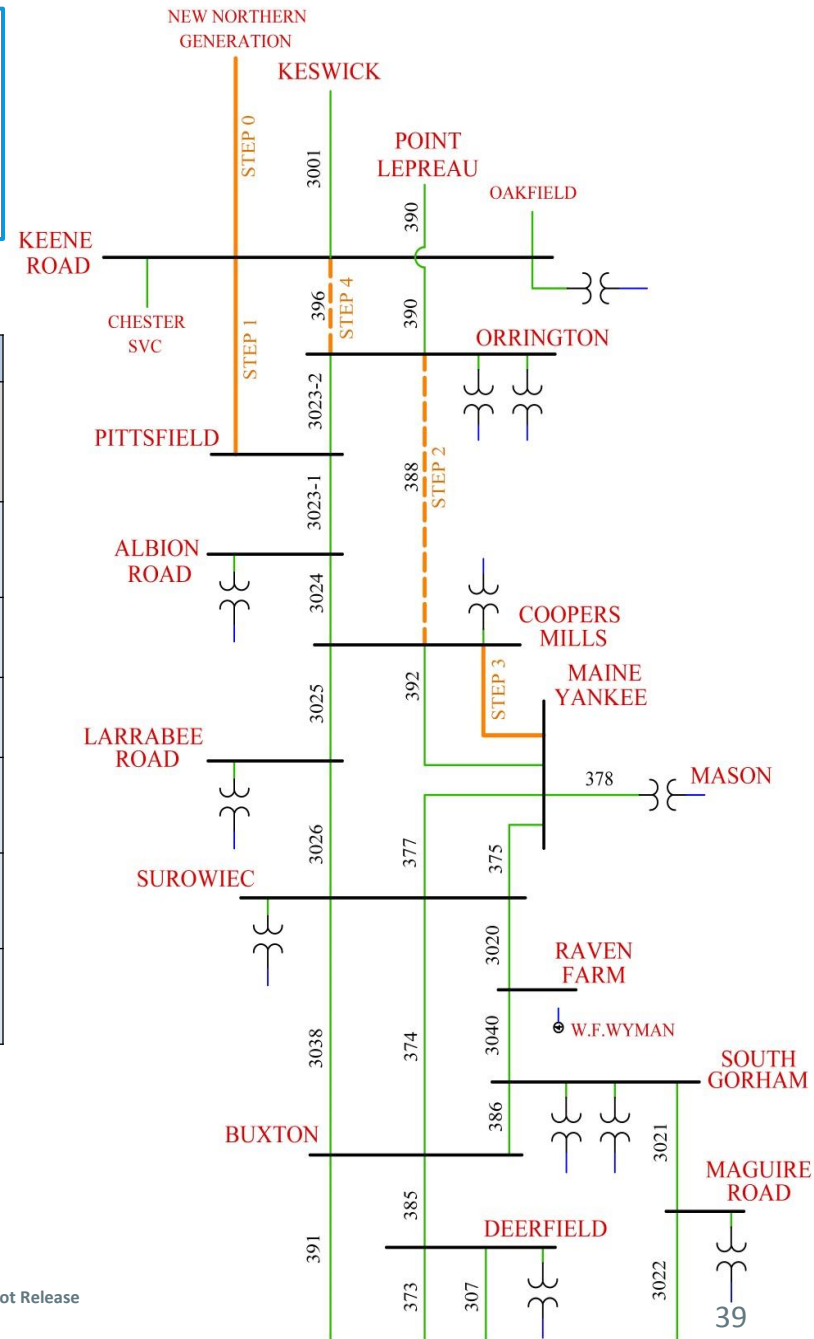
N-1 New Northern Gen.

Option 3 - Interconnect at Keene Road and Pittsfield. Bypass Haynesville.

(New Generation to Keene Road to Pittsfield)

Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	Add New Gen. (Keene Rd.-New Gen.)	S.396 (Orr.-Keene Rd)	Orrington K390-1 Breaker Failure	132
1	New Lines (Pittsfield-Keene Rd.)	S.388 (Orrington-Coopers)	Any Albion Road Stuck Breaker	371
			S.3023-1 (Albion-Pittsfield)	393
2	S.388 (Orrington-Coopers)	S.392 (Coopers-ME Yankee)	S.3025 (Coopers-Larrabee)	424
3	Build Parallel S.392 (Coopers-ME Yankee)	S.396 (Orr.-Keene Rd)	New Line (Pittsfield-Keene Rd.)	502
4	S.396 (Orr.-Keene Rd)	S.3038/374 (Buxton-Surowiec)	S.3040 (South Gorham-Raven)	995

*No re-dispatch north of Maine-New Hampshire was conducted for these results



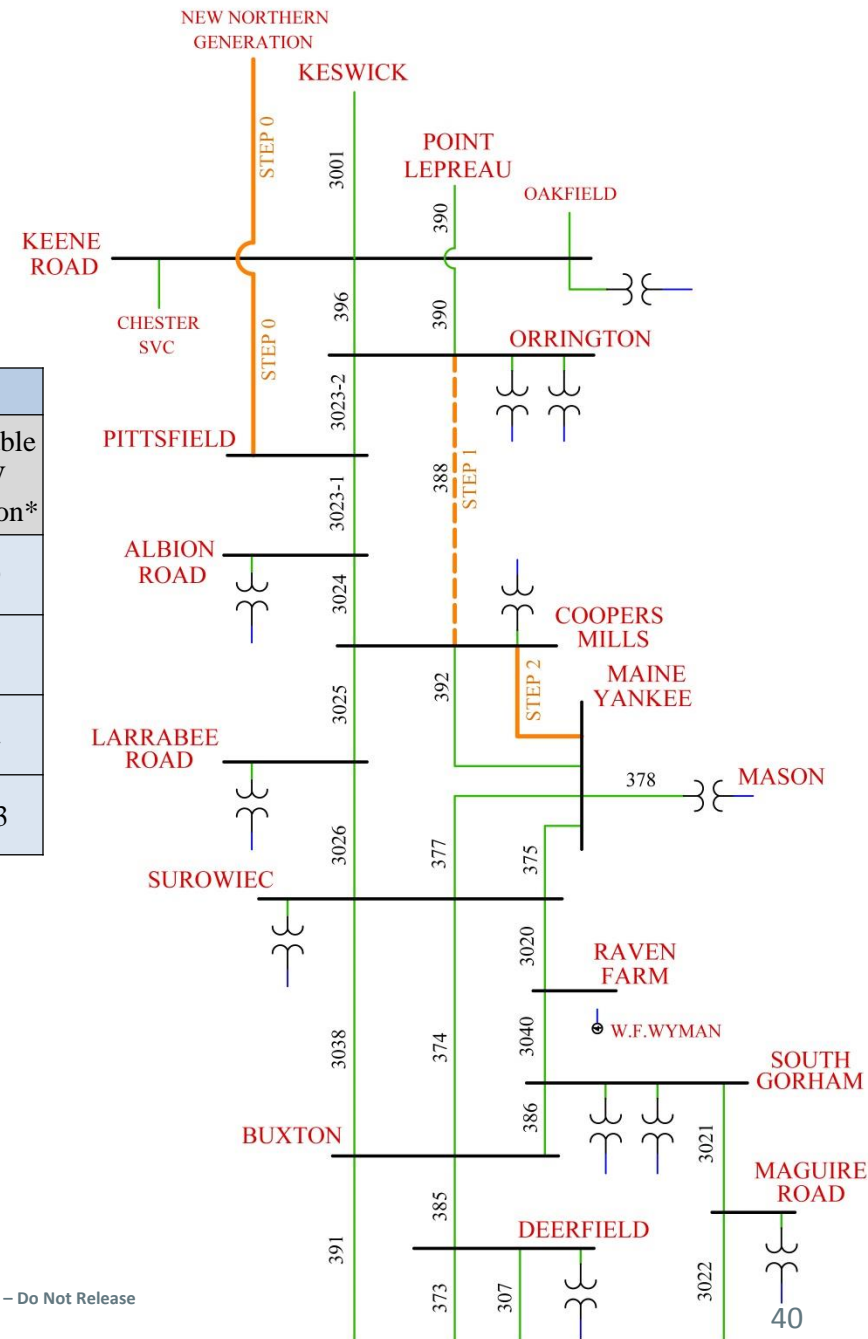
N-1 New Northern Gen.

Option 4 - Interconnect at Pittsfield. Bypass Haynesville and Keene Road.

(New Generation to Pittsfield)

Step	Add New Line(s) or Upgrade the Listed Existing Line	Next Most-Limiting Element	Limiting Contingency	Available MW Injection*
0	Add New Gen. (Pittsfield-New Gen.)	S.388 (Orrington-Coopers)	Any Albion Road Stuck Breaker	379
			S.3023-1 (Albion-Pittsfield)	401
1	S.388 (Orrington-Coopers)	S.392 (Coopers-ME Yankee)	S.3025 (Coopers-Larrabee)	432
2	Build Parallel S.392 (Coopers-ME Yankee)	S.3038/374 (Buxton-Surowiec)	S.3040 (South Gorham-Raven)	1003

*No re-dispatch north of Maine-New Hampshire was conducted for these results

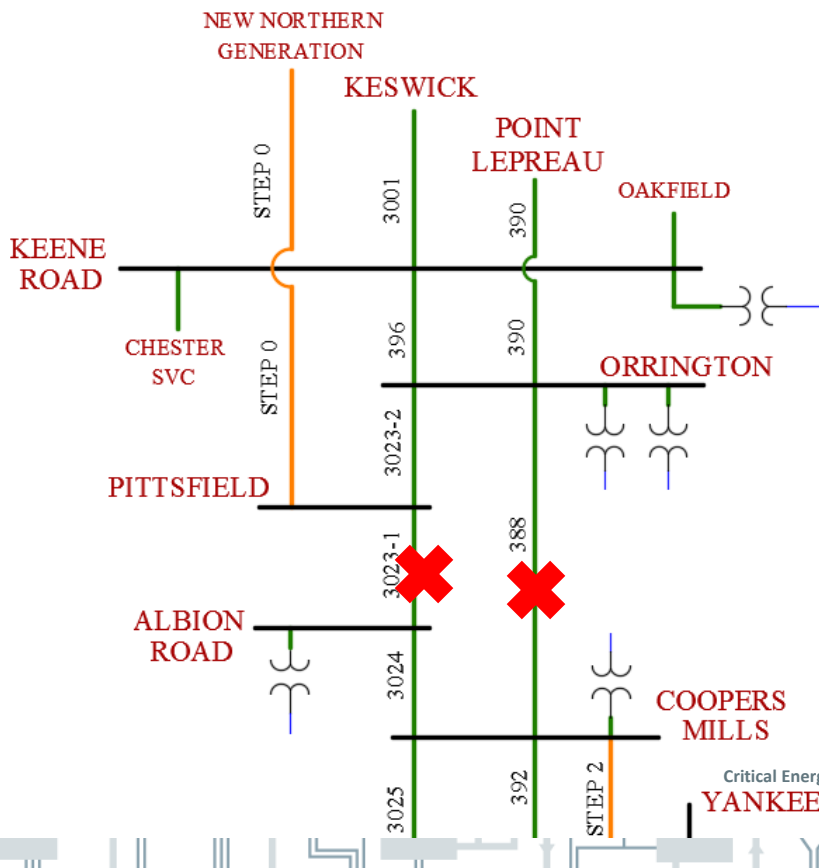


Northern N-1-1 Thermal Results

First Level Outage	Contingency	Monitored Facility	LTE Rating	Option 1	Option 2	Option 3	Option 4
				Haynes. & Keene Road Interconnect	Keene Road Bypassed	Haynes. Bypassed	Haynes. & Keene Road Bypassed
				Available MW Injections			
LN_3023-1	Orrington K390/388 <i>(Several Contingencies)</i>	CMP_65_EM 115 BUCKSPORT 115 1	193	345	344	345	346

One line diagram for Option 4

Note that all 4 options were tested



The N-1-1 Limit for all Options is approx 345 MW – additional upgrades defined in the N-1 analysis will not increase this limit. In order to increase this limit another line from Pittsfield or Orrington-South is required.

*No re-dispatch north of Maine-New Hampshire was conducted for these results

ISSUES WITH ADDING INTERCONNECTIONS NORTH OF ORRINGTON SOUTH

One-line in Northern Maine

To Q272

Auto T2

South to Keene Rd
Or Pittsfield

New Generation

New Substation
Haynesville

3001S

Keswick

396

K396-5

K3001-5

KT1H-1

KT1H-2(NO)

Keene Road

Auto T1

Chester SVC

3001N

K3-6

K3-5

K3-4

Orrington

T1

3003

P3-4

P3-10

P3-9

Pt. Lepreau

390

Maine

New Brunswick

K396/3023

K388/390

K3023-1

K388-1

3023

388

T2

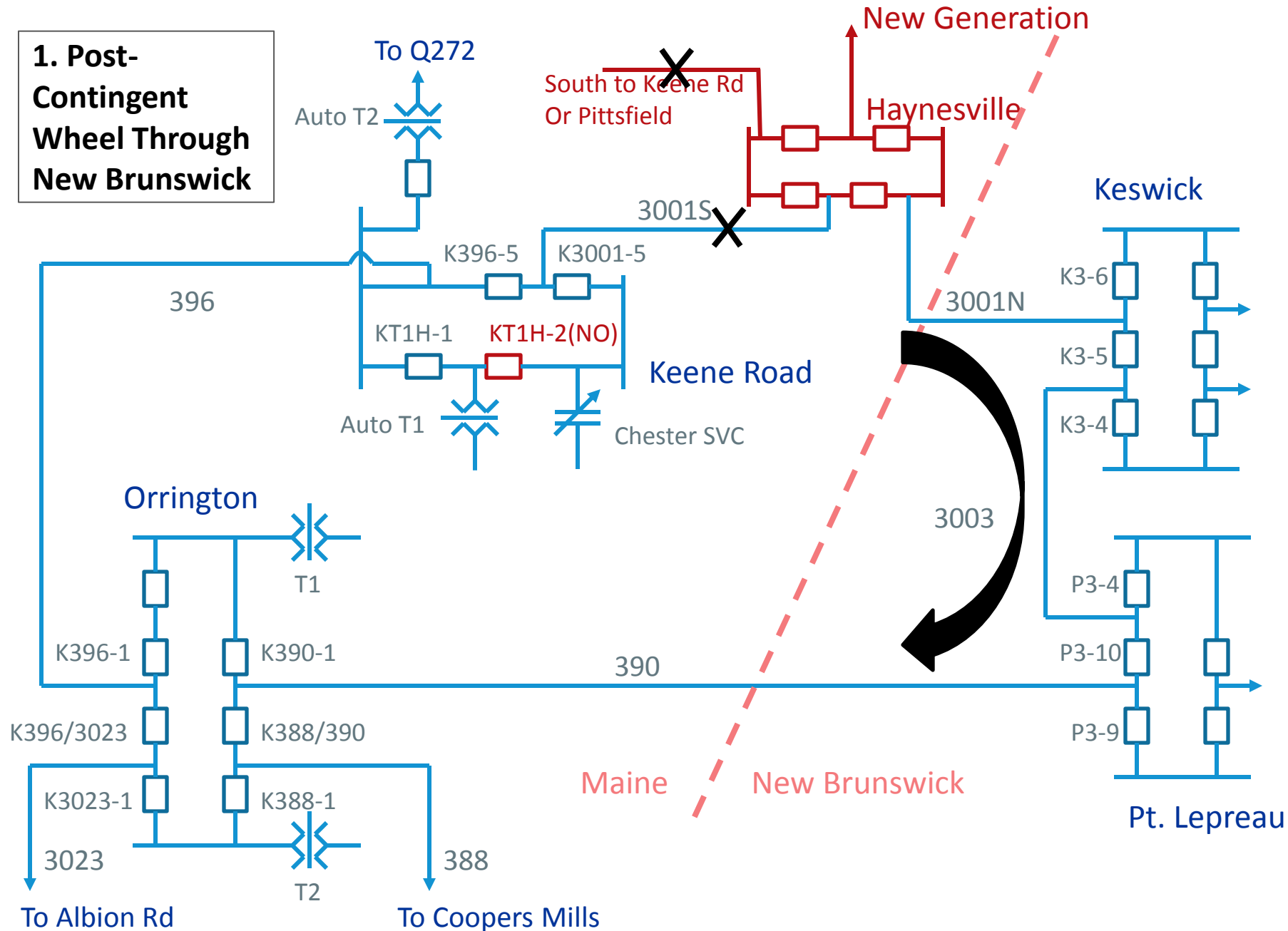
To Albion Rd

To Coopers Mills

Issues When Adding New Connections North of Orrington South

1. Unacceptable post-contingency wheel-through New Brunswick
2. Interaction with existing Special Protection Systems causing unacceptable loss-of-source
3. Extremely high short-term voltages caused by interaction with the existing Chester Static Var Compensator

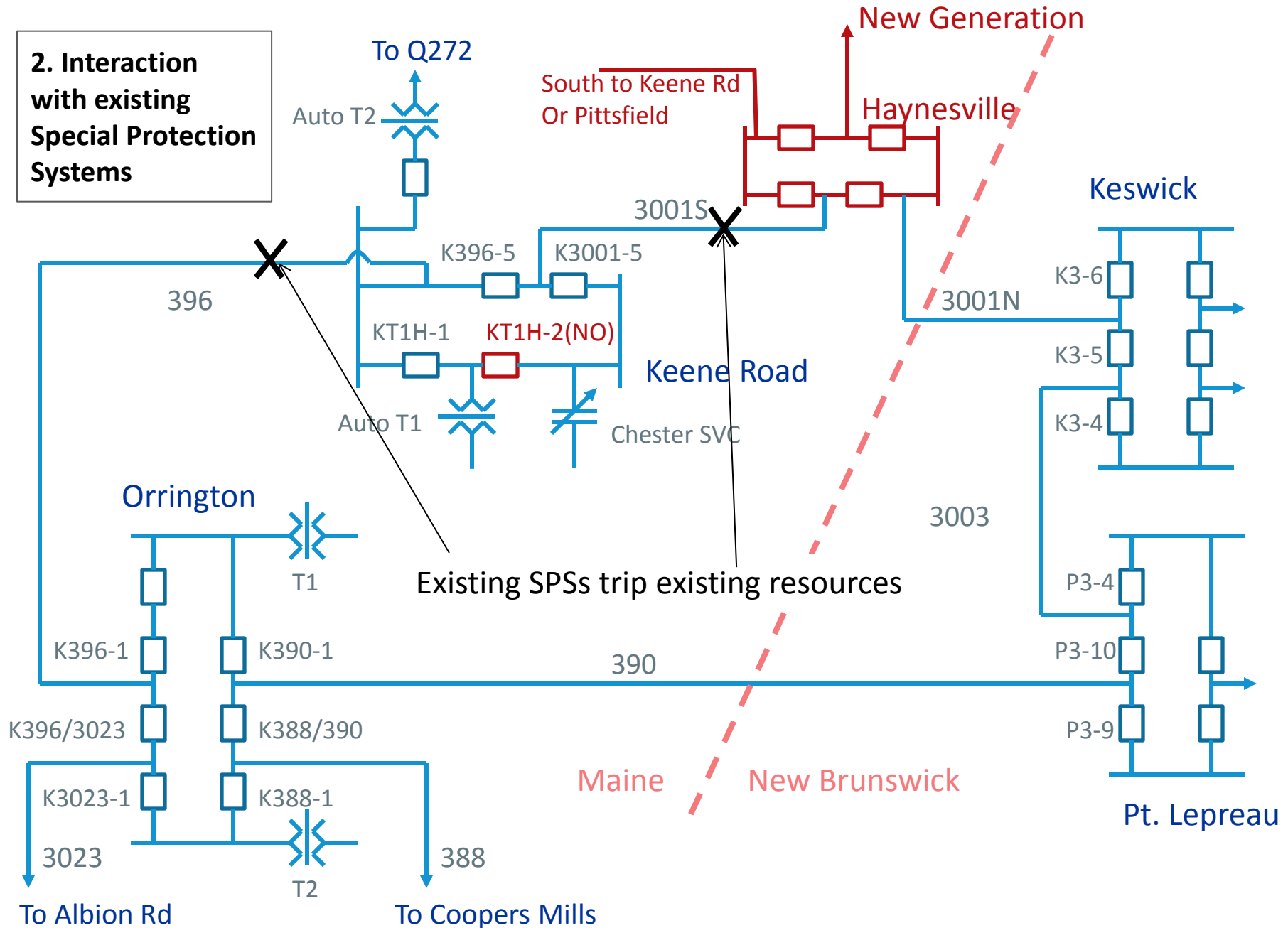
1. Post-Contingent Wheel Through New Brunswick



Post-Contingent Wheel Through New Brunswick

- The N-1-1 wheel-through New Brunswick causes unacceptably low voltages at the Point Lepreau Nuclear Generating Station
 - Could only be mitigated by a full back-down of the new generation between the first and second contingency, or, an extremely large dynamic reactive device at Orrington

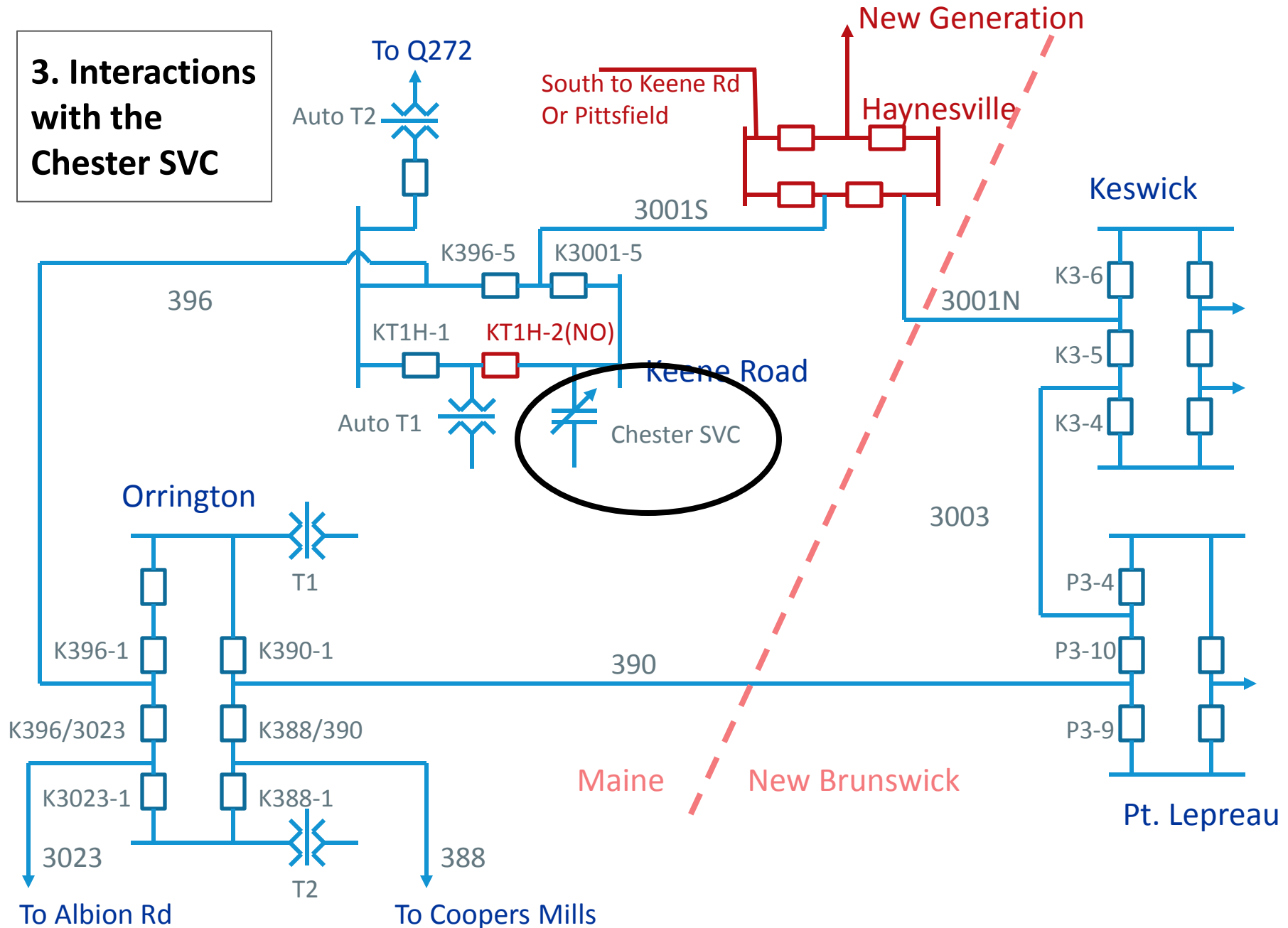
2. Interaction with existing Special Protection Systems



Room to Back-Down New Resources Limited by the Presence of Existing SPSs

- New Brunswick Direct Path Logic SPS
 - Trips up-to 400 MW of New Brunswick generation for the loss of Line 390, 396 or 3001
- 396 SPS
 - Trips Maine Independence Station for the loss of Line 396 or 3001
- The overall reduction in reduction in resources for N-1 or N-1-1 contingencies is limited to 1,200 MW
 - There are dispatch scenarios where the ability to add new resources to this back-down is very limited

3. Interactions with the Chester SVC



Interactions with the Chester SVC

- The Chester SVC is a large fast-acting dynamic reactive device
 - Added before the addition of the second New Brunswick tie or the Keene Road substation
- Very high post-contingent voltages have been identified in studies that would trip wind-farms in close electrical proximity to the Chester SVC
 - Resulted in breaker-open operation at Keene Road
- Connection of new resources in close electrical proximity to the Chester SVC would either require retirement of the SVC or retuning of the SVC
 - This would require the addition of offsetting dynamic reactive device(s) elsewhere on the system



Interconnection North of Orrington - Conclusion

- For the reasons described above, the ISO is recommending the avoidance of a new interconnection north of Orrington
 - Northern Option 4 bypasses all of the issues north of Orrington
 - Northern Option 4 is recommended, in combination with additional infrastructure, as described in the following section

STEADY STATE RESULTS COMBINED NORTHERN AND WESTERN MAINE

Northern and Western Combination

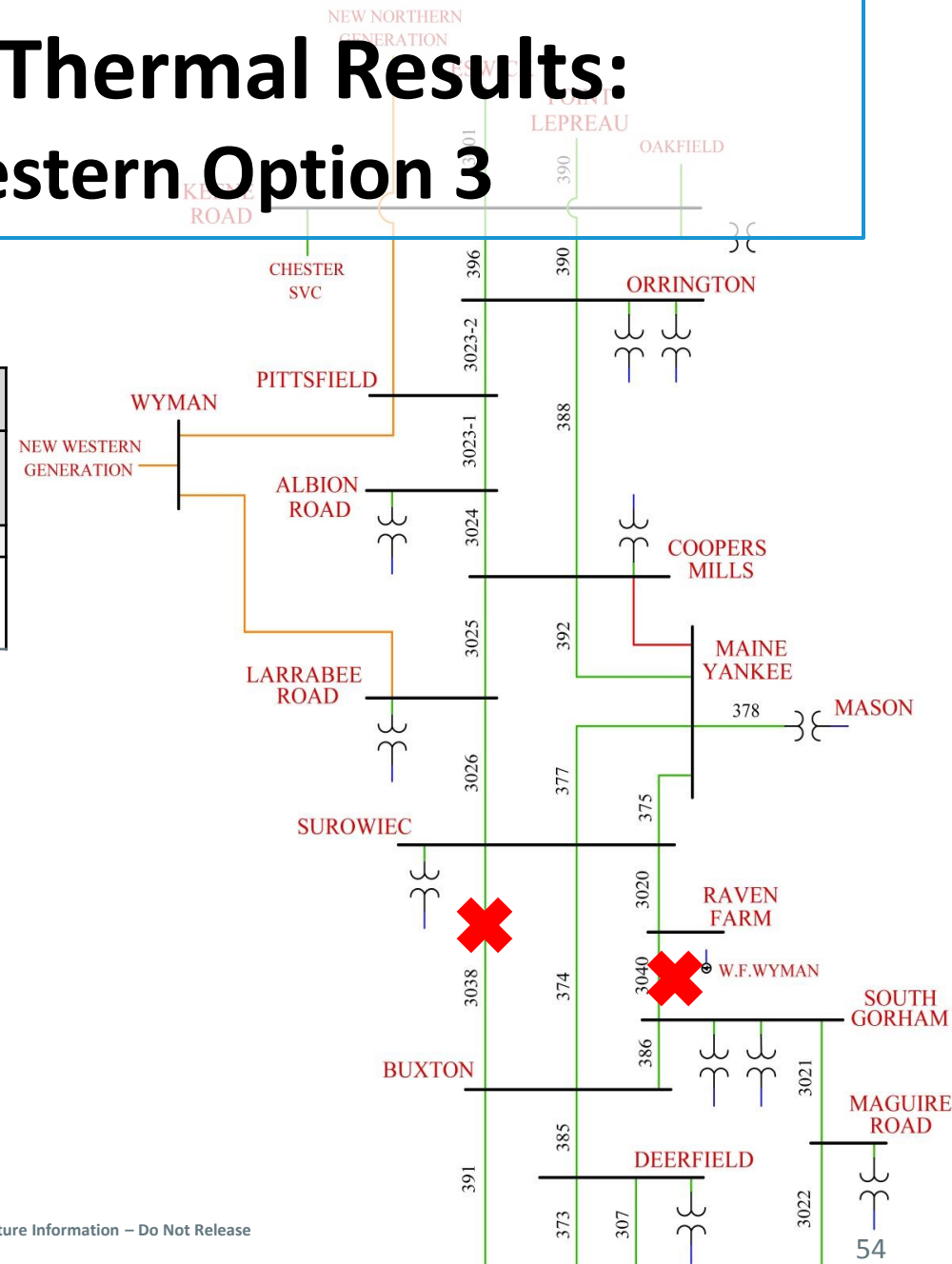
- The Northern Option 4 was chosen together with the Western Option 3 because this provided a complete new 345 kV path from Aroostook County down to Larrabee Road
 - Recall that N-1-1 testing of Northern Option 4 identified that an additional path south of Pittsfield would be required for new resource additions greater than 345 MW
 - Other combinations may be reviewed based on further testing

Combination N-1-1 Thermal Results: Northern Option 4, Western Option 3

First Level Scenario	Contingency Name	Monitored Facility	LTE Rating	North, Option 4	West, Option 3
				Haynes. & Keene Road Bypassed	Pittsfield-Wyman-Larrabee
				Available MW Injection	
LN_3038	LN_3040	SUROWIEC 345 BUXTON 345 1	1429	863	

The N-1-1 Limit for the combination of Northern Option 4 and Western Option 3 is approx 863 MW (modeled in this case as 500 MW from the North and 363 MW from the West).

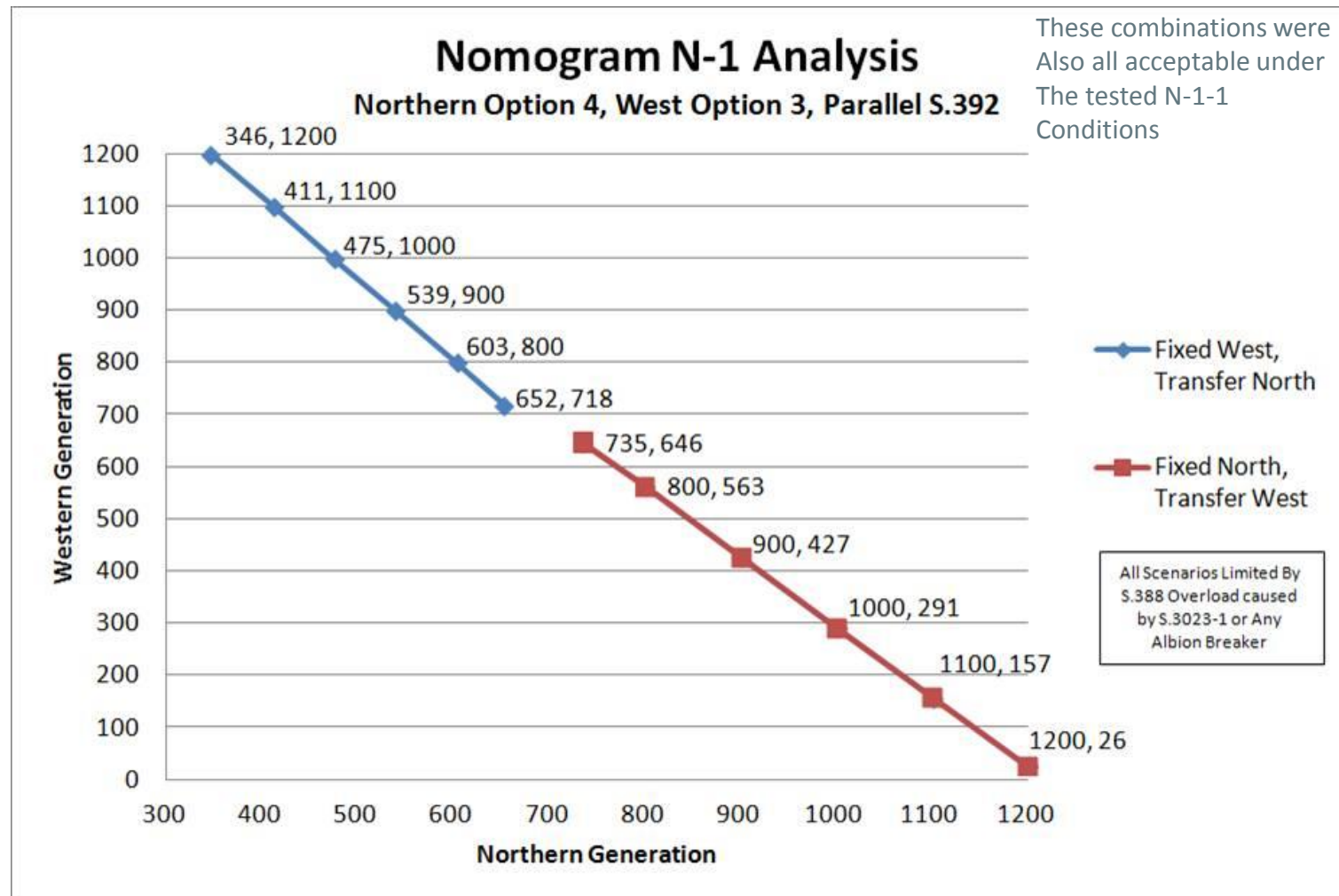
*No re-dispatch north of Maine-New Hampshire was conducted for these results



NCIS Re-dispatch considerations – North/West Combination

- Because Northern Option 4 connects south of Orrington, the analysis can use the same re-dispatch approach that was used for Western Maine
- When dispatching against Yarmouth 4 and existing Western Maine resources – no N-1 or N-1-1 thermal violations were identified for the addition of up-to 1,200 MW of new resources in Northern Maine (with no resources added in Western Maine)
 - From a thermal perspective, North Option 4/Western Maine Option 3 combination can accommodate up-to 1,200 MW from the North
 - **Note that significant stability and voltage testing is still required to demonstrate achievability**
 - **Preliminary stability and voltage testing is showing that very large reactive upgrades (perhaps more than 1,000 MVAR)**
 - **A preliminary review of short circuit strength is showing that significant reinforcement could be required, either in the form of synchronous condensers or additional transmission**
- Simultaneous Western and Northern injection was also investigated

North/West Combination – Simultaneous Injection Capability



Steady State Analysis Conclusions

- The combined Northern Option 4 and Western Option 3 is the preferred alternative for interconnecting the most new resources from both the North and the West
- The ISO is considering designating the West and North as separate clusters and allowing the North and West clusters to dispatch against each other for thermal testing – with the new 2,200 MW Surowiec South interface as the binding limit
 - Stability testing will still require scenarios where both West and North clusters are running at full output

Next Steps

- Perform weak grid evaluations
- Complete stability analysis
- Present final results
 - Q1 2017

A circular arrangement of blue icons representing various energy sources and infrastructure. The icons include solar panels, wind turbines, factories with smokestacks, power lines, a large central battery icon, and a car. The icons are arranged in a circular pattern, with the battery icon at the bottom center.