Revision 1

Operational Fuel-Security Analysis

Stakeholder Requests for Additional Scenarios

Operational Fuel-Security Analysis: Stakeholder Requests

- In January 2018, ISO-NE issued the Operational Fuel-Security Analysis to improve the ISO's and the region's understanding of operational risks and inform subsequent discussions with stakeholders
- Stakeholders were provided an opportunity to submit requests for additional hypothetical sensitivities to the ISO's study
- By mid-February, the ISO received requests equating to hundreds of new scenario combinations in the operational model

Operational Fuel-Security Analysis: Stakeholder Requests, cont.

- Due to the volume of requests, the ISO was not able to prepare an individual analysis to address every item; however, a significant number (~150) of additional runs of the model were conducted based on the requests received
- Graphical depictions, providing directional information about expected energy shortfalls when the sensitivities are shifted up or down, have also been created to provide stakeholders with additional information on the region's reliability challenges presented by different scenarios requested

Presentation Outline

- Section 1: General Comments and Clarifications
  - Addresses requests for general explanations or clarifications of ISO-created Scenarios
- Section 2: Graphic Depictions of Changes to Inputs
  - Addresses requests for changes to various input assumptions by grouping similar requests and showing directional trends
- Section 3: Specific Scenario Results
  - Reports results of stakeholder-requested model runs that ISO was able to conduct

SECTION 1:
GENERAL COMMENTS & CLARIFICATIONS

Caveats for the Operational Fuel-Security Analysis

- The Operational Fuel-Security Analysis is a ***deterministic*** analysis that provides ***directional guidance; it is not a forecast or prediction of actual future events***
- The Operational Fuel-Security Analysis ***does not reflect the potential for market response*** to pricing or other incentives
  - While the study did not explicitly consider specific market responses, the ISO assumed that prices in each scenario would sustain the inputs to that scenario
- The Operational Fuel Analysis does not evaluate impacts of the sudden draw-down of oil or LNG

Certain Limitations or Constraints not Addressed by the Model

ISO's model is not capable of modeling:

- State emissions limitations or goals
- Local constraints on the electric transmission or gas transportation systems
- Market response to pricing or state-mandated purchases

Note: If a stakeholder request provided a proxy for such scenarios using the model's inputs or variables, the ISO ran it through the model

Requested Clarification on Modeling of Mystic and Distrigas

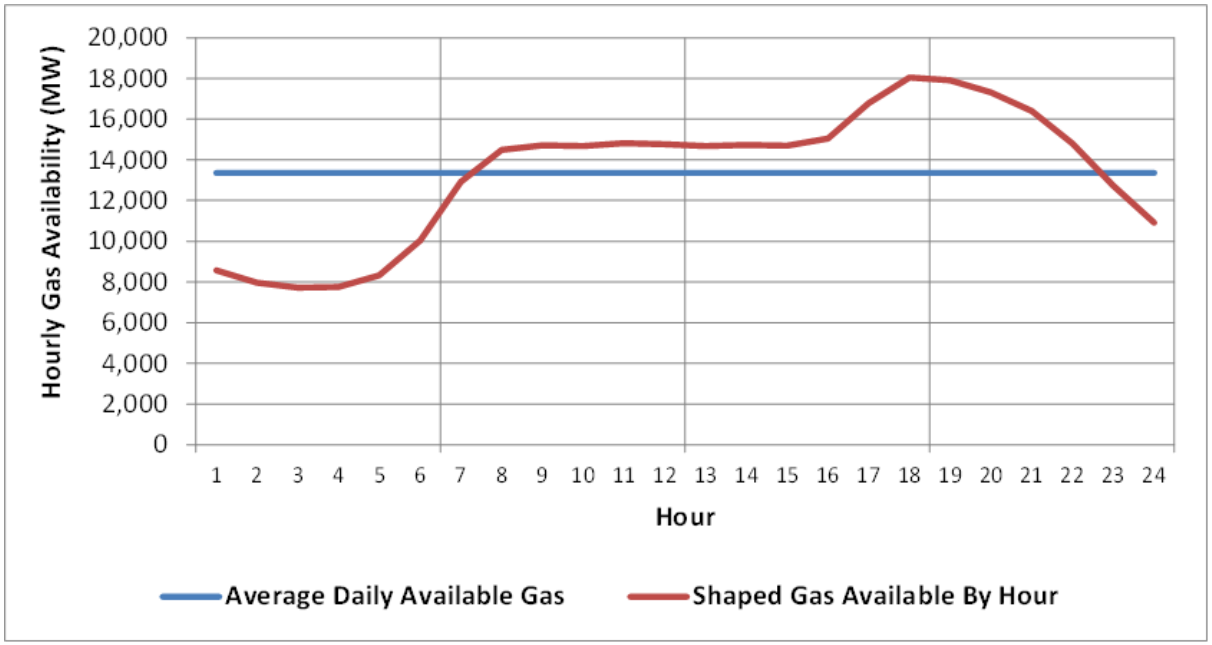
- The model assumed Distrigas can support a LNG vaporization rate capable of providing the full output needed for Mystic 8 and 9 *and* simultaneously allow pipeline injections
  - Enough fuel for Mystic 8 and 9 at full output
  - Plus 0.435 Bcf/d injections
    - 0.3 Bcf/d into Algonquin and Tennessee
    - 0.135 Bcf/d into the local gas utility distribution system
- LNG vaporized to provide fuel for Mystic 8 and 9 is in addition to the LNG injection caps used in any of the 23 scenarios in the Analysis
  - LNG injection caps apply only to sources injecting into the interstate pipelines ***and do not consider locational factors***
  - When Distrigas is out of service, the Mystic units are also out of service

Requests for Clarification on Inclusion/Exclusion of Specific Pipeline Expansion Projects

- The only pipeline expansion projects included in the assessment were based on the ICF International analysis
  - Specifically those that were to be completed in the study horizon **and** that would add incremental pipeline capacity to the existing infrastructure
    - Ex: Portland Natural Gas Transmission System expansion (0.3 Bcf/d), Continent to Coast (0.21 Bcf/d), and Portland Express (0.3 Bcf/d)
- Excludes those that do not add capability directly into New England such as the New Market Project, Millennium Eastern System Upgrade, and Northeast Supply Enhancement, which are New York pipeline expansions
  - Note: If stakeholders provided a proxy for such scenarios using the model's inputs or variables, the ISO ran it through the model

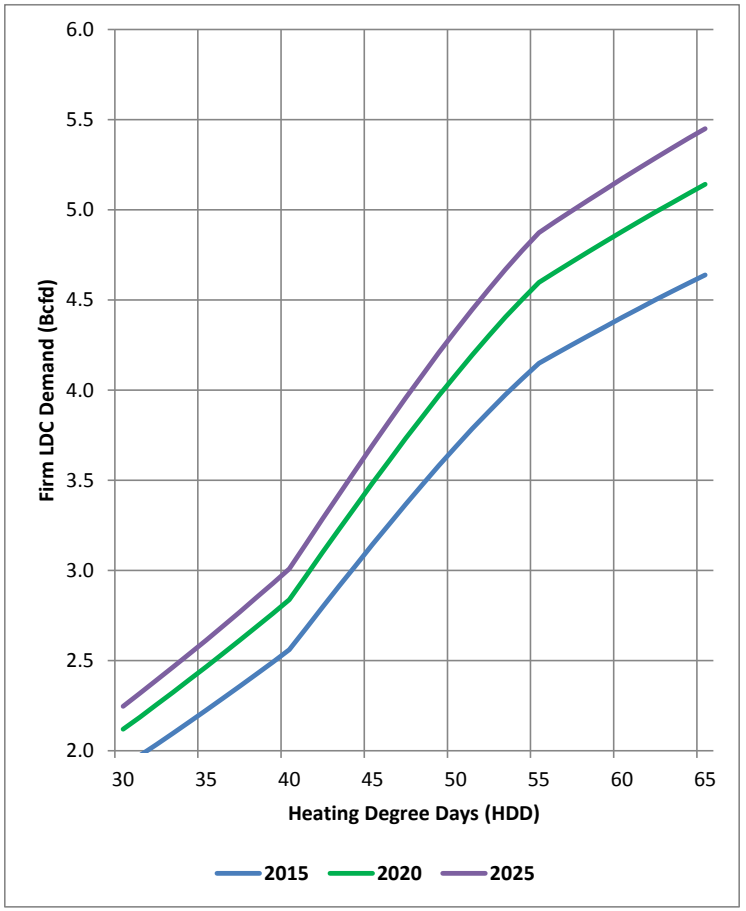
Requested Clarifications on LDC Demand and Gas Availability

- ICF developed a winter day gas demand vs. daily Heating Degree Day (HDD) curve that was then scaled up to the total New England gas demand forecast for Winter 2025
- As the chart shows, Daily Available Gas was shaped to reflect hourly gas usage. Gas availability profile was shifted from off-peak hours to on-peak hours to follow the hourly electric demand curve
  - (Total Daily Available Gas) = (Daily Pipeline Available Gas) + (Daily LNG Injections Available) + (Daily Satellite Gas Injections)
  - (Total Daily Available Gas for Generation) = (Total Daily Available Gas) – (New England Daily LDC Demand) – (New Brunswick Daily LDC Demand)
  - (Hourly Gas Available for Generation) = (Total Daily Available Gas for Generation)/ 24 * (Ratio of Hourly Electric Demand to Peak Demand for the Day)



Requested Clarifications on LDC Demand and Gas Availability, cont.

- LDC gas demand is highly correlated to the heating needs of a particular day and the heating needs over the entire winter. Low average daily temperatures, which translate to high degree days, drive up natural gas demand by gas LDCs and reduce the availability of gas for electric power generation
- The chart shows the assumed New England LDC gas demand as a function of temperature for 2015, 2020, 2025, and 2030. These curves are based on the April 2014 ICF gas demand model that estimated LDC gas demand as a function of HDD
  - LDC gas demand of 65 HDD based on the October 2016 ICF forecast

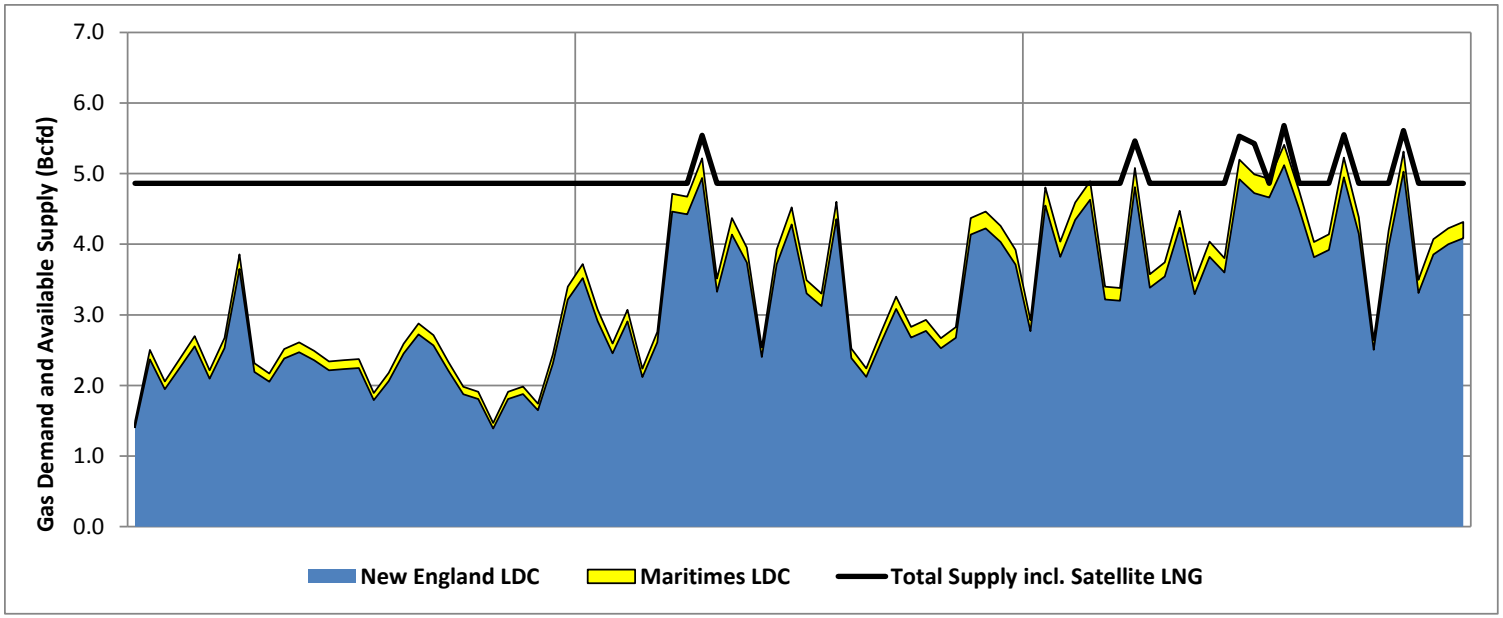


Requested Clarifications on LDC Gas Profiles and Assumptions Underlying LDC Demand

- The analysis assumed depletion of the Sable Island and Deep Panuke gas fields
- Therefore, the ICF analysis indicated that by 2024/2025, the Maritimes' LDC would likely be served entirely by LNG from Canaport or deliveries of pipeline gas imported from New York or Quebec via the M&N pipeline
- Because pipeline gas is typically less expensive than LNG, it was assumed that pipeline gas would be used before vaporization of LNG at Canaport, Distrigas, or the buoy
- If Maritimes demand is served by pipeline gas from the west, less natural gas would be available for New England
- Even if the Maritimes LDC gas demand is overstated, the combined gas consumption of the Maritimes (LDC plus power sector) seems to match observations and will, consequently, affect inventory draw-down

Requested Clarifications on LDC Gas Profiles and Assumptions Underlying LDC Demand, cont.

- The chart shows the gas demand of the LDCs (including commercial and industrial loads) in both New England and the Maritimes, and total supply
  - The total supply is based on the 3.860 Bcf/d of gas from pipelines from New York and Québec, plus an assumed cap on the amount of LNG vaporization set at 1.0 Bcf/d in the reference case, for a total of 4.860 Bcf/d available from pipelines and LNG import facilities
  - On cold days, local satellite LNG facilities are called into service to support the gas distribution system so that the total supply exceeds the pipeline gas plus the assumed LNG cap of 4.860 Bcf/d



LDC gas demand in 2024/2025 for New England and the Maritimes based on winter 2014/2015 weather (Bcf/d)

Requested Clarifications on Compressor Outage Scenario

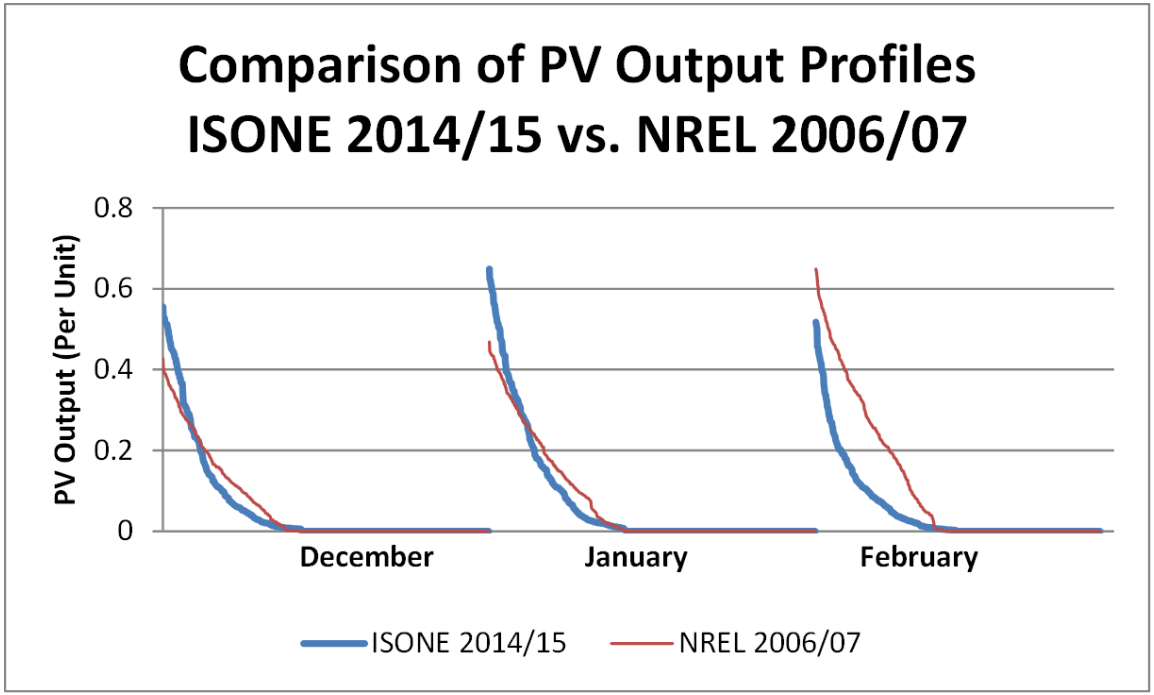
- The case labeled as “Compressor Outage” in the Analysis would have the effect of completely eliminating throughput at a single point on the pipeline
- The scenario represents several possible outages throughout the region and is not specific to any single point on any specific pipeline
  - Several gas companies noted that a pipeline outage would reflect the magnitude represented in the model, but may not last all winter, while a compressor outage may last all winter but not of the magnitude in the model
  - The “Compressor Outage” in the Analysis represents the general blend of these outcomes

Requested Clarifications on Hourly Loads Underlying the 90-Day Winter Load Scenario

- Although the entire winter of 2014/2015 was one of the coldest based on cumulative HDDs, the peak load day was much warmer than a "normal" winter peak load day
  - The actual temperature was 19°F compared with the 7°F temperature assumed for the 50/50 peak loads and the 1.6°F temperature assumed for a 90/10 winter peak load
- The 2014/2015 load shape was adjusted to the forecasted conditions in the 2024/2025 timeframe
  - In this future period, the New England system was modeled with an increase in winter gross loads countered by more energy efficiency that will result in a generally lower net load
- The 2014/2015 actual gross peaks are comparable in magnitude to the forecast 2024/2025 peaks. Additionally, the actual peak load in 2014/2015 was approximately equal to the 90/10 winter peak for the study year
  - Therefore, to model the 2024/2025 winter loads to reflect the 2014/2015 weather, the hourly profile was scaled up slightly by 0.8%

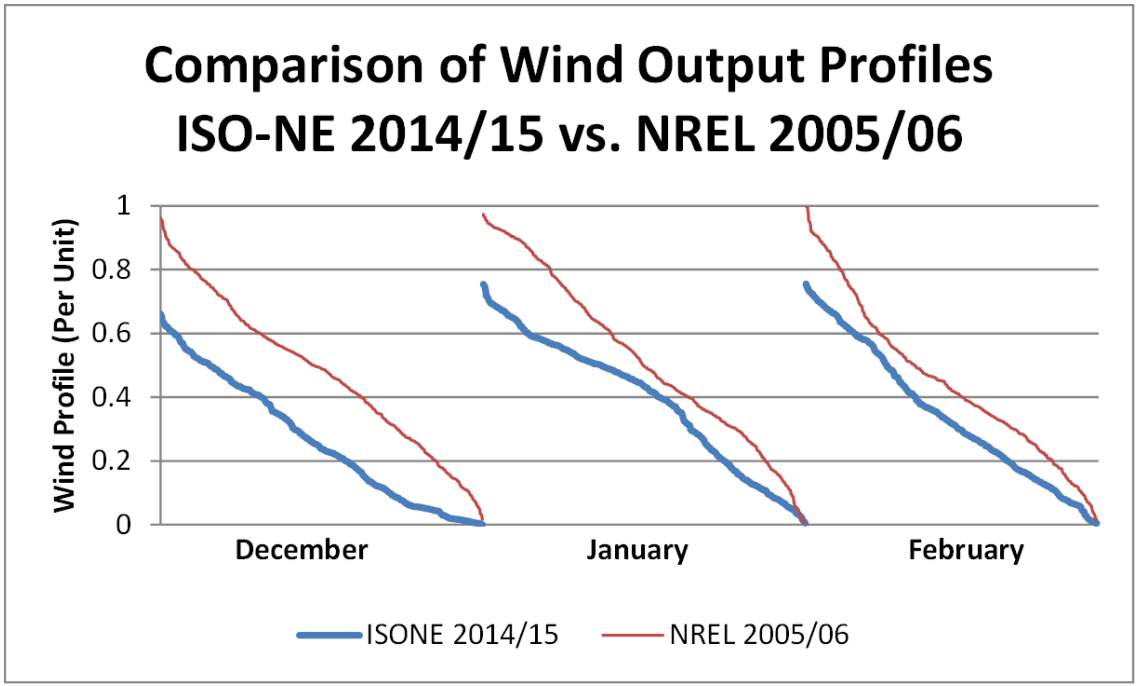
Requested Updates for PV and Onshore Wind Profiles

- The use of the higher National Renewable Energy Laboratory (NREL) PV output in the Operational Fuel-Security analysis would have tended to decrease the OP4/OP7 metrics slightly compared to the New England estimates of PV output



Requested Updates for PV and Onshore Wind Profiles, cont.

- The use of the higher NREL onshore wind output in the Operational Fuel-Security analysis would have tended to decrease the OP4/OP7 metrics slightly compared to the actual New England onshore wind output



SECTION 2:
GRAPHIC DEPICTIONS OF CHANGES TO INPUTS

Sensitivity Charts

Revision 1

- The sensitivity charts below summarize the results of many requests for changes to input assumptions used in the Analysis
- Using the ISO Reference Case as a zero point, the charts show the expected energy shortfall impacts of increasing or decreasing a singular input value such as Gas Only Units, Imports, Peak Load Forecast, etc.
- All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation (i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Revision 1

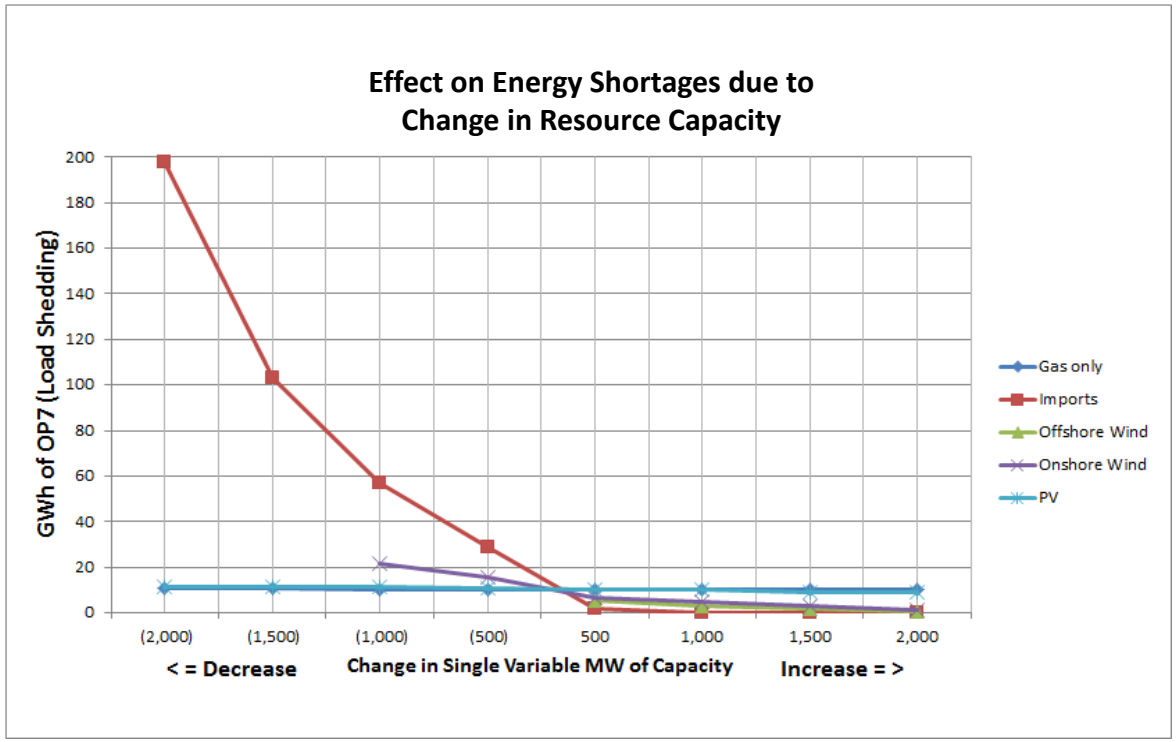
GRAPHIC DEPICTIONS OF CHANGES TO INPUTS

Effect on Energy Shortages (OP7)

Effect on Energy Shortages (OP7) due to Changes in Resource Capacity

Revision 1

- In general, several variables showed minimal effect on the expected energy shortages (OP7) when adjusted, while others were more sensitive to shifts in resource capacity in the model



Change in Capacity (MW)	Gas only (GWh of OP7)	Imports (GWh of OP7)	Offshore Wind (GWh of OP7)	Onshore Wind (GWh of OP7)	PV (GWh of OP7)
-2,000	11	198	-	-	12
-1,500	11	103	-	-	11
-1,000	10	57	-	22	11
-500	10	29	-	16	11
500	10	2	5	7	10
1,000	10	0	3	5	10
1,500	10	0	2	3	9
2,000	10	0	1	1	9

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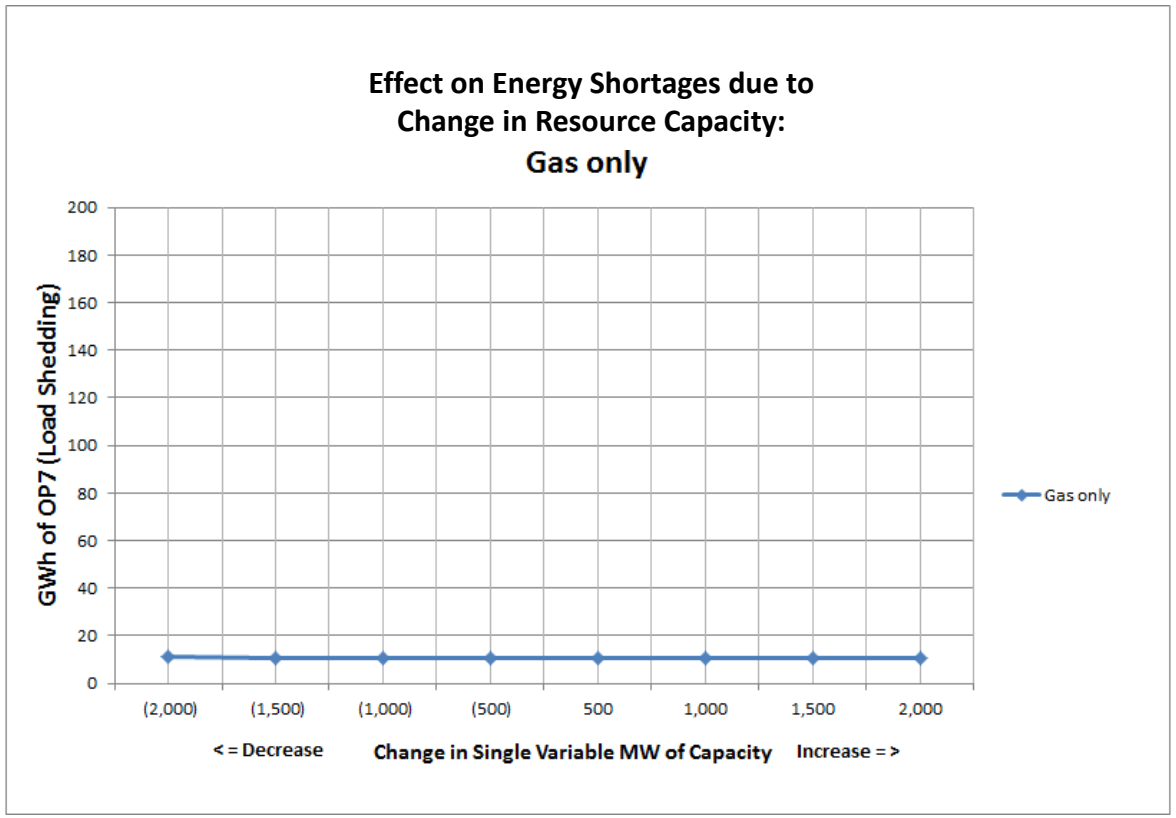
Effect on Energy Shortages (OP7) due to Changes in Resource Capacity: Gas-Only

Revision 1

- As the gas-only units' capacity was adjusted in the model, it showed no impact on the expected energy shortages (OP7) in the Operational Fuel-Security Analysis



Change in Capacity (MW)	Gas only (GWh of OP7)
-2,000	11
-1,500	11
-1,000	10
-500	10
500	10
1,000	10
1,500	10
2,000	10

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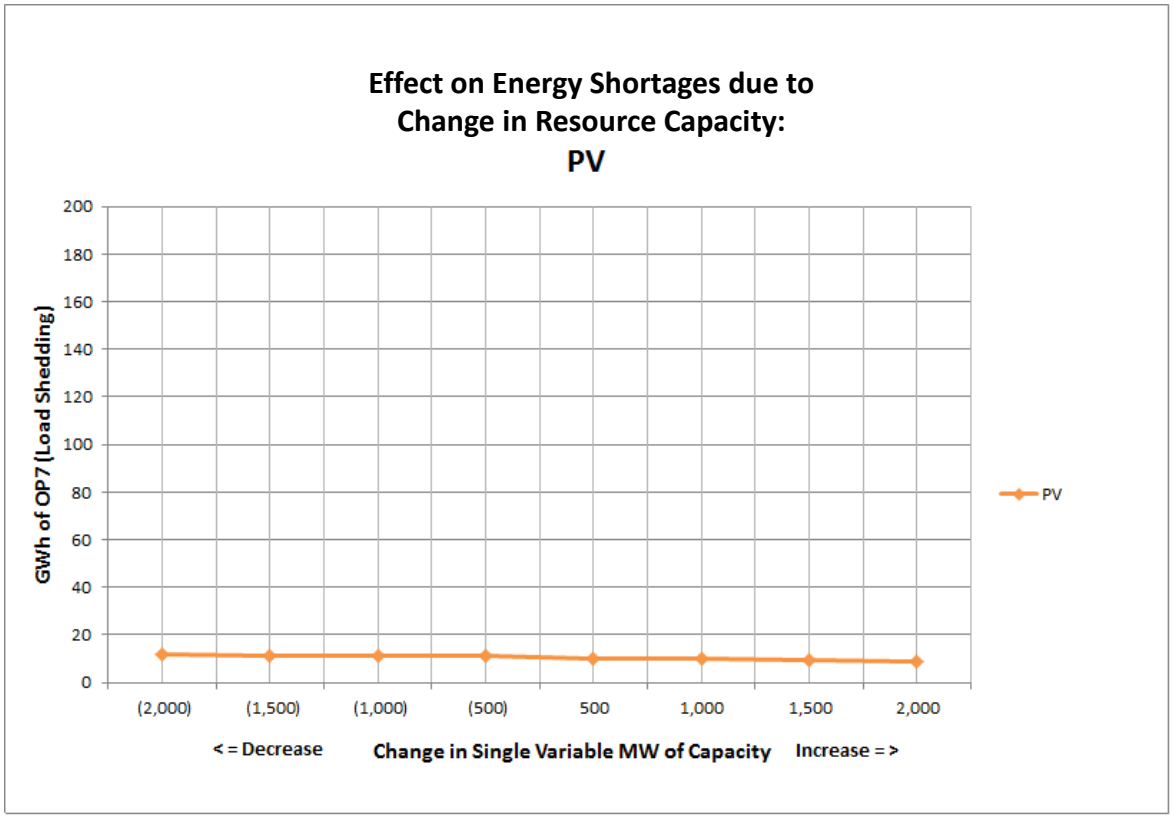
Effect on Energy Shortages (OP7) due to Changes in Resource Capacity: PV

Revision 1

- As the PV units capacity was adjusted in the model, it showed minimal impact on the expected energy shortages (OP7) in the Operational Fuel-Security Analysis



Change in Capacity (MW)	PV (GWh of OP7)
-2,000	12
-1,500	11
-1,000	11
-500	11
500	10
1,000	10
1,500	9
2,000	9

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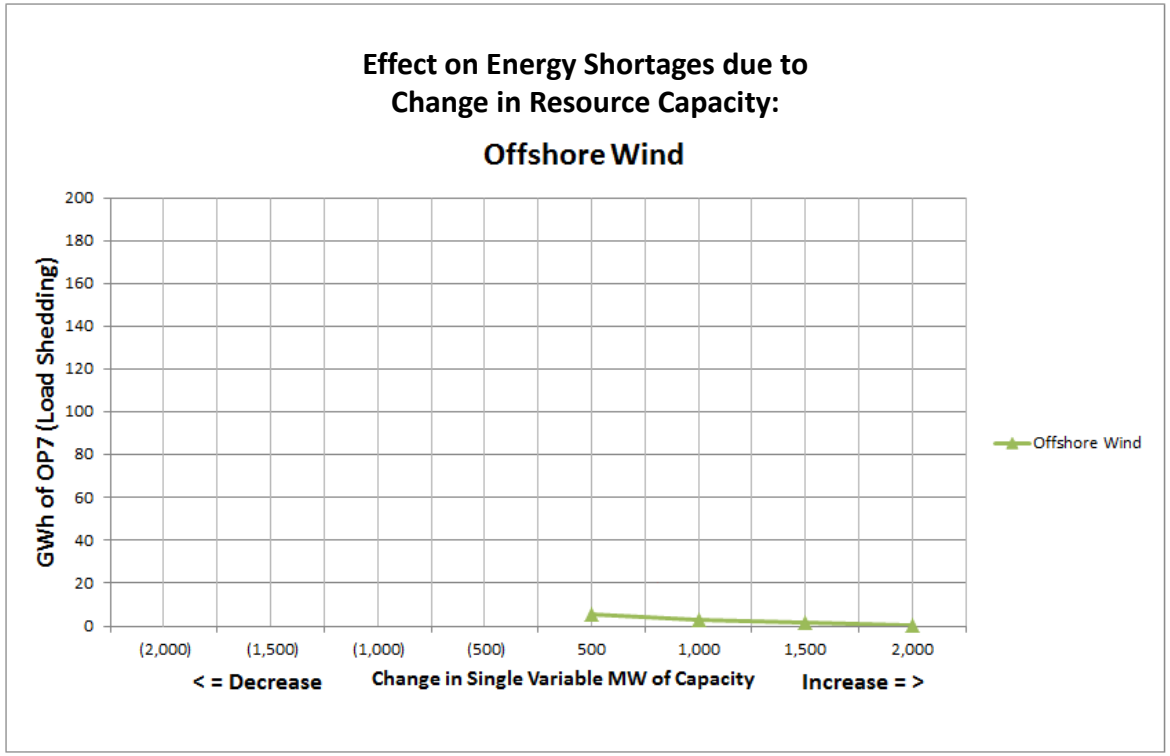
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP7) due to Changes in Resource Capacity: Offshore Wind

Revision 1

- As offshore wind was adjusted in the model, it showed decreases in the expected energy shortages (OP7) if the offshore wind was increased



Change in Capacity (MW)	Offshore Wind (GWh of OP7)
-2,000	-
-1,500	-
-1,000	-
-500	-
500	5
1,000	3
1,500	2
2,000	1

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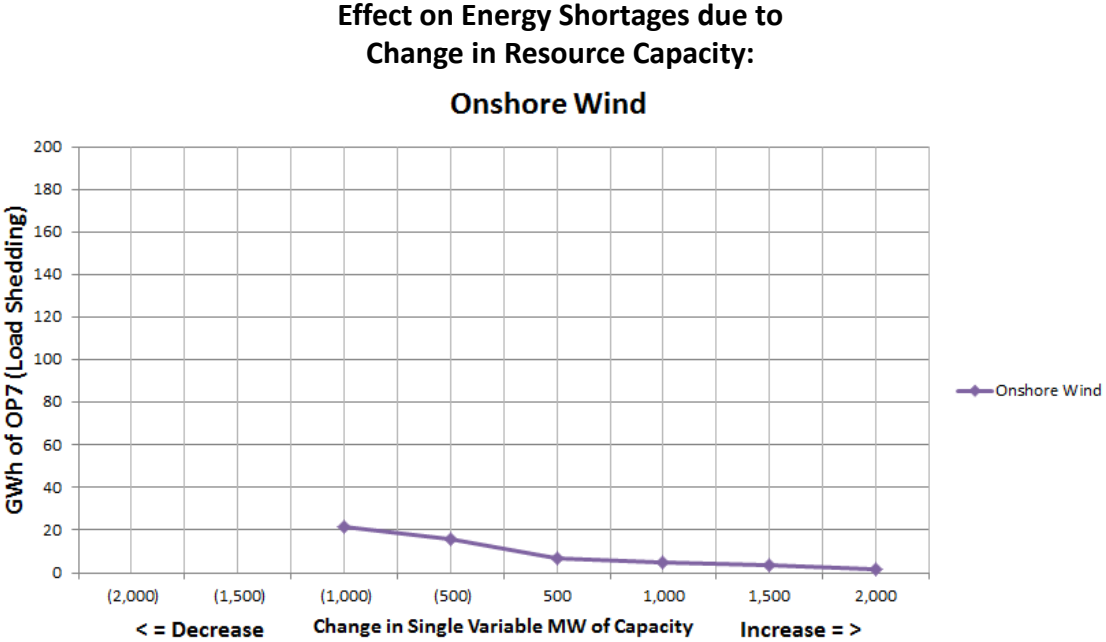
Effect on Energy Shortages (OP7) due to Changes in Resource Capacity: Onshore Wind

Revision 1

- As onshore wind was adjusted in the model, it showed increases in the expected energy shortages (OP7) if the onshore wind was decreased and it showed decreases in the expected energy shortages (OP7) if the onshore wind was increased



Change in Capacity (MW)	Onshore Wind (GWh of OP7)
-2,000	-
-1,500	-
-1,000	22
-500	16
500	7
1,000	5
1,500	3
2,000	1

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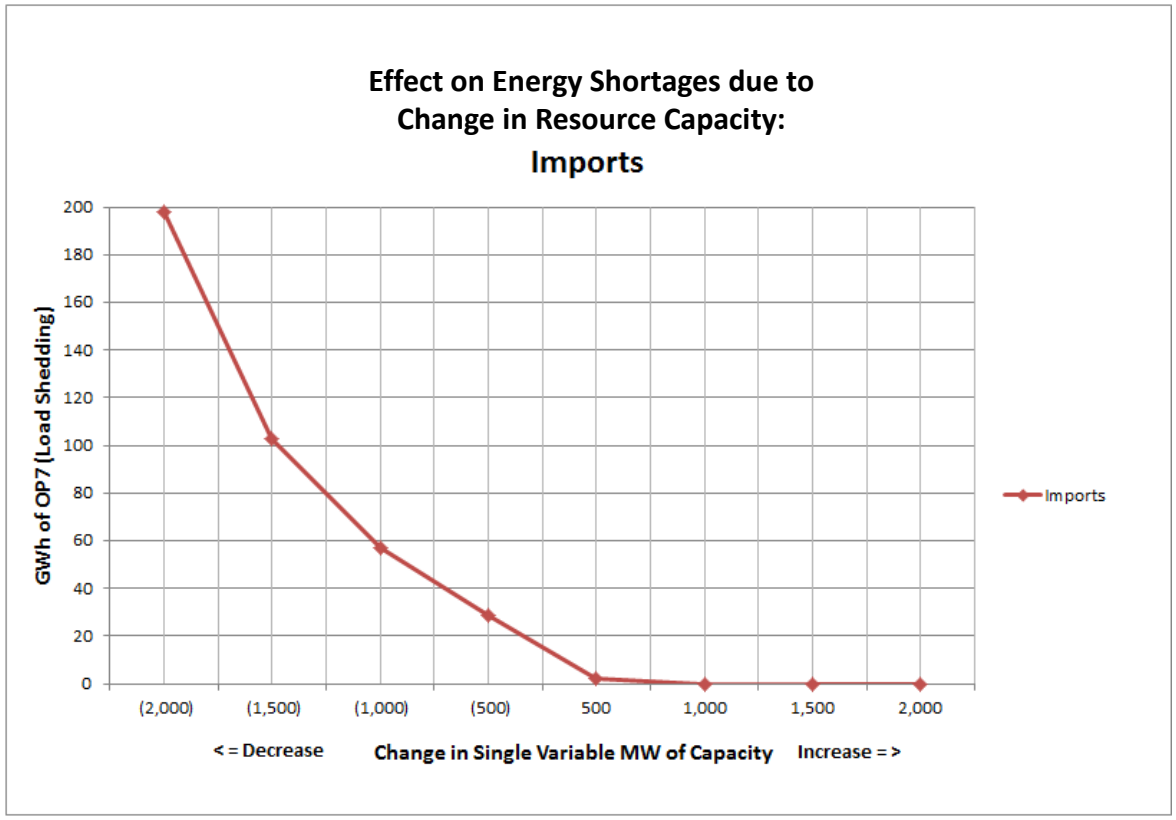
Effect on Energy Shortages (OP7) due to Changes in Resource Capacity: Imports

Revision 1

- As imports were adjusted in the model, it showed significant increases in the expected energy shortages (OP7) if the imports were decreased and it showed decreases in the expected energy shortages (OP7) if the imports were increased



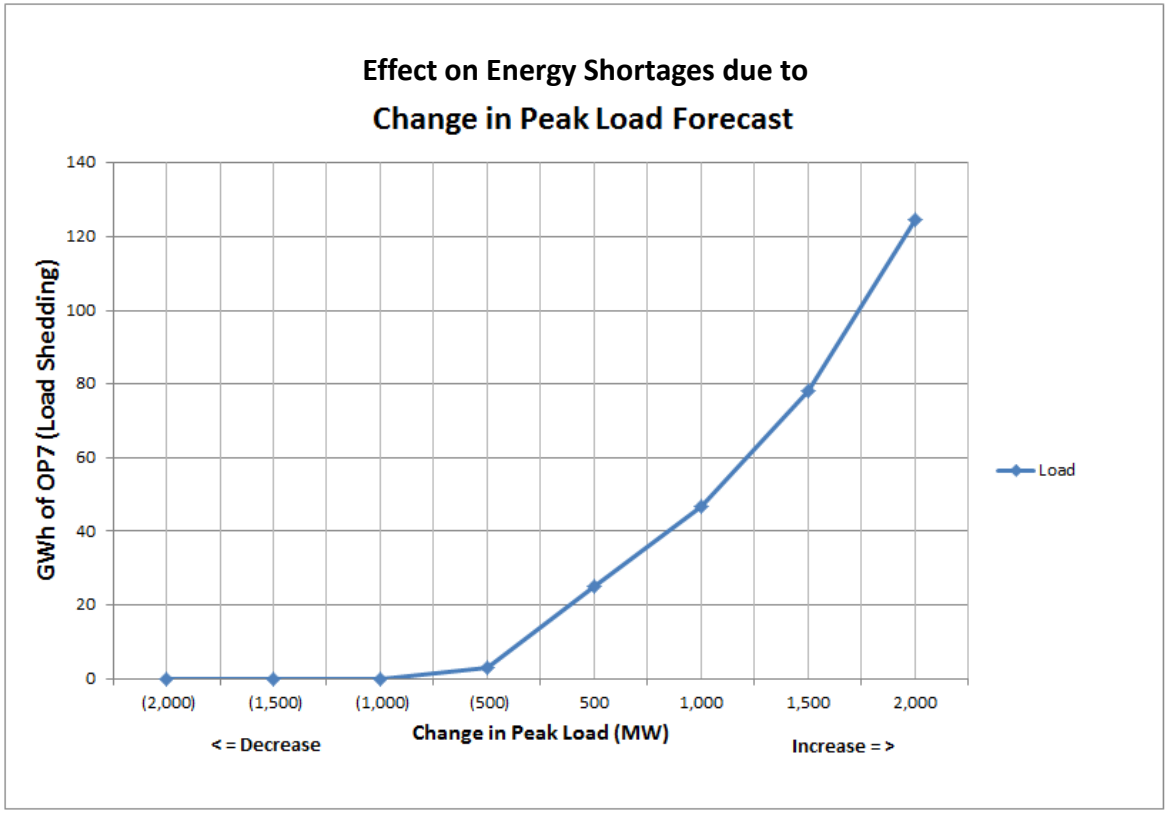
Change in Capacity (MW)	Imports (GWh of OP7)
-2,000	198
-1,500	103
-1,000	57
-500	29
500	2
1,000	0
1,500	0
2,000	0

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP7) due to Changes in Peak Load Forecast

Revision 1

- As the Peak Load Forecast was adjusted in the model, it showed significant increases in the expected energy shortages (OP7) if the forecast increased and it showed decreases in the expected energy shortages (OP7) if the forecast



Change in Peak Load Forecast (MW)	GWh of OP7
-2,000	0
-1,500	0
-1,000	0
-500	3
500	25
1,000	47
1,500	78
2,000	125

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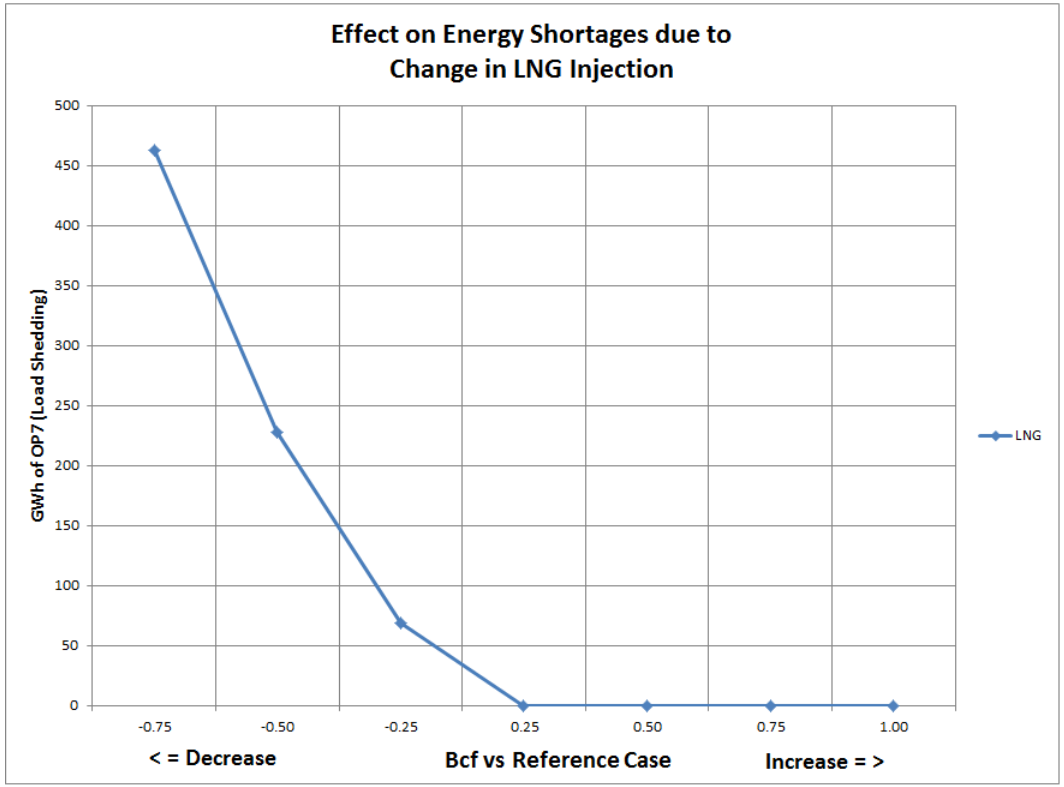
Effect on Energy Shortages (OP7) due to Changes in LNG Injection

Revision 1

- As the LNG injection was adjusted in the model, it showed significant increases in the expected energy shortages (OP7) if the LNG injection was decreased and it showed decreases in the expected energy shortages (OP7) if the LNG injection increased



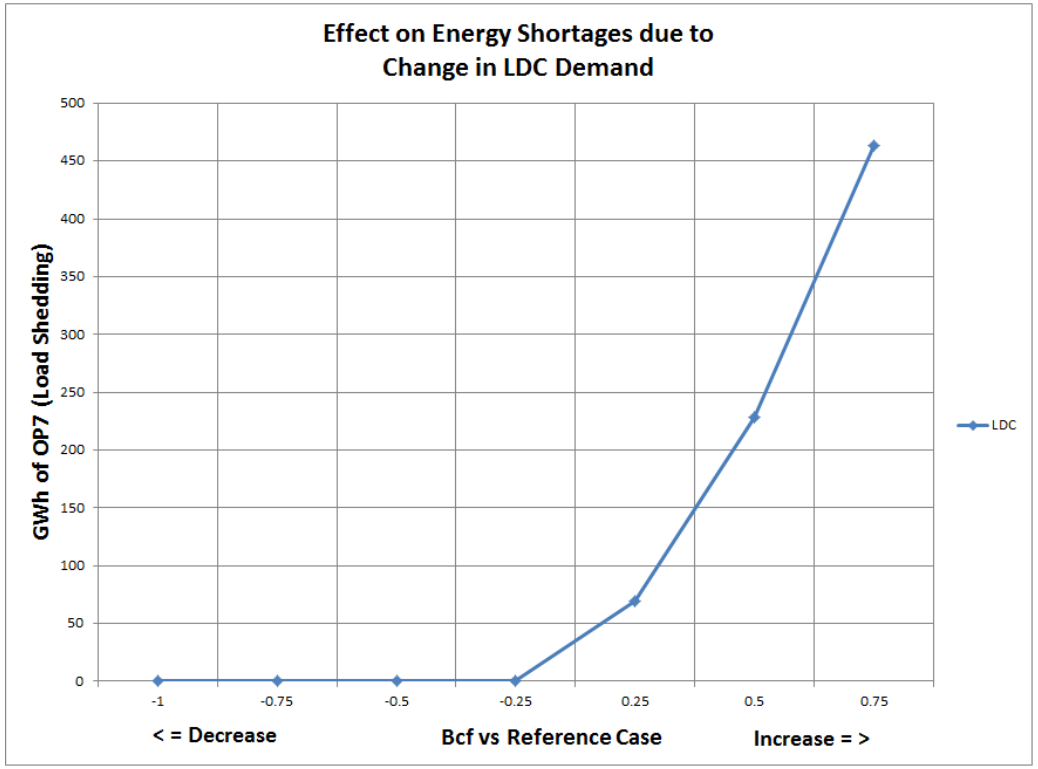
Change in LNG Injection (Bcf)	GWh of OP7
-0.75	463
-0.50	228
-0.25	69
0.25	0
0.50	0
0.75	0
1.00	0

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP7) due to Changes in LDC Demand

Revision 1

- As the LDC Demand was adjusted in the model, it showed significant increases in the expected energy shortages (OP7) if the LDC Demand was increased and it showed decreases in the expected energy shortages (OP7) if the LDC Demand decreased



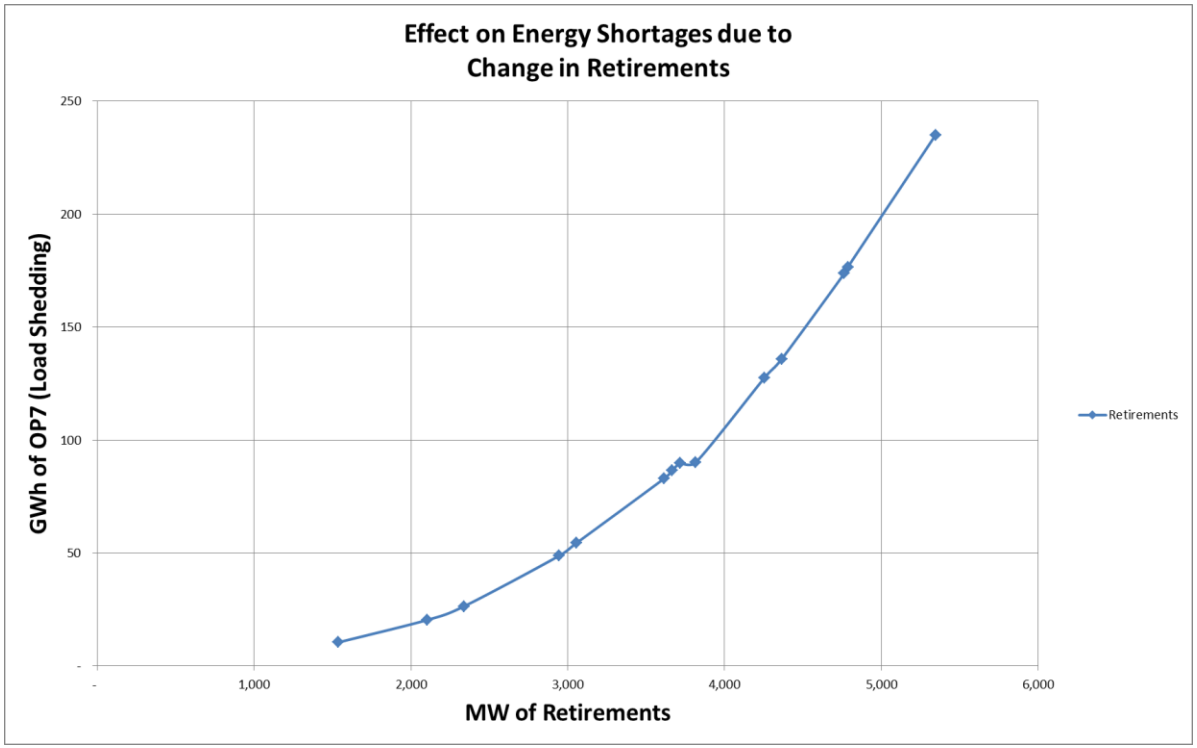
Change in LDC Demand (Bcf)	GWh of OP7
-1.00	0
-0.75	0
-0.50	0
-0.25	0
0.25	69
0.50	228
0.75	463

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP7) due to Changes in Retirements

Revision 1

- As the retirements were adjusted in the model, it showed significant increases in the expected energy shortages (OP7) as the retirements increase



Change in Retirements (MW)	GWh of OP7
1,537	10
2,104	20
2,337	26
2,943	49
3,057	54
3,616	83
3,667	86
3,717	90
3,817	90
4,254	127
4,364	136
4,764	174
4,786	177
5,346	235

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
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Revision 1

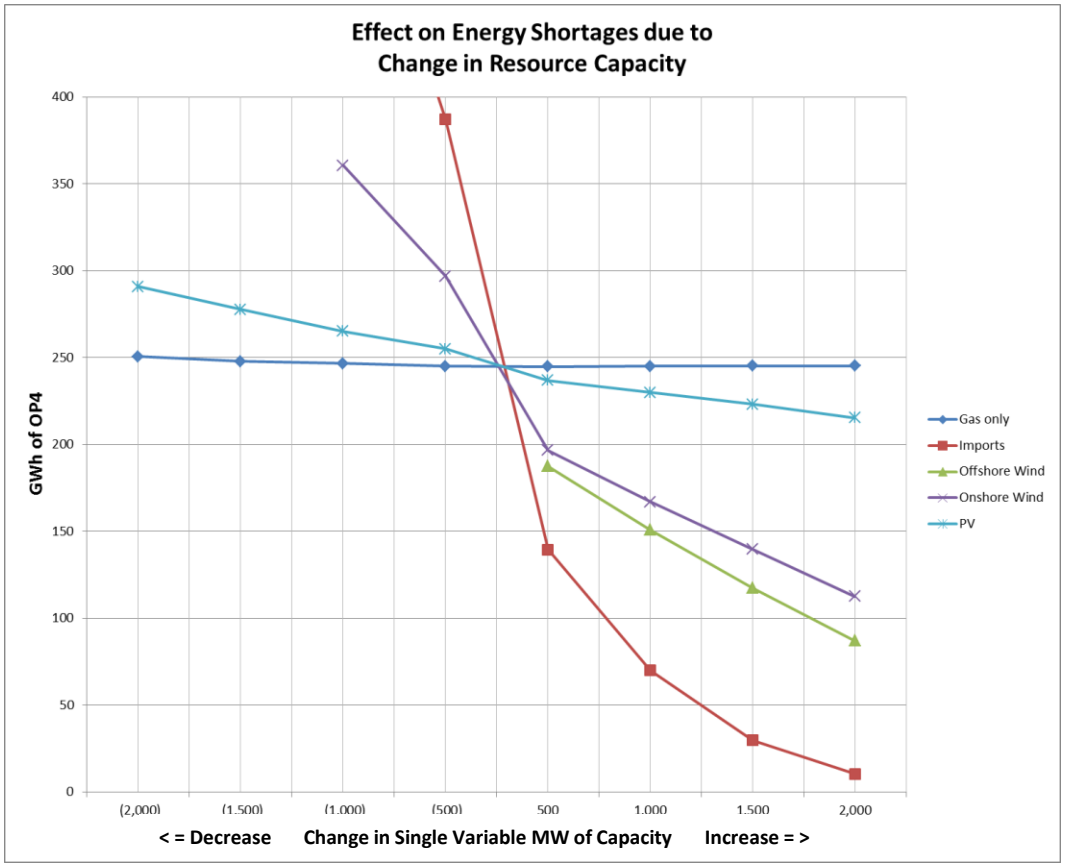
GRAPHIC DEPICTIONS OF CHANGES TO INPUTS

Effect on Energy Shortages (OP4)

Effect on Energy Shortages (OP4) due to Changes in Resource Capacity

Revision 1

- In general, one variable showed minimal effect on the expected energy shortages (OP4) when adjusted, while others were more sensitive to shifts in resource capacity in the model



Change in Capacity (MW)	Gas only (GWh of OP4)	Imports (GWh of OP4)	Offshore Wind (GWh of OP4)	Onshore Wind (GWh of OP4)	PV (GWh of OP4)
-2,000	251	1,072	-	-	291
-1,500	248	787	-	-	278
-1,000	247	567	-	361	265
-500	245	387	-	297	255
500	245	140	188	197	237
1,000	245	70	151	167	230
1,500	245	30	117	140	223
2,000	245	11	87	113	215

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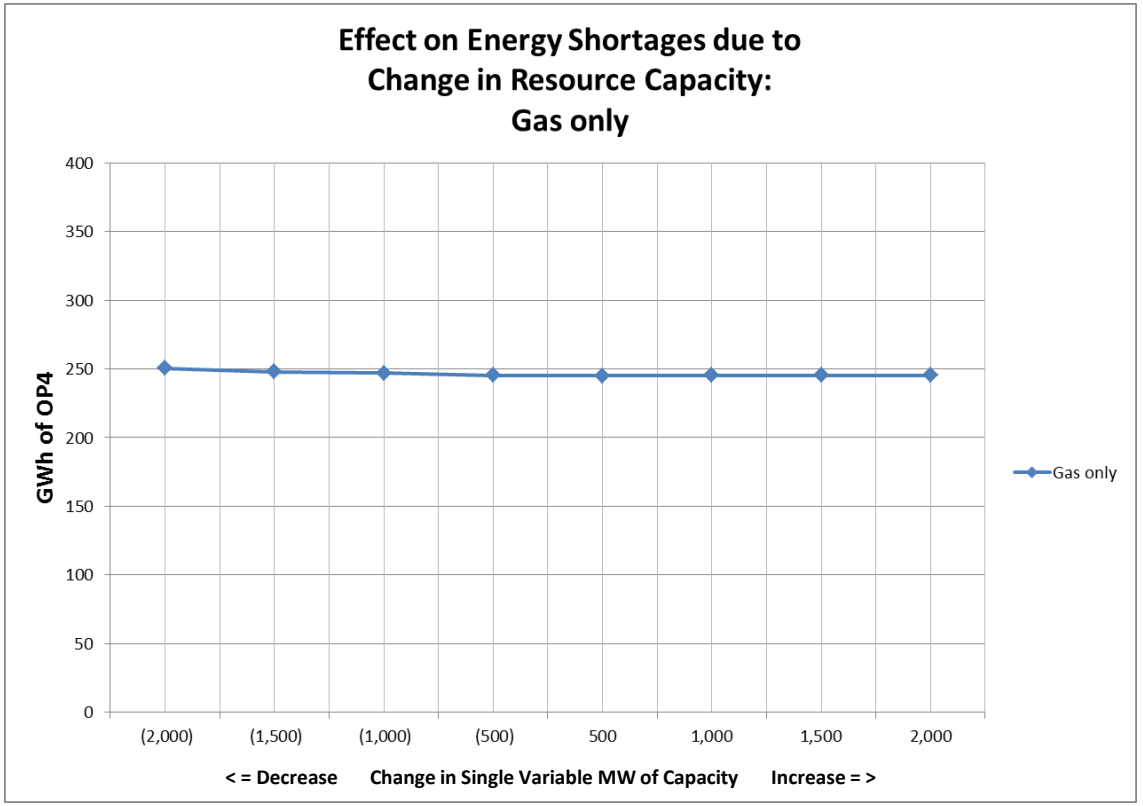
Effect on Energy Shortages (OP4) due to Changes in Resource Capacity: Gas-Only

Revision 1

- As the gas-only units' capacity was adjusted in the model, it showed minimal impact on the expected energy shortages (OP4) in the Operational Fuel-Security Analysis



Change in Capacity (MW)	Gas only (GWh of OP4)
-2,000	251
-1,500	248
-1,000	247
-500	245
500	245
1,000	245
1,500	245
2,000	245

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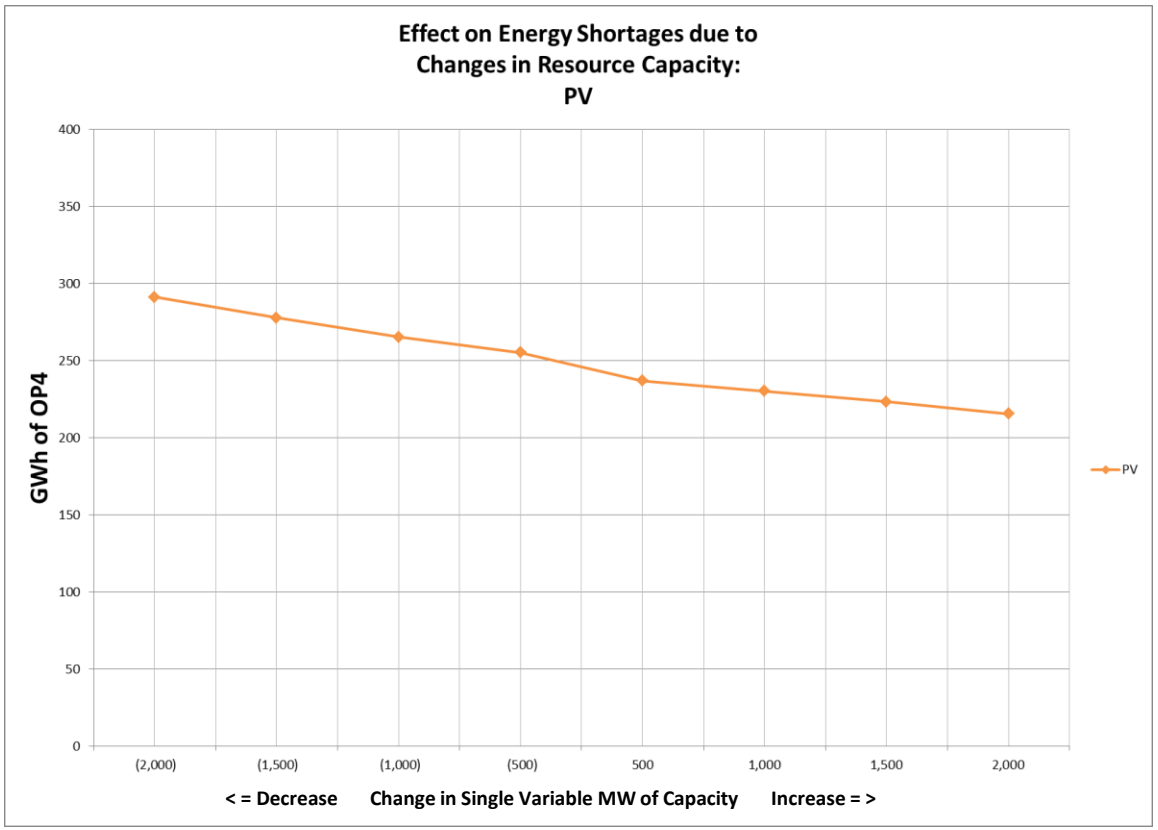
Effect on Energy Shortages (OP4) due to Changes in Resource Capacity: PV

Revision 1

- As the PV units capacity was adjusted in the model, it showed increases in the expected energy shortages (OP4) if the PV was decreased and it showed decreases in the expected energy shortages (OP4) if the PV was increased



Change in Capacity (MW)	PV (GWh of OP4)
-2,000	291
-1,500	278
-1,000	265
-500	255
500	237
1,000	230
1,500	223
2,000	215

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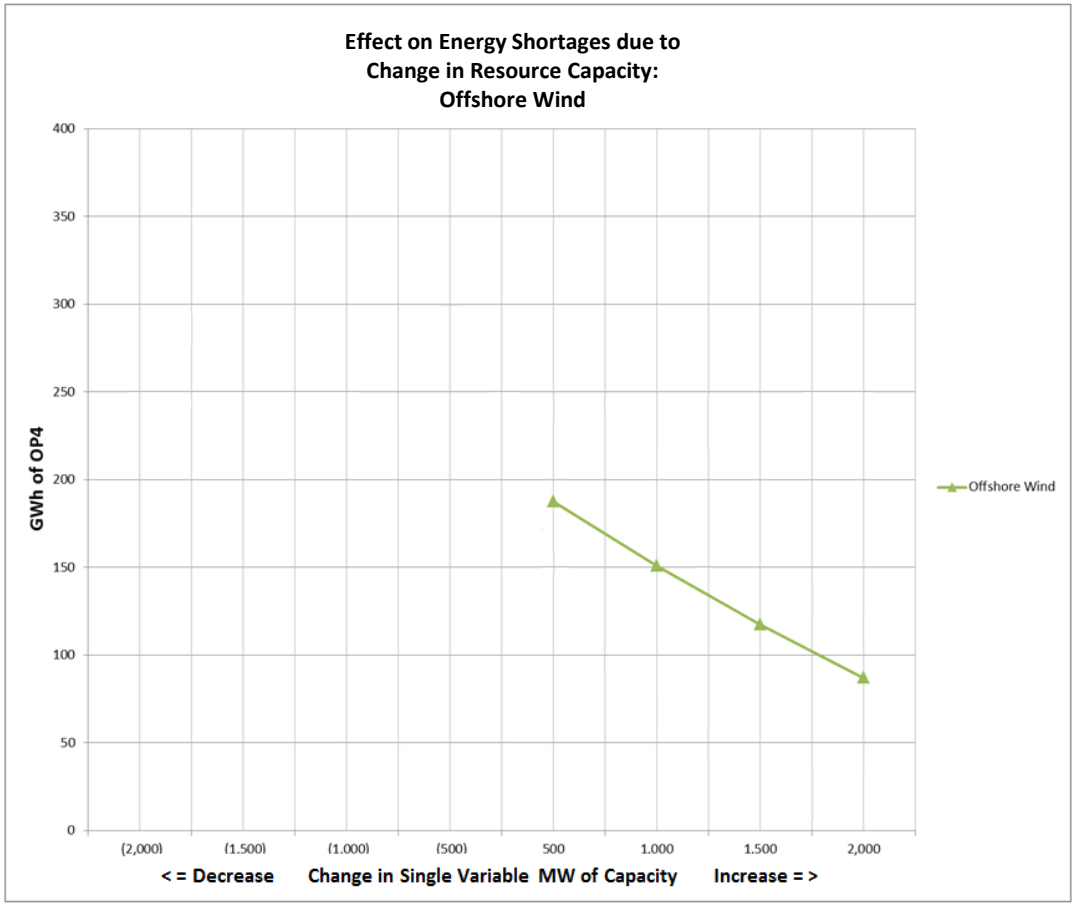
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP4) due to Changes in Resource Capacity: Offshore Wind

Revision 1

- As offshore wind was adjusted in the model, it showed decreases in the expected energy shortages (OP4) if the offshore wind was increased



Change in Capacity (MW)	Offshore Wind (GWh of OP4)
-2,000	-
-1,500	-
-1,000	-
-500	-
500	188
1,000	151
1,500	117
2,000	87

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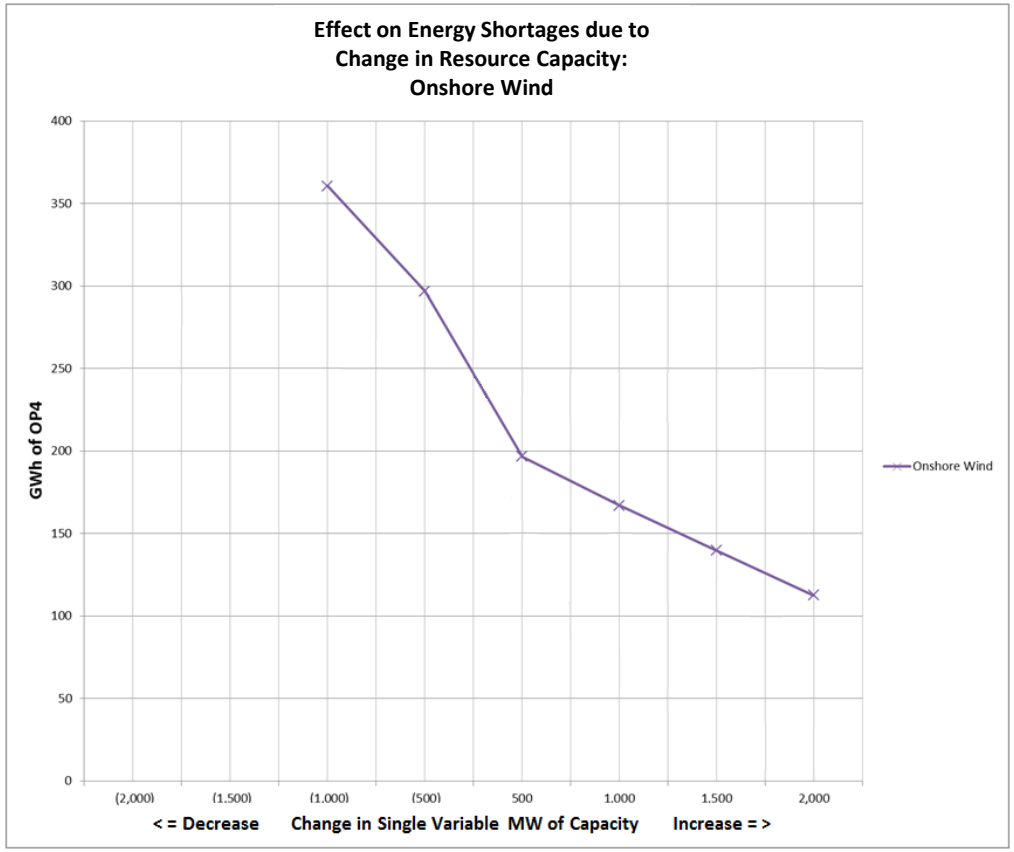
Effect on Energy Shortages (OP4) due to Changes in Resource Capacity: Onshore Wind

Revision 1

- As onshore wind was adjusted in the model, it showed increases in the expected energy shortages (OP4) if the onshore wind was decreased it showed decreases in the expected energy shortages (OP4) if the onshore wind was increased



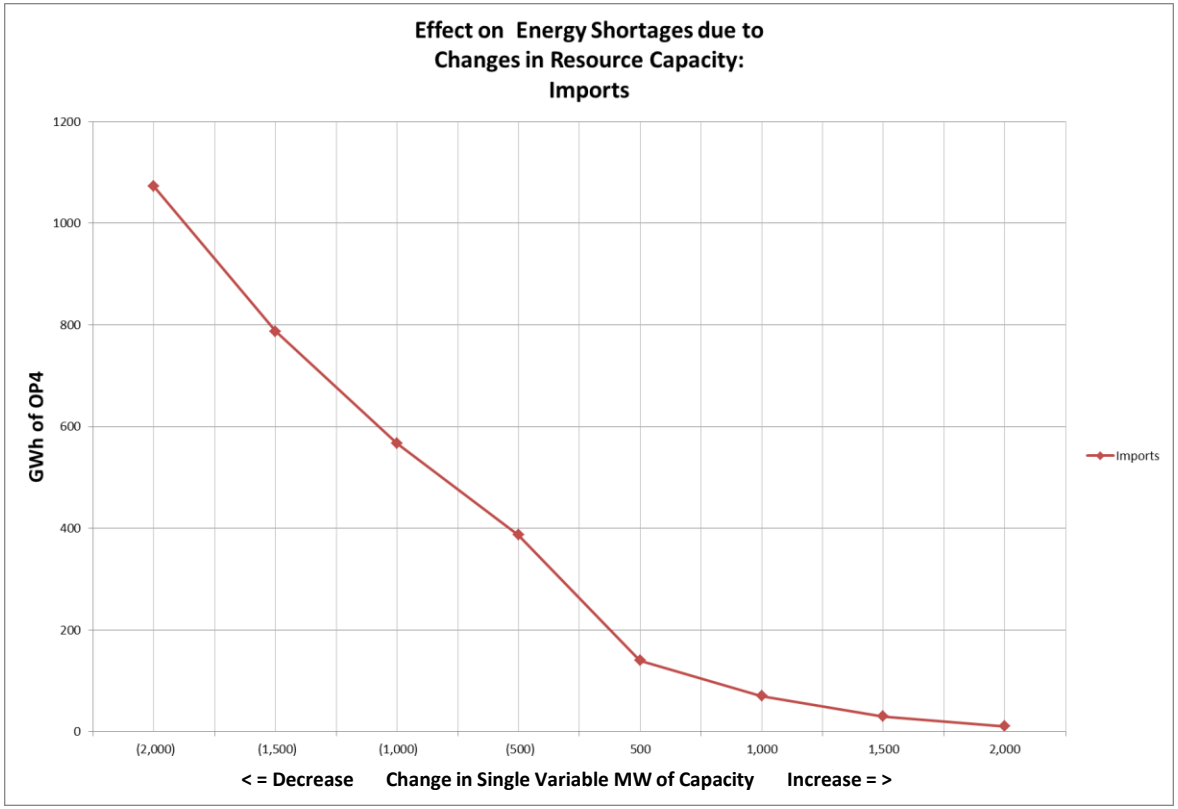
Change in Capacity (MW)	Onshore Wind (GWh of OP4)
-2,000	-
-1,500	-
-1,000	361
-500	297
500	197
1,000	167
1,500	140
2,000	113

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP4) due to Changes in Resource Capacity: Imports

Revision 1

- As imports were adjusted in the model, it showed significant increases in the expected energy shortages (OP4) if the imports were decreased and it showed significant decreases in the expected energy shortages (OP4) if the imports were increased



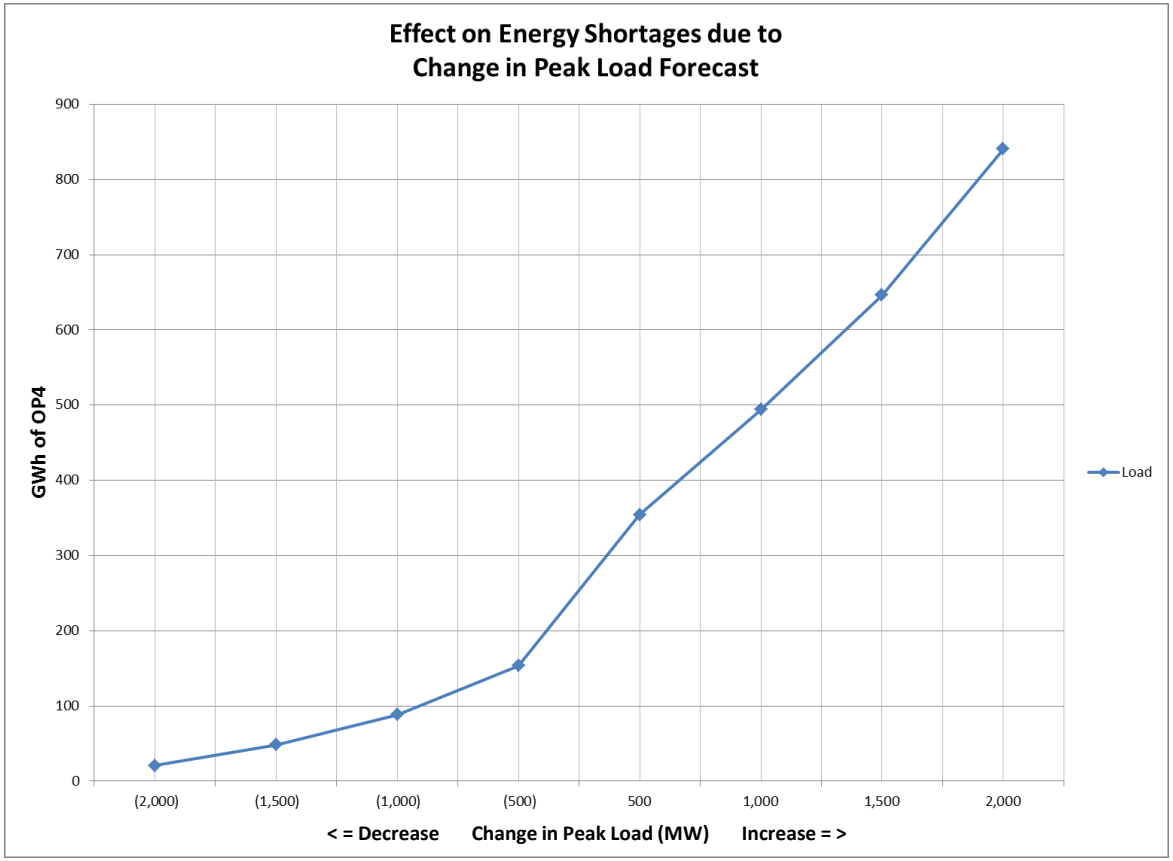
Change in Capacity (MW)	Imports (GWh of OP4)
-2,000	1,072
-1,500	787
-1,000	567
-500	387
500	140
1,000	70
1,500	30
2,000	11

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP4) due to Changes in Peak Load Forecast

Revision 1

- As the Peak Load Forecast was adjusted in the model, it showed significant increases in the expected energy shortages (OP4) if the forecast increased and it showed decreases in the expected energy shortages (OP4) if the forecast decreased



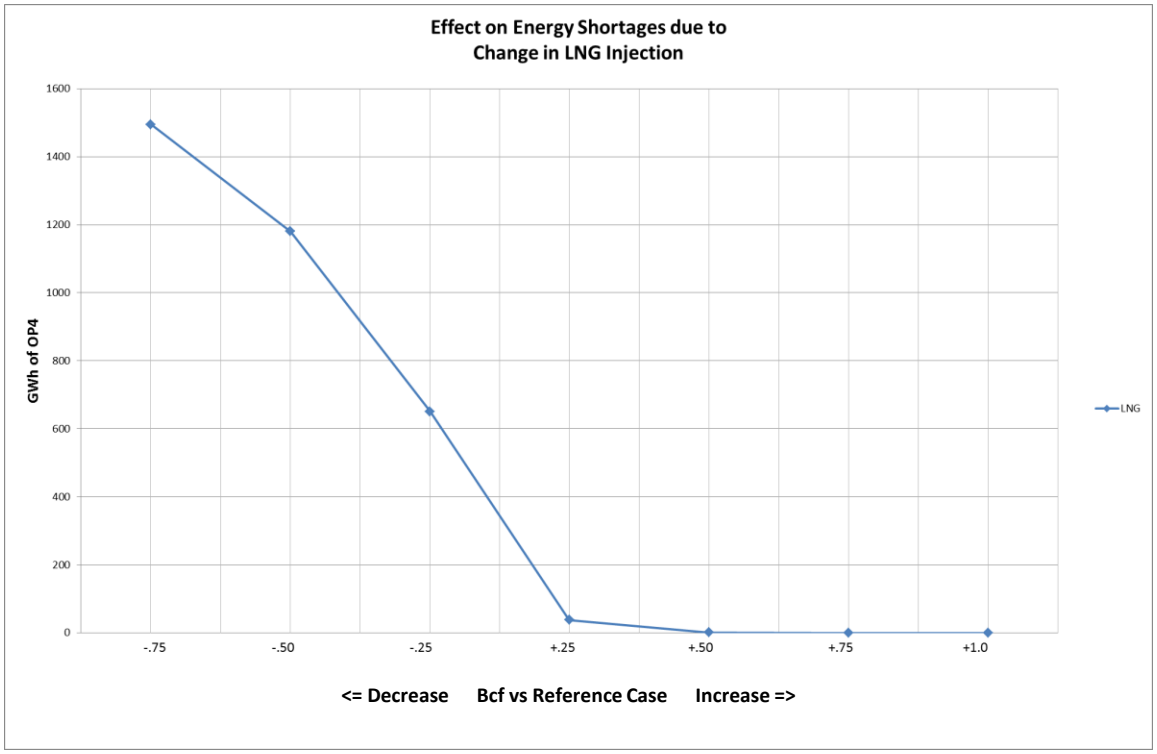
Change in Peak Load Forecast (MW)	GWh of OP4
-2,000	21
-1,500	49
-1,000	88
-500	153
500	354
1,000	494
1,500	646
2,000	841

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP4) due to Changes in LNG Injection

Revision 1

- As the LNG injection was adjusted in the model, it showed significant increases in the expected energy shortages (OP4) if the LNG injection was decreased and it showed decreases in the expected energy shortages (OP4) if the LNG injection increased



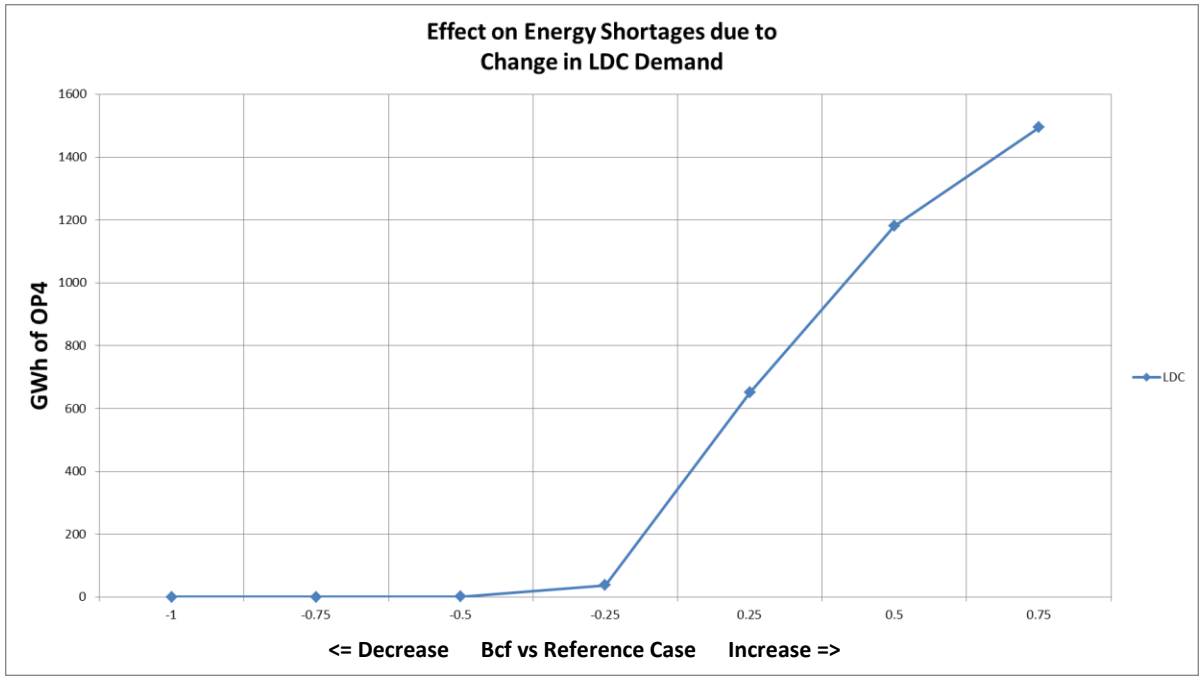
Change in LNG Injection (Bcf)	GWh of OP4
-0.75	1,495
-0.50	1,180
-0.25	651
0.25	38
0.50	1
0.75	0
1.00	0

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP4) due to Changes in LDC Demand

Revision 1

- As the LDC Demand was adjusted in the model, it showed significant increases in the expected energy shortages (OP4) if the LDC Demand was increased and it showed decreases in the expected energy shortages (OP4) if the LDC Demand decreased



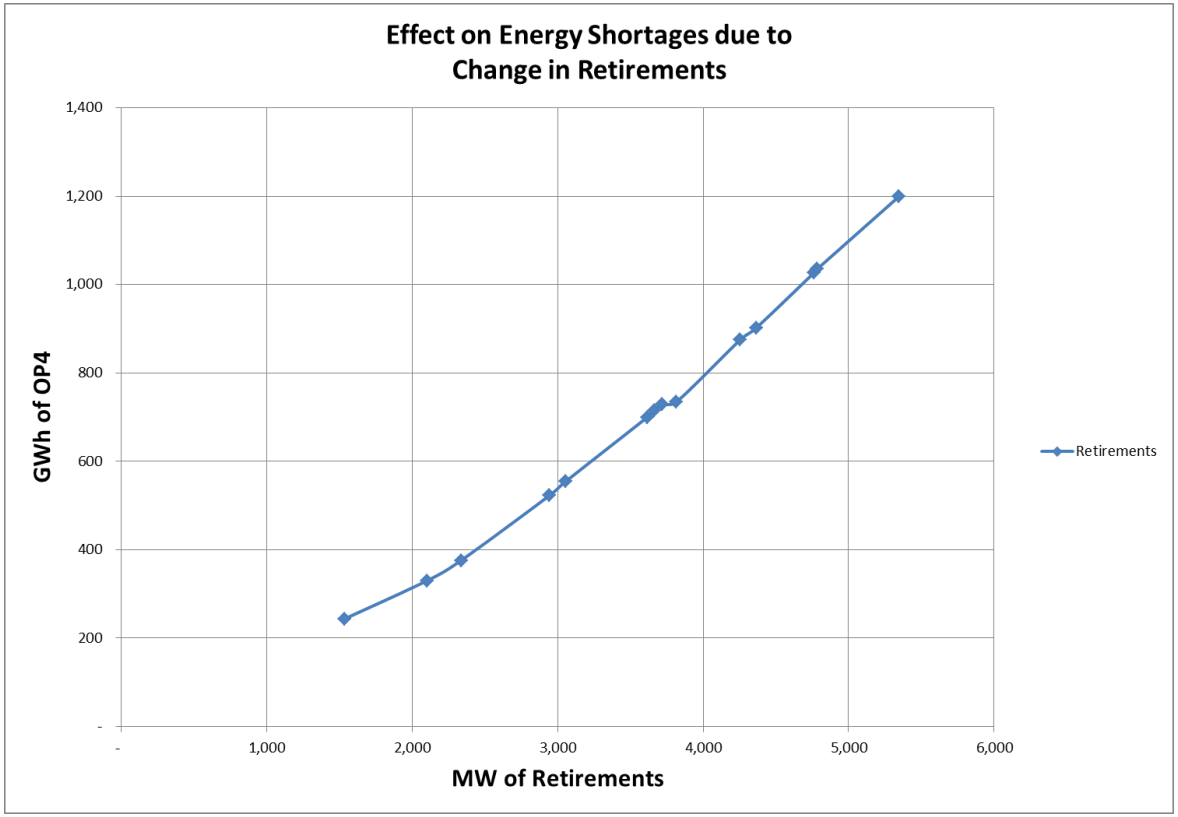
Change in LDC Demand (Bcf)	GWh of OP4
-1.00	0
-0.75	0
-0.50	1
-0.25	38
0.25	651
0.50	1,180
0.75	1,495

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

Effect on Energy Shortages (OP4) due to Changes in Retirements

Revision 1

- As the retirements were adjusted in the model, it showed significant increases in the expected energy shortages (OP4) as the retirements increase



Change in Retirements (MW)	GWh of OP4
1,537	244
2,104	330
2,337	376
2,943	522
3,057	555
3,616	700
3,667	715
3,717	729
3,817	735
4,254	875
4,364	902
4,764	1,027
4,786	1,036
5,346	1,199

All sensitivities in the following cases are subject to the caveats and constraints noted in slides 6 & 7 of this presentation
(i.e., if certain resources are added, other resources may retire and thus the sensitivities are linked in ways the model does not specifically reflect)

SPECIFIC REQUESTED SCENARIOS

Scenarios Modeled

- The following slides summarize the results of scenarios run by the ISO based on requests received by February 15, 2018
- Scenarios are identified by a name provided by the requester or otherwise identifying the requester

JOINT REQUESTERS SCENARIOS

All scenarios are based on the "Joint Requesters Business As Usual (BAU) Scenario"

“Joint Requesters* #1: BAU” Scenario

Revision 1

- This scenario modifies the ISO Reference Case variables to reflect:
  - 0.7% annual LDC gas demand growth (vs. the 1.26% from ISO reference)
  - 500 MW of Active DR
  - 3,500 MW of imports (vs. 2,500 MW from ISO reference)
  - 1.25 Bcf/d LNG cap (vs. 1 Bcf/d from ISO reference)
  - 5,073 MW of PV based on a 14.4% capacity factor
  - 1,453 MW of onshore wind based on a 32% capacity factor
  - 430 MW of offshore wind based on a 44.5% capacity factor
  - Incorporated the 2018 CELT Forecast for gross load and EE
- This scenario serves as a "Joint Requestors’ BAU Reference" for all of the other Joint Requesters scenarios
- The label for each additional Joint Requesters’ scenario was provided by the Joint Requesters

*The Joint Requesters include the Massachusetts Attorney General’s Office, New Hampshire Office of the Consumer Advocate, RENEW Northeast, Conservation Law Foundation, Brookfield Renewable, The Cape Light Compact, Environmental Defense Fund, NextEra Energy Resources, Natural Resources Defense Council, PowerOptions Inc., Acadia Center, Sierra Club, Union of Concerned Scientists, and Vermont Energy Investment Corporation.

“Joint Requesters #1: BAU” Scenario Summary *Revision 1*

- This scenario serves as a "Joint Requestors’ BAU Reference" for all of the other Joint Requesters scenarios

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-

"Joint Requesters #2: BAU + Higher LDC Gas Demand Growth" Scenario Summary

Revision 1

- This scenario increased the LDC gas demand forecast from the "Joint Requestors' BAU Reference" to 1.26%/yr.

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #2: BAU + Higher LDC Gas Demand Growth	-1,500	1.25	2	3,500	7,900	22	-	-	-	-	-

"Joint Requesters #3: BAU + Increased Thermal EE" Scenario Summary

Revision 1

- This scenario increased thermal EE from the "Joint Requestors' BAU Reference" by reducing annual LDC gas demand growth from 0.7%/yr. to 0.5%/yr.

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #3: BAU + Increased Thermal EE	-1,500	1.25	2	3,500	7,900	9	-	-	-	-	-

"Joint Requesters #4: BAU + Accelerated Renewables" Scenario Summary

Revision 1

- This scenario modified the "Joint Requesters' BAU Reference" to reflect:
  - 5,442 MW of PV
  - 2,553 MW of onshore wind
  - 1,630 MW of offshore wind

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #4: BAU + Accelerated Renewables	-1,500	1.25	2	3,500	10,700	5	-	-	-	-	-

"Joint Requesters #5: BAU + Increased Electric EE" Scenario Summary

Revision 1

- This scenario increased electric EE from the "Joint Requestors' BAU Reference" by 1,180 MW

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #5: BAU + Increased Electric EE	-1,500	1.25	2	3,500	7,900	5	-	-	-	-	-

"Joint Requesters #6: BAU + Battery Storage" Scenario Summary

Revision 1

- This scenario added 250 MW of battery storage to the "Joint Requestors' BAU Reference"

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #6: BAU + Battery Storage	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-

"Joint Requesters #7: BAU + Increased Security Combination" Scenario Summary

Revision 1

- This scenario modified the "Joint Requestors' BAU Reference" to reflect "Accelerated Renewables," "Increased Electric EE," "Increased Thermal EE," "Battery Storage," 3 dual-fuel tank refills, and increased the LNG cap to 1.50 Bcf/d

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #7: BAU + Increased Security	-1,500	1.5	3	3,500	10,700	1	-	-	-	-	-

"Joint Requesters #8: Accelerated Renewables + CASPR Success" Scenario Summary

Revision 1

- This scenario increased retirements from the "Joint Requestors' BAU Reference" by 2,849 MW and included the "Accelerated Renewables"

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #8: Accelerated Renewables + CASPR Success	-4,349	1.25	2	3,500	10,700	5	-	-	-	-	-

"Joint Requesters #9: BAU + Add'l Retirements" Scenario Summary

Revision 1

- This scenario increased retirements from the "Joint Requestors' BAU Reference" by 2,849 MW

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #9: BAU + Add'l Retirements	-4,349	1.25	2	3,500	7,900	13	-	-	-	-	-

"Joint Requesters #10: BAU + Add'l Retirements + Add'l LNG" Scenario Summary

Revision 1

- This scenario increased retirements from the "Joint Requestors' BAU Reference" by 2,849 MW and increased the LNG cap to 1.50 Bcf/d

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #10: BAU + Add'l Retirements + Add'l LNG	-4,349	1.5	2	3,500	7,900	3	-	-	-	-	-

"Joint Requesters #11: BAU + Compressor Outage + Counteracting Changes" Scenario Summary

Revision 1

- This scenario modified the "Joint Requestors' BAU Reference" to reflect a compressor outage, "Accelerated Renewables," "Increased Electric EE," "Increased Thermal EE," 3 dual-fuel tank refills, and increased the LNG cap to 1.50 Bcf/d

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #11: BAU + Compressor Outage + Counteracting Changes	-1,500	1.5	3	3,500	10,700	36	4	-	-	-	-

"Joint Requesters #12: BAU + More LNG" Scenario Summary

Revision 1

- This scenario increased the LNG Cap from the "Joint Requestors' BAU Reference" to 1.50 Bcf/d

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #12: BAU + More LNG	-1,500	1.5	2	3,500	7,900	3	-	-	-	-	-

"Joint Requesters #13: BAU + More Dual Fuel Replenishment" Scenario Summary

Revision 1

- This scenario increased the dual-fuel tank fills from the "Joint Requestors' BAU Reference" to 3 dual-fuel tank fills

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #13: BAU + More Dual Fuel Replenishment	-1,500	1.25	3	3,500	7,900	13	-	-	-	-	-

"Joint Requesters #14: BAU – Imports" Scenario Summary

Revision 1

- This scenario decreased the imports from the "Joint Requestors' BAU Reference" to 2,500 MW

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #14: BAU - Imports	-1,500	1.25	2	2,500	7,900	18	-	-	-	-	-

"Joint Requesters #15: BAU + Max Retirements" Scenario Summary

Revision 1

- This scenario increased the retirements from the "Joint Requestors' BAU Reference" to 5,400 MW

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #15: BAU + Max Retirements	-5,400	1.25	2	3,500	7,900	13	-	-	-	-	-

"Joint Requesters #16: BAU + Compressor Outage" Scenario Summary

Revision 1

- This scenario modified the "Joint Requestors' BAU Reference" to reflect a compressor outage, 3 dual-fuel tank refills, and increased the LNG Cap to 1.50 Bcf/d

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
JR #1: BAU	-1,500	1.25	2	3,500	7,900	13	-	-	-	-	-
JR #16: BAU + Compressor Outage	-1,500	1.5	3	3,500	7,900	37	49	10	3	-	-

SCENARIOS BASED ON ISO'S ANALYSIS

These scenarios reflect changes to inputs to the ISO's 23 scenarios and requests for additional scenarios

“AVANGRID” & “BP Energy Scenario #24” Scenario Summary

- These scenarios added 0.50 Bcf/d gas pipeline infrastructure to different ISO scenarios

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
Avangrid & BP Energy High Boundary + 0.50 Bcf/d	-1,500	1.25	3	3,500	8,000	11	-	-	-	-	-
Avangrid & BP Energy More Renewables + 0.50 Bcf/d	-1,500	1	2	3,500	8,000	17	-	-	-	-	-
Avangrid & BP Energy More Imports + 0.50 Bcf/d	-1,500	1	2	3,000	6,600	21	-	-	-	-	-
Avangrid & BP Energy More Duel-Fuel Replenishments + 0.50 Bcf/d	-1,500	1	3	2,500	6,600	24	-	-	-	-	-
Avangrid & BP Energy More LNG + 0.50 Bcf/d	-1,500	1.25	2	2,500	6,600	18	-	-	-	-	-
Avangrid & BP Energy Reference + 0.50 Bcf/d	-1,500	1	2	2,500	6,600	24	2	-	-	-	-
Avangrid & BP Energy More Retirements + 0.50 Bcf/d	-4,500	1	2	2,500	6,600	24	41	13	5	1	1

“AVANGRID” & “BP Energy Scenario #24” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
Avangrid & BP Energy Less LNG + 0.50 Bcf/d	-1,500	0.75	2	2,500	6,600	30	40	10	6	-	-
Avangrid & BP Energy Less Duel-Fuel Replenishments+ 0.50 Bcf/d	-1,500	1	1	2,500	6,600	24	31	7	3	-	-
Avangrid & BP Energy Less Imports + 0.50 Bcf/d	-1,500	1	2	2,000	6,600	24	8	-	-	-	-
Avangrid & BP Energy Low Boundary + 0.50 Bcf/d	-4,500	0.75	1	2,000	6,600	32	460	338	285	140	13

“ENGIE” Scenario Summary

- These scenarios added various amounts to the LNG Cap to different ISO scenarios

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
ENGIE07 Low LNG @ 0.94 Bcf/d	-1,500	0.94	2	2,500	6,600	36	207	102	72	22	6
ENGIE 02 and 05 More LNG @2.54 Bcf/d	-1,500	2.54	2	2,500	6,600	-	-	-	-	-	-
ENGIE14 Millstone Nuclear Outage Ref @ 2.11 Bcf/d	-1,500	2.11	3	2,500	6,600	19	-	-	-	-	-
ENGIE14 Millstone Nuclear Outage Max @ 2.54 Bcf/d	-5,400	2.54	3	3,500	9,500	1	-	-	-	-	-
ENGIE 13 Compressor Outage Ref @ 2.11 Bcf/d	-1,500	2.11	3	2,500	6,600	39	106	40	26	3	3
ENGIE 13 Compressor Outage Max @ 2.54 Bcf/d	-5,400	2.54	3	3,500	9,500	23	7	2	1	-	-

“ENGIE” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
ENGIE 12 Distrigas LNG Outage Ref @ 2.11 Bcf/d	-1,500	2.11	3	2,500	6,600	18	-	-	-	-	-
ENGIE 12 Distrigas LNG Outage Max @ 2.11 Bcf/d	-5,400	2.11	3	3,500	9,500	7	-	-	-	-	-
ENGIE 15 Canaport LNG Outage Ref @ 0.91 Bcf/d	-1,500	0.91	3	2,500	6,600	36	106	40	26	3	3
ENGIE 15 Canaport LNG Outage Max @ 1.54 Bcf/d	-5,400	1.54	3	3,500	9,500	21	7	2	1	-	-

“Environmental Defense Fund” Scenario Summary

- These scenarios either adjusted the LNG Cap, included 0.7% LDC growth, or added 0.40 Bcf/d gas pipeline infrastructure to different ISO scenarios

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
EDF Reference LNG Cap @ 1.25 Bcf/d	-1,500	1.25	2	2,500	6,600	32	40	9	6	-	-
EDF More LNG LNG Cap @ 1.50 Bcf/d	-1,500	1.5	2	2,500	6,600	24	2	-	-	-	-
EDF High Boundary 0.7% LDC Growth	-1,500	1.25	3	3,500	8,000	14	-	-	-	-	-
EDF More Renewables 0.7% LDC Growth	-1,500	1	2	3,500	8,000	20	-	-	-	-	-
EDF More Imports 0.7% LDC Growth	-1,500	1	2	3,000	6,600	24	2	-	-	-	-
EDF More Dual-Fuel Replenishments 0.7% LDC Growth	-1,500	1	3	2,500	6,600	27	1	-	-	-	-
EDF More LNG 0.7% LDC Growth	-1,500	1.25	2	2,500	6,600	21	-	-	-	-	-
EDF Reference 0.7% LDC Growth	-1,500	1	2	2,500	6,600	27	10	1	-	-	-

“Environmental Defense Fund” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
EDF More retirements 0.7% LDC Growth	-4,500	1	2	2,500	6,600	27	112	38	24	4	2
EDF Less LNG 0.7% LDC Growth	-1,500	0.75	2	2,500	6,600	35	91	33	21	2	2
EDF Less Dual-Fuel Replenishments 0.7% LDC Growth	-1,500	1	1	2,500	6,600	27	78	23	17	2	1
EDF Less Imports 0.7% LDC Growth	-1,500	1	2	2,000	6,600	31	25	7	2	-	-
EDF Low Boundary 0.7% LDC Growth	-4,500	0.75	1	2,000	6,600	35	607	442	385	205	19
EDF Low LNG/ High Renewables/ Higher Retirements 0.7% LDC Growth	-4,000	0.75	2	3,500	8,000	23	71	18	12	2	1

“Environmental Defense Fund” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
EDF High LNG/ High Renewables/ Higher Retirements 0.7% LDC Growth	-4,000	1.25	2	3,500	8,000	14	-	-	-	-	-
EDF High Renewables/ High Retirements 0.7% LDC Growth	-3,000	1	2	3,500	8,000	20	-	-	-	-	-
EDF Max Renewables/ Max Retirements 0.7% LDC Growth	-5,400	1	2	3,500	9,500	18	6	2	-	-	-
EDF Millstone Nuclear Outage Ref 0.7% LDC Growth	-1,500	1	3	2,500	6,600	36	48	16	6	1	1
EDF Millstone Nuclear Outage Max 0.7% LDC Growth	-5,400	1	3	3,500	9,500	24	92	28	15	2	1
EDF Compressor Outage Ref 0.7% LDC Growth	-1,500	1.5	3	2,500	6,600	46	274	136	95	25	10
EDF Compressor Outage Max 0.7% LDC Growth	-5,400	1.5	3	3,500	9,500	37	359	185	128	44	12

“Environmental Defense Fund” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
EDF Distrigas LNG Outage Ref 0.7% LDC Growth	-1,500	1	3	2,500	6,600	35	33	5	3	-	-
EDF Distrigas LNG Outage Max 0.7% LDC Growth	-5,400	1	3	3,500	9,500	23	50	11	7	1	1
EDF Canaport LNG Outage Ref 0.7% LDC Growth	-1,500	0.65	3	2,500	6,600	36	58	19	8	1	1
EDF Canaport LNG Outage Max 0.7% LDC Growth	-5,400	0.65	3	3,500	9,500	23	90	27	18	3	2

“Environmental Defense Fund” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
EDF Reference + 0.4 Bcf/d	-1,500	1	2	2,500	6,600	24	9	1	-	-	-
EDF Millstone Outage Max + 0.4 Bcf/d	-5,400	1	3	3,500	9,500	23	86	24	14	2	1
EDF Compressor Outage Max + 0.4 Bcf/d	-5,400	1.5	3	3,500	9,500	36	324	155	117	35	9
EDF - Distrigas LNG Outage Max + 0.4 Bcf/d	-5,400	1	3	3,500	9,500	23	44	10	5	1	1
EDF - Canaport LNG Outage Max + 0.4 Bcf/d	-5,400	0.65	3	3,500	9,500	23	79	26	15	3	2

“Eversource” Scenario Summary

- These scenarios added 1.50 Bcf/d gas pipeline infrastructure to different ISO scenarios

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
Eversource High Boundary + 1.50 Bcf/d	-1,500	1.25	3	3,500	8,000	-	-	-	-	-	-
Eversource More Renewables + 1.50 Bcf/d	-1,500	1	2	3,500	8,000	-	-	-	-	-	-
Eversource More Imports + 1.50 Bcf/d	-1,500	1	2	3,000	6,600	-	-	-	-	-	-
Eversource More Dual-Fuel Replenishments + 1.50 Bcf/d	-1,500	1	3	2,500	6,600	-	-	-	-	-	-
Eversource More LNG + 1.50 Bcf/d	-1,500	1.25	2	2,500	6,600	-	-	-	-	-	-
Eversource Reference + 1.50 Bcf/d	-1,500	1	2	2,500	6,600	-	-	-	-	-	-
Eversource More Retirements + 1.50 Bcf/d	-4,500	1	2	2,500	6,600	-	-	-	-	-	-
Eversource Less LNG + 1.50 Bcf/d	-1,500	0.75	2	2,500	6,600	-	-	-	-	-	-

“Eversource” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
Eversource Less Dual-Fuel Replenishments + 1.50 Bcf/d	-1,500	1	1	2,500	6,600	-	-	-	-	-	-
Eversource Less Imports + 1.50 Bcf/d	-1,500	1	2	2,000	6,600	-	-	-	-	-	-
Eversource Low Boundary + 1.50 Bcf/d	-4,500	0.75	1	2,000	6,600	3	-	-	-	-	-
Eversource Low LNG/ High Renewables/ Higher Retirements + 1.50 Bcf/d	-4,000	0.75	2	3,500	8,000	-	-	-	-	-	-
Eversource High LNG/ High Renewables/ Higher Retirements + 1.50 Bcf/d	-4,000	1.25	2	3,500	8,000	-	-	-	-	-	-
Eversource High Renewables/ High Retirements + 1.50 Bcf/d	-3,000	1	2	3,500	8,000	-	-	-	-	-	-

“Eversource” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
Eversource Max Renewables/ Max Retirements + 1.50 Bcf/d	-5,400	1	2	3,500	9,500	-	-	-	-	-	-
Eversource Millstone Nuclear Outage Ref + 1.50 Bcf/d	-1,500	1	3	2,500	6,600	3	-	-	-	-	-
Eversource Millstone Nuclear Outage Max + 1.50 Bcf/d	-5,400	1	3	3,500	9,500	-	-	-	-	-	-
Eversource Compressor Outage Ref + 1.50 Bcf/d	-1,500	1.5	3	2,500	6,600	18	-	-	-	-	-
Eversource Compressor Outage Max + 1.50 Bcf/d	-5,400	1.5	3	3,500	9,500	7	-	-	-	-	-

“Eversource” Scenario Summary, cont.

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
Eversource Distrigas LNG Outage Ref + 1.50 Bcf/d	-1,500	1	3	2,500	6,600	3	-	-	-	-	-
Eversource Distrigas LNG Outage Max + 1.50 Bcf/d	-5,400	1	3	3,500	9,500	-	-	-	-	-	-
Eversource Canaport LNG Outage Ref + 1.50 Bcf/d	-1,500	0.65	3	2,500	6,600	3	-	-	-	-	-
Eversource Canaport LNG Outage Max + 1.50 Bcf/d	-5,400	0.65	3	3,500	9,500	-	-	-	-	-	-
Eversource High Boundary + 1.50 Bcf/d	-1,500	1.25	3	3,500	8,000	-	-	-	-	-	-

“Iroquois” Scenario Summary

Revision 1

- These scenarios changed the capacity loss from 1,200 MDth/day to 430 MDth/day in two of the ISO scenarios

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
Iroquois Compressor Outage Ref	-1,500	1.5	3	2,500	6,600	35	46	13	8	1	1
Iroquois Compressor Outage Max	-5,400	1.5	3	3,500	9,500	24	69	21	12	3	2

“National Grid” Scenario Summary

- These scenarios either reduced the natural gas supply, or considered an overlapping outage of natural gas and a nuclear unit

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
NGrid Compressor Outage Ref -1.4 Bcf/d	-1,500	1.5	3	2,500	6,600	50	525	377	319	200	19
NGrid Compressor Outage Max -1.4 Bcf/d	-5,400	1.5	3	3,500	9,500	46	598	398	333	169	25
NGrid Compressor Outage Ref -1.4 Bcf/d – Nuclear Unit Outage	-1,500	1.5	3	2,500	6,600	60	864	709	650	504	36
NGrid Compressor Outage Max -1.4 Bcf/d – Nuclear Unit Outage	-5,400	1.5	3	3,500	9,500	50	907	764	693	485	38

“NESCOE” Scenario Summary

Revision 1

- These scenarios increased the renewables assumption to 8,000 MW and the Imports assumption to 3,500 MW

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
NESCOE More Imports/ Increase Renewables + Increase Imports	-1,500	1	2	3,500	8,000	29	24	6	2	-	-
NESCOE More Dual-Fuel Replenishment w/ Increase Renewables + Increase Imports	-1,500	1	3	3,500	8,000	29	8	1	1	-	-
NESCOE More LNG w/ Increase Renewables + Increase Imports	-1,500	1.25	2	3,500	8,000	23	1	-	-	-	-
NESCOE Reference w/ Increase Renewables + Increase Imports	-1,500	1	2	3,500	8,000	29	24	6	2	-	-
NESCOE More Retirements w/ Increase Renewables + Increase Imports	-4,500	1	2	3,500	8,000	29	186	81	62	13	5

“NESCOE” Scenario Summary, cont.

Revision 1

	INPUTS					TOTAL WINTER IMPACT					
	 Retirements (MW)	 LNG Cap (Bcf/Day)	 Dual-Fuel (Oil Tank Fills)	 Imports (MW)	 Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
NESCOE Less LNG w/ Increase Renewables + Increase Imports	-1,500	.75	2	3,500	8,000	35	119	49	30	5	3
NESCOE Less Dual-Fuel Replenishment w/ Increase Renewables + Increase Imports	-1,500	1	1	3,500	8,000	29	125	56	35	7	3
NESCOE Less Imports w/ Increase Renewables + Increase Imports	-4,500	1	2	3,500	8,000	29	24	6	2	-	-
NESCOE Low Boundary w/ Increase Renewables + Increase Imports	-4,500	.75	1	3,500	8,000	35	555	393	343	178	18

“NESCOE” Scenario Summary, cont.

Revision 1

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
NESCOE Millstone Outage Ref w/ Increase Renewables + Increase Imports	-1,500	1	3	3,500	8,000	36	92	30	21	3	2
NESCOE Compressor Outage Ref w/ Increase Renewables + Increase Imports	-1,500	1.5	3	3,500	8,000	45	171	63	47	10	5
NESCOE Distrigas Outage Ref w/ Increase Renewables + Increase Imports	-1,500	1	3	3,500	8,000	36	63	19	11	2	1
NESCOE Canaport Outage Ref w/ Increase Renewables + Increase Imports	-1,500	.65	3	3,500	8,000	36	62	20	7	-	-

“NRG” Scenario Summary

Revision 1

- These scenarios were performed with all oil units in and all oil units out

	INPUTS					TOTAL WINTER IMPACT					
	Retirements (MW)	LNG Cap (Bcf/Day)	Dual-Fuel (Oil Tank Fills)	Imports (MW)	Renewables (MW)	Days of LNG at ≥95% Assumed Cap	All OP 4 Hours	OP 4 Actions 6–11	Hrs. of 10-Min. Reserve Depletion	Hrs. of Load Shedding (OP 7)	Days with Load Shedding (OP 7)
NRG Reference All Oil Units In	-500	1	2	2,500	6,600	35	128	55	40	9	5
NRG Reference All Oil Units Out	-5,400	1	2	2,500	6,600	46	874	793	751	599	33

Stakeholder Meeting Schedule

Revision 1

Stakeholder Meetings	Scheduled Project Milestone
January 24, 2018 Reliability Committee	Begin discussion of the study inputs and results
February 15, 2018	Written comments due with requested assumptions to the RC Secretary (Marc Lyons)
March 28, 2018 Reliability Committee	Reliability Committee to discuss results of any stakeholder assumptions
May 9, 2018 Reliability Committee/ Markets Committee	Committees to discuss problem and objectives for next steps
Q2 2018 – Q2 2019	Participants and ISO submit and discuss potential solutions

Questions