Operational Impact of Extreme Weather Events

Preliminary Results of Energy Adequacy Studies for Summer 2032 and Review of Stakeholder Sensitivity Requests

Stephen George
DIRECTOR, OPERATIONAL PERFORMANCE, TRAINING & INTEGRATION
Jinye Zhao
TECHNICAL MANAGER, ADVANCED TECHNOLOGY SOLUTIONS

Operational Impact of Extreme Weather Events – Energy Adequacy Study

- ISO is working with EPRI to conduct a probabilistic energy adequacy study for the New England region in the operational time frame under extreme weather events
- Study results are intended to inform the region on risks
  - These results may help in 'quantifying' a problem statement on energy adequacy, against which possible solutions can be assessed
- This study has established a framework for risk analysis under extreme weather events
  - This framework will be essential as climate projections are refined and the resource mix evolves

Operational Impact of Extreme Weather Events – Energy Adequacy Study, cont.

- There are three major steps in this framework:
  - Step 1: Weather Modeling (performed by EPRI)
  - Step 2: Risk Screening Model Development and Scenario Generation (performed by EPRI)
  - Step 3: Energy Assessments (performed by the ISO)
- The ISO has been reviewing and discussing each step of the process with the Reliability Committee
- Preliminary results of Step 3 energy assessments were presented for the 2027 winter events in May, were presented for the 2027 summer events in July, and were presented for the 2032 winter events in August
- This presentation reviews preliminary results of Step 3 energy assessments completed for 2032 summer events and summarizes stakeholder sensitivity requests that ISO plans to perform

ASSUMPTIONS AND SELECTED EVENTS FOR SUMMER 2032 STUDIES

Resource and Demand Assumptions for Summer 2032 Events

- Summer 2032 studies include resources that obtained a Capacity Supply Obligation (CSO) in FCA16, resources that delisted in FCA16 and didn't obtain a CSO[1], and state-sponsored resources under contract or have been selected under recent RFP's
  - ISO's 2032 baseline studies include Millstone Station, which is currently on a state contract
- Summer 2032 studies incorporate ISO's 2022 CELT heating and transportation electrification forecasts

Summer Study Assumptions		
	2027 Study Year	2032 Study Year
CELT Load Forecast Year	2022	2022
FCA Results	FCA16	FCA16
Retired Capacity*	2,100	2,100 (no change from 2027)
Offshore Wind Capacity*	1,600	4,800
Storage Battery Capacity*	1,450	1,450 (no change from 2027)
Utility-scale PV Capacity*	1,250	1,250 (no change from 2027)
BTM PV Capacity*	9,500	12,000

1: this is intended to clarify what is meant by the "FCA16" resource mix; clarification applies to all 2027 and 2032 studies that are based on FCA16

**capacity values listed in the table above, in MW, are based on nameplate and are approximate*

21-Day Weather Events Selected By Risk Screening Model For Summer 2032

- Summer 2032 events selected for study are characterized by short to long-duration heat waves with low winds and low solar irradiance:
  - Summer Cluster 1 – characterized by longer-duration events
    - July 13, 1979 (highest avg. system risk and severity index*)
    - July 5, 1994 (medoid event)
  - Summer Cluster 2 – characterized by short to mid-duration events
    - August 2, 1984 (highest avg. system risk)
    - July 26, 1984 (highest severity index)
    - July 11, 1995 (medoid event)
  - Summer Cluster 3 – characterized by events with moderate summer temperatures with very low winds and solar
    - July 28, 2008 (highest avg. system risk and severity index)
    - August 6, 2001 (medoid event)

*Average System Risk and Severity Index are metrics calculated by EPRI's Risk Screening Model; these metrics are used to rank events and aid in the selection of events for study

STEP 3: PRELIMINARY RESULTS OF SUMMER 2032 EVENTS

Summary of Preliminary Results of Summer 2032 Events

- No energy shortfall was observed in any of the Summer 2032 events; only 1 hour of thirty-minute reserve shortfall was observed in one July 13, 1979 case and in one July 26, 1984 case
- Baseline studies of Summer 2032 events indicate an energy shortfall risk similar to that of the Summer 2027 events
- ISO is evaluating performing sensitivity analysis of Summer 2032 events using the 2023 CELT forecast; results of any sensitivity analysis of summer events will be shared at a future RC meeting

STAKEHOLDER-INFORMED SENSITIVITY ANALYSIS OF WINTER 2032

Overview of Stakeholder-Informed Sensitivity Analysis

- Recognizing interest in assumptions related to the region's resource mix and demand projections for 2032, ISO has accepted stakeholder input regarding additional sensitivity analysis of the worst case of the Jan 22, 1961 event; input was requested by September 1
- ISO received requests for the performance of ~35 sensitivities from 15 different stakeholders
- Stakeholder sensitivity requests reflected significant interest in sensitivities related to the impacts of additional renewables and generator retirements
- As described on the following slides, ISO is planning to perform analysis of ~28 sensitivity requests and intends to review the results of those studies at the November RC meeting
  - In some cases there was overlap across requests from different stakeholders, overlapping requests have been consolidated where possible
  - ISO has followed up with stakeholders who submitted requests that cannot be performed due to the structure of the current modeling framework

Overview of Stakeholder-Informed Sensitivity Analysis, cont.

- All sensitivities will focus on scenarios that include the NECEC in-service; this is due to the high likelihood of NECEC being in-service by 2032
- Sensitivities are deterministic in nature given the modification of specific inputs; probabilistic data will not be generated as part of the sensitivity analysis because probabilities of certain modified input data may be unavailable
- Descriptions of sensitivity analysis to be performed (*see* slides 15-25) are based on ISO's understanding of stakeholder requests with any deviations noted where applicable

Overview of Stakeholder-Informed Sensitivity Analysis, cont.

- Stakeholder feedback indicates a strong preference for performance of sensitivity analysis using a baseline that incorporates ISO's 2023 CELT load forecast and a resource mix aligned with ISO's FCA17 sensitivity analysis
- Stakeholder-informed sensitivity analysis will be performed using ISO's 2023 CELT load forecast
  - This change, based on stakeholder feedback, is a modification of ISO's original plan which was to perform sensitivity analysis using the 2022 CELT load forecast

Resource and Demand Assumptions for Stakeholder-Informed Winter 2032 Sensitivity Analysis Baseline

- Resource assumptions for stakeholder-informed sensitivity analysis will be based on ISO's "2032 FCA17/2023 CELT" sensitivity study[1] which includes resources that obtained a CSO in FCA17 and state-sponsored resources under contract or have been selected under recent RFP's
  - This includes Millstone Station, which is currently on a state contract
- Resources that de-listed in FCA17 and did not obtain a CSO in FCA17 are assumed to be retired in ISO's "2032 FCA17/2023 CELT" sensitivity study (the retirement of these resources is different than in FCA16 studies)
  - Modelled resource retirements total ~1,600 MW of capacity (in addition to the 2,100 MW of retirements from FCA16)
  - Retirements include ~375 MW of natural gas-only, ~450 MW of coal, and ~750 MW of RFO resources; retired capacity of generators is replaced with new capacity based on a 1:1 nameplate MW ratio
  - Replacement capacity is based on the percentage of resource types currently in ISO's interconnection queue; a blend of offshore wind (~50%), utility-scale PV (~10%), and storage battery capacity (~40%)

Sensitivity Analysis Baseline Assumptions	
CELT Load Forecast Year	2023
FCA Results	FCA17 (plus retirements)
Retired Capacity*	3,700 (+1,600 due to retirements)
Offshore Wind Capacity*	5,600 (+800 due to retirements)
Storage Battery Capacity*	2,050 (+600 due to retirements)
Utility-scale PV Capacity*	1,450 (+200 due to retirements)
BTM PV Capacity*	12,000

**capacity values listed in the table above, in MW, are based on nameplate and are approximate*

1: for details on ISO's "2032 FCA17/2023 CELT" sensitivity study, see slide 44 of the "Operational Impact of Extreme Weather Events" presentation given at the August 15, 2023 RC Meeting

STAKEHOLDER-INFORMED SENSITIVITY ANALYSIS TO BE PERFORMED

Sensitivities with Additional Renewable Resources and Corresponding Retirements

- Four sensitivities that incorporate additional renewable resources based on qualified capacity (QC) values and retire a corresponding amount of fossil-fuel resources based on a 1:1 QC MW basis
  1) 1,000 QC MW additional utility-scale PV
  2) 1,000 QC MW additional battery storage
  3) 1,000 QC MW additional offshore wind
  4) 1,000 QC MW additional onshore wind
- One sensitivity modelled after ISO's Pathways Study ("Status Quo") incorporates additional renewable resources based on nameplate values and retires a corresponding amount of fossil-fuel resources based on a 1:1 QC MW basis; resource values shown below are total nameplate capacity:
  - 4,602 MW utility-scale PV (+3,152 MW)
  - 4,251 MW battery storage (+2,201 MW)
  - 8,841 MW offshore wind (+3,240 MW)
  - 2,465 MW onshore wind (+1,015 MW)
- Additional renewable resources are incremental to those already modelled in ISO's "2032 FCA17/2023 CELT" sensitivity study
- Per the submitted requests, retirements will be comprised of fossil-fuel resources based on the proportions of each type of resource available to be retired in sensitivity scenarios

Sensitivities with Additional Behind-the-Meter PV and Demand Response

1) Incremental addition of 20% BTM PV nameplate capacity
   - Additional BTM PV will be incremental to ~12,000 MW of nameplate capacity already modelled in ISO's 2032 studies for a total of 14,400 MW
2) Incremental addition of 500 MW of demand response
3) Incremental addition of 1,000 MW of demand response
   - In both of the demand response sensitivities, the additional demand response capacity will be incremental to the ~300 MW of real-time demand response capacity already modelled in ISO's 2032 studies for a total of 800 MW and 1,300 MW, respectively
   - As a reminder, demand response is the last resource to be dispatched in ISO's 21-day energy simulator

Sensitivities with Delayed or Reduced Renewables

1) Cap offshore wind at 1,600 MW nameplate capacity
   - 1,600 MW nameplate capacity for offshore wind is the quantity used in ISO's 2027 studies; this sensitivity request is to apply the same quantity to the 2032 study
2) 25% reduction of offshore wind, battery storage, and utility-scale PV capacity
   - Reduction is from nameplate capacities used in ISO's "2032 FCA17/2023 CELT" sensitivity study; nameplate capacities following 25% reduction will be:
     - Offshore wind: 4,200 MW (-1,400 MW)
     - Battery storage: 1,538 MW (-512 MW)
     - Utility-scale PV: 1,088 MW (-362 MW)

Sensitivities with Retirement of Residual Fuel Oil Resources

1) Retirement of 1,600 MW of RFO resource capacity; replacement of the retired capacity with renewables based on a 1:1 QC ratio
   - Sensitivity will utilize the replacement ratio ISO used in its Winter 2023 sensitivity analysis (50% offshore wind, 10% utility-scale PV, and 40% battery storage)
   - Request is similar to ISO's sensitivity analysis, "2032 FCA17+RFO/2023 CELT", but uses a 1:1 QC ratio instead of a 1:1 nameplate ratio for replacement of retired capacity

2) Retirement of 1,600MW of RFO resource capacity combined with a 25% reduction of offshore wind, battery storage, and utility-scale PV nameplate capacity; replacement of the retired capacity with renewables based on a 1:1 nameplate ratio
   - Sensitivity will utilize the same replacement ratio ISO used in its Winter 2023 sensitivity analysis
   - Request is similar to ISO's sensitivity analysis, "2032 FCA17+RFO/2023 CELT," but additionally incorporates a 25% reduction of renewables

3) Retirement of all RFO resource capacity; replacement of the retired capacity with renewables based on 1:1 nameplate ratio
   - Sensitivity will utilize a modified replacement ratio: 65% offshore wind, 25% battery storage, 10% utility-scale PV

4) Retirement of all RFO resource capacity; no replacement of retired capacity

Sensitivities with Retirement of Nuclear Resources

1) Retirement of 1,000 MW of nuclear resource capacity; replacement of the retired capacity with renewables based on 1:1 nameplate ratio
   - Sensitivity will utilize a modified replacement ratio: 65% offshore wind, 25% battery storage, 10% utility-scale PV
2) Retirement of all nuclear resource capacity; no replacement of retired capacity
3) Retirement of all nuclear resource capacity and cap offshore wind at 1,600 MW nameplate; no replacement of retired capacity

Sensitivities with Retirement of Natural Gas-Only Resources

1) Retirement of 1,500 MW of natural gas-only resource capacity; replacement of retired capacity based on a 1:1 nameplate ratio
   - Sensitivity will utilize the same replacement ratio ISO used in its Winter 2032 sensitivity analysis

Sensitivities with Modifications of Imports

- The following sensitivities will incorporate modifications to the hourly net interchange levels; import levels will be capped at the maximum import limit, as needed
  1) Increase imports by 20%
  2) Increase imports by 50%
  3) Decrease imports by 20%
- All sensitivity cases will be run on scenarios that include the NECEC in-service

Sensitivity with Additional Imports and Renewable Resources

- Incremental addition of imports and renewable resources based on nameplate values with retirement of a corresponding amount of resources based on a 1:1 QC MW basis
  - Imports will be increased incrementally by 1,200 MW/hr
  - Increase in renewables is from nameplate capacities used in ISO's "2032 FCA17/2023 CELT" sensitivity study; nameplate values following increase will be:
    - Onshore wind: 2,450 MW (+1,000 MW)
    - Offshore wind: 7,000 MW (+1,400 MW)
    - Battery storage: 4,000 MW (+1,950 MW)
    - Utility-scale PV: 1,650 MW (+200 MW)
  - Corresponding retirements will be comprised of fossil-fuel resources based on the proportions of each type of resource available to be retired in sensitivity scenarios

Sensitivities with Modification of Load Profiles

- The following sensitivities will incorporate modifications to the hourly load profiles:
  1) Increase loads by 10%
  2) Decrease loads by 10%
  3) Decrease loads by 20%

Sensitivities with Modification of LNG Inventories and Replenishment

1) In "without EMT" scenarios, reduce starting LNG inventories and LNG replenishment quantities by 30%
   - Starting LNG inventory will decrease from ~6.5 Bcf to ~4.55 Bcf and total LNG replenishment will decrease from ~4.1 Bcf to ~2.87 Bcf
2) In "without EMT" scenarios, include 1,600 MW of additional RFO retirement and reduce starting LNG inventories and LNG replenishment quantities by 30%
   - This sensitivity will be similar to ISO's sensitivity analysis, "2032 FCA17+RFO/2023 CELT," but will incorporate the reduced LNG inventories and replenishment as requested
   - Replacement of the retired capacity with renewables will be based on 1:1 nameplate ratio and will use the same replacement ratio ISO used in its Winter 2032 sensitivity analysis

Sensitivities with Modification of Fuel Oil Inventories

1) Reduction in RFO inventories which is offset by increases in distillate fuel oil (DFO) inventories
   - For this scenario, it is requested that all DFO tanks begin the 21-day period full and the increase in DFO inventory (the amount needed to achieve full tanks) is offset by a corresponding decrease in RFO inventory
   - The decrease in RFO inventory will be allocated proportionally across RFO stations

Stakeholder Schedule

Schedule is subject to change based on modeling progress

Stakeholder Committee and Date	Scheduled Project Milestone
Reliability Committee February 15, 2022	Initial presentation
Reliability Committee March 15, 2022	Summary of EPRI's historical weather analysis deliverables and discussion of macro assumptions
Reliability Committee May 17, 2022	Share results of Step 1 (Extreme Weather Modeling) report. Review and discuss Step 2 (Risk Model Development and Scenario Generation) activities
Reliability Committee July 19, 2022	Review progress on Step 2 activities
Reliability Committee September 20, 2022	Continue to gather feedback with respect to Step 2 activities
Reliability Committee November 16, 2022	Continue to gather feedback with respect to Step 2 activities
Reliability Committee January 18, 2023	Discuss preliminary results of Step 2 Risk Screening Model
Reliability Committee February 14, 2023	Continued discussion of Step 2 Risk Screening Model results

Stakeholder Schedule

Schedule is subject to change based on modeling progress

Stakeholder Committee and Date	Scheduled Project Milestone
Reliability Committee March 14, 2023	Review outage draw and categorical branching methodologies (including LNG, fuel inventory, imports, etc.)
Reliability Committee April 18, 2023	Review 21-day energy assessment simulator, review return period methodology, and follow-up on stakeholder questions regarding modeling
Reliability Committee May 16, 2023	Review Step 3 winter 2027 preliminary results
Reliability Committee July 18-19, 2023	Review Step 3 summer 2027 preliminary results, address stakeholder feedback, outline plan for accepting stakeholder input to additional studies
Reliability Committee August 15, 2023	Review Step 3 winter 2032 preliminary results
Reliability Committee September 19, 2023	Review Step 3 summer 2032 preliminary results and review stakeholder sensitivity requests selected for analysis
Reliability Committee November 14, 2023	Review results of sensitivity analyses

Questions