memo

To: Power Supply Planning Committee / Reliability Committee / Market Committee

From: Fei Zeng, Technical Manager – Resource Studies and Assessments/Planning Services

Date: December 16, 2020

Subject: Operating Reserve Deficiency Information – Capacity Commitment Period 2024-2025

In response to stakeholders' request, ISO New England (ISO) conducts an annual study to forecast the expected number of system-wide operating reserve deficiency hours covering installed capacity resource levels of the New England system, at, lower and higher than the net Installed Capacity Requirement (ICR) for the Capacity Commitment Period (CCP) associated with the upcoming Forward Capacity Auction (FCA)[1]. This memorandum presents this year's study results covering the 2024-2025 CCP (FCA 15). This year's study relied on the same load and resource assumptions used to develop the net ICR for the 2024-2025 CCP. The ISO conducted similar studies in 2013 for the 2016-2017 CCP, and in 2016 through 2019 for the 2020-2021 through 2023-2024 CCPs. Results of these studies are available by assessing the links listed in the Appendix.

This memorandum provides the following information for the 2024-2025 CCP covering a New England system with installed capacity level ranging from 1,600 MW below the net ICR (31,670 MW) to 3,200 MW above the net ICR (34,870 MW) in a 400 MW increment:

- The expected number of operating reserve deficiency hours;
- The frequency distribution (*i.e.* percentiles) of the expected operating reserve deficiency hours; and
- A comparison of the 2020 study (2024-2025 CCP) result with prior study results.

Study Approach and Assumptions

The ISO employs the probabilistic General Electric Multi-Area Reliability Simulation (GE MARS) program to determine the ICR for the Forward Capacity Market (FCM) auctions. This program provides estimates of the expected number of days per year (known as the Loss of Load Expectation, or LOLE) in which supply would be insufficient to meet demand during the year. In addition to estimating the LOLE, the program also estimates the expected number of hours per year in which there would be insufficient capacity to meet the system's load plus operating reserve requirements.

[1] The upcoming FCA is the fifteenth FCA associated with the 2024-2025 CCP. This CCP starts on June 1, 2024 and ends on May 31, 2025.

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The GE MARS model, applying Monte Carlo simulation techniques, evaluates the annual (or a chosen period) bulk power system resource adequacy by simulating the availability of resources and the assumed demand on an hourly basis. If the amount of available resources in the system is not adequate to meet the system load and operating reserve requirement for the hour of interest, the program registers a shortage hour. At the end of the simulation, the program sums up and reports the total number of shortage hours for the year (or a chosen period). Here, we want to emphasize that while GE MARS provides the number of hours of operating reserve shortage, it does not provide the number of events that resulted in these expected shortage hours. By way of example, 20 hours of annual operating reserve shortage could represent 20 non-continuous discrete shortage hours, or one shortage of 20-hours duration, or shortages of different hours of duration. The GE MARS program calculates the "expected hours" of operating reserve shortage, after thousands of Monte Carlo iterations to sample the system load and resource conditions, as the average number of shortage hours during a year.

As a reliability tool mainly used for assessing the resource adequacy of the system, GE MARS captures the randomness of the resources' outages. However, it does not consider the operational parameters associated with the resources such as ramp rate, minimum up/down times, maximum number of starts per day, etc. The GE MARS does not model operational requirements and economic objectives associated with unit commitment or economic dispatch. The ICR calculation and this "Expected Operating Reserve Deficiency" study assume no internal transmission constraints. Therefore, reserve shortage hours due to transmission constraints associated with transmission maintenance, system upgrades or unforeseen loss of transmission elements are not considered. In addition, the shortage hours reported in this study do not reflect any shortage hours that could arise relating to operational risks such as under-commitment due to load forecast error in operations, loss of fuel supply facilities; or lack of fuel supply, etc.

The ISO derived all of the results in this memorandum from the GE MARS probabilistic simulations. As noted earlies, this year's study relied on the same load and resource assumptions used to develop the net ICR for the 2024-2025 CCP. These assumptions are detailed in the ISO's FERC filing of "Installed Capacity Requirement, Hydro Quebec Interconnection Capability Credits and Related Values for the Capacity Commitment Period 2024-2025",[2] and an ISO presentation to the Power Supply Planning Committee dated October 9, 2020 entitled "*Estimated Hours of System Operating Reserve Deficiency for Capacity Commitment Period 2024-2025 (FCA 15)"*.[3]

[2] https://www.iso-ne.com/static-assets/documents/2020/11/icr_for_fca_15.pdf

[3] https://www.iso-ne.com/static-assets/documents/2020/10/a03_pspc_2020_10_09_est_hrs_or_def_fca15.pptx

Summary of Results

Table 1: Estimated Hours of System Operating Reserve Deficiencies Annually

Capacity Level	Expected	5/95	50/50	95/5
Net ICR + 3,200 MW	**0.9**	0.4	0.8	2.0
Net ICR + 2,800 MW	**1.2**	0.6	1.0	2.6
Net ICR + 2,400 MW	**1.6**	0.7	1.3	3.4
Net ICR + 2,000 MW	**2.1**	0.9	1.8	4.3
Net ICR + 1,600 MW	**2.8**	1.1	2.5	5.5
Net ICR + 1,200 MW	**3.7**	1.6	3.4	7.0
Net ICR + 800 MW	**4.8**	2.3	4.4	8.7
Net ICR + 400 MW	**6.2**	3.2	5.7	10.8
Net ICR (33,270 MW)	**7.9**	4.3	7.2	13.5
Net ICR - 400 MW	**9.9**	5.6	9.1	16.7
Net ICR - 800 MW	**12.3**	7.1	11.2	20.7
Net ICR - 1,200 MW	**15.4**	8.9	14.2	25.8
Net ICR - 1,600 MW	**19.3**	11.1	18.1	31.6

Table 1 provides the summary information regarding: (a) the expected number of hours of operating reserve deficiency annually, and (b) the estimated relative frequency of hours of operating reserve deficiency conditions annually. In Table 1, entries in the column labeled '5/95' indicate the lower 5th percentile of the simulation results for the number of hours with system operating reserve deficiency conditions; entries in the '50/50' column indicate the median hours; and entries in the '95/5' column show the 95th percentile.

For example, the value 0.4 in the first row and column labeled '5/95' means that, based on the simulation, there is a 1-in-20 (or 5%) chance that the annual number of hours with operating reserve deficiency conditions would equal *0.4 hours or less* when the amount of installed capacity equals net ICR plus 3,200 MW. Similarly, the value of 2.0 in the far-right column labeled '95/5' means that, based on the simulation, there is a 19-in-20 (or 95%) chance that the number of hours with operating reserve deficiency conditions would be *2.0 or less* annually. The values listed in the column labeled "*Expected*" are calculated as the average of all outcomes for a particular capacity level while the column labeled "50/50" is the median value[4].

[4] The median value represents the middle value of the shortage hours in a year in which one-half of the numbers are above the median and the other half are below. The expected value is the average value of the shortage hours in a year.

Figure 1: Plot of Estimated Hours of System Operating Reserve Deficiencies Annually

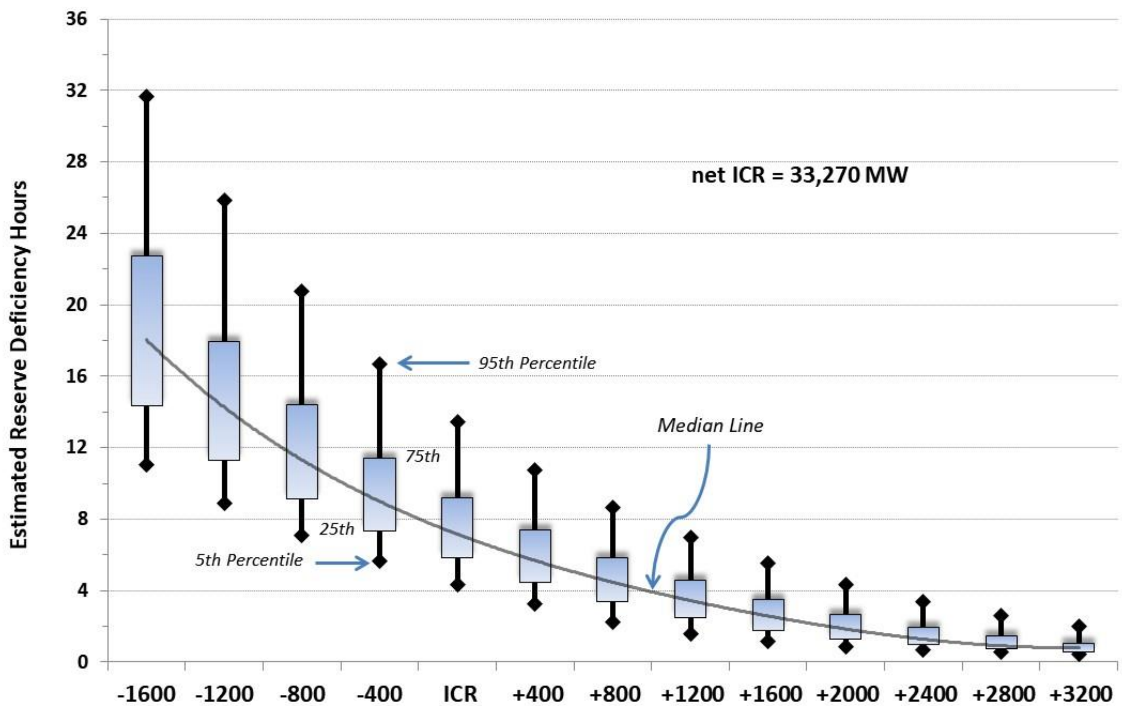

Figure 1 is a '*box-and-whisker*' plot of the data in Table 1 with the values for the 25th and 75th percentiles included in addition to the 5th, 50th and 95th percentiles shown in Table 1. In Figure 1, each shaded '*box*' indicates the upper and lower quartiles (25th and 75th percentiles) for the distribution of the total number of hours of operating reserve deficiency conditions annually, at each level of installed capacity. The extended '*whiskers*' show the 5th and 95th percentile values from Table 1, and the smooth line interpolates the median ('50/50') hours data from Table 1.

Observations

Similar to the prior studies, the results of the 2020 study demonstrate that as the level of installed capacity in the New England system decreases, the estimated number of hours with operating reserve deficiency conditions increases gradually at first, then more quickly as the system becomes close to or below its criteria capacity requirement.

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Figure 2: Comparison of the 2018 Study (2022-2023 CCP), 2019 Study (2023-2024 CCP), and 2020 Study (2024-2025 CCP) Results of Estimated Hours of Reserve Deficiency

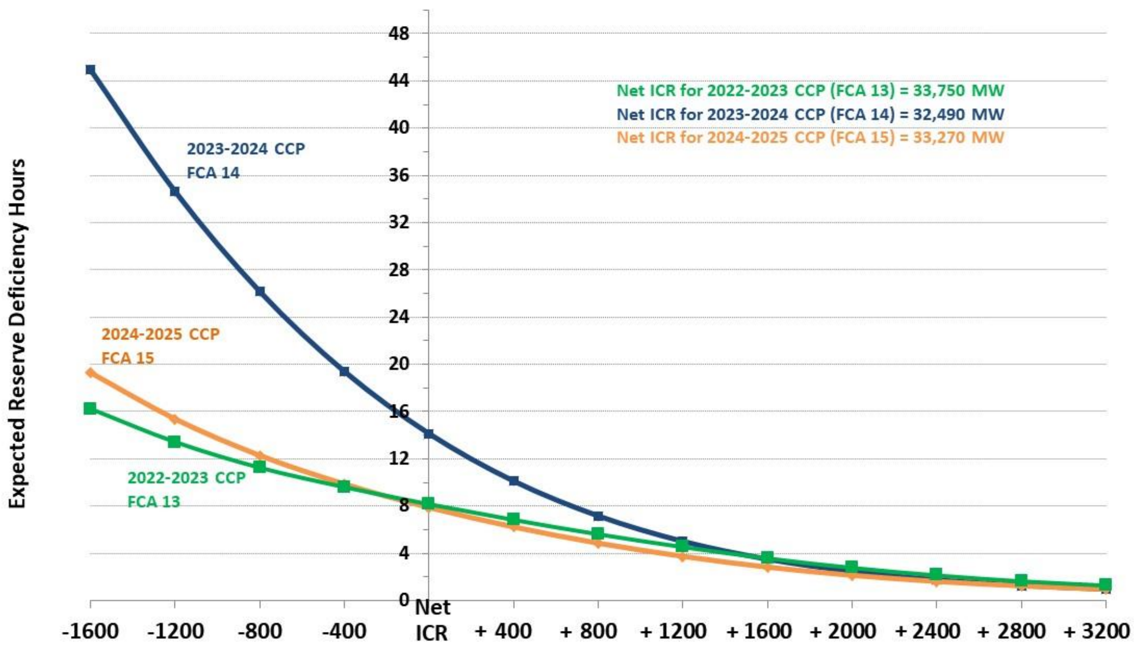
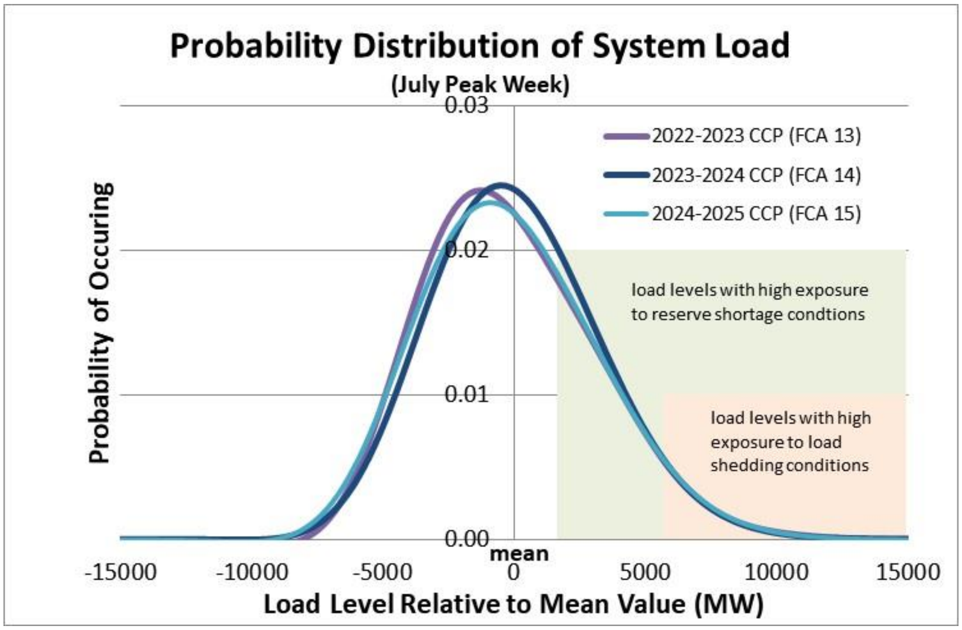


Figure 2 compares the expected number of hours of operating reserve deficiency of the studies for the 2022-2023, 2023-2024, and 2024-2025 CCPs. The estimated annual hours of operating reserve deficiencies for the 2024-2025 CCP are lower than the values for the 2023-2024 CCP, but they are similar to the results for the 2022-2023 CCP. The decrease in the expected number of operating shortage hours for the 2024-2025 CCP as compared with the values for the 2023-2024 CCP is mainly attributed to the updated load forecast assumption, and to a lesser extent, the higher net ICR value and the lower tie benefits assumption used for the 2024-2025 CCP (FCA 15) ICR calculation.

Figure 3, below, compares the load forecast probability distributions for the peak week of July of the 2022-2023 through 2024-2025 CCPs used in the ICR calculations. The probability of extreme high loads (high exposure to load shedding conditions) to occur in the peak week of July are similar for the 3 CCPs studied. However, the probability of intermediate high loads (high exposure to reserve shortage conditions) to occur in the peak week in July is similar for the 2022-2023 and 2024-2025 CCPs but it is lower than the probability for the 2023-2024 CCP. These load forecast probability distributions explain one of the major reasons why the expected number of operating reserve shortage hours are similar for the 2022-2023 and 2024-2025 CCPs, but lower than the values for the 2023-2024 CCP.

Figure 3: Comparison of the Load Probability Distribution (July Peak Week) for the 2022-2023 through 2024-2025 CCPs



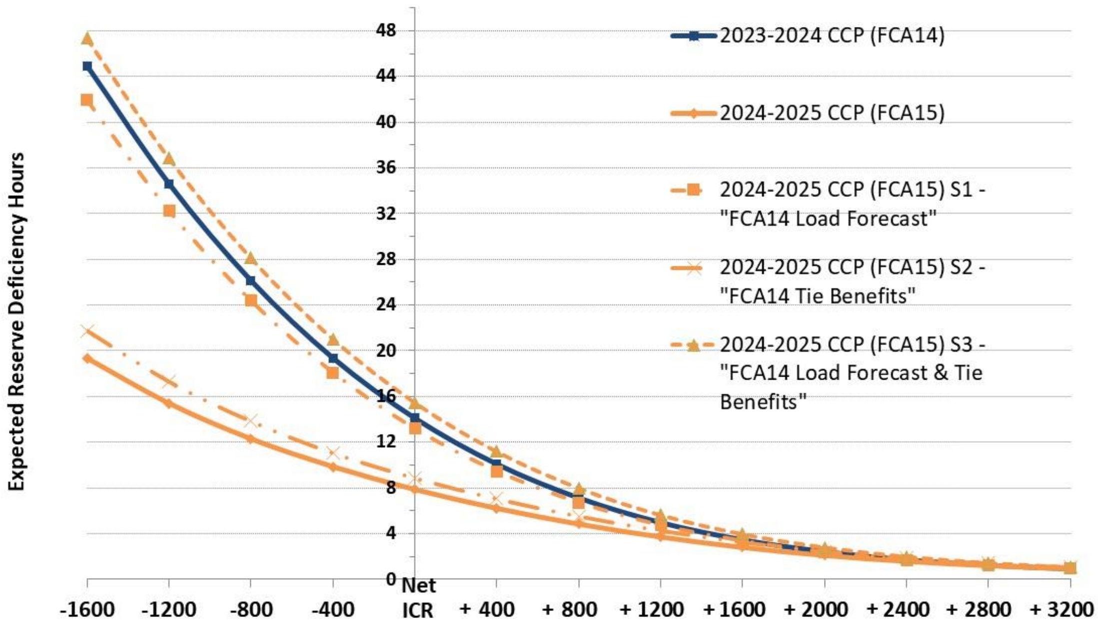
Another contributing factor to the difference between the results for the 2023-2024 and the 2024-2025 CCPs relates to the ratio of the amount of the regular resources (as represented by the net ICR) and the amount of the OP 4 resources (as represented by the tie benefits, the load relief obtainable from implementing voltage reductions and the depletion of system operating reserve requirements). The LOLE simulations use both the regular resources and the OP 4 resources to meet the system reliability criterion. The tie benefits assumption for the 2024-2025 CCP is about 200 MW lower than the value assumed for the 2023-2024 CCP. The net ICR for 2024-2025 CCP is about 800 MW higher than the value for the 2023-2024 CCP. Relying on more regular resources and less OP 4 resources means that there are more installed capacity available to meet the load and operating reserve requirements in the 2024-2025 CCP as compared with the conditions for the 2023-2024 CCP, thus resulting in lower operating reserve shortage hours in the 2024-2025 CCP.

To verify and quantify the impact on the results from the changes to the 2024-2025 CCP study assumptions, the following 3 sensitivity scenarios are simulated using the 2024-2025 CCP model as the base:

- S1: Replace "FCA 15 load forecast model" with "FCA 14 load forecast model"
- S2: Replace "FCA 15 tie benefits assumptions" with "FCA 14 tie benefits assumptions"
- S3: Replace "FCA 15 load forecast model and tie benefits assumptions" with "FCA 14 load forecast model and tie benefits assumptions"

The results of the sensitivity simulations are summarized in Figure 4, and they show that the updated load forecast assumption is the major contributing factor to the lower number of expected operating reserve deficiency for the 2024-2025 CCP as compared with the study results for the 2023-2024 CCP.

Figure 4: Results of Sensitivity Scenarios of the 2020 Study



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Appendix – Past Studies

- The 2013 studies for the 2016-2017 CCP are available at:

  https://www.iso-ne.com/static-assets/documents/committees/comm_wkgrps/mrkts_comm/mrkts/mtrls/2013/jul10112013/a12a_iso_memo_07_05_13.pdf

  https://www.iso-ne.com/committees/comm_wkgrps/mrkts_comm/mrkts/mtrls/2013/jun452013/a07b_iso_memo_05_29_13.pdf

- The 2016 study for the 2020-2021 CCP is available at:

  https://www.iso-ne.com/static-assets/documents/2016/12/iso_memo_operating_reserve_deficiency_dec_19_2016.pdf

- The 2017 study for the 2021-2022 CCP is available at:

  https://www.iso-ne.com/static-assets/documents/2017/12/pspc_oprting_resrve_deficiency_memo_12072017.pdf

- The 2018 study for the 2022-2023 CCP is available at:

  https://www.iso-ne.com/static-assets/documents/2018/12/pspc_oprting_resrve_deficiency_memo_12072018.pdf

- The 2019 study for the 2023-2024 CCP is available at:

  https://www.iso-ne.com/static-assets/documents/2020/02/2020_05_28_pspc_iso_memo_fca_14_operating_reserve_deficiency_info.pdf

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