memo

To:	Power Supply Planning Committee / Reliability Committee / Market Committee
From:	Fei Zeng, Technical Manager – Resource Studies and Assessments/Planning Services
Date:	February 14, 2020
Subject:	Operating Reserve Deficiency Information – Capacity Commitment Period 2023-2024

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 for capacity resource levels of the New England system, at, lower and higher than the net Installed Capacity Requirement (ICR). This forecast uses the latest available information for the Forward Capacity Auction (FCA) ICR calculation for each Capacity Commitment Period (CCP). Such studies were previously conducted in 2013, 2016, 2017, and 2018[1] for the 2016 -2017 CCP (FCA 7), 2020-2021 CCP (FCA 11), 2021-2022 CCP (FCA 12), and 2022-2023 CCP (FCA 13), respectively. This memorandum provides the results of the 2019 study, using the ISO planning models and assumptions for calculating the ICR and Related Values for the 2023-2024 CCP (FCA 14) with Mystic 8 & 9.

Specifically, this memorandum provides the following annual information for the 2023-2024 CCP, given system total installed capacity at net ICR and also at values lower and higher than the net ICR:

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[1] 2013 studies 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

2016 study available at

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

2017 study available at

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

2018 study available at

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

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- The expected number of operating reserve deficiency hours;
- The frequency distribution (*i.e.* percentiles) of operating reserve deficiency hours; and
- A comparison of the 2018 (FCA 13) and 2019 (FCA 14) study results.

Approach and Assumptions

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

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 total number of shortage hours for the year (or a chosen period) is summed up and reported. 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 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 "expected hours" of operating reserve shortage are calculated, after thousands of Monte Carlo iterations, 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. It does not, however, consider the operational parameters associated with the resources such as ramp rate, minimum up/down times, maximum number of starts per day, etc. In addition, operational requirements associated with unit commitment/economic dispatch; or transmission constraints associated with transmission maintenance, system upgrades or unforeseen loss of transmission elements are also not considered. Therefore, 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 critical transmission elements, loss of fuel supply facilities; or lack of fuel supply, etc.

All of the results in this memorandum are derived from the ISO's probabilistic simulation using GE MARS. The simulation results are based on the ICR and Related Values calculation inputs and assumptions for FCA 14 with Mystic 8 & 9. These inputs and 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 2023-2024,[2] and an ISO presentation to the Reliability Committee on November 19, 2019 entitled "*Estimated Hours of System Operating Reserve Deficiency - Capacity Commitment Period 2023-2024 (FCA 14)*".[3]

[2] https://www.iso-ne.com/static-assets/documents/2019/11/er20-___-000_11-5-19_icr_hqiccs_related_values_fca_14.pdf

[3] https://www.iso-ne.com/static-assets/documents/2019/11/reservedeficiencyhours_ccp2023-2024.pptx

With the integration of Demand Resources into the energy and reserve markets in 2018, Active Demand Capacity Resources are assumed available for dispatch prior to the system entering an operating reserve deficiency. This is consistent with the 2016, 2017, and 2018 studies.

Tie Benefits (emergency assistance from neighboring Control Areas to the New England system during capacity deficiencies) are assumed available after a declaration of a reserve deficiency under ISO-NE Operating Procedure No. 4, *Actions During a Capacity Deficiency* (OP 4), consistent with prior studies.

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**	0.5	0.8	2.0
Net ICR + 2,800 MW	**1.3**	0.6	1.0	3.0
Net ICR + 2,400 MW	**1.7**	0.7	1.3	4.1
Net ICR + 2,000 MW	**2.4**	1.0	1.8	5.8
Net ICR + 1,600 MW	**3.5**	1.2	2.7	8.3
Net ICR + 1,200 MW	**5.0**	1.8	4.1	11.6
Net ICR + 800 MW	**7.1**	2.5	5.9	15.8
Net ICR + 400 MW	**10.1**	3.9	8.5	21.3
Net ICR (32,490 MW)	**14.1**	5.8	12.4	28.1
Net ICR - 400 MW	**19.4**	8.4	17.5	36.8
Net ICR - 800 MW	**26.1**	12.4	24.0	47.3
Net ICR - 1,200 MW	**34.6**	18.1	32.3	58.8
Net ICR - 1,600 MW	**44.9**	25.1	42.5	72.9

Table 1 provides 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.

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For example, the value 0.5 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 *0.5 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].

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

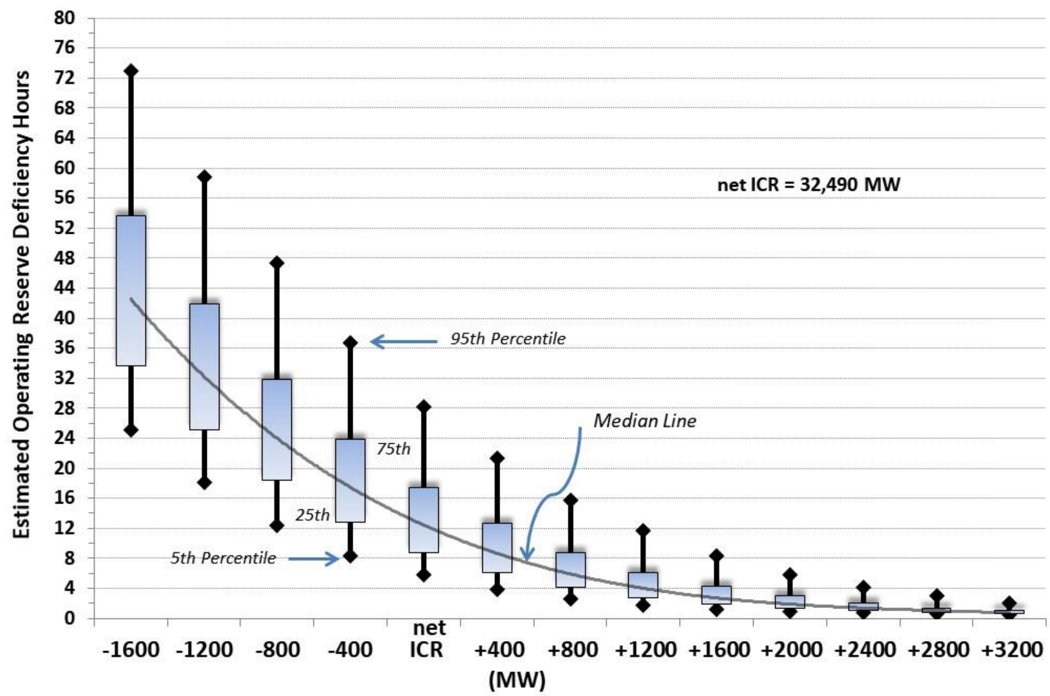

Figure 1 is a '*box-and-whisker*' plot of the data in Table 1 with the values for the 25th and 75th percentiles included in addition to the 5th, 50th and 95th percentiles shown in Table 1. In Figure 1, each shaded '*box*' indicates the upper and lower quartiles (25th and 75th percentiles) for the distribution 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 2019 study demonstrate that as the level of installed capacity in the New England system decreases from the most surplus condition studied (Net ICR + 3200 MW) to the

[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.

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most deficient condition studied (Net ICR – 1600 MW), 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.

Figure 2: Comparison of the 2018 (FCA 13) and 2019 (FCA 14) Study Results of Estimated Hours of Reserve Deficiency

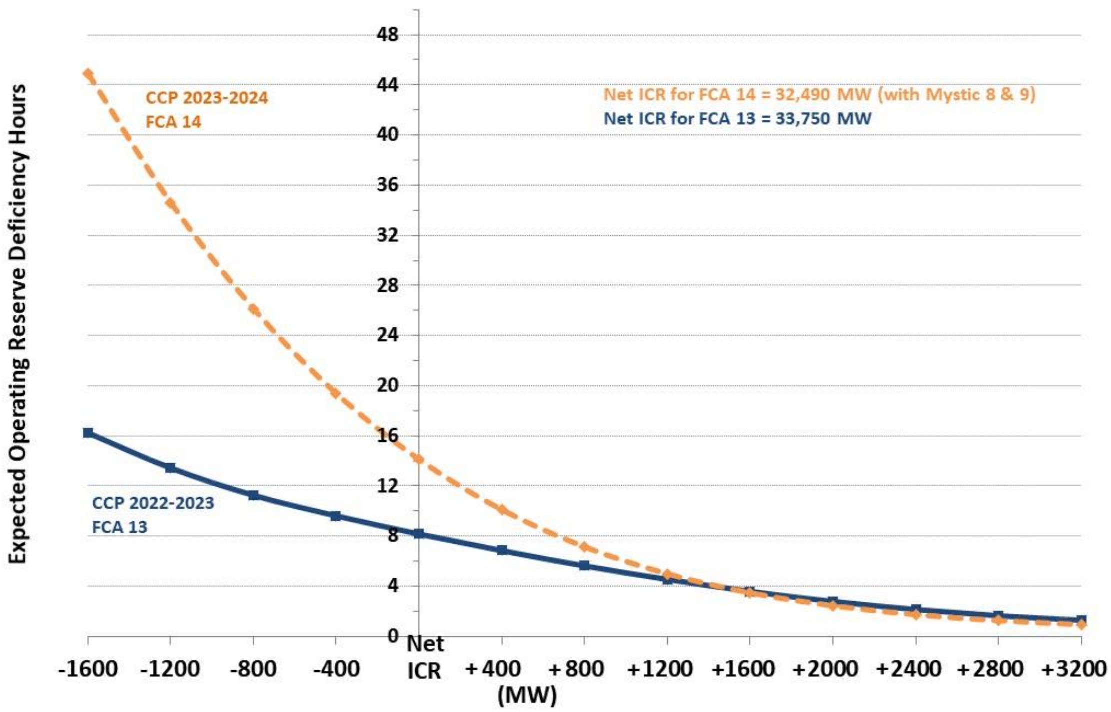


Figure 2 compares the expected number of hours of operating reserve deficiency between the study for the FCA 13 and this 2019 study for the FCA 14. The estimated annual hours of operating reserve deficiencies for the FCA 14 increase faster as compared to FCA 13. This is mainly attributed to the updated load forecast assumption and the updated resources' 5-yr average EFORds for the FCA 14 ICR calculation.

Figure 3 and 4 below compare the load forecast probability distribution between FCA 13 and FCA 14 for the peak week of July and August. The probability of occurring is lower for the extreme high load levels (high exposure to load shedding conditions) in the FCA 14 forecast, resulting in fewer loss of load events and a reduction to ICR. However, the probability of occurring is higher for the intermediate high load levels (high exposure to reserve shortage conditions) in the FCA 14 forecast, resulting in more reserve deficiency hours.

Figure 3: Comparison of the Load Probability Distribution (July Peak Week) between FCA 13 and FCA 14

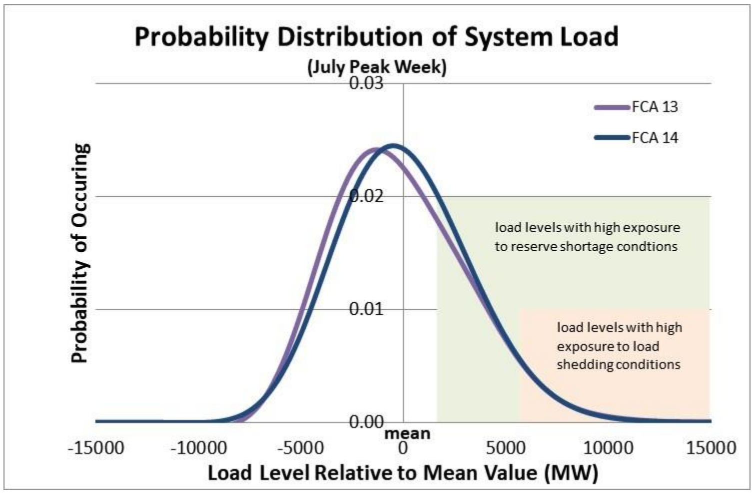


Figure 4: Comparison of the Load Probability Distribution (August Peak Week) between FCA 13 and FCA 14

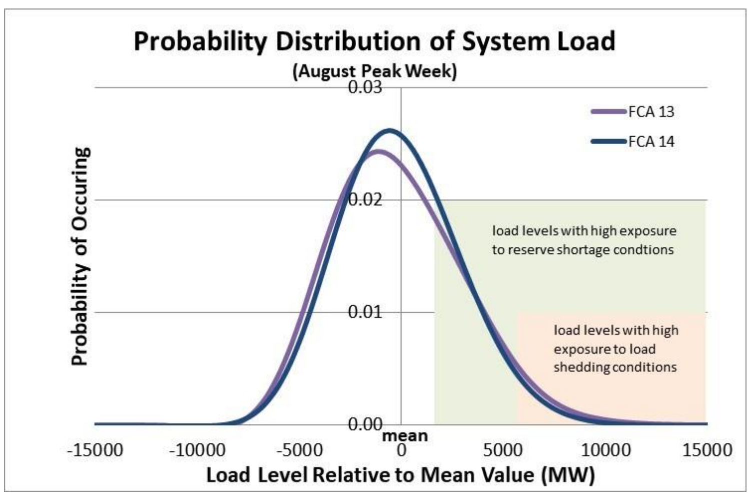


Figure 5 compares the probability distribution of generating resource outages between FCA 13 and FCA 14. The probability is lower for the extreme high outage levels (high exposure to load shedding conditions) in the FCA 14 forecast, resulting in fewer loss of load events and a reduction to ICR. However, the probability is higher for the intermediate high outage level (high exposure to reserve shortage conditions) in the FCA 14 forecast, resulting in more reserve deficiency hours.

Figure 5: Comparison of the Probability Distribution of Resource Outage Levels between FCA 13 and FCA 14

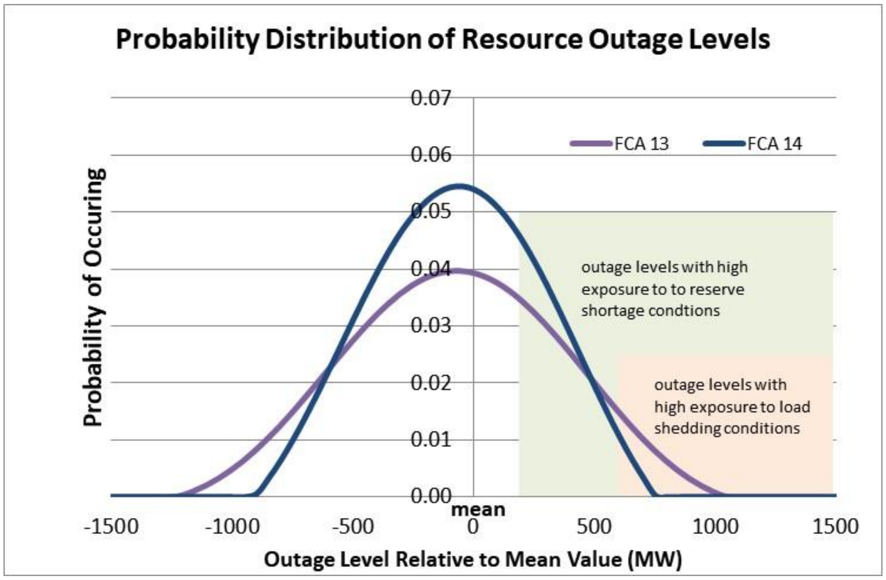
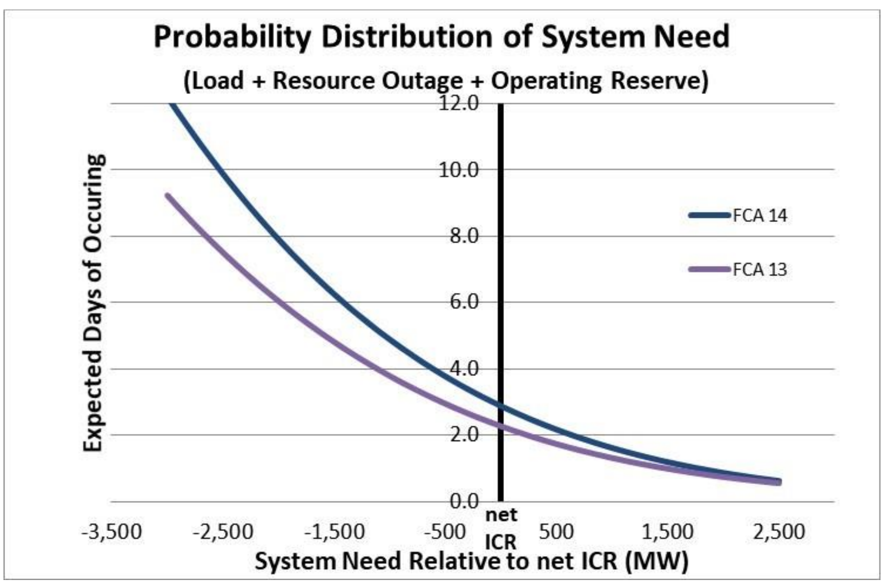


Figure 6 compares the cumulative probability distribution of system need (relative to system net ICR level), which takes into account the combined impacts from the load probability distribution of all weeks and resource outage distribution. As shown in the graph, as the capacity level decreases relatively to the net ICR, the expected number of days that may be exposed to reserve shortage conditions is higher and increases faster for FCA 14.

Figure 6: Comparison of the Probability Distribution of System Need between FCA 13 and FCA 14



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