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ICS Attachment #3

Review and Assessment of the LFU Model
Its Evolution, Impact , and Model Performance

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NEW YORK STATE
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RELIABILITY COUNCIL

Purpose and Scope of the Review

- The impact of the LFU on the final IRM, as defined by the difference between the final IRM and the no LFU result, has increased from 3.7% in the 2000-2001 IRM study to 9.1% for the 2020-2021 IRM study.
- The parametric analysis for the comparison of the 2019 IRM Study vs. 2020 IRM Study showed that out of the total increase for the 2020 IRM VS. 2019 of 2.1% a little more than 50% of the increase was accounted for by the LFU update.
- NYSRC consultant Adams was asked to review the LFU model update.
- It was concluded that the data and analysis presented by NYISO staff supported the impact of the LFU model update.
- The LFU model impact consist of two parts.
- One being the weather sensitivity of the system which is nominally measured in MW per degree.
- The system is becoming more weather sensitive which is why LFU model update resulted in an increase in the 2020 IRM VS. 2019.

Purpose and Scope of the Review (continued)

- The second being the distribution of temperature extremes by the 7 LFU bins.
- The weather sensitivity combined with bin temperature is used to develop the LFU distribution where the bin load is expressed as a % of the expected summer peak load.
- The initial review focused on the weather sensitivity aspect of the LFU model.
- The purpose of this review is three-fold:
    1. To document the LFU model changes that have occurred over time that were observed in the initial review.
    2. To review distributional aspects of the LFU model by presenting the observed distribution of load forecast uncertainty VS the LFU model predictions.
    3. To provide sufficient information to the ICS for the ICS to determine whether a review of the LFU model potentially could be in order.

Purpose and Scope of the Review (continued)

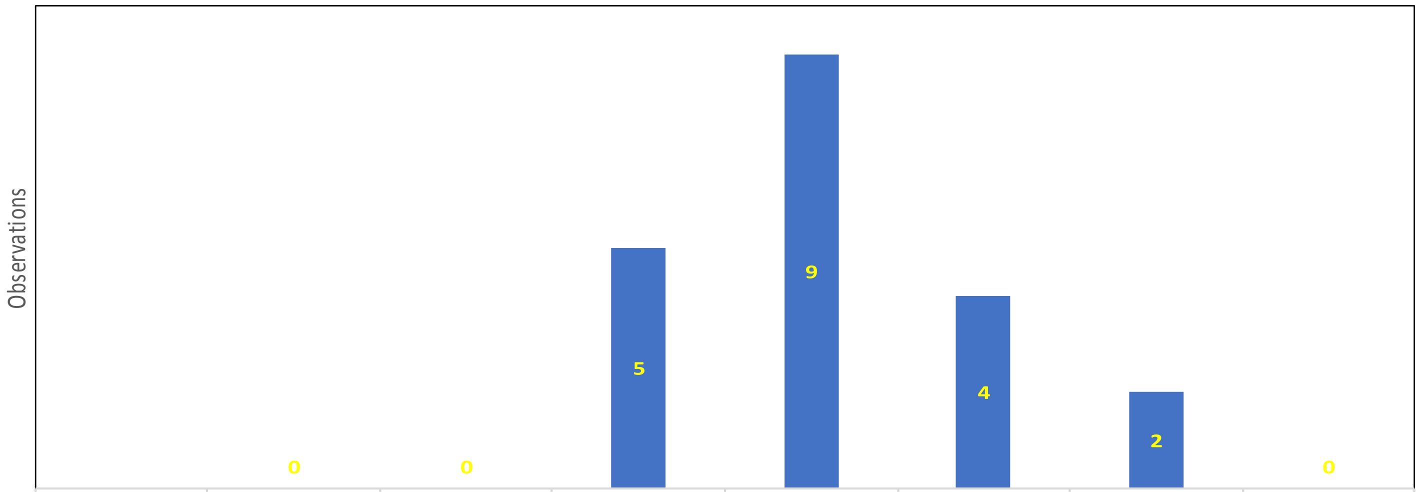
- The scope of the review includes the following:
    1. A table which documents the model changes over time (2000 to present) in terms of the level of disaggregation (i.e., the number of area models), prob. distribution, bandwidth as measured by bin 1 and the impact of the LFU on the IRM results.
    2. The distribution of the ratio of the actual NYCA peak to the weather normalized peak (i.e., the actual peak as a % of the weather normalized) by the 7 probability bins 1999 to 2018 which is how the LFU is measured.
    3. The distribution of NYCA wide CTHI temperatures at the time of the NYCA peak by the 7 probability bins 1999 to 2018.
    4. A scatter plot of Peak CTHI VS. Ratio of Actual Peak to Weather Normalized Peak
    5. Time series plot of the ratio of the actual peak to the weather normalized peak.
    6. An example of the distribution of LOLE by LFU bins.
    7. Observations

History of LFU Model Changes: Its Evolution and Impact on the IRM

Study Year	LFU Model Area(s)	Prob. Distribution	Bin 1 as % of the Peak	IRM Impact %
2000-2001	NYCA	Type I extreme prob. distr. or Gumbel Distr.	NYCA 1.06	3.7
2004-2005	3 Areas: J&K by Con Ed and LIPA, A-I or NYCA net which is NYCA minus J &K	Type 1 for NYCA & A-I Normal Distr. J&K	NYCA 1.06 A-I 1.04 J 1.05 K 1.14	3.2
2006-2007	3 Areas; J&K, NYCA net	NYCA net model developed based on the normal distr. J&K normal distr.	NYCA Net/A-I 1.13 J 1.05 K 1.13 NYCA combined 1.11	Report noted that updated LFU model increased IRM by 1.9%. LFU sensitivity not reported
2007-2008	4 Areas: J&K, Zone I, NYCA net or Rest-Of-State (ROS) A-H	Normal Distr.	I 1.06 J 1.03 K 1.22 ROS 1.13	5.8
2008-2009	4 Areas: Zone H separated from ROS and combined with I to create HI	Normal Distr.	HI 1.06 J 1.03 K 1.16 ROS 1.15	7.3
2009-2010	4 Areas: HI, J, K, ROS	Normal distr. but the distribution of the weather variable at the tails for ROS was truncated. The rationale for this is that only 30 years of weather data are available, but 100 years would be needed to determine the extremes empirically.	HI 1.05 J 1.035 K 1.16 ROS 1.13	6.5
2013-2014	5 Areas: ROS split into 2 Areas A-E and FG	Normal Distr. with HI, J provided by ConEd and K by LIPA	HI 1.13 J 1.075 K 1.13 ROS A-E 1.13 ROS FG 1.15	8.8
2020-2021	5 Areas	Normal Distr. with the models for A-J developed by NYISO staff	HI 1.13 J 1.094 K 1.18 ROS A-E 1.154 ROS FG 1.163	9.1

Distribution of the Ratio of The Actual Peak to the Weather Normalized Peak 1999 to 2018 by LFU Bin

Max Value 1.08, Min Value 0.89



Bin	B7	B6	B5	B4	B3	B2	B1
Temp	<85%	85%-89%	89%-95%	95%-103%	103%-108%	108%-113%	>=113%
Act	0.00	0.00	0.20	0.45	0.25	0.10	0.00
Exp	0.0062	0.0606	0.2417	0.3830	0.2417	0.0606	0.0062

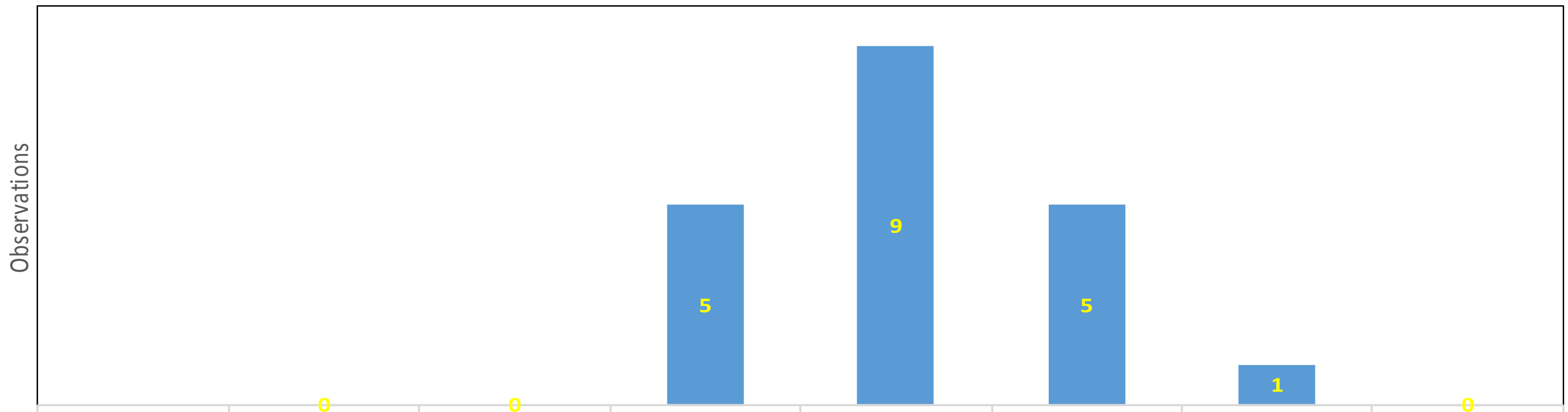
LFU Bin

Observations:

1. Overall the distribution of ratios appears to be consistent with expectations except for possibly Bin 6
2. Bin 1 and Bin 2 are extreme or rare events with bin 1 expected return time of about every 160+ years and bin 2 has a return time of every 16+ years VS LOLE of 1 day in 10 years.
3. The 2 observations in Bin 2 fell right on or close to the boundary between Bin 2 and Bin 3

Distribution of CTHI Temperature at the Time of the NYCA Peak 1999 to 2018 by LFU Bin

Max Value 88.22 Min Value 79.67 Avg. 83.8

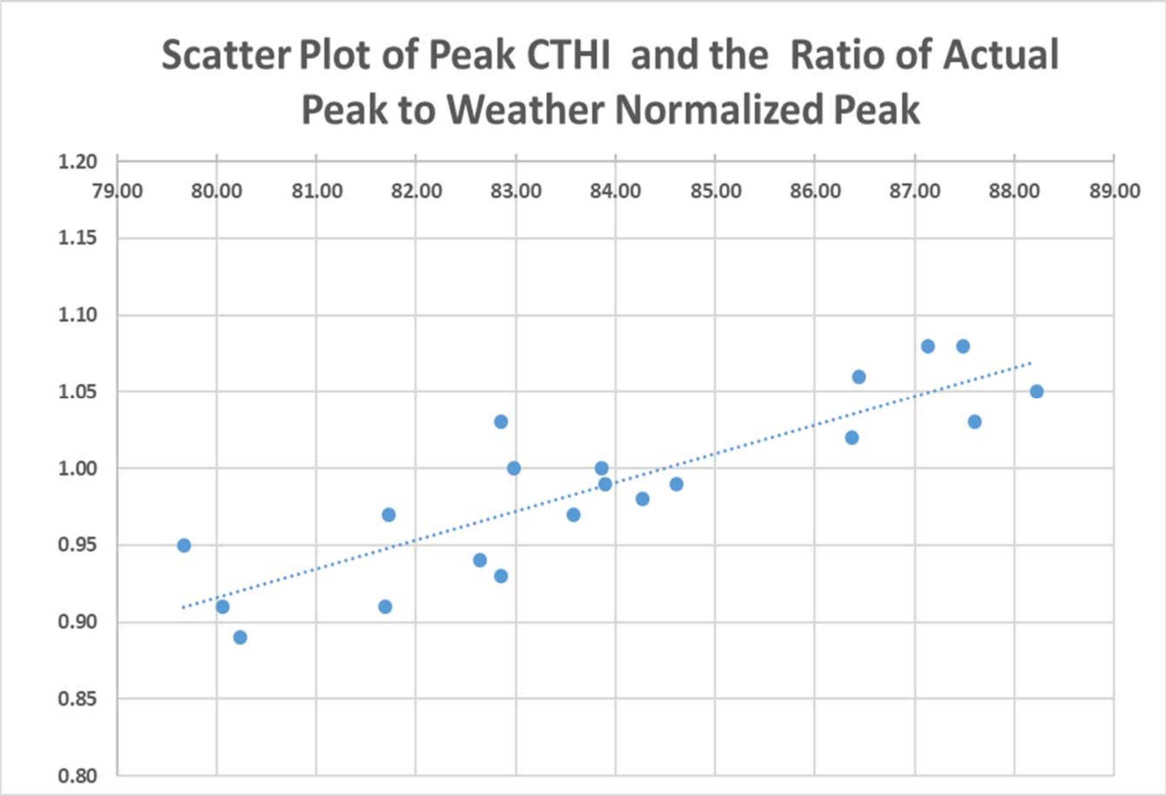


Bin	B7	B6	B5	B4	B3	B2	B1
Temp	76.5	78.6	80.5	83.8	87.1	89.0	91.1
Act	0.00	0.00	0.25	0.40	0.30	0.05	0.00
Exp	0.0062	0.0606	0.2417	0.3830	0.2417	0.0606	0.0062

LFU Bin

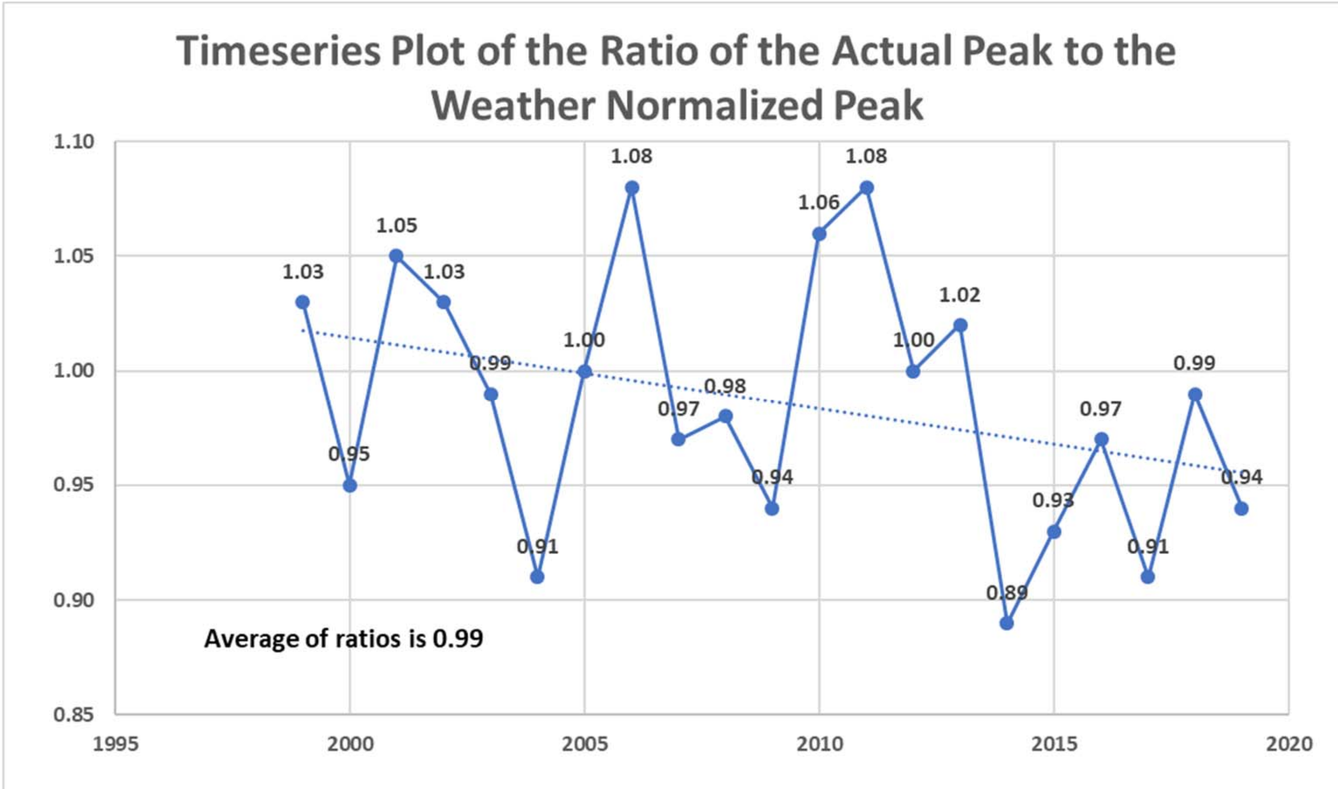
Observations:

1. Again, overall the distribution of CTHI temperatures appears to be consistent with expectations except for possibly Bin 6.
2. It is also generally consistent with the ratio distribution.
3. The Bin 2 observation value is slightly above the boundary value between Bin 2 and Bin 3
4. The Bin 2 observation which is the max value occurred in 2001. NYISO provided CTHI data all the way back to 1950. Sorting this data showed 3 occurrences of CTHI temperatures that were in that range but not anything above that.



Observations:

1. Upward sloping as expected but does show there is a certain amount of noise in the process. E.G., the largest CTHI value did not produce the largest ratio value.



Observations:

1. Average of the ratios is 0.99 which could be the result that the weather normalized peak includes loads normalized to 1 in 3 temperatures.
2. Is the downward sloping trend indicating something or just spurious? Joe Bastardi formerly with AccuWeather and now with WeatherBELL observed that summer nighttime min temperature's are increasing while daytime max temperatures are being damped. He attributed this to the fact that warming ocean and great lake temperatures have resulted in an increase in the level of water vapor in the atmosphere which has resulted in more cloud cover. It is this increased cloud cover which has caused daytime max temperatures to be damped.

IRM 2017 PBC Results

NYCA LOLE (dys/yr)

Load Level	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
1	0	0	0	0	0	0.000	0.002	0.015	0	0	0	0	0.017
2	0	0	0	0	0.000	0.000	0.018	0.052	0	0.000	0	0	0.070
3	0	0	0	0	0.000	0.000	0.002	0.008	0.000	0	0	0	0.010
4	0	0	0	0	0	0	0.000	0.002	0.000	0	0	0	0.002
5	0	0	0	0	0	0	0	0.001	0	0	0	0	0.001
6	0	0	0	0	0	0	0	0.000	0	0	0	0	0.000
7	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	0	0	0	0	0.000	0.000	0.022	0.078	0.000	0.000	0	0	**0.100**

NOTE: There are events occurring in May, June, September, and October that are negligible.

Observations:

1. This is page 4 from a presentation entitled "Distribution of Loss of Load Events in 2017 IRM PBC" was presented to the ICS at its March 1, 2017 meeting.
2. It demonstrates that the majority LOLE events are captured in LFU bins 1 & 2.

Concluding Observations and Remarks

- The LFU temperature distribution is derived by fitting the continuous normal probability distribution to the historical weather data which then determines the temperature values for the tails - i.e., bins 1 & 2.
- Although an extreme value problem, primary concern is that based on the NYCA analysis there appears to be a paucity of data for estimating the tails of the distribution. This concern was raised in the 2009-2010 IRM study. The tails of the distribution are where the majority of the LOLE events are observed.
- Highest max/extreme values since 1950 have occurred in 1999 and 2001.
- Given the impact of the LFU on the IRM, it is recommended for the 2022 IRM study that the development of the LFU distribution undergo an in-depth review.
    1. Is the continuous normal distribution still the appropriate distribution for modeling the max/extreme value?
    2. Should the distribution be bounded in some way? EG, using estimate of the max value techniques or truncated in some way as suggested in the 09-10 study or just model bins B5-B2, etc.
    3. It would be beneficial if the LFU presentation included what years of weather data were used and the max and min value observed for the weather data used for the analysis.
    4. Is it possible to standardize on the same temperature variable for modeling all areas of the NYCA?