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Independent System Operator

Load Forecast Uncertainty Modeling: Phase 3 Scope

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Agenda

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Background and Motivation

- Load Forecast Uncertainty (LFU) models quantify the impact of extreme weather variability on seasonal peak loads. The resulting LFU multipliers are a significant input into resource adequacy simulations in both the NYISO planning reliability studies, and in the IRM study approved by the New York State Reliability Council (NYSRC). LFU models and results are discussed with and reviewed by the Load Forecasting Task Force and the NYSRC Installed Capacity Subcommittee (ICS).

- The LFU Phase 1 Study and Whitepaper focused largely on the analysis of weather distributions and their impacts on the year-over-year variability of NYCA and regional peak loads
  - Particular attention paid to the distributions of peak load and temperature analysis
  - Comparison of Temperature-Humidity Indices
  - Long-term Cumulative Temperature & Humidity Index (CTHI) Distribution Analyses (extreme temperatures, goodness of fit of the Normal distribution)
  - Inter-Annual Weather Sensitivity and LFU Trends

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Background and Motivation

- **LFU Phase 2 focused primarily on load shape analysis, along with follow-up work stemming from select Phase 1 findings**
  - Recommendation of the 2013, 2017, and 2018 load shapes for use in future reliability studies, following a review of historical load shapes, duration curves, and weather conditions
  - Introduced procedures to account for the increasing impact of BTM solar on load shapes (i.e., calculation of historical gross load shapes, and load shapes adjusted to reflect a projected increase in BTM solar capacity)
  - Assessed the change in load duration curves and peak day shapes resulting from increasing penetration of BTM solar
  - Quantified potential impacts of increasing BTM solar penetration on LFU multipliers

- **LFU Phase 3 will address remaining areas of inquiry on LFU and load shape assumptions, with a focus on issues that will become more critical over time**
  - The NYISO is projected to trend toward a winter peaking system due to the increasing penetration of electric vehicles and electric heating
  - Impacts of climate change will enhance focus on extreme weather assumptions and scenarios
  - Increasing levels of BTM solar will continue to add to load variability and contribute to evolving shapes

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Existing LFU Study Work

- **LFU Phase 1 Whitepaper**
  - March 2021 (Paper, Presentation)
- **LFU Phase 2 Scope Discussion**
  - May 2021 (link)
- **Load Duration Curve Review - 2002 through 2020**
  - May 2021 (link)
- **Load Duration Curve Review – BTM Solar Impacts**
  - July 2021 (link)
- **Impact of BTM Solar on LFU Multipliers**
  - July 2021 (link)
- **Updated Load Shape Recommendation**
  - March 2022 (link)

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LFU Phase 3 Study Topics

1 - Off-Peak Load Variability

- Examine the relative variability of off-peak summer load hours relative to the variability of the summer peak load hour, as defined by the current LFU process
- Currently, the same LFU multiplier is applied to all summer load hours
- Background material on this topic is included in the upcoming slides

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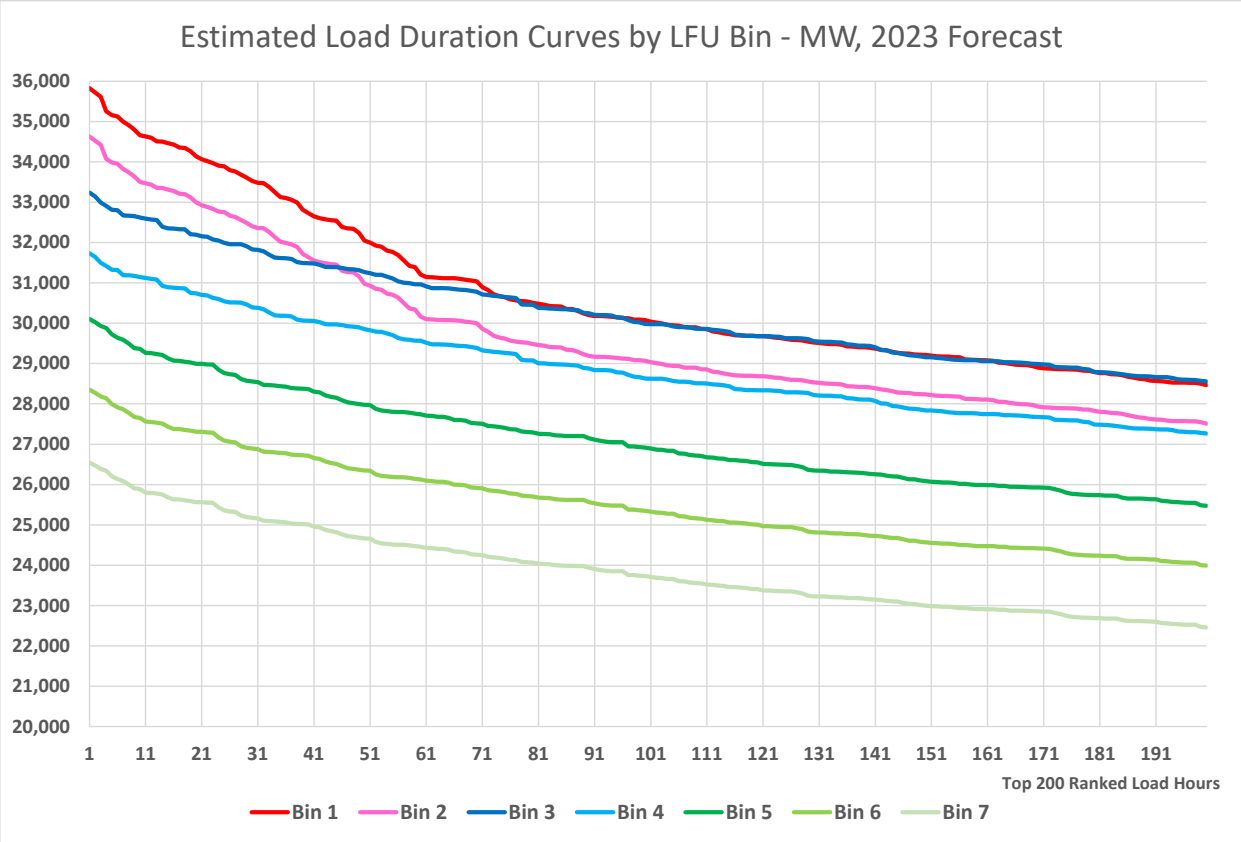
NYCA Load Duration Curves by Bin



- This graph shows estimated hourly summer load duration curves by LFU bin.
- The underlying historical load shapes are 2013 for bins 1&2, 2018 for bins 3&4, and 2017 for bins 5 to 7, per the updated load shape recommendation.
- Duration curves are calibrated to the current 2023 coincident summer peak forecast, and to current LFU bin multipliers.
- These curves are meant to reflect approximate net load that would be used in reliability studies. They may not match the actual values used in the studies.

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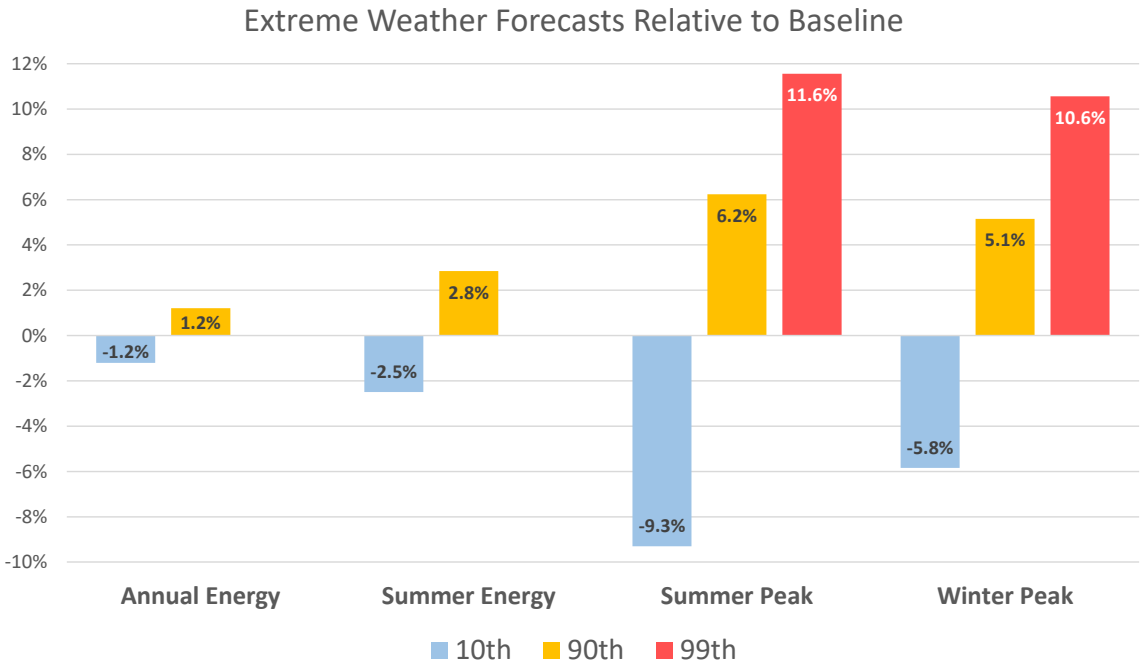
Energy vs. Seasonal Peak Variability



2022 Energy and Peak Forecasts				
Forecast	**Baseline**	**10th**	**90th**	**99th**
Annual Energy (GWh)	151,260	149,430	153,090	--
Summer Energy (GWh)	56,200	54,800	57,800	--
Summer Peak (MW)	31,765	28,810	33,747	35,436
Winter Peak (MW)	23,893	22,497	25,123	26,417

- This graph compares the uncertainty due to weather across annual energy, summer energy, summer peak, and winter peak forecasts.
- The seasonal peak ratios are defined using the LFU process. Annual energy ratios are based on the historical distribution of weather-related impacts on annual energy usage. These ratios are from the 2022 Gold Book.
- Deviations in summer energy were estimated using the historical distribution of weather-related impacts on energy usage in June through September.
- The load variability due to weather is much greater on seasonal peak demand than on energy usage. This implies that the variability on the peak hour is larger than that on an average hour.

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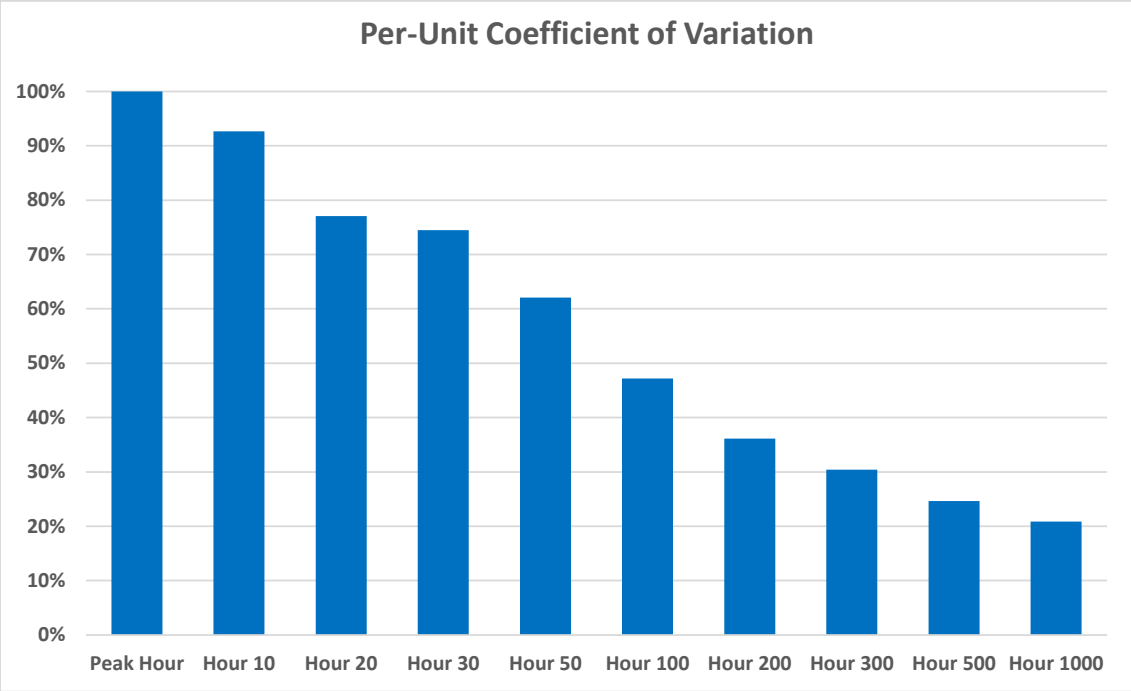
Hour Rank	Per-Unit CV
Peak Hour	100%
Hour 10	93%
Hour 20	77%
Hour 30	74%
Hour 50	62%
Hour 100	47%
Hour 200	36%
Hour 300	30%
Hour 500	25%
Hour 1000	21%

Note: From the May 2021 LFTF LDC review presentation



- The Coefficient of Variation (CV) is the standard deviation divided by the average
- These figures show the average per-unit CV across the 2002 through 2020 summers, reflecting the variation in ranked hour load as a percentage of the variation in the single peak load hour
- There is a significant decline in the load variability of off-peak summer load hours relative to the variability of the peak hour

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2 – Winter LFU Development

- As the NYCA trends towards becoming a winter peaking system during the 2030s, winter LFU modeling will become more impactful on reliability analyses
- Subtask – development of an improved winter weather variable that better correlates with winter peak loads (akin to CTHI used for summer modeling)
  - Historically, average temperature and/or heating degree days (HDD) were used for winter LFU modeling
  - The recent LFU models used an alternate variable based on a composite of minimum temperature, maximum temperature, and the 6 PM temperature
  - Other variables including wind speed may be included in future analyses
- Subtask – development of regional models for winter LFU, reflecting the five areas used for summer modeling. Comparison of these results with the NYCA-wide winter model
- Potential subtask (if time allows) – investigate the potential impact that building electrification may have on future LFU results, as the saturation of electric heating increases

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3 – Load Shape Weather Assumptions

- Upper bin LFU multipliers and the resulting summer load shapes are representative of extreme weather conditions on peak, and throughout the remainder of the year or season

- Subtask – quantify the assumed weather conditions underlying the current upper bin load shapes used in MARS, across the entire summer seasonal (and potentially winter) load shape

- Potential subtask – compare these underlying weather conditions against existing or proposed extreme weather scenarios

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4 – On-Peak Solar Variability

- Review historical BTM solar generation and variability on summer peak-type load days
- Link this variability to future BTM solar capacity levels and projected peak day load shapes
- Quantify the potential variability of BTM solar generation during future peak load days and hours

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Next Steps

- Present pertinent analyses and findings to LFTF and/or ICS as available, beginning in 2022 Q3

- Target 2023 Q1 to deliver conclusions on Phase 3 study topics

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Questions/Discussion

Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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