

Impact of High Behind the Meter (BTM) Solar on Load Forecast Uncertainty (LFU)

LFU Phase 3 Analysis

Riaz Khan

Demand Forecasting & Analysis

NYSRC ICS

May 03, 2023

Agenda

- **Background and Motivation**
- **Methodology**
- **Results**
- **Questions & Discussion**

Background & Motivation

- Load patterns are continuing to evolve across the New York Control Area (NYCA)
- Increased penetration of BTM Solar is impacting the peak load
 - Shifting the peak load towards later hours
 - Decreasing the peak MW
- Developing Load Forecast Uncertainty (LFU) involves modeling the peak
- The variation of model structure, along with changes in MW load levels may impact the LFU values
- Goal: Examine what higher levels of BTM Solar impact will have on regional peak load hour characteristics and LFU models in the future

BTM Solar Scenarios

- Analyses were performed under three BTM solar scenarios
- Under each scenario, net load was calculated by subtracting corresponding solar level at that scenario capacity from the gross load^[1]
- The scenario net loads were analyzed for peak hour and load forecast uncertainty (LFU)

BTM solar scenarios:

Scenario 1	BTM Nameplate Capacity 7,000 MW at NYCA level
	Projected to reach by early 2026 (GB 2022)
Scenario 2	BTM Nameplate Capacity 8,500 MW at NYCA level
	Projected to reach by the end of 2027 (GB 2022)
Scenario 3	BTM Nameplate Capacity 10,000 MW at NYCA level
	Projected to reach by late 2029 (GB 2022)

Baseline scenario: 4,269 MW at NYCA level

[1] The gross load was calculated as the sum of net observed load and BTM Solar

Summary Results

Δ LFU Delta

AE

	Scenario 1	Scenario 2	Scenario 3
Bin 1	1.85%	1.96%	2.04%
Bin 2	0.84%	0.88%	0.91%
Bin 3	0.27%	0.27%	0.27%

HI

	Scenario 1	Scenario 2	Scenario 3
Bin 1	0.08%	0.45%	0.80%
Bin 2	0.04%	0.23%	0.41%
Bin 3	0.01%	0.07%	0.12%

K

	Scenario 1	Scenario 2	Scenario 3
Bin 1	1.52%	2.44%	2.07%
Bin 2	0.82%	1.30%	1.13%
Bin 3	0.33%	0.51%	0.45%

FG

	Scenario 1	Scenario 2	Scenario 3
Bin 1	2.73%	2.90%	2.90%
Bin 2	1.36%	1.43%	1.42%
Bin 3	0.48%	0.49%	0.48%

J

	Scenario 1	Scenario 2	Scenario 3
Bin 1	0.28%	0.31%	0.43%
Bin 2	0.13%	0.14%	0.20%
Bin 3	0.03%	0.04%	0.05%

- Overall, upper bins LFU values increase with the increased level of BTM solar
- In general,
 - $\Delta @ \text{Bin 1} > \Delta @ \text{Bin 2} > \Delta @ \text{Bin 3}$
 - $\Delta @ \text{Scen 3} > \Delta @ \text{Scen 2} > \Delta @ \text{Scen 1}$
- For Bin 1, Scenario 3,
 - largest change is observed in Zones F&G (~3%)
 - ~2% change for Zones A-E and Zone K
 - small change in Zones H&I and Zone J (less than 1%)
- The upward change is primarily driven by reduced reference load
- All changes are relative to current LFU values

Methodology

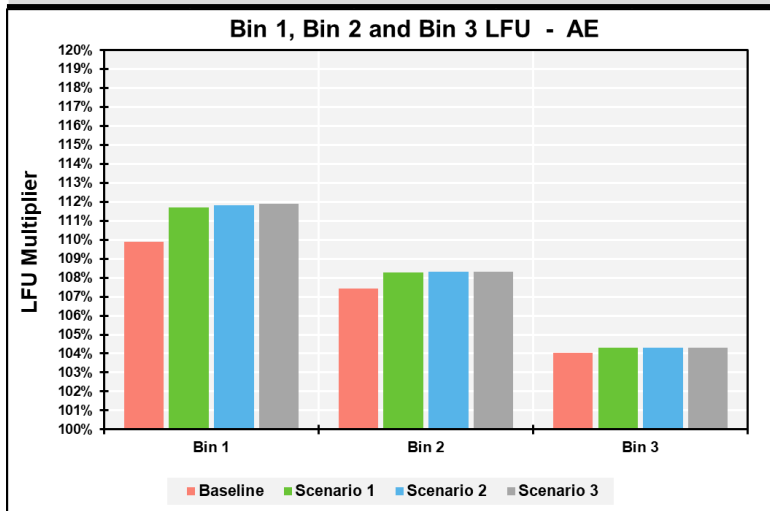
- LFU multipliers were calculated for each BTM scenario and current net load
- For each scenario, net load was calculated by subtracting scenario BTM solar from the gross load
- LFU models were developed for the scenario net loads
- For each LFU area, a base model structure was developed for the current summer peak loads
- The base model structure and data were kept unchanged across all scenarios for consistency

Notes on Base Model

- Years: 2018, 2019, 2021
- Months: Jun – Aug
- Weekends: Yes
- Outliers removed
- Stepwise regression was performed to determine the “best” model for the base case

BTM Solar Impact on LFU: Zones A-E

	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	113.18%	115.03%	115.14%	115.22%
Bin 2	109.25%	110.09%	110.13%	110.16%
Bin 3	104.80%	105.07%	105.07%	105.07%



AE	Baseline	Scenario 1	Scenario 2	Scenario 3
BTM Capacity (MW)	1,734	3,365	4,160	4,934
Reference Load (MW)	9,254	8,858	8,800	8,758
Reference Load relative to baseline (MW)		-396	-454	-495

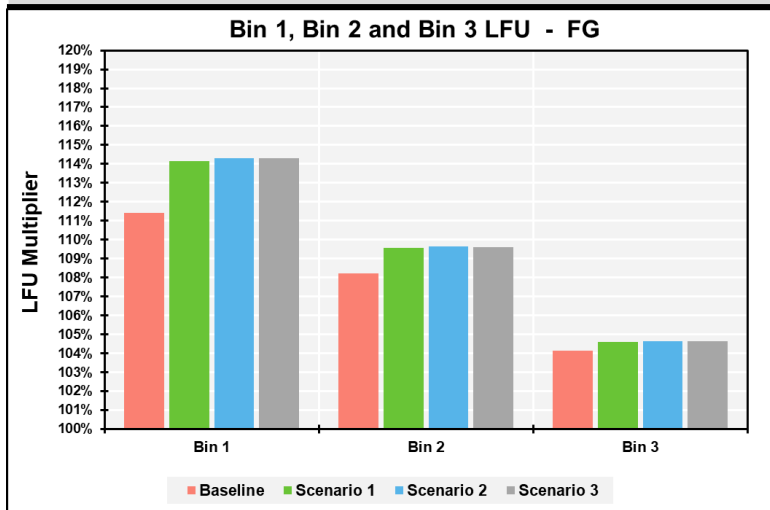
- Due to increased BTM solar, both reference load and loads at other bins decrease.
- Reduction in upper bins and reference load have opposite effects.

$$LFU_{bin_n} = \frac{MW_{bin_n}}{MW_{ref}}$$

- Reference load reduces more relative to upper bin load
- LFU increase for reduction in reference load overpowers LFU decrease for decrease of upper bin load
- About +1~2% of LFU change in upper two bins. Negligible change in bin 3.

BTM Solar Impact on LFU: Zones F&G

	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	111.42%	114.15%	114.32%	114.32%
Bin 2	108.20%	109.56%	109.63%	109.62%
Bin 3	104.14%	104.62%	104.63%	104.62%

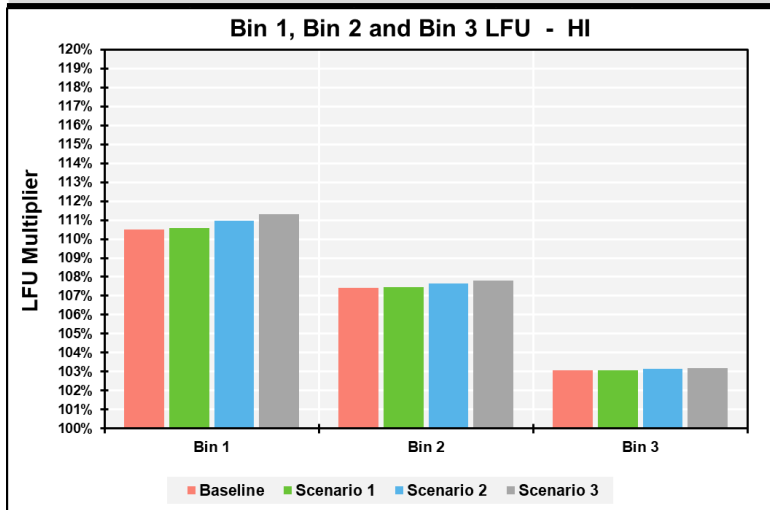


- Reference load decrease is about 2~2.5 times the load decrease in upper bins
- Higher relative decrease of reference load caused increase in LFU in the upper bins
 - 2.7~2.9% in bin 1
 - about 1.5% in bin 2
 - about 0.5% in bin 3

FG	Baseline	Scenario 1	Scenario 2	Scenario 3
BTM Capacity (MW)	1,158	1,827	2,203	2,525
Reference Load (MW)	4,543	4,379	4,351	4,329
Reference Load relative to baseline (MW)		-164	-192	-214

BTM Solar Impact on LFU: Zones H&I

	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	110.50%	110.58%	110.95%	111.30%
Bin 2	107.41%	107.45%	107.64%	107.82%
Bin 3	103.08%	103.09%	103.15%	103.20%

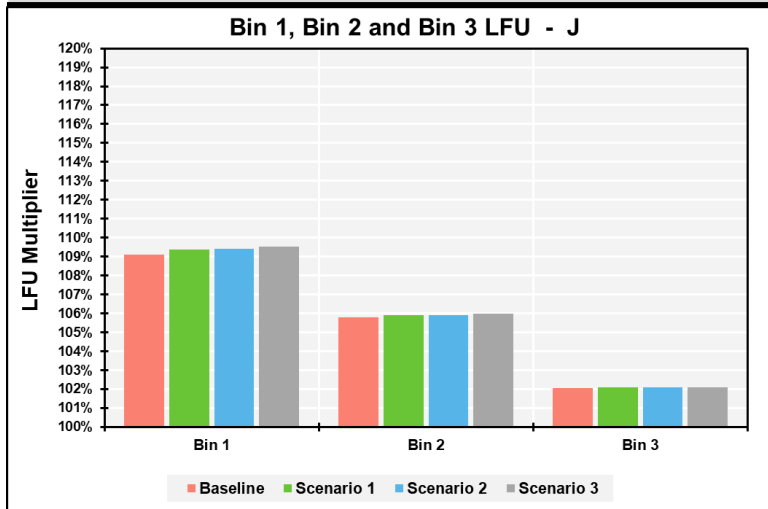


- Similar decrease in reference and upper bin loads
- Almost no change in upper LFUs in scenario 1
- Modest change in upper two bins
 - Maximum change 0.8% (scenario 3, bin 1)

HI	Baseline	Scenario 1	Scenario 2	Scenario 3
BTM Capacity (MW)	140	210	262	314
Reference Load (MW)	1,977	1,946	1,935	1,926
Reference Load relative to baseline (MW)		-31	-42	-51

BTM Solar Impact on LFU: Zone J

	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	109.10%	109.38%	109.41%	109.53%
Bin 2	105.78%	105.91%	105.92%	105.98%
Bin 3	102.05%	102.08%	102.09%	102.10%

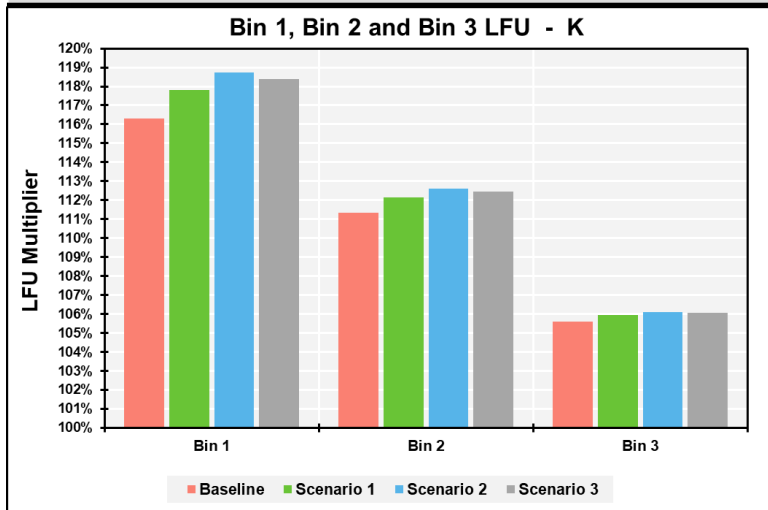


- Modest change in the LFUs
 - Maximum change 0.4% (scenario 3, bin 1)
- Reference load decrease is larger than upper bins load decrease (~ 120% to 150%)
- However, since relative changes are small (for higher Zone J load level), the resulting change in LFU is modest

J	Baseline	Scenario 1	Scenario 2	Scenario 3
BTM Capacity (MW)	367	499	603	758
Reference Load (MW)	10,658	10,591	10,556	10,508
Reference Load relative to baseline (MW)		-67	-102	-150

BTM Solar Impact on LFU: Zone K

	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	116.30%	117.82%	118.74%	118.37%
Bin 2	111.32%	112.14%	112.62%	112.45%
Bin 3	105.60%	105.93%	106.11%	106.05%



K	Baseline	Scenario 1	Scenario 2	Scenario 3
BTM Capacity (MW)	870	1,099	1,272	1,469
Reference Load (MW)	5,144	5,082	5,046	5,007
Reference Load relative to baseline (MW)		-62	-98	-138

- Relatively higher MW change of reference load with respect to upper bin loads
 - Bin 1 LFU increases by about 1.5~2.5%
 - Bin 2 LFU increases by about 0.8~1.3%
 - Bin 3 LFU increases by about 0.5%

Takeaways

- **Overall, a common trend of LFU increase with the increase of BTM Solar penetration was observed**
 - Projected increases are slight and may not necessarily be indicative of future LFU trends
 - Numerous factors contribute to the final model selection
- **NYISO plans to further look into this matter, with an aim to develop methods for potential implementation of the findings in the future years**

Questions

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

Reference Slides

LFU at Different Scenarios

AE				
	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	113.18%	115.03%	115.14%	115.22%
Bin 2	109.25%	110.09%	110.13%	110.16%
Bin 3	104.80%	105.07%	105.07%	105.07%

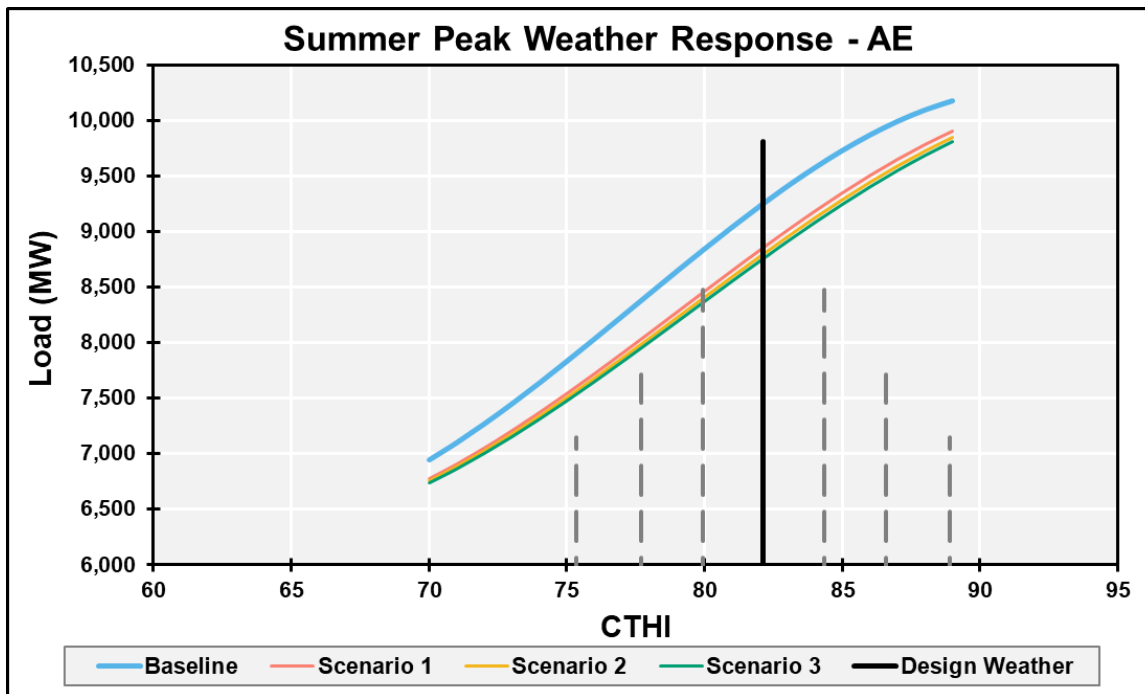
HI				
	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	110.50%	110.58%	110.95%	111.30%
Bin 2	107.41%	107.45%	107.64%	107.82%
Bin 3	103.08%	103.09%	103.15%	103.20%

K				
	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	116.30%	117.82%	118.74%	118.37%
Bin 2	111.32%	112.14%	112.62%	112.45%
Bin 3	105.60%	105.93%	106.11%	106.05%

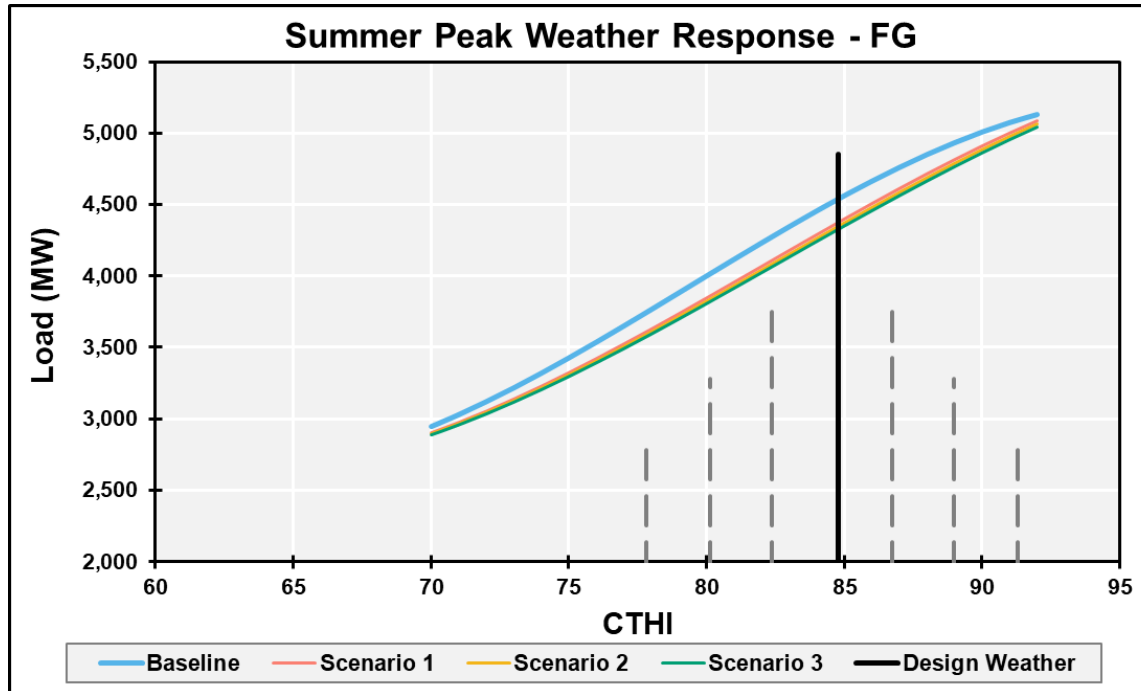
FG				
	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	111.42%	114.15%	114.32%	114.32%
Bin 2	108.20%	109.56%	109.63%	109.62%
Bin 3	104.14%	104.62%	104.63%	104.62%

J				
	Baseline	Scenario 1	Scenario 2	Scenario 3
Bin 1	109.10%	109.38%	109.41%	109.53%
Bin 2	105.78%	105.91%	105.92%	105.98%
Bin 3	102.05%	102.08%	102.09%	102.10%

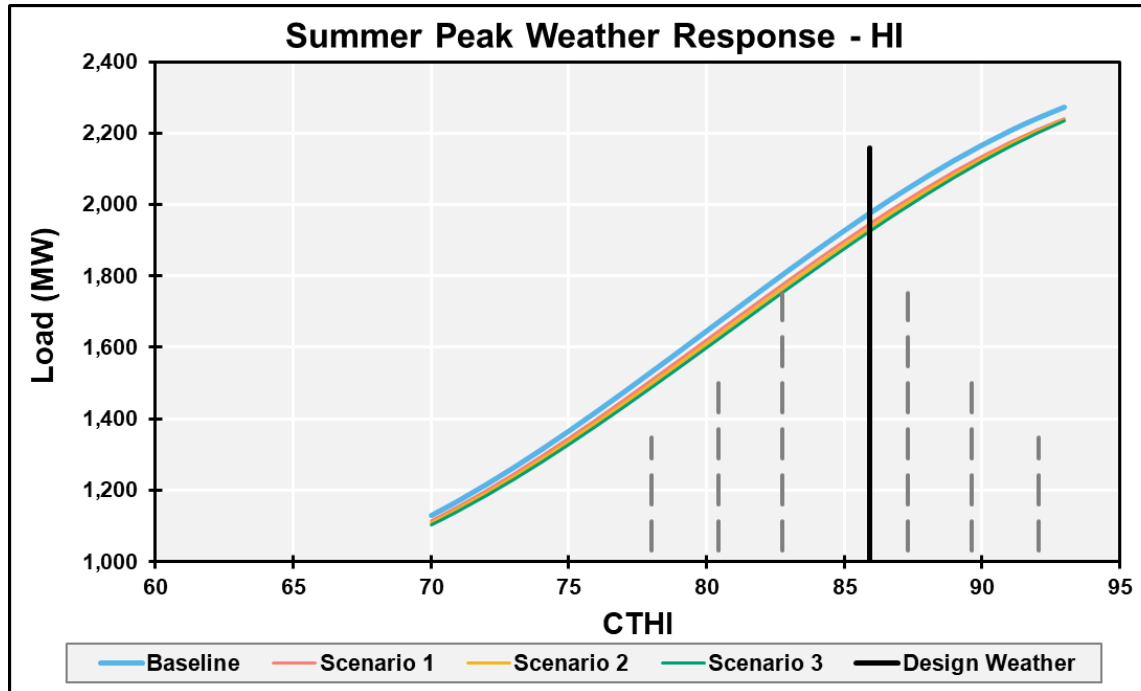
Weather Response: Zones A-E



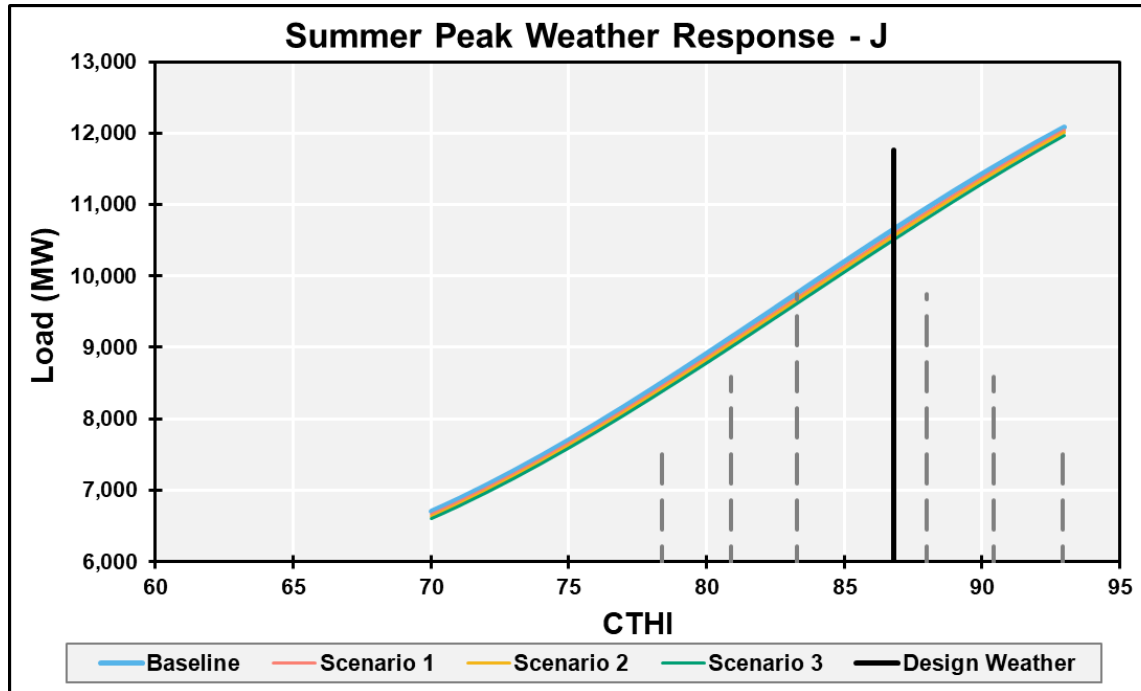
Weather Response: Zones F&G



Weather Response: Zones H&I



Weather Response: Zone J



Weather Response: Zone K

