New York ISO
Independent System Operator

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

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Agenda

- Impact of Behind-the-Meter (BTM) Solar on the Peak Load Hour
- Impact of BTM Solar on Load Forecast Uncertainty (LFU)
- Questions & Discussion

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Background, Motivation and Summary Results

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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

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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
- 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)

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Summary Results

ΔLFU 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%

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%

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%

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%

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%

- Overall, the peak hour shifts towards later hours
- Overall, upper bins LFU values increase with the increased level of BTM solar
- In general,

$$\Delta @ \boldsymbol{Bin\ 1} > \Delta @ \boldsymbol{Bin\ 2} > \Delta @ \boldsymbol{Bin\ 3}$$
$$\Delta @ \boldsymbol{Scen\ 3} > \Delta @ \boldsymbol{Scen\ 2} > \Delta @ \boldsymbol{Scen\ 3}$$

- 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

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General Methodology

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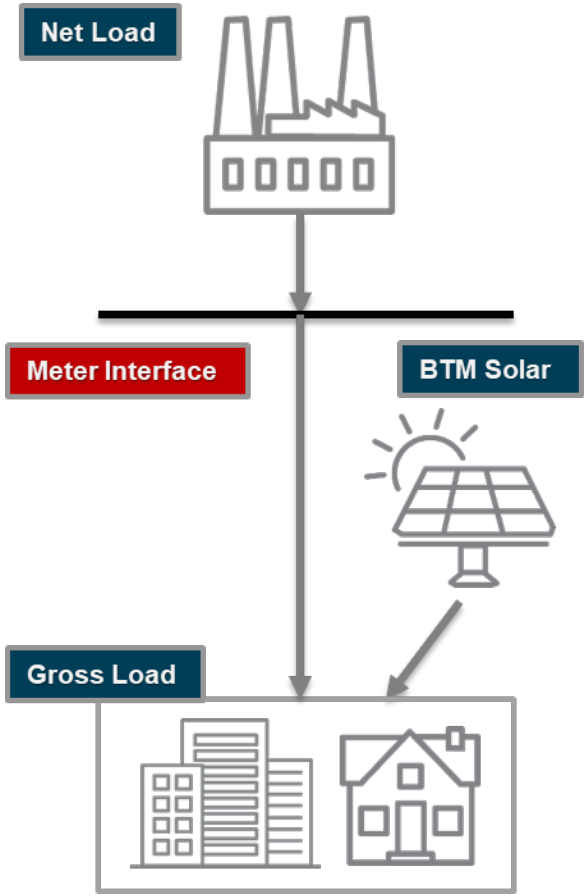
Methodology

- NYISO loads in different LFU modeling areas were collected from DSS
- NYISO DSS database gives the “net” load
- A gross load was derived by adding the estimated actual BTM Solar to the net load
- Load shape and peak producing hours were analyzed using the gross and net loads, under different BTM solar scenarios
- Analysis centered on most recent LFU model years (2018, 2019 and 2021)



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Peak Hour Shifting, Peak Reduction

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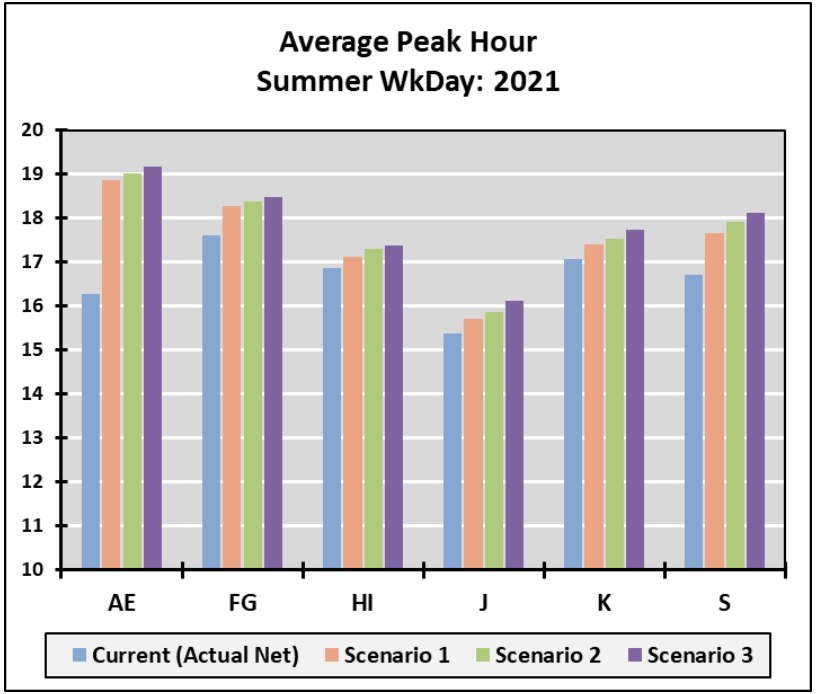
Peak Hour Shifting

- Peak shifting analysis was performed by examining the average peak hour (calculated as the average of all summer weekday peak hours)
- A general trend of peak hour shifting (towards evening) was observed across all LFU areas with increased BTM solar
- The more the BTM solar, more shifting of peak



Scenario	AE	FG	HI	J	K	S
Current (Actual Net)	16.3	17.6	16.9	15.4	17.1	16.7
Scenario 1	18.9	18.3	17.1	15.7	17.4	17.7
Scenario 2	19.0	18.4	17.3	15.9	17.5	17.9
Scenario 3	19.2	18.5	17.4	16.1	17.7	18.1

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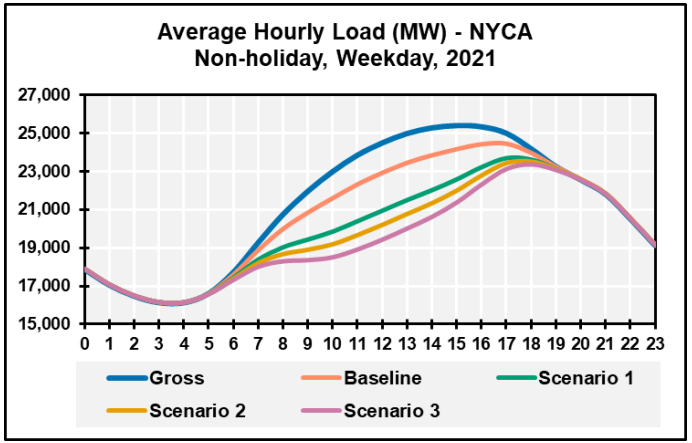
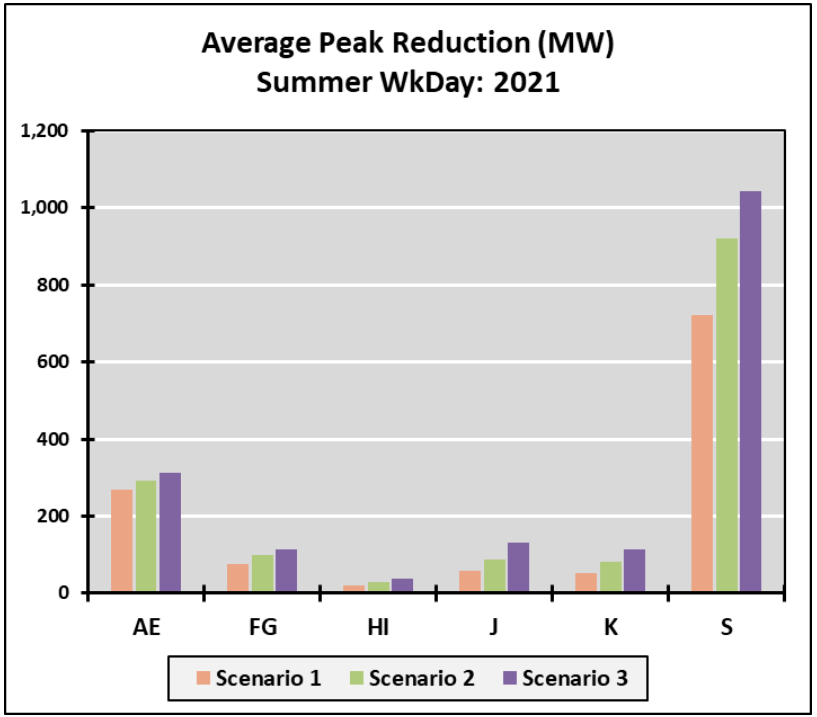
Peak Reduction

- With the increase of BTM solar, the peak reduces
- LFU area AE has the highest reduction (270~300 MW across three scenarios)
  - Higher BTM capacity, earlier baseline peak
- At the NYCA level, the estimated peak reduction is about 1,000 MW in scenario 3





MW Peak Change (relative to baseline)						
Scenario	AE	FG	HI	J	K	S
Scenario 1	269	75	19	58	53	720
Scenario 2	291	101	29	87	81	921
Scenario 3	312	114	38	132	114	1,043

Impact on Summer LFU values

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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
- All models were found reasonably well in terms of overall fit (R-sq)

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

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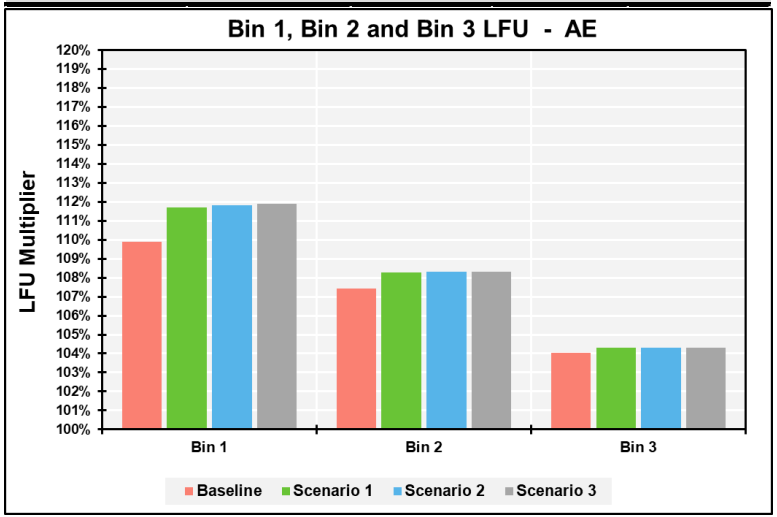
BTM Solar Impact on LFU: Zones A-E

	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.

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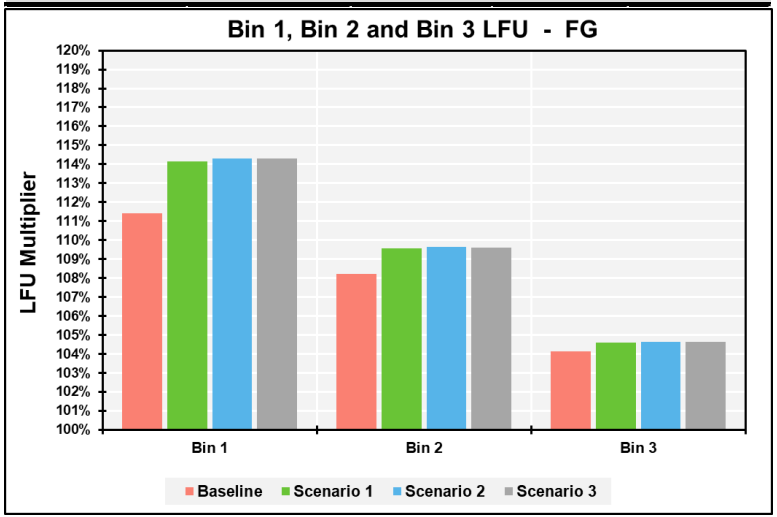
BTM Solar Impact on LFU: Zones F&G

	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%



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

- 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

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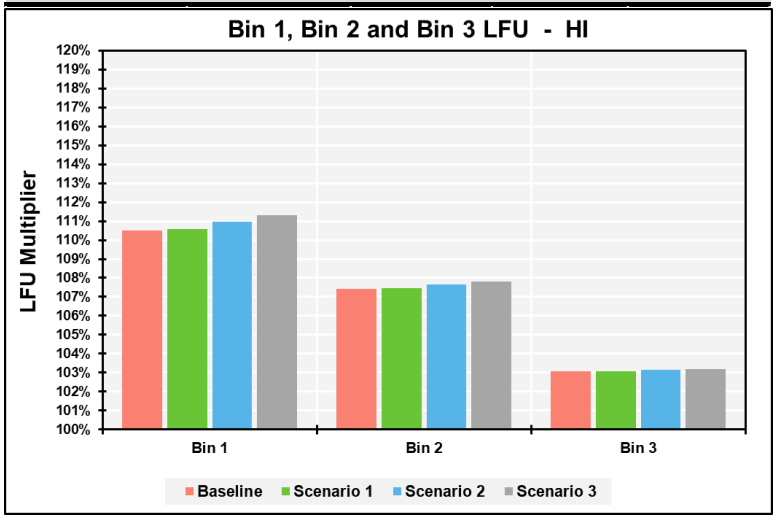
BTM Solar Impact on LFU: Zones H&I

	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%



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

- 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)

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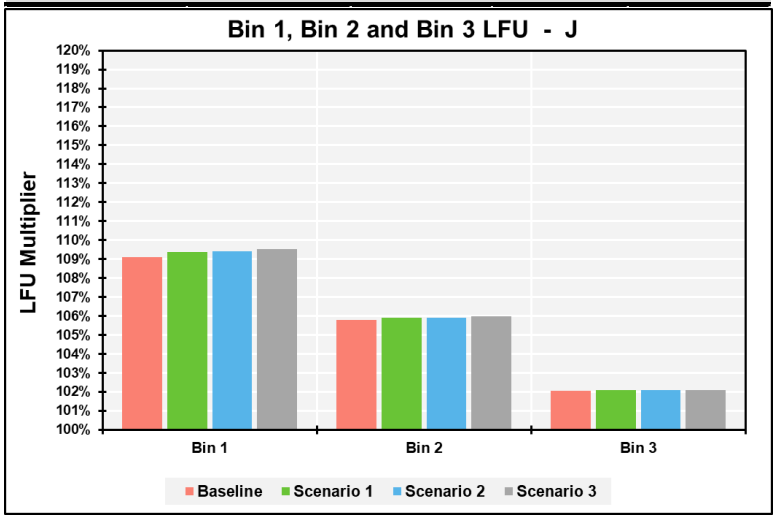
BTM Solar Impact on LFU: Zone J

	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%



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

- 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

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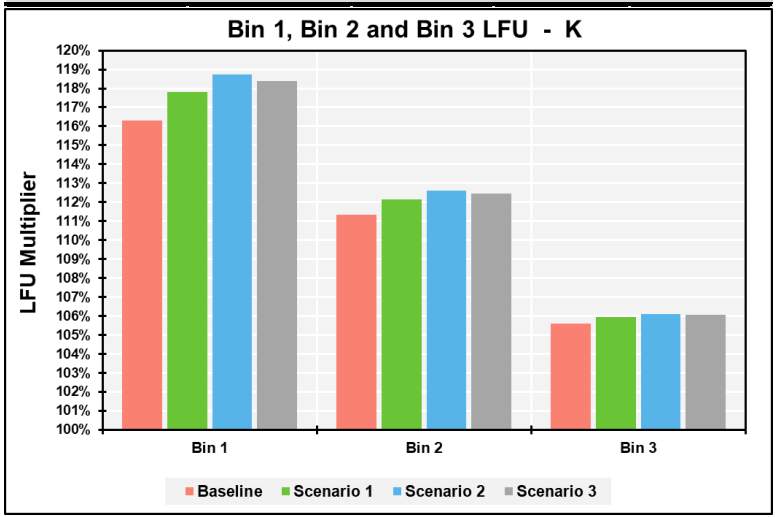
BTM Solar Impact on LFU: Zone K

	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%

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Questions

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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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Reference Slides

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LFU at Different Scenarios

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Bin 2	109.25%	110.09%	110.13%	110.16%
Bin 3	104.80%	105.07%	105.07%	105.07%

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Bin 3	104.14%	104.62%	104.63%	104.62%

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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%

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%

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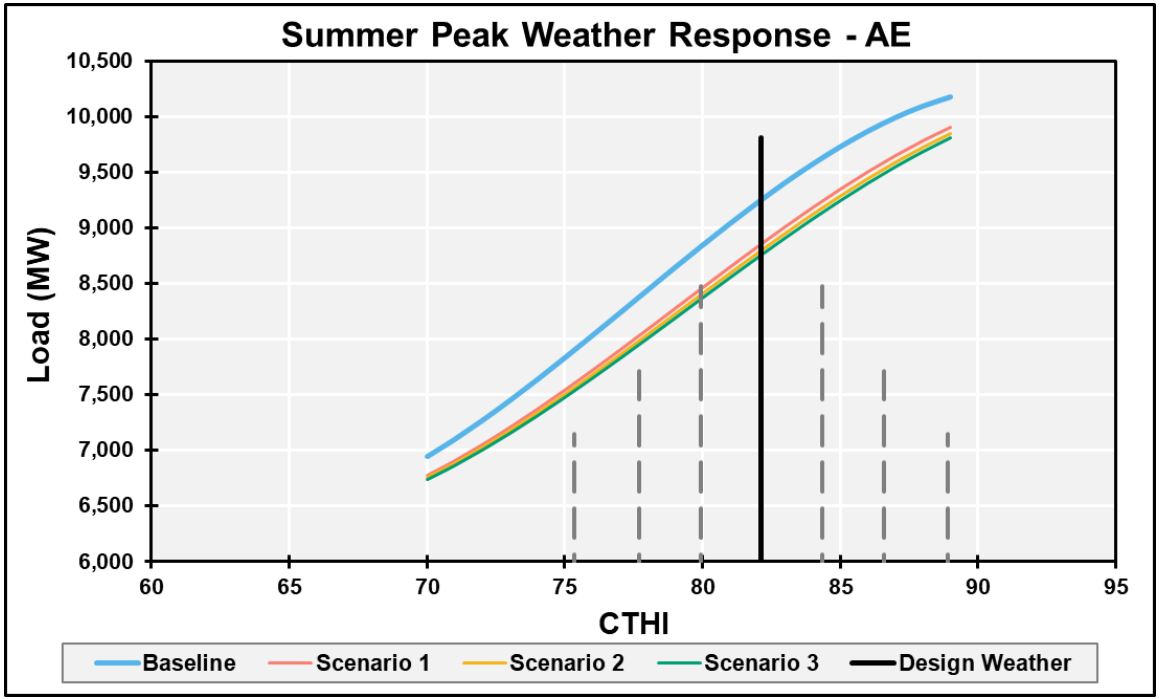
Weather Response: Zones A-E



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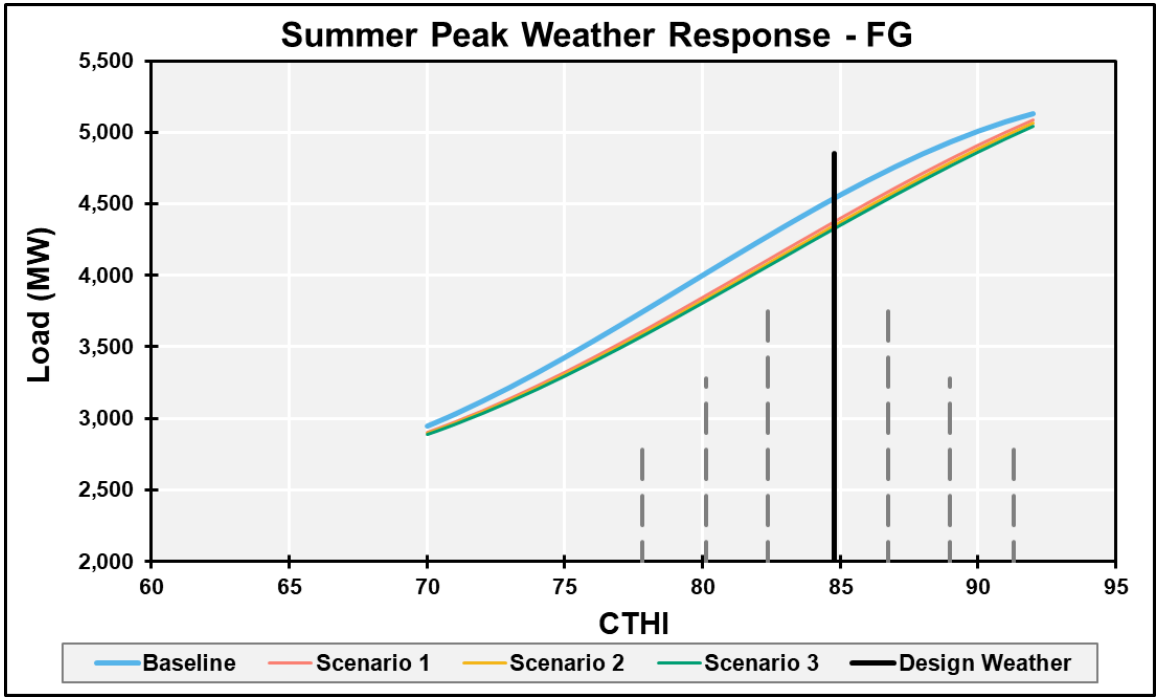
Weather Response: Zones F&G



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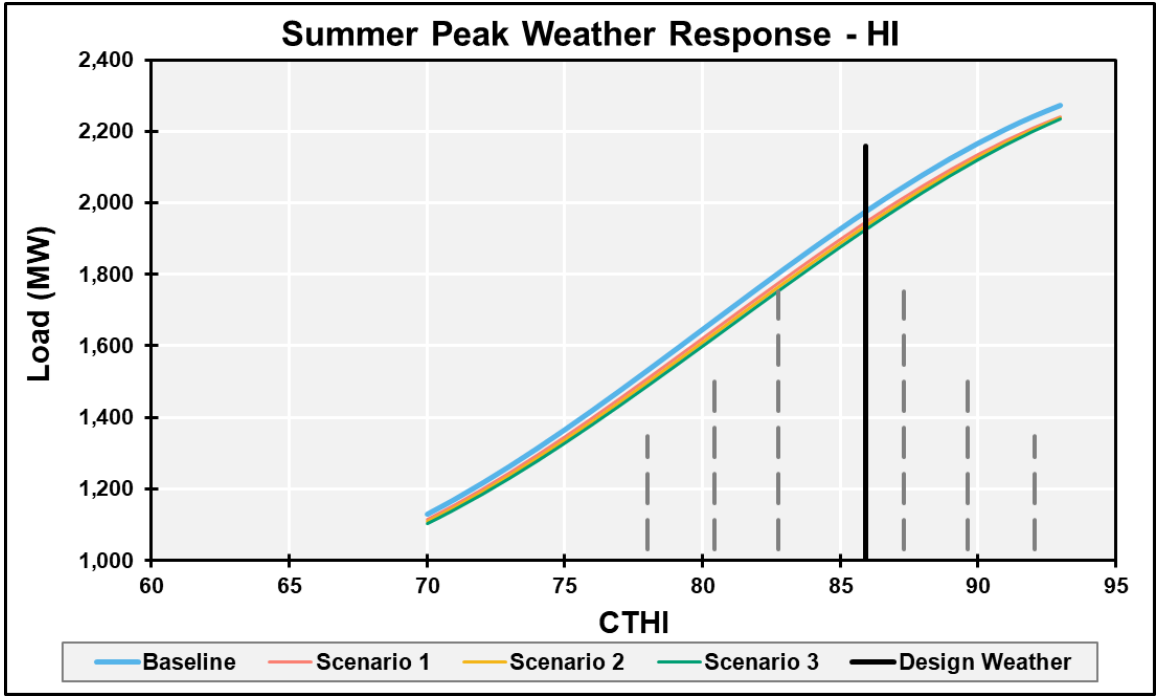
Weather Response: Zones H&I



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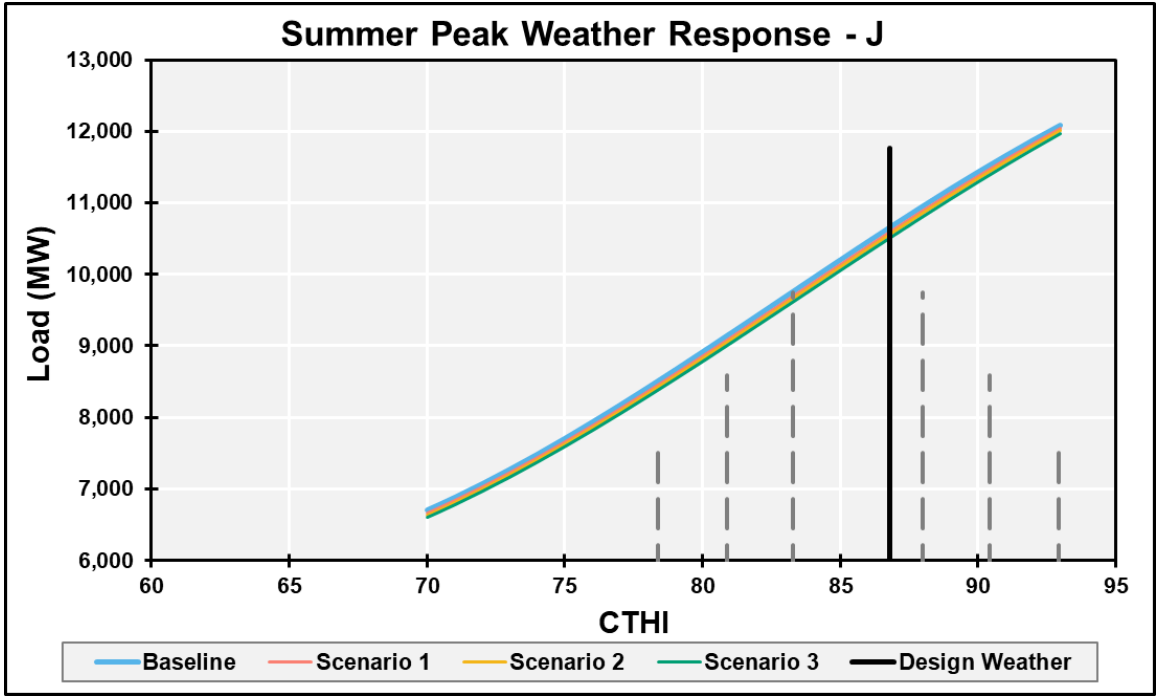
Weather Response: Zone J



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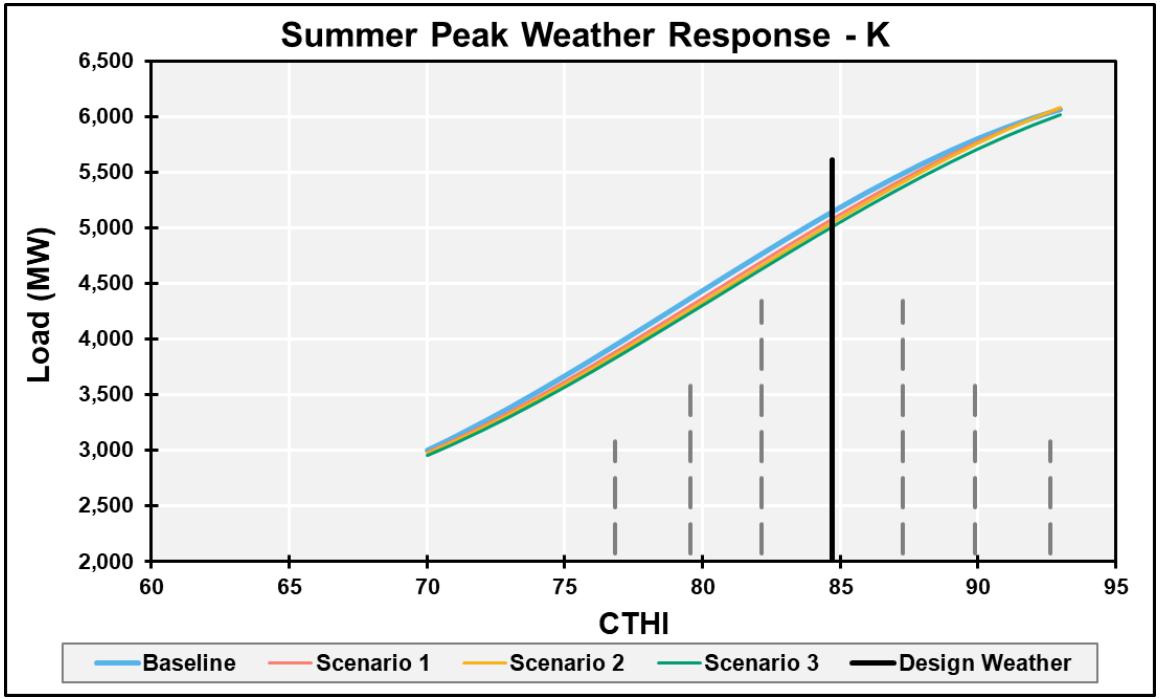
Weather Response: Zone K



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