

# Impact of Behind-the-Meter (BTM) Solar on Load Forecast Uncertainty Models

---

Riaz Khan

Demand Forecasting & Analysis

**Load Forecasting Task Force**

July 21, 2021, Teleconference

# Agenda

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

# Background, Motivation and Summary Results

# 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

# Summary Results

## ■ BTM Solar Impacts on the Peak Load Hour:

- Zones F&G and Zone K have the deepest BTM Solar penetration
- The “net” load profile exhibits a slower ramp up to the peak hour due to higher BTM Solar generation
- Peak hours have been shifting later in the day (evening hours) – this trend is projected to continue as more BTM Solar is added to the system

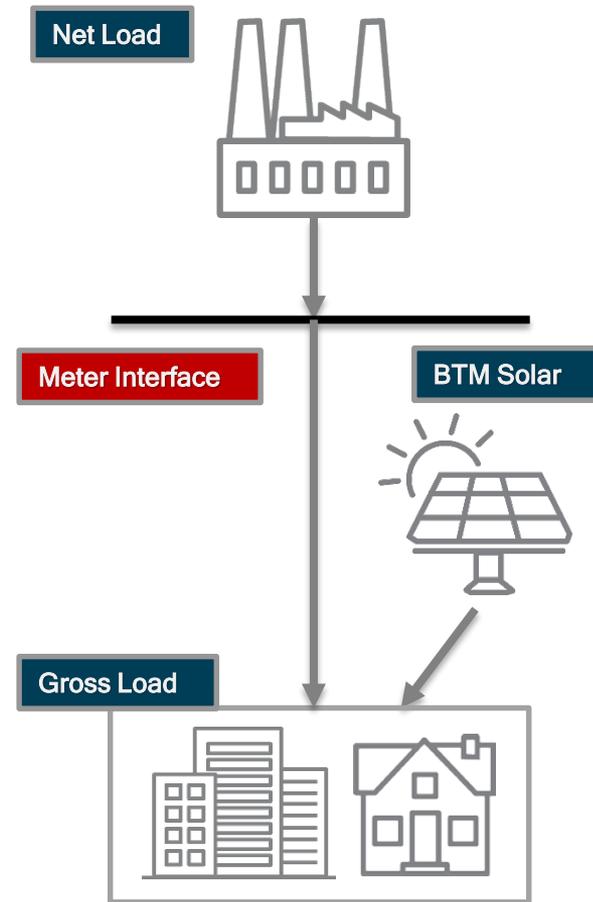
## ■ BTM Solar Impacts on LFU Model Results:

- Overall, a 300% growth in BTM Solar produces only a modest increase in LFU values
- With the increase of BTM Solar, the LFU values in the top three bins generally increase
- Impacts of BTM Solar vary by LFU modeling area. Largest impacts observed in areas of highest BTM Solar penetration (Zones F&G and K). Marginal difference in the LFU values observed in the other LFU modeling areas

# Impact of BTM Solar on Peak Producing Hour

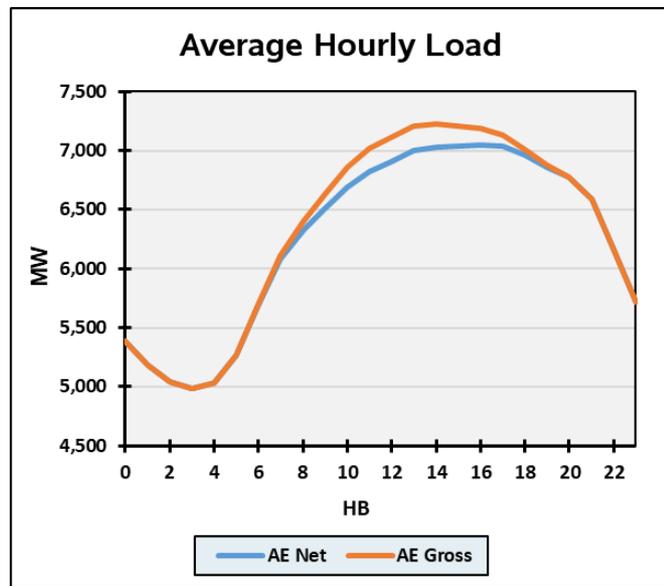
# Methodology

- 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
- Analysis centered on most recent LFU model years (2018 and 2019)

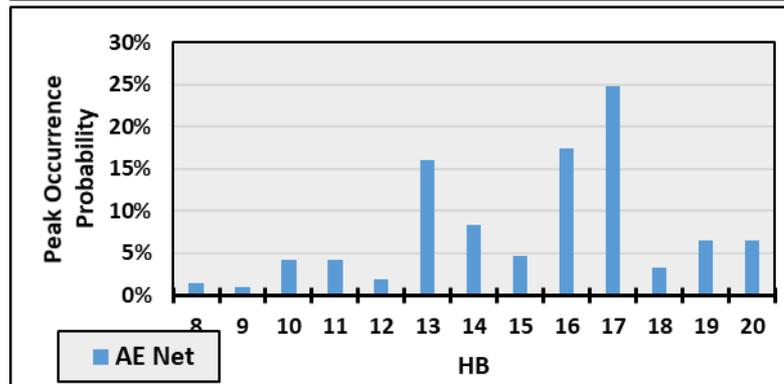
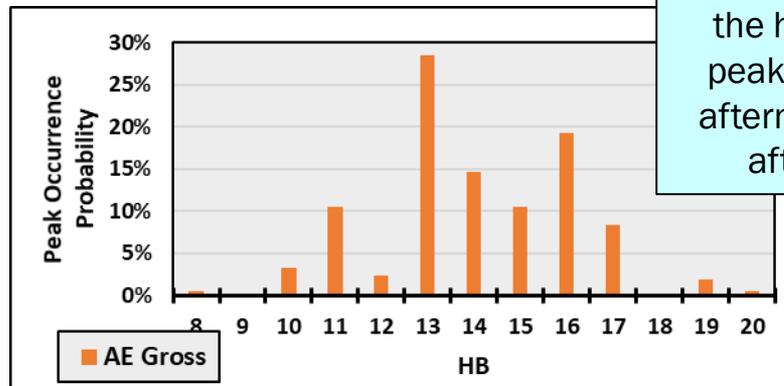


# BTM Solar Impact on Peak: Zones A-E

Reliability Area	AE	
BTM (max, as of 9/30/19)	359	MW
Average BTM Impact on Peak	144	MW
	2.0	%



May - Sep Weekdays (2018, 2019)

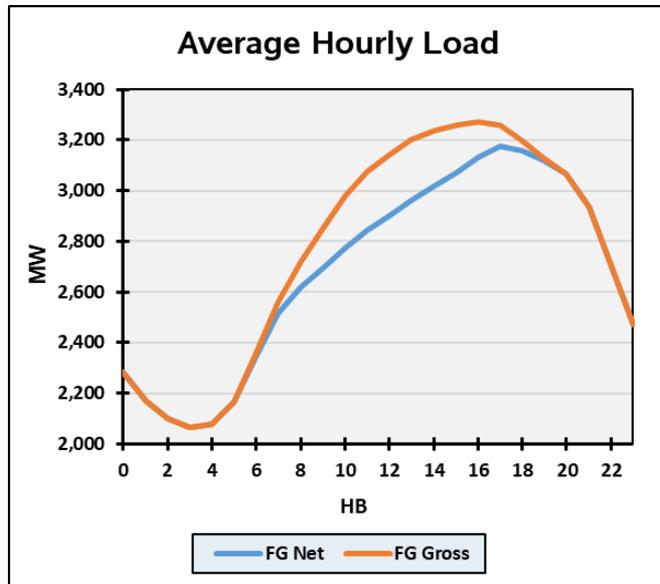


HB = Hour Beginning

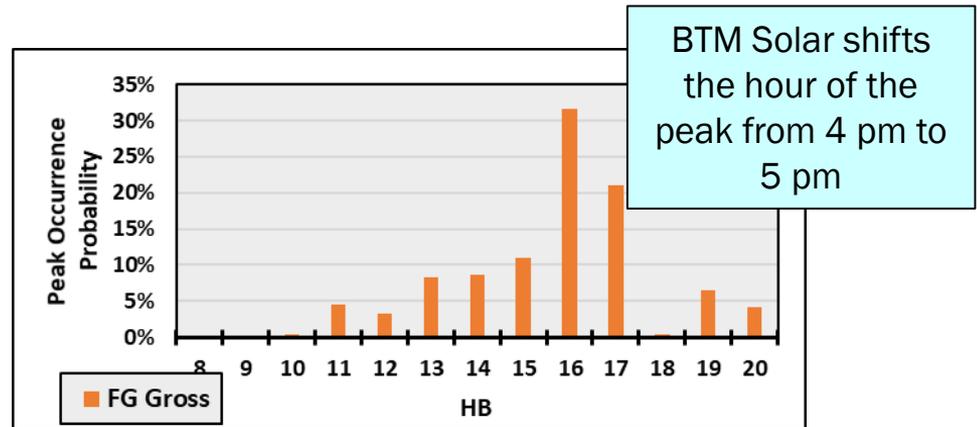
BTM Solar shifts the hour of the peak from early afternoon to late afternoon.

# BTM Solar Impact on Peak: Zones F&G

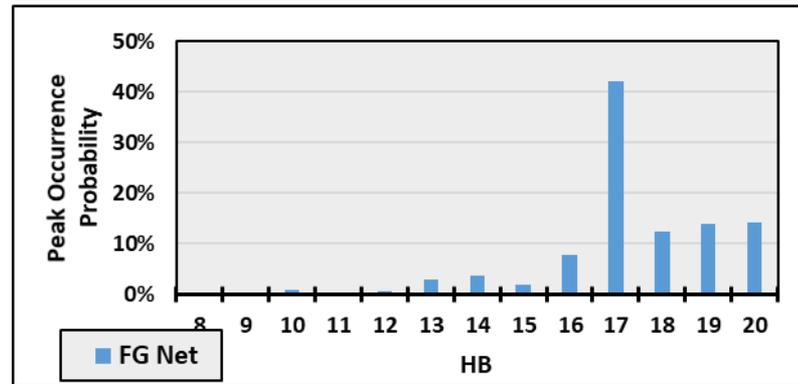
Reliability Area	FG	
BTM (max, as of 9/30/19)	400	MW
Average BTM Impact on Peak	96	MW
	2.9	%



May - Sep Weekdays (2018, 2019)



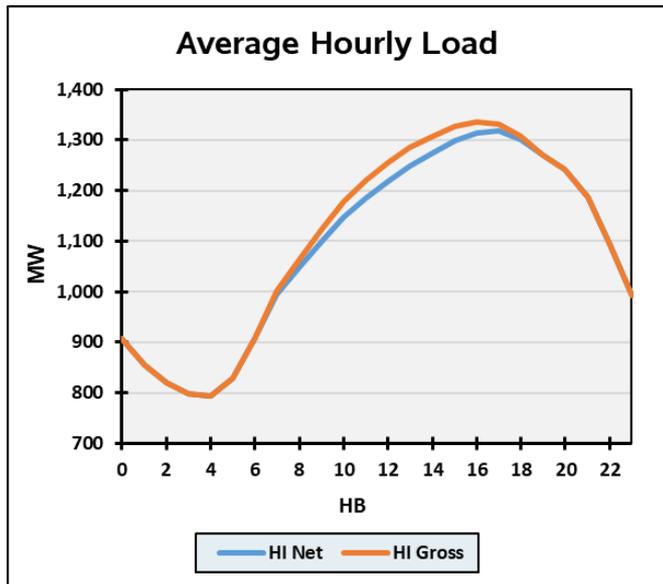
BTM Solar shifts the hour of the peak from 4 pm to 5 pm



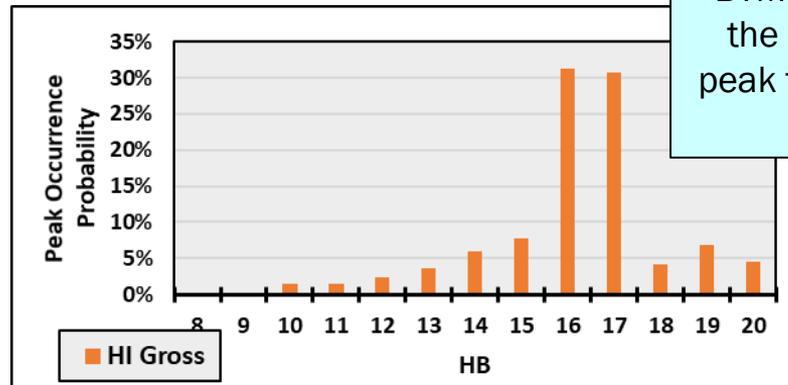
HB = Hour Beginning

# BTM Solar Impact on Peak: Zones H&I

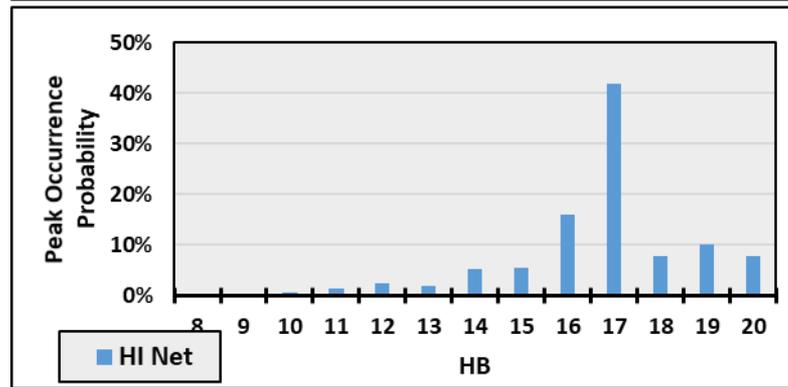
Reliability Area	HI	
BTM (max, as of 9/30/19)	60	MW
Average BTM Impact on Peak	17	MW
	1.3	%



May - Sep Weekdays (2018, 2019)



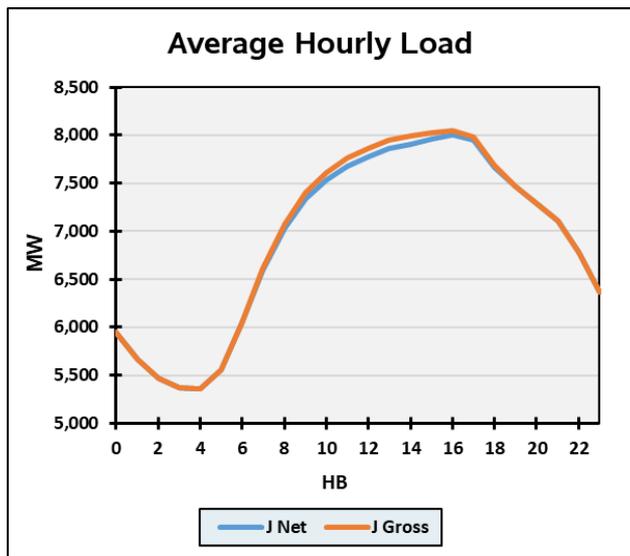
BTM Solar shifts the hour of the peak from 4 pm to 5 pm



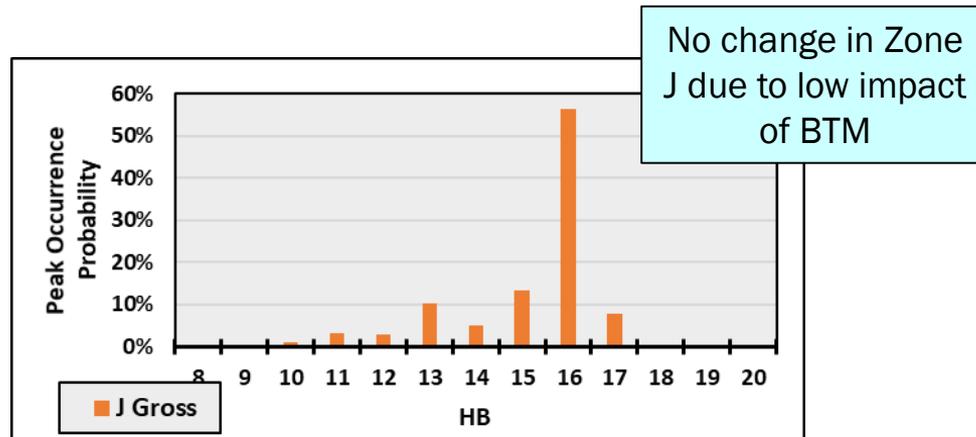
HB = Hour Beginning

# BTM Solar Impact on Peak: Zone J

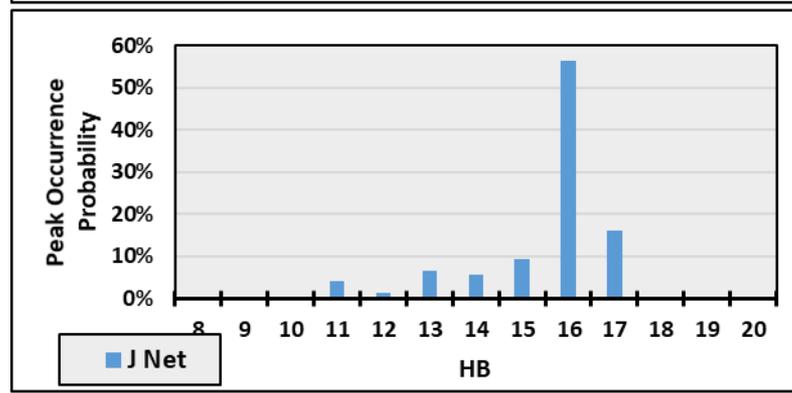
Reliability Area	J	
BTM (max, as of 9/30/19)	154	MW
Average BTM Impact on Peak	61	MW
	0.8	%



May - Sep Weekdays (2018, 2019)



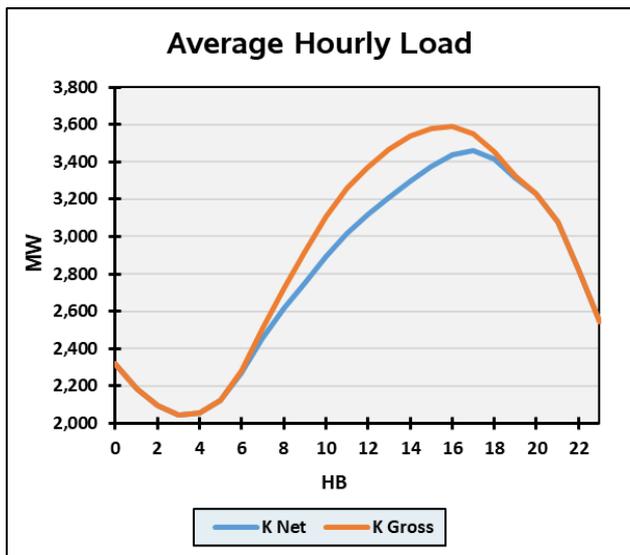
No change in Zone J due to low impact of BTM



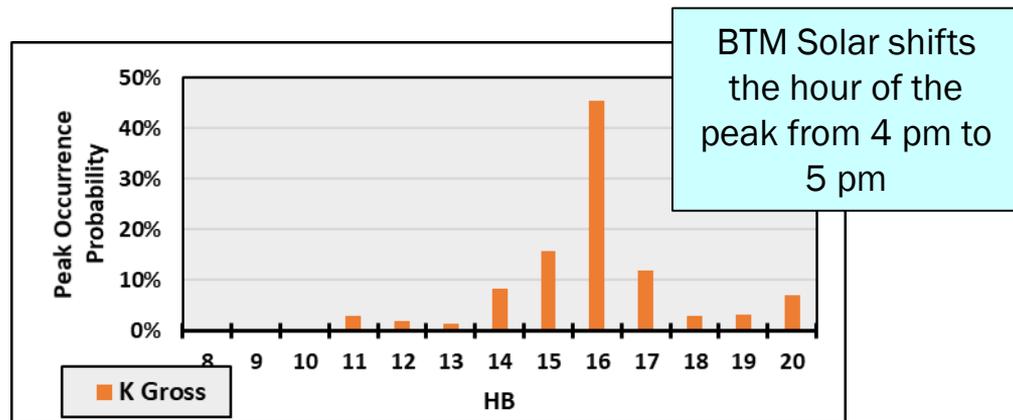
HB = Hour Beginning

# BTM Solar Impact on Peak: Zone K

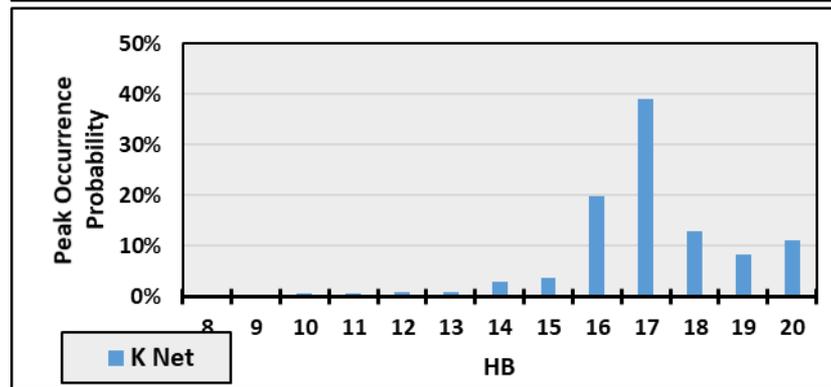
Reliability Area	K	
BTM (max, as of 9/30/19)	411	MW
Average BTM Impact on Peak	121	MW
Peak	3.3	%



May - Sep Weekdays (2018, 2019)



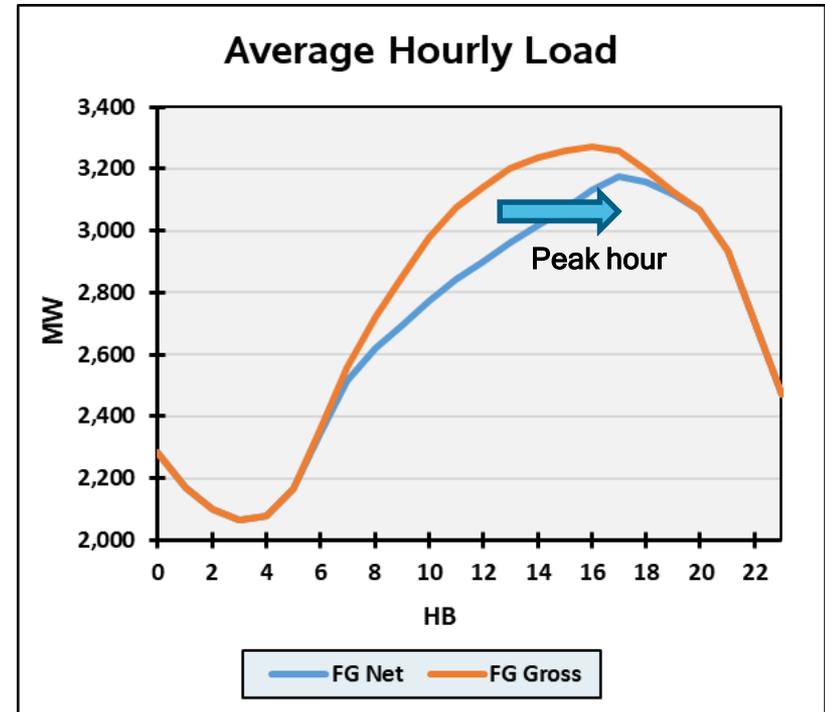
BTM Solar shifts the hour of the peak from 4 pm to 5 pm



HB = Hour Beginning

# BTM Solar Impact on Peak: Summary

- Zones F&G and Zone K have the deepest BTM Solar penetration
  - On average the BTM Solar is reduced by 2.9% and 3.3 in F&G and K respectively
- Zone J has the least impact on peak load (0.8%)
- The “net” load profile exhibits a slower ramp up to the peak hour due to higher BTM Solar generation
- Peak hours have been shifting later in the day (evening hours)
- This trend is projected to continue as more BTM Solar is added to the system



# Impact of BTM Solar on LFU Model Results

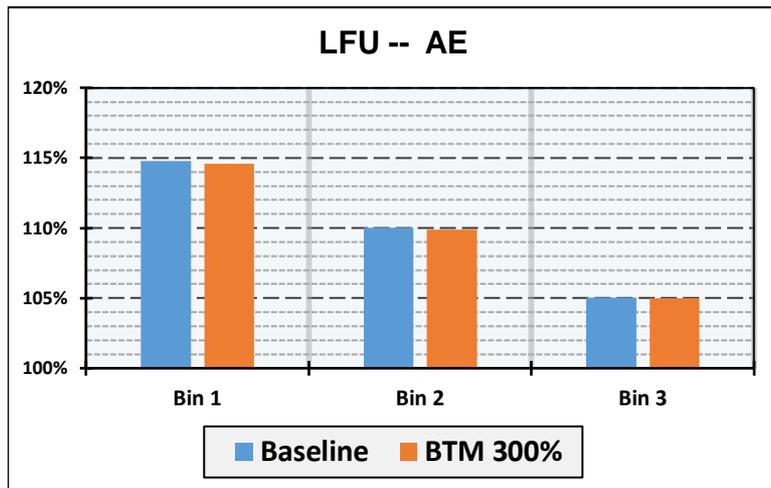
# Methodology

- **Load forecast models were developed using net load profiles from the IRM 2020 Study**
  - Official LFU values recommended in June 2021 contained updated bin structure (only change)
  - This is the baseline LFU with 100% BTM Solar (relative to September 2019)
- **Using estimates of actual BTM Solar generation, net profiles that incorporate 300% of current BTM values were generated**
- **Baseline LFU models were applied to the updated net load profiles and LFU per-unit multipliers for each of the 7 bins were derived**
- **The purpose is to examine what higher levels of BTM Solar impact will have on LFU models in the future**

# BTM Solar Impact on LFU: Zones A - E

Bin	Bin Lower Bound	Bin Upper Bound	Bin Probability	Equal Area Based z Score	LFU -- AE		LFU Delta BTM 300% - Baseline
					Baseline	BTM 300%	
Bin 1	2.5	+ Inf	0.0062	2.74	114.78%	114.61%	-0.16%
Bin 2	1.5	2.5	0.0606	1.79	110.01%	109.89%	-0.12%
Bin 3	0.5	1.5	0.2417	0.89	105.06%	104.99%	-0.07%
Bin 4	-0.5	0.5	0.3829	0.00	100.00%	100.00%	0.00%
Bin 5	-1.5	-0.5	0.2417	-0.89	94.88%	94.96%	0.08%
Bin 6	-2.5	-1.5	0.0606	-1.79	89.73%	89.91%	0.17%
Bin 7	- Inf	-2.5	0.0062	-2.74	84.63%	84.92%	0.28%

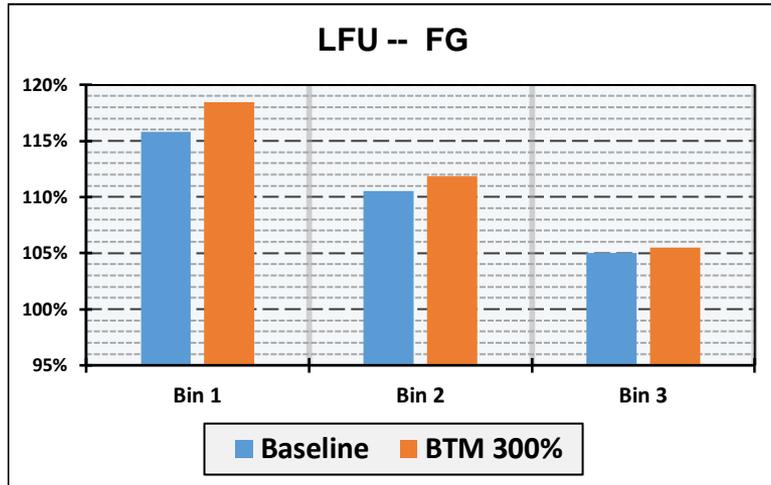
- At the baseline, the average peak reduction is about 2%
- The BTM Solar is projected to triple (relative to the baseline) by 2022
- Negligible decrease of LFU values with the increased level of BTM Solar at the top three bins



BTM Level (max, as of 9/30/19)		
Current	359	MW
3 times of current	1,077	MW

# BTM Solar Impact on LFU: Zones F & G

Bin	Bin Lower Bound	Bin Upper Bound	Bin Probability	Equal Area Based z Score	LFU -- FG		LFU Delta BTM 300% - Baseline
					Baseline	BTM 300%	
Bin 1	2.5	+ Inf	0.0062	2.74	115.85%	118.49%	2.64%
Bin 2	1.5	2.5	0.0606	1.79	110.53%	111.85%	1.32%
Bin 3	0.5	1.5	0.2417	0.89	105.01%	105.47%	0.46%
Bin 4	-0.5	0.5	0.3829	0.00	99.36%	99.32%	-0.04%
Bin 5	-1.5	-0.5	0.2417	-0.89	93.61%	93.34%	-0.27%
Bin 6	-2.5	-1.5	0.0606	-1.79	87.77%	87.50%	-0.28%
Bin 7	- Inf	-2.5	0.0062	-2.74	81.88%	81.80%	-0.09%



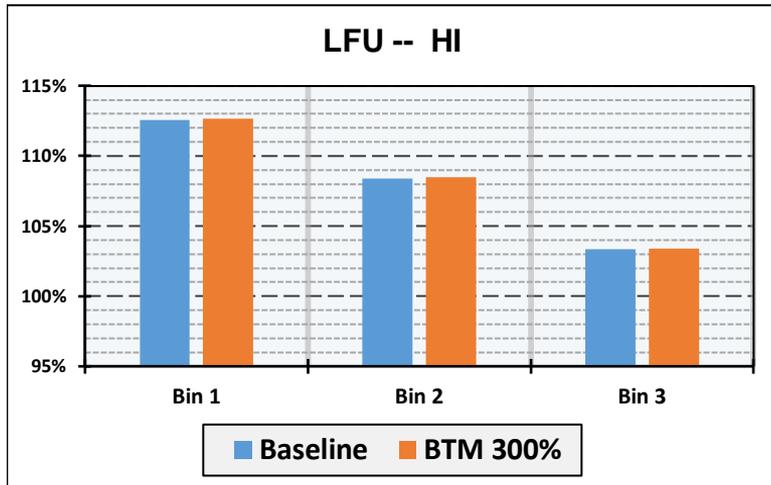
- At the baseline, the average peak reduction is about 2.9%
- The BTM Solar is projected to triple (relative to the baseline) by 2025
- 1% to 3% increase of LFU values with the increased level of BTM Solar at the top three bins

BTM Level (max, as of 9/30/19)		
Current	400	MW
3 times of current	1,200	MW

# BTM Solar Impact on LFU: Zones H&I

Bin	Bin Lower Bound	Bin Upper Bound	Bin Probability	Equal Area Based z Score	LFU -- HI		LFU Delta BTM 300% - Baseline
					Baseline	BTM 300%	
Bin 1	2.5	+ Inf	0.0062	2.74	112.55%	112.68%	0.13%
Bin 2	1.5	2.5	0.0606	1.79	108.40%	108.47%	0.08%
Bin 3	0.5	1.5	0.2417	0.89	103.36%	103.39%	0.03%
Bin 4	-0.5	0.5	0.3829	0.00	97.68%	97.67%	-0.02%
Bin 5	-1.5	-0.5	0.2417	-0.89	91.50%	91.45%	-0.05%
Bin 6	-2.5	-1.5	0.0606	-1.79	84.89%	84.82%	-0.07%
Bin 7	- Inf	-2.5	0.0062	-2.74	77.98%	77.89%	-0.08%

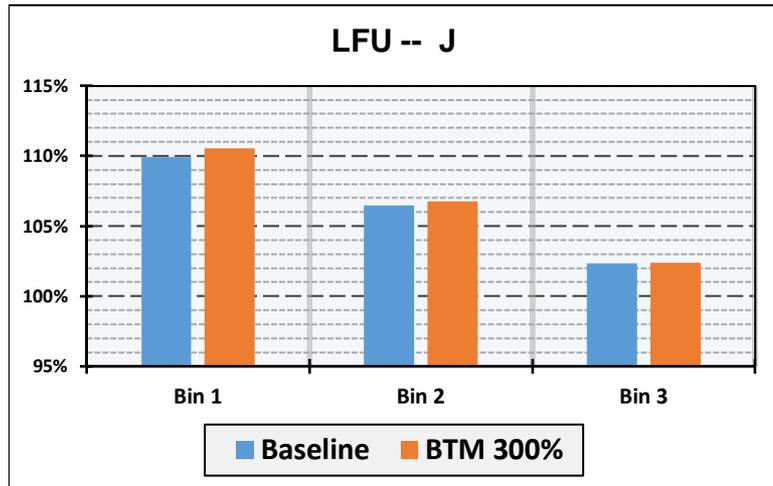
- At the baseline, the average peak reduction is about 1.3%
- The BTM Solar is projected to double (relative to the baseline) by 2027
- Negligible increase of LFU values with the increased level of BTM Solar at the top three bins



BTM Level (max, as of 9/30/19)		
Current	60	MW
3 times of current	180	MW

# BTM Solar Impact on LFU: Zone J

Bin	Bin Lower Bound	Bin Upper Bound	Bin Probability	Equal Area Based z Score	LFU -- J		LFU Delta
					Baseline	BTM 300%	BTM 300% - Baseline
Bin 1	2.5	+ Inf	0.0062	2.74	109.95%	110.54%	0.59%
Bin 2	1.5	2.5	0.0606	1.79	106.49%	106.78%	0.29%
Bin 3	0.5	1.5	0.2417	0.89	102.33%	102.41%	0.08%
Bin 4	-0.5	0.5	0.3829	0.00	97.67%	97.61%	-0.06%
Bin 5	-1.5	-0.5	0.2417	-0.89	92.58%	92.43%	-0.15%
Bin 6	-2.5	-1.5	0.0606	-1.79	87.13%	86.94%	-0.19%
Bin 7	- Inf	-2.5	0.0062	-2.74	81.38%	81.17%	-0.20%

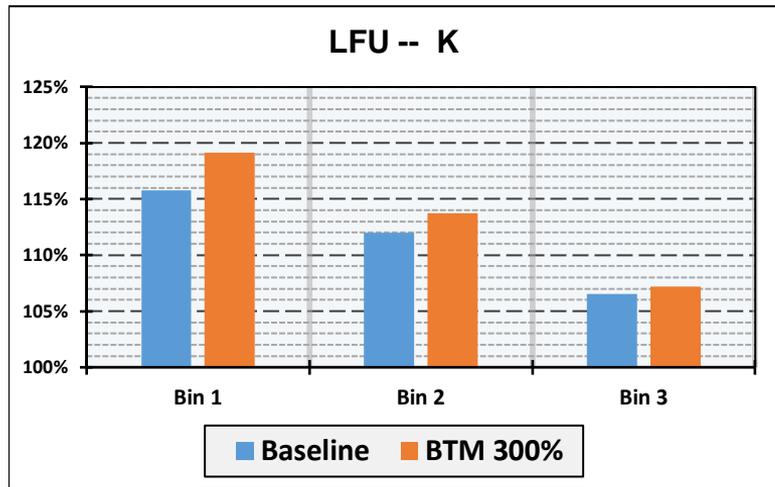


- At the baseline, the average peak reduction is about 0.8%
  - Zone J region contains the least amount of BTM Solar penetration as a percentage of load
- The BTM Solar is projected to triple (relative to the baseline) by 2032
- Marginal increase (0.3% to 0.6%) of LFU values with the increased level of BTM Solar at the top three bins

BTM Level (max, as of 9/30/19)		
Current	154	MW
3 times of current	462	MW

# BTM Solar Impact on LFU: Zone K

Bin	Bin Lower Bound	Bin Upper Bound	Bin Probability	Equal Area Based z Score	LFU -- K		LFU Delta
					Baseline	BTM 300%	BTM 300% - Baseline
Bin 1	2.5	+ Inf	0.0062	2.74	115.80%	119.13%	3.33%
Bin 2	1.5	2.5	0.0606	1.79	111.97%	113.72%	1.75%
Bin 3	0.5	1.5	0.2417	0.89	106.55%	107.22%	0.68%
Bin 4	-0.5	0.5	0.3829	0.00	100.00%	100.00%	0.00%
Bin 5	-1.5	-0.5	0.2417	-0.89	92.63%	92.26%	-0.37%
Bin 6	-2.5	-1.5	0.0606	-1.79	84.65%	84.17%	-0.48%
Bin 7	- Inf	-2.5	0.0062	-2.74	76.31%	75.95%	-0.37%



- At the baseline, the average peak reduction is about 3.3%
  - Highest BTM Solar penetration
- The BTM Solar is projected to double (relative to the baseline) by 2035
- 1.7% to 3.3% increase of LFU values with the increased level of BTM Solar at the top three bins

BTM Level (max, as of 9/30/19)		
Current	411	MW
3 times of current	1,233	MW

**Note:**

The baseline LFU model in these results is the NYISO model which produced similar results to the LIPA developed model used in the 2020 and 2021 IRM Studies

# BTM Solar Impact on LFU – Summary

- **With the increase of BTM, the LFU values in the top three bins generally increase (true for all modeling area except for the Zone A-E area)**
  - Marginal difference of LFU values between the baseline level and 300%<sup>[1]</sup> BTM Solar level in Zones A-E, H&I and J
  - Increases range between 0.13% to 0.64%
- **Larger impacts are observed in F&G and K with the increased level of BTM Solar**
  - Region F&G and Zone K have highest BTM Solar penetration
  - 2.64% increase of Bin 1 LFU at 300% BTM Solar in F&G
  - 3.33% increase of Bin 1 LFU at 300% BTM Solar in K
- **Zone K has the slowest growth path (currently projected to reach 150% by 2025 and double by 2035<sup>[2]</sup>)**
- **Overall, a 300% growth in BTM Solar produces only modest increases in LFU values.**

---

[1] 300% of 2019 actual level

[2] 2019 actual level compared against Gold Book projection

# Questions/Discussion

# Our mission, in collaboration with our stakeholders, is to serve the public interest and provide benefit to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policymakers, stakeholders and investors in the power system

