Load Forecast Uncertainty Models for the 2021 IRM Study

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Load Forecasting Task Force

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New York ISO

NYSRC Policy 5-14

The load forecast uncertainty (LFU) model captures the impacts of weather conditions on future loads. The LFU gives the MARS program information regarding seven load levels (three loads lower and three loads higher than the median peak) and their respective probabilities of occurrence. For each modeled hour, the MARS program determines the resource adequacy and calculates an average loss of load expectation for the capability year for each of the seven load levels. MARS uses this information to evaluate a probability weighted-average LOLE for each area. Recognizing the unique LFU nature of individual NYCA zones, the LFU model is subdivided into five separate areas: New York City (Zone J), Long Island (Zone K), Zones H and I, Zones F and G, and the rest of New York State (Zones A-E).

NYSRC Policy 5-14, continued

Preparation of the LFU model is coordinated by the NYISO in collaboration with the TOs. The process used to develop the LFU model generally follows the procedure used to calculate the forecasted NYCA ICAP peak as described in the NYISO Load Forecasting Manual. This process follows the development of the NYCA peak, insofar as the LFU is a distribution, not a point estimate. Following acceptance from the NYISO Load Forecasting Task Force, the NYISO submits the final LFU model to be used in MARS to ICS for review and approval...

1. Summary of 2021 Load Forecast Uncertainty Models

New York ISO

Recommended 2021 LFU

LFU 2021						
Bin	Probability	A-E	F&G	H&I	J	K
B1	0.62%	116.02%	117.17%	113.56%	110.73%	116.38%
B2	6.06%	111.11%	111.70%	109.46%	107.33%	111.97%
B3	24.17%	105.70%	105.70%	104.06%	102.89%	105.98%
B4	38.30%	100.00%	99.36%	97.68%	97.67%	100.00%
B5	24.17%	94.22%	92.89%	90.66%	91.91%	91.88%
B6	6.06%	88.58%	86.48%	83.35%	85.86%	82.34%
B7	0.62%	83.28%	80.33%	76.06%	79.79%	75.52%

Delta	A-E	F&G	H&I	J	K
B1 - B4	16.02%	17.80%	15.88%	13.06%	16.38%
B4 - B7	16.72%	19.04%	21.62%	17.88%	24.48%
Total Range	32.74%	36.84%	37.50%	30.94%	40.87%

Load Forecast Uncertainty Distributions
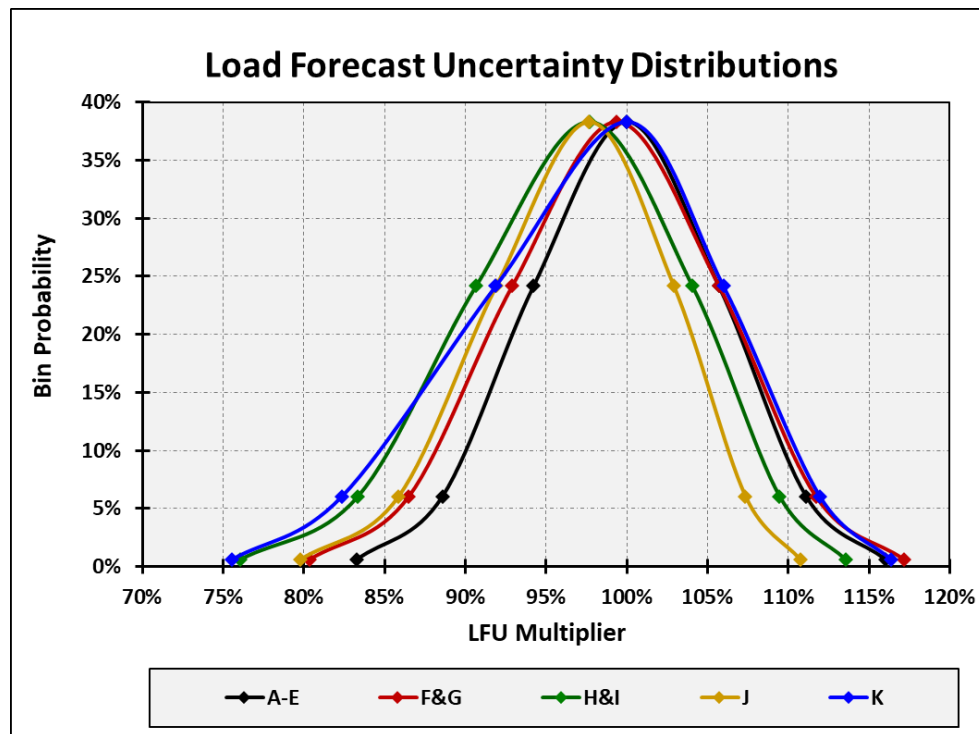
Comparison with 2020 LFU

LFU 2020

Bin	Probability	A-E	F&G	H&I	J	K
B1	0.62%	115.39%	116.28%	113.11%	109.38%	118.09%
B2	6.06%	110.57%	111.25%	108.90%	106.28%	112.92%
B3	24.17%	105.39%	105.52%	103.72%	102.45%	106.93%
B4	38.30%	100.00%	99.31%	97.82%	98.04%	100.00%
B5	24.17%	94.58%	92.86%	91.43%	93.24%	92.36%
B6	6.06%	89.29%	86.39%	84.79%	88.19%	84.73%
B7	0.62%	84.30%	80.12%	78.15%	83.07%	78.16%

Delta	A-E	F&G	H&I	J	K
B1 - B4	15.39%	16.97%	15.30%	11.34%	18.09%
B4 - B7	15.70%	19.19%	19.66%	14.97%	21.84%
Total Range	31.09%	36.16%	34.96%	26.31%	39.93%

Comparison

Bin	Probability	A-E	F&G	H&I	J	K
B1	0.62%	0.63%	0.89%	0.44%	1.34%	-1.70%
B2	6.06%	0.53%	0.45%	0.56%	1.05%	-0.95%
B3	24.17%	0.31%	0.18%	0.33%	0.45%	-0.95%
B4	38.30%	0.00%	0.05%	-0.14%	-0.38%	0.00%
B5	24.17%	-0.35%	0.03%	-0.76%	-1.33%	-0.49%
B6	6.06%	-0.71%	0.09%	-1.45%	-2.33%	-2.39%
B7	0.62%	-1.02%	0.21%	-2.10%	-3.29%	-2.64%

Delta	A-E	F&G	H&I	J	K
B1 - B4	0.63%	0.84%	0.58%	1.72%	-1.70%
B4 - B7	1.02%	-0.16%	1.96%	2.91%	2.64%
Total Range	1.65%	0.68%	2.54%	4.63%	0.94%

New York ISO

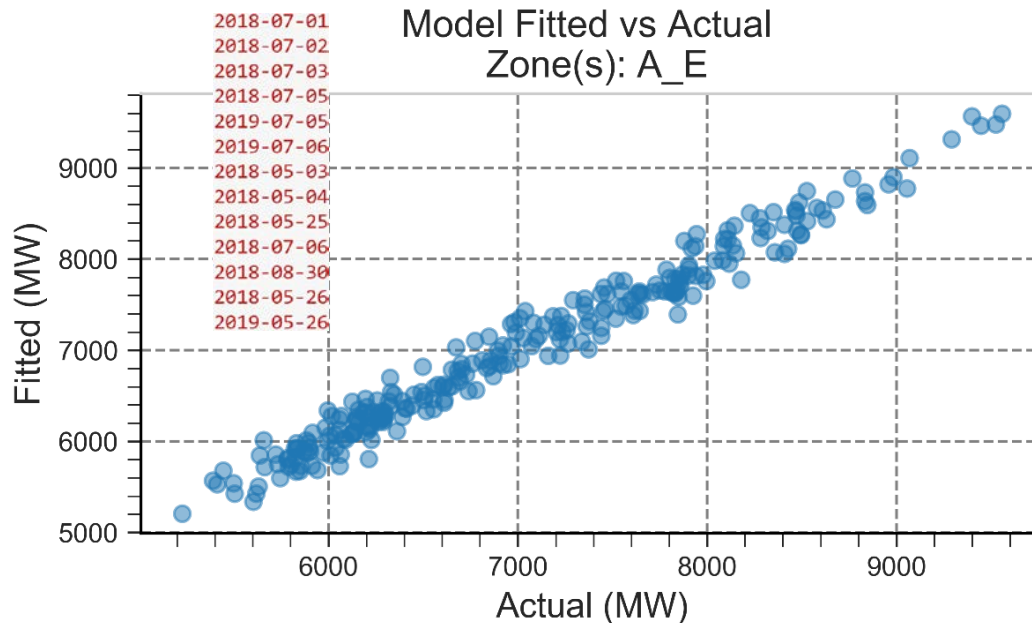# LFU 2021- General Methodology

Summer LFU

- **Data: Summer 2018, 2019 (Zone K- 2019)**
- **Data Exclusion**
    - All holidays (Memorial Day, Labor Day, July 4th)
    - Influential points (*e.g. 7/3/2018*)
- **Univariate**
    - Single weather driver (CTHI, THI4)
    - Polynomial (Zone K- piecewise) regression
    - Driver variable < certain value excluded
- **Fixed effect for different year, month, day type**
- **Iterative process**
    - Combination of fixed effects
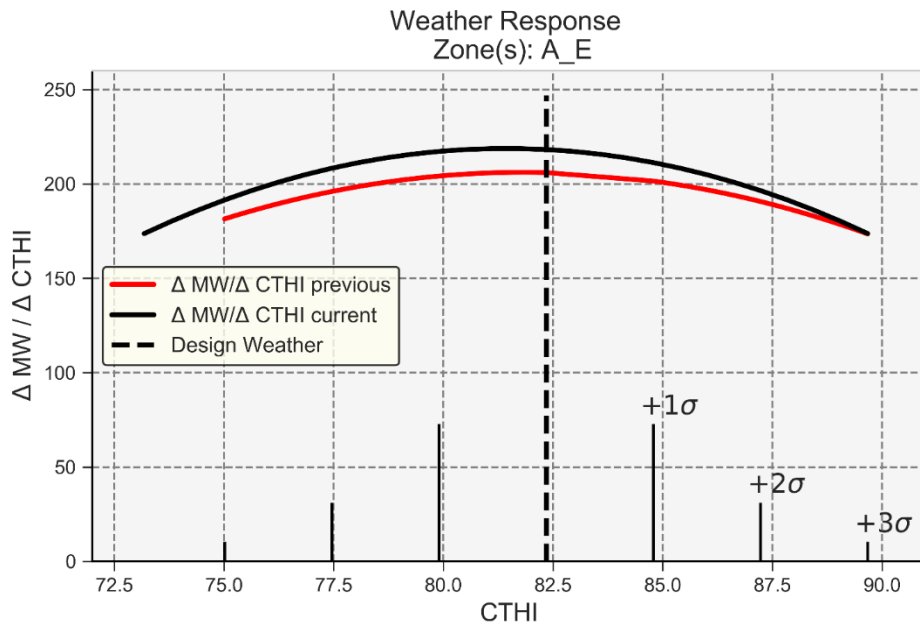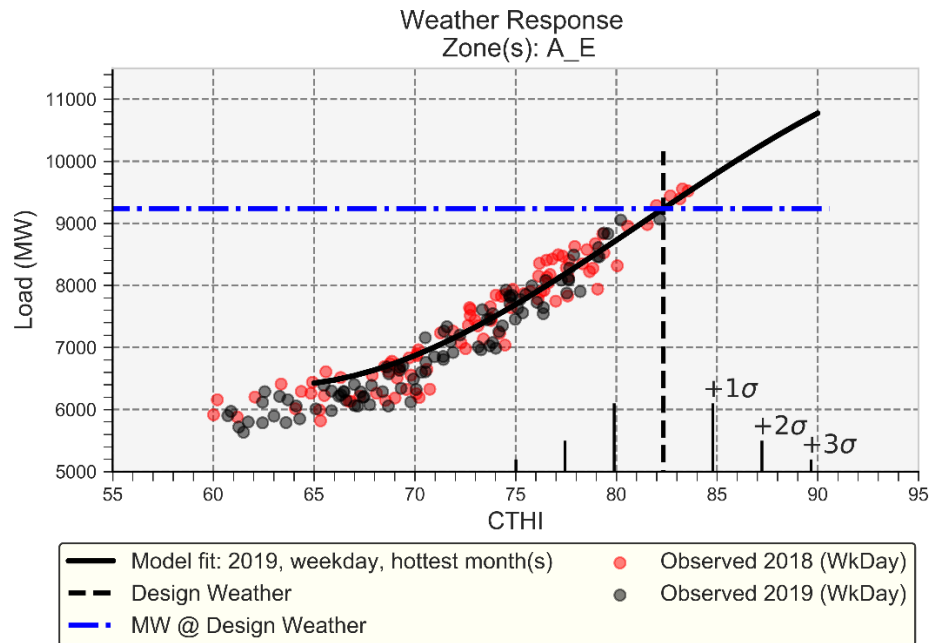   - Interactions

New York ISO

2. LFU Model: Zones A-E

New York ISO

Zones A-E: Model (CTHI)

	Coef.	Std.Err.	t	P>|t|
Intercept	110588.9	18071.32	6.1196	0
CTHI	-4178.98	759.8813	-5.4995	0
CTHI2	54.0086	10.6105	5.0901	0
CTHI3	-0.2211	0.0492	-4.4929	0
Y2018	151.9303	21.2299	7.1564	0
May	-581.581	38.9632	-14.9264	0
Jun	-315.753	30.2845	-10.4262	0
Sep	-179.037	31.1538	-5.7469	0
Fri	-89.1189	30.3057	-2.9407	0.0036
Sat	-655.458	30.4144	-21.5509	0
Sun	-545.412	30.6196	-17.8125	0

Adjusted R-Squared: 0.971

NYISO model
Dates shown in red are excluded

Model Fitted vs Actual Zone(s): A_E

2018-07-01
2018-07-02
2018-07-03
2018-07-05
2019-07-05
2019-07-06
2018-05-03
2018-05-04
2018-05-25
2018-07-06
2018-08-30
2018-05-26
2019-05-26

Zones A-E: Response

Zones A-E: LFU

Bin	Probability	Wthr	MW	LFU (2021)	LFU (2020)
	Zones(s): A-E				
B1	0.62%	89.67	10,719	116.02%	115.39%
B2	6.06%	87.23	10,265	111.11%	110.57%
B3	24.17%	84.78	9,765	105.70%	105.39%
B4	38.30%	82.34	9,239	100.00%	100.00%
B5	24.17%	79.90	8,705	94.22%	94.58%
B6	6.06%	77.46	8,184	88.58%	89.29%
B7	0.62%	75.01	7,694	83.28%	84.30%
Design		82.34	9,239		

Zones(s): A-E — Bin Probability vs. LFU Multiplier

LFU (2021) ◆ LFU (2020) ◆

New York ISO
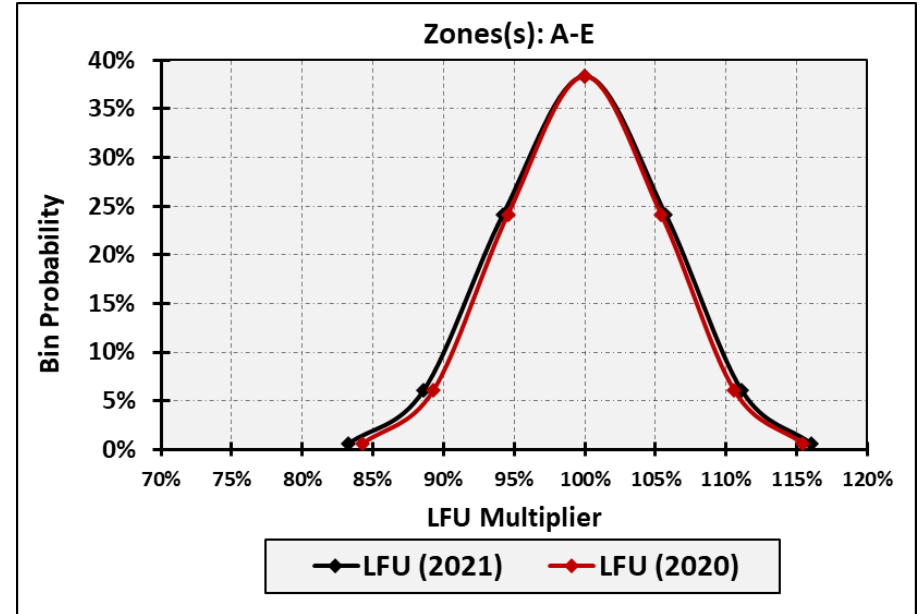
3. LFU Model: Zones F&G

New York ISO

Zones F&G: Model (CTHI)

	Coef.	Std.Err.	t	P>|t|
Intercept	52184.81	7868.277	6.6323	0
CTHI	-1971.06	324.682	-6.0707	0
CTHI2	25.1897	4.4428	5.6698	0
CTHI3	-0.1012	0.0202	-5.0206	0
Y2018	80.2075	12.0844	6.6373	0
May	-294.023	22.3851	-13.1348	0
Jun	-110.281	18.341	-6.0128	0
Sep	-91.1009	19.3792	-4.701	0
Fri	-77.7487	17.3419	-4.4833	0
Sat	-239.208	17.5146	-13.6576	0
Sun	-181.116	17.6766	-10.2461	0

Adjusted R-Squared: 0.971

Model Fitted vs Actual
Zone(s): F_G

2018-05-29
2018-07-03

NYISO model
Dates shown in red are excluded

New York ISO

Zones F&G: Response

Weather Response
Zone(s): F_G

Weather Response
Zone(s): F_G
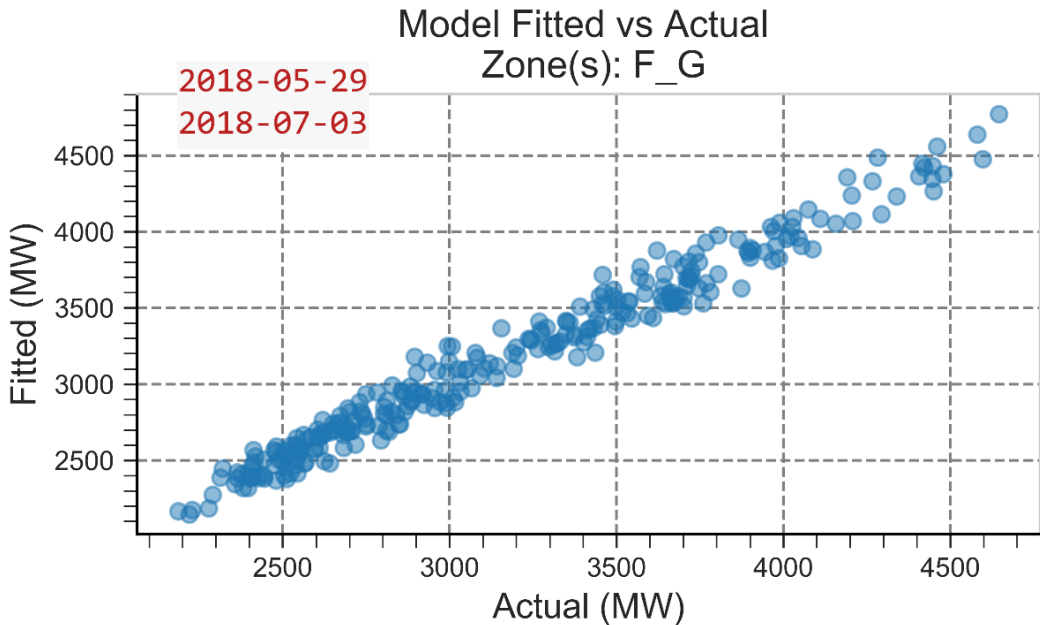
Zone F&G: LFU

Zones(s): F&G					
Bin	**Probability**	**Wthr**	**MW**	**LFU (2021)**	**LFU (2020)**
B1	0.62%	91.94	5,207	117.17%	116.28%
B2	6.06%	89.50	4,964	111.70%	111.25%
B3	24.17%	87.05	4,698	105.70%	105.52%
B4	38.30%	84.61	4,416	99.36%	99.31%
B5	24.17%	82.16	4,128	92.89%	92.86%
B6	6.06%	79.72	3,843	86.48%	86.39%
B7	0.62%	77.28	3,570	80.33%	80.12%
	Design	84.85	4,444		
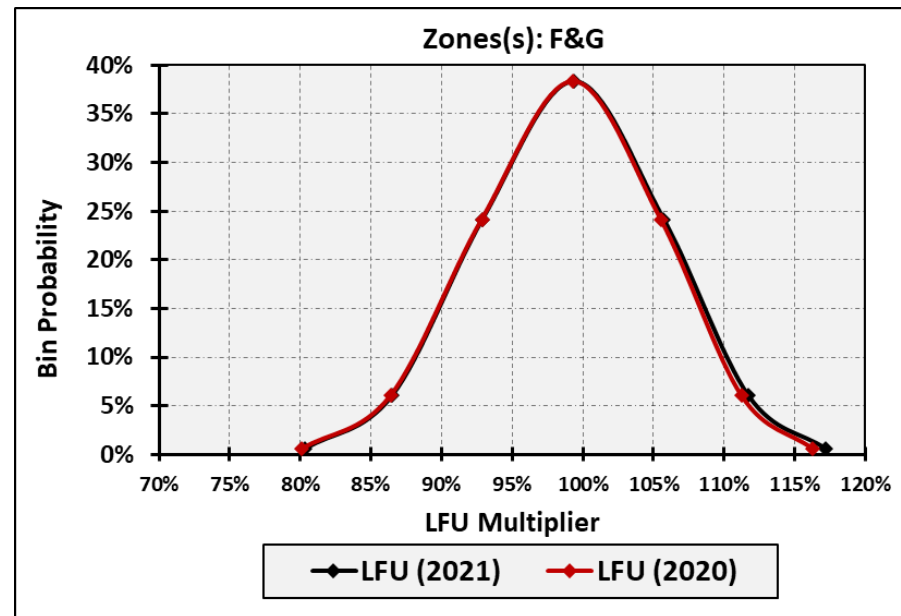
4. LFU Model: Zones H&I

New York ISO

Zones H&I: Model (CTHI)

	Coef.	Std.Err.	t	P>|t|
Intercept	32956.47	4975.818	6.6233	0
CTHI	-1284.69	204.6373	-6.2779	0
CTHI2	16.7199	2.794	5.9841	0
CTHI3	-0.0694	0.0127	-5.4772	0
Y2018	26.9593	6.5159	4.1375	0
May	-74.709	10.5669	-7.0701	0
Sep	-38.1318	8.8869	-4.2908	0
Fri	-25.9661	9.455	-2.7463	0.0064
WkEnd	-113.574	7.4845	-15.1745	0

Adjusted R-Squared: 0.964

Model Fitted vs Actual
Zone(s): H_I

2018-05-30
2018-07-02
2018-07-03
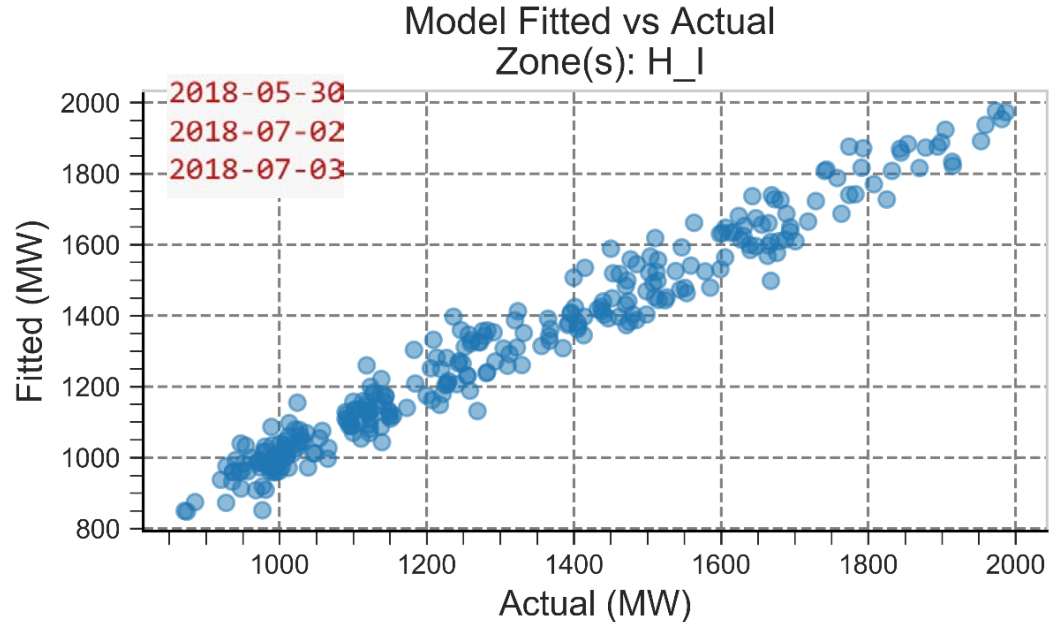
NYISO model
Dates shown in red are excluded

Zones H&I: Response
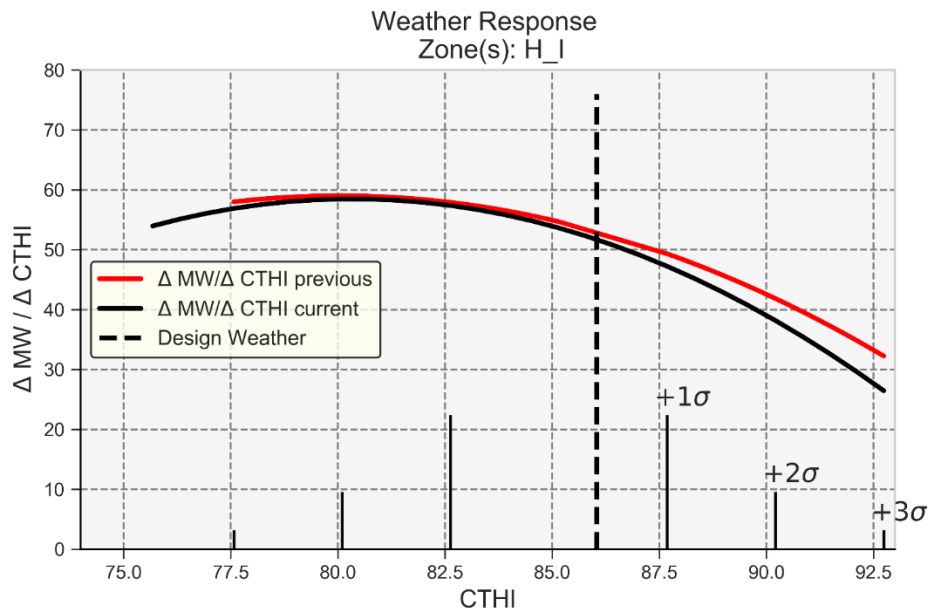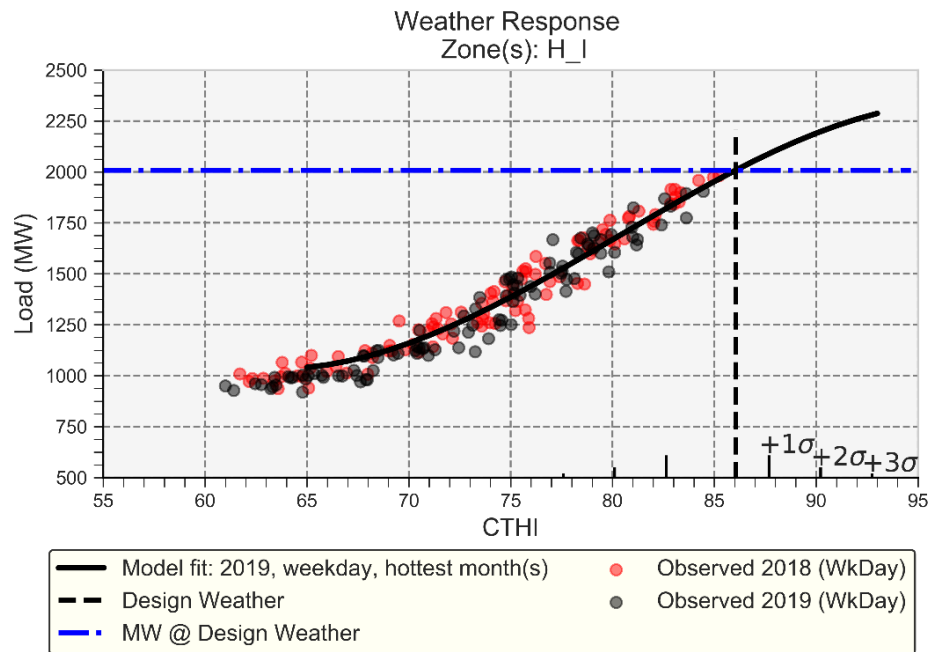
Zones H&I: LFU

Zones(s): H&I					
Bin	**Probability**	**Wthr**	**MW**	**LFU (2021)**	**LFU (2020)**
B1	0.62%	92.74	2,280	113.56%	113.11%
B2	6.06%	90.21	2,198	109.46%	108.90%
B3	24.17%	87.68	2,089	104.06%	103.72%
B4	38.30%	85.15	1,961	97.68%	97.82%
B5	24.17%	82.63	1,820	90.66%	91.43%
B6	6.06%	80.10	1,673	83.35%	84.79%
B7	0.62%	77.57	1,527	76.06%	78.15%
Design		86.04	2,008		

5. LFU Model: Zone J

New York ISO
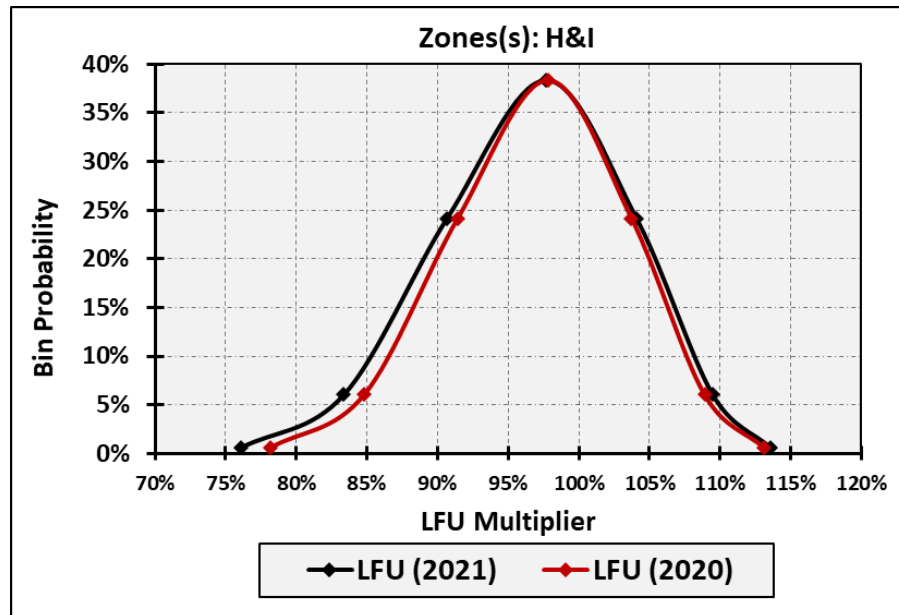
Zone J: Model (CTHI)

Data: Mon-Thu

CTHI > 61

	Coefficients	Standard Error	t Stat	P-value
Intercept	128821.36	20252.14	6.36	0.00
CTHI	-4994.83	830.43	-6.01	0.00
CTHI2	65.61	11.30	5.80	0.00
CTHI3	-0.27	0.05	-5.34	0.00
Y2018	109.70	26.32	4.17	0.00
May	-227.60	40.86	-5.57	0.00
Thurs	-62.85	30.02	-2.09	0.03

Model Fitted vs Actual
Zone: J

5/30/2018
7/2/2018
7/3/2018
8/1/2018
8/16/2018
9/27/2018
5/21/2019
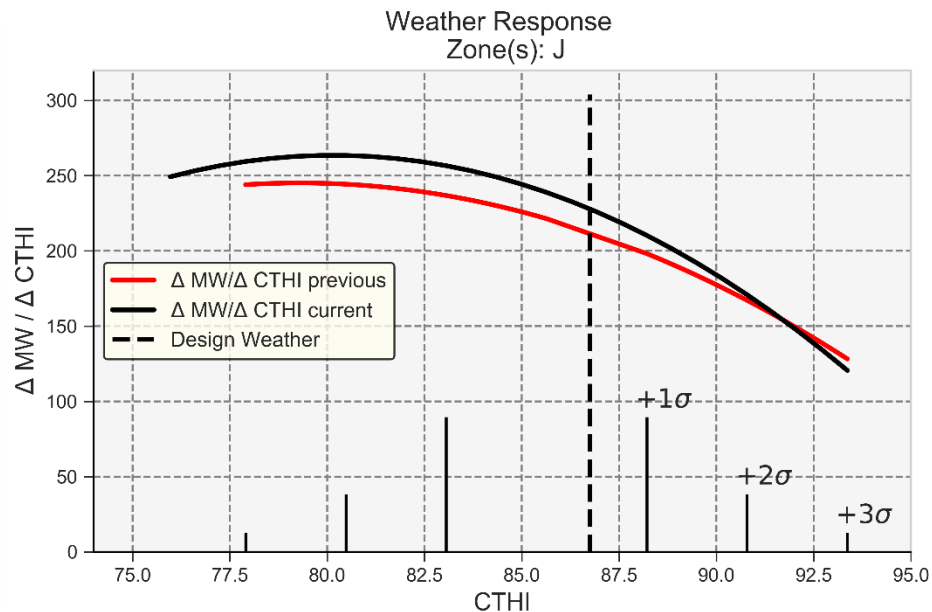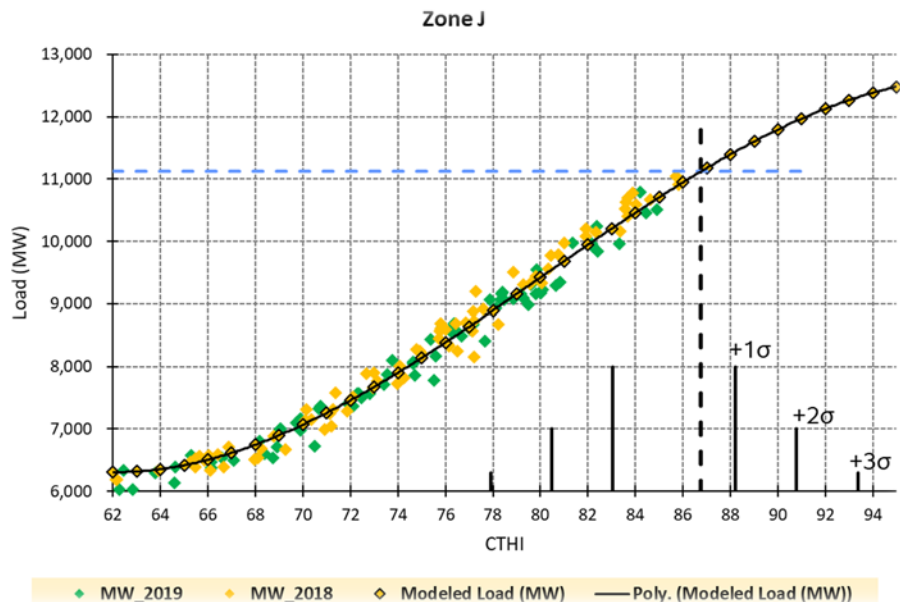7/23/2019
9/5/2019
9/24/2019
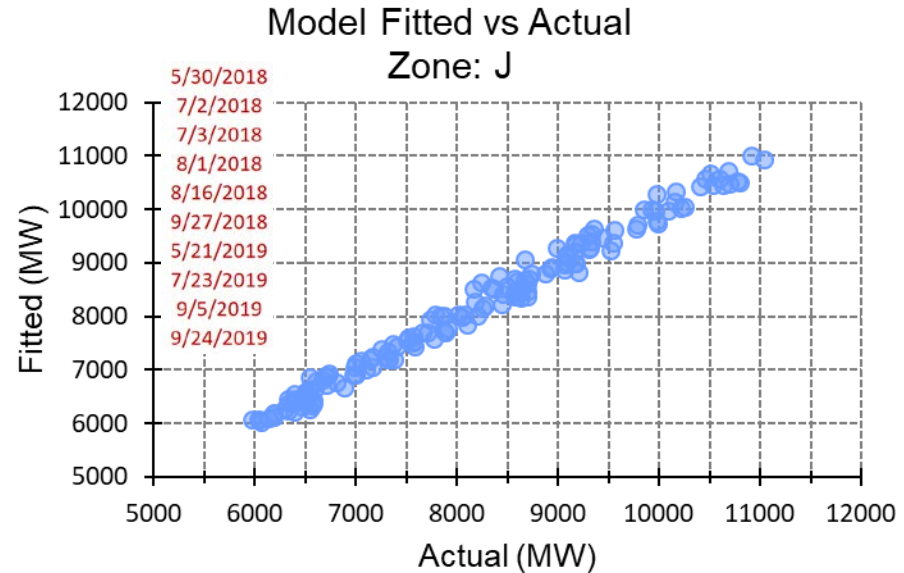
Adjusted R-Squared: 0.986

Con-Ed model- CTHI
Dates shown in red are excluded
Model independently developed by NYISO produced similar results

New York ISO

Zones J: Response

Zone J: LFU

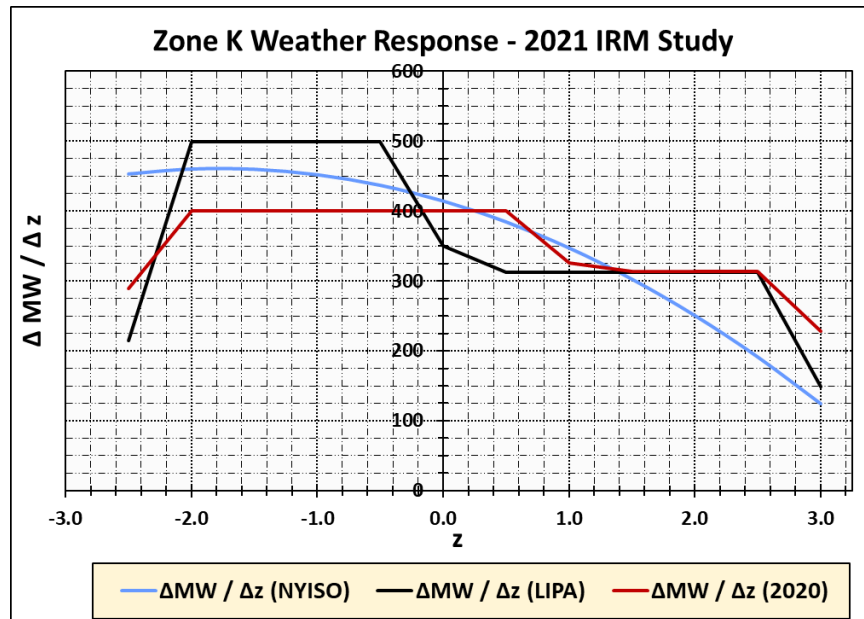|		Zones(s): J			
Bin	**Probability**	**Wthr**	**MW**	**LFU (2021)**	**LFU (2020)**
B1	0.62%	93.36	12,315	110.73%	109.38%
B2	6.06%	90.79	11,937	107.33%	106.28%
B3	24.17%	88.21	11,444	102.89%	102.45%
B4	38.30%	85.64	10,863	97.67%	98.04%
B5	24.17%	83.06	10,222	91.91%	93.24%
B6	6.06%	80.48	9,550	85.86%	88.19%
B7	0.62%	77.91	8,874	79.79%	83.07%
Design		86.75	11,122		

6. LFU Model: Zone K

New York ISO
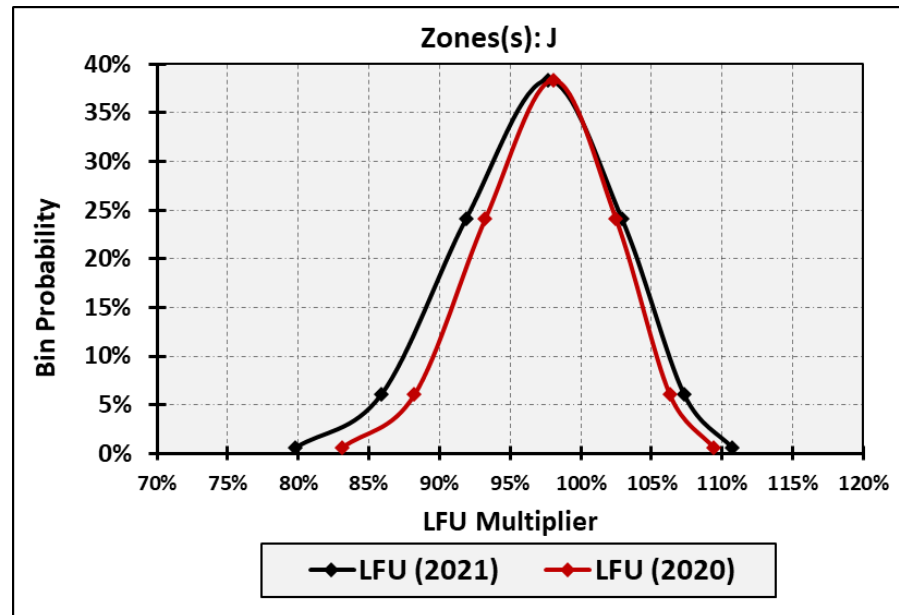
Zone K: Model Summary

Independently developed LIPA and NYISO models

- **NYISO- OLS, CTHI**
- **LIPA- piecewise, THI4**

z-score	MW (NYISO)	MW (LIPA)	ΔMW / Δz (NYISO)	ΔMW / Δz (LIPA)	ΔMW / Δz (2020)
-3.0	3,888	3,948			
-2.5	4,115	4,055	453	215	289
-2.0	4,345	4,304	460	499	400
-1.5	4,575	4,554	460	499	400
-1.0	4,801	4,803	452	499	400
-0.5	5,019	5,052	437	499	400
0.0	5,226	5,228	414	351	400
0.5	5,419	5,384	385	313	400
1.0	5,592	5,540	347	313	326
1.5	5,744	5,697	303	313	314
2.0	5,869	5,853	250	313	314
2.5	5,964	6,010	191	313	314
3.0	6,027	6,084	124	149	228

Zone K Weather Response - 2021 IRM Study

LIPA model- THI4
NYISO model and LIPA model- similar results

Zone K: LFU

Zones(s): K					
Bin	**Probability**	**z**	**MW**	**LFU (2021)**	**LFU (2020)**
B1	0.62%	3	6,084	116.38%	118.09%
B2	6.06%	2	5,853	111.97%	112.92%
B3	24.17%	1	5,540	105.98%	106.93%
B4	38.30%	0	5,228	100.00%	100.00%
B5	24.17%	-1	4,803	91.88%	92.36%
B6	6.06%	-2	4,304	82.34%	84.73%
B7	0.62%	-3	3,948	75.52%	78.16%
	Design	0	5,228		
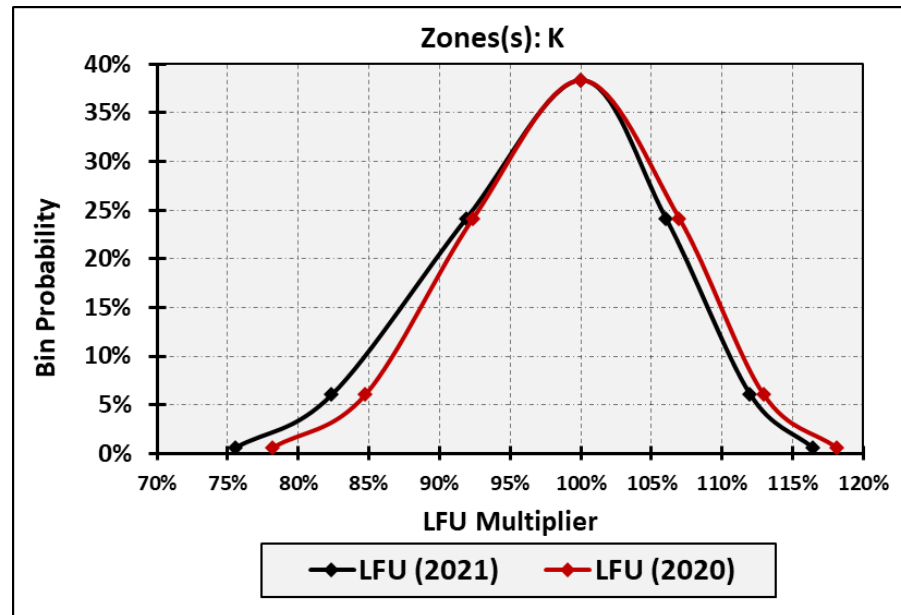
7. LFU Model: NYCA- Winter

New York ISO

# NYCA Winter: Model (HDD_55)

NYCA Winter LFU

- Data: 2017-18, 2018-19, 2019-20
- Driver: HDD_55 (0<HDD_55<55)
- Holidays excluded
- Quadratic model
- Fixed effect: year, month, day type
- Iterative process

New York ISO

NYCA Winter: Model (HDD_55)

	Coef.	Std.Err.	t	P>|t|
Intercept	19500.95	128.6435	151.5891	0
HDD_55	43.0524	9.7942	4.3957	0
HDD_552	1.308	0.1968	6.6479	0
CP_2017_18	651.6266	59.6048	10.9324	0
CP_2018_19	387.0183	58.3658	6.6309	0
Jan	-255.984	58.6974	-4.3611	0
Feb	-795.702	58.551	-13.5899	0
WkEnd	-1489.18	53.9265	-27.615	0
Fri	-425.439	69.1682	-6.1508	0

Model Fitted vs Actual
Zone(s): NYCA_Winter
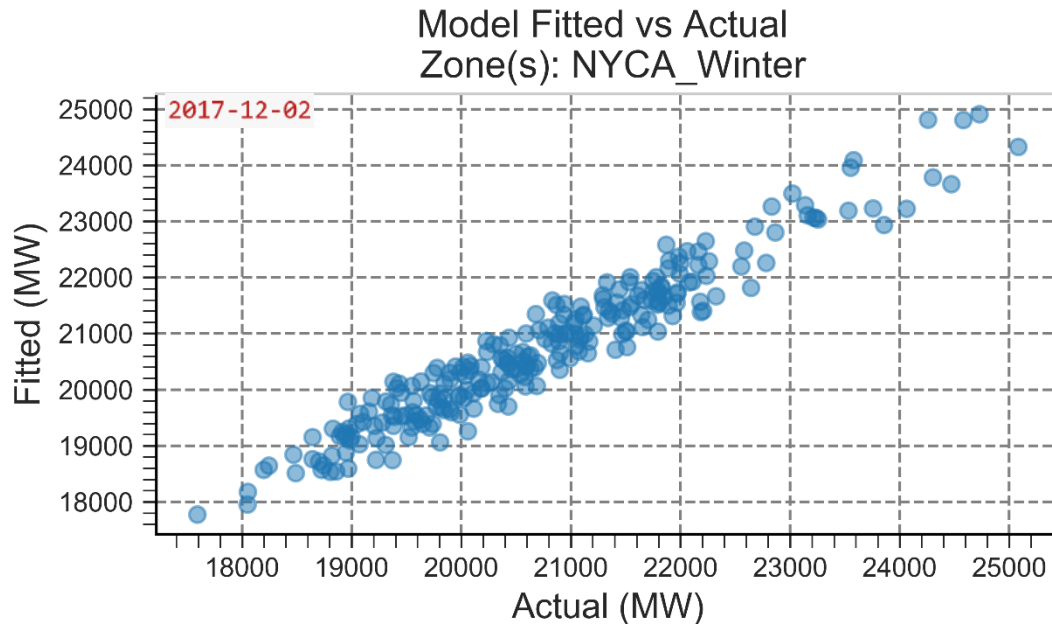
Adjusted R-Squared: 0.927

NYISO model
Dates shown in red are excluded

New York ISO

NYCA Winter: Response

Weather Response
Zone(s): NYCA_Winter

Weather Response
Zone(s): NYCA_Winter
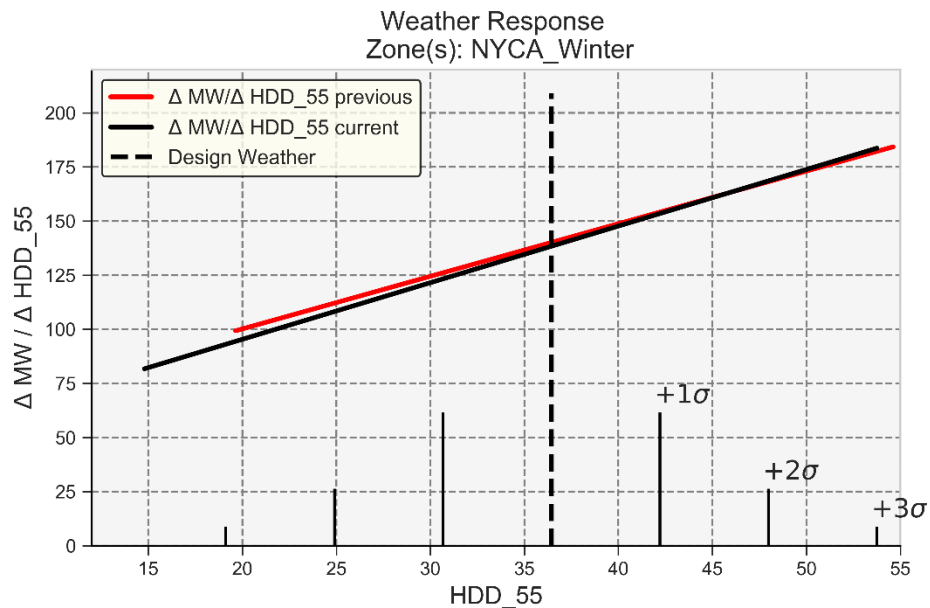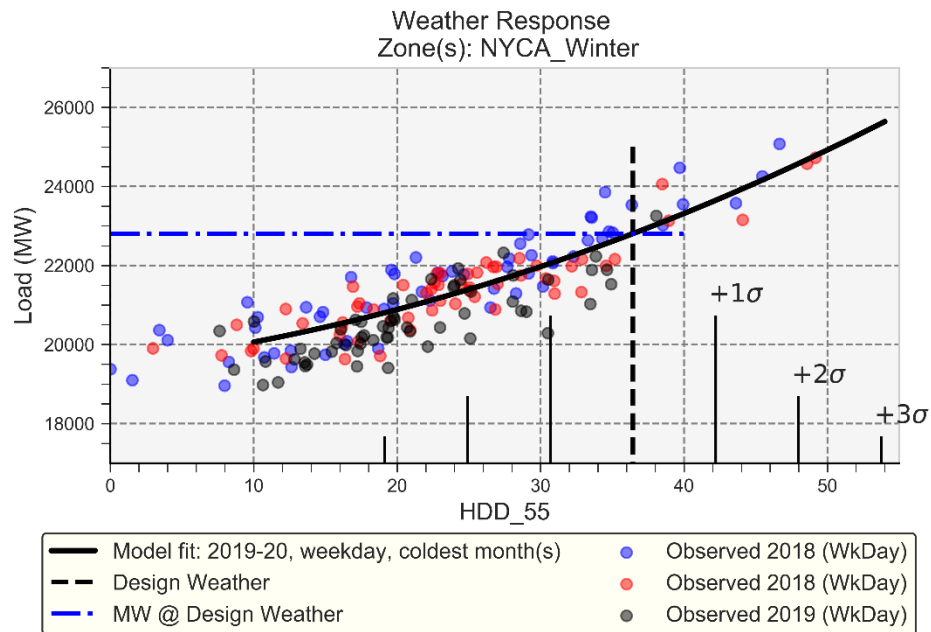
NYCA Winter: LFU

Zones(s): NYCA (Winter)					
Bin	**Probability**	**Wthr**	**MW**	**LFU (2021)**	**LFU (2020)**
B1	0.62%	53.75	25,593	112.22%	111.80%
B2	6.06%	47.98	24,577	107.77%	107.52%
B3	24.17%	42.20	23,648	103.69%	103.59%
B4	38.30%	36.43	22,806	100.00%	100.00%
B5	24.17%	30.66	22,051	96.69%	96.75%
B6	6.06%	24.89	21,383	93.76%	93.85%
B7	0.62%	19.12	20,802	91.22%	91.28%
	Design	36.43	22,806		

Questions?

New York ISO
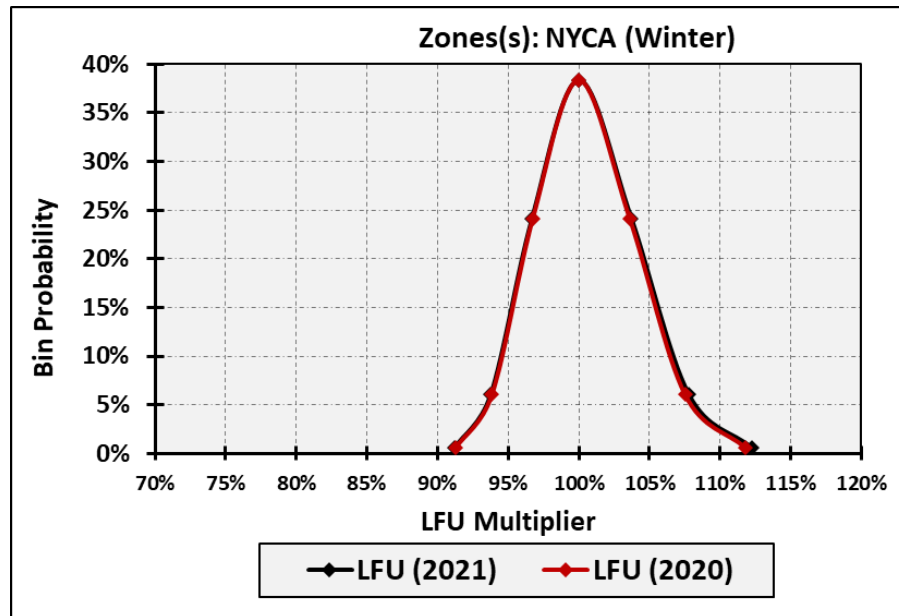
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- Maintaining and enhancing regional reliability

- 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

New York ISO