Load Forecast Uncertainty Models for the 2021 IRM Study

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New York State Reliability Council - Installed Capacity Subcommittee

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Overview

1. Summary of 2021 Load Forecast Uncertainty Models
2. LFU Models: Zones A-E
3. LFU Models: Zones F&G
4. LFU Models: Zones H&I
5. LFU Models: Zone J
6. LFU Models: Zone K
7. LFU Models: NYCA Winter

The LFU Model Results in this presentation will also be applied in the NYISO 2020 Reliability Needs Assessment

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).

New York ISO

# 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...

New York ISO

1. Summary of 2021 Load Forecast Uncertainty Models

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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

New York ISO
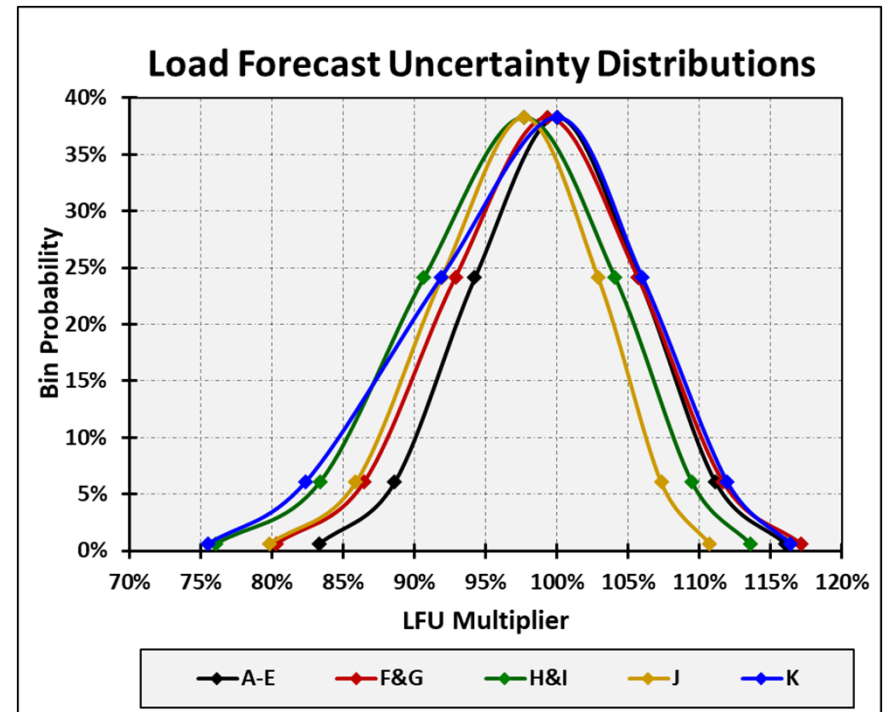
Comparison with 2020 LFU

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%

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	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%

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%

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LFU 2021- General Methodology

Summer LFU

- Data: May-September 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
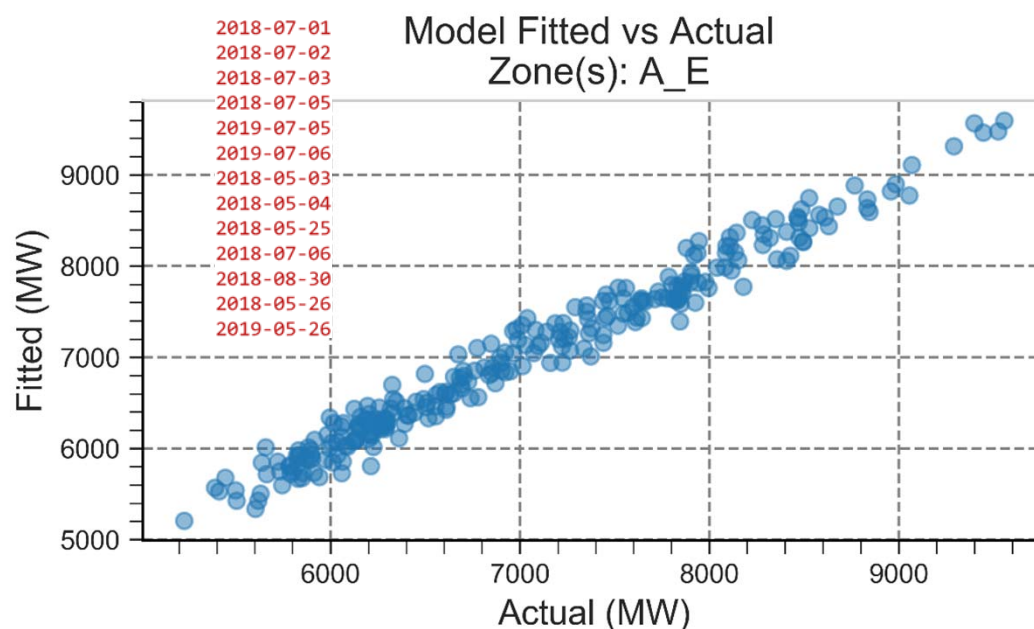 - Combination of fixed effects
  - Interactions

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Key Changes in Methodology

Item	LFU 2020	LFU 2021
Data	2013, 2016, 2018	2018, 2019
Summer months	June - September	May - September
Weekends	Excluded before modeling	Modeled through factorial variable(s)

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

New York ISO

Zones A-E: Response
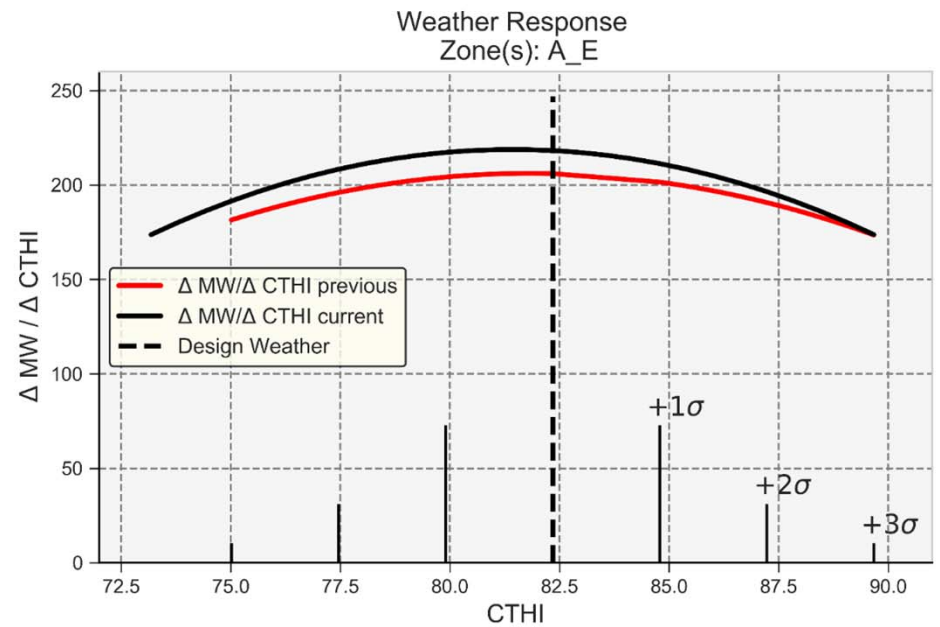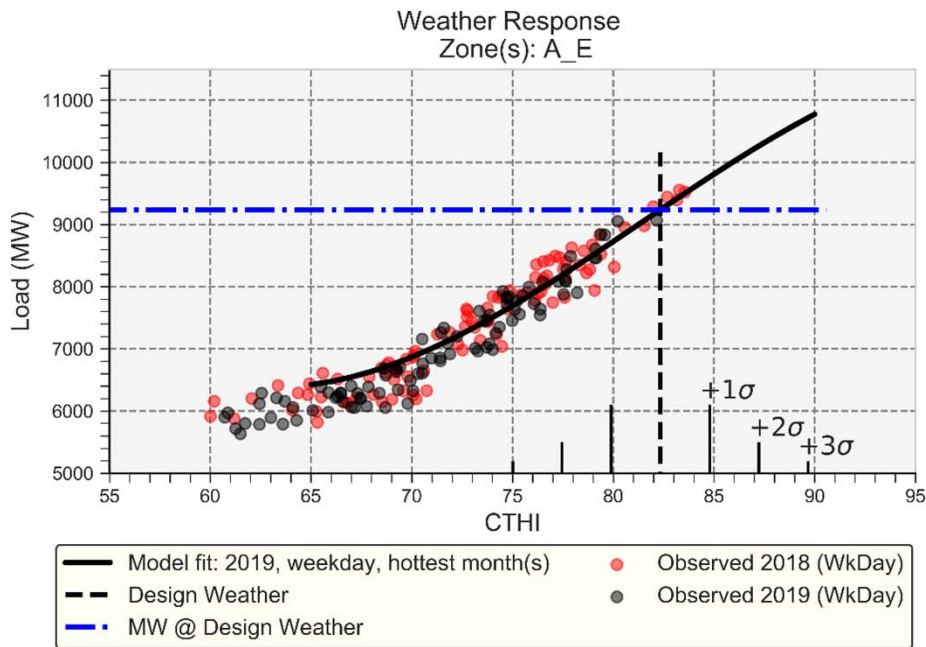
Zones A-E: LFU

Zones(s): A-E					
Bin	Probability	Wthr	MW	LFU (2021)	LFU (2020)
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		
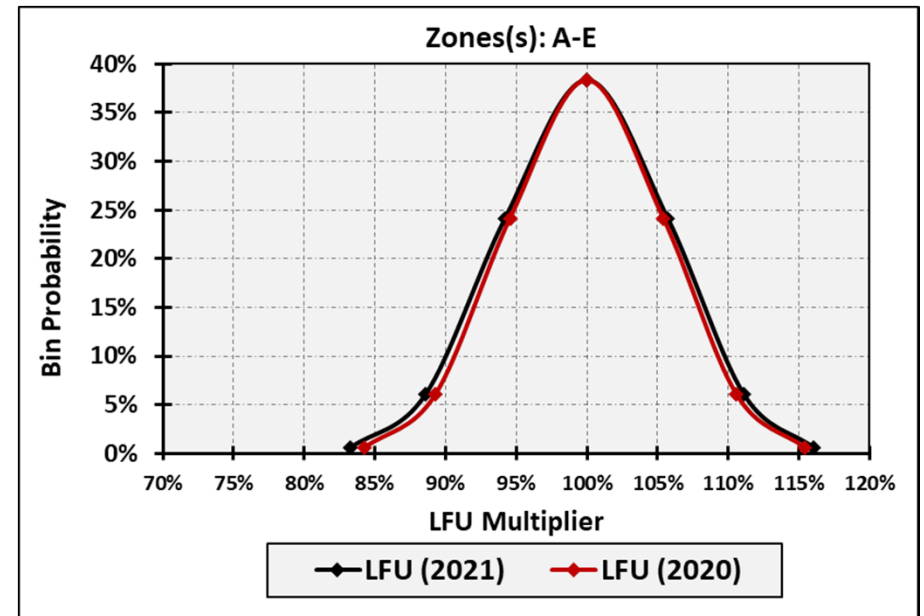
3. LFU Model: Zones F&G

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

NYISO model
Dates shown in red are excluded

Model Fitted vs Actual Zone(s): F_G
2018-05-29
2018-07-03
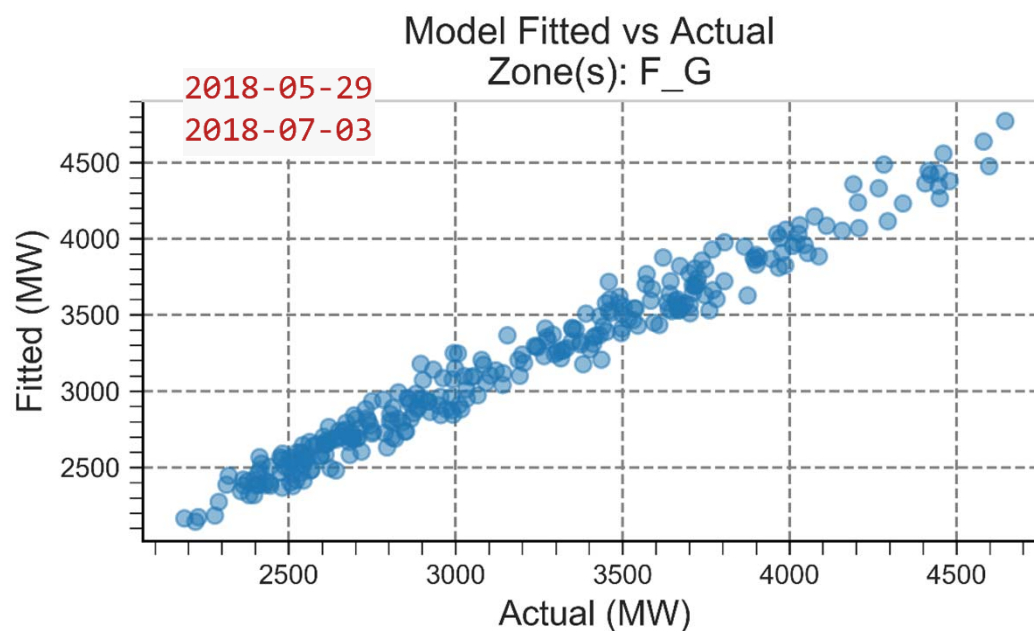
Zones F&G: Response
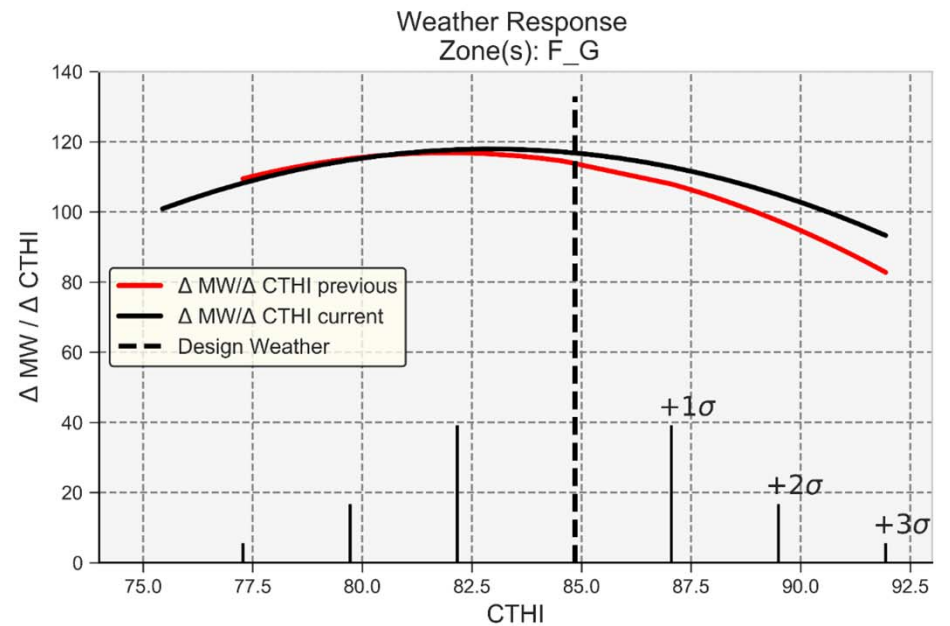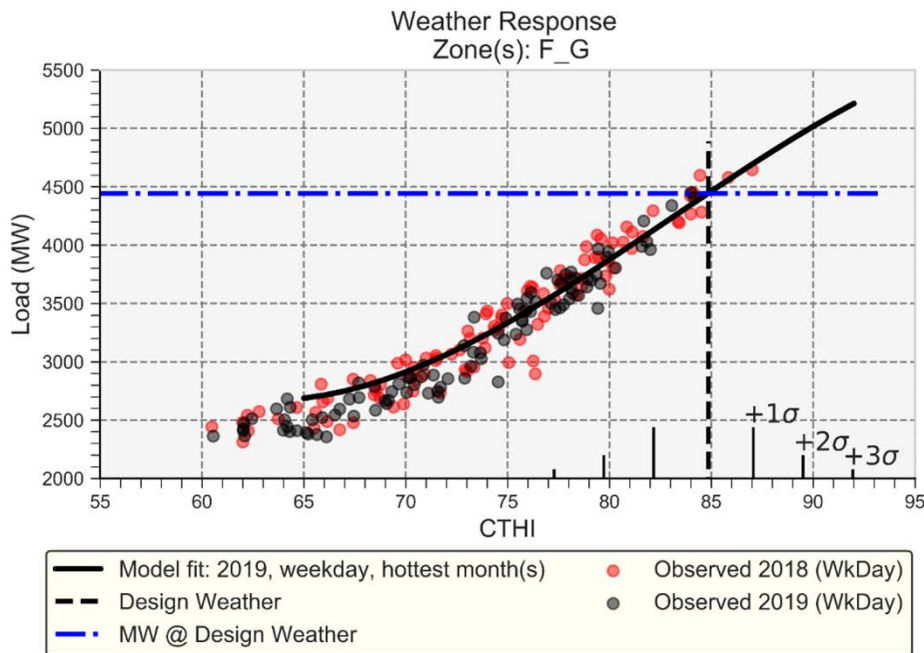
Zone F&G: LFU

	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		

New York ISO
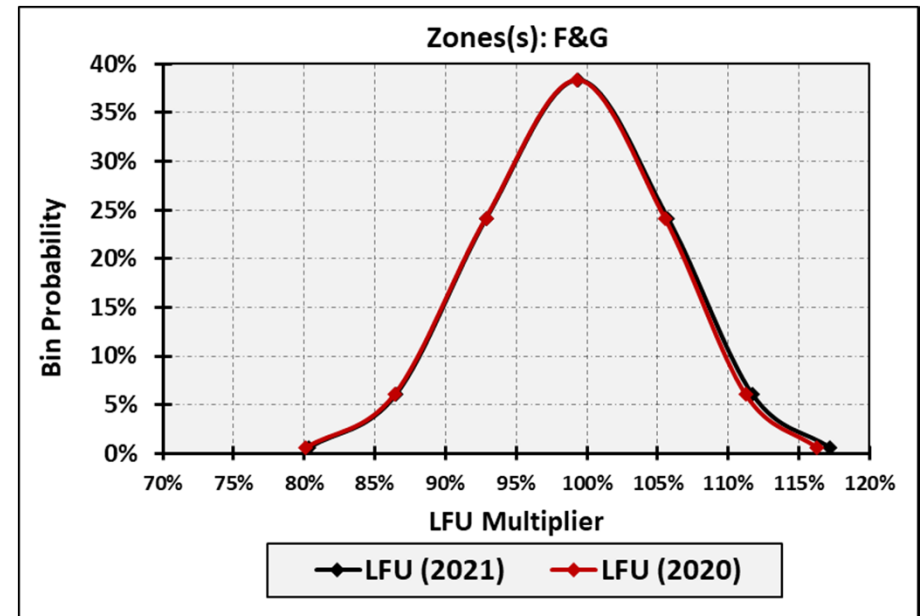
4. LFU Model: Zones H&I

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

Model Fitted vs Actual Zone(s): H_I

2018-05-30
2018-07-02
2018-07-03
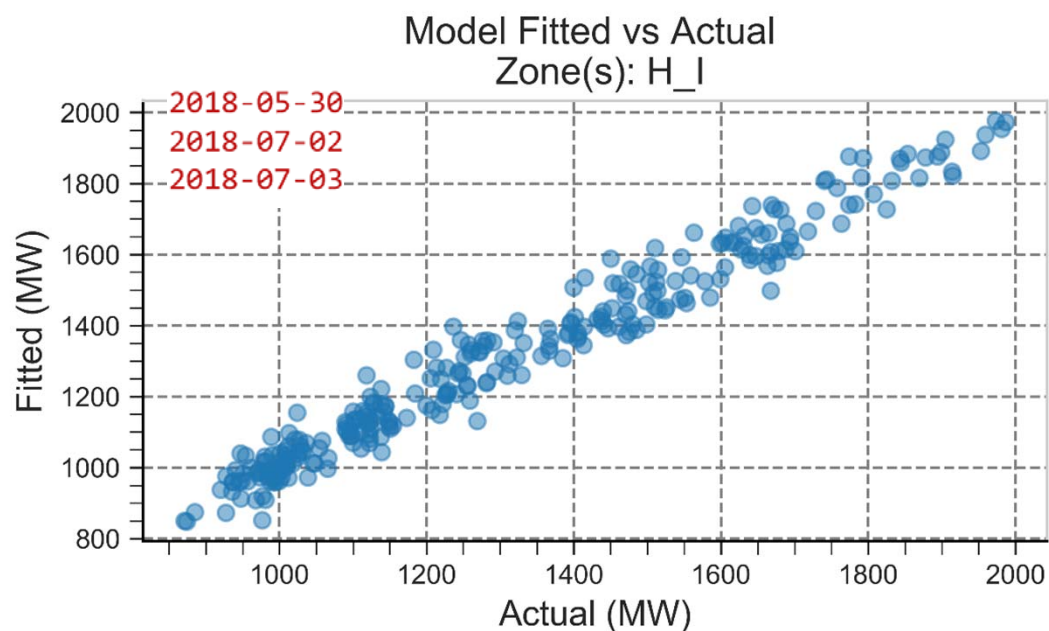
Adjusted R-Squared: 0.964

NYISO model
Dates shown in red are excluded

New York ISO

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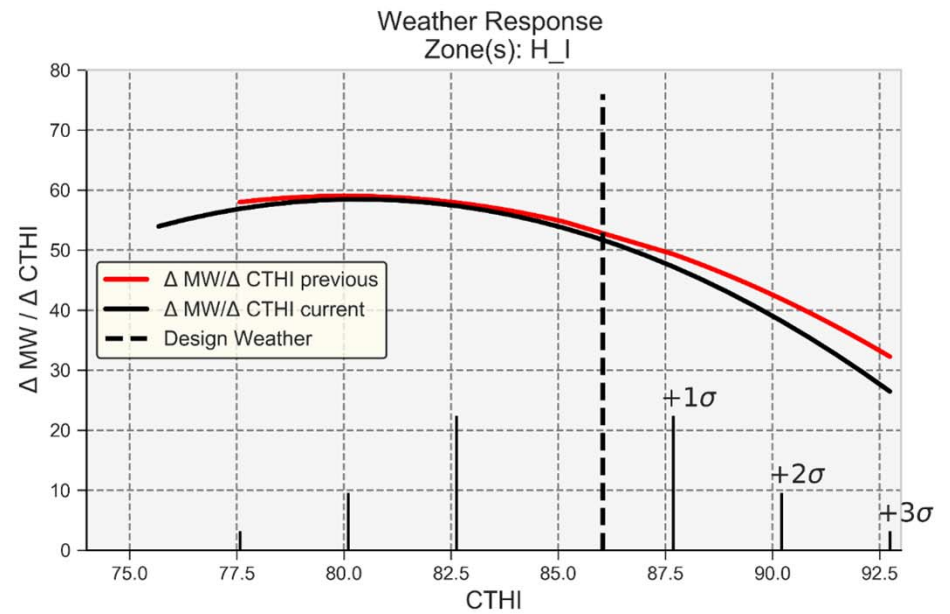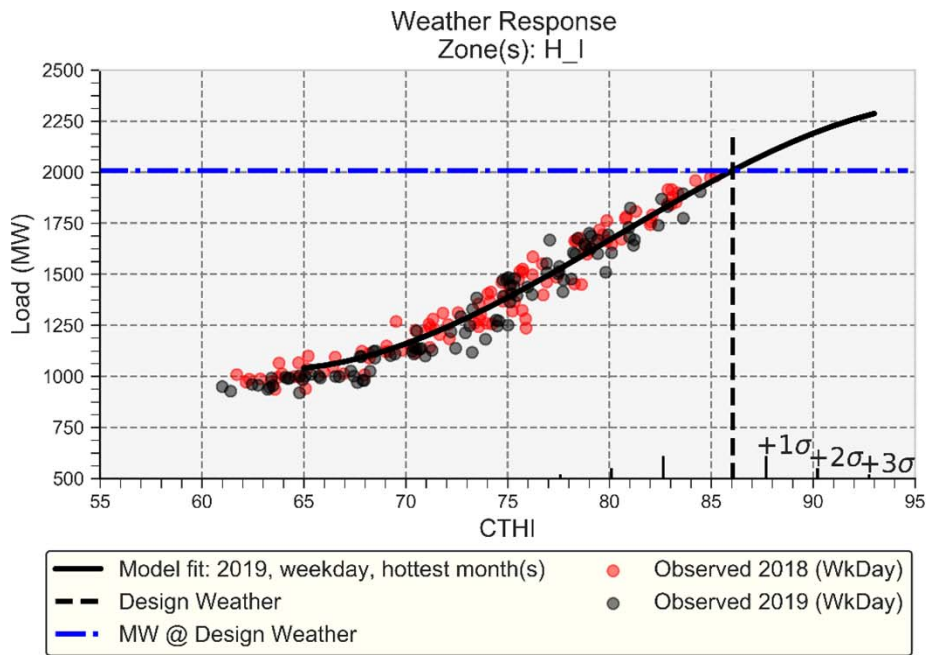
Zones H&I: LFU

	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
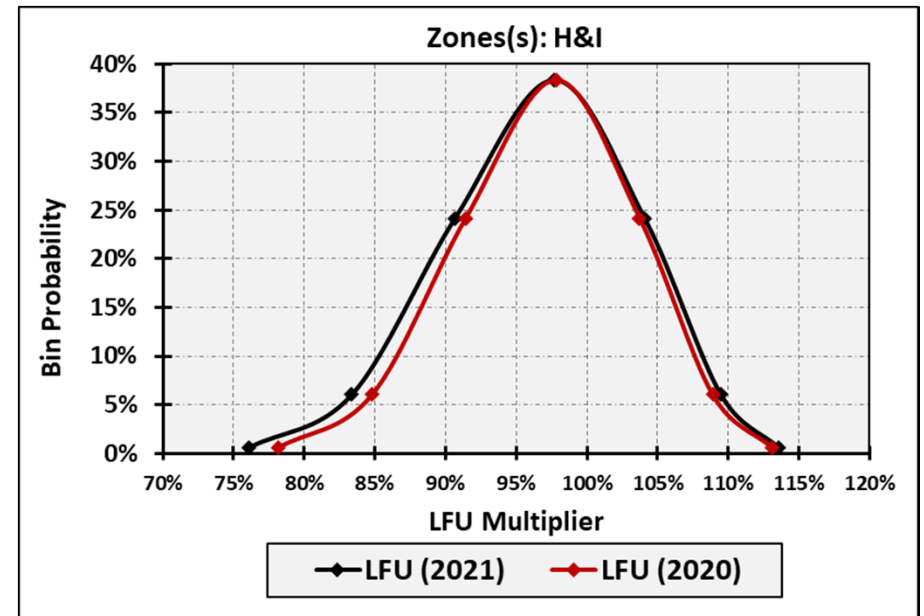
Zone J: Model (CTHI)

Exclusion: Weekend, Fri, CTHI < 61

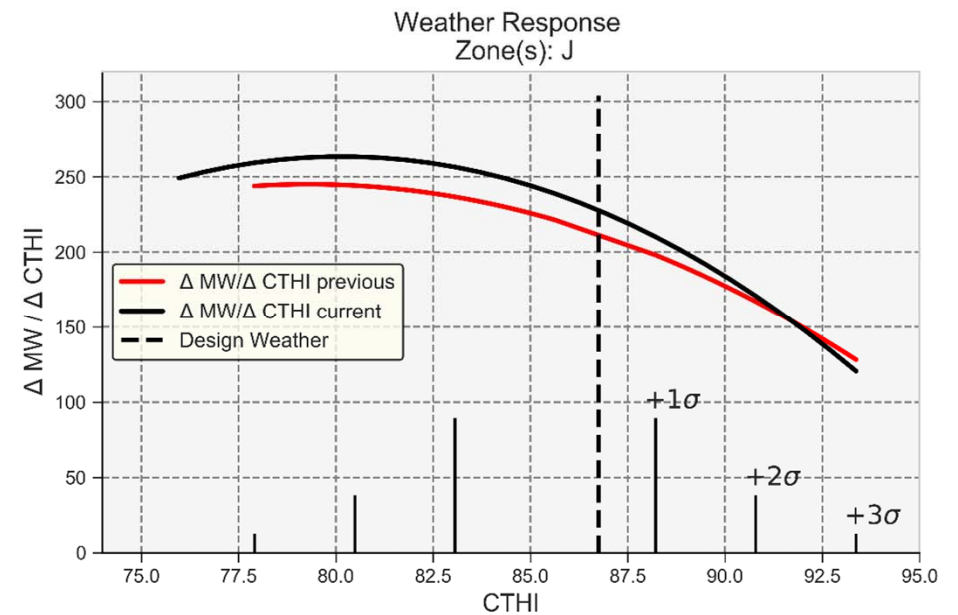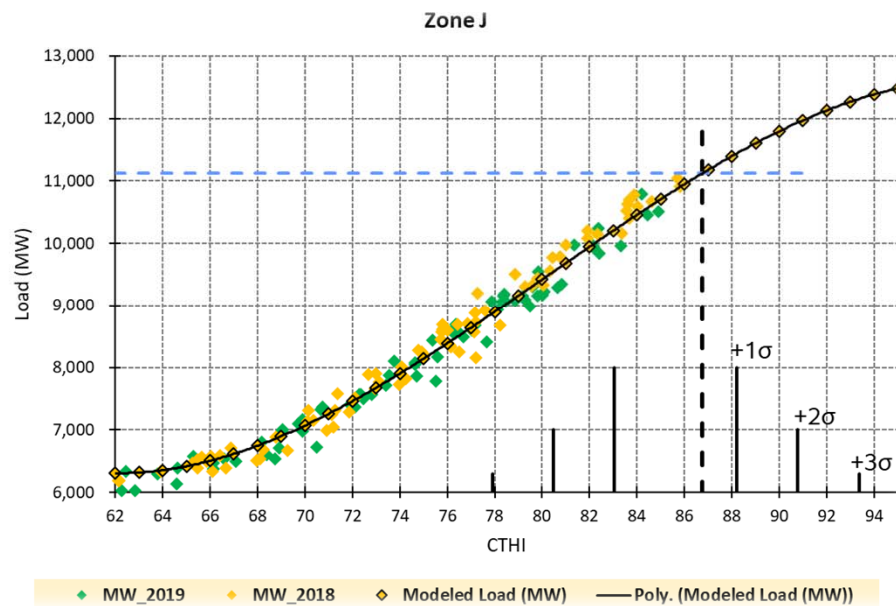|	Coefficients	Standard Error	t Stat	P-value
Intercept	128821.36	20252.14	6.36	0.0000
CTHI	-4994.83	830.43	-6.01	0.0000
CTHI2	65.61	11.30	5.80	0.0000
CTHI3	-0.27	0.05	-5.34	0.0000
Y2018	109.70	26.32	4.17	0.0001
May	-227.60	40.86	-5.57	0.0000
Thurs	-62.85	30.02	-2.09	0.0380
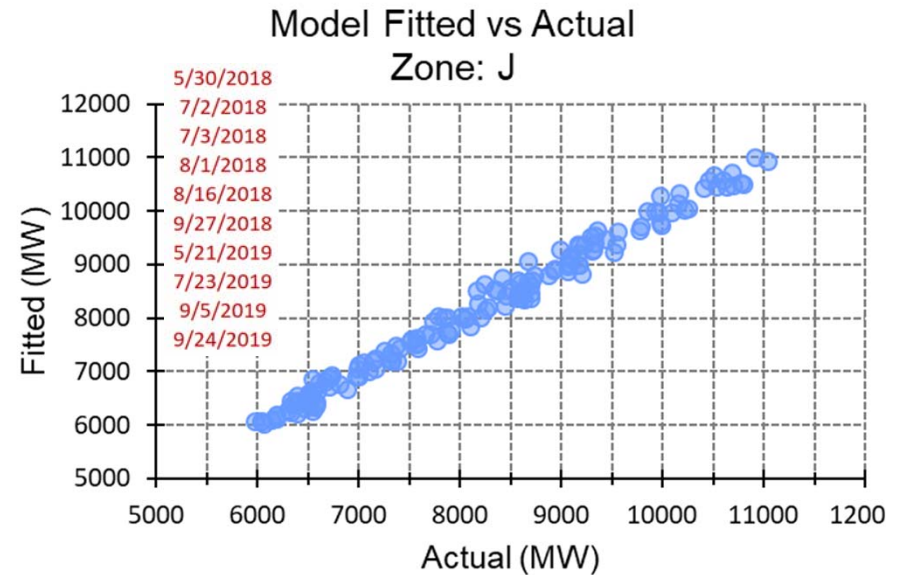
Adjusted R-Squared: 0.986

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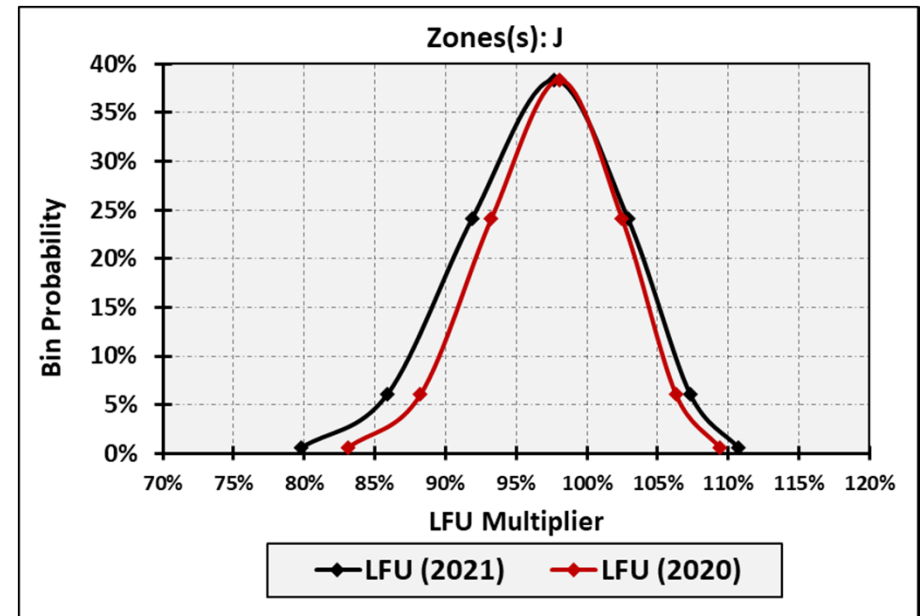*Model independently developed by NYISO produced similar results*

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

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		

New York ISO

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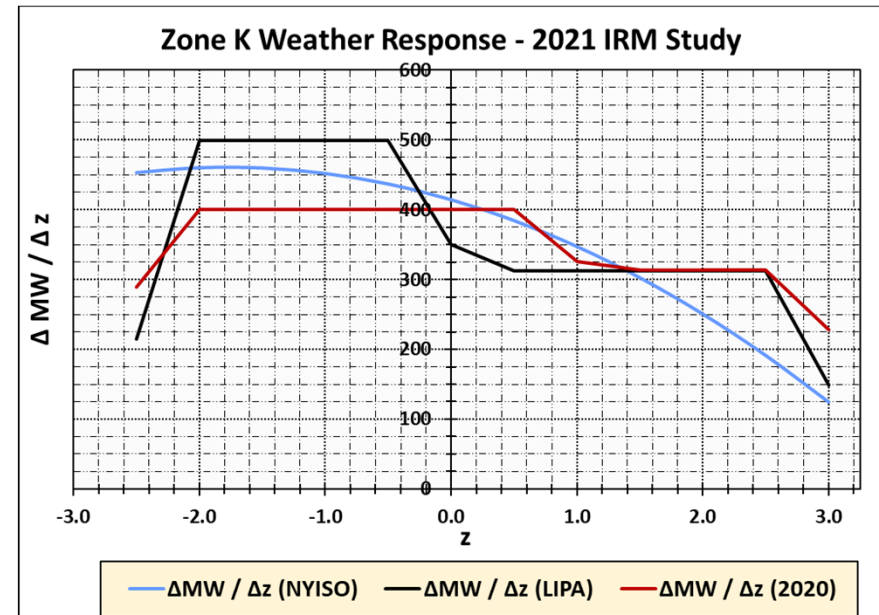
LIPA model- THI4
NYISO model and LIPA model- similar results

New York ISO

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		
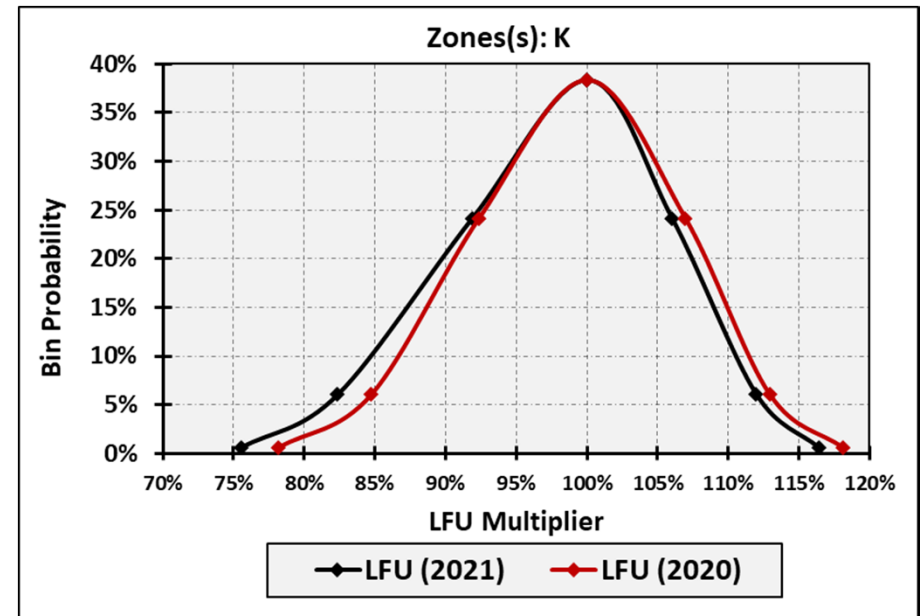
7. LFU Model: NYCA- Winter

New York ISO

# NYCA Winter: Model (HDD_55)

NYCA Winter LFU

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

Key Changes

| Item	LFU 2020	LFU 2021
Data	CP 2017-18, 2018-19	CP 2017-18, 2018-19, 2019-20
Weekends	Excluded before modeling	Modeled through factorial variable(s)

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
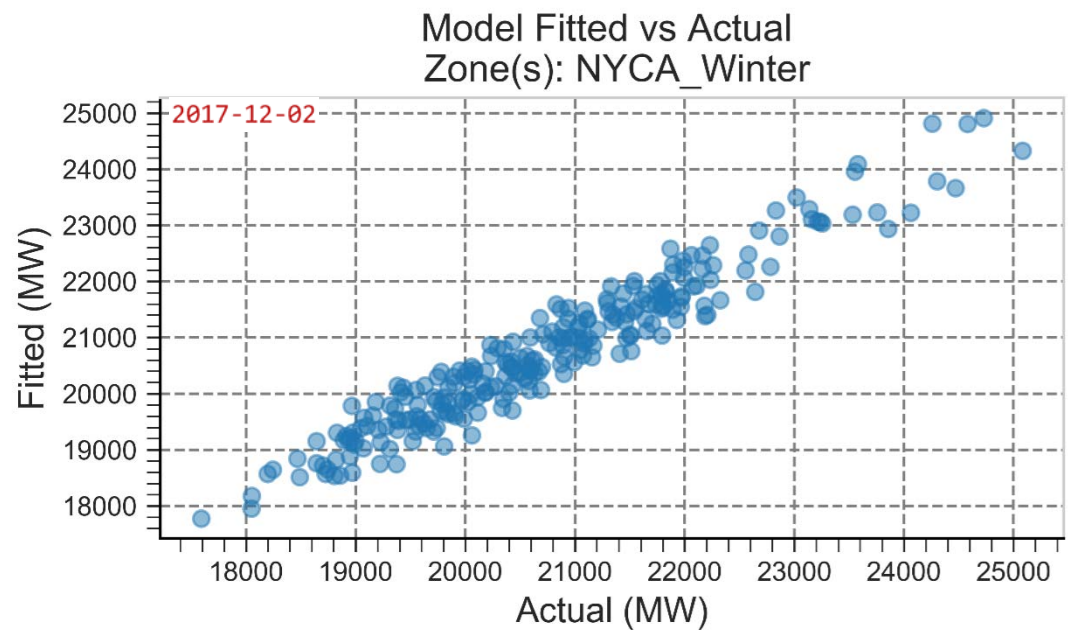
Adjusted R-Squared: 0.927

NYISO model
Dates shown in red are excluded

Model Fitted vs Actual
Zone(s): NYCA_Winter

New York ISO

NYCA Winter: Response
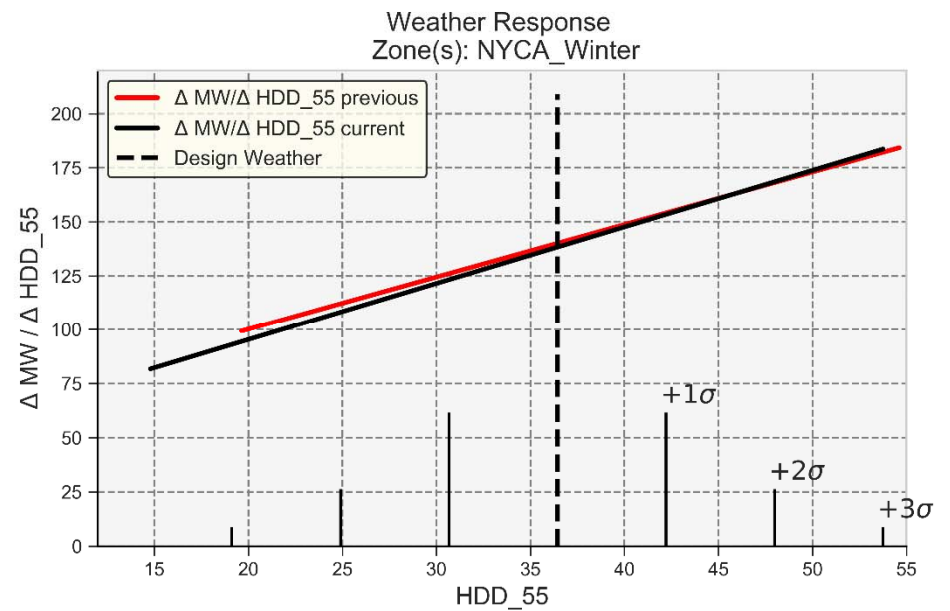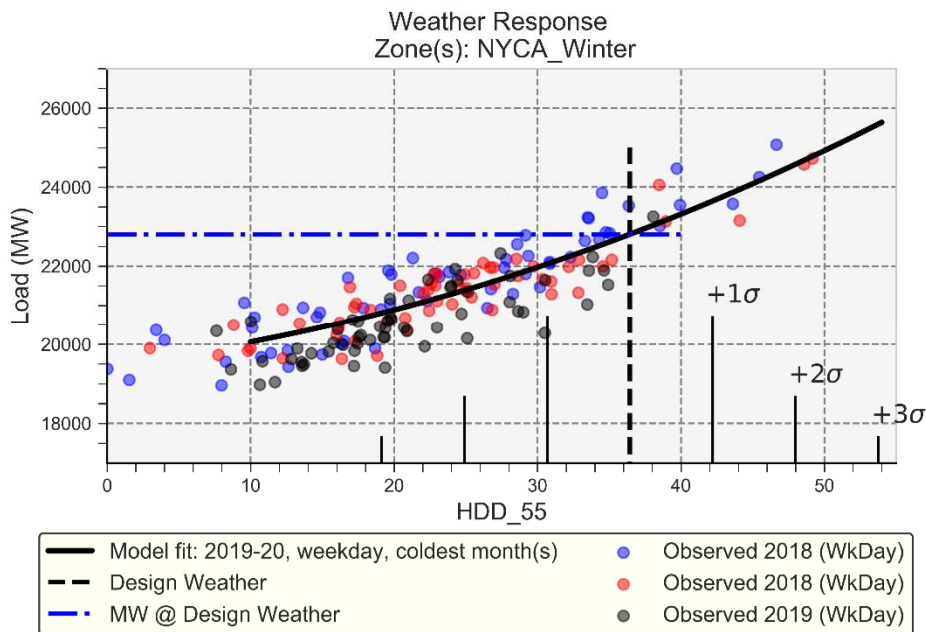
NYCA Winter: LFU

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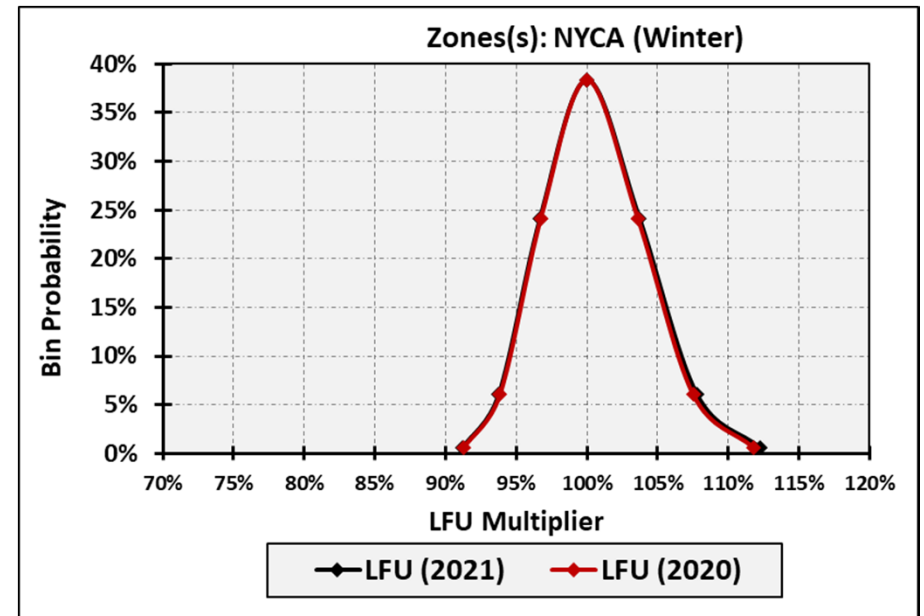
Our mission, in collaboration with our stakeholders, is to serve the public interest and provide benefit to consumers by:

- 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

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