

Load Forecast Uncertainty Models for the 2020 IRM Study

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Installed Capacity Subcommittee

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Overview

1. Summary of 2020 Load Forecast Uncertainty Models
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Load Forecast Uncertainty Model

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).

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. . . .

NYSRC Policy 5-14

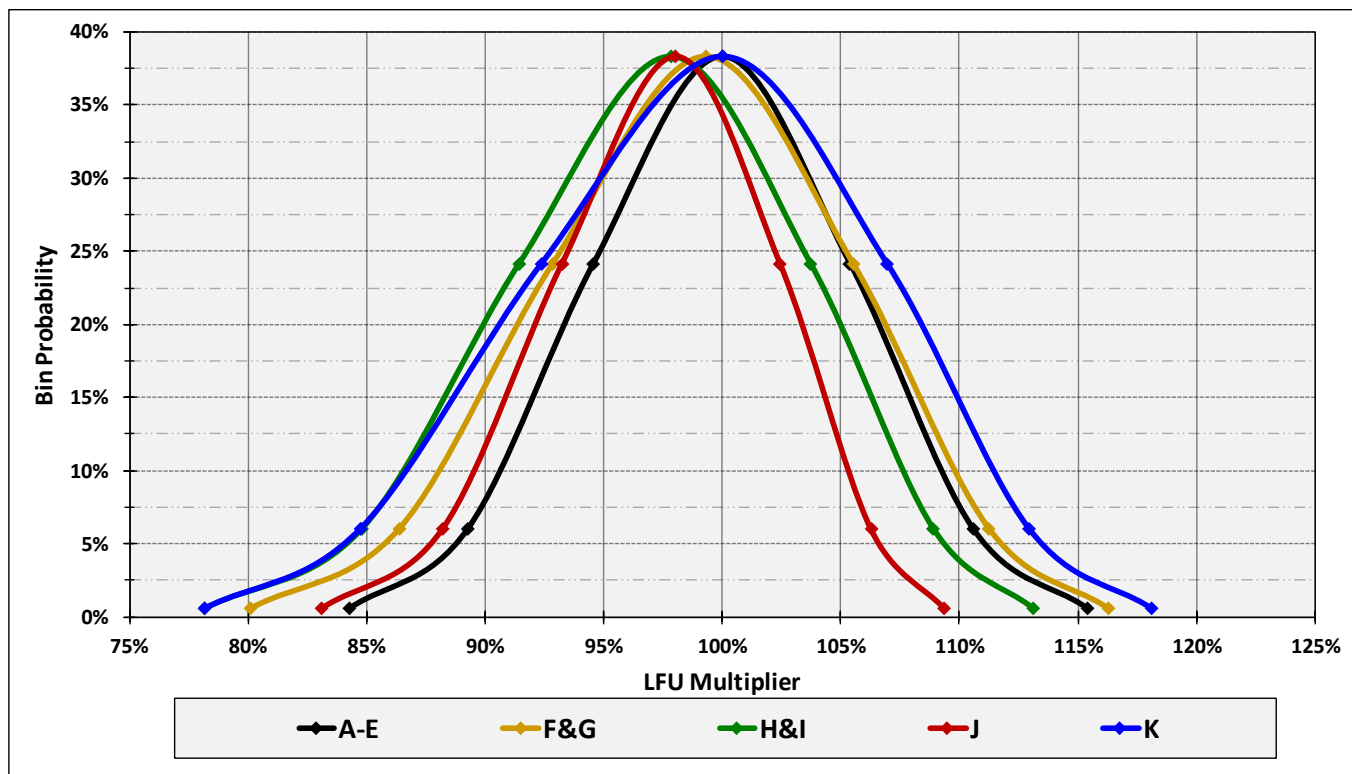
(1) Summary of 2020 Load Forecast Uncertainty Models

Recommended 2020 LFU Models

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

Delta	A-E	F&G	H&I	J	K
Bin 7 - Bin 4	15.70%	19.19%	19.66%	14.97%	21.84%
Bin 4 - Bin 1	15.39%	16.97%	15.30%	11.34%	18.09%
Total Range	31.09%	36.16%	34.96%	26.31%	39.93%

2020 LFU Distributions



2018 LFU Models

Bin	Probability	A-E	F&G	H&I	J	K
B7	0.62%	84.31%	80.67%	79.78%	83.88%	79.59%
B6	6.06%	89.44%	86.74%	86.24%	88.87%	83.51%
B5	24.17%	94.74%	93.03%	92.49%	93.71%	91.75%
B4	38.30%	100.00%	99.33%	98.17%	98.21%	100.00%
B3	24.17%	105.02%	105.41%	102.93%	102.19%	106.95%
B2	6.06%	109.59%	111.07%	106.39%	105.47%	112.06%
B1	0.62%	113.51%	116.08%	108.22%	107.86%	115.86%

Delta	A-E	F&G	H&I	J	K
Bin 7 - Bin 4	15.69%	18.66%	18.39%	14.33%	20.41%
Bin 4 - Bin 1	13.51%	16.75%	10.05%	9.65%	15.86%
Total Range	29.20%	35.41%	28.44%	23.98%	36.27%

Comparison with 2018 Models

Bin	Probability	A-E	F&G	H&I	J	K
B7	0.62%	-0.01%	-0.55%	-1.63%	-0.81%	-1.43%
B6	6.06%	-0.15%	-0.35%	-1.45%	-0.68%	1.22%
B5	24.17%	-0.16%	-0.17%	-1.06%	-0.47%	0.61%
B4	38.30%	0.00%	-0.02%	-0.35%	-0.17%	0.00%
B3	24.17%	0.37%	0.11%	0.79%	0.26%	-0.02%
B2	6.06%	0.98%	0.18%	2.51%	0.81%	0.86%
B1	0.62%	1.88%	0.20%	4.89%	1.52%	2.23%

Delta	A-E	F&G	H&I	J	K
Bin 7 - Bin 4	0.01%	0.53%	1.27%	0.64%	1.43%
Bin 4 - Bin 1	1.88%	0.22%	5.25%	1.69%	2.23%
Total Range	1.89%	0.75%	6.52%	2.33%	3.66%

(2) Model for Zones A-E

Model Specification: Zones A-E

- MW & load-weighted Cumulative Temperature & Humidity Index (“CTHI”) from NYISO archives, including Demand Response (“DR”) impacts
- Years: 2013, 2016, 2018 (with binaries)
- Months: June through September (June & September binaries)
- Days: Weekdays (Monday & Friday binaries), no Holidays
- 3rd order polynomial
- Days with CTHI < 60 were removed

Model Summary: Zones A-E

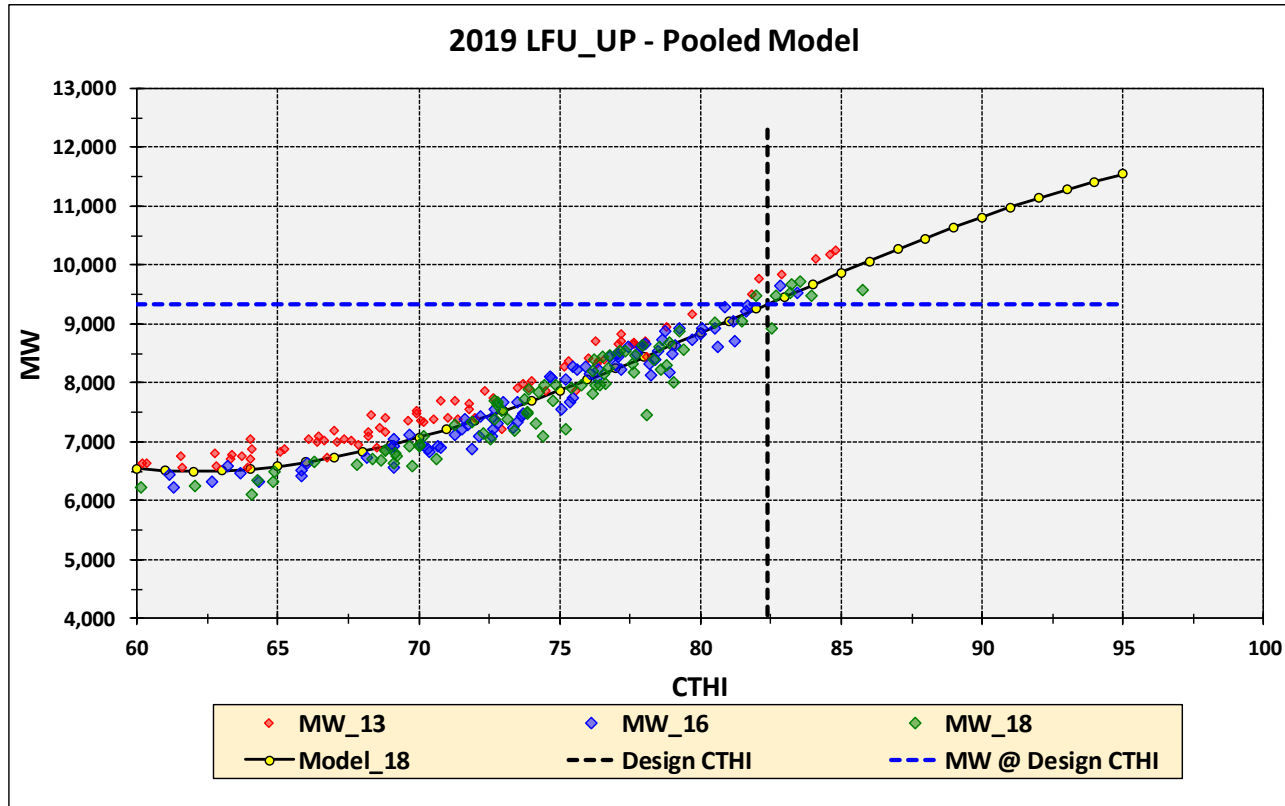
Bin	z	Cum Prob	CTHI	MW	MW/CTHI	LFU
	-3.50	0.000	73.75	7,648	172	0.8197
B7	-3.00	0.001	74.98	7,866	181	0.8430
	-2.50	0.006	76.21	8,094	190	0.8675
B6	-2.00	0.023	77.44	8,331	196	0.8929
	-1.50	0.067	78.67	8,576	201	0.9191
B5	-1.00	0.159	79.90	8,825	204	0.9458
	-0.50	0.309	81.13	9,077	206	0.9728
B4	0.00	0.500	82.36	9,331	206	1.0000
67th	0.43	0.667	83.42	9,549	205	1.0233
	0.50	0.691	83.59	9,584	205	1.0271
B3	1.00	0.841	84.82	9,833	202	1.0539
	1.50	0.933	86.05	10,079	197	1.0801
B2	2.00	0.977	87.28	10,317	191	1.1057
	2.50	0.994	88.51	10,547	183	1.1304
B1	3.00	0.999	89.74	10,767	174	1.1539
	3.50	1.000	90.97	10,974	163	1.1760
Design	0.00	0.500	82.36	9,331	206	1.0000

Load Model	
β_0	87,996.82
β_{CTHI}	-3,299.66
β_{CTHI^2}	42.83
β_{CTHI^3}	-0.17

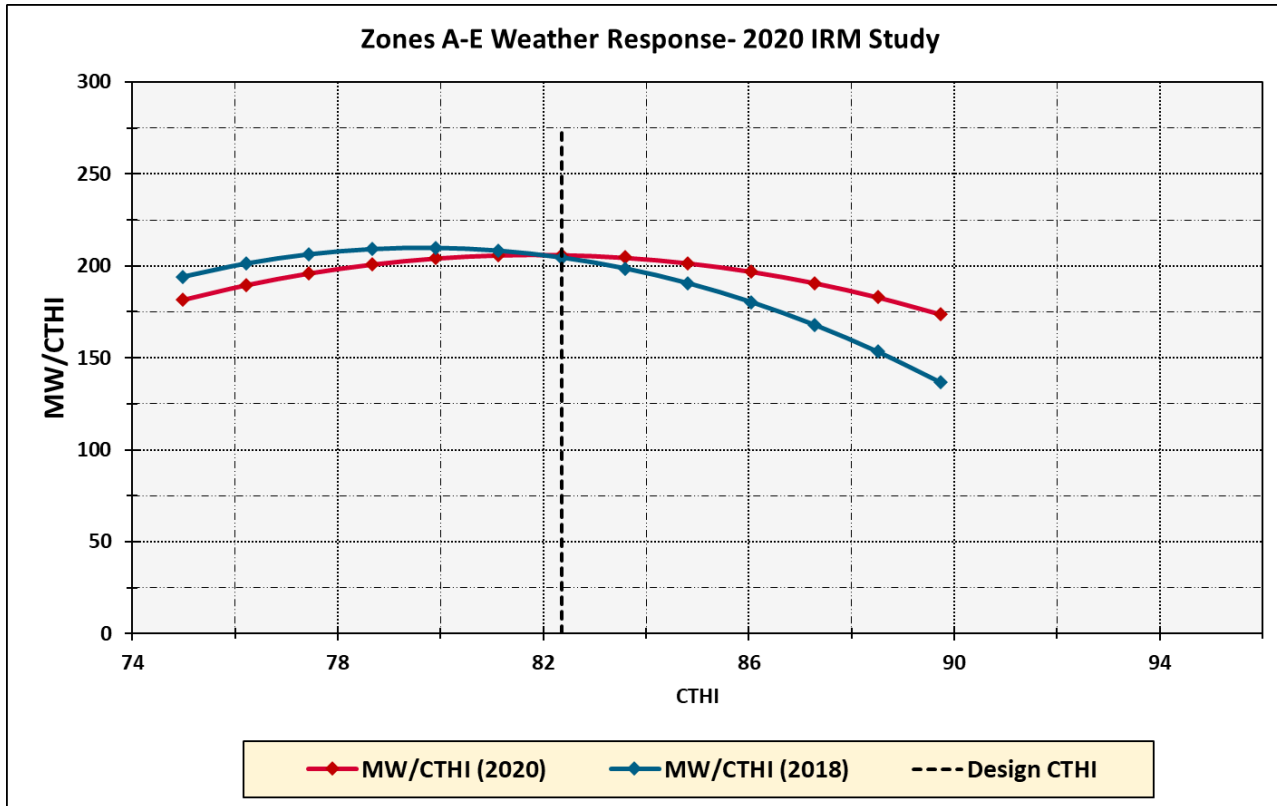
CTHI	
Mean	82.36
SD	2.46
Design	82.36

Design	
z	0.00
Percentile	0.50
MW	9,331

Weather Response: Zones A-E



Weather Response: Zones A-E



(3) Model for Zones F&G

Model Specification: Zones F&G

- MW & load-weighted CTHI from NYISO archives, including DR impacts
- Years: 2013, 2016, 2018 (with binaries)
- Months: June through September (June & September binaries)
- Days: Weekdays (Monday & Friday binaries), no Holidays
- 3rd order polynomial
- Days with CTHI < 60 were removed

Model Summary: Zones F&G

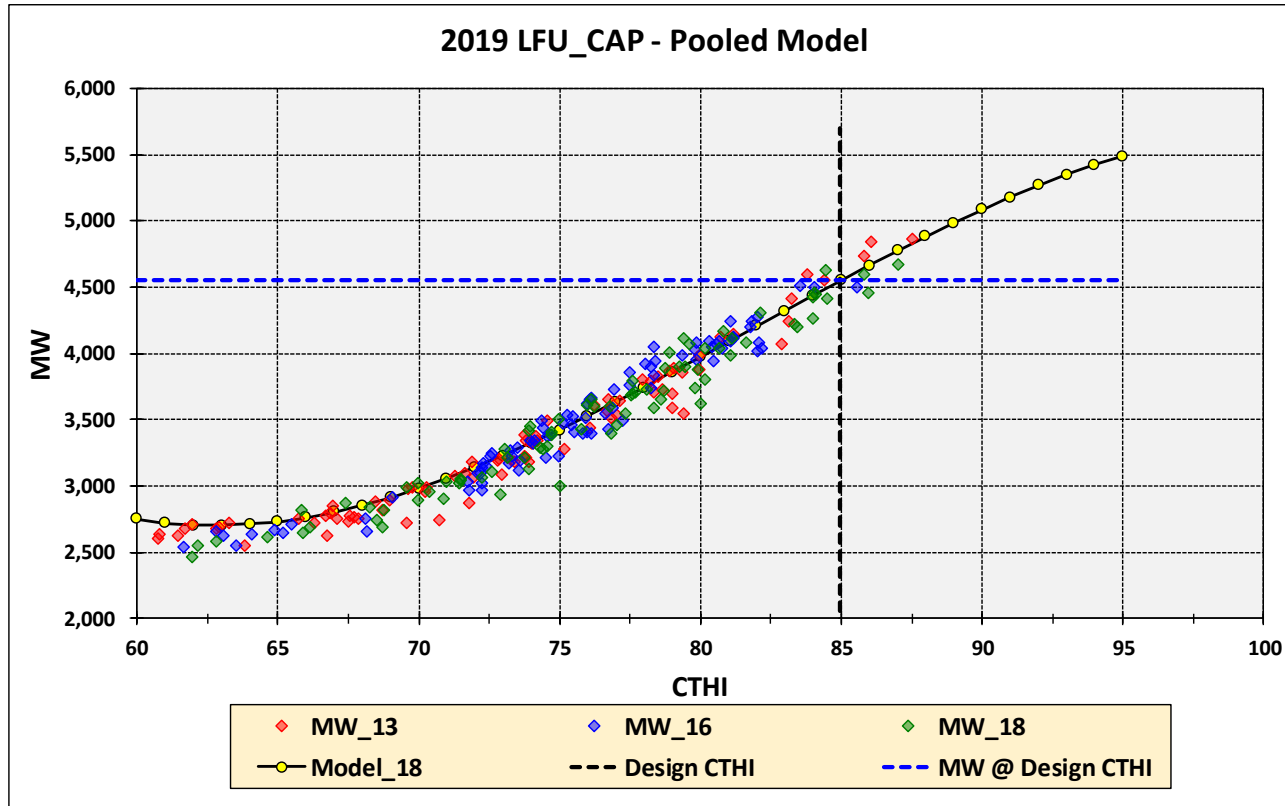
Bin	z	Cum Prob	CTHI	MW	MW/CTHI	LFU
	-3.50	0.000	75.84	3,508	105	0.7714
B7	-3.00	0.001	77.10	3,644	109	0.8012
	-2.50	0.006	78.37	3,785	113	0.8322
B6	-2.00	0.023	79.63	3,929	115	0.8639
	-1.50	0.067	80.90	4,076	117	0.8961
B5	-1.00	0.159	82.16	4,224	117	0.9286
	-0.50	0.309	83.43	4,371	116	0.9611
B4	0.00	0.500	84.69	4,517	114	0.9931
67th	0.43	0.667	85.78	4,641	112	1.0203
	0.50	0.691	85.96	4,660	112	1.0246
B3	1.00	0.841	87.22	4,799	108	1.0552
	1.50	0.933	88.49	4,933	103	1.0846
B2	2.00	0.977	89.75	5,060	97	1.1125
	2.50	0.994	91.02	5,179	91	1.1387
B1	3.00	0.999	92.28	5,289	83	1.1628
	3.50	1.000	93.55	5,388	74	1.1846
Design	0.11	0.543	84.96	4,548	112	1.0000

Load Model	
β_0	52,842.54
β_{CTHI}	-2,015.16
β_{CTHI^2}	26.02
β_{CTHI^3}	-0.11

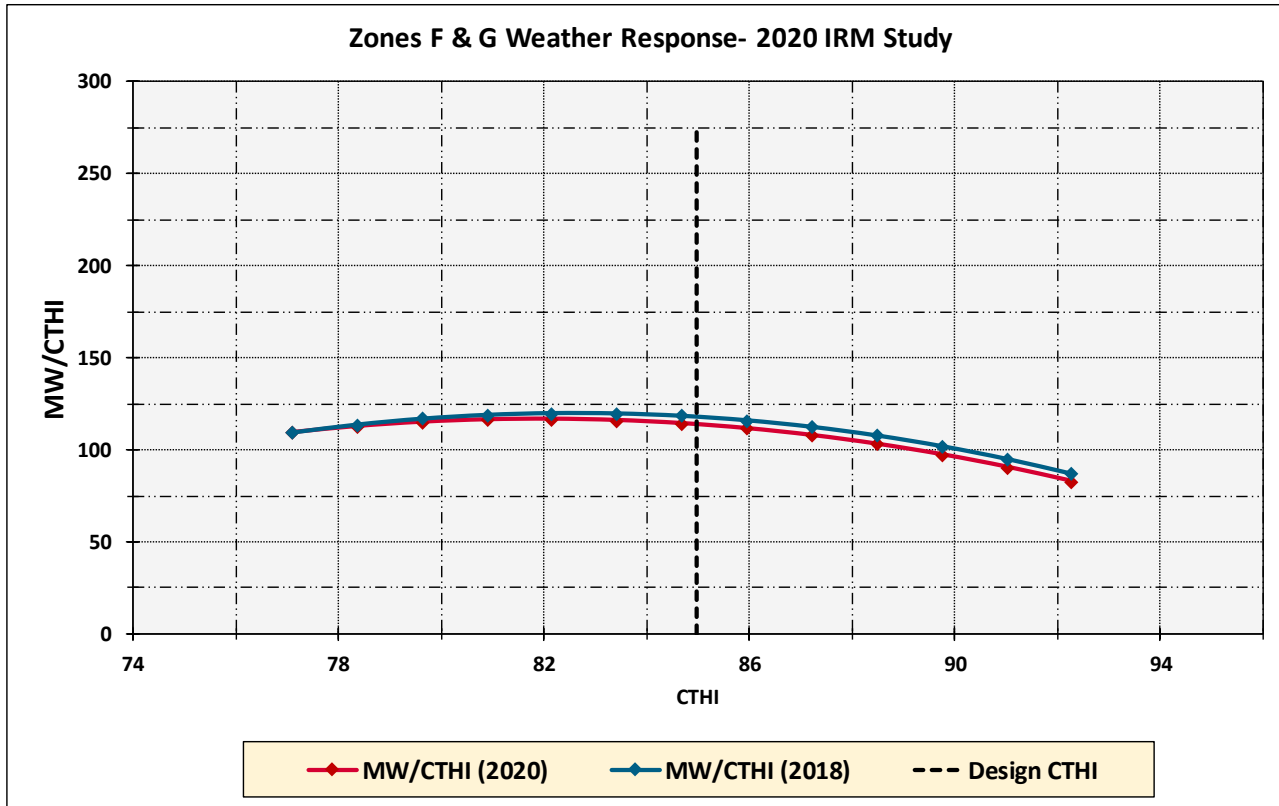
CTHI	
Mean	84.69
SD	2.53
Design	84.96

Design	
z	0.11
Percentile	0.54
MW	4,548

Weather Response: Zones F&G



Weather Response: Zones F&G



(4) Model for Zones H&I

Model Specification: Zones H&I

- MW from NYISO archives, including DR impacts
- Used Con Ed's Temperature Variable ("TV") instead of CTHI. TV and CTHI are highly correlated.
- Years: 2011, 2016, 2018 (with interaction binaries)
- Months: June through September
- Days: Weekdays (Friday binary), no Holidays
- 3rd order polynomial
- Days with TV < 60 were removed

Model Summary: Zones H&I

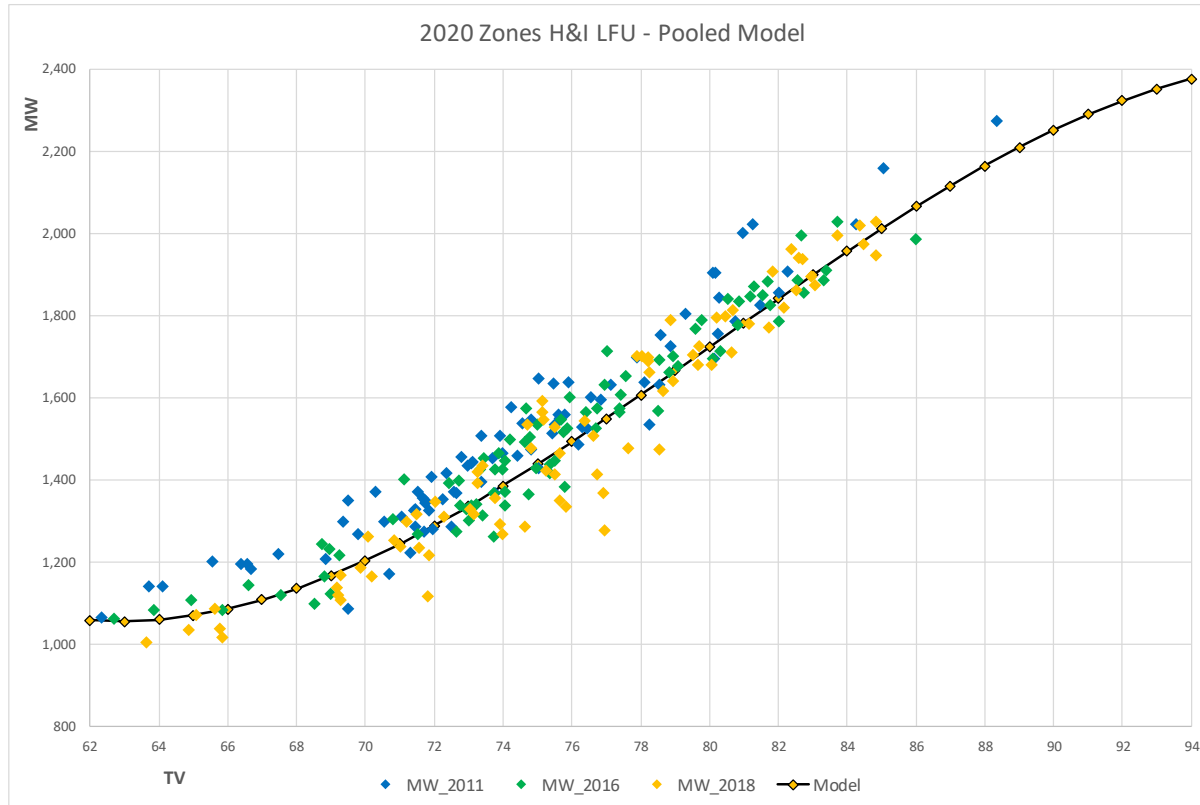
Bin	z	Cum Prob	TV	MW	MW/TV	LFU
	-3.50	0.000	76.76	1,536	57	0.7491
B7	-3.00	0.001	77.92	1,602	58	0.7815
	-2.50	0.006	79.08	1,670	59	0.8146
B6	-2.00	0.023	80.24	1,739	59	0.8479
	-1.50	0.067	81.40	1,807	59	0.8813
B5	-1.00	0.159	82.56	1,875	58	0.9143
	-0.50	0.309	83.72	1,941	57	0.9467
B4	0.00	0.500	84.88	2,006	55	0.9782
67th	0.43	0.667	85.88	2,059	53	1.0043
	0.50	0.691	86.04	2,068	52	1.0085
B3	1.00	0.841	87.20	2,127	49	1.0372
	1.50	0.933	88.36	2,182	46	1.0642
B2	2.00	0.977	89.52	2,233	42	1.0890
	2.50	0.994	90.68	2,279	37	1.1114
B1	3.00	0.999	91.84	2,319	32	1.1311
	3.50	1.000	93.00	2,353	27	1.1478
Design	0.36	0.640	85.71056	2,050	53	1.0000

Load Model	
Constant	30,884.97
TV	-1,208.54
TV^2	15.81
TV^3	-0.07

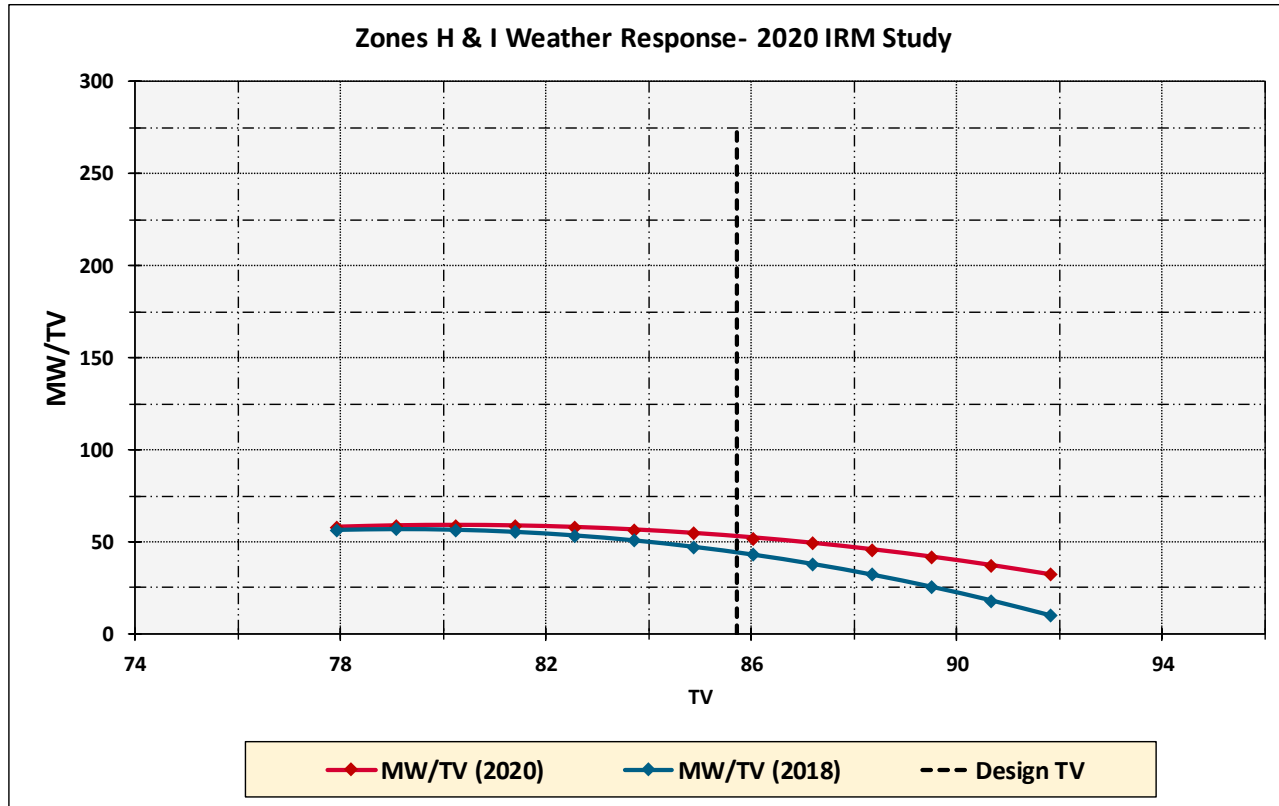
TV	
Mean	84.88
SD	2.32
Design	85.71

Design	
z	0.36
Percentile	0.00
MW	2,050

Weather Response: Zones H&I



Weather Response: Zones H&I



(5) Model for Zone J

Model Specification: Zone J

- MW from NYISO archives, including DR impacts
- Used Con Ed's TV instead of CTHI. TV and CTHI are highly correlated.
- Years: 2011, 2016, 2018 (with interaction binaries)
- Months: June through September
- Days: Weekdays (Friday binary), no Holidays
- 3rd order polynomial
- Days with TV < 60 were removed

Model Summary: Zone J

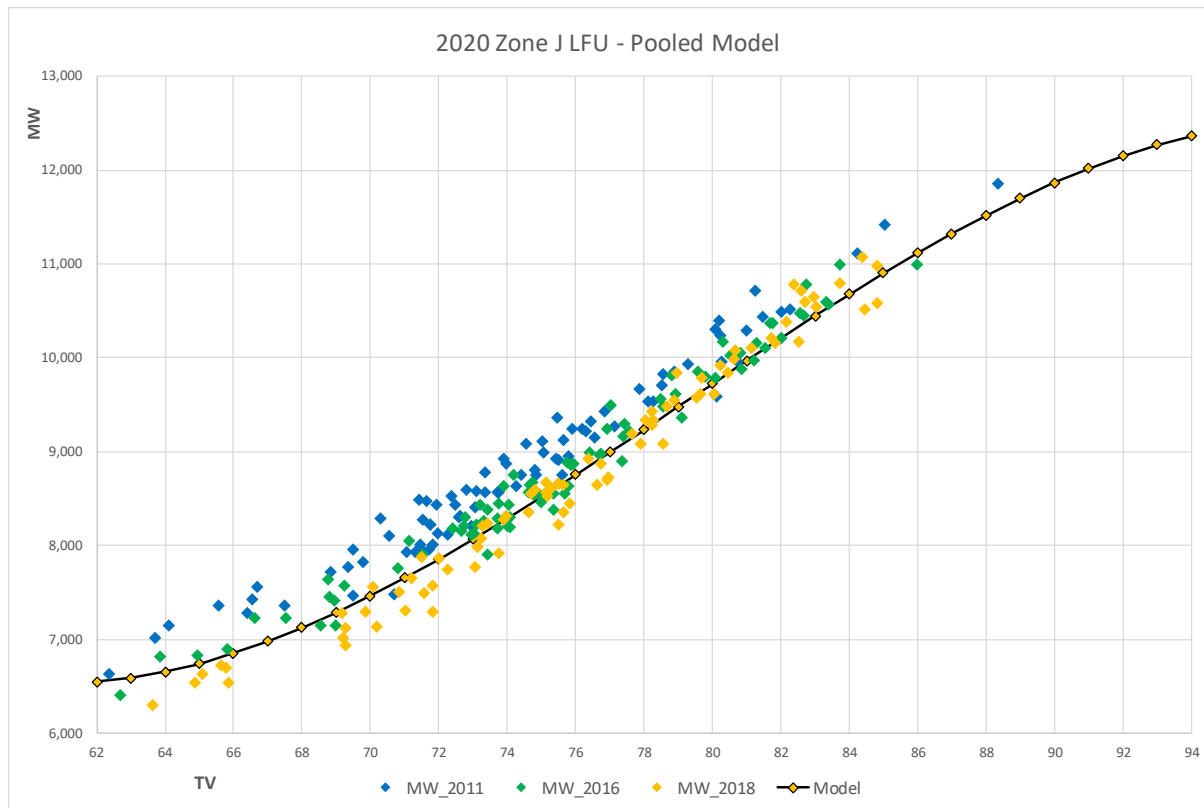
Bin	z	Cum Prob	TV	MW	MW/TV	LFU
	-3.50	0.000	76.76	8,934	241	0.8053
B7	-3.00	0.001	77.92	9,216	244	0.8307
	-2.50	0.006	79.08	9,500	245	0.8563
B6	-2.00	0.023	80.24	9,784	244	0.8819
	-1.50	0.067	81.40	10,066	242	0.9073
B5	-1.00	0.159	82.56	10,343	237	0.9324
	-0.50	0.309	83.72	10,614	230	0.9568
B4	0.00	0.500	84.88	10,876	221	0.9804
67th	0.43	0.667	85.88	11,093	212	1.0000
	0.50	0.691	86.04	11,127	211	1.0031
B3	1.00	0.841	87.20	11,365	198	1.0245
	1.50	0.933	88.36	11,586	184	1.0444
B2	2.00	0.977	89.52	11,790	167	1.0628
	2.50	0.994	90.68	11,974	149	1.0793
B1	3.00	0.999	91.84	12,134	128	1.0938
	3.50	1.000	93.00	12,270	106	1.1061
Design	0.43	0.667	85.87992	11,093	212	1.0000

Load Model	
Constant	110,706.66
TV	-4,324.29
TV^2	57.71
TV^3	-0.24

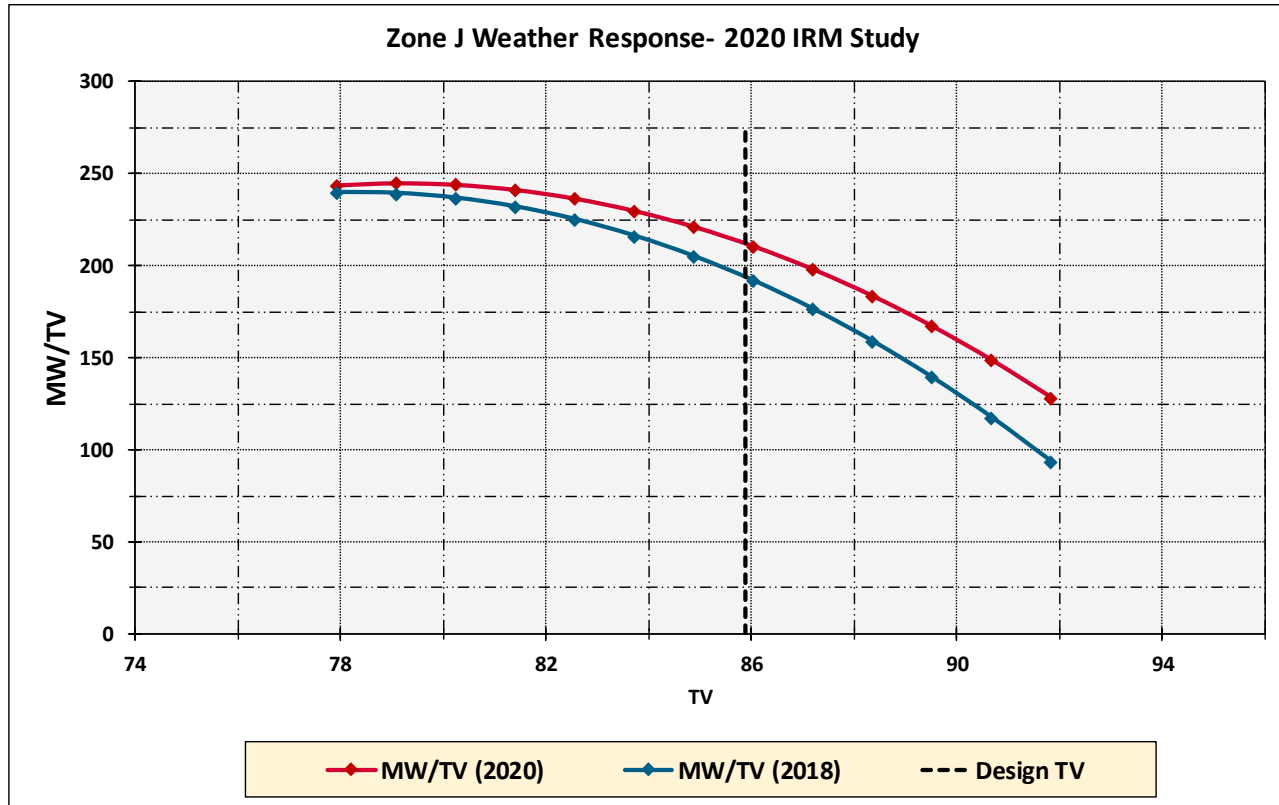
TV	
Mean	84.88
SD	2.32
Design	85.88

Design	
z	0.43
Percentile	0.00
MW	11,093

Weather Response: Zone J



Weather Response: Zone J



(6) Model for Zone K

Model Specification: Zone K

- **LIPA specified model**
 - Piecewise linear function
 - 2011 and 2018
 - Use 4-hour Temperature & Humidity Index (“THI 4”) instead of CTHI. THI 4 and CTHI are highly correlated.

- **Independently developed NYISO model produced similar results**
 - 2013, 2016, 2018 - MW & CTHI
 - 3rd order polynomial

Zone K Model – LIPA Specification

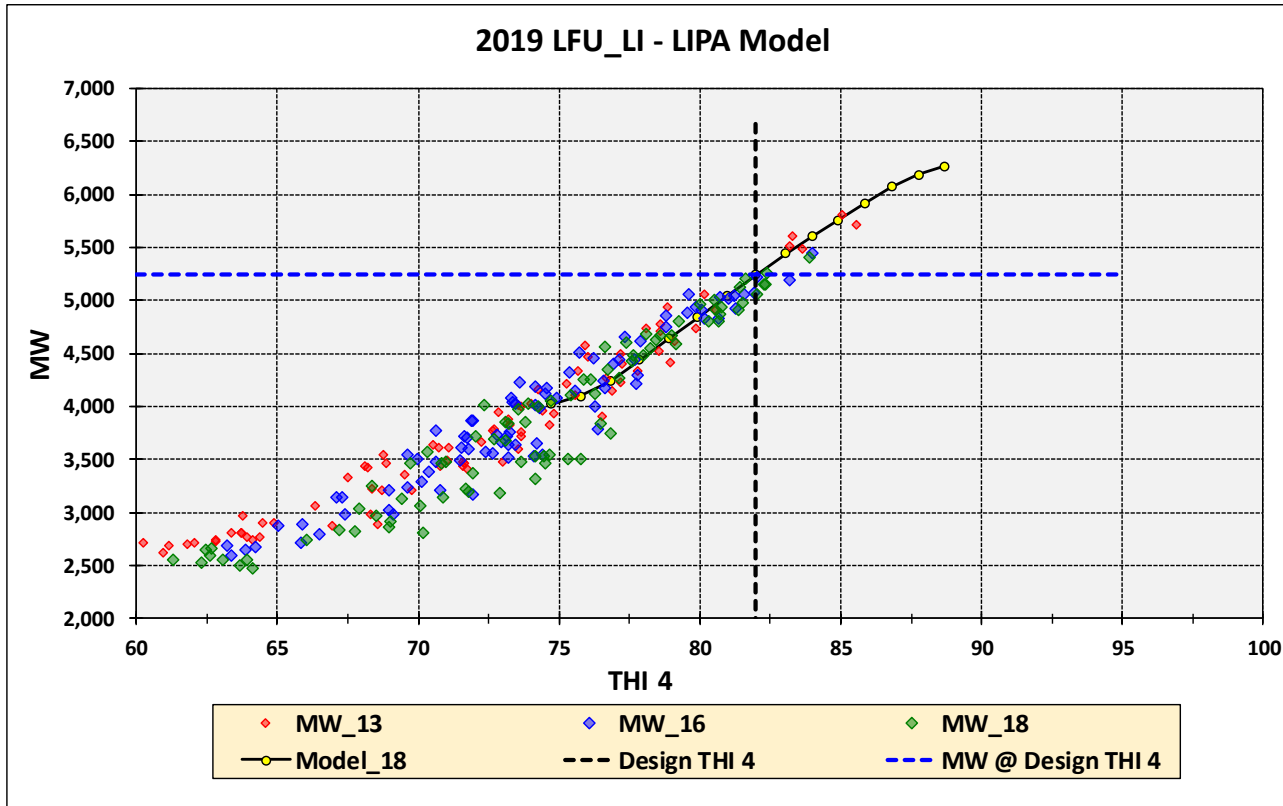
Z	Cum Prob	THI 4	MW	Δ MW	Δ THI 4	$\frac{\Delta$ MW}{\DeltaTHI 4	$\frac{MW}{MWCP=50\%}$
-4.0			3,987				
-3.5	0.023%	74.7	4,023	36	1.04	35	0.7678
-3.0	0.135%	75.8	4,095	72	1.04	70	0.7816
-2.5	0.621%	76.8	4,240	144	1.04	139	0.8091
-2.0	2.275%	77.8	4,440	200	1.04	193	0.8473
-1.5	6.681%	78.9	4,640	200	1.04	193	0.8855
-1.0	15.866%	79.9	4,840	200	1.04	193	0.9236
-0.5	30.854%	81.0	5,040	200	1.04	193	0.9618
0.0	50.000%	82.0	5,240	200	1.04	193	1.0000
0.5	69.146%	83.0	5,440	200	1.04	193	1.0382
1.0	84.134%	84.0	5,603	163	0.94	173	1.0693
1.5	93.319%	84.9	5,760	157	0.94	166	1.0993
2.0	97.725%	85.9	5,917	157	0.94	166	1.1292
2.5	99.379%	86.8	6,074	157	0.94	166	1.1591
3.0	99.865%	87.7	6,188	114	0.94	121	1.1809
3.5	99.977%	88.7	6,263	75	0.94	79	1.1951
4.0			6,312				

THI 4 is the average THI value for the four hours preceding the peak load hour.

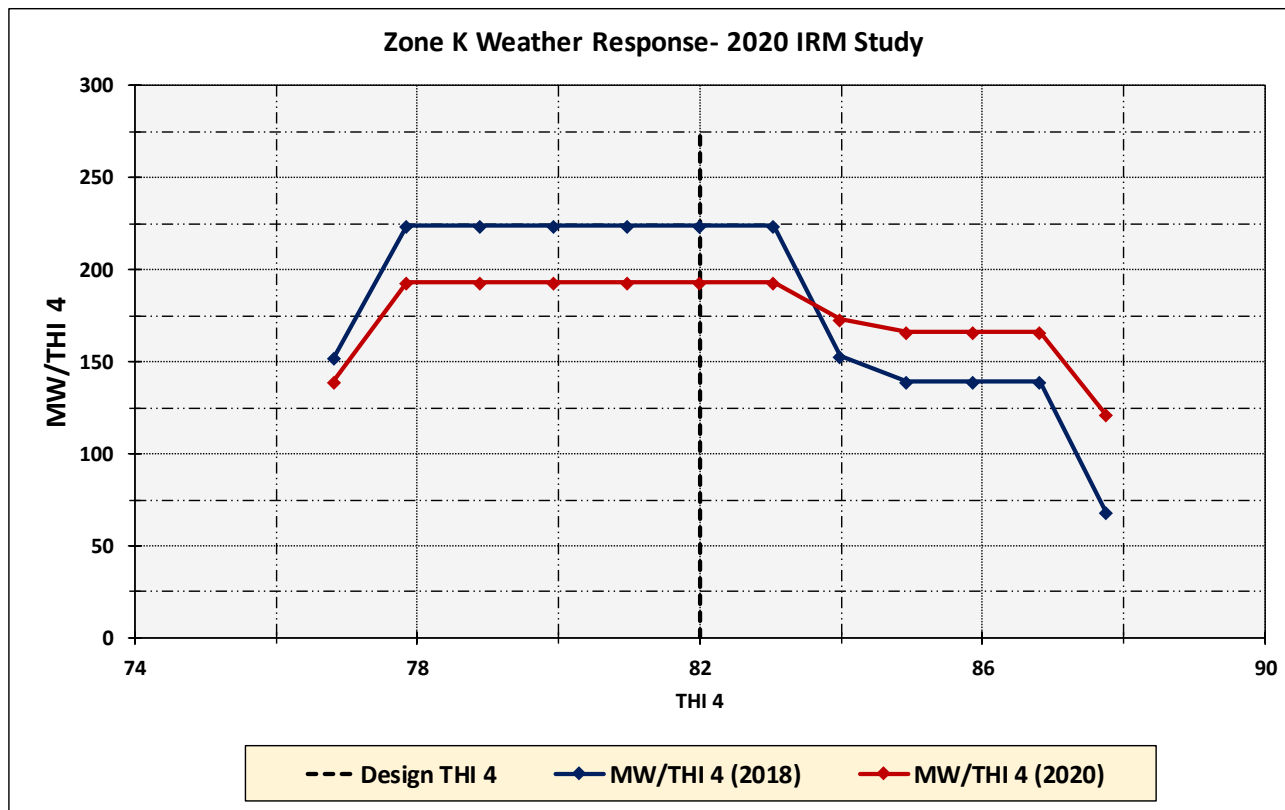
Model Summary: Zone K

Bin	z	Cum Prob	THI 4	MW	MW/THI 4	LFU
	-3.50	0.000	74.74	4,023	35	0.7678
B7	-3.00	0.001	75.77	4,095	70	0.7816
	-2.50	0.006	76.81	4,240	139	0.8091
B6	-2.00	0.023	77.85	4,440	193	0.8473
	-1.50	0.067	78.89	4,640	193	0.8855
B5	-1.00	0.159	79.92	4,840	193	0.9236
	-0.50	0.309	80.96	5,040	193	0.9618
B4	0.00	0.500	82.00	5,240	193	1.0000
67th	0.43	0.667	82.89	5,412	193	1.0328
	0.50	0.691	83.04	5,440	193	1.0382
B3	1.00	0.841	83.98	5,603	173	1.0693
	1.50	0.933	84.92	5,760	166	1.0993
B2	2.00	0.977	85.86	5,917	166	1.1292
	2.50	0.994	86.81	6,074	166	1.1591
B1	3.00	0.999	87.75	6,188	121	1.1809
	3.50	1.000	88.69	6,263	79	1.1951
Design	0.00	0.50	82.00	5,240	193	1.0000

Weather Response: Zone K



Weather Response: Zone K



(7) Winter LFU – NYCA

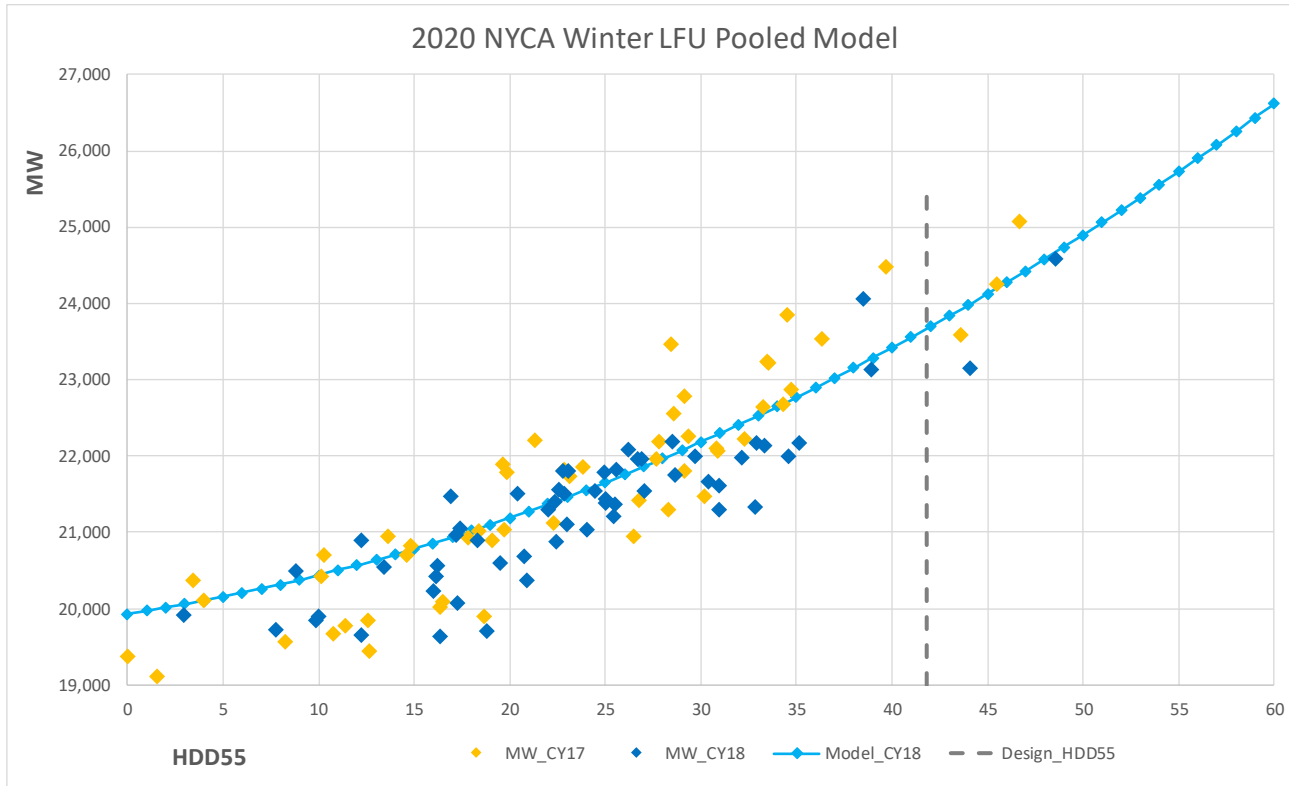
Model Specification: NYCA Winter

- NYCA MW & base 55 Heating Degree Days (“HDD55”) from NYISO archives
- 2017/18 and 2018/19 Winters
- Months: Dec., Jan., Feb. (February binary)
- Days: Weekdays (Friday binary), no Holidays
- 2nd order polynomial

2020 Winter LFU – NYCA Model

Bin	Probability	HDD55	MW	NYCA Winter LFU
B7	0.62%	24.48	21,602	91.28%
B6	6.06%	30.25	22,209	93.85%
B5	24.17%	36.03	22,897	96.75%
B4	38.30%	41.81	23,666	100.00%
B3	24.17%	47.58	24,516	103.59%
B2	6.06%	53.36	25,447	107.52%
B1	0.62%	59.14	26,458	111.80%

Weather Response: NYCA Winter Model



Questions?

The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefits 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 policy makers, stakeholders and investors in the power system



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