Load Forecast Uncertainty Models for the 2018 IRM Study

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Load Forecast Uncertainty Model

The load forecast uncertainty (LFU) model captures the impacts of weather and economic 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. Each modeled hour, the MARS program determines the resource adequacy and calculates an average for the year for all 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 four separate areas: New York City, Long Island, Westchester, and the rest of New York State.

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 5-11

(1) Summary of 2018 Load Forecast Uncertainty Models

Recommended 2018 LFU Models

Bin	Probability	A-E	F&G	H&I	J	K
B7	0.62%	84.31%	80.67%	79.78%	83.88%	76.59%
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%	14.34%	23.41%
Bin 4 - Bin 1	13.51%	16.76%	10.04%	9.65%	15.86%
Total Range	29.19%	35.42%	28.43%	23.99%	39.27%

2018 LFU Distributions
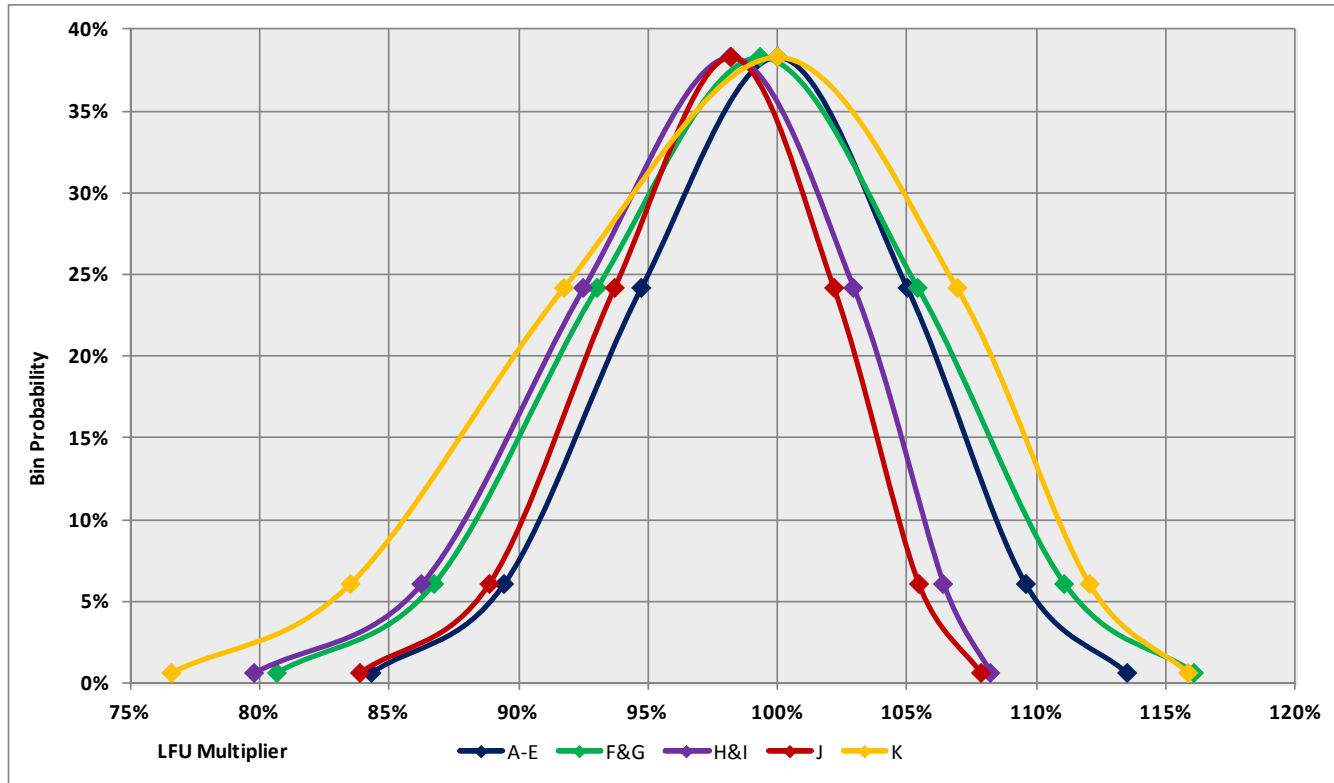
2017 LFU Models

Bin	Probability	A-E	F&G	H&I	J	K
B7	0.62%	83.99%	79.97%	79.92%	85.43%	78.74%
B6	6.06%	88.92%	86.70%	85.98%	90.02%	83.96%
B5	24.17%	94.34%	93.47%	91.97%	94.40%	91.98%
B4	38.30%	100.00%	100.00%	97.68%	98.42%	100.00%
B3	24.17%	105.59%	106.02%	102.91%	101.92%	108.02%
B2	6.06%	110.73%	111.24%	107.46%	104.75%	111.23%
B1	0.62%	114.94%	115.39%	111.13%	106.76%	114.00%

Delta	A-E	F&G	H&I	J	K
Bin 7 - Bin 4	16.01%	20.03%	17.76%	12.99%	21.26%
Bin 4 - Bin 1	14.94%	15.39%	13.45%	8.34%	14.00%
Total Range	30.95%	35.42%	31.21%	21.33%	35.26%

Comparison with 2017 LFU Models

Bin	Probability	A-E	F&G	H&I	J	K
B7	0.62%	0.32%	0.70%	-0.14%	-1.55%	-2.15%
B6	6.06%	0.52%	0.04%	0.26%	-1.15%	-0.45%
B5	24.17%	0.40%	-0.44%	0.52%	-0.69%	-0.23%
B4	38.30%	0.00%	-0.67%	0.49%	-0.21%	0.00%
B3	24.17%	-0.57%	-0.61%	0.02%	0.27%	-1.07%
B2	6.06%	-1.14%	-0.17%	-1.07%	0.72%	0.83%
B1	0.62%	-1.43%	0.69%	-2.91%	1.10%	1.86%

Delta	A-E	F&G	H&I	J	K
Bin 7 - Bin 4	-0.32%	-1.37%	0.63%	1.35%	2.15%
Bin 4 - Bin 1	-1.43%	1.37%	-3.41%	1.31%	1.86%
Total Range	-1.76%	0.00%	-2.78%	2.66%	4.01%

(2) NYISO LFU Model for Zones A to E

Model Specifications for Zones A to E

- Per-unit MW data & load-weighted CTHI from NYISO archives, including DR impacts
- Years: 2013 to 2016 (with binaries)
- Months: June through September (Jun & Sep binaries)
- Days: Weekdays (Mon & Fri binaries), no Holidays
- 3rd order polynomial
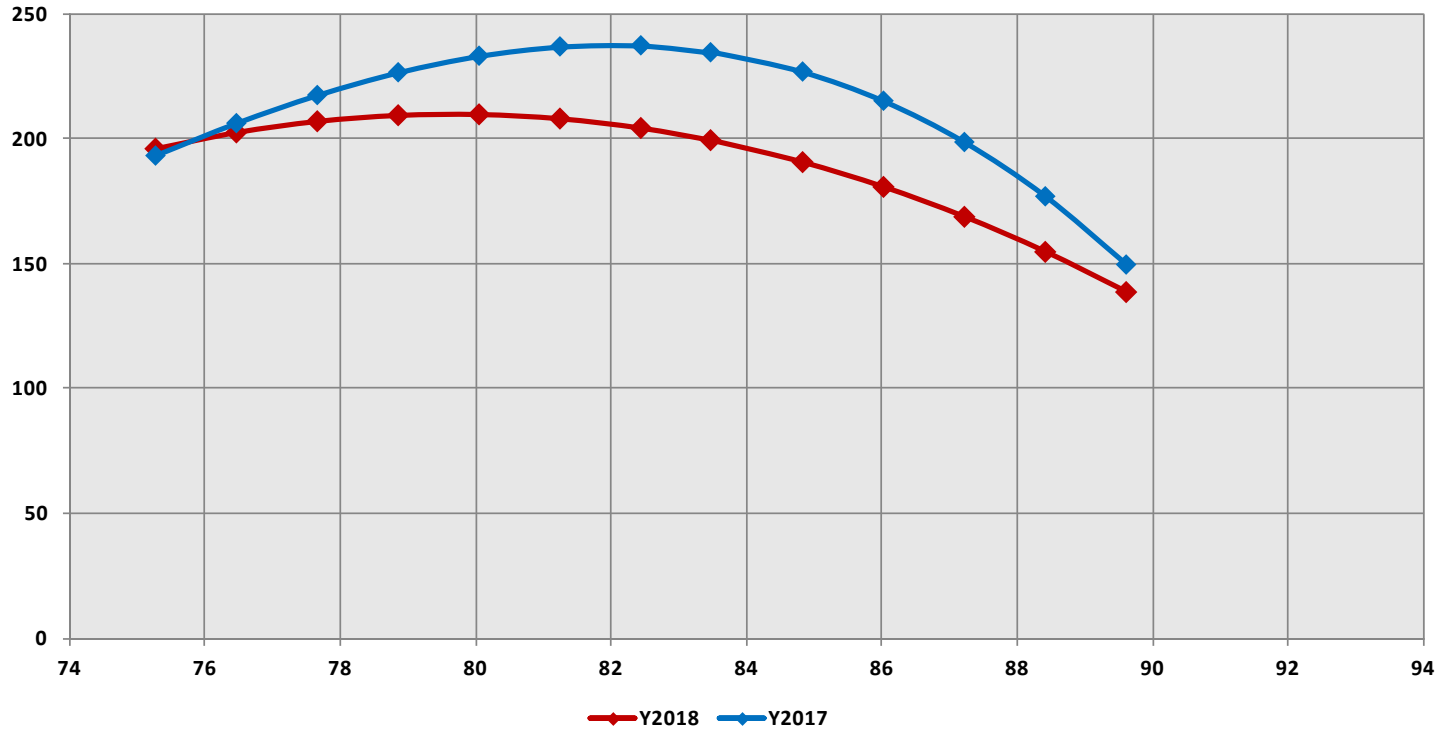- Total observations - 297

2018 LFU Model – Zones A to E

Load Model

A0	113,336.37
A1	-4,354.61
A2	57.30
A3	-0.24

CTHI

Mean	82.44
SD	2.39
Design	82.44

Design

Z	0
Percentile	50%

Bin	Z	Cum Prob	CTHI	MW	MW/CTHI	LFU
	-3.5	0.000	74.08	7,717	187	0.8188
B7	-3.0	0.001	75.27	7,946	196	0.8431
	-2.5	0.006	76.47	8,184	202	0.8684
B6	-2.0	0.023	77.66	8,429	207	0.8944
	-1.5	0.067	78.86	8,678	209	0.9208
B5	-1.0	0.159	80.05	8,928	210	0.9474
	-0.5	0.309	81.25	9,178	208	0.9739
B4	0.0	0.500	82.44	9,425	204	1.0000
67th	0.431	0.667	83.47	9,633	199	1.0221
	0.5	0.691	83.64	9,665	198	1.0255
B3	1.0	0.841	84.83	9,898	191	1.0502
	1.5	0.933	86.03	10,120	181	1.0738
B2	2.0	0.977	87.22	10,329	169	1.0959
	2.5	0.994	88.42	10,522	155	1.1164
B1	3.0	0.999	89.61	10,697	139	1.1351
	3.5	1.000	90.81	10,852	120	1.1515
Design	0	0.500	82.44	9,425		1.0000

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Zones A to E Weather Response - 2018 IRM Study
MW per CTHI vs. CTHI

Zones A to E LFU Model - 2018 IRM Study
MW vs. CTHI

$y = -0.24x^3 + 57.30x^2 - 4{,}354.61x + 113{,}336.37$

Legend: Y2013-15, Y2016, Model, Poly. (Model)
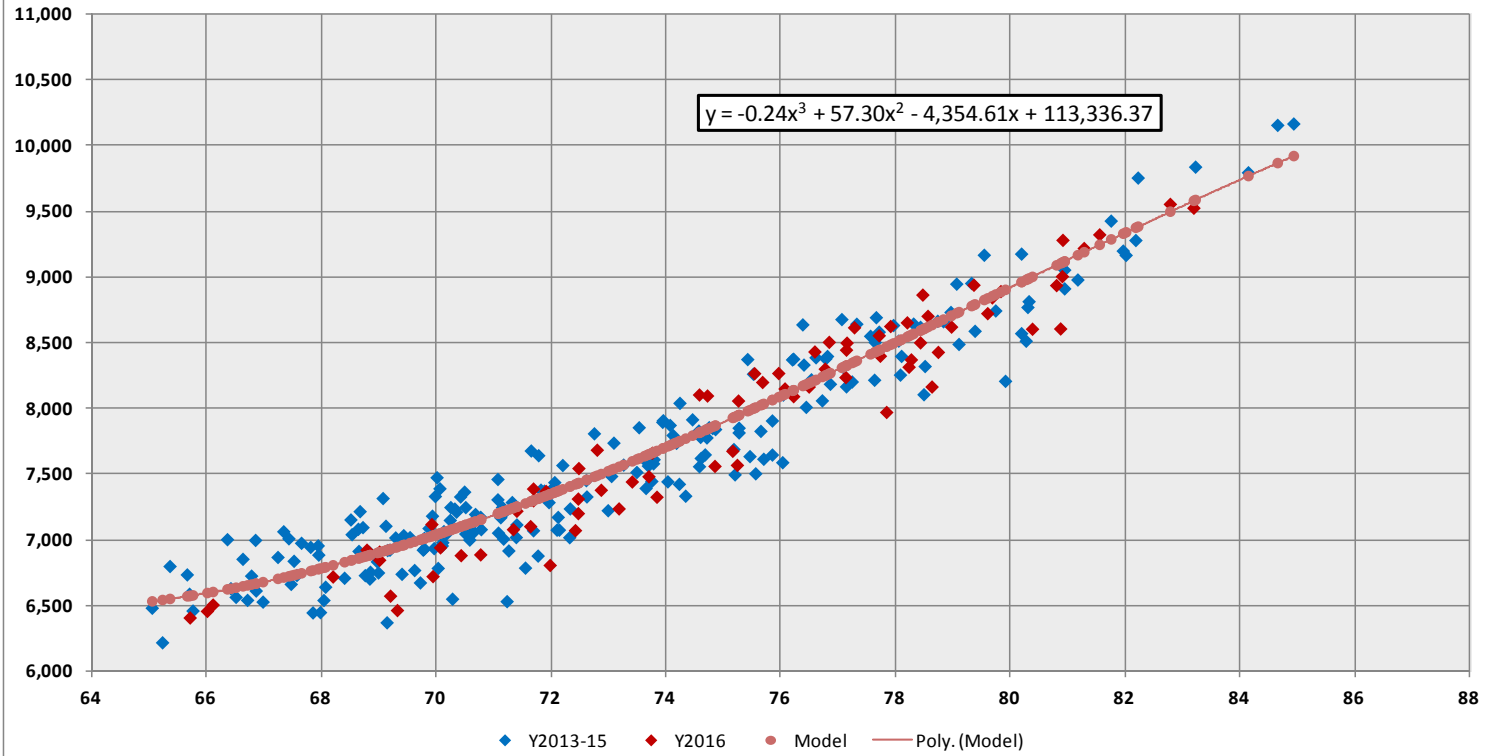
(3) NYISO LFU Model for Zones F and G

Model Specifications for Zones F and G

- Per-unit MW data & load-weighted CTHI from NYISO archives, including DR impacts
- Years: 2013 to 2016 (with binaries)
- Months: June through September (Jun & Sep binaries)
- Days: Weekdays (Mon & Fri binaries), no Holidays
- 3rd order polynomial
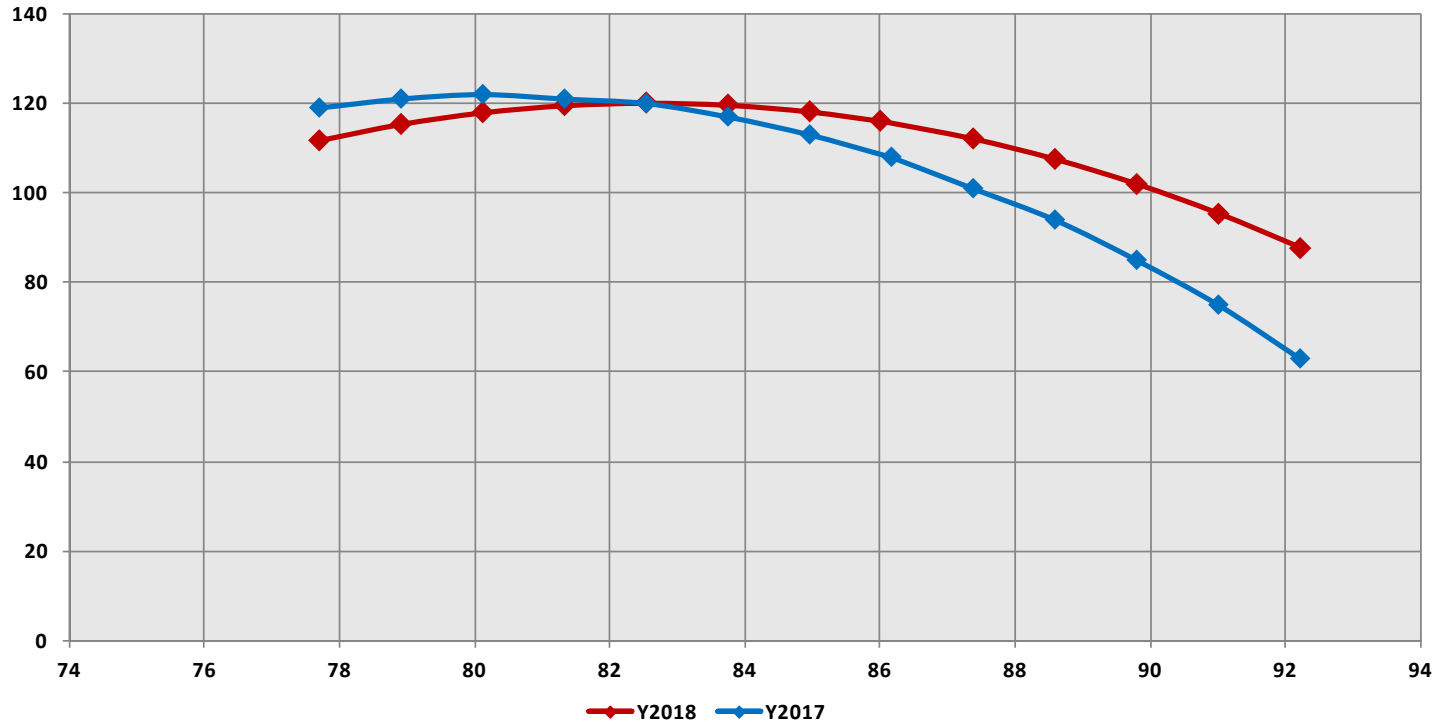- Total observations - 311

2018 LFU Model – Zones F and G

Load Model	
A0	60,370.73
A1	-2,277.43
A2	29.03
A3	-0.12

CTHI	
Mean	84.96
SD	2.42
Design	85.22

Design	
Z	0.108
Percentile	54%

Bin	Z	Cum Prob	CTHI	MW	MW/CTHI	LFU
	-3.5	0.000	76.49	3,571	107	0.7778
B7	-3.0	0.001	77.70	3,704	112	0.8067
	-2.5	0.006	78.91	3,841	115	0.8366
B6	-2.0	0.023	80.12	3,982	118	0.8674
	-1.5	0.067	81.33	4,126	120	0.8987
B5	-1.0	0.159	82.54	4,271	120	0.9303
	-0.5	0.309	83.75	4,416	120	0.9619
B4	0.0	0.500	84.96	4,560	118	0.9933
67th	0.431	0.667	86.00	4,682	116	1.0199
	0.5	0.691	86.17	4,702	116	1.0241
B3	1.0	0.841	87.38	4,840	112	1.0541
	1.5	0.933	88.59	4,973	108	1.0831
B2	2.0	0.977	89.80	5,100	102	1.1107
	2.5	0.994	91.01	5,219	95	1.1367
B1	3.0	0.999	92.22	5,330	88	1.1608
	3.5	1.000	93.43	5,431	79	1.1828
Design	0.108	0.543	85.22	4,591		1.0000

Zones F and G Weather Response - 2018 IRM Study
MW per CTHI vs. CTHI

Zones F and G LFU Model - 2018 IRM Study
MW vs. CTHI

$$y = -0.12x^3 + 29.03x^2 - 2{,}277.43x + 60{,}370.73$$

Legend: Y2013-15 ◆, Y2016 ◆, Model ●, Poly. (Model) ——
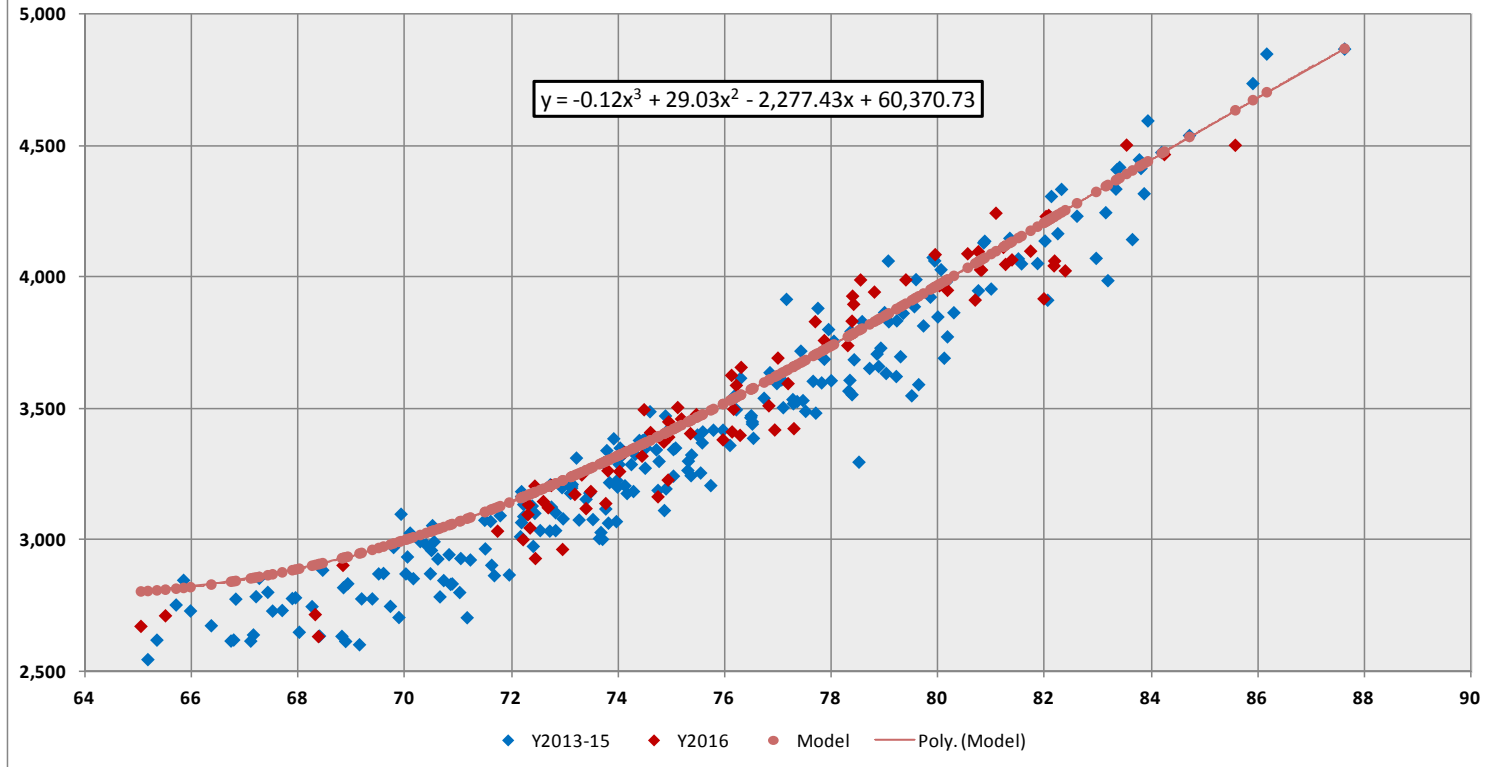
(4) NYISO LFU Model for Zones H and I

Model Specifications for Zones H and I

- Per-unit MW data including DR impacts from NYISO archives, and TV data from Con Ed
- Years: 2013 to 2016 (with binaries)
- Months: June through September (Jun & Sep binaries)
- Days: Weekdays (Mon & Fri binaries), no Holidays
- 3rd order polynomial
- Total observations - 309
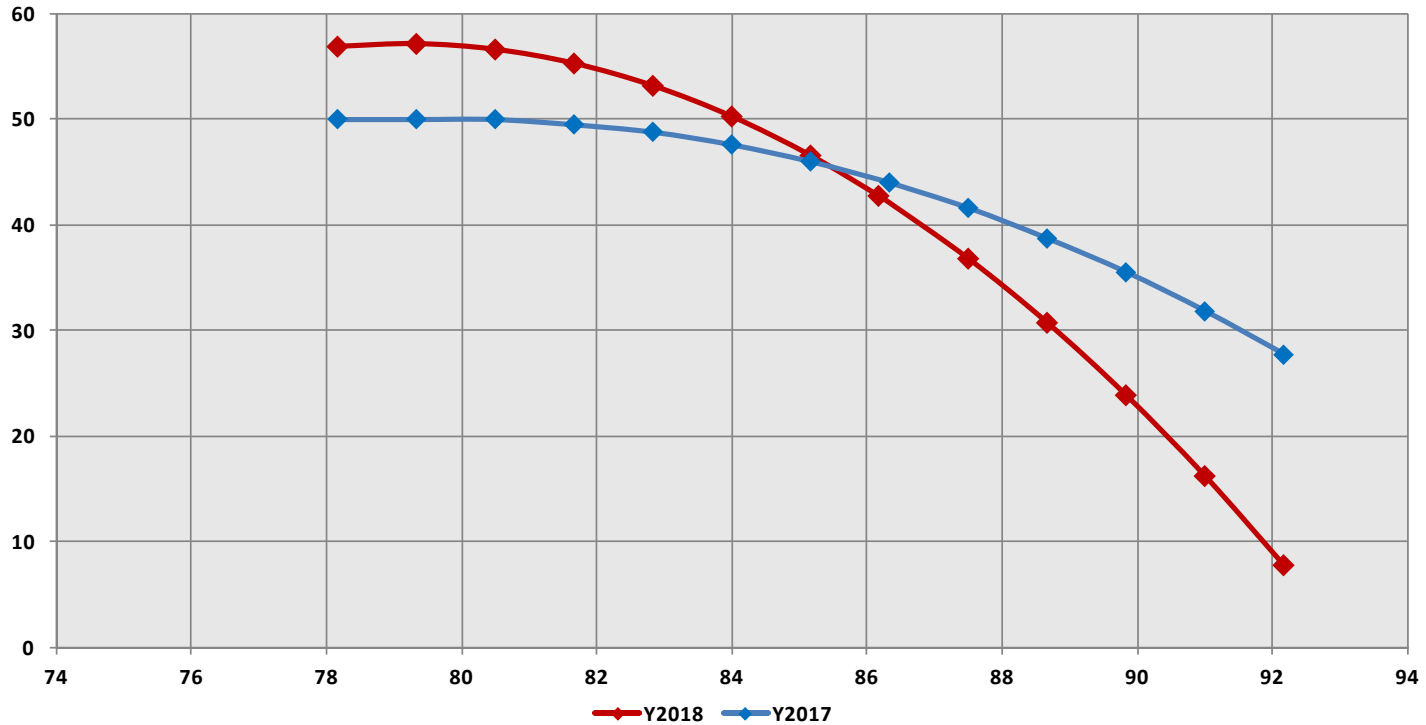
2018 LFU Model – Zones H and I

Load Model	
A0	45,127.01
A1	-1,760.75
A2	22.97
A3	-0.10

TV	
Mean	85.16
SD	2.33
Design	86.00

Design	
Z	0.358
Percentile	64%

Bin	Z	Cum Prob	TV	MW	MW/TV	LFU
	-3.5	0.000	77.00	1,577	56	0.7659
B7	-3.0	0.001	78.16	1,643	57	0.7978
	-2.5	0.006	79.33	1,709	57	0.8302
B6	-2.0	0.023	80.50	1,776	57	0.8624
	-1.5	0.067	81.66	1,841	55	0.8942
B5	-1.0	0.159	82.83	1,905	53	0.9249
	-0.5	0.309	84.00	1,965	50	0.9543
B4	0.0	0.500	85.16	2,022	47	0.9817
67th	0.431	0.667	86.17	2,066	43	1.0036
	0.5	0.691	86.33	2,073	42	1.0069
B3	1.0	0.841	87.50	2,119	37	1.0293
	1.5	0.933	88.67	2,159	31	1.0484
B2	2.0	0.977	89.83	2,191	24	1.0639
	2.5	0.994	91.00	2,214	16	1.0753
B1	3.0	0.999	92.17	2,228	8	1.0822
	3.5	1.000	93.33	2,232	1	1.0840
Design	0.358	0.640	86.00	2,059		1.0000

Zones H and I Weather Response - 2018 IRM Study
MW per TV vs. TV

Zones H and I LFU Model - 2018 IRM Study
MW vs. TV

$y = -0.10x^3 + 22.97x^2 - 1,760.75x + 45,127.01$

Legend: Y2013-15, Y2016, Model, Poly. (Model)
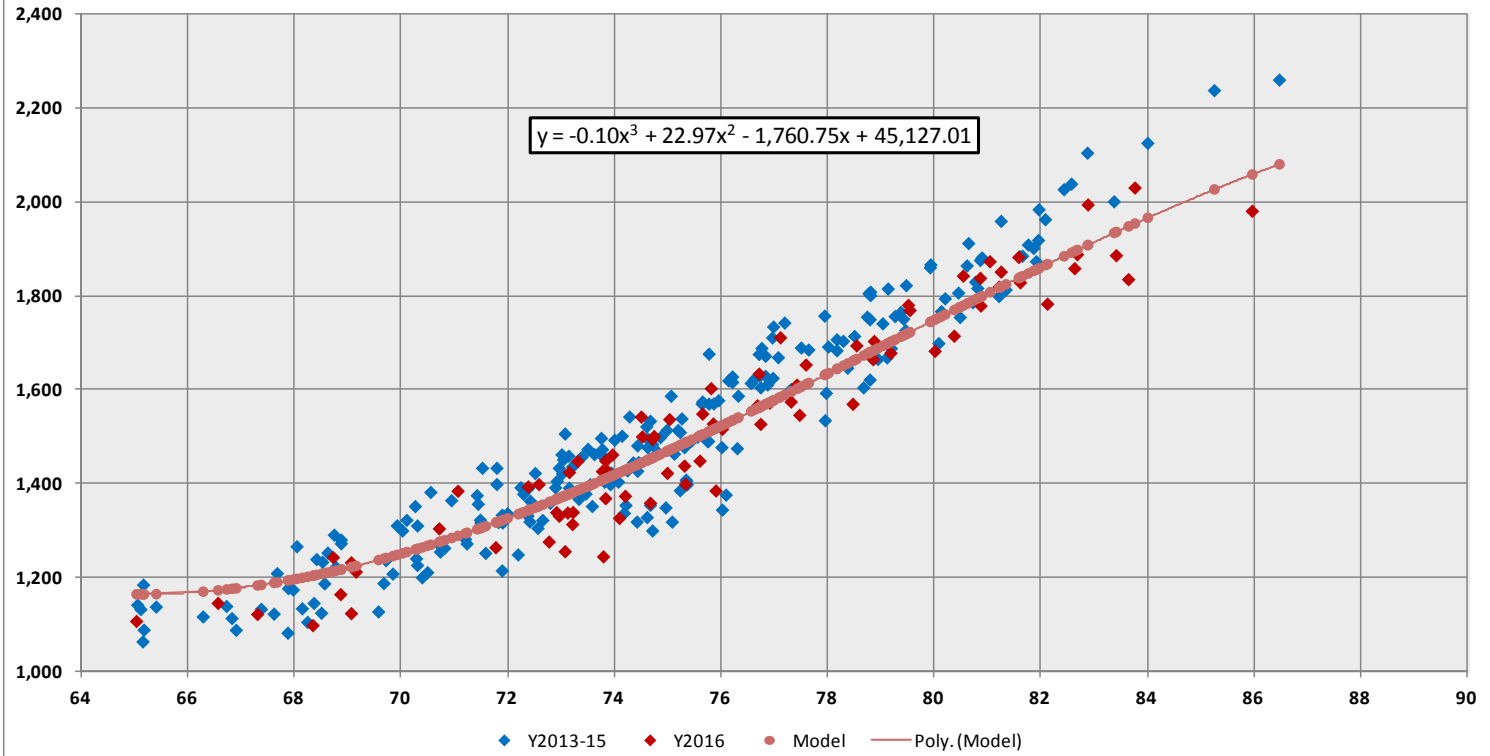
(5) NYISO LFU Model for Zone J

Model Specifications for Zone J

- Per-unit MW data including DR impacts from NYISO archives, and TV data from Con Ed
- Years: 2013 to 2016 (with binaries)
- Months: June through September (Jun & Sep binaries)
- Days: Weekdays (Mon & Fri binaries), no Holidays
- 3rd order polynomial
- Total observations - 312

2018 LFU Model – Zone J

Load Model	
A0	117,008.52
A1	-4,604.65
A2	61.91
A3	-0.26

TV	
Mean	84.99
SD	2.33
Design	86.00

Design	
Z	0.431
Percentile	67%

Bin	Z	Cum Prob	TV	MW	MW/TV	LFU
	-3.5	0.000	76.83	9,080	238	0.8138
B7	-3.0	0.001	77.99	9,359	240	0.8388
	-2.5	0.006	79.16	9,639	239	0.8639
B6	-2.0	0.023	80.33	9,917	237	0.8888
	-1.5	0.067	81.49	10,190	232	0.9133
B5	-1.0	0.159	82.66	10,456	225	0.9371
	-0.5	0.309	83.83	10,713	215	0.9602
B4	0.0	0.500	84.99	10,958	204	0.9821
67th	0.431	0.667	86.00	11,158	192	1.0000
	0.5	0.691	86.16	11,188	190	1.0028
B3	1.0	0.841	87.33	11,402	175	1.0219
	1.5	0.933	88.50	11,596	157	1.0392
B2	2.0	0.977	89.66	11,767	137	1.0546
	2.5	0.994	90.83	11,914	115	1.0678
B1	3.0	0.999	92.00	12,034	90	1.0786
	3.5	1.000	93.16	12,125	64	1.0867
Design	0.431	0.667	86.00	11,158		1.0000

Zone J Weather Response - 2018 IRM Study
MW per TV vs. TV

Zone J LFU Model - 2018 IRM Study
MW vs. TV

$$y = -0.26x^3 + 61.91x^2 - 4{,}604.65x + 117{,}008.52$$

Legend: Y2013-15, Y2016, Model, Poly. (Model)
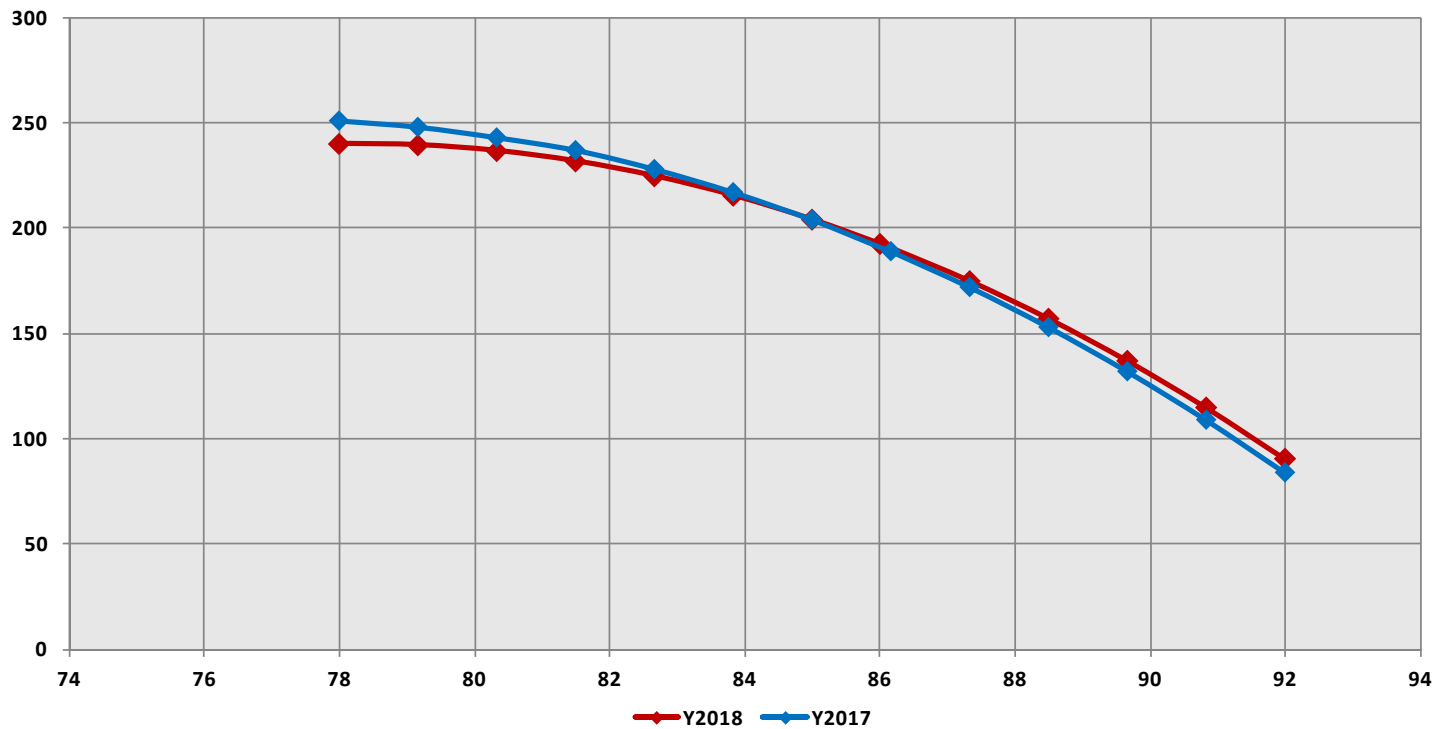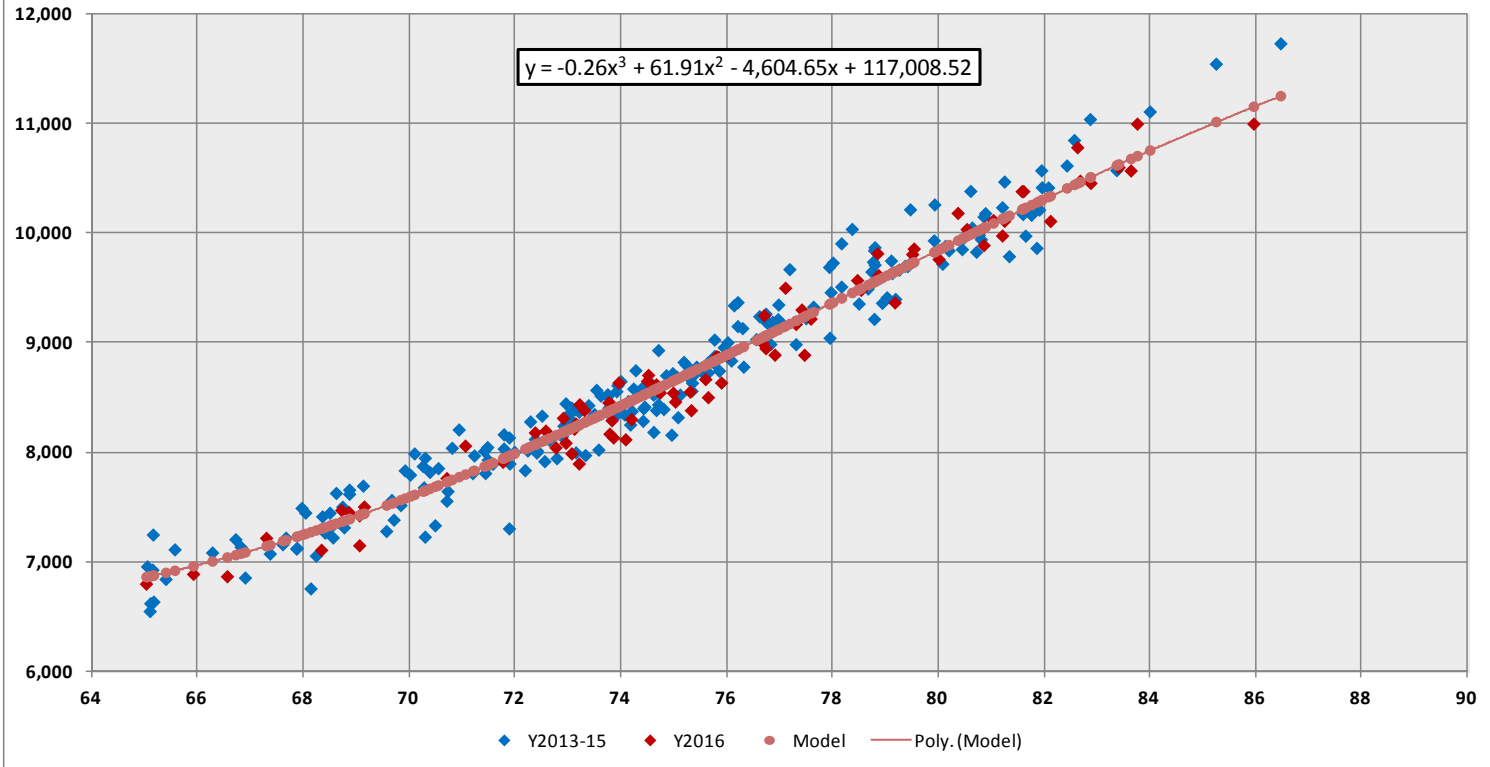
# (6) NYISO LFU Model for Zone K

Model Specifications for Zone K

- ## LIPA-specified model
  - Piece-wise linear model using THI4 (the THI value for the 4 hours preceding the peak)

- ## Independently developed NYISO model produced similar results
  - Per-unit MW data & CTHI
  - 3rd order polynomial

2018 LFU Model, LIPA – Zone K

Standard Normal Variate Z	Cumulative Probability	THI 4	MW	ΔMW	ΔTHI 4	ΔMW / ΔTHI 4	MW / MW$_{CP=50\%}$
-3.0	0.135%	76.5	4,156				0.7659
-2.5	0.621%	77.5	4,308	151	1.0	152	0.7939
-2.0	2.275%	78.5	4,532	224	1.0	224	0.8351
-1.5	6.681%	79.5	4,755	224	1.0	224	0.8763
-1.0	15.866%	80.5	4,979	224	1.0	224	0.9175
-0.5	30.854%	81.5	5,203	224	1.0	224	0.9588
0.0	**50.000%**	**82.5**	**5,427**	**224**	**1.0**	**224**	**1.0000**
0.5	69.146%	83.5	5,650	224	1.0	224	1.0412
1.0	84.134%	84.4	5,804	153	0.9	162	1.0695
1.5	93.319%	85.4	5,942	139	0.9	147	1.0950
2.0	97.725%	86.3	6,081	139	0.9	147	1.1206
2.5	99.379%	87.3	6,220	139	0.9	147	1.1461
3.0	99.865%	88.2	6,287	68	0.9	72	1.1586

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

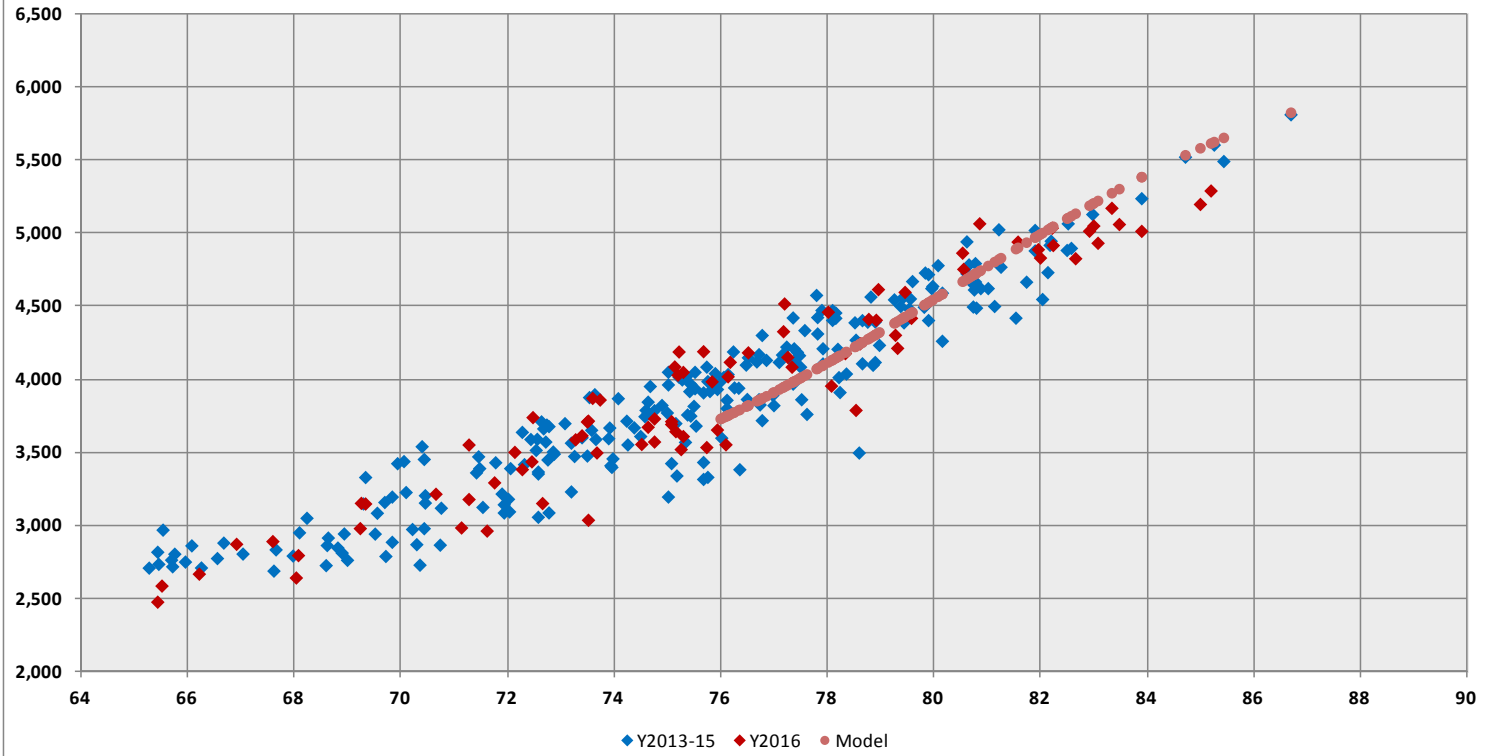NEW YORK INDEPENDENT SYSTEM OPERATOR

Zone K Weather Response - 2018 IRM Study
MW per CTHI vs. CTHI
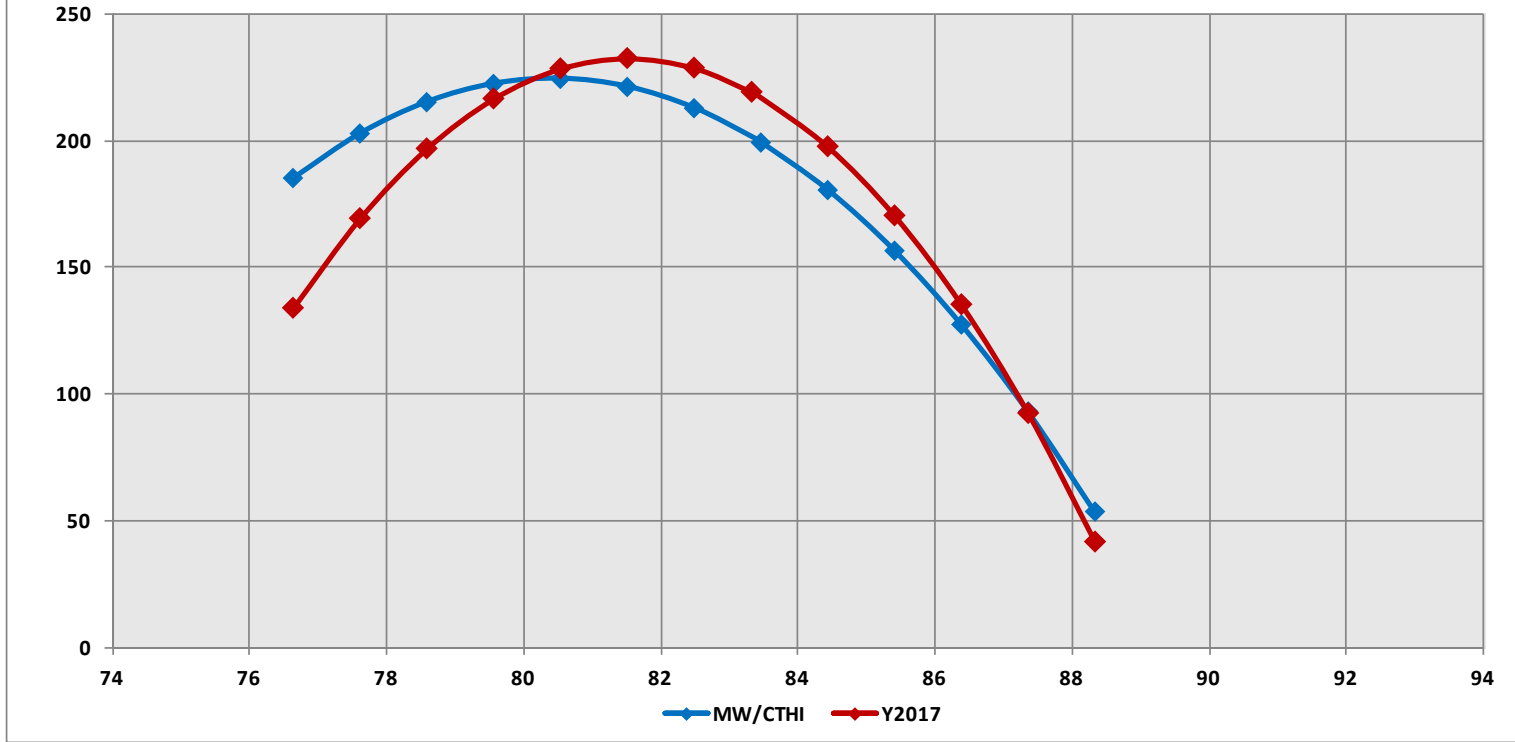
These weather response functions are based upon polynomial models that are equivalent to the piece-wise linear models provided by LIPA. LIPA's weather response functions move in steps.

Zone K LFU Model - 2018 IRM Study
MW vs. CTHI

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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