New York ISO
Independent System Operator

ICAP Forecast Process Example

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ICAP Forecast Process Example

- This presentation is intended to serve as a high-level overview of the annual ICAP Market forecast process.

- This presentation includes an example forecast. The state is split into two regions (analogous to Transmission Districts or Zones): upstate (corresponding to zones A to F) and downstate (zones G to K).

- This analysis is intended as a hypothetical example and is for discussion purposes only. The data and results shown do not directly correspond to the 2022 IRM and ICAP forecasts, which are developed independently.

ICAP Forecast Process Steps

- Summer Peak Design Conditions
- Coincident Peak Weather Normalization
- Regional Load Growth Factors
- Coincident Peak Forecast
- NCP to CP Ratios
- Non-Coincident Peak Forecast
- Proportional Loss Reallocation
- ICAP Market Peak Forecast

Summer Peak Design Conditions

Summer Peak Design Conditions

- Design weather represents the expected regional temperature (or other temperature variable) on the day of the system peak.

- The expected weather is calculated using the history of coincident peak day weather over the last 20 years. This example uses the 20-year history of NYISO's Cumulative Temperature & Humidity Index (CTHI). Transmission Owners may use different variables to define their peak day weather.

- In this example, the upstate design condition is defined as the 50th percentile (or average) peak day weather. This means that the design temperature is expected to be exceeded on average once every two summers.

- In this example, the downstate design condition is defined as the 67th percentile peak day weather. This means that the design temperature is expected to be exceeded on average once every three summers. The 67th percentile is calculated using the mean and standard deviation of the 20-year CTHI history.

- Per the Load Forecasting Manual, individual Transmission Owners may determine their own design condition, provided it is at the 50th percentile or higher. In practice, Con Edison and O&R design at the 67th percentile; and Central Hudson, LIPA, National Grid, NYPA, NYSEG, and RG&E design at the 50th percentile.

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Cumulative Temperature & Humidity Index

Step 1: Calculate hourly THI as a weighted average of the dry bulb temperature (DB) and the wet bulb temperature (WB). There are 24 values per day:

For any day d,

$$(\boldsymbol{THI})_{\boldsymbol{di}} = \mathbf{0.6} \times (\boldsymbol{DB})_{\boldsymbol{di}} + \mathbf{0.4} \times (\boldsymbol{WB})_{\boldsymbol{di}}$$

Where $\boldsymbol{i} = 0, 1, 2, \dots, 23$ indicate the hours of a day

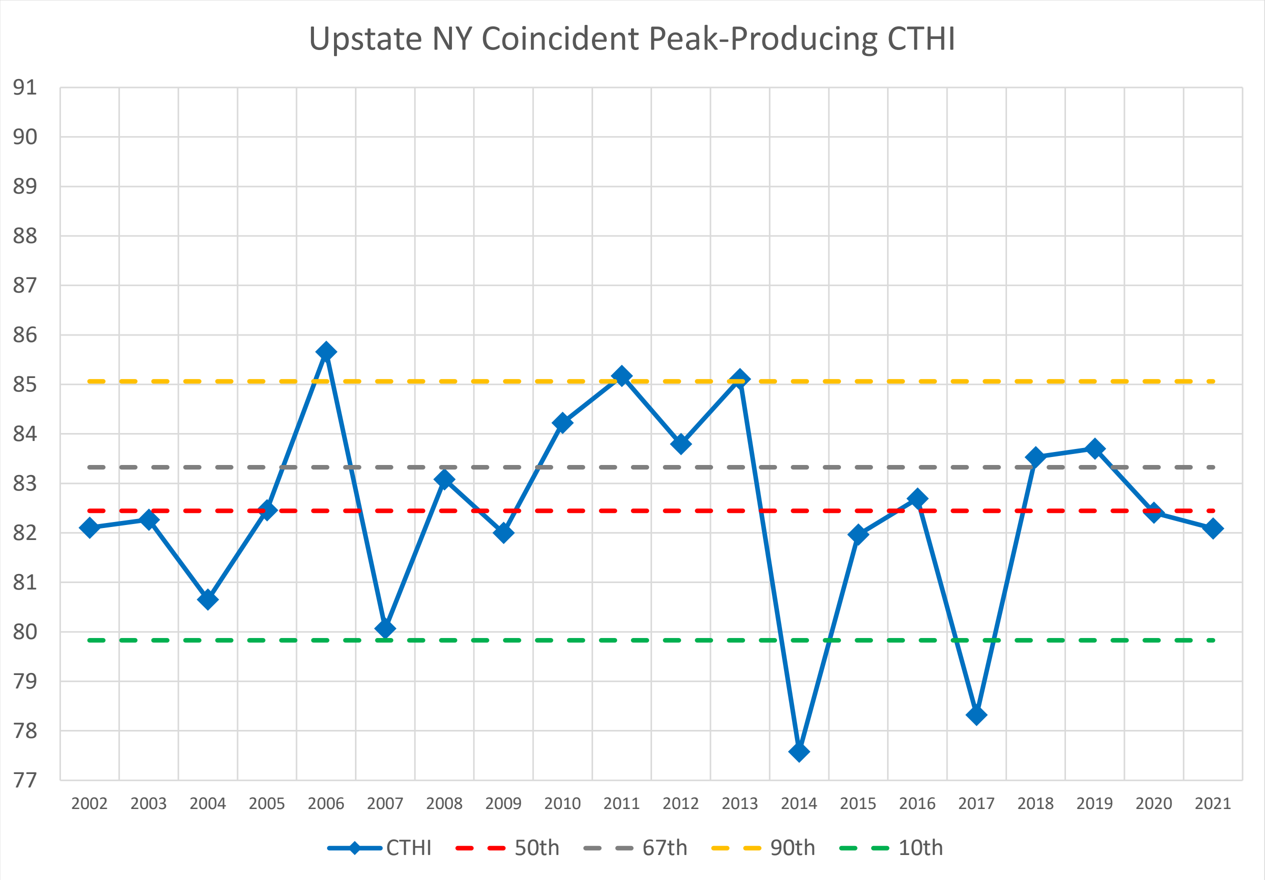
Step 2: Calculate the THI_max for a day. This is the maximum hourly THI value for that day:

$$(\boldsymbol{THI\_max})_{\boldsymbol{d}} = \mathbf{max}\left((\boldsymbol{THI})_{\boldsymbol{di}}\right)$$

Step 3: Calculate the daily CTHI using a weighted average of three days (the day for which the CTHI is being calculated and the two preceding days):

$$(\boldsymbol{CTHI})_{\boldsymbol{d}} = \mathbf{0.7} \times (\boldsymbol{THI\_max})_{\boldsymbol{d}} + \mathbf{0.2} \times (\boldsymbol{THI\_max})_{\boldsymbol{d-1}} + \mathbf{0.1} \times (\boldsymbol{THI\_max})_{\boldsymbol{d-2}}$$

Upstate Peak Day Weather and Design Condition



20-Year CTHI Stats	
Avg	82.44
StDev	2.04
50th	82.44
67th	83.32
90th	85.06
10th	79.83
Design	82.44
2021	82.09
Delta	-0.35
21 Pctile	43%

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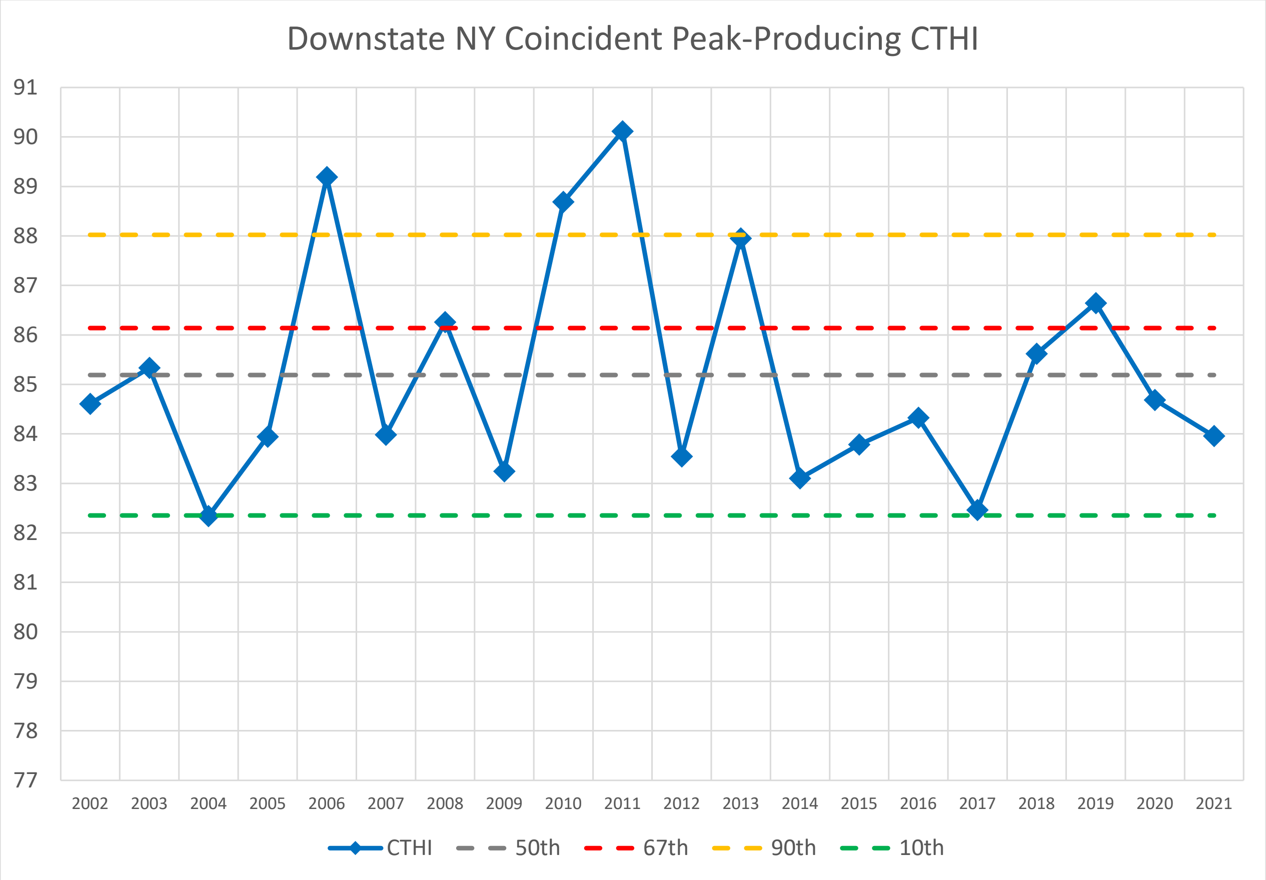
Downstate Peak Day Weather and Design Condition



20-Year CTHI Stats	
Avg	85.19
StDev	2.21
50th	85.19
67th	86.14
90th	88.02
10th	82.35
Design	86.14
2021	83.96
Delta	-2.19
21 Pctile	29%

Coincident Peak Weather Normalization

Weather Normalization Regression

- For the summer(s) selected, daily peak loads are regressed against daily CTHI60, including polynomial terms and other variables as appropriate. CTHI60 is CTHI with a reference or base value of 60 degrees. This example uses summer 2021 alone. In practice, a pooled model including data from recent hot summers is often utilized.

- The derivative of the regression line at the design temperature is calculated. This value represents the average additional MW of load gained per degree of increase in CTHI on the peak day.

- The weather adjustment is calculated as the product of the slope of the regression line and the CTHI delta (design CTHI less peak day CTHI).

- The weather adjustment is added to the actual coincident peak load to derive the weather normalized peak.

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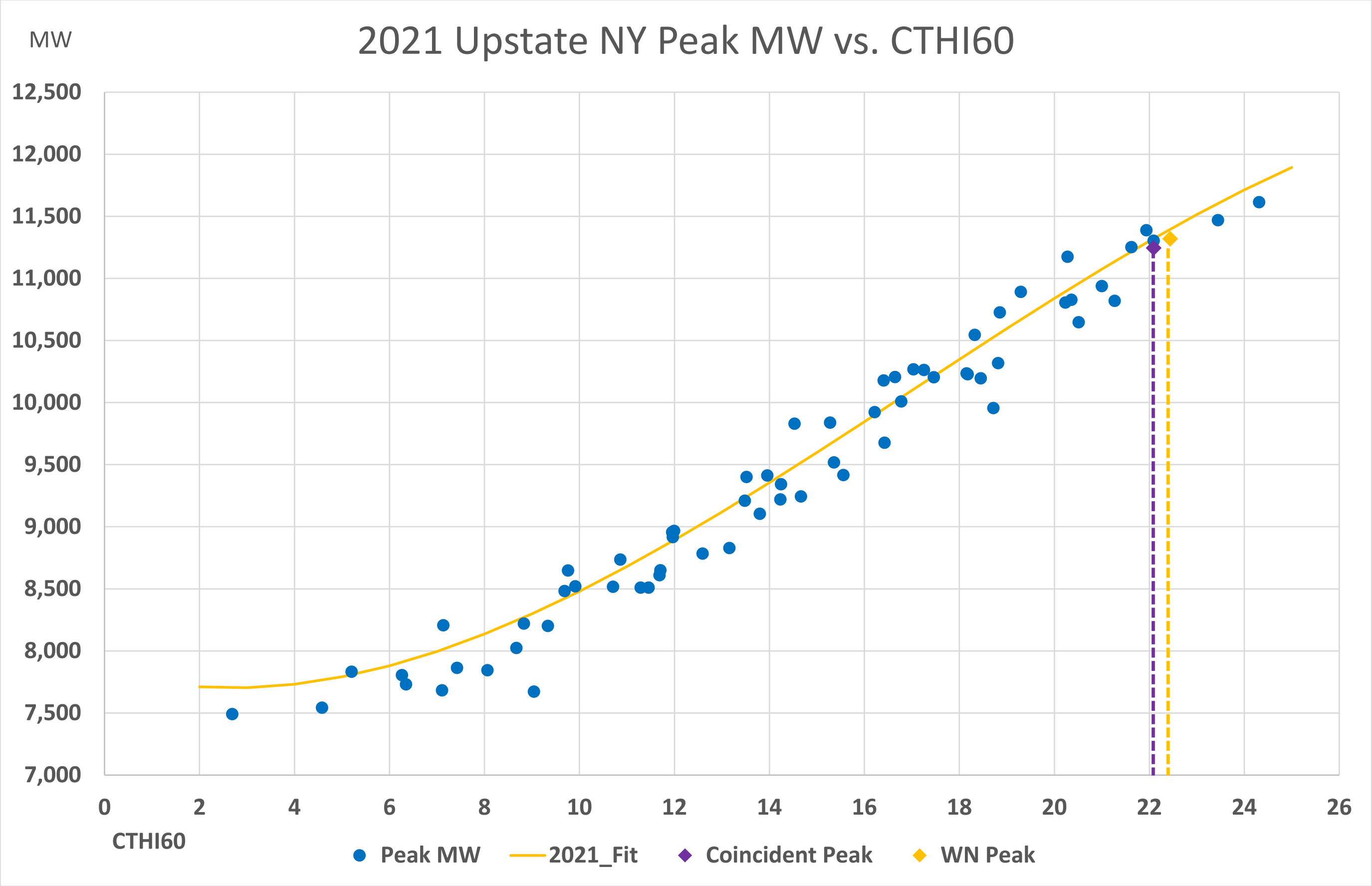
Upstate Regression Model



Blue dots show summer weekday peak MW vs CTHI

Yellow curve shows regression model fit

Purple dot shows coincident peak

Purple line shows peak day CTHI

Yellow line shows design CTHI

Yellow dot shows weather normalized peak. The peak day load has been adjusted upward to reflect design peak day weather.

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Upstate Regression Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.988
R Square	0.976
Adjusted R Square	0.974
Standard Error	184.8879
Observations	65

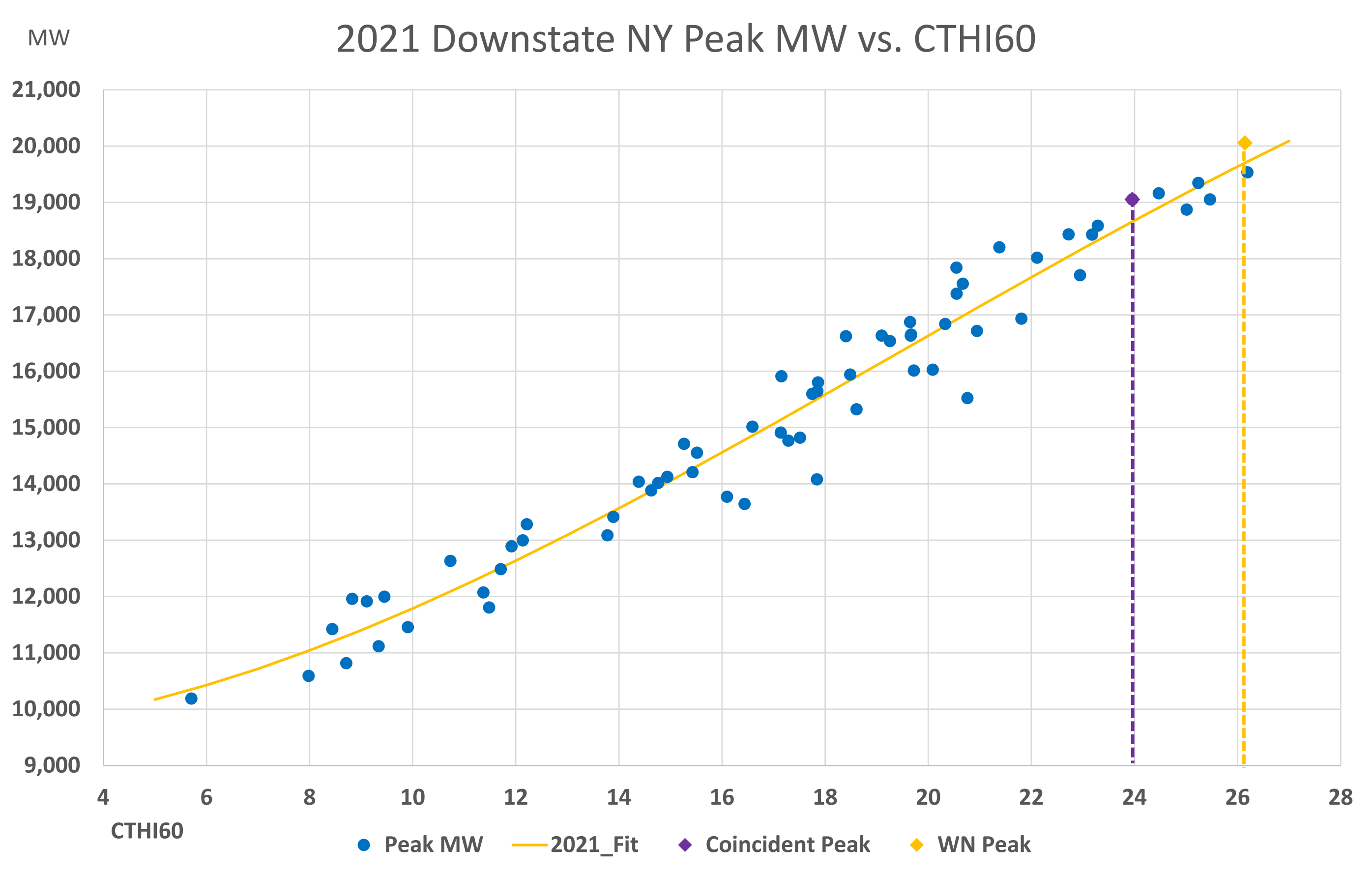
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	83604970	16720994	489	0.0000
Residual	59	2016829	34184		
Total	64	85621800			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	7837.8593	296.3663	26.4465	0.0000
CTHI60	-103.4635	72.8868	-1.4195	0.1610
CTHI2	20.8632	5.6517	3.6915	0.0005
CTHI3	-0.4094	0.1365	-2.9992	0.0040
June	-168.7086	56.0134	-3.0119	0.0038
Friday	-114.0880	58.5801	-1.9476	0.0562

Item	Value
Peak Load	11,245
Peak CTHI60	22.09
Design CTHI60	22.44
Delta CTHI	0.35
MW / CTHI	214
Delta MW	75
WN Peak	**11,320**

Downstate Regression Model



Blue dots show summer weekday peak MW vs CTHI

Yellow curve shows regression model fit

Purple dot shows coincident peak

Purple line shows peak day CTHI

Yellow line shows design CTHI

Yellow dot shows weather normalized peak. The peak day load has been adjusted upward to reflect design peak day weather.

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Downstate Regression Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.979
R Square	0.958
Adjusted R Square	0.957
Standard Error	520.734
Observations	65

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	387154453	193577227	714	0.0000
Residual	62	16812181	271164		
Total	64	403966635			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	9556.4835	267.4948	35.7259	0.0000
CTHI2	26.9316	2.7405	9.8272	0.0000
CTHI3	-0.4623	0.1010	-4.5760	0.0000

Item	Value
Peak Load	19,052
Peak CTHI60	23.96
Design CTHI60	26.14
Delta CTHI	2.18
MW / CTHI	460
Delta MW	1,005
WN Peak	**20,057**

Weather Normalized Peak Acceptance Criteria

- **Actual load data and estimated weather adjustments are provided by and discussed with the Transmission Owners**

- **Per the Load Forecasting Manual, the NYISO generally accepts TO values given they fall within the prescribed acceptance criteria**

- **Actual Load Value**
  - Actual Load: within +/- 1%

- **Weather Normalized Peak – must pass at least one of the following:**
  - Weather Normalized Peak: within +/- 1%

  OR

  - Weather Adjustment: within +/- 25%

Weather Normalized Peak Summary

- **In addition to the measured load and weather adjustment, the weather normalized peak also includes impacts due to the following:**
  - Demand Response (the regression model itself may contain loads adjusted for DR)
  - Municipal Generation
  - Station Power Deduction

Weather Normalized Coincident Peak

Item	Upstate	Downstate	System
Coincident Peak Load	11,245	19,052	30,297
Weather Adjustment	75	1,005	1,080
Demand Response	235	75	310
Municipal Generation	40	0	40
Station Power Deduction	-15	0	-15
Weather Normalized Peak	11,580	20,132	31,712

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Regional Load Growth Factors

Evaluation of RLGFs – Criteria 1, 2, and 3

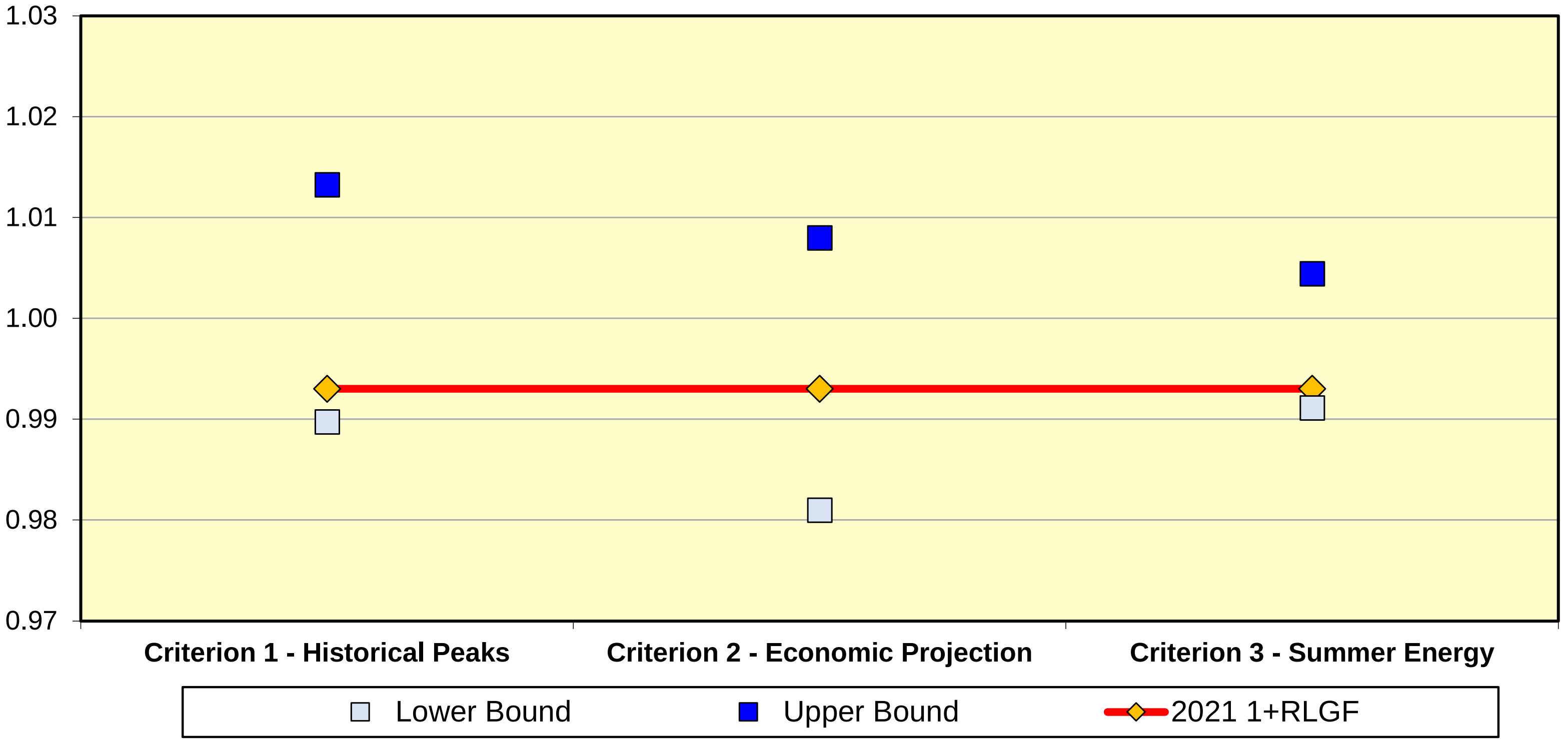
- Regional Load Growth Factors are submitted to the NYISO by the Transmission Owners, and reflect expected growth in summer peak load. The 1+RLGF is expressed as the ratio of the forecast year peak load to the current year weather normalized peak.

- The Load Forecasting Manual and Technical Bulletin 251 specify that the NYISO will evaluate Regional Load Growth Factors (RLGF) in the current year for each Transmission District based upon three criteria:

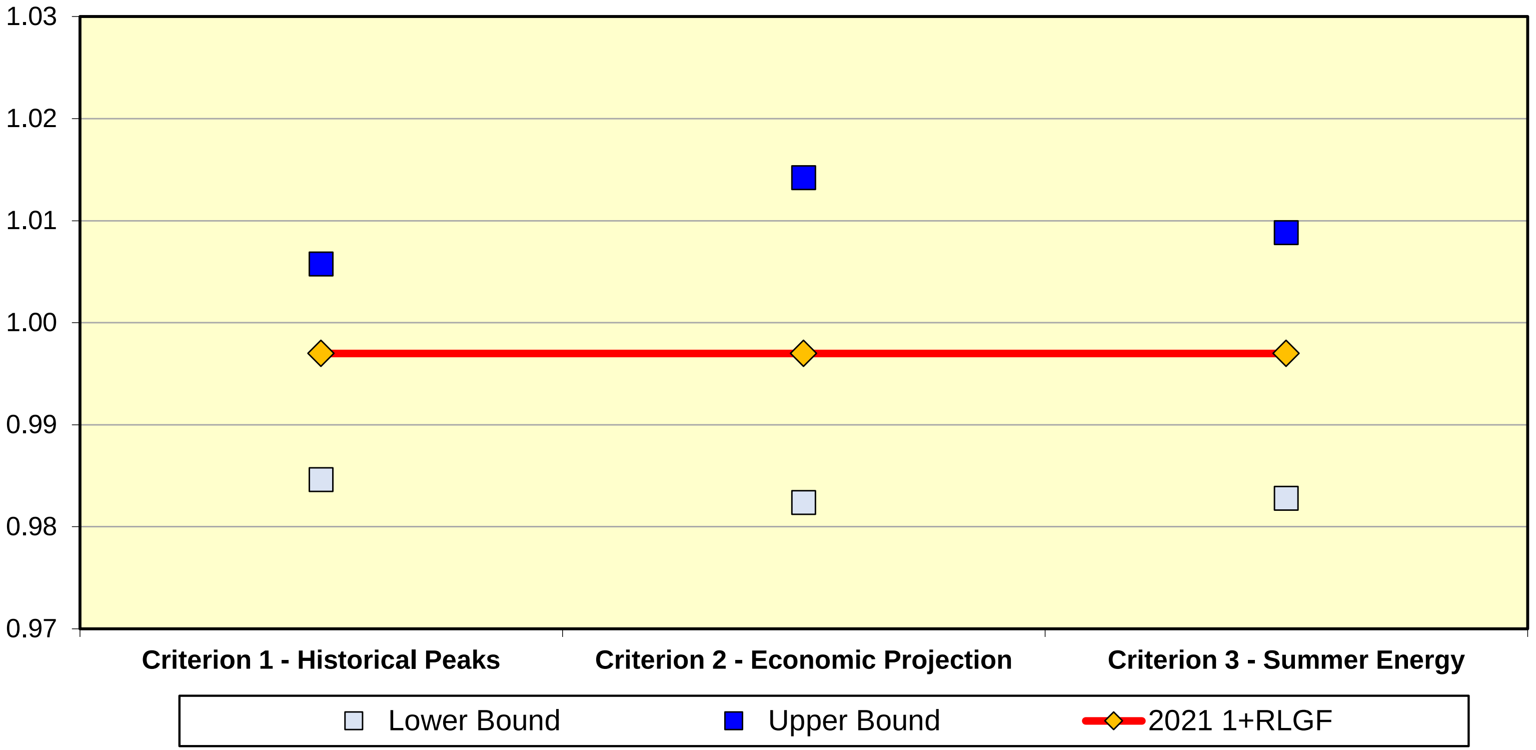
  - Criterion 1 – Index of Recent Historical Peak Load Growth
    Bandwidth based only on the recent growth of weather-adjusted peaks
  - Criterion 2 – Projection of Peak Load Growth in Relation to Economic Growth
    Projection of peak load growth based on a regression of historical summer daily peaks, historical economic data and other variables, and projected economic growth
  - Criterion 3 – Projections Performed by the ISO
    An independent projection of load growth currently based upon a regression of historical summer energy, historical economic data and other variables, and projected economic growth

- If at least two of the three criteria are satisfied, then the load growth factor for the Transmission District is accepted.

Example Upstate NY 1+RLGF Criteria



Example Downstate NY 1+RLGF Criteria



Criteria 1, 2 & 3 Summary

<u>Load Growth Criteria</u>

A '1' in the column labeled 'Test' indicates that the RLGF is between the upper and lower bandwidths.

A '0' in the column labeled 'Test' indicates that the RLGF is not between the upper and lower bandwidths.

Each RLGF must fall within 2 of the 3 criteria. In the event that Criteria 1 and 2 are mutually exclusive and a Combined Criterion is required, it is sufficient for the RLGF to fall within either the Combined Criterion or Criterion 3.

Region	Type	Lower Bound	1+RLGF	Upper Bound	Test
UPSTATE	Criterion 1 - Historical Peaks	0.9897	0.9930	1.0132	1
UPSTATE	Criterion 2 - Economic Projection	0.9810	0.9930	1.0080	1
UPSTATE	Criterion 3 - Summer Energy	0.9911	0.9930	1.0044	1
DOWNSTATE	Criterion 1 - Historical Peaks	0.9847	0.9970	1.0058	1
DOWNSTATE	Criterion 2 - Economic Projection	0.9824	0.9970	1.0142	1
DOWNSTATE	Criterion 3 - Summer Energy	0.9828	0.9970	1.0088	1

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Coincident and Non-Coincident Summer Peak Forecasts

Summer Coincident Peak Forecast

- The coincident peak forecast is the product of the current year weather normalized coincident peak and the 1+RLGF

- The coincident peak forecast is made prior to the reallocation of losses, and generally corresponds to the first year of the Gold Book summer coincident peak forecast

Coincident Peak Forecast

Item	Upstate	Downstate	System
Weather Normalized Peak	11,580	20,132	31,712
1+RLGF	0.9930	0.9970	0.9956
Coincident Peak Forecast	11,499	20,072	31,571

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NCP to CP Ratios

- The Non-Coincident Peak to Coincident Peak (NCP to CP) ratio reflects the typical difference in independent peak load relative to load during the system peak.

- The NCP to CP ratios are calculated using peak day loads from the past 15 summers. Outlier years are taken out of the ratio calculation. Outlier years are defined as those that have an NCP to CP ratio of over 1.65 standard deviations above the historical average, representing the upper 5% tail of the distribution.

- The NYCA and Locality peak hours used in the calculations are restricted to the ICAP Market peak day period (July and August non-holiday weekdays).

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NCP to CP Ratio Calculation

NCP to CP Ratio

Item	Upstate	Downstate
Average 2007-2021 NCP*	11,670	20,308
Average 2007-2021 CP*	11,504	20,127
NCP to CP Ratio	1.0144	1.0090

*Excludes years with outlier ratio

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Summer Non-Coincident Peak Forecast

- The non-coincident peak forecast is the product of the current year weather normalized coincident peak, the NCP to CP ratio, and the 1+RLGF

- For zones and regions that form a Locality, the NCP forecast represents the Locality peak forecast. Locality and NCP forecasts are calculated prior to the reallocation of losses

Non-Coincident Peak Forecast

Item	Upstate	Downstate
Weather Normalized CP	11,580	20,132
NCP to CP Ratio	1.0144	1.0090
Weather Normalized NCP	11,747	20,313
1+RLGF	0.9930	0.9970
NCP Forecast	11,665	20,252

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Loss Reallocation and ICAP Market Forecast

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Proportional Loss Reallocation

- For the New York Control Area (NYCA) ICAP Market peak forecast, bulk power system losses are reallocated among the Transmission Districts proportional to their weather normalized peak load (less losses). This approach provides that for the NYCA ICAP Market, bulk power system losses are shared equitably among Transmission Owners according to their share of the total statewide peak load.

- For the ICAP Locality peak forecasts (Zone J, Zone K, and Zones G-to-J), there is no reallocation of bulk power system losses. These forecasts include local (i.e., Transmission District) bulk power system losses as found. This approach provides that the Locality peak forecasts accurately estimate the total load expected in the Locality during the Locality peak hour.

Loss Reallocation Calculation

Reallocation of Losses

Row	Formula	Item	Upstate	Downstate	System
a		Actual Load Less Losses	10,871	18,803	29,674
b		Bulk Power System Losses	374	249	623
c	= a+b	Actual Load With Losses	11,245	19,052	30,297
d	= b/c	Percent Losses	3.33%	1.31%	2.06%
e		Weather Normalized Load With Losses	11,580	20,132	31,712
f	= (e/c)*b	Weather Normalized Losses	385	263	648
g	= e-f	Weather Normalized Load Less Losses	11,195	19,869	31,064
h	share of g	Percent Loss Allocation	36.0%	64.0%	100.0%
i	= h*sum(f)	Proportional Allocation of Losses	234	414	648
j	= g+i	Adjusted Actual Load	11,429	20,283	31,712
k	= j-e	Loss Reallocation	-151	151	0

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ICAP Market Forecast

- The ICAP Market NYCA peak forecast is the product of the current year Adjusted Actual Load and the 1+RLGF

- The ICAP Market NYCA peak forecast includes proportionally reallocated bulk power system losses

ICAP Market Forecast

Item	Upstate	Downstate	System
Adjusted Actual Load	11,429	20,283	31,712
1+RLGF	0.9930	0.9970	0.9956
ICAP Market Forecast	11,349	20,222	31,571

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Peak Forecast Adjustments

- Peak forecasts, including the coincident peak, non-coincident peak, ICAP Market, and Locality forecasts, may be adjusted for factors other than those shown in this example.

- For the IRM and LCR forecasts, projected peak proxy loads for Behind-the-Meter Net Generation (BTM:NG) resources are added to the final forecasts.

- For the 2022 IRM and ICAP forecasts, anticipated load growth due to specific large load projects are added to the peak forecasts. These projects are categorized outside of the 1+RLGFs, which are meant to capture general trends in load growth.

- In other years, ad hoc adjustments may be made as necessary. For example, as part of the 2019 weather normalized peak calculation, coincident peak loads were increased to correct for the load-reducing impacts of the weekend system peak.

Questions?

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- 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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