memo

To: Market Participants

From: Market Administration

Date: May 16, 2025

Subject: Day-Ahead Ancillary Services - Model Update - Effective June 01, 2025

The purpose of this memo is to provide an update on the retraining of ISO New England's statistical model for next-day real-time locational marginal prices (RT LMPs). The ISO uses this model to calculate hourly strike prices for day-ahead ancillary services, and in determining the expected close-out component of day-ahead energy option offer benchmark levels.

The ISO's statistical model estimates a probability distribution of hourly RT LMPs for each hour of the next operating day, using daily input information that is available to participants when they submit offers and bids into the day-ahead market (DAM). The ISO regularly retrains the model, to ensure it remains relevant and up to date as market conditions evolve over time.

For a comprehensive overview of the underlying statistical model's computation and integration with the day-ahead ancillary services products, please consult the memorandum available on the ISO's web site at [Day-Ahead Ancillary Services Initiative – Statistical Model for Real-Time Energy Prices]. That prior memorandum explains and contains the model's interpretation and detailed mathematical specifications; this memorandum provides the model's updated numerical parameters and retraining information.

Model Retraining Period and Numerical Parameter Updates

The ISO's model estimates the likelihood that the RT LMP at the ISO's hub pricing point with take on different possible values each hour of the next day. The present statistical technique used for this purpose is known as a Gaussian Mixture Model (GMM).[1] The ISO retrains the GMM to incorporate newly available data that reflect recent market conditions, using an updated data span of 60 continuous recent months. The latest retraining data period is 05/01/2020 to 04/30/2025.

The retrained model's numerical parameter values (also called its 'sensitivity parameters') are detailed in Technical Appendix A1 to this memorandum. These sensitivities are not the model's main goal; rather, they serve as intermediary values for calculating hub RT LMP probabilities, expected values, and expected close-out costs each day.

[1] Statistical mixture models are a well-developed class of data modeling techniques. A readily-accessible technical summary is available on Wikipedia at https://en.wikipedia.org/wiki/Mixture_model.

ISO New England Inc.
One Sullivan Road
Holyoke, MA 01040-2841
413-540-4220
AskISO@iso-ne.com

iso-ne.com
isonewswire.com
@isonewengland
iso-ne.com/isotogo
iso-ne.com/isoexpress

Overall Retrained Model's Performance

For statistical models designed to estimate probability distributions, a standard measure of model performance is to compare their predicted confidence intervals (i.e., predicted percentiles) with actual outcomes. Below we summarize the results of this comparison, and their interpretation.

In the context of this GMM, confidence intervals reflect where the model predicts the hub RT LMPs will occur with specified frequencies, such as 50%, 80%, or 90% of the time. In theory, actual RT LMPs frequencies should reasonably align with a statistical model's predicted confidence intervals. For instance, the actual RT LMP should ideally fall within the 90% confidence interval in 90% of all hours.

A measure of the overall performance of the retrained GMM is the model's coverage probabilities—how often the actual RT LMP falls within a predicted confidence interval. Table 1 below summarizes the latest model's coverage probabilities for the retraining data period.

Data Period	50% Confidence Interval	80% Confidence Interval	90% Confidence Interval
05/01/2020--04/30/2025	51.59%	81.57%	91.29%

Table 1. *Coverage probabilities for the latest retrained model. Cell entries are the actual frequency of RT LMP falling within the retrained model's predicted confidence intervals for each hour of this 60-month period.*

In interpreting these results, note that small deviations of actual from predicted frequencies are to be expected; the model is fit to a sample of data, and random fluctuations (known generally as sampling error) will tend to yield small deviations in any given retraining period. Larger deviations relative to predicted confidence intervals may also be informative. Specifically, if the actual RT LMP falls within the target confidence intervals more frequently than anticipated (i.e., when there are larger numbers in the cells in Table 1 than the target confidence interval percentages in the column headers), this indicates the model may overestimate the RT LMP's price variability which, in turn, may overestimate expected close-out costs of energy option offers. Conversely, if the actual RT LMP falls within the target confidence intervals less frequently than anticipated (i.e., smaller numbers than expected in the cells in Table 1), this indicates the model may underestimate the RT LMP's variability and expected close-out costs.

Table 2 below summarizes comparative results of the actual average RT LMPs and the expected RT LMPs derived from the retrained GMM. Additionally, Table 2 compares the average realized closeout costs, as computed from actual market outcomes, with the GMM's predicted closeout costs determined sequentially, one day before each operating day.

Data Period	Average Actual RT LMP	Average Expected RT LMP	Average Actual Closeout	Average Expected Closeout
05/01/2020--04/30/2025	$49.98	$49.75	$4.79	$5.03

Table 2. *Actual and model expected RT LMPs, and actual and expected closeout costs.*

Ideally, the actual values of the average RT LMP and the average closeout cost should align closely with the expected counterparts from the statistical model. This alignment indicates the model's effectiveness in mirroring actual market conditions, even though the statistical model's predictions are performed one day before actual real-time market prices are known.

In interpreting the model's performance and Table 2, many of the prior points apply. Specifically, small deviations between actual and expected outcomes are not atypical, due to the model being fit to a 60-month data span. Larger average deviations, depending on their direction, may indicate a tendency of the model to slightly over or underestimate expected RT LMPs and expected closeout costs. Subsequent retraining updates should tend to correct any larger deviations, as future months' data will increasingly incorporate more information on any persistent changes in market conditions and pricing fundamentals.

The ISO will continue to evaluate the model's performance and provide retrained model updates to maintain its effectiveness in our region's dynamic energy market.

Technical Appendices

Appendix A1. Retrained Gaussian Mixture Model (GMM) Parameter Values

The full mathematical formulas used in the GMM and their application are provided in the ISO's earlier memorandum (linked on page 1). The latest retraining update to the model uses a set of n = 11 covariates and k = 3 Gaussian-mixture components. The retrained model's updated parameters are listed in **Table 3** below.

These parameters, denoted as coefficients β, represent the sensitivity of the mean, variance, and mixture proportions in the GMM to each of the 11 input data variables. Specifically:

- β_k^{μ}: Coefficients of the mean of each Gaussian distribution, which influence the central tendency of each component.

- β_k^{μ}: Coefficients of the variance of each Gaussian distribution, which affect the spread or variability around the mean of each component.

- β_k^{μ}: Coefficients of the mixture probabilities, which define the relative contribution of each Gaussian component to the overall model, affecting how strongly each component influences the combined outcome.

For coefficient interpretations and subsequent use in calculating expected RT LMPs, confidence intervals, and expected closeout costs, see the examples and discussions in appendices of the ISO's earlier memorandum (linked on page 1).

	k	Constant	DAM Load Forecast	Lagged RT LMP	Gas Price	No.6 Oil Price	Irradiance	Temperature	Dew Point	Wind Speed	Winter	Change in Forecasted Load
Mean coefficients β_k^{μ}	1	-798.6	1.0	7.1	503.4	67.1	-0.2	3.4	-3.3	-6.7	-1.6	-0.1
	2	-1,801.8	3.1	29.3	469.0	64.5	-0.4	-8.6	-4.8	-32.7	-4.1	1.7
	3	-8,709.5	14.2	6.9	165.7	229.3	-8.0	-27.2	-54.5	42.5	-35.2	8.7
Variance coefficients β_k^{σ}	1	66.7	0.1	0.9	20.7	-3.6	0.0	0.6	0.3	-2.0	0.8	0.0
	2	354.2	0.0	0.4	23.5	-1.2	0.1	-0.7	0.6	-0.2	0.6	0.1
	3	273.2	0.2	-0.1	-1.6	5.7	-0.2	6.0	-4.2	4.6	0.4	0.2
Mixture probability coefficients β_k^{π}	1	723.5	-0.3	0.4	-20.5	-19.6	0.0	6.1	-0.7	-10.0	0.7	0.0
	2	440.8	-0.2	-0.5	-19.3	-5.7	-0.2	6.8	-3.4	-1.8	0.1	0.2
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3. *Updated numerical values of the statistical model's parameters*

Appendix A2. Input Data Summary

The covariates (input data) used in the GMM are listed in Table 4 below. While other covariates were considered previously, they exhibited minimal predictive power. The input data set below ensures that the model is both streamlined and efficient, focusing only on those input data series that are available prior to the (DAM) each day and that significantly enhance the model's accuracy.

Input Data	Units	Source
ISO's day-ahead system load forecast	MWh	ISO New England (public data)
Last available real-time hourly hub LMP for the same hour[2]	$ per MWh	ISO New England (public data)
Natural gas price index (AGT-CG non-G)	$ per mmBTU	Intercontinental Exchange (commercial vendor service)
Fuel oil price (No. 6, 1%, NY Harbor)	$ per mmBTU	Argus Media (commercial vendor service)
Forecast mean irradiance	Watts/m^2	Multiple commercial weather

[2] For the daily calculation of the strike price, a smoothing algorithm is applied when the lagged real-time LMP increases by more than $500/MWh. Specifically, if the current hour's lagged RT LMP is greater than the previous hour's lagged RT LMP by more than $500/MWh, the strike price is calculated using the smoothed lagged RT LMP, calculated as the simple average of the lagged RT LMPs from the current hour and the four preceding hours.

Input Data	Units	Source
Forecast mean temperature	°F	forecasting vendor services. Note: Twenty-three-city averages for New England. Hourly data.
Forecast mean dew point	°F	
Mean wind speed forecast	Miles per hour	
Winter season indicator	1 between November 1st and March 31st, 0 otherwise	ISO New England (constructed from date)
Change in Forecasted Load	MWh	ISO New England (public data)

Table 4. *Input data explanatory variables used in the statistical model*