



California ISO
Your Link to Power

Technical Bulletin

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AS Procurement – Regulation

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Background:

The California ISO (ISO) procures one-hundred percent (100%) of its Ancillary Services requirements in the Integrated Forward Market (“IFM”) as published on OASIS. The ISO procures incremental Ancillary Services as needed in the Real-Time Market. Between the implementation of the ISO’s new market and October 3, 2009, the ISO set the Regulation (up and/or down) requirement and procured to a fixed value for an entire Operating Day when procuring Regulation in the IFM.

Prior to October 3, 2009, the amount of upward and downward Regulation the ISO procured varied from day to day between +/-375 and +/-500 MW as necessary to maintain compliance with NERC control performance standards, but remained fixed for all 24 hours of the Operating Day. During the real-time operating processes, operators have varied Regulation requirements as needed.

Beginning October 3, 2009, the ISO added new functionality to vary its Regulation requirements in the IFM for different hours of the day. The ISO publishes these varying Regulation requirements for the IFM on OASIS.

Variable Regulation Requirements:

Setting an entire Operating Day’s Regulation requirements to a fixed amount may create an inefficient procurement relative to operational needs of the system because operational drivers that create the need for Regulation change during different periods of the day.

- If the ISO sets the Regulation requirement for the entire Operating Day based on the maximum operational need in any ten minute period of the day to 500 MW, then the ISO will likely procure more Regulation than is operationally necessary during other periods of the day.
- If the ISO sets the Regulation requirement for the entire day based on the minimum operational need in any ten minute period of the day to 375 MW then the ISO will likely procure less Regulation than is necessary in critical hours of the day when the operational need is greater.

The ISO has implemented a Regulation procurement forecasting tool to address the fact that operational needs for Regulation vary throughout the day. This tool calculates the amount of Regulation needed for Regulation Up separate from Regulation Down, and at variable values for each hour based on changes in the Demand forecast, Generation Self-Schedule changes, and hourly Intertie fluctuation. Based on these variables, the calculation for determining the Regulation Up and Regulation Down requirements reflects the coincidental 10 minute peak Regulation Up and Regulation Down need separately for each Operating Hour.

When the system experiences significant Demand, Generation and/or Intertie ramps, the ISO may need more Regulation Up or Regulation Down depending on the relative slope and direction of the ramp as compared to other periods of the Operating Day. The ISO calculates the total ramp required based on the total change in Energy requirement caused by the change in hourly Interties, Load forecast, and Generation Self-Schedules.

The ISO procures Regulation for many reasons including load following, frequency response, Demand forecast inaccuracies, and market imbalance inaccuracies that occur between one Real Time Dispatch (RTD) period to the next. Through Automatic Generation Control, the ISO uses Regulation to balance all deviations continuously while the RTD corrects the 5 minute Energy imbalances. Although some of the reasons to procure Regulation have a high degree of predictability other reasons do not. Regulation requirements consist of variable and fixed components. The ISO believes any Regulation forecasting tool should calculate requirements for Regulation Up and Regulation Down and across each hour as accurately as possible. However, any tool should also establish a minimum and a maximum amount that the ISO should procure to operate the system in a reliable manner and provide consistent signals to Market Participants.

Regulation MW Amount Calculation:

During its Real-Time Market, the ISO calculates Regulation needs based on the projected worst 10 minute ramp rate required, up and down, separately. The ISO's RTD sends a dispatch instruction based upon forecasted Demand, while the ISO's Energy Management System accounts for any imbalances through Regulation to compensate for changes within the RTD 5 minute horizon. Three important drivers for this imbalance are 20 minutes of Intertie schedule changes (occurring around the start of each hour), 20 minutes of Self-Scheduled Generation (occurring around the start of each hour based on Awards in the Day-Ahead Market), and the actual system Demand variations. The ISO can calculate these three components with a high level of confidence.

Intertie schedule changes are based on the actual Awarded and Self-Scheduled hourly net variation in any 10 minute interval of each Operating Hour. Self-Scheduled Generation is based on Awards and Self-Schedules in the Day-Ahead Market. The Demand forecast is based on the deviation between two operating hours. The ISO calculates the amount of Regulation for each hour for Regulation Up separate from Regulation Down for the IFM as follows:

$$\begin{aligned} \text{Regulation up requirement} = 2 * \text{Max} (& (G_{i+1} - G_i)/4 + (T_{i+1} - T_i)/4 + (L_{i+1} - L_i)/12, \\ & (G_{i+1} - G_i)/4 + (T_{i+1} - T_i)/4 + (L_{i+1} - L_i)/6, \\ & \text{PRUP} * (\text{Shuts}_i) + (T_{i+1} - T_i)/4 + (L_{i+1} - L_i)/6 \end{aligned}$$

$$\begin{aligned} \text{Regulation down requirement} = 2 * \text{Min} (& (G_{i+1} - G_i)/4 + (T_{i+1} - T_i)/4 + (L_{i+1} - L_i)/12, \\ & (G_{i+1} - G_i)/4 + (T_{i+1} - T_i)/4 + (L_{i+1} - L_i)/6, \\ & \text{PRDN} * (\text{Starts}_i) + (T_{i+1} - T_i)/4 + (L_{i+1} - L_i)/6 \end{aligned}$$

Where:

- G_i Aggregate Total MW of all Self-Schedule and Awards Generation in hour i
 G_{i+1} Aggregate Total MW of all Self-Schedule and Awards Generation in the hour following hour i
 T_i Aggregate Total MW of all Interties in hour i
 T_{i+1} Aggregate Total MW of all Interties in the hour following hour i
 L_i CAISO Forecast of CAISO Demand for hour i
 L_{i+1} CAISO Forecast of CAISO Demand for the hour following hour i
 PRUP Participation value of Regulation Up for all Generating Units shutting down. Currently set to .4
 $Shuts_i$ The sum of Pmin for all Generating Units shutting down at the beginning of the hour i
 PRDN Participation value of Regulation Down for all Generating Units starting up. Currently set to .2
 $Starts_i$ The sum of Pmin for all Generating Units starting up at the beginning of the hour i

The sign convention in these calculations are positive for Energy supplied from Generation and Intertie imports and negative for Energy from load and Intertie exports. Based on these calculations, the Regulation Up requirement is a positive number and Regulation Down requirement is a negative number.

The ISO calculation of Regulation requirements begins and ends in the middle of the hour because calculation of the worst ramp rate sustained for ten minutes reflects changes between hours. The ISO calculates Regulation requirements based on the maximum Regulation requirements within a three hour timeframe (the current hour, the prior hour, and next hour).

In order to calculate Regulation requirements before the close of the IFM, the ISO uses the normal process of analyzing the next two trading days to forecast the Regulation requirement based on the market price mitigation run for each Trading Day.

The calculation set forth above identifies the worst coincidental peak ramp rate in 5 minutes and assumes the ramp continues for 10 minutes. The MW amount of that ramp can range between zero and over 1000 MW. However, the ISO has limited its variable Regulation requirement in the IFM by lower and upper bounds of 300 to 600 MW, respectively. The 300 and 600 MW boundaries may decrease or increase based on NERC and WECC control performance standards and ISO operational needs.

For the Real-Time Market, the ISO has modified its Regulation requirement tool so the operator starts with the Regulation procured in the IFM and has the option to modify it manually. The ISO does not recalculate the variable Regulation requirements in its Real-Time Market. The ISO is exploring functionalities to provide the operator the ability to recalculate the Regulation requirement needs in the Real-Time Market based on the latest forecast, IFM Awards and Self-Schedules, and Hour Ahead Scheduling Process (HASP) Intertie Awards and Self-Schedules. In the Real-Time Market, Regulation requirements

might vary for each 15 minute interval based on the Real-Time Unit Commitment (RTUC) process. Under this new functionality, the HASP will use the calculated IFM Regulation requirement for the new hourly Interties schedules while all other RTUC runs will recalculate the Regulation requirements based on the last RTUC run.