# 3. Real-time Imbalance Energy Market

## 3.1 Prices and Volumes

### *3.1.1 Real-time Imbalance Energy Market*

One of the key functions of the CAISO is to maintain the reliable physical operation of the system. In order to do this, the CAISO must perform real-time balancing of load and generation at a system-wide level. The CAISO maintains real-time balance through the combined use of (1) units providing regulation reserves, units on automatic generation control (AGC) requiring no explicit dispatch instructions, (2) units providing operating reserve ancillary services (A/S), and (3) resources that submit supplemental energy bids. The CAISO dispatches the latter two categories through awards of bids in the real-time imbalance energy market. In that market, supply (and some load) resources submit energy bids to *increment*, or increase, or *decrement*, or decrease their operating levels in response to CAISO dispatch instructions.

Whenever generation output is less than load, the CAISO will pay generators to increment their output above their schedules. Generators offer to increment generation at the price they are willing to accept to increase output. The CAISO calls upon as much energy as it needs, in order of the least to the most expensive price bid (subject to operating constraints), and pays all generators it calls upon to generate the marginal (or last) bid taken. Thus, no generator receives less for its energy than it was willing to accept to increment output.

Sometimes schedules plus minimum-load energy may actually exceed the amount of energy that is needed to serve load. As a result, the CAISO must dispatch some generators to decrement their output below their schedules. Generators bid prices they are willing to pay to decrement output, since they avoid costs such as fuel and variable operations and maintenance expense they would otherwise incur to produce electricity. In this case, the CAISO sorts bids from the highest to the lowest price, and allows units to decrement in economic merit (decreasing price) order. All units asked to decrement must pay the CAISO the marginal price. Thus, no generator is required to pay any more to be allowed to decrement than it had bid to do so.

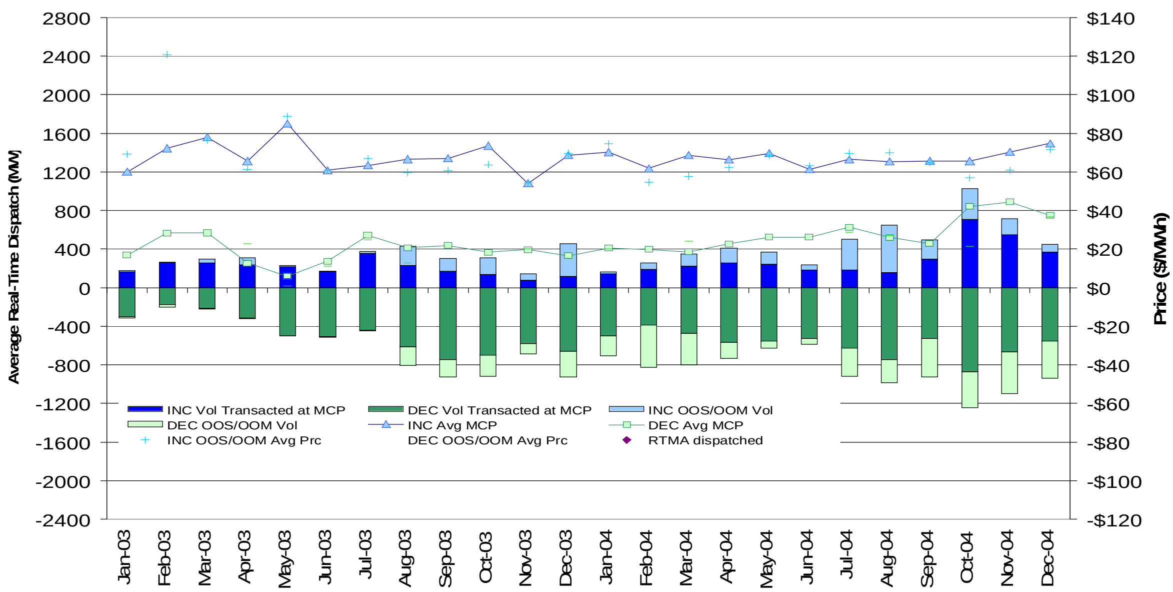
#### 3.1.1.1 Real-time Imbalance Energy Prices

Monthly average prices for incremental energy in 2004 were remarkably stable, averaging between \$60 and \$80/MWh in every month of the year. Average prices for decremental energy were also stable, ranging between \$20 and \$30/MWh, until the deployment of RTMA when they increased to approximately \$40/MWh for the last few months of the year. (All else being equal, higher prices for decremental energy, the prices generators pay for the privilege of avoiding the costs of generation, lowers costs to load.) Prices on an interval basis became considerably more volatile after the new RTMA systems were implemented on October 1.

#### 3.1.1.2 Real-time Imbalance Energy Volumes

In 2004, the CAISO's use of real-time balancing energy was overwhelmingly in the decremental direction, as has been the case since mid-2003. The ratio of decremental to incremental energy volume averaged 1.85 to 1 over the year. Forward-contracted deliveries and generation committed pursuant to the must-offer obligation together were often more than sufficient to meet load. Frequently, any in-sequence incremental dispatch was simply to balance the out-of-sequence decremental dispatches of generation at Mexicali, Mexico, or in the Palo Verde area in Arizona, to manage intra-zonal congestion at the Miguel, Sylmar, and Lugo substations, and to ensure compliance with the Southern California Import Transmission Nomogram (SCIT), a technical limit on the volume of power that can instantaneously be imported into the SP15 zone. Less often, but frequently nonetheless, decremental dispatches outside SP15 or north of the Lugo and Magunden Substations also offset incremental OOS dispatches to manage intra-zonal congestion at those choke points. (Please see Chapter 6 for details on intra-zonal congestion mitigation.) Figure 3.1 shows monthly average dispatch prices and volumes in 2003 and 2004.

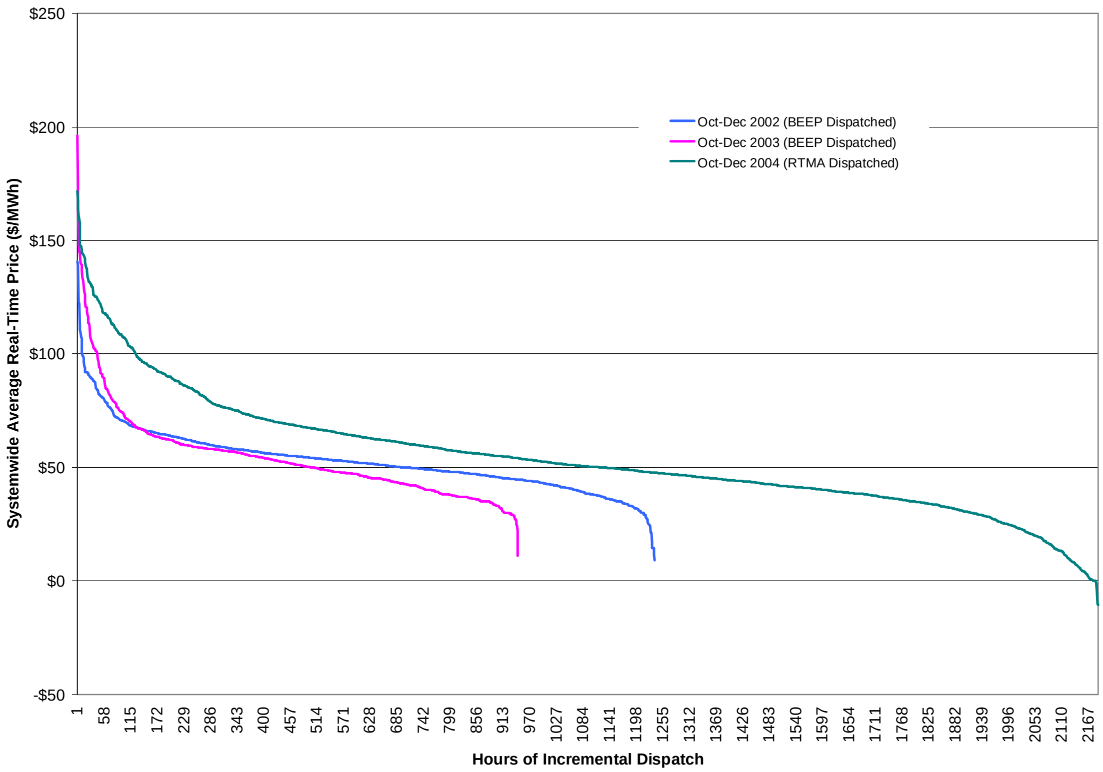
**Figure 3.1 Monthly Average Dispatch Prices and Volumes, 2003-2004**




After the CAISO implemented the RTMA software on October 1, real-time volumes increased. Around this time, prices became significantly more volatile, rapidly moving between prices near $0/MWh (usually when decrementing) to prices above $150/MWh (usually when incrementing), several times per day. Figure 3.2 shows duration curves for hourly average real-time incremental dispatch prices in October through December, in 2002, 2003 and 2004.[1]

[1] 2004 prices are ten-minute settlement prices, a composite of two five-minute dispatch prices. 2003 prices are ten-minute prices used for both dispatch and settlement.

**Figure 3.2 Duration Curves for Hourly Average Systemwide Real-Time Prices: October through December 2002, 2003, and 2004**




Several fundamental events had an impact on the increases in dispatch volumes and price volatility in the market:

- RTMA has an efficient market-clearing feature, which trades high-priced decremental energy for low-priced incremental energy, in order to reduce the overall cost to load of real-time energy. This has significantly increased real-time dispatch volumes.
- RTMA's least cost algorithm may also cause brief price spikes and rapid price swings. During ramping periods, RTMA often dispatches many units simultaneously to ramp quickly overall. Shortly thereafter, it can trade the most expensive units' energy by ramping them downward, as the less-expensive units continue to ramp upward. For the period of October through December 2004, the volume of total dispatched energy for economic clearing has averaged approximately 15 percent of total real-time energy for instate 5-minute dispatchable resources and 28 percent for pre-dispatched hourly dispatchable intertie resources. The remaining energy dispatched was used to balance generation with load, as shown in Figures 3.3 and 3.4 below.

**Figure 3.3 Monthly Average Volumes of RTMA Dispatch for Economic Clearing vs. Load Following for In-state Generation Resources**

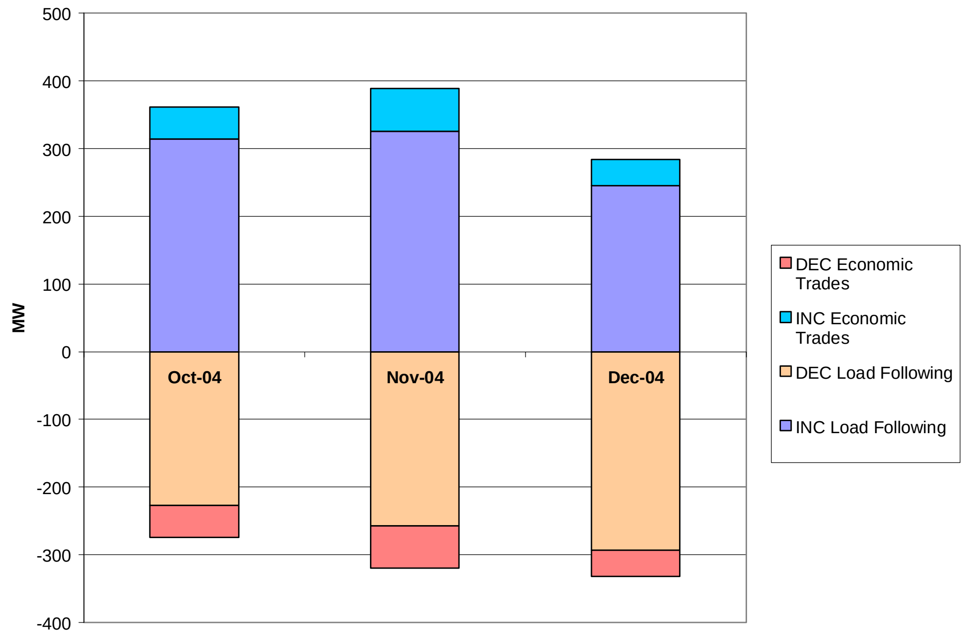
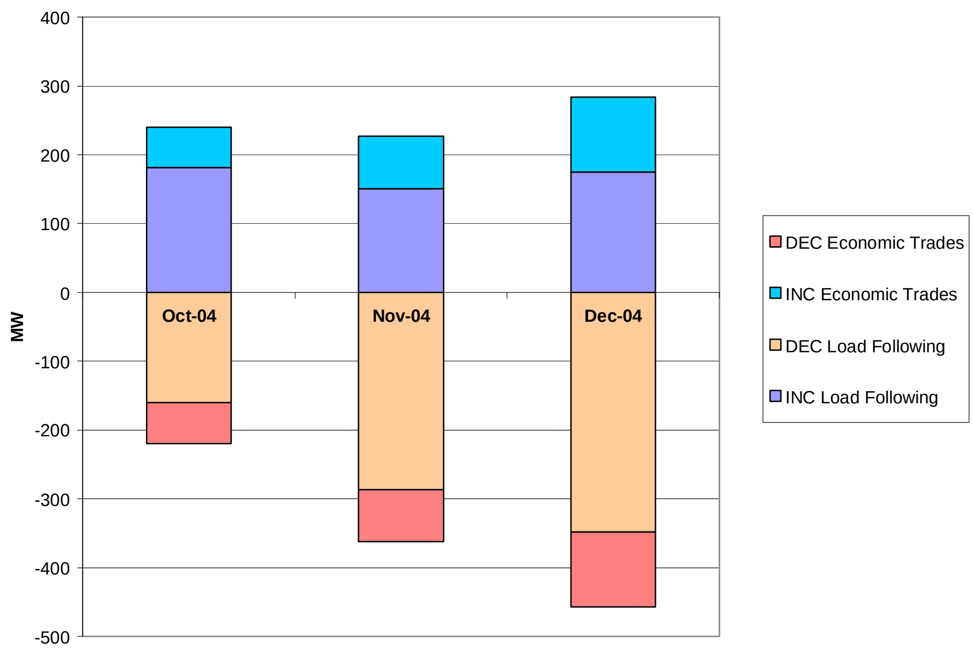
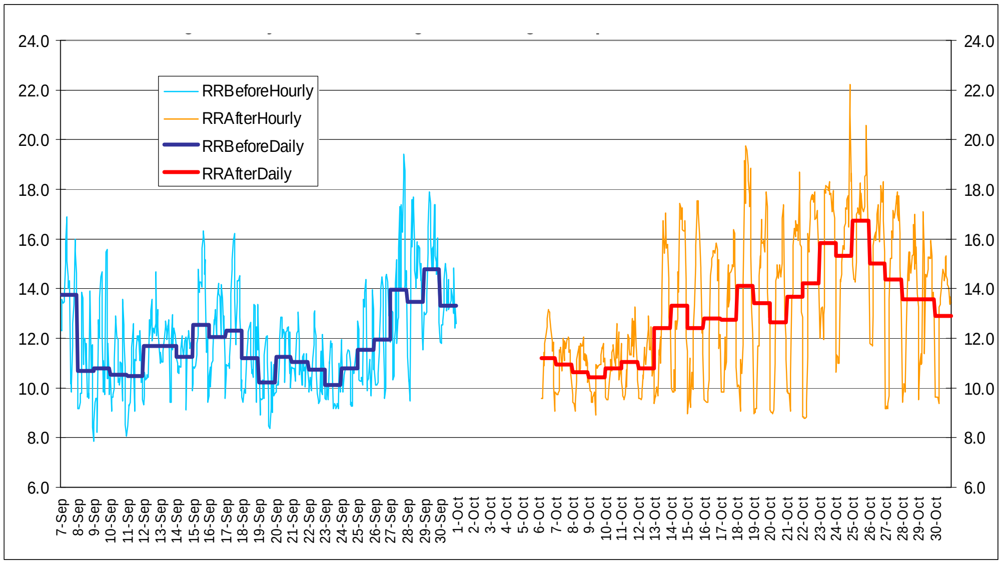



**Figure 3.4 Monthly Average Volumes of RTMA Dispatch for Economic Clearing vs. Load Following for Pre-dispatched Intertie Resources**



- RTMA also automates processes that previously involved manual forecasting, such as the must-offer commitment.
- Planned outages of the Pacific DC transmission line and two nuclear units concurrent with RTMA deployment also contributed to higher prices and price volatility. The Pacific DC Intertie was de-energized for upgrade work that had the effect of limiting imports from the Pacific Northwest directly into the Los Angeles basin, and increased reliance on internal generation. Also at that time, the San Onofre Nuclear Generating Station (SONGS) Unit 3 and Diablo Canyon Nuclear Unit 2 both were offline for annual refueling. Since these are large baseload units, together supplying as much as 15 percent of California's winter load, their absence further increased reliance on internal thermal generation. This is the case not only because these units supply power, but also because SONGS provides local voltage support, a service necessary for reliability within the Los Angeles Basin. The SONGS outage itself makes the SCIT nomogram more constraining, requiring more local generation to offset this loss of voltage support.
- Prior to the implementation of the new RTMA software, market participants could only submit a single ramp rate with their bid segments. That changed with the implementation of Phase 1B. Market participants now submit up to 10 bid segments, each having its own ramp rate. Initially, the new market design called for default ramp rates to be set at a unit's minimum ramp rate. However, during system testing, the CAISO found the default ramp rates caused a problem. RTMA would have to dispatch several units to meet small load imbalances due to the tight ramp rate restrictions. The CAISO filed Amendment 54 that, in part, called for the default ramp rate to be set at a unit's maximum ramp rate. This provision was approved by FERC and implemented on October 2. This helped to settle down some of the volatile market outcomes observed during the first two days of RTMA market operation. System ramping capability remained below that of September and contributed to pricing volatility in early October. Increased ramp rates submitted later in the month led to more price stability. Figure 3.5 below shows the average ramp rates of the real-time energy market just prior to and after implementation of RTMA. One concern with the implementation of uninstructed deviation penalties is that generators may be overly conservative when supplying the CAISO with their real-time ramping capability. By submitting conservative ramp rates, generators would have an easier time following CAISO dispatch instructions and reduce their chance of incurring uninstructed deviation penalties. Such an outcome could lead to more volatile real-time prices.

**Figure 3.5 Daily and Hourly Average Ramp Rates of Units Bid into Real-Time Market: 9/7/04 – 10/30/04**




### 3.1.1.3 Volatility (Annualized historical volatility of hourly RT prices by zone)

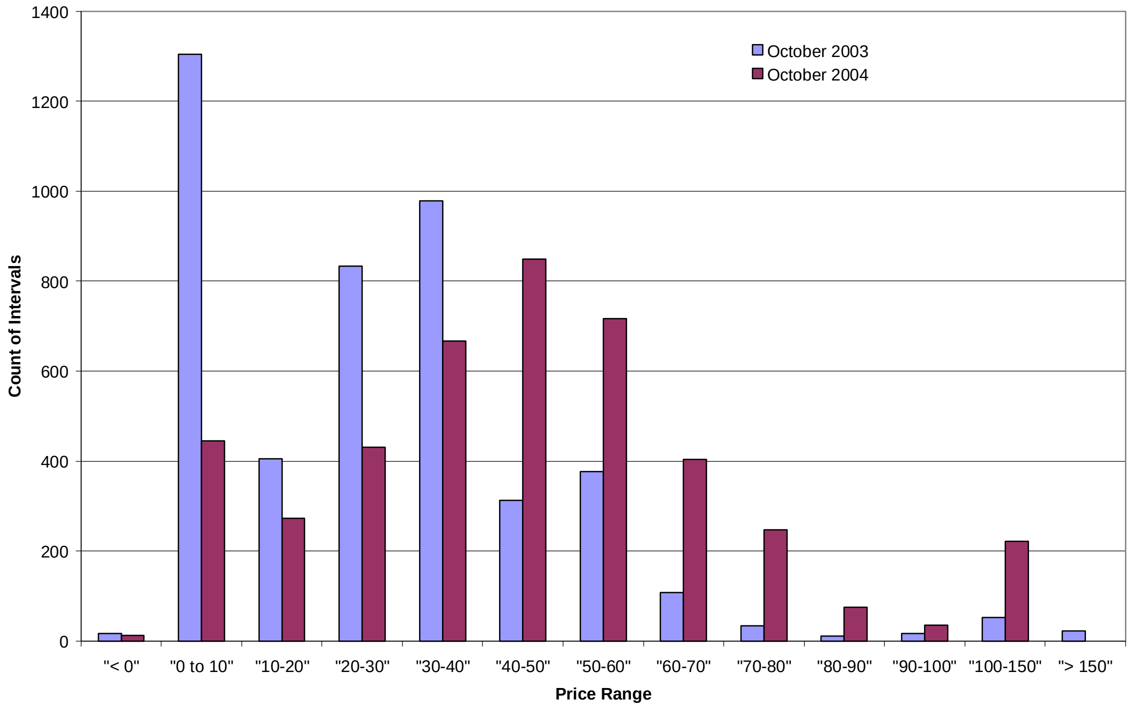
Real-time price volatility has continued to decrease, as was the case throughout 2003. One measure of volatility is the “volatility index,” a ratio of the standard deviation to the average price. A small volatility index indicates low volatility relative to price. Because the RTMA market uses a single price, this report combines incremental and decremental prices in place prior to Phase 1B implementation into a single price for the purposes of the calculation of volatility. This methodology also uses ten-minute settlement prices during the Phase 1B period, in order to be comparable to the prior period. Table 3.1 shows annual average volatility between 2001 and 2004, with 2004 broken into Phase 1a (January through September) and Phase 1b (October through December) periods.

**Table 3.1. Volatility in Zonal Real-Time Prices**

| | NP15 | | | SP15 | | |
|---|---|---|---|---|---|---|
| | Avg. Price | St. Dev. | Volatility Index | Avg. Price | St. Dev. | Volatility Index |
| 2001 | $ 69.28 | $ 64.20 | 0.93 | $ 63.36 | $ 64.22 | 1.013 |
| 2002 | $ 26.75 | $ 21.43 | 0.80 | $ 27.29 | $ 21.62 | 0.792 |
| 2003 | $ 34.90 | $ 24.91 | 0.71 | $ 35.88 | $ 25.95 | 0.723 |
| 2004 Ph. 1a | $ 35.78 | $ 20.17 | 0.56 | $ 36.59 | $ 23.19 | 0.634 |
| 2004 Ph. 1b | $ 45.12 | $ 25.94 | 0.58 | $ 49.05 | $ 30.00 | 0.612 |

Since Phase 1b was implemented, prices appear to have dispersed to some degree. Whereas in October 2003 prices were bimodally distributed, with prices most often falling in the $0-10 and $30-40/MWh ranges, prices in 2004 were more normally distributed, with the largest number of intervals falling in the $40-50/MWh range. The following chart is a histogram comparing the dispersion of real-time prices in SP15 for October 2003 and October 2004.[2]

### Figure 3.6 Dispersion of SP15 Real-Time Prices: October 2003 vs. October 2004

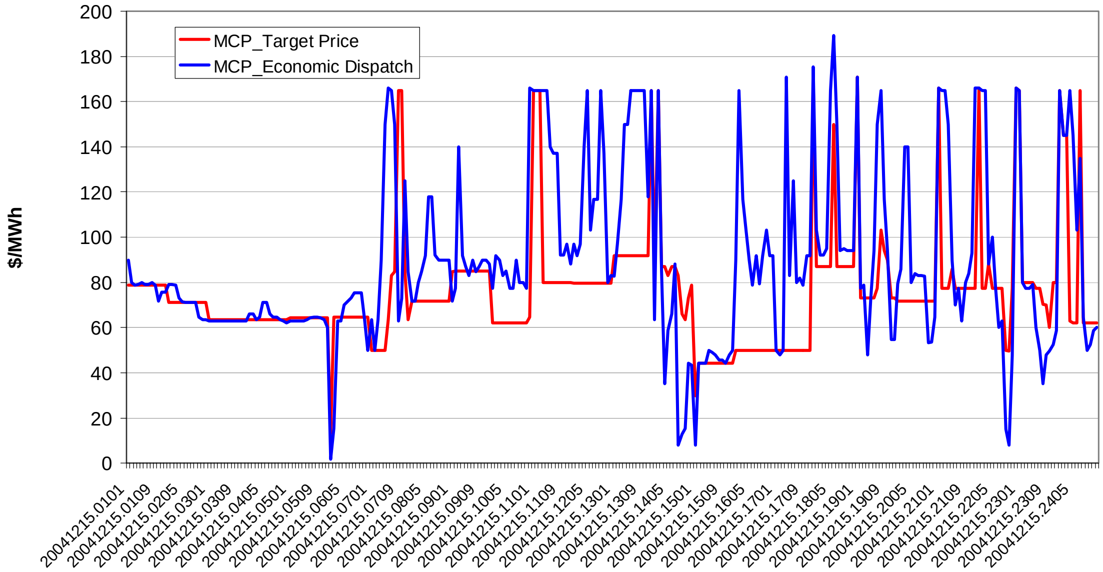



Price volatility will be greater under economic dispatch under the new RTMA systems than the previous target price methodology. Under the target price methodology, incremental and decremental overlapping bids were not cleared and in order to make a monotonically increasing bid curve, a target price would be established equal to the intersection of the lowest incremental energy bid and the decremental energy bid supply curve. This resulted in the market clearing price frequently being set at the target price and not necessarily reflecting the true marginal bid price using bids supplied for real-time market dispatches. Using actual bids submitted to the market, the CAISO conducted a study comparing market-clearing prices under the previous target price methodology and the new economic dispatch methodology. The standard deviation of the market clearing prices under the target price methodology was $19.7/MWh, while the standard deviation under the economic dispatch methodology was $26.8/MWh. Figure 3.7 shows the results using actual bids submitted on December 15, 2004. As shown, prices are more volatile under the economic dispatch methodology. This is expected because under the target price methodology, the price

[2] For an apples-to-apples comparison, 2003 prices are weighted averages of INC and DEC ten-minute interval prices, and 2004 prices are ten-minute settlement interval prices.

is often stuck at the target price for several intervals as illustrated by the flat line segments for the target price market clearing prices.

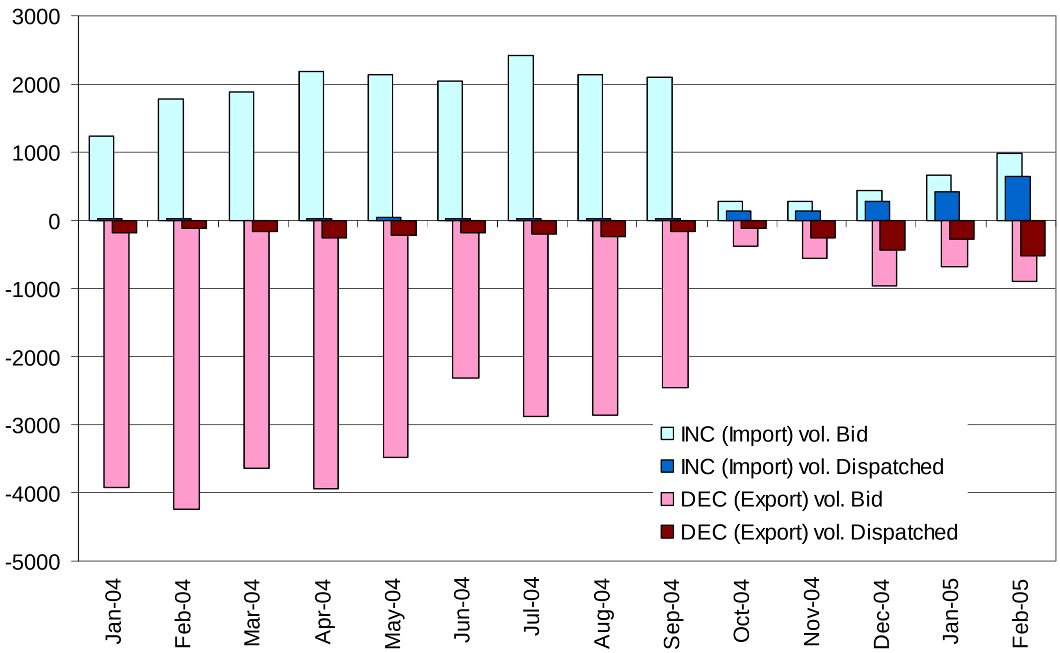
**Figure 3.7 Simulation of Real-time Market Clearing Prices under Target Price and Economic Dispatch Methodologies – December 15, 2004**




### *3.1.2 Real-time Supplemental Energy Import Bids*

Bids to supply imported supplemental energy were numerous between January and September, averaging in the neighborhood of 2,000 MW. They then immediately decreased in October. This follows typical seasonal changes in hydro energy output, planned maintenance outages and import limitations resulting from outages of transmission (the Pacific DC Intertie and the Miguel substation) that occurred at this time. The drop-off is also in part likely due to the fact that RTMA does not accept bids on de-energized paths. Meanwhile, real-time pre-dispatched energy on interties increased substantially, primarily due to the economic clearing of import (INC) and export (DEC) real-time energy bids from resources outside the CAISO control area. Figure 3.8 shows monthly average real-time import/export bids and dispatches in 2004.

**Figure 3.8 Monthly Average Import/Export Bids and Dispatch Volume**




### *3.1.3 Uninstructed Deviations*

Uninstructed deviations are defined as resources that operate at a different level than their instructed operating point. Uninstructed deviations are problematic for real-time operations, as operators need some certainty in the amount of imbalance energy that will be injected into the system following dispatch instructions. The new RTMA systems should result in lower levels of uninstructed deviations because the software takes into account the current operating constraints of real-time energy units. This should reduce or eliminate the issuance of dispatch instructions. Uninstructed deviation penalties that are slated for implementation in the spring of 2005 will provide real-time resources with further incentives to closely follow dispatch instructions. Ultimately this should result in a more reliable and efficient real-time energy market.

RTMA was implemented on October 1, 2004. Comparing levels of uninstructed deviations for the periods October 1, 2003 through December 31, 2003 and October 1, 2004 through December 31, 2004, the overall level of uninstructed deviations had remained fairly constant. Uninstructed deviation levels of participating generation units, which will be subject to uninstructed deviation penalties, increased by around 6 percent for positive deviations and decreased by around 19 percent for negative deviations. We expect the level of uninstructed deviations to fall as scheduling coordinators and system operators become more proficient with the new systems. We also expect better adherence to dispatch instructions once the uninstructed deviation penalties are in place, which will provide a strong incentive for scheduling coordinators to closely follow dispatch instructions.

### *3.1.4 Forward Scheduling*

For most of 2004, scheduling was more than sufficient to meet load, when supplemented by generation committed at minimum load pursuant to the must-offer obligation. In 2004, monthly average forward schedules were within 2 percent of actual load throughout the year, similar to the previous two years. This has resulted in small real-time imbalance energy dispatch volumes. Figure 3.9 below shows the monthly average forward scheduled energy volumes compared to actual loads and the percent under/overscheduling for the years 2000 through 2004.

**Figure 3.9 Monthly Average Loads and Scheduling Deviations, 2000 through 2004**