

# Memorandum

**To:** ISO Board of Governors  
**From:** Eric Hildebrandt, Director, Market Monitoring  
**Date:** September 1, 2010  
**Re:** *Market Monitoring Report*

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*This memorandum does not require Board action.*

## Executive Summary

This memo provides a brief summary of market performance during the months of April through mid-August 2010. The report summarizes and updates analysis provided in the last quarterly report prepared by the Department of Market Monitoring (DMM) covering the second quarter of 2010.<sup>1</sup> Key findings include the following:

- The day-ahead integrated forward market (IFM) has continued to be very stable and competitive, with average prices close to levels that DMM estimates would result under extremely competitive conditions.
- In June and July, average real-time market prices rose significantly above competitive baseline prices due to an increase in the frequency and magnitude of high real-time price spikes. Because most energy is scheduled in the day-ahead market, higher average real-time prices have had minimal impact on overall wholesale energy costs.
- These price spikes were attributable to a wide range of different factors. Market modeling and forecasting improvements being pursued by the ISO may address the underlying cause of some of these price spikes. In general, however, these price spikes involve short-term system and market conditions that can be expected to occur periodically and result in high real-time prices.
- Starting April 1, 2010, the energy bid cap was raised from \$500/MWh to \$750/MWh. Bidding behavior has not changed significantly after this increase in the bid cap. However, penalty prices used to determine market prices when model constraints are violated are also set at the bid cap. Thus, the increase in the bid cap has indirectly contributed to an increase in the magnitude of price spikes when these modeling constraints are violated for brief periods in the real-time market.

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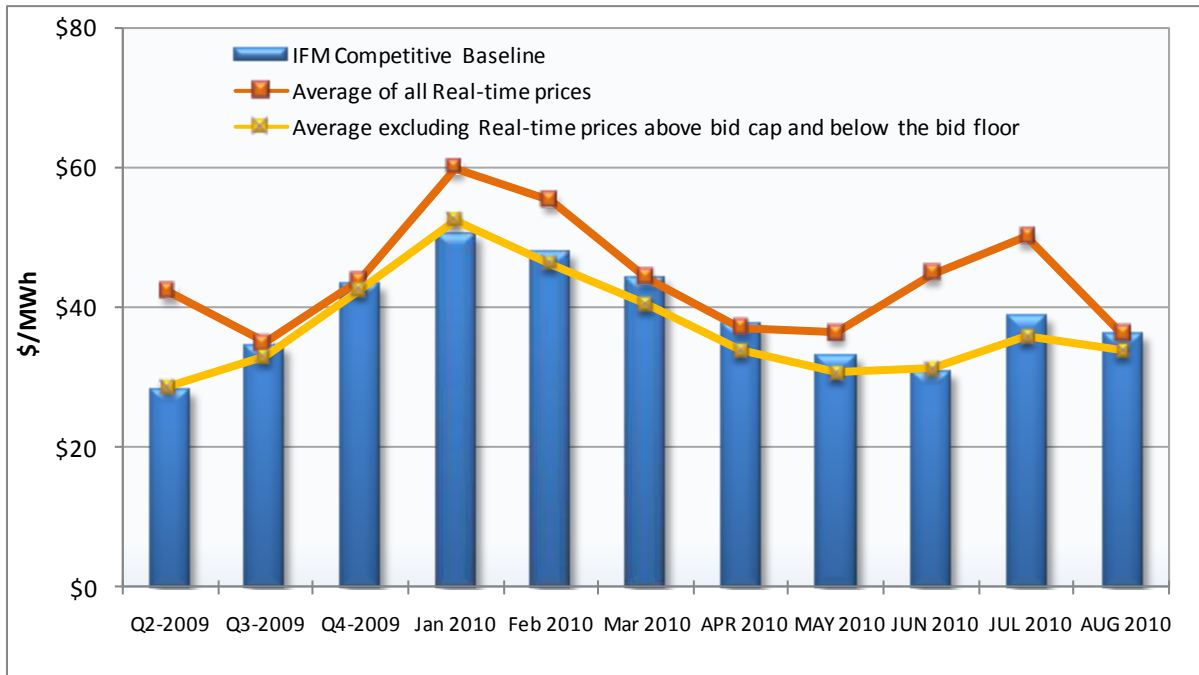
<sup>1</sup> *Quarterly Report on Market Issues and Performance*, August 11, 2010, covering April through June, 2010, <http://www.caiso.com/27ef/27ef9dc058db0.pdf>

- In the second quarter 2010 (April to June), the ISO software continued to decrease net imports in the hour-ahead market at relatively low prices, and then dispatch additional energy at higher prices in the 5-minute real-time market from resources within the ISO. This causes revenue imbalances that must be recovered from load-serving entities. In June, these imbalances were the highest for any month since the start of the market. These charges have decreased in July and even more through mid-August.
- DMM recommends that the ISO focus additional attention to addressing the issue of price divergence by improving the consistency of dispatches and prices in the hour-ahead and 5-minute markets.

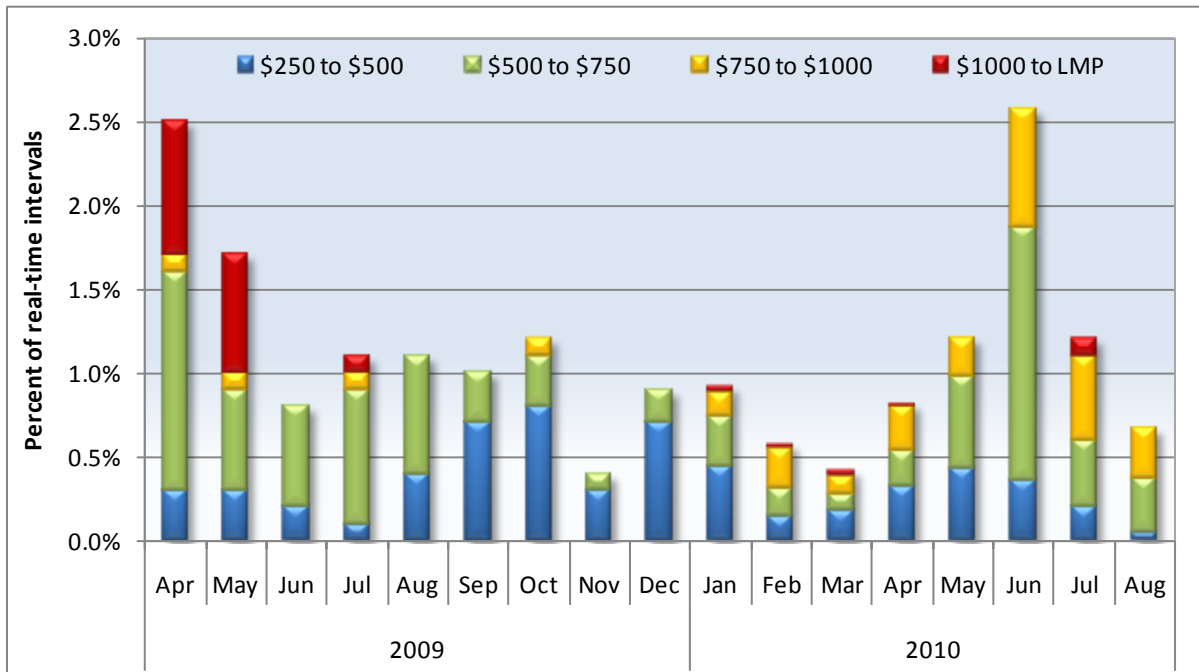
### **Overall market performance**

- The day-ahead market has continued to be very stable and competitive, with a very high portion of load and supply being scheduled in the day-ahead market (e.g., typically 95 to 100 percent).
- Average energy prices in the day-ahead market during each month of 2010 continue to be approximately equal to average benchmark prices estimated under perfectly competitive conditions.
- Average prices in the 5-minute real-time market during April and May 2010 were close to average competitive baseline levels, as shown in
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- Figure 1.
- In June, average real-time prices throughout the system increased significantly above day-ahead and competitive baseline prices. In July, average real-time prices in the SCE and SDG&E areas continued to exceed day-ahead and competitive baseline prices, while prices in the PG&E area were approximately equal to day-ahead prices and competitive baseline levels.
- Through mid-August, average real-time prices have been approximately equal to competitive levels throughout the system.
- Because most energy is scheduled in the day-ahead market and such a small portion of overall energy is procured in the real-time market, higher average real-time prices have had minimal impact on overall wholesale energy costs.
- The higher real-time prices in June and July reflect an increase in the frequency and magnitude of real-time energy price spikes, as shown in
- Figure 2. These price spikes have been due to a combination of different factors, as described in more detail in the following section.

**Figure 1 Comparison of competitive baseline price to average real-time prices (SCE)<sup>2</sup>**



**Figure 2 Frequency and magnitude of price spikes in real-time market by month<sup>3</sup>**



<sup>2</sup> Prices for August include data from August 1 through August 15.

<sup>3</sup> See footnote 2.

## **Real-time price spikes**

In June, most price spikes occurred during the late evening ramping and late night off-peak hours due to shortages of upward ramping capability during brief intervals of time. The shortage of upward ramping capacity in these hours was attributable to several factors:

- Due to relatively low loads and high hydro conditions in June, the ramping capability of on-line thermal fleet was sometimes insufficient to meet the sudden increases in the demand for upward ramping.
- During the late evening hours, upward ramping capacity is particularly limited as some thermal resources begin shutting down – sometimes without providing sufficient advance notice via a SLIC normal card for these outages to be incorporated in the market software for some intervals.
- In June, the load forecast used in the hour-ahead dispatch process for imports and exports tended to be lower than the actual load in real-time during the late evening and early off-peak hours when load is decreasing. This caused the hour-ahead market software to underestimate the amount of load needing to be met in real-time. This trend was addressed in mid-June by shifting the three 5-minute interval load forecast average, which determines the 15-minute load forecast used in the hour-ahead process, to look “backwards” one additional 5-minute interval.
- During initial off-peak hours (hours ending 24, 1, 2, and 3), numerous price spikes were caused by pump loads coming on when limited short-term upward ramping capacity was available.

In July, most price spikes occurred during peak hours, and occurred in the SCE and SDG&E areas only due to congestion on Path 26. Specifically:

- On July 15, loads were unexpectedly high and actual loads exceeded day-ahead schedules by up to 2,000 MW during peak hours.
- From July 15 to 17, a series of real-time price spikes continued to occur in the SCE and SDG&E areas due to congestion on Path 26.
- From July 29 through 31, Path 26 was de-rated due to fires, causing significant congestion and high prices in Southern California.

## **Increase in bid cap**

On April 1, 2010, the energy bid cap increased from \$500/MWh to \$750/MWh. Analysis in DMM’s second quarter report for 2010 shows that increasing bidding behavior did not change substantially after the energy bid cap was raised to \$750/MWh, and that most high prices after April were not due to the dispatch of high priced energy bids.<sup>4</sup>

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<sup>4</sup> See pp. 31 to 38 in DMM’s *Quarterly Report on Market Issues and Performance*, August 11, 2010.

However, penalty prices used to determine market prices when model constraints are violated are also set at the bid cap. Thus, the increase in the bid cap has indirectly contributed to an increase in the magnitude of price spikes when these modeling constraints are violated for brief periods in the real-time market.

Analysis by DMM shows that the two primary drivers of high real-time locational marginal prices (LMPs) involve violations of the power balance constraint and congestion on transmission constraints. The penalty prices for both types of constraints are set equal to the bid cap. During intervals when these constraints are violated, these higher penalty prices will result in higher energy and congestion prices.

Although the precise impact of higher penalty prices on these constraints cannot be feasibly calculated, DMM has performed analysis to provide an indication of the degree to which higher penalty prices on these constraints impact prices. For example:

- Over 85 percent of the load aggregation point LMPs over \$475/MWh from April to mid-August were driven by violations of the power balance constraint and/or transmission congestion. Of these two factors, the power balance constraint violations were more likely to cause high 5-minute market prices and were typically due to relatively short-term real-time ramping limitations.
- In June and July, DMM estimates that the increase in penalty prices from \$500/MWh to \$750/MWh increased average load aggregation point prices in the 5-minute real-time market by up to 10 percent.<sup>5</sup> For comparison, real-time prices in the SCE area exceeded competitive baseline levels calculated by DMM in June by about 46 percent and about 30 percent in July.

This analysis indicates that the increase in penalty prices due to the higher bid cap was a significant factor that contributed to the increase in real-time prices above day-ahead prices in these months, most notably in periods when there were short-term ramping limitations.

### **Increase in maximum price limit**

Before April 2010, energy LMPs were restricted to be between  $\pm$  \$2,500/MWh. These price limits were eliminated on April 1, 2010. As noted in DMM's report on the second quarter of 2010, elimination of these price limits had a negligible impact on market prices.<sup>6</sup> Specifically:

- In the day-ahead market, there were no instances where nodal prices were outside the  $\pm$  \$2,500/MWh limits previously in place.
- In the 5-minute real-time market, there were only five hours in the second quarter of 2010 where nodal prices exceeded the former caps in the real-time market. The estimated incremental cost of real-time nodal LMPs above the previous \$2,500/MWh limit is less than \$20,000.

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<sup>5</sup> DMM estimated the impact of higher penalty prices on the power balance constraint by truncating prices at \$500/MWh during intervals when the power balance constraint was violated, and then recalculating average monthly prices.

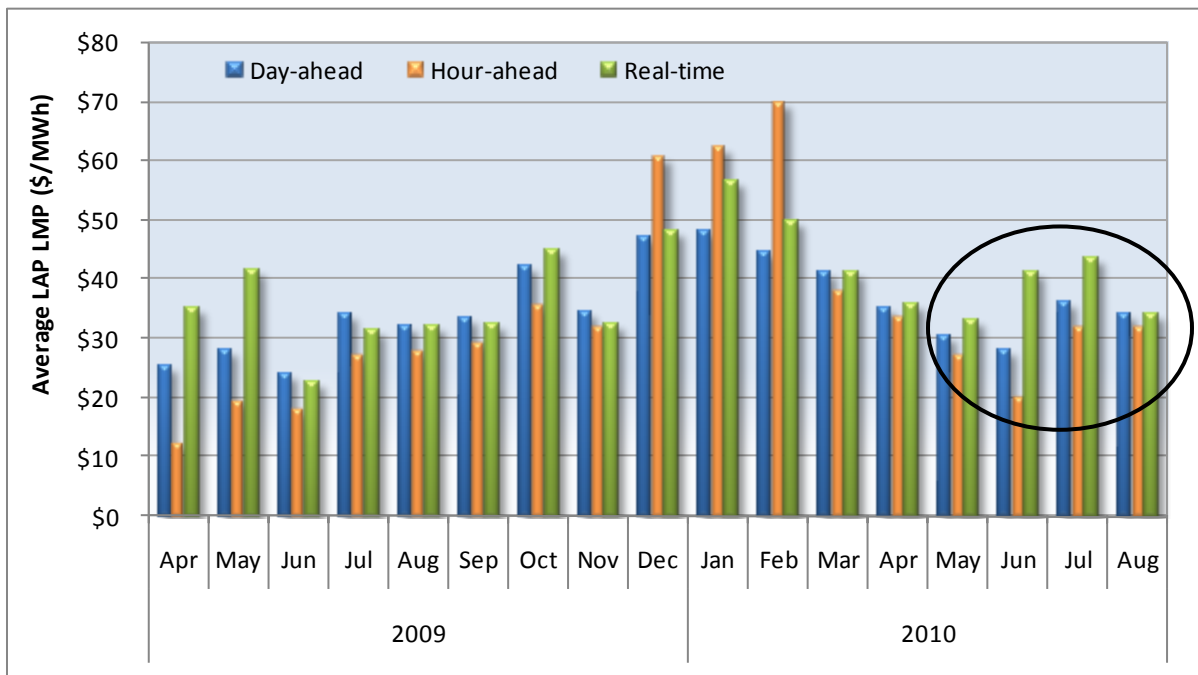
<sup>6</sup> See p 38 in DMM's *Quarterly Report on Market Issues and Performance*, August 11, 2010.

### Divergence in hour-ahead and real-time prices

As shown in Figure 3, prices in the hour-ahead scheduling process (HASP) were significantly lower than prices in the 5-minute real-time dispatch (RTD) market in the second quarter of 2010. A combination of multiple factors contributed to this change in price convergence, which was most notable in June. These include:

- Real-time de-rates on transmission capacity from the Northwest;
- Unscheduled flows requiring reduced imports and de-rates on internal transmission paths;
- Load forecast differences between the hour-ahead scheduling process and real-time;
- Steep load ramp in the evening hours;
- Limited short-term ramping capacity in real-time during off-peak hours; and
- Generation deviations by both renewable and other generation resources in real-time.

**Figure 3 Monthly average prices (SCE LAP)<sup>7</sup>**



The consistency of prices in the hour-ahead and real-time markets improved slightly in July and improved significantly in the first half of August.

As discussed in DMM’s quarterly report for the third quarter of 2009, divergence in the hour-ahead scheduling process and real-time dispatch can create substantial uplifts that must be recovered from load-serving entities through the real-time imbalance energy offset charge (Charge Code 6477). These additional costs are incurred when price divergence is coupled with a trend for the ISO to export relatively large quantities of additional energy in the hour-ahead

<sup>7</sup> Prices for August include data from August 1 through August 15.

scheduling process (at low prices), and then dispatch additional energy within the ISO in the real-time dispatch (at significantly higher prices).

As shown in Section 3 of DMM's second quarterly report for 2010, the amount of import/export energy that is reduced in the hour-ahead and then re-procured in the 5-minute real-time market has increased from an average of about 300 MW per hour in April to over 900 MW per hour in June 2010.

Figure 4 shows the estimated costs of additional imbalance energy as a result of decreasing net imports in the hour-ahead and increasing procurement of imbalance energy in real-time at a higher price. Figure 4 also shows the actual real-time imbalance energy offset charges from the ISO settlement system for each month. Since other factors can increase or decrease these settlement charges, these actual settlement charges and DMM's estimate of the costs associated with decreased net imports in the hour-ahead are equal and vary in some months.

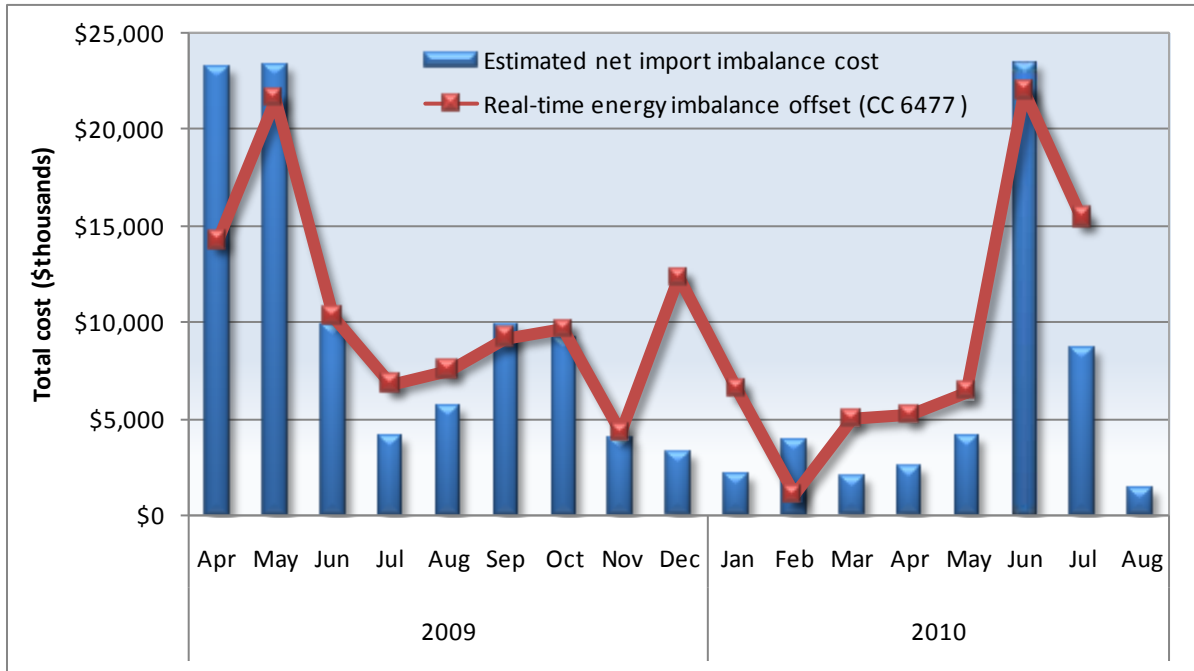
As shown in Figure 4, actual charges under Charge Code 6477 and DMM's estimate of costs due to "selling low" in hour-ahead and "buying high" in real-time are highly correlated, and increased substantially in June to over \$23 million. This compares to an average estimated cost of about \$5 million per month in the prior 12 months, and represents the largest estimated cost in any month since the start of the new market.

DMM's estimate of costs fell by over 60 percent to \$8.5 million in July and fell again to just under \$1.4 million through the first half of August. The majority of the costs in July can be explained by two events.<sup>8</sup> Combined, these two events totaled \$4.8 million in estimated costs. The remainder of July accounted for \$3.6 million, less than the estimated cost for July 2009.

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<sup>8</sup> First, a large negative price spike to -\$1,600/MWh in the hour-ahead scheduling process on July 4 due to load forecasting issues drove the daily average estimated cost to \$3 million. Second, Path 26 was derated significantly on July 29 and 30 compared to the day-ahead market run, causing substantial readjustments in real-time.

**Figure 4 Estimated imbalance costs due to decreased net hour-ahead imports reprocured in 5-minute real-time market at higher price<sup>9</sup>**



**Recommendations**

The pattern of selling relatively large quantities of import/export energy in the hour-ahead scheduling process and then re-purchasing additional energy in the 5-minute market at higher prices remains one of the most critical areas for further improvement in the new market software and processes.

Many of the changes identified in DMM’s third quarter report for 2009 that might address this issue are still under development by the ISO. In several cases, implementation of these modifications was initially anticipated in the end of 2009 or early 2010, but implementation is now anticipated in Q3 2010. The status of these changes as well as other ISO actions is outlined below.

- As reported in DMM’s Q3 2009 report, the ISO is developing a new short-term forecasting tool that is designed to provide a more accurate and consistent forecast for both the hour-ahead scheduling process and the real-time market. In addition, this new forecast will specifically be designed to provide forecasts at the 15-minute and 5-minute level of granularity over the approximately two hour forecasting timeline needed for the hour-ahead and real-time markets. Implementation of this new forecasting tool is anticipated in the third quarter of 2010.

<sup>9</sup> Results for August include data from August 1 through August 15. Since settlement data for charge code 6477 was only complete for a small set of the days for August 2010 at the writing of this memo, it has been left off Figure 4.



- In the interim, before the new forecasting tool is operational, the ISO has taken steps to better forecast loads during ramping periods. An adjustment was implemented early in 2010 to reduce differences between the hour-ahead and the real-time forecasts by “shifting” the interval from the hour-ahead forecast used to estimated real-time loads. This adjustment was further tuned in mid-June 2010.
- In Q3 2009, the ISO assessed a variety of options that might mitigate the impacts of the differences in ways that inter-tie schedules and ramping of resources are modeled in hour-ahead compared to real-time. As an initial step, the ISO is developing enhancements that would modify the hour-ahead scheduling process to account for the imbalance energy difference that arises due to the fact that it does not model how changes in net hourly inter-tie schedules are ramped in over a 20-minute period each operating hour. Testing of this enhancement is currently in progress. The target for release is also during the third quarter of 2010.
- The ISO is continuing to look for opportunities to improve how and when to bias the system. As part of this effort, the ISO is developing a more systematic procedure that gives the operators more guidance to the maintenance of load biasing to determine whether a bias should be removed or continued.
- In late July 2010, the ISO implemented the capability to produce automated *compensating injections* in the hour-ahead and 5-minute real-time market software. This feature is designed to automatically align flows produced by the market software with actual observed flows. Thus, this feature is expected to decrease the need for manual conforming of transmission limits, and may help to improve price convergence between the hour-ahead and 5-minute markets.
- The ISO has begun a process to evaluate what products, if any, may be necessary to support renewable integration. These products could potentially address some of the issues related to low ramping capability which can affect price convergence.

While implementation of the changes identified above may improve convergence of prices in the hour-ahead and 5-minute markets, DMM believes the ISO should continue to seek to identify other potential sources of the divergence between prices and dispatches in these markets and how these may be addressed. As illustrated by the relatively high revenue imbalance costs incurred in June, such divergences can involve significant market costs.