Memorandum

To: ISO Board of Governors

From: Eric Hildebrandt, Director, Department of Market Monitoring

Date: January 30, 2014

Re: **Market Monitoring report**

This memorandum does not require Board action.

EXECUTIVE SUMMARY

This memo provides analysis and comments of the Department of Market Monitoring (DMM) on three issues.

- **Full network model expansion**. DMM strongly supports the ISO's proposal to improve modeling of the ISO system by expanding the topology and inputs used to project actual power flows in the day-ahead and real-time market models. While most of the discussion throughout this initiative has focused on the market efficiency impacts of this modeling enhancement, it is important to note that the primary driver of this initiative is the reliability benefits that will stem from increased visibility and co-ordination with other balancing areas, and the ability to enforce more reliability constraints and feasible schedules in the ISO. The initiative also provides the opportunity for increased market efficiency from more accurate pricing of schedules and lower congestion uplifts. However, as discussed in detail in the opinion of the Market Surveillance Committee (MSC), accurately projecting unscheduled flows using a full network model is a complex task. Consequently, DMM joins the MSC in recommending the ISO commit the resources necessary to analyze, validate, and benchmark the full network model before and after implementation to ensure this feature provides the intended benefits. DMM will continue to work closely with the ISO and MSC in this important effort.

- **Market competiveness in 2013.** As noted in prior Board memos, overall prices in 2013 increased about 30 percent due to higher gas prices and costs associated with the state's cap-and-trade program for greenhouse gases. However, analysis by DMM completed for our 2013 annual report indicates prices were even more competitive than in 2012, after taking into account the impact of higher gas prices, greenhouse gas compliance costs and other supply and demand conditions. Prices in 2013 were in the range expected in an extremely competitive market, and were consistent with the highly competitive prices observed in 2010 through 2012.

- **Implementation of 15-minute market**. DMM is working closely with the ISO before and after implementation of the new 15-minute market this spring to monitor market performance and make any adjustments that may be appropriate to manage and ensure the efficiency of this new market. In our report on performance in the third quarter of 2013, DMM identified a long term trend of relative high prices in the ISO's current 15-minute pre-dispatch process, which are currently non-binding and not used in any financial settlement. However, since that report, 15-minute prices have tracked more closely with other market prices, and the ISO has identified the cause of the price divergence and steps that may be taken to mitigate any trend of high average 15-minute prices that might re-occur after implementation of the new 15-minute market this spring.

FULL NETWORK MODEL EXPANSION

DMM strongly supports the ISO's proposal to improve modeling of the ISO system by expanding the topology and inputs used to project actual power flows in the day-ahead and real-time market models. By expanding the full network model to include other balancing areas, the ISO will also be able to reflect outages and other reliability parameters on those external systems and analyze how that may affect the ISO market. This provides the opportunity for substantial reliability benefits under scenarios such as that which led to the major southwest blackout on September 8, 2011.

These modeling enhancements should also improve market efficiency by allowing better management of congestion. Including these modeling improvements in the day-ahead and real-time markets will help the ISO create feasible schedules, enforce reliability, and accurately price market transactions. Expanding the ISO's network model to a regional level that includes other balancing authority areas is also a key component needed to ensure the efficiency and future expansion of the ISO's energy imbalance market.

The ISO's initial proposal was modified significantly as the result of input from DMM, the Market Surveillance Committee and stakeholders. Specifically, major changes involving how pricing of imports and exports would be affected by assumptions about actual physical sources or sinks of these transactions were deferred for consideration in a later phase. DMM strongly supported deferral of this aspect of the proposal. The final proposal will still affect the pricing of some import and export transactions. However, under the final proposal, the price for imports and exports will only be higher or lower based on the ISO's own modeling of the impact and value of these schedules given actual power flows.

As explained in Management's memo, the key feature of the final proposal is that the ISO's network model will be expanded to include the other balancing areas in the Western Electricity Coordinating Council area. This expanded model will be used to model the unscheduled electrical flows that will occur within the ISO balancing area caused by the load, generation, and interchanges forecast for other balancing areas in the western interconnection. The goal of this is to produce day-ahead and real-time schedules and prices that more accurately reflect actual system constraints and the impact schedules have on these constraints.

In addition to increasing reliability, this expanded network model may help reduce real-time congestion imbalance offset costs that are incurred when unscheduled real-time flows create the need to reduce flows created by schedules awarded in the day-ahead market. One potential limitation of this effort is that the ISO may not have data on schedules outside the ISO that are complete, timely, or accurate enough to sufficiently project next-day base schedules used in the full network model.

Even with this information, the accuracy with which unscheduled flows can be projected will depend on a variety of other modeling assumptions that must be made, such as which generation schedules in other balancing areas are ultimately increased or decreased as a result of imports or exports with the ISO. Consequently, monitoring the impact that this has on projections of unscheduled flow and congestion in the day-ahead and real-time market models – and modifying these models in response to this monitoring – will be critical.

DMM strongly supports the opinions and recommendations of the MSC on this issue which have been stressed throughout the stakeholder process and are summarized in their final opinion on Mangements' proposal. As noted in the MSC opinion, creating and testing the full network model is likely to be a difficult and complex task, and other ISOs have experienced serious challenges in improving the accuracy of their estimates of unschedled flows. Consequently, DMM joins the MSC in recommending that the ISO analyze, validate, and benchmark the full network model before and after implementation to ensure this feature provides the intended benefits.

The ISO has committed to performing a variety of studies as part of pre-implementation testing and to report on these results to stakeholders and the Board. DMM supports this approach, but also emphasizes that this pre-implementation testing be viewed as the first step in an ongoing process of monitoring, analysis, refinement and improvement of the full network model. More specifically, DMM provides the following recommendations on this process:

- Analysis and benchmark studies of the performance of the full network model in terms of accounting for unscheduled flows should be performed in advance of implementation and should continue after implementation of the model to provide timely feedback and adjustments to improve performance tuning.

- As part of this pre-implementation analysis and testing, DMM recommends development of a variety of automated metrics that can be used to assess the impact that modeling inputs and assumptions are having on market congestion in the day-ahead and real-time. Automation of metrics that can flag the most critical aspects of performance is critical due to the massive amount of data involved in assessing unscheduled flows.

- Unless the estimated or actual flow on a line is actually near a limit in the day-ahead or real-time market, there may be little or no consequences of any improvement of

projected flows in terms of reliability or market costs. Therefore, DMM recommends that these automated metrics focus on the impact that the full network model is having on estimated flows on specific constraints which are at or near their limits in the day-ahead and real time markets based on estimated or actual flows.

- DMM also recommends that the ISO's metrics and analysis focus on constraints on which the actual market impact of congestion is highest. As identified in prior reports by DMM, the bulk of real-time energy congestion offset costs that have been incurred in the past are associated with a relatively small number of constraints on any given period. Automated metrics can be used to quickly identify these constraints and allow resources to be focused on modeling improvements or adjustments that have the highest value in terms of reliability and market benefits.

DMM looks forward to continuing to work closely with the ISO and MSC in development of such metrics and other analysis both before and after implementation of the full network model.

MARKET COMPETITIVENESS IN 2013

As noted in prior Board memos, overall prices in 2013 increased about 30 percent due to higher gas prices and costs associated with the state's cap-and-trade program for greenhouse gases. However, analysis by DMM indicates prices were even more competitive than in 2012, after taking into account the impact of higher gas prices, greenhouse gas compliance costs and other supply and demand conditions.

To assess the competitiveness of the ISO energy markets, DMM compares actual market prices to *competitive benchmark* prices we estimate would result under highly competitive conditions. DMM estimates competitive baseline prices by re-running the day-ahead market software with bids reflecting the actual marginal cost of gas-fired units and actual system loads.[1] DMM calculates the overall *price-cost mark-up* based on the difference between actual market energy prices and the competitive benchmark price. For instance a markup of 5 percent would indicate overall average energy prices 5 percent above the average competitive baseline price.

Figure 1 compares this competitive baseline price to average prices in the day-ahead and 5-minute real-time markets. When comparing these prices, it is important to note that baseline prices are calculated using the day-ahead market software under highly competitive conditions, which does not reflect all of the system conditions and limitations that impact real-time prices.

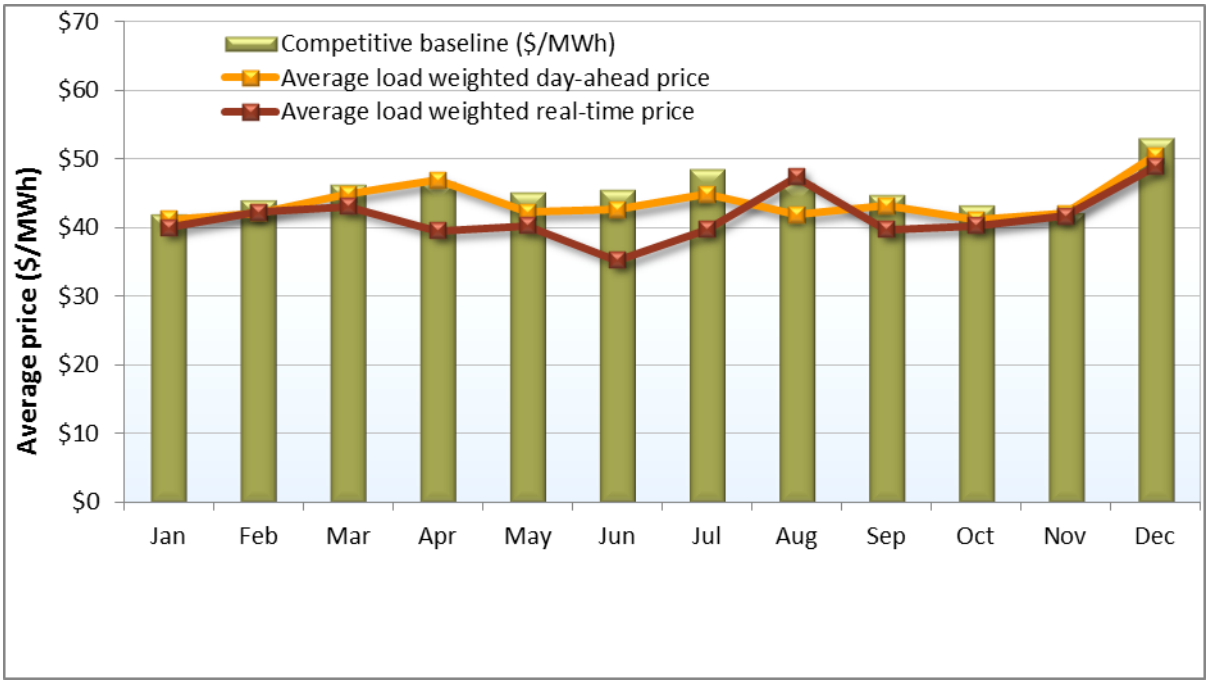
As shown in Figure 1, day-ahead market prices tracked very closely with competitive baseline prices during most months. In the real-time market, average prices were lower

[1] This analysis is performed using physical supply bids and actual system demand only (excluding virtual supply and demand bids). This scenario represents the combination of perfect load forecast with competitive bidding of gas-resources that typically set price in the ISO system setting resources. For January through April, DMM used an alternative model of the ISO market (PROBE) since data needed to run the day-ahead market software was unavailable.

than the competitive baseline in 2013 in most months except for August. A major factor contributing to these lower real-time prices was the substantial amount of real-time energy that was not scheduled in the day-ahead market.[2]

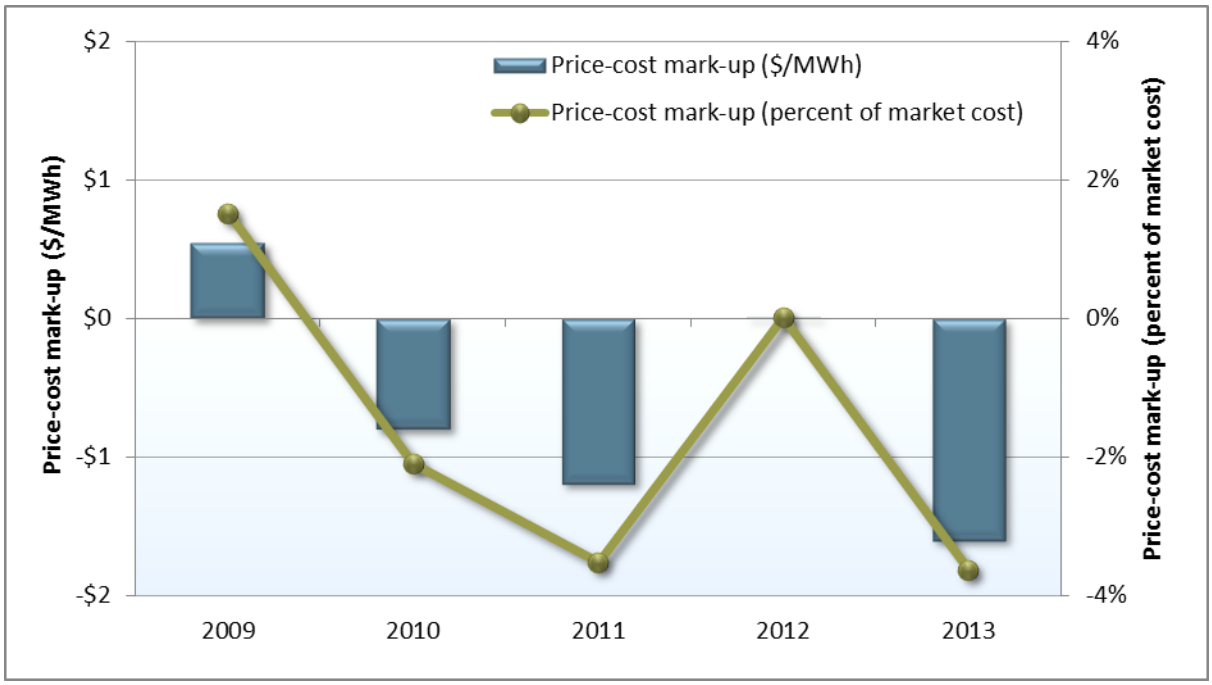
As shown in Figure 2, the overall combined average of day-ahead market and real-time prices were about $1.50/MWh or about 3.8 percent lower than the competitive baseline price. This represents a slight drop in the price-cost markup in 2013 and is consistent with the slightly negative price-cost markups observed in 2010 and 2011. Slightly negative price-cost markups reflect the fact that many suppliers bid somewhat lower than their default energy bids – which include a 10 percent adder above estimated marginal costs. Another factor contributing to the slightly negative price-cost mark-up in 2013 is the additional sources of supply that are available in the ISO's real-time market which are not available in the day-ahead market model used to calculate the competitive baseline price.

Figure 1. Comparison of competitive baseline with day-ahead and real-time prices



[2] This unscheduled energy was the combined result of a variety of factors, rather than being driven by any single source. Various sources off additional real-time energy included minimum load energy from units committed after the day-ahead market through the residual unit commitment process and exceptional dispatches, additional self-scheduled energy from thermal generating resources, and unscheduled energy from intermittent renewable energy. A detailed analysis of this issue will be provided in DMM's 2013 Annual Report.

Figure 2. Price-cost mark-up index (2009-2013)



IMPLEMENTATION OF 15-MINUTE MARKET

FERC Order No. 764 requires that all FERC-jurisdictional transmission providers provide the opportunity for intra-hour schedule changes in 15 minute increments.[3] This requirement is instrumental to facilitating proposed enhancements that will create a market structure oriented around renewable resources while also eliminating existing market inefficiencies.

The ISO has taken the opportunity created by FERC Order No. 764 to make additional changes in the hour-ahead and real-time markets in spring 2014. Specifically, the ISO is proposing to change inter-tie scheduling and settlement from an hourly to a 15-minute basis, and to also establish a 15-minute settlement for internal resources and convergence bids. The ISO proposal also includes retaining the existing 5-minute dispatch to provide real-time balancing.

The ISO's 15-minute real-time pre-dispatch market already produces energy prices for each 15-minute interval which are non-binding (i.e. not used in any financial settlement). In DMM's report on the third quarter of 2013, DMM provided a comparison of these 15-minute

[3] On June 22, 2012, FERC approved Order 764 to remove barriers to the integration of variable energy resources by requiring each transmission provider to: (1) offer an option to schedule energy with 15-minute granularity; and (2) require variable energy resources to provide meteorological and forced outage data for the purpose of power production forecasting. Draft Final Proposal - FERC Order No. 764 Market Changes. For more information, see http://www.caiso.com/informed/Pages/StakeholderProcesses/FERCOrderNo764MarketChanges.aspx.

non-binding prices to day-ahead and 5-minute real-time prices. This comparison showed that these 15-minute prices had been consistently significantly higher than day-ahead and real-time prices dating back to at least 2012.

As a result, DMM recommended that the ISO look into the cause of this difference and closely monitor these prices leading up to implementation of the 15-minute market in spring 2014.Since that time, the ISO and DMM have performed additional analysis of the causes of these higher 15-minute prices, monitored these prices, and identified factors and steps that could mitigate any trend of systematically high or low 15-minute prices once the new market design is implemented.

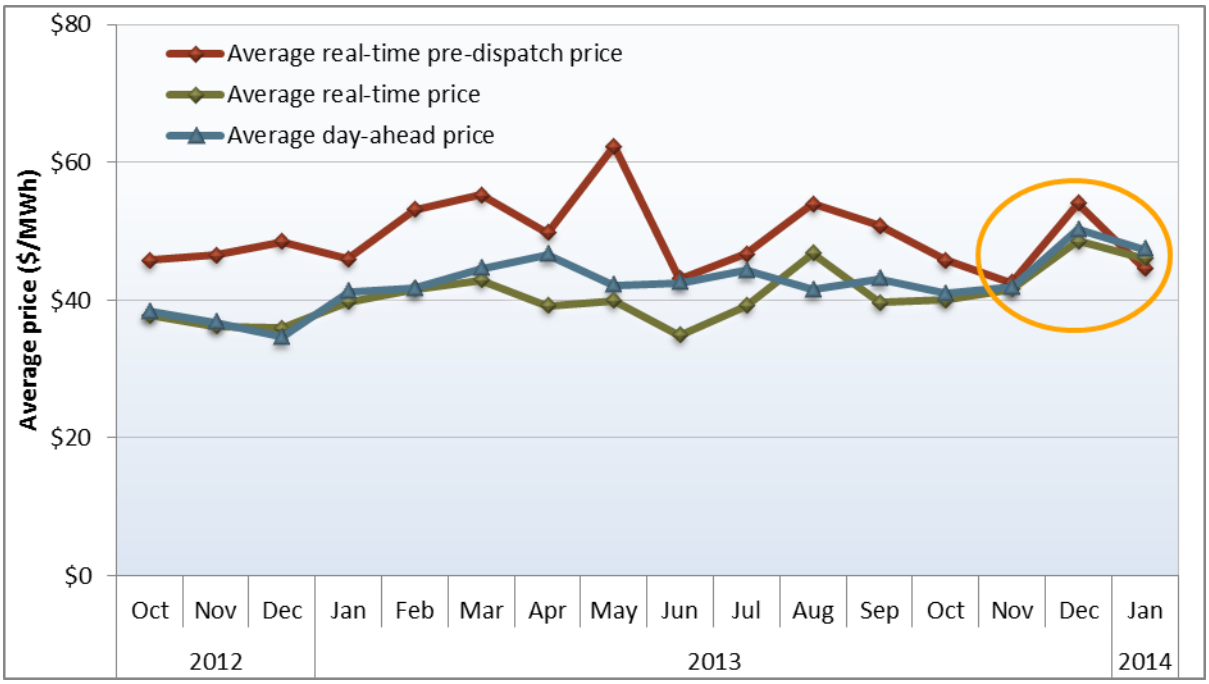
Analysis by the both the ISO and DMM confirms that the primary cause of higher average 15-minute prices in 2013 has been the flexible ramping constraint (or price at which this constraint is relaxed rather than resulting in an extreme re-dispatch of resources), which is enforced in the 15-minute pre-dispatch process but not the 5-minute market. Although this constraint binds and cannot be met during a relatively small percentage of intervals, when this constraint does bind it creates high 15-minute prices.

As shown in Figure 3, the trend of higher 15-minute prices has changed significantly starting in November. This appears to be driven in large part by a decrease in the number of intervals when the flexible ramping constraint cannot be met and results in very high prices. This may be due largely to seasonal factors that result in additional supply of flexible capacity in recent months.

Prices in Figure 3 represent prices for the first 15-minute interval after the current pre-dispatch process is performed, since these are the only 15-minute prices that have been saved historically. When the 15-minute market is implemented, market prices will actually be based on the second 15-minute interval after the 15-minute process is performed. Prices in this second 15-minute interval should be marked by fewer price spikes driven by the flexible ramping constraint, since there will be much more ramping capacity and flexibility available over this additional 15 minute period. The ISO has modified the software to save prices from this second 15-minute interval under the current process and will monitor these prices up to implementation of the new 15-minute market.

Another factor that is expected to help mitigate extreme price spikes in the 15-mintue market with implementation of the new 15-minute market is a reduction in the penalty price for the flexible ramping constraint. The ISO is currently evaluating how to reduce this value from $247/MW.

Figure 3. Comparison of average 15-minute real-time prices to day-ahead and real-time prices



The ISO is also prepared to closely monitor, manage and modify operating practices as the new 15-minute market is implemented to help achieve an efficient balance between the day-ahead, 15-minute and 5-minute market prices. For example:

- The requirement that is set for flexible ramping capacity will be closely monitored and adjusted if necessary as the new 15-mintue market is implemented. If this requirement is set at levels that cannot be met by the available ramping capacity, the requirement can be reduced to levels that may be binding and result in additional flexible ramping capacity, while avoiding extreme price spikes that are created when the requirement cannot be met.
- The ISO will also monitor and adjust the use of the any load bias in the 15-minute market. Grid operators may address reliability concerns by increasing the projected system load in the 15-minute pre-dispatch process to ensure commitment of additional short start units. When the new 15-minute market is implemented, this can also have the impact of raising the 15-minute prices that will now be used for financial settlement. Thus, the use of load bias and the impacts it has on pricing will be closely monitored as the new 15-minute market is implemented.

DMM will continue to work closely with the ISO before and after implementation of the new 15-minute market this spring to monitor market performance and make any adjustments that may be appropriate to manage and ensure the efficiency of this new market.