Memorandum

To: ISO Board of Governors

From: Eric Hildebrandt, Director, Market Monitoring

Date: August 18, 2011

Re: **Market Monitoring Report**

This memorandum does not require Board action.

EXECUTIVE SUMMARY

This report provides comments and recommendations by the Department of Market Monitoring on two proposals being presented to the ISO Board of Governors by Management at the August 25-26, 2011 meeting.

- **Convergence bidding on interties.** DMM supports Management's proposal to eliminate convergence bidding for imports or exports on interties as a step that can be implemented immediately to help reduce high real-time imbalance energy offset charges. DMM anticipates this change will significantly reduce these offset charges without creating any decrease in overall market efficiency. However, even without convergence bidding at the interties, high offset charges will continue to result when the ISO reduces net physical imports at relatively low prices in the hour-ahead market and then increases energy purchased from resources within the ISO at higher prices in the 5-minute real-time market. While this trend of "selling low and buying high" has been reduced in recent months through software and operational improvements, a systematic divergence between the hour-ahead and real-time markets persists. A comprehensive re-design of the hour-ahead and 5-minute real-time markets that would address this issue is expected to take several years. Therefore, DMM recommends that the ISO consider additional modifications for settlement of physical intertie schedules that may be implemented on a relatively short time frame. One such interim option DMM believes merits further consideration is the type of settlement rule for physical intertie transactions employed by the New York ISO.

- **Flexible ramping constraint.** DMM supports Management's proposal to implement a new flexible ramping constraint in the real-time market optimization to increase the amount of ramping capacity available in the 5-minute real-time market. This is one of several key software enhancements the ISO anticipates may reduce the frequency and severity of price spikes in the 5-minute real-time market caused by very short and often minor deficiencies of upward ramping capacity. As noted in prior DMM reports, these price spikes generally reflect

forecasting and modeling limitations, rather than fundamental underlying supply conditions.[1] These price spikes account for most of the divergence between prices in the 5-minute real-time market and prices in the day-ahead ahead and hour-ahead markets. The market impact of this new feature is difficult to predict and will need to be assessed by the ISO after implementation. Based on this analysis, the ISO should be prepared to adjust the amount of ramping capacity being procured if necessary to ensure that the benefits exceed the cost of this new constraint.

The more detailed discussion of these proposals provided below is designed to supplement Management's memos and opinions by the Market Surveillance Committee on these two issues being provided to the Board.

CONVERGENCE BIDDING ON INTERTIES

Background

Since the start of the ISO's new market design in 2009, prices in the hour-ahead scheduling process have been systematically lower than prices in the day-ahead and 5-minute real-time dispatch real-time markets. In the hour-ahead market, relatively low prices have led to significant reductions in net imports. In most hours, this reduction in net imports has required the ISO to re-purchase additional energy in the 5-minute real-time market at higher prices. This pattern of selling low in the hour-ahead market and buying high in the real-time market has created substantial revenue imbalances that are allocated to load-serving entities.

Since 2009, DMM has expressed concern that this trend is caused by systematic differences in the inputs and models used in the hour-ahead and 5-minute real-time markets, and may persist unless specifically addressed though enhanced modeling, operational practices or market design changes. For example, when convergence bidding was approved by the Board in October 2009, DMM noted that:

> While further improvements are needed and challenges remain, DMM is optimistic that with the necessary support from Management significant improvements can be made prior to the implementation of convergence bidding more than one year from now. For example, DMM believes that it is important for the ISO to continue to identify and address the root cause of systematic price divergences that have been observed between the integrated forward market (IFM), hour-ahead scheduling process (HASP) and the 5-minute real-time markets prior to implementation of nodal convergence bidding. While nodal convergence bidding is designed to help to resolve some of the price divergence between these markets, it may also be more difficult for the ISO to identify and address once convergence bidding is implemented … [Thus], the ISO should continue to place a high priority on identifying and addressing the root cause of systematic price divergences between the day-ahead and real-

[1] A detailed discussion of this issue was provided in DMM's *Quarterly Report on Market Issues and Performance*, February 8, 2011, pp.10-17, http://www.caiso.com/2b1f/2b1f838819910.pdf.

time markets over the more than 12 months that remain prior to implementation of convergence bidding.[2]

In 2010, the ISO indicated that addressing this price divergence would be a high priority and identified numerous software and modeling enhancements aimed at improving price convergence. In addition to these modeling enhancements, DMM recommended that the ISO also implement improved operational procedures or guidelines for manual adjustments to the load forecast made by system operators that have a significant impact on price convergence between the hour-ahead and 5-minute real-time markets.

However, in 2010 this price divergence persisted despite numerous software enhancements by the ISO. Real-time energy imbalance offset costs caused by price divergence totaled over $80 million. Therefore, prior to implementation of convergence bidding in February 2011, DMM specifically cautioned that unless the causes of this divergence were addressed, convergence bidding may increase these real-time energy imbalance costs. As noted in DMM's 2010 annual report:

> If systematic price differences continue to occur after implementation of convergence bidding in February 2011, this may create substantial additional revenue imbalances that must be allocated to load-serving entities. These price trends may be further exacerbated by the April 2011 increase in the bid cap from $750 to $1,000/MWh.[3]

Since the introduction of convergence bidding, the ISO has implemented numerous additional operational and software changes that appear to have reduced the frequency extreme price spikes in the 5-minute market and increased overall price convergence. However, predictable and systematic price divergences have continued to exist for sustained periods.

Market performance during the first six months of convergence bidding provides convincing evidence that fundamental structural aspects of the ISO's current market design tend to create systematic differences in hour-ahead and real-time prices. Convergence bidding has allowed some participants to profit from persistent and predictable differences in hour-ahead and real-time price differences. These profits contribute to revenue imbalances that are allocated to load-serving entities. However, as explained below and in other board documents, under the ISO's current market design, convergence bidding on the interties is exacerbating energy offset charges without providing any significant market efficiency benefits.

Impact of convergence bidding on interties

The California market has a unique feature that makes it different from other ISOs and RTOs. The ISO's new market design re-optimizes imports and exports at the interties in an hour-ahead market, with all changes to hourly intertie schedules being settled financially based on prices produced by this hour-ahead optimization process. Convergence bids for virtual imports or exports on interties are also settled based on the difference in prices from the

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[2] Memorandum to ISO Board of Governors from Eric Hildebrandt, Interim Director, Market Monitoring, October 21, 2009, p. 2 and p. 8, http://www.caiso.com/Documents/091029InformationalReport-Department-MarketMonitoringReport.pdf,

[3] *2010 Annual Report on Market Issues and Performance*, Department of Market Monitoring, p.2. http://www.caiso.com/Documents/2010AnnualReportonMarketIssuesandPerformance.pdf

day-ahead market and this hour-ahead process. Meanwhile, resources within the ISO dispatched in the 5-minute real-time market are settled based on prices from this 5-minute real-time dispatch. Convergence bids at internal nodes settle are settled based on the difference in prices from the day-ahead market and this hour-ahead process.

This feature of the ISO market design has led to a convergence bidding strategy that allows participants to exploit price divergence between the hour-ahead and real-time market. With this strategy, an entity places a virtual supply bid at an intertie, combined with a virtual demand bid for an equal quantity at a point within the ISO. These offsetting virtual demand and supply bids provide no net supply or demand in the day-ahead market. However, the entity placing these bids receives a payment whenever the hour-ahead price is lower than the 5-minute real time market price.

While this virtual bidding strategy has been highly profitable for some participants, this has increased revenue imbalances allocated to load-serving entities and does not provide any significant benefits in terms of helping to converge prices or increase the efficiency of unit commitment and dispatch. Virtual import schedules offset by virtual demand at internal points from unaffiliated entities also have this same effect of increasing energy offset charges without providing any significant increase in market efficiency.

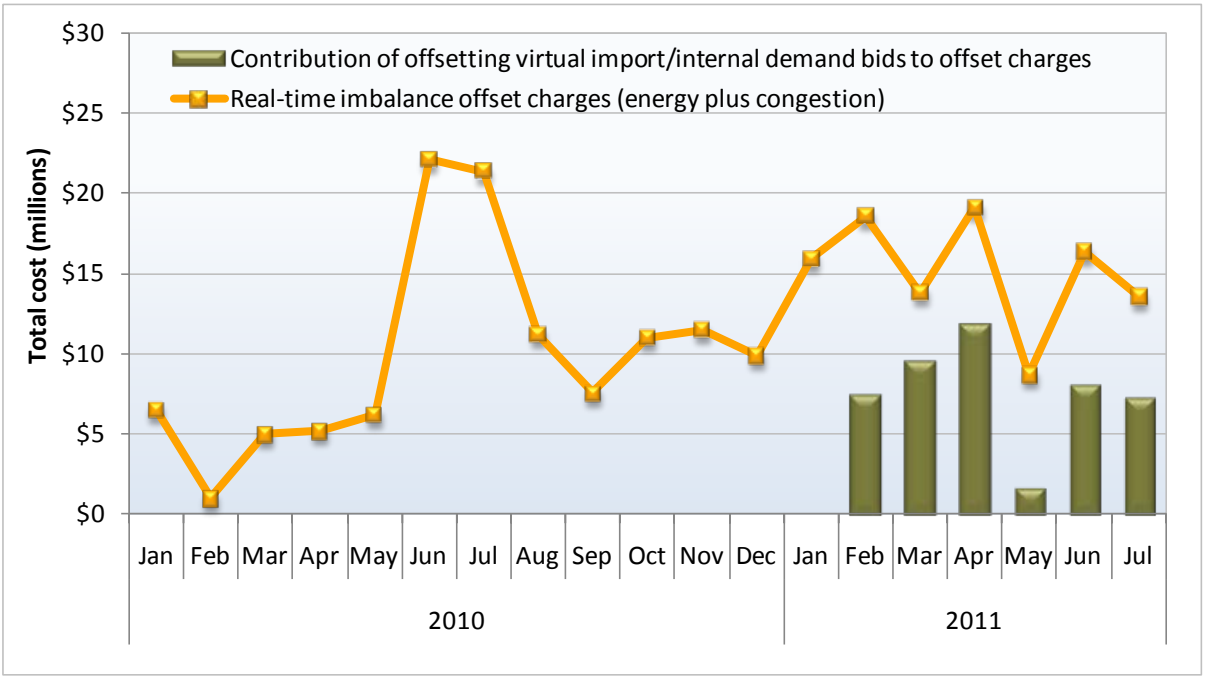
Figure 1 on the following page shows the monthly real-time imbalance offset charges for energy and congestion assessed to load serving entities (see yellow line). The green bars in Figure 1 show the portion of these charges DMM estimates are attributable to payments made for accepted virtual import bids that were offset by accepted virtual demand within the ISO during the same hour. As shown in Figure 1:

- Since the implementation of convergence bidding in February, real-time energy and congestion offset charges have totaled over $100 million or an average of over $17 million per month.

- Since implementation of convergence bidding in February, a large portion of these charges were due to virtual imports at inter-ties that were offset by virtual demand within the ISO and therefore did not provide any benefits from improved unit dispatch or price convergence.

- From February to July virtual imports, DMM estimates that virtual import bids offset by virtual demand bids within the ISO during the same hour have accounted for about $7.7 million per month or approximately 46 percent of real-time energy and congestion offset charges.

Figure 1. Real-time imbalance energy and congesetion offset charges



DMM believes that eliminating convergence bidding at the interties would benefit the ISO markets in several ways:

- **Reduce energy imbalance offset charges**. DMM believes that eliminating virtual bidding at the interties would result in a significant reduction in real-time imbalance energy offset charges. Even if savings from elimination of virtual bidding on interties are lower than the levels currently attributable to virtual import bids offset by virtual demand bids within this ISO, the resulting savings will be significant. As previously noted, DMM recommends that additional steps may be needed to achieve further reductions in offset charges. However, there is no need to defer elimination of virtual bidding at the interties while these additional measures are considered or implemented.

- **Avoid need to modify position limits.** The ISO's initial convergence bidding market design limits the amount of virtual bids each participant may submit on each intertie to 5 percent of the intertie capacity. These position limits were intended to serve as a general precaution that would help mitigate a range of potential market issues, particularly in the initial phases of convergence bidding. Limits on the amount of virtual bids that can be submitted by each participant on each intertie are scheduled to increase to 25 percent of the intertie's capacity on October 1. This increase in position limits has the potential to significantly increase the magnitude of energy offset charge costs. However, the elimination of convergence bidding on interties mitigates this issue as well.

- **Allow internal virtual bids to increase price convergence.** Given the current design for settlement of intertie transactions and the persistent divergence between the hour-ahead and real-time market prices due to market design issues, virtual bidding has failed to contribute to the convergence of prices in these two markets.[4] However, DMM believes that eliminating virtual bids at the interties may allow virtual bidding at internal nodes within the ISO to have a greater effect in terms of promoting price convergence between the day-ahead and 5-minute real-time markets. For example, during periods when real-time prices tend to exceed day-ahead prices, virtual demand bids at locations within the ISO would continue to be profitable. This net demand may increase unit commitment performed in the day-ahead market and help to moderate real-time prices. This could also have the effect of improving convergence of hour-ahead and real-time prices and reduce energy offset charges.

Stakeholder comments

Load-serving entities that are being assessed imbalance energy offset charges strongly support the proposal to eliminate virtual bidding at interties. Stakeholders most vocally opposed to elimination of convergence bidding at interties are financial institutions and traders that do not serve any load or operate any generating resources within the ISO, but are receiving most of the profits from convergence bidding. Entities opposed to the ISO's proposal have contended that convergence bidding at interties provides three main potential benefits:

- **Impact on day-ahead market prices.** Some participants contend that the net effect of convergence bidding has been to lower day-ahead prices, and that the benefits of these lower prices outweighs the costs of higher energy offset charges for load-serving entities. DMM does not believe that the goal of convergence bidding is to lower day-ahead prices – but is instead to improve market efficiency and improve convergence of market prices. DMM also finds this argument uncompelling given that the ISO's proposal is supported by all load-serving entities that actually purchase energy in the ISO markets and must pay these energy offset charges. Moreover, to the extent that virtual bidding on inter-ties might lower day-ahead prices under some conditions, this would represent a transfer of payments from owners of physical generation within the ISO (who receive lower day-ahead prices) to the traders and financial entities that are receiving most of the profits being paid out for convergence bidding. Such a transfer of payments would be contrary to efforts to promote retention of existing gas-fired generation capacity within the ISO.

- **Scheduling of renewable imports**. Some entities profiting from convergence bidding have argued that virtual bidding on interties will promote import of resources with variable output or availability (such as renewable wind resources). With convergence bidding, entities seeking to import such resources could schedule their day-ahead forecast of expected output as virtual supply. Prior to the hour-ahead market, they could purchase transmission as needed based on updated forecast of available supply. The resource owner could then schedule expected output of the resource as a physical schedule in the hour-ahead market. This would allow the entity to earn the day-ahead price for most of its output, but avoid purchasing excess transmission in the event its day-ahead forecast of supply exceeds its hour-ahead

[4] More detailed explanations of this conclusion are also provided in Management's memo and the Market Surveillance Committee opinion on this topic.

forecast. However, under this scenario, a renewable resource could achieve the same financial outcome by scheduling its day-ahead forecast of supply as a physical import in the day-ahead market. The resource owner can then simply adjust its physical import schedule in the hour-ahead market based on its updated forecast of available supply and purchase the amount of transmission needed to meet this updated schedule. DMM has discussed this scenario with numerous participants to confirm that both these approaches are financially equivalent, and that virtual bidding is not needed to facilitate imports of renewable or other resources with variable output. Analysis by DMM and discussion with stakeholders also indicate this practice is not being used at this time to facilitate imports of renewable or intermittent generation.

- **Hedging physical imports through virtual exports.** An entity seeking to import generation could theoretically use virtual exports to partial hedge against the price risk they face if they cannot deliver supply scheduled in the day-ahead market as the result of a generation or transmission outage occurring prior to the hour-ahead market. Under this scenario, a supplier would need to reduce their day-ahead schedule in the hour-ahead market and be charged for this reduction at the hour-ahead market price. By scheduling virtual exports in the day-ahead market, a supplier could hedge any financial risk that the hour-ahead price paid for such reductions and would be higher than the day-ahead price received for energy scheduled day-ahead market. Analysis by DMM indicates that any use of virtual bidding on interties for this type of hedging is de minimus at most.[5]

Additional steps

There is a growing consensus between the ISO and many stakeholders that the best long-term solution to increasing the efficiency of the hour-ahead and real-time markets and reducing imbalance offset charges is to fundmentally redesign of how external and internal resources are scheduled and settled. However, the implementation of such a redesign is likely to take several years and may need to be coordinated with changes in current practices for scheduling intertie transactions throughout the west. In the meantime, even without virtual bidding at the interties, the real-time energy imbalance uplift may still be significant. DMM therefore recommends that the ISO continue to pursue other steps that can be taken to reduce these charges.

In particular, DMM recommends that the ISO continue to consider implementing the type of rules employed in the New York ISO's real-time method for settling intertie schedules. With this approach, the ISO would continue to dispatch additional imports or exports in the hour-ahead process that were projected to be economic based on their bid prices. However, with this approach:

- Any additional exports or decrease in imports would be treated as *price-takers* and charged the hourly average of prices in the 5-minute real-time market. This would eliminate the significant

[5] While day-ahead physical imports average over 7,000 MW per hour, an average of only about 11 MW per hour of virtual demand is scheduled by entities with cleared day-ahead physical imports at the same intertie. Even if all 11 MWs an hour were intended to hedge a potential outage, the total value of this hedge would be de minimus compared to the direct cost of virtual bidding on the real-time imbalance energy offset charge.

impact that reductions in day-ahead physical import schedules have had on real-time energy imbalance offset charges.

- Any increase in imports or decrease in exports in the hour-ahead process would be paid the higher of their bid or the 5-minute real-time market price or their bid. This would provide a bid price guarantee for any additional imports scheduled to meet ISO load in the hour-ahead process. Historical market data indicate that bid cost recovery payments of increased imports would be very limited under this approach. However, this approach would retain the ISO's ability to attract enough additional net imports in the hour-ahead market to ensure reliability when needed.

FLEXIBLE RAMPING CONSTRAINT

The ISO is proposing to implement a new flexible ramping constraint in the real-time market optimization to increase the amount of ramping capacity available in the 5-minute real-time market. This is one of several key software enhancements the ISO hopes may reduce the frequency and severity of price spikes in the 5-minute real-time market caused by very short and often minor deficiencies of upward ramping capacity. As noted in prior DMM reports, these price spikes generally reflect forecasting and modeling limitations, rather than fundamental underlying supply conditions. However, these price spikes account for most of the divergence between prices in the 5-minute market and prices in the day-ahead and hour-ahead markets.

In theory, the flexible ramping constraint could be set so that is binding and therefore has an impact on market dispatches and prices when it is most needed to prevent false scarcity conditions. This would result in pricing this service during a relatively small percentage of time intervals. As noted in DMM's recent quarterly reports, shortages of upward ramping capacity occur during less than 1 percent of market intervals and most of these shortages have lasted only one or two 5-minute intervals.[6] The ISO believes that this new flexible ramping constraint is likely to be effective in mitigating price spikes caused by these short term shortages of ramping capacity, without having a more significant impact on market prices and costs.

In practice, DMM notes that to mitigate these extreme price spikes, this new ramping constraint may need to be set so that it is binding more frequently and therefore impacts market dispatches and prices during a much larger percentage of intervals. Thus, the costs and benefits of this new market feature need to be carefully monitored by the ISO and managed by adjusting the specific details of this constraint.

The ISO has performed a limited number of simulations which suggest this new constraint will be effective at increasing ramping capacity at a reasonably low cost. The actual costs and benefits of this new constraint may vary significantly under actual operating conditions. DMM notes that assessing the impact of this new constraint cannot be done directly on market results and will require that the ISO develop special algorithms to estimate the impact this constraint may have had on market outcomes and/or perform special market re-simulations with this constraint removed from the market model.

[6] For example, see DMM's *Quarterly Report on Market Issues and Performance*, February 8, 2011, pp.13-15, http://www.caiso.com/2b1f/2b1f838819910.pdf.

DMM has offered the following recommendations regarding further potential design enhancements and issues the ISO should prepare to monitor and respond to once the feature is implemented:

- ***Calculated ramping requirement.*** The ISO should explicitly specify the calculation for determining the flexible ramping requirement that will be applied in the real-time pre-dispatch performed every15-minutes.
- ***Manual adjustments.*** Grid operators will have the opportunity to adjust the calculated requirement that could have significant impacts on market outcomes. The ISO should have procedures in place for determining an appropriate adjustment, record such adjustments separately from the calculated requirement, and require logging of the purpose for the adjustment.
- ***Monitoring overall performance and impacts.*** The ISO should develop monitoring metrics for the following areas and report on these issues:
    - *Overall market impact:* Has the flexible ramping constraint reduced the frequency of instances where the imbalance dispatch and pricing show scarcity of ramping capacity?
    - *Impact on resource dispatch:* To what extent is the flexible ramping constraint committing additional short-start resources or reserving capacity from those already online?
    - *Impact on energy prices in constrained areas:* Is the flexible ramping constraint procuring from online resources in constrained areas and alleviating system ramping constraints at the expense of exacerbating higher local prices in these areas?
- ***Pricing.*** The ISO is proposing a pricing model that potentially includes both the opportunity cost of energy and the opportunity cost of not selling ancillary services in the 15-minute pre-dispatch process. However, capacity reserved for the flexible ramping constraint in the 15-minute pre-dispatch process can then be dispatched to provide energy in the 5-minute dispatch. If this occurs frequently, the price paid to resources providing ramping capacity based on their opportunity cost in the 15-minute pre-dispatch may exceed their actual opportunity cost in the 5-minute real-time market. DMM recommends the ISO review this issue after this new market feature is implemented to consider the appropriateness of pricing paid to resources providing ramping capacity relative to these resources actual opportunity costs.
- ***Bid cost recovery.*** Resources providing flexible ramping capacity are eligible to receive a payment for providing that service. The ISO proposal does not propose to include these revenues in the bid-cost recovery calculations. Since these payments do contribute to the daily profitability of resources, DMM believes these revenues should be included in the bid-cost recovery calculations as a matter of principle. The ISO has indicated this modification would introduce additional complexity to the implementation of this feature. If overall revenues from this new constraint are reasonably low, as expected by the ISO, this should not be a significant issue.

- ***Resource performance.*** Resources will be paid for a service as a result of the flexible ramping constraint. The ISO should monitor the extent to which resources paid for reservations from the flexible ramping constraint are called upon in the 5-minute dispatch and provide energy consistent with their dispatch into the reservation. The ISO should consider rescinding payment for resources that do not perform, as is done with ancillary services. The ISO has indicated this modification would introduce additional complexity to the implementation of this feature.

Based on this analysis, the ISO should be prepared to adjust aspects of this new constraint as necessary to ensure that the benefits exceed the cost of this new constraint. Most importantly, the ISO should be prepared to quickly adjust the quantity of ramping capacity required by this constraint as needed to ensure the cost-effectiveness of this constraint.