THE UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

California Independent System Operator Corporation	**)**	**Docket No. ER15-____-000**

PETITION FOR LIMITED WAIVER OF TARIFF PROVISIONS, REQUEST FOR SHORTENED COMMENT PERIOD, AND REQUEST FOR COMMISSION ACTION BY APRIL 28, 2015

The California Independent System Operator Corporation (CAISO) respectfully requests that the Commission grant a limited waiver,[1] effective May 1, 2015, of provisions in three sections of the CAISO tariff that otherwise would require the CAISO to reinstate virtual bidding[2] at the interties on May 1.[3] The CAISO has determined that the potential benefits of reinstating intertie virtual bidding at this time are outweighed by market inefficiencies due to the lack of intertie economic bids in the fifteen-minute market.[4] This conclusion is based on a CAISO Department of Market Monitoring (DMM) analysis of the current state of liquidity of the fifteen-minute market (Supplemental DMM Report), which is

[1] The CAISO submits this petition pursuant to Rule 207 of the Commission's Rules of Practice and Procedure, 18 C.F.R. § 385.207 (2013). Capitalized terms not otherwise defined herein have the meanings set forth in appendix A to the CAISO tariff, and references to sections are references to sections of the CAISO tariff unless otherwise stated.

[2] Virtual bidding is also commonly referred to as "convergence bidding." The CAISO tariff uses the terms virtual bids and virtual bidding, and therefore this pleading will adopt that usage.

[3] The CAISO requests waiver of such provisions in tariff sections 30.9, 30.7.3.6.3, and 30.7.3.6.3.2.

[4] *See Cal. Indep. Sys. Operator Corp.*, 146 FERC ¶ 61,204, P 103 (2014) (March 2014 Order) (authorizing the CAISO to recommence convergence bidding at the interties upon submitting a report discussing whether "the anticipated benefits of intertie convergence bidding outweigh any expected market inefficiencies").

attached hereto and is simultaneously being filed in Docket No. ER14-480.[5] The CAISO requests that this waiver remain in effect for a maximum of 12 months from May 1, 2015, *i.e.*, until no later than May 1, 2016.

Reinstituting virtual bidding under current conditions would create incentives for convergence bidding entities to profit from differences between congestion prices in the day-ahead market and the fifteen-minute market caused by the current illiquidity of the fifteen-minute market at the interties. As described in the Supplemental DMM Report, if there is congestion in the day-ahead market but no economic bids at the interties in the fifteen-minute market, then the fifteen-minute market upon which virtual bids are settled generally does not produce a congestion price reflected in the locational marginal prices for the fifteen-minute market at those locations.

The Supplemental DMM Report explains that reintroducing virtual bidding under these conditions will likely decrease economic efficiency by increasing the need for the CAISO to manage real-time congestion by curtailing schedules *pro rata*, rather than based on economic merit order of physical bids, while allowing virtual bidders to take advantage of predictable fifteen-minute market prices. Moreover, profits received by convergence bidding entities could come at the expense of other market participants.

Good cause exists to grant this waiver because it is of limited scope, will remedy a concrete problem, and will not have undesirable consequences. The

[5] As explained below, today the CAISO is also filing the attached DMM report in Docket No. ER14-480 to supplement an informational filing regarding the reinstatement of intertie virtual bidding that the CAISO submitted in that proceeding on December 31, 2014.

waiver merely maintains the status quo for a maximum period of 12 months. During the term of the waiver, the CAISO will explore the causes underlying the lack of liquidity at the interties in the fifteen-minute market. The CAISO cannot, however, compel parties to submit fifteen-minute market bids. Therefore, the CAISO will seek stakeholder input as to whether there are feasible solutions to the liquidity issues and identify what level of liquidity is sufficient, from a market efficiency perspective, to reinstitute intertie virtual bidding. The waiver period will also provide the CAISO with sufficient time to make any necessary tariff filings if the CAISO, in consultation with stakeholders, determines that it is appropriate to adopt additional or alternative criteria relating to intertie virtual bidding.

Granting the waiver is consistent with the Commission's conditioning reinstitution of intertie virtual bidding on the "CAISO filing a report to demonstrate that the new market structure is providing the expected price convergence," that the market structure "is working to reduce systemic price divergence" and that "the anticipated benefits of intertie convergence bidding outweigh any expected market inefficiencies, including any risk of market manipulation."[6] Lastly, granting the waiver will have no undesirable consequences and will prevent market participants from exploiting the arbitrage opportunity that DMM has identified.

The CAISO respectfully requests that the Commission issue an order granting this petition by no later than April 28, 2015. To permit the timely issuance of an order, the CAISO also requests that the Commission shorten the comment period regarding this petition to no more than seven calendar days.

[6] March 2014 Order at P 103.

I. Background Regarding Need for Limited Tariff Waiver

A. Virtual Bidding in the CAISO Market

Virtual bidding enables market participants to hedge their physical market positions and manage their exposure to the differences between day-ahead and real-time prices. Virtual bids – also known as convergence bids – are purely financial bids to buy or sell electricity in the day-ahead market without any obligation to provide or consume electricity.[7] If a market participant's virtual bid is cleared in the day-ahead market, it is automatically liquidated with the opposite buy/sell position at the real-time price.[8] One of the main expected benefits of virtual bidding is to improve the convergence of day-ahead and real-time prices in the CAISO markets.[9]

The CAISO implemented virtual bidding on February 1, 2011 at both internal nodes and the interties.[10] Two issues arose with virtual bidding on the interties soon afterwards. The first and most significant issue was that convergence bidding entities were able to take advantage of the real-time bifurcated settlement structure in existence at that time, *i.e.*, the use of different locational marginal prices in the hour-ahead scheduling process for intertie pricing points and the real-time market for internal pricing points for purposes of

[7] *See* CAISO Tariff, section 30.9.

[8] *See* CAISO Tariff, section 11.3.

[9] *See, e.g.*, *Cal. Indep. Sys. Operator Corp.*, 130 FERC ¶ 61,122, P 35 (2009) ("Nodal convergence bidding provides benefits that have been well-documented by the Commission. We have found that convergence bidding can . . . improve day-ahead and real-time price convergence . . ."); *Cal. Indep. Sys. Operator Corp.,* 133 FERC ¶ 61,039, P 14 (2010) ("The Commission has found that convergence bidding reduces the price differences between the real-time and the day-ahead markets.").

[10] *See id.* at PP 1, 253.

financial settlement. The second and less significant issue that arose with virtual bidding on the interties was that the use of two software constraints (a physical and also a combined physical and virtual constraint) in the day-ahead market periodically caused market clearing prices on the interties to be inconsistent with the bid prices offered by a physical exporter or importer.

The CAISO sought to address these two issues through several stakeholder initiatives and, in a tariff amendment submitted on September 21, 2011, proposed to discontinue virtual bidding at the interties, at least until the CAISO could address issues regarding the design of the hour-ahead scheduling process and real-time market through a comprehensive market redesign stakeholder initiative. On May 2, 2013, the Commission issued an order conditionally accepting the CAISO's proposal to discontinue intertie virtual bidding.[11] The Commission found that the CAISO "should focus its efforts on developing a comprehensive, long-term structural solution that will permit the reinstatement of intertie convergence bidding with just and reasonable outcomes, improving market efficiency by committing supply resources to meet real-time needs."[12] The Commission noted that the CAISO had "chose[n] to address intertie settlement issues in a new stakeholder initiative that will also address compliance with Order No. 764."[13]

On November 26, 2013, the CAISO filed a tariff amendment in Docket No. ER14-480 to implement real-time market design enhancements related to Order

[11] *Cal. Indep. Sys. Operator Corp.,* 143 FERC ¶ 61,087 (2013) (May 2013 Order).

[12] *Id.* at P 61.

[13] *Id.* at P 74.

No. 764, including the establishment of a fifteen-minute market to schedule and settle both intertie and internal resources at the same financially binding 15-minute intervals,[14] and to reinstate virtual bidding at the interties. The CAISO explained that it and its stakeholders had developed a comprehensive, long-term structural solution to address the two issues discussed above and permit the reinstatement of intertie convergence bidding with just and reasonable outcomes.[15]

The CAISO also noted that numerous stakeholders and DMM had raised significant concerns with implementation of virtual bidding on the interties at the same time the market was gaining experience with the other significant design changes contained in the tariff amendment. To address these concerns, the CAISO proposed to reinstate virtual bidding at the interties 12 months after the CAISO implemented the other changes contained in the tariff amendment, *i.e.*, on May 1, 2015.[16] As another precautionary measure, the CAISO proposed to phase in the reinstatement of virtual bidding on the interties through the use of gradually increasing position limits, which would limit the megawatt quantity of virtual bids that could be submitted by a convergence bidding entity to a specified

[14] Pursuant to this tariff amendment, the CAISO now administers the day-ahead market and the real-time market, which includes, *inter alia*, the hour-ahead scheduling process and the fifteen-minute market.

[15] Transmittal letter for November 26, 2013 tariff amendment, Docket No. ER14-480-000, at 44-45.

[16] The CAISO had originally proposed that the other tariff revisions go into effect on April 1, 2014, and thus that intertie convergence bidding would go into effect on April 1, 2015. However, on March 10, 2014, the CAISO filed a motion to extend those effective dates to May 1, 2014 and May 1, 2015, respectively.

percentage of the intertie transfer capability.[17] The CAISO proposed to revise existing tariff section 30.9 to permit intertie virtual bidding and to revise existing tariff section 30.7.3.6.3 and add new tariff section 30.7.3.6.3.2 to set forth provisions regarding position limits for convergence bidding entities at the interties.[18]

In the March 2014 Order, the Commission conditionally accepted the tariff amendment, including the proposal to reinstate virtual bidding at the interties effective May 1, 2015. The Commission stated that, "in light of the previous issues with substantial uplift that led to the suspension of intertie convergence bidding, and the magnitude of the market design changes being proposed here," it would condition its acceptance of the reinstatement of virtual bidding upon the CAISO filing an informational report by December 31, 2014 "to demonstrate that the new market structure is providing the expected price convergence and that the issues that resulted in the suspension of intertie convergence bidding have been resolved."[19] The Commission also required that the report "demonstrate that the new market design is working to reduce systemic price divergence" and

[17] The CAISO proposed percentages and time periods for the position limits applicable to the gradual reinstatement of convergence bidding on the interties that were the same as percentages and time periods that the Commission had authorized when it approved the original implementation of convergence bidding on the interties. *See Cal. Indep. Sys. Operator Corp.,* 133 FERC ¶ 61,039, at PP 95, 121-23,125-26, *reh'g denied*, 134 FERC ¶ 61,070, at PP 17-23 (2011).

[18] Transmittal letter for November 26, 2013 tariff amendment, Docket No. ER14-480-000, at 46-48. The CAISO also proposed to revise and add other tariff provisions related to the reinstatement of intertie convergence bidding, but only the tariff provisions listed above are required to reinstate it.

[19] *Id.* at P 103. *See also id.* at P 58 n.89 ("We note that all of the reports directed in this order are for informational purposes only and will neither be noticed nor require Commission action.").

"discuss whether the anticipated benefits of intertie virtual bidding outweigh any market inefficiencies, including any risk of market manipulation."[20]

On December 31, 2014, the CAISO filed the informational report required by the March 2014 Order. The report stated that the data it contained "do not present a basis for not moving forward with reinstating intertie convergence bidding on May 1, 2015" but noted that "[i]f new data becomes available suggesting otherwise, then the CAISO will take appropriate actions to address those issues."[21] One party, Pacific Gas and Electric Company (PG&E), filed comments on the report. PG&E noted that "[c]onvergence bidding at the interties can have very complex effects on the CAISO markets" and that the report did not examine the role congestion may play in understanding whether intertie convergence bidding should be reinstituted.[22]

B. Recent Evidence of Low Market Liquidity on the Interties in the Fifteen-Minute Market and Its Effect on Intertie Virtual Bidding

When it filed its informational report on December 31, 2014, the CAISO was optimistic that increased experience with the CAISO's fifteen-minute market, as well as anticipated changes in scheduling practices in other balancing authority areas in the Western Interconnection, would lead to a greater number of economic physical bids submitted into the fifteen-minute market via the interties.

[20] *Id.* at P 103. In addition, the Commission directed the CAISO to file a follow-up report within 30 days after 12 months of operation that details the performance of intertie convergence bidding, including the associated uplift costs and a measure of the market benefits provided, and any market inefficiencies." *Id.* Further, the Commission stated that, "due to the possibility that reinstating convergence bidding could present new opportunities for market manipulation," the Commission would "closely monitor transactions on the interties and the impact of intertie convergence bidding on market outcomes." *Id.*

[21] CAISO informational report, Docket No. ER14-480-000, at 3 (Dec. 31, 2014).

[22] PG&E comments, Docket No. ER14-480-000, at 2-3 (Feb. 10, 2015).

However, based on a continued lack of liquidity, the concerns raised in the comments PG&E filed in response to the report, and the imminent reinstitution of intertie virtual bidding, the CAISO determined that further observation and analysis were warranted. For these reasons, the CAISO's DMM performed the analysis reflected in the Supplemental DMM Report attached to this petition.[23]

The Supplemental DMM Report indicates that there has been no significant increase in economic bids submitted over the interties since the fifteen-minute market went into effect on May 1, 2014. Instead, the DMM analysis shows that most of the dozens of CAISO interties have no market participants providing economic bids in the fifteen-minute market and only a few interties have multiple market participants providing such bids.[24] The fifteen-minute market has been in effect for almost a year. Thus, market participants have had sufficient time to become familiar with its operation. Moreover, at the end of 2014, Bonneville Power Administration (BPA) instituted 15-minute scheduling, which the CAISO anticipated would substantially address structural concerns that some market participants had suggested were limiting the submission of economic import bids into the CAISO's fifteen-minute market. However, neither of these developments has significantly increased the number of bids submitted into the 15-minute markets at the interties. Therefore, the CAISO has no reason to believe that market liquidity at the interties will increase prior to, or upon reinstitution of, intertie virtual bidding.

[23] On April 3, 2015, the CAISO also filed the Supplemental DMM Report for informational purposes in Docket No. ER14-480, pursuant to the March 2014 Order.

[24] DMM Supplemental Report at Figure 1.

The CAISO does not yet understand the causes of this low market liquidity. Based on informal feedback from market participants, the CAISO believes that some of the possible causes may be neighboring balancing authority areas not supporting 15-minute schedule changes, difficulty in procuring transmission in 15-minute blocks, an absence of bilateral trading at a 15-minute granularity, and reticence of resource owners to adjust their output within the hour.

Regardless of the causes, based on DMM's recent analysis, the CAISO has determined that the existence of such low market liquidity, as evidenced by the lack of economic bids submitted in the fifteen minute marker, makes it problematic to reinstate intertie virtual bidding. Specifically, the existence of interties where no economic bidding occurs in the fifteen-minute market can create incentives for market participants to arbitrage transparent and persistent differences between the day-ahead market and the fifteen-minute market prices to the detriment of market efficiency.[25]

As the Supplemental DMM Report explains, a lack of economic bids in the CAISO's fifteen-minute market at interties means that there generally will be no congestion price reflected in the locational marginal prices for the fifteen-minute market at those locations. This creates a discrepancy between day-ahead and fifteen-minute market prices that will incent market participants to submit virtual demand bids in an attempt to arbitrage these prices. In addition, because virtual

[25] The inefficiencies that are likely to result due to a combination of a lack of market liquidity and virtual bidding are unique to the interties, as opposed to CAISO internal nodes, because of the scheduling limitations associated with the interties and the rule that cuts to intertie schedules are performed on a pro-rata basis. *See* DMM Supplemental Report at 14.

demand is cleared against physical supply in the day-ahead, an increased amount of physical imports will be able to clear the day-ahead market regardless of the capacity limit of the relevant interties, to the extent those imports are offset by virtual exports. However, all virtual positions are automatically liquidated at the fifteen-minute market price, which means that the CAISO must reduce any physical import schedules above the capacity rating of an intertie.

At the same time, the lack of any congestion component for the fifteen-minute market price creates an incentive for importers to submit self-schedules rather than economic bids into the hour-ahead scheduling process because any schedule reductions in the hour-ahead scheduling process will have to be "bought back" by the importer at the higher fifteen-minute market locational marginal price. Therefore, importers will have the incentive to bid as low as possible to avoid a buyback loss, with the lowest bid being a price taker, *i.e.*, a self-schedule.

The combination of these effects can lead to inefficient scheduling of imports into the CAISO. The most direct scheduling inefficiency is the non-economic curtailment of schedules in the hour-ahead scheduling process. The CAISO's market optimization software has no way of knowing the costs of imports when they are submitted as self-schedules. Therefore, higher-priced imports will be curtailed on the same *pro-rata* basis as lower-priced imports, resulting in higher overall costs to the CAISO market. The DMM Supplemental Report provides illustrative examples of the anticipated adverse outcomes.[26]

[26] DMM Supplemental Report at 11-14.

Notably, these adverse outcomes would not be avoided through implementation of the position limits included in the CAISO tariff, because the position limits apply on a market participant basis, rather than on an overall percentage of the specific intertie's capacity limit. The CAISO anticipates that the price disparities between markets would be sufficiently transparent and durable to incent many convergence bidding entities, rather than an isolated few, to bid up to their position limits. With multiple convergence bidding entities bidding in similar ways, the position limits may mitigate the extent of the harm to market efficiency, but that harm would still occur if there were pervasive virtual demand bids at interties that are illiquid in the fifteen-minute market.

The CAISO and DMM continue to recognize that the reinstitution of virtual bidding at the interties may help create price convergence. However, because of the substantial inefficiencies that will result when coupled with a lack of liquidity at the interties, there is no opportunity for efficient arbitrage. Rather, reintroduction of virtual bidding at the interties will result in an overall decrease in market efficiency. Therefore, it is the CAISO's belief that until the problems associated with liquidity at the interties can be understood and addressed, the anticipated benefits of reinstating intertie virtual bidding do not outweigh the expected market inefficiencies of doing so.

The CAISO can only address these issues with virtual bidding at the interties in consultation with its stakeholders. Therefore, it is appropriate to delay the implementation of virtual bidding at the interties for a reasonable period to allow the CAISO and stakeholders to explore these issues in greater detail.

Aside from the direct issue of what factors limit liquidity, the CAISO also may explore issues such as: what constitutes sufficient liquidity to reinstitute virtual bidding at the interties; whether the reinstitution should be evaluated on an intertie-specific basis; and whether any observed increased liquidity is durable, seasonal, or merely episodic.

In addition to the issues to be explored with stakeholders, the CAISO also has identified several potential software enhancements that may help eliminate divergences in congestion between prices in the hour-ahead scheduling process and the fifteen-minute market. These enhancements relate to, among other things, how the market accounts for unused existing transmission contract/transmission ownership rights and how the hour-ahead scheduling process accounts for losses among bordering balancing authority areas. In the next year, the CAISO is confident that it will be able to implement at least some of these software enhancements. But these issues are not the reason for the lack of liquidity, and the software enhancements will not increase the liquidity of the fifteen-minute market at the interties. The software enhancements will nevertheless help to ensure that the congestion prices in the fifteen-minute market appropriately reflect the congestion also present in the hour-ahead scheduling process, and vice versa. This will help to make the market less sensitive when there is lower liquidity.

II. Request for Limited Waiver of CAISO Tariff Provisions

The CAISO requests a limited waiver of the provisions in sections 30.9, 30.7.3.6.3, and 30.7.3.6.3.2 of the CAISO tariff that govern the reinstitution of

intertie virtual bidding, in order to maintain the status quo of not allowing virtual bidding at the interties. This waiver will permit the CAISO to investigate, with stakeholder input, the causes underlying the lack of liquidity in the fifteen-minute market at the interties and explore, through a stakeholder process, whether there are potential solutions that would allow the reinstitution of virtual bidding at the interties in a manner that ensures that the benefits thereof outweigh any market inefficiencies. The CAISO proposes that this waiver remain in place until the earlier of 12 months from May 1, 2015 (*i.e.*, May 1, 2016), or until such time as the CAISO makes a filing under section 205 of the Federal Power Act proposing to amend the tariff provisions relating to intertie virtual bidding.

The Commission has previously granted requests for tariff waivers in situations where: (1) the waiver is of limited scope; (2) a concrete problem needed to be remedied; and (3) the waiver did not have undesirable consequences, such as harming third parties.[27] In this case, all three elements under Commission precedent for granting a tariff waiver are satisfied. Therefore, good cause exists to grant the CAISO's request for waiver.

The waiver the CAISO requests is of limited scope because it only concerns provisions in the three tariff sections listed above, will maintain the status quo beyond the planned May 1, 2015 reinstatement of intertie convergence bidding, and only will be in effect for a maximum of 12 months. A waiver of no more than 12 months will provide sufficient time for the CAISO to

[27] *See, e.g.*, *New York Independent System Operator, Inc.*, 146 FERC ¶ 61,061, P 19 (2014); *PJM Interconnection, L.L.C.*, 141 FERC ¶ 61,103, P 8 (2012); *ISO New England Inc.*, 134 FERC ¶ 61,182, P 8 (2011); *Cal. Indep. Sys. Operator Corp.,* 132 FERC ¶ 61,004, P 10 (2010).

seek stakeholder input on the underlying causes of the lack of liquidity at the interties and determine whether there are solutions that would permit the reintroduction of intertie virtual bidding, such that the benefits of intertie virtual bidding outweigh any market inefficiencies.

The lack of liquidity in the fifteen-minute market at the interties is a concrete problem that needs to be understood and addressed. As explained above, DMM's analysis shows that the existence of interties where no economic bidding occurs in the fifteen-minute market can, when coupled with virtual bidding, create arbitrage opportunities and related incentives for market participants that significantly undermine market efficiency. The Commission's previous directives regarding intertie virtual bidding support the conclusion that the CAISO must address the concrete problem of low market liquidity before it can reinstate intertie virtual bidding. In the May 2013 Order, the Commission authorized the CAISO to discontinue intertie virtual bidding due primarily to arbitrage opportunities resulting from the real-time bifurcated settlement structure, which market participants were able to exploit, and directed the CAISO to develop a solution to permit the reinstatement of intertie virtual bidding "with just and reasonable outcomes, improving market efficiency."[28] Further, in the March 2014 Order, the Commission conditioned reinstatement of intertie virtual bidding on the CAISO demonstrating that all issues with such bidding have been resolved and that the anticipated benefits of intertie convergence bidding outweigh any expected market inefficiencies, including any risk of market

[28] May 2013 Order at P 61.

manipulation.[29] Given the problems presented by low market liquidity at the interties in the fifteen-minute market, the CAISO cannot be confident that reinstating intertie virtual bidding will result in just and reasonable outcomes. To the contrary, the inefficiencies that likely will result from reinstituting intertie virtual bidding outweigh any anticipated benefits thereof.

Lastly, the waiver will not have undesirable consequences, such as harming third parties. No undesirable consequences have resulted from the current absence of virtual bidding at the interties, and depriving market participants of an arbitrage that will, on balance, decrease the efficiency of the CAISO markets cannot reasonably be deemed an undesirable consequence. Granting the requested waiver will simply allow the status quo to continue while the CAISO and stakeholders explore the causes of low market liquidity and consider potential solutions.

III. Request for Shortened Comment Period and Commission Action by April 28, 2014

The CAISO respectfully requests that the Commission act expeditiously and issue an order no later than April 28, 2015, that grants this petition effective as of May 1, 2015. An order by April 28 will grant the CAISO the necessary time to make the appropriate system settings that will either: ensure that intertie virtual bidding will not be reinstituted on May 1 (if the Commission grants the requested action); or allow intertie virtual bidding to move forward on May 1 (if the Commission does not grant the requested action).

[29] March 2014 Order at P 103.

To permit the timely issuance of the order, the CAISO also requests that the Commission shorten the comment period regarding this petition to no more than seven calendar days.

IV. Service

The CAISO has served copies of this filing upon the California Public Utilities Commission and all parties with effective scheduling coordinator service agreements under the CAISO tariff. In addition, the CAISO has posted this filing on its website.

V. Correspondence

The CAISO requests that all correspondence, pleadings and other communications concerning this filing be served upon the following:

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VI. Conclusion

The CAISO respectfully requests that the Commission grant a limited waiver until May 1, 2016, of the tariff provisions discussed above. The CAISO

also respectfully requests that the Commission shorten the comment period on this petition to seven calendar days, so that it may issue an order by April 28, 2015, that prospectively grants the requested waiver effective as of May 1, 2015.

Respectfully submitted,

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Dated: April 3, 2015

California Independent
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California ISO

Potential market inefficiencies from convergence bidding at interties with insufficient liquidity of fifteen-minute bids

April 3, 2015

Department of Market Monitoring

Summary

When structural differences exist between the day-ahead and real-time markets, convergence (or virtual) bids can decrease the efficiency of day-ahead market schedules even while converging prices between the markets.[1] External impediments to the participation of price-sensitive intertie resources that can respond to fifteen-minute schedule changes create this type of structural difference between the ISO's day-ahead and fifteen-minute market on intertie constraints. These structural differences create systematic differences between the ISO's day-ahead and fifteen-minute market intertie congestion prices which would be profitable for virtual bidders. However, this paper provides analysis showing how the reintroduction of virtual bids at ISO interties that lack sufficient liquidity of fifteen-minute market economic bids is likely to decrease the efficiency of ISO intertie schedules.

If there is intertie constraint congestion in the day-ahead market, but there are no economic bids in the fifteen-minute market, the ISO's fifteen-minute market software generally does not currently produce shadow costs reflecting any congestion. In this situation, intertie convergence bids would first settle on the day-ahead market price that includes intertie congestion and would then be liquidated at a fifteen-minute market price which does not include intertie congestion. Convergence bidders would therefore have the incentives to profit from the structural differences between congestion prices in the day-ahead market and the fifteen-minute market. In order to profit from these congestion price differences, convergence bids would create counterflow that would increase the extent to which physical schedules exceeded intertie scheduling limits.

At interties that lack sufficient liquidity of fifteen-minute market economic bids, congestion in the real-time market would likely be managed by hour-ahead curtailments made on a *pro rata* basis rather than on the underlying costs of the intertie resources. Therefore, the reintroduction of convergence bidding under these conditions is likely to decrease economic efficiency by increasing the need to manage real-time congestion through *pro rata* schedule cuts, instead of based on economic merit order of physical bids. While intertie convergence bidding would be profitable for the convergence bidder and may decrease differences in congestion prices by lowering day-ahead congestion, the overall impact of convergence bidding would be to decrease economic efficiency. Moreover, profits received from these virtual bids would ultimately be borne by other participants.

Careful consideration should be given to understanding the structural barriers outside of ISO markets preventing such fifteen-minute market bidding before fully implementing convergence bidding on the interties.

[1] See John E. Parsons, et al, "Financial Arbitrage and Efficient Dispatch in Wholesale Electricity Markets," *CEEPR WP 2015-002*, February 2015.

Introduction

Background

In May 2014, the ISO implemented a major re-design of its real-time energy market in response to FERC Order No. 764. FERC Order No. 764 required the ISO to establish fifteen-minute intra-hour schedule changes along interties to facilitate the integration of large amounts of renewable variable energy resources. The ISO's new market design went beyond the requirements of FERC Order 764, and established a real-time market based on bidding and settlement of intertie transactions in a fifteen-minute energy market.

The new real-time market design allows participants a variety of options for scheduling intertie transactions:

- **Fifteen-minute economic bid:** Market participants have the option to submit economic bids that the ISO can schedule in fifteen-minute intervals based on price. These transactions are settled at the fifteen-minute market price.
- **Fixed hourly self-schedules:** Market participants can submit fixed self-schedules for the hour. These transactions are settled at the average fifteen-minute market price over the operating hour.
- **Fixed hourly economic bid:** Market participants can submit economic bids for intertie transactions that are a fixed quantity for the hour and that the ISO schedules in the hour-ahead scheduling process based on price. These transactions are settled at the average fifteen-minute market price over the operating hour.
- **Fixed hourly economic bid with single intra-hour schedule change:** Similar to the fixed hourly economic bid option above, market participants can submit economic bids for intertie transactions that are a fixed quantity for the hour and that the ISO schedules based on price. However, this option allows for the schedule to be changed once per hour during the fifteen-minute market. These transactions are settled against fifteen-minute market prices.
- **Dynamic transfer:** Market participants continue to be able to establish dynamic transfer arrangements that enable 5-minute dispatch and settlement of intertie transactions. These are settled similar to internal generation.

The real-time market continues to include an hour-ahead scheduling process. However, it is only used to schedule intertie transactions that must be fixed for the hour. These fixed hourly schedules are no longer guaranteed the price projected by the hour-ahead scheduling process. Rather, they are paid the price in each of the fifteen-minute market settlement intervals during the hour they are scheduled. This settlement feature of the new market design was intended to encourage a transition from hourly bidding on interties to more flexible fifteen-minute bidding of interties resources.

Under this new market design, convergence (or virtual) bids on interties are settled based on the difference between the day-ahead market price and the fifteen-minute market prices. These fifteen-minute prices are used to settle the bulk of physical imports/exports and resources within the ISO system. The settlement of convergence bids based on the same fifteen-minute prices used to settle most other real-time transactions was intended to avoid revenue imbalances that were created under

the prior market design by settling intertie virtual bids on hourly prices while settling internal virtual bids on 5-minute prices.[2]

However, due to the uncertainties associated with this new market structure and prior problems caused by convergence bidding at interties, this market design called for convergence bidding on interties to be phased in after at least the first 12 month of this new market design. Intertie convergence bidding position limits were set to zero for the first year after implementation, to be followed by a gradual increase afterwards. On May 1, 2015, convergence bidding on interties is scheduled to be re-introduced by raising the position limit for each entity registered to participate in convergence bidding to 5 percent of the total capacity on each intertie.

Intertie participation and pricing in new fifteen-minute market

With this new real-time market design, under most scenarios in which there are no economic bids at an intertie in the 15-minute market, the current ISO optimization will not generate a shadow value for the intertie constraint. This is because if the only real-time participation is by hourly block bids or self-schedules, any congestion is resolved in the hour-ahead scheduling process. The quantity of fixed hourly schedules will equal the intertie constraint limit if there was congestion from these hourly blocks. These fixed hourly schedules are then transferred to each fifteen-minute market with penalty prices to protect them from being changed in a fifteen-minute market run. In the absence of any fifteen-minute market economic bids, the bid stack at the intertie will end with the protected hourly block schedules at the intertie limit. There will not be any economic bids above or below the intertie limit that can be used to set a congestion price for the intertie constraint. [3]

Figure 1 shows the average bidding over interties in the FMM for March 2015. Each color represents a distinct market participant.[4] Most ISO interties have little or no economic bids in the fifteen-minute market.

Stakeholders have indicated that there may be structural reasons that imports and exports cannot be bid into the fifteen-minute Market.[5] Therefore, there appears to be structural barriers outside of the ISO's markets currently preventing the fifteen-minute market from accurately reflecting the cost of congestion of most intertie constraints. Table 1 describes the differences in intertie congestion between the DAM and FMM over the most recent month. As shown in Table 1, congestion has occurred in a relatively high portion of hours on three interties in March. Significant congestion has occurred in the FMM on only one of these interties (MALIN500), but not on the other two interties frequently congested in the DAM (NOB_ITC and IPPUTAH_ITC). Figure 2 illustrates how the congestion at MALIN500 is being reflected in both the day-ahead and fifteen-minute markets. This reflects how economic bids in the FMM from EIM internal Participating Resources and other dynamic resources allow the underlying real-time cost of congestion at MALIN500 to be reflected in the FMM.

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[2] See Department of Market Monitoring, "Real-time Revenue Imbalance in CAISO Markets," April 2013, available at: http://www.caiso.com/Documents/DiscussionPaper-Real-timeRevenueImbalance_CaliforniaISO_Markets.pdf

[3] The ISO has indicated it will provide more information on this in a forthcoming Market Quality and Validation report.

[4] The economic bids include dynamic schedules, with the exception of the economic bids over MALIN500 from all Participating Resources in the PacifiCorp EIM BAAs. These were excluded because their large quantity would distort the scale of the graph, reducing visibility into the details of the other interties. See DMM's reports to FERC on the EIM transitional period for information on the quantity of capacity bid by Participating Resources in PacifiCorp EIM BAAs.

[5] See stakeholder comments on the FO 764 market initiative.

Figure 1. Average fifteen-minute market intertie bids (March 1 – 30, 2015)

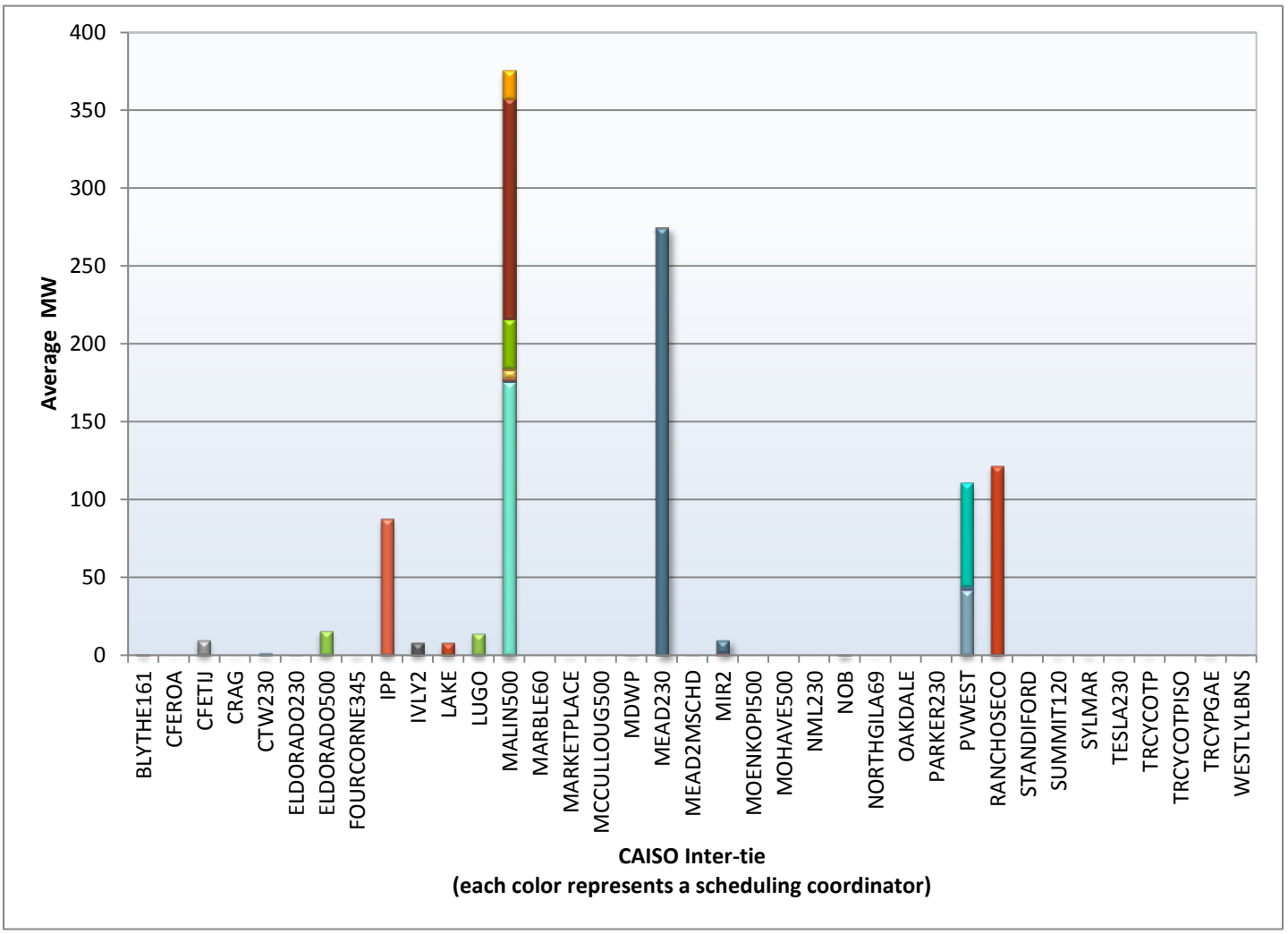
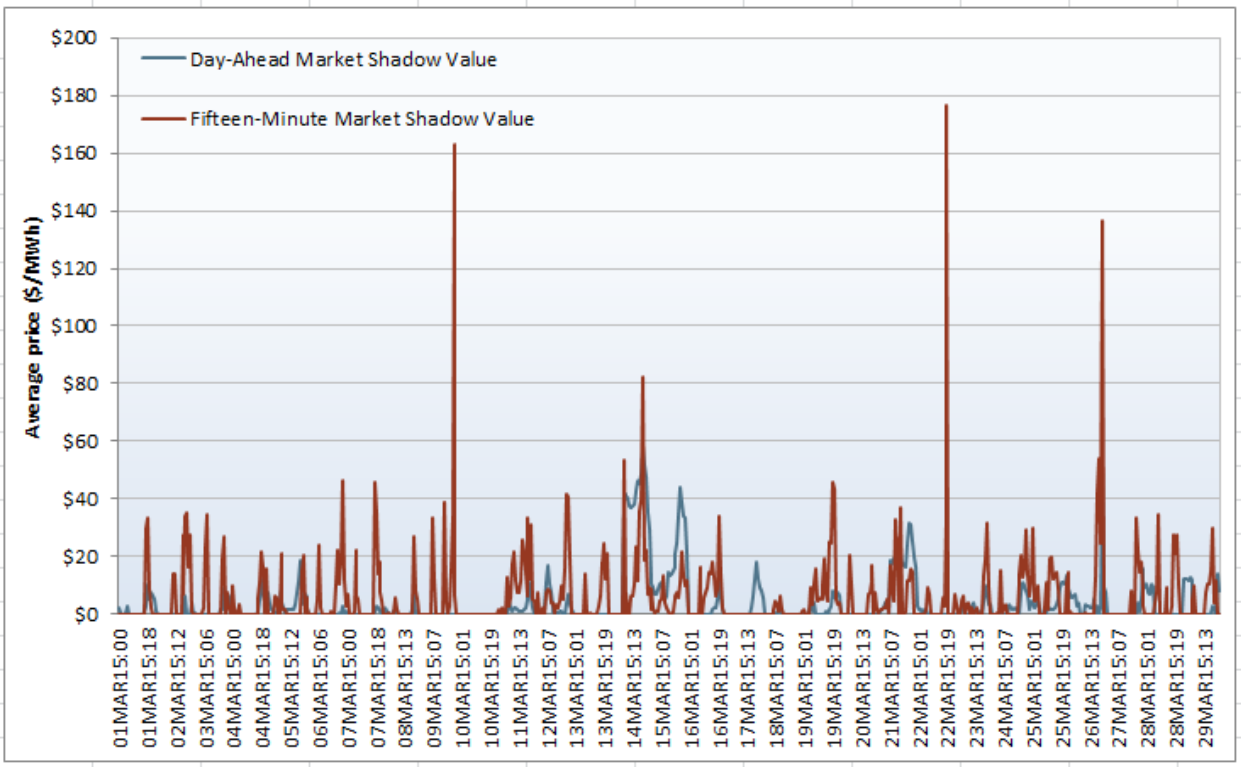


Table 1. Differences in DAM and FMM congestion on intertie constraints (March 1 – 30, 2015)

Intertie Name	DAM Hours Binding	DAM Average Shadow Price	FMM Hours Binding	FMM Average Shadow Price
NOB_ITC	442	$4.60	11	$2.17
MALIN500	304	$3.62	335	$6.05
IPPUTAH_ITC	210	$1.26	1	$0.06
PALOVRDE_ITC	14	$0.87	7	$0.16
IPPDCADLN_ITC	7	$0.05	0	$0.00
CASCADE_ITC	10	$0.05	0	$0.00
SUMMIT_ITC	6	$0.02	0	$0.00

Figure 2. MALIN500 - Average hourly DAM and FMM shadow prices (March 2015)



However, the congestion at NOB_ITC and IPPUTAH_ITC is markedly different, as shown in Figure 3 and Figure 4.[6] Given the absence of economic bids in FMM over those intertie constraints during most hours, the real-time congestion cannot be accurately reflected in the FMM shadow prices. As a result, convergence bids at interties such as this would have the opportunity to profit from the expected structural discrepancy between the DAM and FMM shadow prices.

Systematic differences in congestion between the DAM and FMM on interties such as these would make it profitable for participants to place virtual demand bids at these interties (representing virtual exports). Counterflow on these interties from these convergence bids may tend to converge the shadow prices by reducing the day-ahead market congestion. However, such virtual counterflow would exacerbate the divergence between the physical schedules in the day-ahead and fifteen-minute markets.

Convergence bids at these interties would create a divergence in the physical schedules by allowing the physical imports that clear in the day-ahead market to exceed the limit on the physical schedules that can actually flow in real-time. In the following section, we use a series of examples to illustrate the inefficiencies that can arise from allowing convergence bidding over interties at which there is insufficient liquidity of fifteen-minute market bids.

[6] The IPPUTAH_ITC is the MDWP intertie in Figure 1.

Figure 3. NOB_ITC - Average hourly DAM and FMM shadow prices (March 2015)

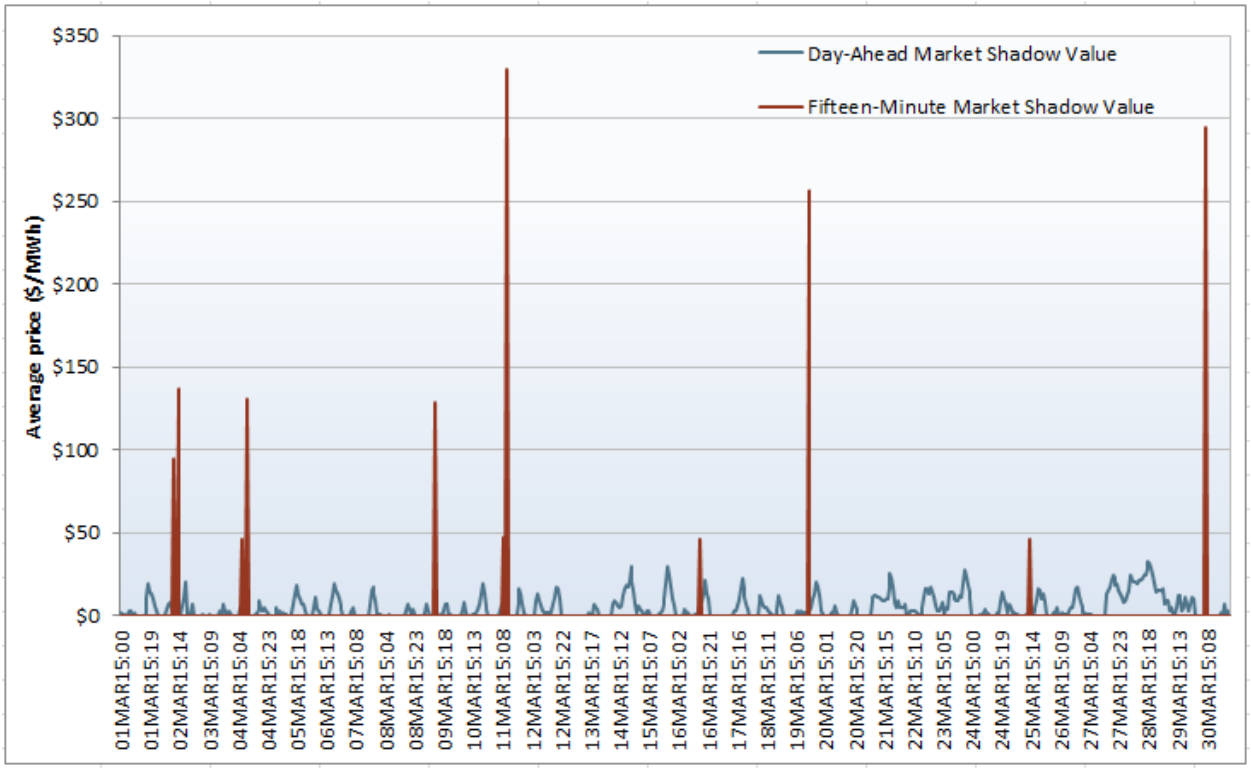
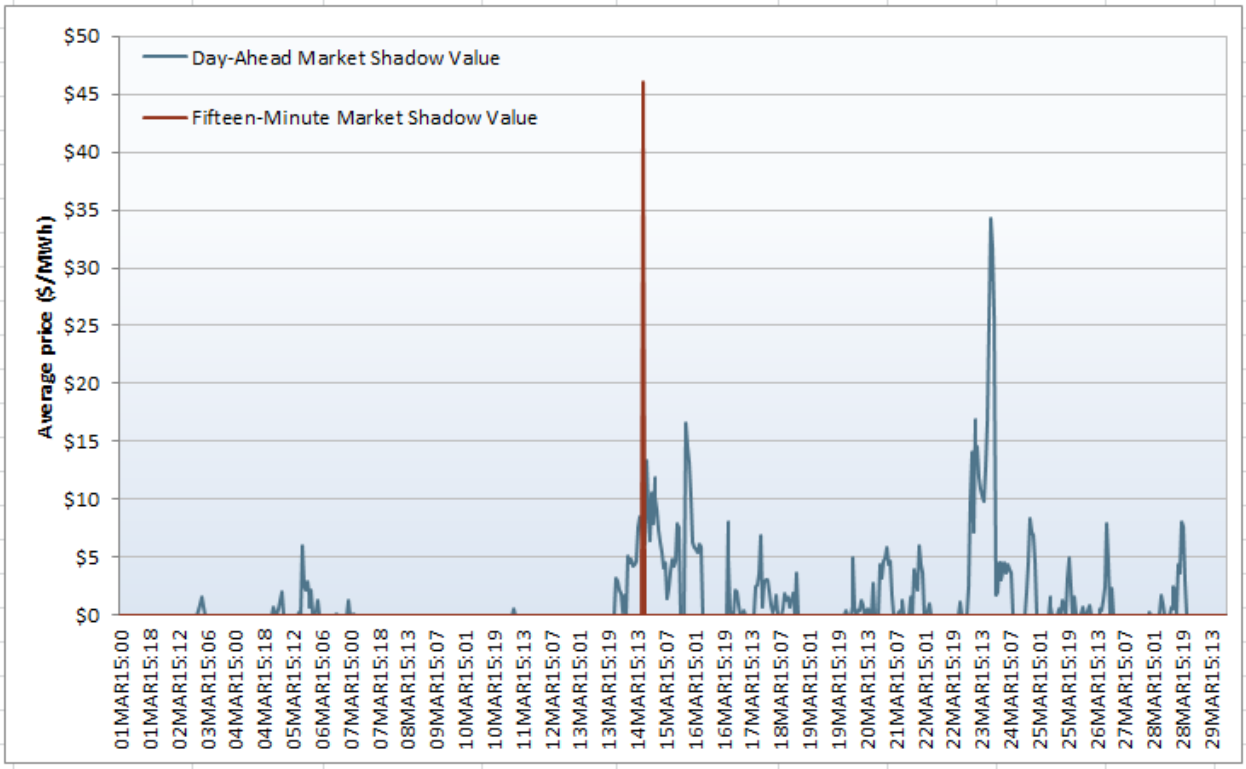


Figure 4. IPPUTAH_ITC average hourly DAM and FMM shadow prices (March 2015)



1 Scenario 1: Interties without convergence bidding and without economic bids in the fifteen-minute market

Scenario description

Table 2 shows an example where suppliers with 1,200 MW of hourly physical imports bid their marginal cost into the DAM. The intertie limit constrains imports to 1,000 MW. The System Marginal Energy cost in the DAM is $35.[7] There are no convergence bids in this example.

The DAM clears 1,000 MWs of total imports. The LMP at the intertie is the cost of the marginal import, $12. The shadow value on the constraint is $23. This reflects the difference between the cost of energy in the ISO ($35) and the cost of importing at the intertie ($12).

In this scenario, suppliers have no ability for fifteen-minute scheduling to this intertie. In order to minimize the probability of having to buy back day-ahead schedules at FMM prices above their marginal cost, suppliers clearing the DAM self-schedule their DAM awards into the HASP as fixed hourly blocks.[8] Supplier 5 and Supplier 6 rebid energy that did not clear the day-ahead market as fixed hourly blocks into the HASP at prices of $12 and $14, respectively.

In the HASP, the same 1,000 MW of imports clearing the day-ahead market clears. As in the day-ahead market, the LMP at the intertie is the cost of the marginal import ($12/MW). The shadow value on the constraint is $23, reflecting the difference between the cost of energy in the ISO ($35) and the cost of importing at the intertie ($12).

However, the HASP LMP is not used in the settlement of any transactions. In the FMM there will be no shadow values generated for the intertie because there are no economic bids. The intertie LMPs in the FMM will be $35**.** The $35 LMP in FMM is higher than the $12 LMP generated in HASP because the FMM LMP does not reflect congestion from the intertie constraint.

[7] To simplify the example, we assume there are no losses or congestion on other constraints.

[8] If the resources economically bid their marginal costs into the HASP it would not change the underlying point of this example.

Table 2. Schedules and prices without convergence bids

Day-Ahead Market

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW	$/MW	Award
Import 1	300	$2	300
Import 2	200	$4	200
Import 3	200	$8	200
Import 4	200	$10	200
Import 5	200	$12	100
Import 6	100	$14	0
Total	1,200		1,000

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	-$23
LMP at Intertie	$12

Hour-Ahead Scheduling Process

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW	$/MW	Award
Import 1	300	Self Sch.	300
Import 2	200	Self Sch.	200
Import 3	200	Self Sch.	200
Import 4	200	Self Sch.	200
Import 5	100	Self Sch.	100
Import 5	100	$12	0
Import 6	100	$14	0
Total	1,200		1,000

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	-$23
LMP at Intertie	$12

Fifteen-Minute Market

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW		Award
Import 1	300	Hourly	300
Import 2	200	Hourly	200
Import 3	200	Hourly	200
Import 4	200	Hourly	200
Import 5	100	Hourly	100
Total	1,000		1,000

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	--
LMP at Intertie	$35

Discussion of results

In this example there are no market impacts from the lack of liquidity in the FMM because there are no schedule changes settling at the FMM price. However, this creates an incentive for convergence bids to arbitrage the difference in congestion prices created by the absence of economic bidding on the intertie in the FMM. In the next example we explore the impacts of convergence bids on interties without economic bids in the FMM.

2 Scenario 2: Interties with convergence bidding and no economic bids in the fifteen-minute market

Scenario description

Table 3 shows this same scenario, but assumes there are now 400 MW of virtual demand bid at $15 in the DAM. This allows all 1,200 MW of physical imports to clear, setting the intertie LMP at $15. The virtual demand is automatically liquidated at the FMM price and does not enter the optimization in either the HASP or FMM.

The imports again self-schedule their DAM awards in the HASP. However, it is not feasible to clear all 1,200 MW in real-time. Therefore, *pro rata* schedule cuts are necessary and a penalty price sets the HASP intertie LMP at -$150.

Again, no schedules settle at the HASP price. And since there are no economic bids in the FMM, no shadow value is generated and the LMP on which the schedule changes settle is $35.

The settlement impacts under this scenario are shown in Table 4.

Table 3. Schedules and prices with convergence bids and no economic bids in FMM

Day-Ahead Market

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW	$/MW	Award
Import 1	300	$2	300
Import 2	200	$4	200
Import 3	200	$8	200
Import 4	200	$10	200
Import 5	200	$12	200
Import 6	100	$14	100
Total	1,200		1,200

Virtual Bids	MW	$/MW	Award
Demand	-400	$15	-200

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	-$20
LMP at Intertie	$15

Hour-Ahead Scheduling Process

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW		Award
Import 1	300	Self Sch.	250
Import 2	200	Self Sch.	167
Import 3	200	Self Sch.	167
Import 4	200	Self Sch.	167
Import 5	200	Self Sch.	167
Import 6	100	Self Sch.	83
Total	1,200		1,000

Virtual Bids	MW	$/MW	Award
None	0	--	0

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	-$185
LMP at Intertie	-$150

Fifteen-Minute Market

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW		Award
Import 1	250	Hourly	250
Import 2	167	Hourly	167
Import 3	167	Hourly	167
Import 4	167	Hourly	167
Import 5	167	Hourly	167
Import 6	83	Hourly	83
Total	1,000		1,000

Virtual Bids	MW	$/MW	Award
None	0	--	0

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	--
LMP at Intertie	$35

Table 4. Settlement of imports and virtual demand

Schedule	Day-Ahead Market Award	LMP	Revenue	Fifteen-Minute Market Award	LMP	Revenue	Total Revenue
Import 1	300	$15	$4,500	-50	$35	($1,750)	$2,750
Import 2	200	$15	$3,000	-33	$35	($1,167)	$1,833
Import 3	200	$15	$3,000	-33	$35	($1,167)	$1,833
Import 4	200	$15	$3,000	-33	$35	($1,167)	$1,833
Import 5	200	$15	$3,000	-33	$35	($1,167)	$1,833
Import 6	100	$15	$1,500	-17	$35	($583)	$917
Virtual Demand	-200	$15	($3,000)	200	$35	$7,000	$4,000

Discussion of results

Compared to Scenario 1, the introduction of virtual demand has increased the day-ahead market price from $12 to $15, thereby contributing to converging the day-ahead and fifteen-minute market prices. The virtual demand profits from buying at a lower day-ahead market price than the FMM price at which it sells. However, the virtual demand profits come from the physical imports that are reduced in the real-time market.

The physical imports that are cut in real-time sell at a lower day-ahead market price than the FMM price at which they must buy back their schedule cuts. The FMM price at which the physical importers must buy back their schedule cuts is inflated due to the FMM price not reflecting the underlying intertie constraint congestion cost.

Structural impediment to economic bids at an intertie in the fifteen-minute market creates incentives for convergence bids to provide counterflow to the intertie constraint.

A lack of economic bids at an intertie in the FMM results in no congestion over the intertie constraint in the FMM. When there is congestion over the constraint in the day-ahead market, virtual bids can profit by clearing counterflow over the constraint. However, by clearing counterflow over a constraint congested in the import direction in the day-ahead market, convergence bids allow the quantity of physical imports clearing the day-ahead market to exceed the constraint's limit.

Intertie convergence bids result in inefficient cutting and scheduling of ISO imports.

With virtual counterflow allowing DAM physical imports to exceed the intertie scheduling limit, DAM import schedules must be cut in real-time. However, in the absence of economic bids and pricing of the intertie's congestion in the FMM, hourly block schedules have the incentive to bid as low possible. When the DAM schedules are reduced in HASP to make net import schedules conform to the intertie limit, the HASP optimization does not know which import schedules are the most expensive and should be cut first. Instead, with hourly block schedules self-scheduling, HASP makes *pro rata* cuts to all of the import schedules, including the most efficient, least cost imports.

This results in a loss of economic efficiency, as shown in Table 5.

- Under Scenario 1, without intertie convergence bids, the final FMM awards correspond to the least cost scheduling of imports. The total cost is $6,200 for 1,000 MW of imports.

- Under Scenario 2, with the introduction of convergence bids at the intertie, a total of 1,200 MW of imports are awarded in the DAM. HASP reduces these 1,200 MW of DAM imports down to the 1,000 MW limit through *pro rata* cuts in HASP. This results in a total cost of $7,333 for the 1,000 MW of imports that are actually scheduled in real-time. Thus, the introduction of intertie convergence bids results in an efficiency loss of $1,133 in this example. The lowest cost resources (Imports 1-4) are sub-optimally dispatched down in order to make room on the intertie for the more expensive resources (Imports 5 and 6) that cleared the DAM due to virtual counterflow.

Table 5. Production cost comparison of scenarios 1 and 2

	Scenario 1 No Convergence Bids			Scenario 2 With Convergence Bids		
	Award	**Bid Cost**	**Costs**	**Award**	**Bid Cost**	**Costs**
Import 1	300	$2	$600	250	$2	$500
Import 2	200	$4	$800	167	$4	$667
Import 3	200	$8	$1,600	167	$8	$1,333
Import 4	200	$10	$2,000	167	$10	$1,667
Import 5	100	$12	$1,200	167	$12	$2,000
Import 6	0	$14	$0	83	$14	$1,167
Total Production Costs			**$6,200**			**$7,333**
					Increase in Production Costs =	**$1,133**

By allowing physical imports to exceed the DAM intertie limit, convergence bids exacerbate incentives for hourly block imports to bid below marginal cost and to self-schedule.

Day-Ahead Market import schedules that are reduced in real-time pay the FMM price. Hourly block schedules are set in the HASP. As a result, changes to DAM import schedules face risk that conditions may change between HASP and FMM, resulting in hourly block import schedules buying back imports at prices higher than their bid price. When convergence bids allow the quantity of cleared physical imports at an intertie in the DAM to exceed the intertie's limits, these schedules will compete in HASP. They will compete to avoid being cut and having buybacks exposed to FMM prices that are not lowered by the intertie constraint congestion. Therefore, DAM imports that clear over a congested intertie constraint that does not have economic FMM bids have the incentive to self-schedule as hourly blocks in real-time.

Inefficiency remains regardless of whether or not intertie convergence bids contribute to converging prices between day-ahead and fifteen-minute market.

Virtual counterflow would tend to reduce day-ahead market congestion and increase the DAM price to be closer on average to the FMM price at which imports would have to buy back their schedules. However, a greater quantity of counterflow from convergence bids would allow even more physical imports to clear the day-ahead market. This would increase the quantity of DAM import schedules that

would have to be cut in HASP in order to keep the net import schedules below the scheduling limit. Despite more convergence between DAM and FMM prices at the intertie, imports would still face strong incentives to self-schedule their DAM awards in HASP. Therefore, despite any increased convergence of prices from intertie convergence bids, these virtual exports would create more of the inefficient cutting and scheduling of ISO imports described above. Moreover, profits received from these virtual bids would ultimately be borne by other participants.

Other physical scheduling inefficiencies caused by convergence bids at interties without economic bids in fifteen-minute market.

Intertie convergence bids can create other inefficiencies. Intertie convergence bids at ties with no economic bids in the FMM increase the likelihood that DAM import schedules will be cut in HASP and have to buy back their schedules at FMM prices inflated by the structural lack of intertie congestion. This may result in many suppliers seeking to inefficiently change the intertie over which they schedule imports. It could even result in some suppliers offering fewer imports in the ISO markets.

Counterflow from internal virtual bids does not cause the inefficient physical schedules caused by intertie virtual bids at interties with insufficient liquidity of economic bids in the fifteen-minute market.

Internal virtual bids have incentives to create counterflow on internal constraints over which the virtual bidding entities expect more DAM congestion than FMM congestion. This virtual counterflow can result in physical schedules in the IFM exceeding the physical limit of the constraint. However, internal constraint virtual counterflow does not result in the inefficient dispatch of physical resources described above.

This is because internal physical resources will not face the same incentives that intertie resources do to self-schedule in real-time under these conditions. If internal resources bid their marginal cost in real-time, they will generally only have their schedules reduced if the FMM price on which they settle is below their marginal cost. Internal resources can therefore expect to maximize their profits by rebidding their marginal cost in real-time.

On the other hand, imports at interties with no economic FMM bids who bid their marginal cost in real-time could have their DAM schedules reduced by a HASP price that is below their marginal cost because of congestion on the intertie constraint in HASP. However, the imports would be exposed to buying back their DAM schedules at a price greater than their marginal cost in the FMM because the intertie constraint congestion would not be reflected in the FMM price.

3 Scenario 3: Interties with convergence bidding and with economic bids in the fifteen-minute market

Scenario description

The ability to economically bid into the FMM can change the pricing and settlements at the intertie significantly. Consider what would happen if Import 6 from the prior scenarios could economically bid into the FMM. Table 6 shows the results of Import 6 submitting economic bids at -$150 in the FMM. In this example, the FMM will set the intertie LMP at -$150. Table 7 shows the settlements under these prices.

Table 6. Effect of economic bidding on intertie in the fifteen-minute market

Day-Ahead Market

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW	$/MW	Award
Import 1	300	$2	300
Import 2	200	$4	200
Import 3	200	$8	200
Import 4	200	$10	200
Import 5	200	$12	200
Import 6	100	$14	100
Total	1,200		1,200

Virtual Bids	MW	$/MW	Award
Demand	-400	$15	-200

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	-$20
LMP at Intertie	$15

Hour-Ahead Scheduling Process

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW	$/MW	Award
Import 1	300	Self Sch.	273
Import 2	200	Self Sch.	182
Import 3	200	Self Sch.	182
Import 4	200	Self Sch.	182
Import 5	200	Self Sch.	182
Import 6	100	-$150	0
Total	1,200		1,000

Virtual Bids	MW	$/MW	Award
None	0	--	0

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	-$185
LMP at Intertie	-$150

Fifteen-Minute Market

Intertie Limit = 1,000 MW
System Marginal Energy Cost = $35

Bids	MW	$/MW	Award
Import 1	273	Hourly	273
Import 2	182	Hourly	182
Import 3	182	Hourly	182
Import 4	182	Hourly	182
Import 5	182	Hourly	182
Import 6	100	-$150	0
Total	1,100		1,000

Virtual Bids	MW	$/MW	Award
None	0	--	0

Net Cleared MW on Intertie	1,000
Shadow Value on Intertie	-$185
LMP at Intertie	-$150

Table 7. Settlement of imports and virtual demand

	Day-Ahead Market			Fifteen-Minute Market			Total
Schedule	Award	LMP	Revenue	Award	LMP	Revenue	Revenue
Import 1	300	$15	$4,500	-27	-$150	$4,091	$8,591
Import 2	200	$15	$3,000	-18	-$150	$2,727	$5,727
Import 3	200	$15	$3,000	-18	-$150	$2,727	$5,727
Import 4	200	$15	$3,000	-18	-$150	$2,727	$5,727
Import 5	200	$15	$3,000	-18	-$150	$2,727	$5,727
Import 6	100	$15	$1,500	-100	-$150	$15,000	$16,500
Virtual Demand	-200	$15	($3,000)	200	-$150	($30,000)	($33,000)

Discussion of results

As illustrated by this scenario, submitting convergence bids to attempt to arbitrage the congestion discrepancy could be very risky when a physical importer can place economic bids and schedule on a fifteen-minute basis.

The importer with the ability to schedule on a fifteen-minute basis would have an incentive to bid as low as possible, while still being decremented in the fifteen-minute market, so as to increase revenues from the import buy back. In this case, the lowest the importer could bid would be the -$150 bid floor. The virtual demand loses substantially from having to sell at a very low FMM price. As the number of importers who can bid economically in the FMM increases, the incentive to bid as low as possible while still maximizing the amount of buy-back profits will likely push bids towards marginal costs and make the dynamics at the intertie more stable.

Convergence bids at interties with low, but non-zero, liquidity for economic bids in the FMM can still create inefficiencies.

This third scenario illustrates that the existence of one physical importer that can economically bid and schedule in the fifteen-minute market on an intertie could create a substantial deterrent to other entities bidding virtual counterflow in the day-ahead market. However, in the absence of multiple physical importers that can participate in the FMM at an intertie, convergence bids at the intertie could create the inefficiencies previously described in Scenario 2. This is because if only one physical importer can participate in the FMM at an intertie with multiple day-ahead and HASP market participants, that one FMM importer may find it more profitable to play the role of the virtual demand from Scenario 2.

4 Conclusions

Interties where there is little or no economic bidding in the fifteen-minute market can create incentives for convergence bidding strategies that create inefficient market scheduling. This is particularly important for interties on which there are structural barriers to economic bidding in the fifteen-minute market. Moreover, profits received from these virtual bids would ultimately be borne by other participants. As shown above, there is a lack of bidding on the interties in the fifteen-minute market. Careful consideration should be given to understanding the structural barriers outside of ISO markets preventing such fifteen-minute market bidding before fully implementing convergence bidding on the interties.