

**Opinion on “Modeling and Pricing Integrated Balancing Areas under MRTU”**

**by**  
**Frank A. Wolak, Chairman**  
**James Bushnell, Member**  
**Benjamin F. Hobbs, Member**  
**Market Surveillance Committee of the California ISO**  
**May 7, 2008**

**1. Introduction**

We have been asked to comment on the California Independent System Operator’s (CAISO) proposal for modeling and pricing Integrated Balancing Authority Areas (IBAA) under the Market Redesign and Technology Upgrade (MRTU). IBAA are neighboring Balancing Authority Areas (BAAs) that are not part of the California ISO Balancing Authority Area, but are incorporated into the CAISO’s Full Network Model (FNM) because they are so closely interconnected with the CAISO through AC transmission facilities that the flows within these BAAs have substantial impacts on power flows within the CAISO. Multiple interconnection points between the California ISO BAA and the IBAA can result in loop flows in and out of the California ISO BAA and on the California ISO Controlled Grid that are difficult to model in the day-ahead market without detailed knowledge of the location of load and generation and the configuration of the transmission network in the IBAA.

Currently, the practice is to model the inter-ties between the CAISO and neighboring BAAs as radial, essentially treating each connection as an independent “pipeline” into the CAISO system, analogous to a fictitious generation unit located at the tie point. These radial connections are assumed not to connect with each other outside the CAISO, and therefore flows over individual ties are assumed to create no “loop flows” that result in additional flows over other inter-ties. The current radial network model assumes that flows resulting from an import transaction will be confined to the interface through the “contract path” over which it is scheduled, although actual flows will follow all parallel paths into the CAISO. When loop or other inadvertent flows occur, this will lead to a divergence between scheduled day-ahead flows over these lines and the actual flows in real-time. For some IBAA, the CAISO believes that this divergence between final day-ahead inter-tie schedules and real-time physical flows on these inter-ties will be small enough for the CAISO operators to manage these deviations in real-time with limited reliability and economic consequences. For now, interconnections with this set of BAAs will continue to be modeled as radial interconnections under MRTU.

However, for IBAA that are more closely integrated with the CAISO BAA, the CAISO believes that radial treatment of these interconnections can result in day-ahead schedules that are sufficiently different from real-time power flows so as to create adverse reliability consequences and impose significant costs upon CAISO market participants. For these inter-ties, the CAISO proposal models the looped nature of the transmission network outside of the ISO BAA with the goal of obtaining day-ahead schedules that are more representative of real-time power flows. The CAISO proposes to apply this approach to the Sacramento Municipal Utility District (SMUD) BAA, which includes the systems of the Western Area Power Administration (WAPA),

the Modesto Irrigation District (MID), and the cities of Roseville and Redding, California and the Turlock Irrigation District (TID) BAA.

Individual MSC members have participated in several teleconference and in-person meetings with CAISO staff to discuss the IBAA proposal. One MSC member attended the March 6, 2008 Stakeholder meeting on this topic at the CAISO. The MSC held a joint MSC/Stakeholder meeting on April 11, 2008 to hear stakeholder comments on this issue. A significant portion of that meeting was devoted to a discussion of the experience of eastern CAISOs with pricing injections and withdrawals from neighboring BAAs. We have greatly benefitted from our interactions with CAISO staff and stakeholders on this very complex issue.

In this opinion, we first summarize our understanding of the CAISO's IBAA proposal and what it is designed to achieve. We support the CAISO's "single hub" price proposal. We believe this is superior to the previous multiple IBAA proposal because it severely limits the ability of suppliers to extract revenues from CAISO market participants without providing any significant reliability benefits. We also continue to support an IBAA solution with more pricing points into the CAISO BAA, but only if the CAISO is given access (by neighboring IBAA's) to detailed information on the day-ahead schedules of all generation units and inter-ties outside of the CAISO control area that exert an influence on power flows in the CAISO BAA and if it can be demonstrated that these multiple pricing points improve market efficiency and system reliability. Absent such information and its associated benefits, the CAISO proposal of a single aggregate IBAA with an import and export price appears to be the best available way to obtain day-ahead schedules that are accurate predictions of real-time flows that do not involve significant monetary transfers from CAISO participants to these entities.

## **2. The CAISO IBAA Proposal**

The issues that the CAISO IBAA proposal deals with arise whenever electricity is traded between BAAs. These so-called "seams issues" include questions such as: How should transactions between BAAs be priced? How should their impacts on network flows be accounted for in the day-ahead and real time markets in order to promote reliability and economic efficiency? How should deviations from scheduled flows and the costs they impose be compensated for? Procedures for handling these issues have evolved over decades in the former vertically-integrated, regulated monopoly regime, but as CAISO market rules have changed and inter-BAA trade has increased, the answers to these questions have had to be revisited.

There is no uniformly best solution to many seams issues when adjacent BAAs use very different mechanisms to manage transmission congestion. This is particularly true for scheduling and pricing inter-BAA transfers. On one hand, power flows entering a BAA at different interfaces have different economic value to that BAA because of the configuration of the transmission network and location of load and generation in the BAA. Thus, it is intuitively appealing to reward suppliers in other BAAs for injections at the more valuable locations. On the other hand, because of the way that deviations from scheduled power flows at interfaces between BAAs are managed, there are strong incentives for providers to claim that their power will be injected at the most lucrative (for the provider) interfaces as measured by the locational marginal prices (LMPs), even though power might flow in real-time over the less valuable interfaces. As a result, if the California ISO attempts to provide incentives to neighboring BAAs to supply power

to more valuable interfaces, the result may simply be more payments to suppliers in those BAAs, with no significant changes in the locations and magnitudes of inter-BAA flows. Although there are mechanisms for seams management that can in theory improve the efficiency of inter-area transactions, these are not practical under present institutional arrangements in the Western Electricity Coordinating Council (WECC).<sup>1</sup>

The CAISO's IBAA proposal attempts to balance a number of competing goals under the present WECC protocols for inter-BAA transactions. The first is to obtain a reasonable accurate representation of real-time flows into CAISO BAA from the results of the day-ahead market based on the information these IBAA's are willing to make available to the CAISO operators about their internal load and generation schedules. The second is to set prices for injections and withdrawals into the CAISO BAA that limit the incentives market participants have to profit from these transactions without providing any reliability or market efficiency benefits to the CAISO BAA. The third goal is to allow each entity the option to designate specific resources within the IBAA as dynamic or non-dynamic generation resources with their own LMP, what the proposal calls Dynamic Resource-Specific Resources or Non-Dynamic Resource-Specific System Resources. The CAISO's current IBAA proposal will not implement this feature until a later date.

The CAISO proposal will establish a "single-hub" default pricing rule for transactions between the CAISO and the SMUD/WAPA/MID/TID IBAA. All imports to the CAISO from SMUD/WAPA/MID/TID IBAA will be priced based on the LMP at the Captain Jack Sub-Hub or Proxy Bus and all exports from the CAISO to SMUD/WAPA/MID/TID IBAA will be priced at the SMUD Sub-Hub or Proxy Bus. This single pricing hub with different export and import prices limits the incentive that suppliers have to use facilities outside the CAISO BAA to misrepresent the location of imports or exports in order to increase their revenues or decrease their costs at the expense of CAISO market participants when actual flows will occur at different interconnections. For instance, the current CAISO proposal makes it less likely that it will be possible to extract revenues from the CAISO BAA by scheduling energy out of the CAISO BAA at a low-

---

<sup>1</sup>For a discussion of some of these theoretically elegant solutions, see B. Kim and R. Baldick, "Coarse-grained Distributed Optimal Power Flow," IEEE Transactions on Power Systems, 12(2): 932-939, May 1997. At one extreme, flows through each transmission line connecting two systems could have its own price, with one system compensating another at the relevant real-time LMP if the real-time flow deviates from scheduled flows. This will provide incentives for suppliers in one system to provide accurate day-ahead schedules. However, under current procedures for compensating for imbalances between control areas, this is not possible. This is because adjacent control areas provide compensation only for net imbalances across all interfaces, not for deviations at individual interfaces. For instance, 200 MWh might be scheduled in the day-ahead market to flow into the California ISO Control Area from the SMUD control area, and this schedule might specify that the flow will be split evenly between two inter-ties between the control areas. Suppose that in real-time virtually all of the flow is through a line that is less valuable for the California ISO; however, if the total flow is still 200 MWh, SMUD will not owe any compensation to the California ISO Control Area. A further disincentive to efficient inter-area transaction management is that if a net imbalance does occur in real-time, no financial compensation occurs; instead, compensation takes the form of paying back physical energy (on an MWh for MWh basis) at a later time.

An alternative approach is possible if both control areas use LMPs to price congestion, and use consistent models and data sets for each other's systems. This can result in consistent LMPs in the sense that one system can obtain reasonable estimates of LMPs at locations in the other system. Then suppliers wishing to sell power from one system to a neighboring system can be paid the local LMP at their point of injection by the neighboring system, which then would also pay the congestion cost from that point to any interface. This eliminates any economic rewards associated with misrepresenting the source of power transfers from one control area to the other. This solution is not possible where (1) adjacent control areas do not use consistent LMP-based congestion management systems, (2) data on neighboring systems is inadequate, or (3) one control system agrees to disregard congestion and losses in other systems when calculating LMPs. All three of these conditions apply to the relationship of the CAISO MRTU congestion management process with the ones used in neighboring control areas.

price location and scheduling that same energy back in at a high-price location. Pricing all imports at Captain Jack and all exports at SMUD makes this strategy much less profitable because the LMP at Captain Jack is likely to be less than or equal to the LMP at the SMUD Sub-Hub the vast majority of hours of the year. Consequently, one important advantage of the CAISO's single hub solution is that it limits the incentive of market participants to engage in strategies that result in little or no net injection of energy into the CAISO BAA, but profit from price differences at different interfaces between the CAISO BAA and the IBAA. It is important to emphasize that these pricing point rules apply to all scheduling coordinators (SCs) that inject power into the CAISO BAA from this IBAA or withdraw power from CAISO BAA and sink it in this IBAA, so that all SCs have a strong financial incentive not to engage in these scheduling strategies.

### **3. Assessing the CAISO's IBAA Proposal**

This section assesses the two major components of the CAISO's IBAA proposal. The first is the designation of a single IBAA pricing point rather than multiple IBAA pricing points as was the case in the previous CAISO proposal. The second is the use of a different pricing point for imports and exports into the CAISO BAA from the SMUD/WAPA/MID/TID region. We also note some potential complications associated with having separate import and export prices for the single pricing point and the existing CRR holdings of CAISO market participants and potential conflicts between the CAISO proposal and pre-existing contractual arrangements between the CAISO and the SMUD/WAPA/MID/TID region.

#### **3.1. Simplifying Network Model for CAISO and Neighboring Balancing Authority Areas**

One lesson from the current zonal market design in California is that there is a significant risk of adverse unintended consequences from attempts to simplify the full network model in the day-ahead market and still obtain final energy schedules that are accurate representations of real-time power flows. However, without detailed information on the configuration of the transmission network and day-ahead schedules of all generation units and loads in the neighboring IBAs and scheduled injections and withdrawals from neighboring BAAs besides the CAISO into these IBAs, it is impossible to determine the true source of supply of energy into the CAISO BAA from the SMUD/WAPA/TID/MID region. Without this level of visibility of the neighboring IBAs by the CAISO operators, we do not believe setting more than one IBAA pricing point will increase market efficiency and system reliability. The experience of the eastern ISOs with creating multiple aggregate scheduling points with neighboring BAAs suggests that this creates significant opportunities for market participants to exploit hub price differences while providing inadequate incentives to reduce the difference between scheduled and actual flows on the inter-ties between the two BAAs. The PJM market initially had multiple pricing hubs with neighboring BAAs, but found that this primarily created opportunities for market participants to exploit inability of the PJM operators to determine the true source of supply and earn the higher price for injections and pay the lower price for withdrawals. As a result, PJM has now set a single hub price with neighboring BAAs.

Because inter-tie-level imbalances between the CAISO BAA and the SMUD/WAPA/TID/MID region are not settled at the real-time price, but are instead settled on net flows across all inter-ties on a MWh-for-MWh basis, we see little reason to expect that set-

ting multiple hub prices in the day-ahead and real-time markets will provide incentives for market participants to have inter-tie-level final schedules that are close to real-time flows. As was emphasized by several participants at the March 6, 2008 Stakeholder meeting, it is possible for market participants to use non-CAISO transmission facilities to alter the deemed source of power flowing into the CAISO BAA. For example, a firm supplying from the Pacific Northwest could actually be injecting power at the Captain Jack inter-tie and schedule a transaction that uses transmission facilities not controlled by the CAISO to move this power from Captain Jack to SMUD. Then it could submit a schedule from the SMUD aggregation point to the CAISO BAA to receive the SMUD hub price instead of the Captain Jack price for this electricity. Except in very special circumstances, it is impossible for the CAISO to determine where the energy injected at the SMUD aggregation point was sourced. Yet the actual source of the energy is a key determinant of its value to electricity consumers in the CAISO BAA. The “true” source of the incremental power can have very different impacts on congestion and losses within the CAISO system. Simply put, incremental generation at SMUD would likely be much more valuable to CAISO consumers than incremental generation at Captain Jack for purposes of managing congestion on the CAISO Controlled Grid.

Within the CAISO, the source of incremental power is identified through the balancing process. If the actual generation at a source is greater than the scheduled output, then the generation has been increased. If the generation is promised at a source, but does not materialize, firms are responsible for paying for the difference at the resulting balancing price at that location. The key problem with seams as now managed in the Western Electricity Coordinating Council (WECC) is that this balancing process has little geographic differentiation. Transactions are balanced at the BAA level, rather than at the nodal level, across BAA boundaries. If the total amount energy flowing from the SMUD/WAPA/MID/TID region in real-time is equal to the sum of net schedules between this region and the CAISO BAA, then the systems are considered balanced. This is true even if power that is scheduled at SMUD is provided from somewhere else within the same BAA. Thus, there is no penalty for delivering power at inter-ties besides the ones it was scheduled on.

For all of these reasons, we support a single pricing location for the SMUD/WAPA/MID/TID region. This should provide entities transferring energy in and out of the CAISO BAA from and to the SMUD/WAPA/MID/TID region with an incentive to schedule resources in a least-cost manner. This pricing mechanism will at least eliminate the incentive to schedule power in a way that takes advantage of the inadequacies of the WECC-wide balancing process as it affects CAISO markets. Firms will have a strong incentive to schedule imports to the CAISO BAA from the least cost (to them) location in their region because they will receive the same price for imports regardless of where these imports come from. Similar logic applies to the case of withdrawals. The neighboring IBAA have an incentive to withdrawal energy from the CAISO BAA only in those instances when it truly is more costly to produce energy in their IBAA than it is to purchase it from the CAISO. This alignment of incentives is also likely to improve the agreement between day-ahead schedules and real-time flows between the CAISO BAA and the SMUD/WAPA/MID/TID region.

### **3.2. Different Import and Export Prices**

As noted above, it is impossible for the CAISO to determine the true source of energy injected into the CAISO BAA from a neighboring IBAA or the true sink of a withdrawal from the CAISO BAA given the information the neighboring IBAA's currently provide to the CAISO operators. Consequently, the CAISO must make some assumption about where it believes injections are likely to be sourced from and locations where withdrawals are likely to sink to in the neighboring IBAA's. We believe it is reasonable and prudent for the CAISO to make these choices in a manner that enhances rather than detracts from system reliability and market efficiency in the CAISO BAA.

In a sense, the CAISO's proposal assumes a worst-case scenario for the source and sink. Specifically, rather than assume the incremental energy is being supplied from the highest price location in the IBAA, the CAISO assumes that it is being supplied from distant generation in the Pacific Northwest and therefore uses the Captain Jack LMP. Similarly, rather than assume withdrawals from the CAISO BAA are sinking at a low-price location in the Pacific Northwest, the CAISO assumes that this energy is sinking at the high-price location in the SMUD region and therefore uses the SMUD price.

As noted above, this pricing policy increases the likelihood that the increment of energy necessary to schedule an injection in the CAISO BAA is in fact coming from Captain Jack or some other location in the Pacific Northwest and the withdrawal from the CAISO BAA is in fact going to the SMUD BAA. This logic also implies that the day-ahead schedules are likely to be closer to real-time flows than would be the case without this IBAA pricing approach. These incentive benefits do not come without cost, however. To the extent that the Captain Jack price is lower than the cost of generation within SMUD, for example, customers within the CAISO will not be able to pay an adequate price for power sourced at SMUD and such trading opportunities may be lost. We note, however, that the CAISO's latest proposal offers a means to maintain these trading opportunities by permitting SMUD to obtain a higher price for its generation if it provides more detailed information to the CAISO that substantiates that the SMUD generation is actually supporting the identified inter-tie transaction. This is unfortunate, but paying the higher SMUD price to all power imports would likely be much worse because of the opportunities introduced by inefficient seams management and balancing energy pricing.

The close relationship between the Malin and Captain Jack inter-ties highlights a related concern addressed by the import/export pricing rule. If a single price were used for both imports and exports into the IBAA, this single price would likely be higher than the Captain Jack price. It would then be possible to procure power at Malin and schedule it into the CAISO at Captain Jack. This is in effect a "circular schedule," essentially sourcing and sinking the power at places with no electrical difference, but with potentially significant price differences. Setting the price of imports into the CAISO from the IBAA at the Captain Jack price recognizes the reality that firms trying to import power into the CAISO from one of the IBAA's inter-ties will choose to procure that power at the cheapest source—which is likely Captain Jack.

We believe that the poor experience of the eastern ISOs with setting multiple pricing hubs and a single price for imports and exports, recommends the current CAISO approach of setting different prices for imports and exports. As the CAISO gains experience under MRTU with

this IBAA pricing approach, it can consider increasing the number of pricing locations if it is granted access to the data necessary to determine with sufficient confidence the likely source of energy injected in the CAISO BAA or the sink for energy withdrawn from the CAISO BAA and if there are clear efficiency benefits of moving towards such a pricing alternative.

### **3.3. Congestion Revenue Rights and the IBAA Proposal**

There is one complication with the current IBAA proposal with respect to Congestion Revenue Rights (CRRs) that should be addressed. Because the CAISO would be charging imports and exports different prices it is unclear what price will be used to settle CRRs between the CAISO and the SMUD/WAPA/MID/TID IBAA. Going forward this requires the CAISO to specify two different nodes in the SMUD/WAPA/MID/TID IBAA that market participants can source or sink their CRRs. There are a number of options for settling CRRs with separate import and export prices. The current CAISO proposal is to use the direction of the CRR to determine the settlement price. If the CRR is defined in the import direction, then its sink is the CAISO and it will be settled at the IBAA import price. If the CRR is in the export direction, then its sink is in the IBAA and it must be settled at the IBAA export price. The only outstanding concern is for pre-existing CRRs that were not defined in this manner at the time they were released, so their settlement price locations must be adjusted to match the IBAA pricing rules and this could result in revenue inadequacy. The CAISO expects any such impacts to be small relative to the entire pool of congestion revenues over a month, but it will be able to test for revenue adequacy in advance. If any CRR revenue inadequacy is identified, the CAISO proposes to use the monthly CRR Balancing Account to cover any revenue shortfall that may or may not occur.

### **3.4. The Interaction with Pre-Existing Operating Agreements**

One other issue that was the subject to significant discussion during the stakeholder meetings is the relationship between the new IBAA proposals and any pre-existing agreements for the management of losses on shared inter-ties. Some stakeholders, such as Transmission Agency of Northern California (TANC) and Silicon Valley Power (SVP), have argued that existing contracts specify a reciprocal arrangement in which each party will manage losses on its own part of the transmission network, even though loop flow is causing each party's transactions to incur losses on the other party's portion of the network. It is our understanding that the reciprocal arrangement essentially assumes that these loop flow effects balance out.

The new proposal for IBAA pricing shifts the paradigm for loss cost-allocation from a "payment-in-kind" approach to one in which the cost of losses are incorporated into the prices of transactions using the CAISO system. Under the IBAA proposal, marginal loss charges for flows on CAISO transmission facilities apply only to transactions scheduled into and out of the CAISO BAA. In other words, parties will be charged for the losses caused on the CAISO system by transactions scheduled into or out of the CAISO system. To the extent that firms are required to pay in-kind for their losses by reducing their withdrawals in addition to paying LMPs that reflect marginal losses, this could be construed as double-charging for losses. However, our understanding of the reciprocal arrangement is that it covers losses caused on one system for transactions scheduled *on the other system*. The current CAISO proposal deals with the effect of losses on the CAISO system of transactions scheduled *on the ISO system*. To the extent that the CAISO does not charge IBAA parties for the loss consequences of schedules using only IBAA

facilities, this will not change.

We are not in a position to comment on the exact nature of these contractual commitments, other than to recognize that the issue has been raised. We would also like to point out that incorporating losses on the CAISO network into LMPs for sales into and out of the CAISO BAA is a much more efficient means of compensating for the effect of losses than the "payment-in-kind" approach. Under an LMP market, the system operator is effectively finding the most least-cost (based on offers and bid submitted) way to compensate for losses and including those costs into the prices seen by all market participants. The LMPs also provide all market participants with a price-signal of the cost of the increased losses caused by the transaction. Under a payment-in-kind approach, users provide the physical compensation for the losses themselves. It is an approach somewhat analogous to having each unit provide its own operating reserves, rather than pooling those responsibilities amongst a larger network.

If there is a determination that pre-existing contractual arrangements require a payment-in-kind approach for losses for some of the transactions, ideally the requirement could be met while still maintaining the efficiency benefits of the LMP approach. This could be accomplished through a mechanism such as a "losses-only" revenue right (LRR). This LRR would be similar to a congestion revenue right (CRR) except that it would pay the right holder only the component of the LMP difference caused by losses rather than the entire LMP difference. To avoid distorting scheduling incentives, this quantity of LRR would have to be set at some pre-determined level rather than linked to the amount of daily schedules into and out of the CAISO system.

#### **4. Adapting to Changing Market Conditions**

As noted earlier, there is no optimal solution to modeling and pricing transactions between the CAISO and neighboring BAAs given the current WECC protocols for settling deviations between neighboring BAAs. A clearly superior solution would be to settle inter-tie-level real-time deviations between neighboring BAAs at the real-time LMP at that inter-tie. All parties could then be confident that power is being delivered at the location at which it has been scheduled, and that parties responsible for deviations from that schedule would bear the full costs caused by those deviations. We hope that the neighboring IBAs will provide the necessary information to the CAISO so that it can move toward this solution as soon as possible. More broadly, we urge western BAAs to negotiate seams agreements that allow this sort of imbalance pricing and seams management.

Because the transmission network configuration between the California ISO and the SMUD/WAPA/MID/TID IBAA is likely to change, the CAISO should reserve the right to change the collection of proxy buses that comprise the import and export pricing points. We recommend a stakeholder process justifying the need to change the status quo and the describing the advantages of the proposed change, with the approval by the California ISO Board or in emergency situations the simply the approval the CAISO management with ex post review by the California ISO Board. Our key point is the CAISO must have the flexibility to adapt the import and export pricing points to changing conditions in the CAISO and IBAA BAAs if the CAISO's IBAA proposal is to achieve the two main goals described above.