



## **Comments of Pacific Gas & Electric Company** *Energy Imbalance Market 3<sup>rd</sup> Revised Straw Proposal*

Submitted by	Company	Date Submitted
Will Dong (415) 973-9267 Paul Gribik (415) 973-6274	PG&E	September 9, 2013

Pacific Gas & Electric (PG&E) offers the following comments in the stakeholder process for the California Independent System Operator’s (CAISO) Energy Imbalance Market (EIM) Initiative’s August 13, 2013 3<sup>rd</sup> Revised Straw Proposal (“Proposal”).

PG&E appreciates the CAISO working with stakeholders to improve the EIM design and holding the technical workshops that provided clarifications on key design elements. PG&E understands that three additional workshops are planned to address other topics that can benefit from additional discussions.

Although much of EIM design is seemingly decided, there are numerous elements that are still in flux. It is important that the CAISO and stakeholders have the time needed to resolve the remaining open issues and digest and respond to the remaining three workshops. Depending on the changes made in the planned Draft Final Proposal and the timing of the technical workshops, the CAISO should be open to adjust the EIM schedule, and, if necessary, allow for an additional round of comments and an additional proposal.

PG&E provides eight recommendations on the EIM implementation process and design. We also ask for clarification on three elements of the design.

1. CAISO should phase in the transfer capability for EIM implementation;
2. CAISO should address convergence bidding uplift allocation before EIM goes live;
3. Protections should be implemented to mitigate the problem of base schedule in one BAA causing congestion in another BAA;
4. EIM entities should not be able to opt out of commitment costs incurred by the CAISO;
5. CAISO should have authority to dispatch committed units and commit fast-start resources in the EIM entity;

6. CAISO should examine the impact of the EIM on the proposed RIMPR BCR changes;
7. Following the EIM simulations, the CAISO should seek Board approval for implementation readiness before go-live; and
8. CAISO should develop an EIM reversion plan as part of its implementation planning

This is a sizeable and complex initiative, and PG&E has not been able to fully vet every aspect of the proposal in the time allotted in the stakeholder process. Instead, PG&E has focused on what we consider the most important issues. Therefore, absence of comments on a particular element of the proposal should not be perceived as PG&E's endorsement. We may offer input on the other elements at a later date.

Ultimately, PG&E's support of an EIM will depend on achieving a level of comfort that the benefits to customers will be commensurate with the costs and risks that will be incurred by customers. Overall, PG&E sees the potential opportunity for an EIM to benefit each region, but we will be seeking assurances that the benefits clearly outweigh the costs, and the design results in fair treatment of both the EIM Entities and the CAISO in regards to cost allocation and market obligations.

### **1. CAISO Should Phase In the Transfer Capability for the EIM Implementation**

The proposed EIM requires integrating Balancing Authority Areas (BAAs) with different forward markets, scheduling practices, and different Real-Time (RT) dispatch mechanisms into a combined RT market. The EIM must combine:

- The CAISO BAA with its existing Security Constrained Unit Commitment (SCUC) based day-ahead market that only considers transmission constraints within the CAISO BAA;
- A group of BAAs which rely on forward scheduling using bilateral contracts and physical transmission rights;
- The RT dispatch of CAISO and the other BAAs into a single Security Constrained Economic Dispatch (SCED) based market that enforces the transmission constraints in the combined footprint; and
- The CAISO BAA which is subject to California's Green House Gas (GHG) regulations with BAAs which are not subject to these rules.

This type of integration of BAAs with disparate Day-Ahead market structures and GHG requirements into a single, combined RT market is unique and complex undertaking. The scope of the proposed EIM is ambitious, both from the perspective of market operations and size of the BAAs which the EIM will integrate. No organized market in the United States has attempted to do this.

The CAISO and its stakeholders have been putting forth their best efforts to put in place a robust EIM design. However, given the complexity and novelty of this EIM, one simply cannot anticipate all the possible outcomes, both desirable and harmful ones, prior to the EIM's launch. Given the complexity, there will be unanticipated issues, and, although helpful, the planned simulations are unlikely to uncover all of the shortcomings of the design. Because the EIM may expose millions of customers to potentially costly market risks, adequate safeguards and potential refinements to the EIM are critical to successful implementation. One reasonable safeguard is a phased implementation of the EIM. This can be done by phasing in the EIM transfer capability between the CAISO and PacifiCorp.

PG&E recommends a one-year phased implementation of the EIM by limiting the incremental real-time transfer capability between the CAISO and PacifiCorp to 100 MW for the first year of EIM operation. This allows EIM to adjust flows between BAAs while still providing some safeguard against potentially significant market manipulation or disruption.

Given the breath and complexity of the EIM initiative, a phased implementation is prudent. It is important to safeguard the market used to serve over 30 million customers from unnecessary risk. At the same time, the 100 MW limit is not unduly burdensome. The CAISO has indicated at an April 11, 2013 stakeholder meeting that the initial available transfer capacity is not likely to exceed 100 MW. Thus, the impact of limiting the EIM transfer for a relatively short period of time is minimal.

Operating the EIM within the 100 MW transfer capability limit accomplishes two main objectives. First, it allows the CAISO and market participants to thoroughly test the EIM design. Unlike market simulation, this "test" will be performed with real data (e.g., actual market participant bidding and scheduling and real transmission constraints enforced) and with all the design elements running across the entire market, uncovering issues that may have escaped simulations. The CAISO will be able to evaluate the effectiveness of the EIM design (e.g., under/over-scheduling penalties) and the reasonableness of the uplift costs (e.g., RTCO, BCR); and along with the DMM be able to assess if the market power mitigation rules are working as expected. Second, this phase allows the EIM Entities to gain operational experience with the real-time energy market before additional transfer capability is made available.

PG&E recommends that the phase-in period last one year. This should capture any seasonal effects such as changes in system and resource conditions; it should also provide adequate time to resolve any design or operational issues. Near the end of the phase-in period, the CAISO would report out to the CAISO Board on the performance of the EIM (including a report by the DMM) and seek Board approval before moving into unrestricted EIM operation.

**2. CAISO Should Address Convergence Bidding Uplift Allocation before EIM Goes Live**

The latest proposal would allocate a portion of Real Time Congestion Offset (RTCO) costs incurred on a transmission constraint in an EIM Entity's BAA back to Convergence Bidders who received revenue that were in part funded by such uplifts.<sup>1</sup> PG&E supports this approach, which is consistent with recommendations made by the CAISO's DMM.<sup>2</sup> As discussed below, PG&E believes this type of allocation is appropriate to deter exploitation of structural difference between the day-ahead and real-time markets. Given the EIM will introduce such differences across the combined foot print – in the EIM Entities and the CAISO BAA – the CAISO should also adopt a similar approach for RTCO costs incurred on CAISO constraints.

In its paper “Real-time Revenue Imbalance in CAISO Markets,” the DMM recommended allocating a portion of RTCO costs to convergence bidding, to the extent these day ahead virtual schedules contributed to real time binding constraints and benefitted from the resulting imbalance revenue. According to the DMM, this is a necessary measure to reduce the incentive for virtual bidders to exploit the structural difference between the day-ahead and real-time markets. In this case, the difference is in the day-ahead and real-time limits on a transmission constraint. PG&E agrees with the DMM recommendation.

From the perspective of an EIM Entity, the proposed real time EIM clearly introduces structural differences between the CAISO's day-ahead market and the EIM. This is because the CAISO may not model the final base schedules of the EIM Entities in its Day-Ahead market (due in part because the final base schedules are not known when the DA market is run); it also may not model the transmission constraints in an EIM Entity's BAA in its Day-Ahead market.<sup>3</sup> Consequently, a transmission constraint in the EIM Entity that may not bind when its base schedule is evaluated may be violated when the CAISO's DA schedule and the EIM Entities' final base schedules are considered together.

For the same reasons, the EIM would introduce structural differences from the perspective of a CAISO market participant. By not modeling EIM Entities' final schedules and transmission constraints in the CAISO's day-ahead market, a constraint within the CAISO BAA that is not binding in the CAISO's day-ahead market can bind or be violated when the CAISO's DA schedule and the EIM Entities' final base schedules are considered together.

This type of difference can be exploited by convergence bidding and lead to RTCO costs to manage the constraints. The latest EIM proposal has put forth a method to mitigate this uplift risk on EIM Entity constraints. PG&E encourages the CAISO to promptly commence a

---

<sup>1</sup> Here, RTCO costs are incurred from eliminating violations arising from CAISO's day-ahead schedules and EIM Entities' base schedules.

<sup>2</sup> See DMM Paper “Real-time Revenue Imbalance in CAISO Markets, April 24, 2013.

[http://www.caiso.com/Documents/DiscussionPaper-Real-timeRevenueImbalance\\_CaliforniaISO\\_Markets.pdf](http://www.caiso.com/Documents/DiscussionPaper-Real-timeRevenueImbalance_CaliforniaISO_Markets.pdf)

<sup>3</sup> In its Full Network Model Expansion initiative, CAISO may model the transmission lines in the EIM Entities and other BAAs and the flows caused by CAISO's DA schedules on those lines. However, it may not enforce flow limits on those lines in its DA Market.

stakeholder process to extend this type of protection to CAISO constraints, for they are also affected by structural differences introduced by the EIM. Without such a mechanism in place, the EIM implementation should not proceed beyond the Phase-In state (100 MW transfer capability between CAISO and PacifiCorp) to limit the potential gaming opportunity.

The proper allocation of RTCO uplifts to convergence bidders is appropriate, and is not in conflict with CAISO's ongoing effort to improve modeling consistency between its day-ahead and real-time markets. PG&E appreciates these efforts, including the new Full Network Modeling (FNM) Expansion initiative. However, we believe these efforts alone do not adequately protect California customers from excess uplifts resulting from convergence bidding exploitation and only provide a first line of defense against market exploitation. The structural difference introduced by the EIM, as explained above, will still exist with the expansion of the FNM. PG&E believes the appropriate way to address the associated cost risk is to adopt the DMM's recommendation, and apply it across all constraints within the EIM, including those inside the CAISO. This change in cost allocation provides a second line of defense and is especially prudent given the history of convergence bidding gaming.<sup>4</sup> Without this protection, the level of costs/risks of implementing the EIM could outweigh the possible benefits for California customers.

**3. Protections Should be Implemented to Mitigate the Problem of Base Schedule in One BAA Causing Congestion in Another BAA**

The current proposal would allocate Real Time Congestion Offset (RTCO) costs incurred to eliminate a constraint violation caused by CAISO's Day-Ahead schedules and EIM Entities' base schedules back to the BAA where the violated constraint lies. There are situations where schedules from one BAA may contribute to flow on a constraint that is inside another BAA, possibly causing a violation of the constraint that must then be managed by the EIM. Participants outside of the BAA where a constraint violation occurs may be paid to adjust their Day-Ahead or base schedules in order to alleviate flow on the binding constraint contributing to RTCO. Meanwhile, under the current proposal, the entire RTCO uplift costs needed to fund the adjustment in Day-Ahead or base schedules are borne by the EIM Entity where the constraint lies.

This may induce participants in some BAAs to over-schedule at certain nodes or change their scheduling practices and benefit from imbalance revenues that will be funded in part by RTCO costs charged to participants in other BAAs. In particular, some entities may find it profitable to over-schedule supply and load in their base schedules so that they will be paid to remove the over-schedules in EIM. To reduce the incentives to engage in such practices, PG&E

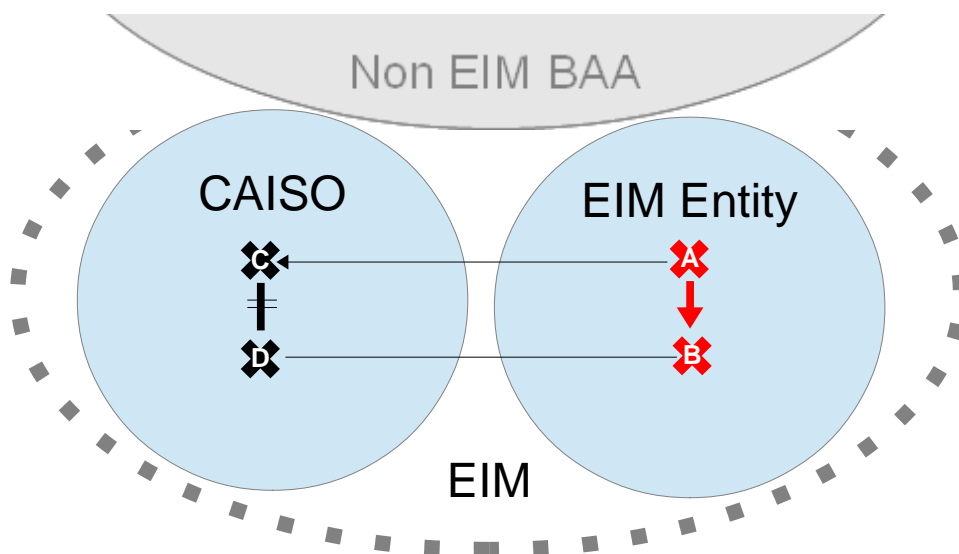
---

<sup>4</sup> As highlighted in our previous comments, in 2012 alone, convergence bidders benefitted from \$70 million RTCO charges, paid by California loads, by exploiting the difference between day-ahead and real-time flows on binding constraints.

recommends putting over-scheduling penalties in place. Such over-scheduling penalties were part of the original EIM proposal; the CAISO later removed them in the 2<sup>nd</sup> revised straw in light of the currently proposed RTCO allocation method.<sup>5</sup> However, as discussed in this section, these penalties are still needed because base schedules within one BAA can cause congestion, and potentially drive up RTCO costs in another BAA.

PG&E prefers an over-scheduling penalty relative to no protection. However, a more comprehensive solution that would protect against both over-scheduling and other scheduling practices that may result in similar overloads may be to modify the RTCO allocation to dis-incent participants from behaving in manipulative behavior.

The simplified example below illustrates the need for over-scheduling penalties (an expanded numerical example is provided in the Appendix). Consider a simple case where the EIM is made up of two BAAs: CAISO and an EIM Entity, where there are four nodes (A, B, C, and D) connected by transmission lines forming a loop. This simple system is depicted in the diagram below. Assume the EIM Entity has a base schedule that injects power at node A and withdraws power at node B. Given the particular network configuration, this schedule will send energy on path A→B, but due to the effect of loop flow, it will also cause some power to flow on path C→D. Let us further assume in the real time EIM, there is transmission constraint on path C→D within the CAISO, which causes price separation at nodes A and B whereby the LMP price at nodes A and B are \$10 and \$20 per MWh, respectively.



Without an over-scheduling penalty, participants in the EIM Entity may have the incentive to over schedule injection at node A and withdraw at node B, relative to the actual energy demand

<sup>5</sup> Over-scheduling penalties were presented in the first EIM Revised Straw Proposal (page 21) <http://www.caiso.com/Documents/RevisedStrawProposal-EnergyImbalanceMarket-053013.pdf>

in the EIM Entity. This is because the Real Time (RT) imbalance payment they receive at node B (as a load) will exceed any RT imbalance charges they will pay at node A (as a resource). In this simple example, without a penalty, a participant with a base schedule on path A→B will receive a \$10 profit from each MW of over-scheduling.

More broadly, PG&E asks the CAISO to revisit the proposed RTCO allocation method to investigate possible methods to share RTCO uplifts arising from reducing violations on 1) CAISO constraints caused by base schedules from EIM Entities and 2) EIM Entity constraints caused by the CAISO's Day-Ahead schedules or base schedules of other EIM Entities. Such an approach would better reflect cost causation. It would also reduce the likelihood of market participants altering day-ahead or base schedules in one BAA to cause congestion in another BAA from which it could profit in EIM. Until such an approach is developed, an over-scheduling penalty is appropriate.

**4. EIM Entities Should Not be Able to Opt Out of Commitment Costs Incurred by the CAISO**

Currently, the proposal allows an EIM Entity to avoid any allocation of Bid Cost Recovery (BCR) charges to cover commitment costs from other BAAs that arise from commitment decisions made in EIM, if that EIM Entity elects not to allow real-time unit commitment through the EIM.<sup>6</sup> However, as reflected in our prior comments, the decision of an EIM Entity not to allow EIM to commit its resources does not prevent EIM from committing units across the combined foot print to benefit the EIM Entity that made the decision not to allow EIM to commit its resources. The EIM will commit units whenever it is economic to do so, even if this involves committing a resource in one EIM Entity or CAISO for the benefit of an EIM Entity that has elected not to allow commitment within its BAA. Allocation of commitment costs should be based on the causation principle and the beneficiaries should pay. By shielding certain EIM Entities from EIM commitment costs, the current proposal violates the cost causation principle and is fundamentally unfair to the other EIM BAAs paying the EIM commitment costs.

In fact, the current proposal may provide the unintended, perverse incentive for EIM Entities to choose not to allow real-time unit commitment through the EIM. By making this choice, these EIM Entities are protected from BCR uplifts, while allowing them to potentially benefit from EIM commitments in other BAAs that allow commitment by EIM. This creates a free rider problem that may lead to more EIM Entities choosing not to allow commitment through the EIM. As a result, the Market Operator will have a smaller resource pool to commit in real time, and this would reduce the benefit of an expanded real-time market.

---

<sup>6</sup> CAISO 3<sup>rd</sup> Revised Straw Proposal, p. 66.

For these reasons, PG&E believes commitment cost should be fairly allocated to all EIM Entities that benefit from it, and no EIM Entity should be exempt from this allocation.

**5. CAISO Should Have Authority to Dispatch Committed Units and Commit Fast-Start Resources in the EIM Entity**

As currently proposed, availability of resources in the EIM Entity for dispatch or commitment is at the discretion of the EIM Participant. To maximize the inter-regional dispatch benefit as purported in the EIM Benefits Study, PG&E recommends that the CAISO develop simple Must Offer Obligation (MOO) rules for the EIM Entity to ensure units that are committed are available for dispatch by the CAISO through the EIM and fast-start units not committed are available for commitment in the EIM.

PG&E suggests developing rules that result in a similar MOO as for CAISO resources; that is, resources that count for Resource Adequacy (RA) and are not out-of-service are generally available to the CAISO. To have real-time must offer rules for CAISO participants (which can benefit the EIM Entity) and no similar rules for the EIM Entity is discriminatory.

Based on our understanding, similar rules may already exist in EIM Entities that allows the transmission provider to commit and dispatch RA-equivalent resources. For instance, according to PacifiCorp's OATT, Network Resources must be made available to the Transmission Provider for re-dispatch to alleviate any transmission constraints, so long as the re-dispatch is performed on a least-cost, non-discriminatory basis.<sup>7</sup> This flexibility provided by PacifiCorp should be incorporated into the CAISO's EIM tariff so the Market Operator can commit and dispatch all RA-equivalent resources (or in the case of PacifiCorp, Network Resources) across the combined foot print.

PG&E understands that the inter-regional dispatch benefit in the Benefits Study was based on modeling that did not artificially restrict resources in PacifiCorp from commitment or dispatch in the EIM. To restrict CAISO's access to PacifiCorp resources in the EIM lessens the possible benefits as compared to the Benefits Study. It is in the interest of all participants to maximize the potential EIM benefits.

**6. CAISO Should Examine the Impact of an EIM on the Proposed RIMPR BCR Changes**

Currently the Bid Cost Recovery (BCR) process nets all profits and losses for a resource across all markets and all hours in the day. If a resource is committed in the Day-Ahead (DA) market but is then determined to be uneconomic in the Real-Time (RT) optimization that unit may not

---

<sup>7</sup> See PacifiCorp OATT, Section 30.5 "Network Customer Redispatch Obligation" ([http://www.oatioasis.com/PPW/PPWdocs/20120209\\_OATTMASTERwRateCase.pdf](http://www.oatioasis.com/PPW/PPWdocs/20120209_OATTMASTERwRateCase.pdf)); A Network Resource counts towards a Network Customer's capacity obligation to meet its share of system peak demand.



receive an actual start-up instruction and would then not be eligible to recover any minimum load costs for the original DA award.

With the upcoming Renewable Integration Market and Product Review (RIMPR) changes netting BCR across all markets would no longer be the case. Once these changes are implemented, a unit that is committed in the DA market is eligible to recover any and all physical costs (except start-up) so long as it follows the final RT dispatch award, even if that award is to de-commit the unit. These BCR costs would then be allocated back to any and all net-load entities from the Day-Ahead market (i.e. any participant with Day-Ahead demand in excess of self-scheduled supply in the IFM market).

While the chance of reversing a commitment decision made in the DA market may be low in today's RT market, it could increase under the EIM. Currently the CAISO optimization models are relatively consistent across the DA and RT markets. The footprint is identical and the available economic units are reasonably similar. With the introduction of additional BAAs and resource sets, the economic baselines of the CAISO's DA market may be significantly reset by the economic availabilities in the EIM market. Furthermore, if the EIM entities introduce a resource set that is generally priced lower than the original CAISO's DA set, then it is possible that the marginal generators from the DA market would no longer be economic and may not be started up as expected. Hence, the likelihood of reversing a DA commitment decision increases under the EIM. These marginal units from the CAISO's DA market will most likely require BCR payments (because the final LMP would not cover the full extent of their costs), and under the proposed RIMPR / BCR changes they would be able to recover their full minimum load and energy cost recovery payments from the DA commitment.

Thus, under an EIM, the proposed RIMPR BCR changes may lead to an additional increase in BCR costs, borne solely by net-load participants in the CAISO's DA market. PG&E believes this issue warrants consideration, and asks the CAISO and the DMM to examine its potential impact, including any new gaming opportunities it may introduce.

#### **7. Following the EIM Simulations, the CAISO Should Seek Board Approval for Implementation Readiness Before Go-Live**

The current implementation schedule provides a period of two to three months for market simulations; however, it does not require subsequent Board approval before go-live.<sup>8</sup> PG&E recommends the CAISO adopt best practices from its MRTU deployment experience, which is to provide sufficient time for robust market simulation, review the simulation results with stakeholders on a weekly basis, and seek Board approval before going live with the EIM.

---

<sup>8</sup> [http://www.caiso.com/Documents/Apr30\\_2013EnergyImbalanceMarketImplementationAgreement-PacifiCorpER13-1372-000.pdf](http://www.caiso.com/Documents/Apr30_2013EnergyImbalanceMarketImplementationAgreement-PacifiCorpER13-1372-000.pdf) (See Exhibit A for EIM Implementation Schedule)

Seeking final Board approval after the simulations is appropriate for the EIM. This is a complex initiative and one that will impact over 30 million customers both within and outside of the CAISO. Board consideration following the simulations will create a valuable opportunity for the CAISO to present simulation results and allow stakeholders to provide feedback to the Board about the simulations before the EIM goes live. Board sign off helps to ensure the readiness for deployment is reviewed by a diverse set of stakeholders, including Board members, and reduces the risks associated with going forward with potentially critical issues unresolved.

#### **8. CAISO Should Develop an EIM Reversion Plan as Part of Its Implementation Planning**

PG&E recommends a reversion plan be developed for the EIM. In the unlikely event of an EIM market failure, this reversion plan would allow each BAA to operate its system reliably independent of the joint EIM. This plan should include provisions for EIM Entities and market participants to retain its existing operational systems, processes, and key personnel for a minimum amount of time (e.g., 6 months) after EIM goes live. Having a reversion plan as part of a large scale implementation is best practices and an approach taken by the CAISO with its 2099 MRTU implementation.

#### **Other Clarifications**

In addition to our recommendation above, PG&E would appreciate further clarification and discussion on the three areas below in the next proposal.

##### ***A. Flexible Ramping Sufficiency Test***

Based on PG&E's understanding, the initial schedule used as the starting point in the ramp sufficiency test for a trading hour starting at time "T" is the schedule produced by EIM, run in the prior hour, for the time 7.5 minutes before T, not the base schedule at time T-7.5 that was submitted by the EIM Entity for that hour.

An EIM Entity may offer sufficient rampable capacity for the hour starting at T with its base schedule. However, it may fail the sufficiency test if in the prior hour the EIM, based on economics, deployed capacity above the EIM Entity's base schedule. That is, the EIM may ramp up resources in the EIM Entity to a level such that the remaining upward ramping capability for the BAA can no longer cover its flexible ramping requirement. Yet the base schedules submitted by the EIM Entity, which would have considered the need to meet its flexible ramping requirement, may have preserved enough ramping capability to pass the sufficiency test. In such a case, the sufficiency test would have incorrectly failed and prevented the EIM Entity from participating fully in the EIM for the upcoming hour.

PG&E understands that CAISO plans to address such issues in an upcoming technical workshop and appreciates the CAISO's continuing investigation of this issue.

## **B. Losses**

The CAISO should provide a discussion on how losses will be treated in an EIM Entity's base schedule, how the CAISO will determine whether adequate supply is scheduled by an EIM Entity to meet its share of losses arising from its base schedule, and how any shortfall or excess will be treated and made up or absorbed in EIM.

The discussion should address the following questions:

- How incremental system losses will be calculated?
- How the incremental system losses will be allocated to nodes in the EIM footprint?
- How a share of the system losses will be allocated to nodes within an EIM Entity?
- When it is appropriate to serve the system losses allocated to nodes in the EIM Entities with resources outside of California and thereby not incur GHG costs to serve those losses?

## **C. EIM Administrative Rate**

The CAISO provides some discussion on the calculation of the EIM administrative rate that will be charged to EIM Entities (19 cents per MWh). This rate will be in effect for the year 2014 and is expected to change in 2015 based on new cost of service study to be filed with FERC. PG&E asks the CAISO to provide additional clarification on the administrative fee calculation.

The initial administrative rate, although in effect for a short time, is important because it may establish a precedent for its calculation. The possible precedential nature of this calculation is reinforced by the EIM Governance White Paper that states, "*Any EIM governance structure should have the objective of preserving for EIM participants, both at the outset and in the future, the significant and tangible benefits of the EIM*". Therefore, a clear understanding of the 2014 administrative cost rate calculation is important.

PG&E asks the CAISO to provide additional detail on the rate calculations (expressed in cents per MWh) presented in the Proposal to the 2012 cost of service study. The supporting reference provided by the CAISO does not provide specific link to a document but links instead to the 2012 Grid Management Charge (GMC) Initiative process page which contains numerous documents. PG&E did review the Feb. 15, 2011 Draft Final GMC Proposal but was unable to tie the rates in the Proposal to any rates or supporting data in the 2011 document. PG&E asks the CAISO to provide the numerator and denominator used to calculate each of the rates provided on page 68 and a reference to the document (and page) of the source document.

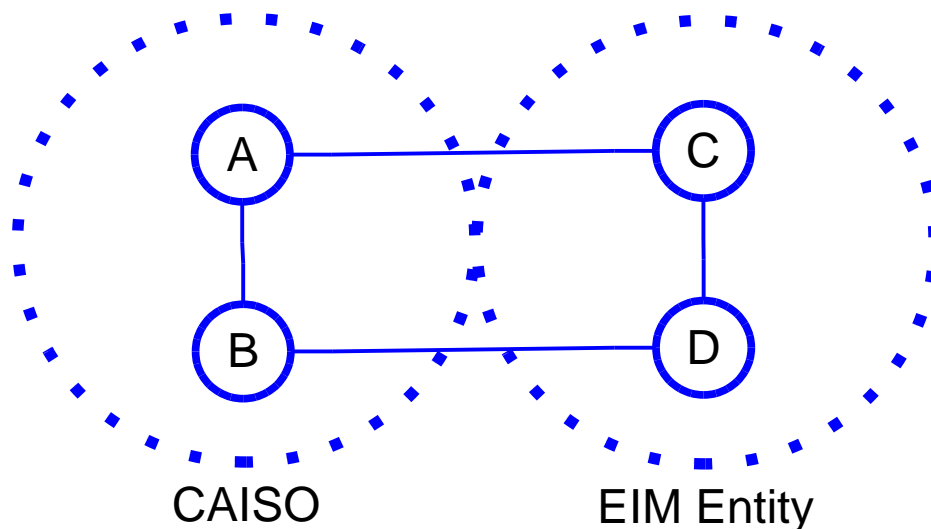
**APPENDIX**

**Numerical example demonstrating the potential incentive for over-scheduling**

This example illustrates how participants in an EIM Entity can benefit from over-scheduling load and supply in their BAA to exacerbate a constraint violation in another BAA.

**System Setup:**

- 1) Consider an EIM consisting of An EIM Entity and CAISO with four nodes (see diagram below)



- 2) Assume there are no losses, and all transmission lines have equal impedance with the following limits on flows

Limit	Line A->B	Line A->C	Line C->D	Line D->B
Min. Flow	-140	-120	-140	-120
Max. Flow	140	120	140	120

- 3) Using node B as the reference, shift factors associated with each node / transmission line are shown below:

Nodes	Line A->B	Line A->C	Line C->D	Line D->B
A	0.75	0.25	0.25	0.25
B	0	0	0	0
C	0.5	-0.5	0.5	0.5
D	0.25	-0.25	-0.25	0.75

**Base Schedules:**

- 1) Assume that the load forecast for CAISO is 160 MW and that the load forecast for the EIM Entity is 120 MW.
  - a. CAISO’s schedule going into the EIM will be its Day-Ahead Schedule, and for convenience of terminology, we will refer to this Day-Ahead schedule as the CAISO’s base schedule.
  - b. Information on CAISO’s Day-Ahead schedule will be available well before the EIM Entity must submit its base schedule. Participants in the EIM Entity may mine this information to develop strategies that extract excess payments from the EIM whose costs will be borne by CAISO participants.
  - c. In this example, some participants in the EIM Entity find that CAISO’s base schedule will bring line A->B close to its limit and that they can profit by over-schedule in the EIM Entity’s base schedule to cause a violation of this line’s flow limit.
- 2) Participants from the two EIM Entities submit the following balanced base schedules. There are two resources at node A (Generators A1 and A2) and at node C (Generators C1 and C2). There is a single resource at node B (Generator B) and at node D (Generator D).

Resource	Gen Schedule(MW)	Load (MW)
A1	80	0
A2	80	0
B	0	160
C1	120	0
C2	200	0
D	0	320

- 3) Flows on the transmission lines due to the base schedules from CAISO and the EIM Entity are calculated below.

	Line A->B (MW)	Line A->C (MW)	Line C->D (MW)	Line D->B (MW)
CAISO	120	40	40	40
EIM Entity	80	-80	240	-80
<b>Total Flow</b>	<b>200*</b>	<b>-40</b>	<b>280*</b>	<b>-40</b>

*\* Even though the combined flows exceed limits on lines A->B and C->D, these limits are not enforced on the combined flows prior to the real-time EIM market*

**Real Time Dispatch and Flows:**

- 1) In the EIM, the bids for the generators that are received at each node are given in the following table. In the dispatch of EIM, the market operator will use its load forecast to dispatch the EIM, thereby removing the over-scheduled load submitted in the base schedule of the EIM Entity. The EIM makes the following dispatch decisions based on economic bids while respecting transmission limits on each line:

Resource	Gen Dispatch (MW)	Minimum Output (MW)	Maximum Output (MW)	Cost (\$/MWh)	Load (MW)
A1	80	0	80	\$20	0
A2	66.67	0	100	\$25	0
B	13.33	0	160	\$40	160
C1	120	0	120	\$25	0
C2	0	0	200	\$200*	0
D	0	0	20	\$50	120*
<b>Total Gen</b>	<b>280</b>			<b>Total Load</b>	<b>280</b>

\* In this case, participants in the EIM Entity submit a high price bid on the over-scheduled supply from generator C2 that balanced the over-scheduled load. This ensures the EIM will dispatch down the over-scheduled supply from C2.

- 2) The resulting EIM flows on the transmission lines from each EIM Entity are shown below, along with the shadow prices on the maximum flow constraints.

	Line A->B (MW)	Line A->C (MW)	Line C->D (MW)	Line D->B (MW)
CAISO	110	36.67	36.67	36.67
EIM Entity	30	-30	90	-30
<b>Total Flow</b>	<b>140*</b>	<b>6.67</b>	<b>126.67</b>	<b>6.67</b>
<b>Shadow Price (\$/MWh)</b>	<b>-20</b>	<b>0</b>	<b>0</b>	<b>0</b>

\* Limits are enforced in the real-time EIM market

### ***EIM Settlement Results:***

- 1) The Locational Marginal Price (LMP) at each node is shown below

Node	LMP (\$/MWh)	Net Injection (MW)	Imbalance Revenue / (Payments) (\$)
A	\$25	-13.33	(\$333.33)
B	\$40	13.33	\$533.33
C	\$30	-200.00	(\$6,000.00)
D	\$35	200.00	\$7,000.00
CAISO			\$200.00 [a]
EIM Entity			\$1,000.00 [b]
<b>Total RTCO charges / (credits)</b>			<b>\$1,200.00 [c]</b>

Notes:

- Total imbalance revenue for participants in CAISO is the sum of revenue earned at nodes A and B
- Total imbalance revenue for participants in EIM Entity is the sum of revenue earned at nodes C and D
- The total RTCO charge is needed to compensate for the sum of the imbalance revenues from the CAISO and the EIM Entity

- 2) The RTCO arising from removing constraint violations in the EIM are given by constraint below.

Constraint	Shadow Price (\$/MWh)	Violation Removed (MW)	RTCO
A->B	-20	60	\$1200.00
A->C	0	0	\$0.00
C->D	0	140	\$0.00
D->B	5		\$0.00

**Conclusion:** The EIM Entity is paid to adjust its schedules to manage the flow on the constraint in CAISO. As currently proposed, CAISO is charged the resulting RTCO since the constraint it in the CAISO BAA. The participants in the EIM Entity can profit by overscheduling load to exacerbate a transmission constraint in CAISO.