Business Practice Manual

For The

Energy Imbalance Market

Version ~~14~~15

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Approval History

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BPM Owners' Titles: Manager, Market Settlement Validation and Resolution and Lead Day-Ahead Market Operator

Revision History

Version	PRR	Date	Description
15	1127,1142	05/02/2019	PRR1127 Applying a tolerance band threshold to the Flexible Ramping Sufficiency Tests for each EIM BA. Targeted for February 15, 2019 PRR1142 This is related to the stakeholder feedback for improvements for business needs related to the EIM resource sufficiency evaluation. Effective date is 4/16/19
14	1117	02/28/2019	PRR1117 Added a note in section 11.3.11 to refer to Market Operations Appendices BPM for load conformance.
13	1090	11/29/2018	PRR1090: This change is to provide clarity for EIM entities scheduling practices related to dynamic pseudo-tie wheeling schedules.
12	1072, 1082, 1085,1093	10/25/2018	PRR1072: This is due to EIM Enhancement 2018 project requirements where the market will not procure flexible ramping up and flexible ramping down capacity when any EIM balancing authority is undergoing a contingency. Expected effective date is Fall 2018. PRR1082: This is to extend the Persistence Forecast modeling to EIM entities. PRR1085: This is due to the EIM Greenhouse Gas Enhancements policy to limit EIM participating resources' greenhouse gas bid quantity to the MW value between the EIM participating resource's base schedule and the resource's upper economic level.

Version	PRR	Date	Description
			PRR1093: This is for an enhancement to modify the calculation logic for the Fifteen-Minute Schedules from hourly resources. The change is explained in a new section 11.3.13. Additionally, we added a clarification in section 16.2.1.1.4 in regards to Energy Transfer System Resource (ETSR) treatment of tagged quantities where EIM BAAs paring includes the ISO BAA.
11	1068	09/04/2018	Added new paragraphs to define the behavior of the energy imbalance market total and incremental flow constraint. Additionally, a clarification was added to paragraph 11.1.6 entitlement constraint for rate of changes. Effective date is August 2018.
10	1033, 1051	4/02/2018	(1033) This revision is due to the EIM Enhancement 2017 initiative which includes the following functionalities; • Automated matching of import/export schedule changes. • Automated mirror system resources at CAISO intertie scheduling points. • Base EIM transfer resource imbalance settlement. • New non-generator resource (NGR) modeling functionality. • Allow submission of base generation distribution factors (GDFs) for aggregated EIM non-participating resources.. In addition, this revision includes some clarification of the provisions associated with the submission and processing of variable energy resource forecasts; • Allow an EIM Entity VER forecast to be considered independent if it is used for balancing their system • Allow for freezing VER forecast between T-55 and T-40. (1051) clarifying the flexible ramping requirements for the new EIM entities joining the EIM
9	1032	1/2/2018	This BPM change is to enhance the current methodology used to calculate histogram percentile that is utilized in the bid range capacity test requirements. Effective 1/4/2018. Section 11.3.2.2 is updated accordingly. PRR 1032.
8	984	5/31/2017	This is due to a recent discovery regarding netting, versus not netting, imports and exports for every hour, for the purpose of calculating histograms percentage differences. Effective 4/1/17.
7	964	4/10/2017	Added new Tariff language to “Metering” Section 8 to include SQMD Plan & requirements for SCME’s; Removed section 12 (PRD/RDRR) from being unavailable to EIM market

Version	PRR	Date	Description
			participants; Added 15-min option to "Participating" Generators granularity level.
6	939	8-31-16	This revision includes congestion cost content due to EIM Y1 P2 enhancement project
5	891	03-31-2016	This revision introduces incremental language pertaining to Available Balancing Capacity (ABC), additionally it improves the language throughout the document.
4	866	12/02/2015	Updates for EIM Year 1 policy enhancements. Addition of Readiness Criteria
3	846	07/06/2015	for clarification on the transmission relaxation, changes to section 10.1.6 and adding new section 10.1.7
2	788	10/30/2014	Clarification to section 10.3.2.1
1	748	10/2/2014	First version released.
0.3		9/18/2014	Updated draft section 10.3.3.
0.2		9/3/2014	Draft updated to reflect answers to the Market Participants' questions and comments.
0.1		7/1/2014	Created BPM draft.

TABLE OF CONTENTS

1. INTRODUCTION

Welcome to the CAISO ***BPM for the Energy Imbalance Market.*** In this Introduction you will find the following information:

- The purpose of California Independent System Operator Corporation (CAISO) Business Practice Manuals (BPMs);
- What you can expect from this CAISO BPM;
- Other CAISO BPMs or documents that provide related or additional information; and
- The draft status of this BPM and expected next steps.

1.1 Purpose of CAISO Business Practice Manuals

The Business Practice Manuals (BPMs) developed by CAISO are intended to contain implementation detail, consistent with and supported by the CAISO Tariff, including: instructions, rules, procedures, examples, and guidelines for the administration, operation, planning, and accounting requirements of CAISO and the markets. Each Business Practice Manual is posted in the BPM Library at: http://bpmcm.caiso.com/Pages/BPMLibrary.aspx. Updates to all BPMs are managed in accordance with the change management procedures included in the **BPM for Change Management**.

1.2 Purpose of This Business Practice Manual

The Energy Imbalance Market is an extension of CAISO's Real-Time Market. Many of the business practices applicable to the Real-Time Market also apply to the Energy Imbalance Market (EIM). This business practice manual is a guideline for EIM participants and will outline the processes in the EIM, including references to existing Business Practice Manuals. Revision requests for the BPMs may be submitted by stakeholders or an internal CAISO department.

If a Market Participant detects an inconsistency between BPMs, it should report the inconsistency to CAISO before relying on either provision.

The provisions of this BPM are intended to be consistent with the CAISO Tariff. If the provisions of this BPM nevertheless conflict with the CAISO Tariff, CAISO is bound to operate in accordance with the CAISO Tariff. Any provision of the CAISO Tariff that may have been summarized or repeated in this BPM is only to aid understanding. Even though every effort will be made by CAISO to update the information contained in this BPM and to notify Market Participants of changes, it is the responsibility of each

Market Participant to ensure that he or she is using the most recent version of this BPM and to comply with all applicable provisions of the CAISO Tariff.

A reference in this BPM to the CAISO Tariff, a given agreement, any other BPM or instrument, is intended to refer to the CAISO Tariff, that agreement, BPM, or instrument as modified, amended, supplemented, or restated.

1.3 References

Reference information related to this BPM includes:

- Other CAISO BPMs
- CAISO Tariff
- EIM Final Proposal, September 23, 2013

CAISO posts current versions of these documents on its website.

Whenever this BPM refers to the Tariff, a given agreement (such as EIM Entity Agreement), or any other BPM or instrument, the intent is to refer to the Tariff, that agreement, any other BPM or instrument as it may have been modified, amended, supplemented, or restated from the release date of this BPM for the Energy Imbalance Market.

The captions and headings in this BPM are intended solely to facilitate reference and not to have any bearing on the meaning of any of the terms and conditions of this BPM.

2. BACKGROUND

Welcome to the Background section of the CAISO BPM for the Energy Imbalance Market. In this section you will find the following information:

- Summary of CAISO's Energy Imbalance Market Processes.
- Summary of distinctive EIM features.

The EIM is a Real-Time Market to dispatch economic bids voluntarily offered by Participating Resources to efficiently balance supply, transfers between balancing authority areas, and load across its footprint.

EIM processes will be similar and integrated with CAISO's existing market processes. The primary difference is that the EIM only includes CAISO's Real-Time Market and not CAISO's Day-Ahead Market. The EIM will have some unique characteristics to reflect this difference. The EIM includes design elements that ensure EIM balancing authorities have sufficient generation resources available in the Real-Time Market, and allocates costs between balancing authorities according to CAISO guiding principles. The EIM also ensures that protections are in place so convergence bidding does not cause cost uplifts in EIM balancing authorities.

This market structure is reflected in the framework of this BPM, which is the same framework as applied to the EIM tariff provisions. Matters that are unique to the EIM will be addressed in this BPM. Matters that are generally applicable to the Real-Time Market and CAISO market participants will be addressed in existing BPMs. Matters applicable to both current Real-Time Market participants and EIM participants, particularly cost allocation of charges applicable to the Real-Time Market, will be addressed in the existing BPMs. This framework integrates this BPM with other BPMs and establishes this BPM as a guide for EIM participants. Existing market participants may continue to find practices applicable to their business in the current BPMs, available on the CAISO website.

2.1 Energy Imbalance Market Overview

CAISO has based the EIM on the Real-Time Market design, which was developed in part to comply with FERC Order No. 764, and consists of a 15-minute market and a 5-minute dispatch. Each of these market runs will produce schedules and locational marginal prices for resources. The EIM will also commit short-start generation units in the 15-minute market. Like CAISO's current Real-Time Market, the EIM will enforce a flexible ramping constraint to commit and position resources to meet future load and supply variability and uncertainty.

In the Day-Ahead time frame, EIM balancing authorities participating in the EIM will submit load forecasts or elect to use the CAISO-created forecast for the EIM balancing, and anticipated resource Base Schedules to CAISO, while remaining responsible for reliability in their area. This information will allow CAISO to identify infeasible schedules, such as those that might cause transmission overloads in the EIM footprint, and provide advisory information to EIM balancing authorities so they can revise the Base Schedules to resolve any infeasibilities. These EIM Base Schedules will help to improve the accuracy of CAISO's Day-Ahead Market model.

In Real-Time, CAISO will financially settle the Energy Imbalance Market in a manner that appropriately recognizes the costs attributable to each participating balancing authority area. For example, CAISO will allocate bid cost recovery payments to resources, as well as neutrality amounts that track differences between payments received from load and payments to generation to each participating balancing

authority, consistent with CAISO's cost allocation principles. The participating balancing authorities will be responsible for allocating these amounts according to their respective open access transmission tariffs. CAISO will use a process based on its existing local market power mitigation approach to mitigate market power in each balancing authority area participating in the EIM, and will monitor and assess the application of market power mitigation before and after implementation.

The proposed tariff revisions recognize the need for resources that serve load in the CAISO balancing authority area through the EIM to comply with California's greenhouse gas cap and trade regulations. As it currently does for resources participating in its Real-Time Market, CAISO will allow EIM participating resources to include the costs of compliance in an EIM bid adder and will incorporate this cost into its dispatch of generation as appropriate. CAISO will not consider this cost when it dispatches this generation that is attributable to serving load outside CAISO, and therefore, greenhouse gas regulation compliance costs will not affect locational prices outside the CAISO balancing authority area.

Transmission access to the EIM will be provided under the applicable transmission service provider tariffs. As part of a reciprocal arrangement, CAISO has proposed that there be no incremental transmission charge for the use of transmission to support EIM transfers between participating balancing authority areas. Within the first year of operation, CAISO will consider in consultation with stakeholders whether to continue this arrangement or to modify it, and this BPM will be updated accordingly.

3. ROLES AND RESPONSIBILITIES

Welcome to the *Roles and Responsibilities* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- This section identifies and describes the basic *Roles and Responsibilities* of the entities that participate in the CAISO Markets.
- This section introduces four new types of participants in the Real-Time Market, which are collectively known as EIM Market Participants.

EIM Entity: The EIM Entity is a balancing authority that elects to participate in the Energy Imbalance Market. As an EIM Market Participant, the EIM Entity is responsible: (1) for identifying available transmission intertie capacity in its balancing authority area for use in CAISO's Real-Time Market and, (2) through its EIM Entity Scheduling Coordinator, for scheduling all load and resources in its balancing

authority area that do not participate in the Real-Time Market (known as non-participating load and non-participating resources) and for settling charges and payments related to non-participating load and non-participating resources.

EIM Entity Scheduling Coordinator: The EIM Entity Scheduling Coordinator is the entity through which the EIM Entity participates in the Real-Time Market. In order to prevent the inappropriate sharing of information regarding transmission and generation, an EIM Entity Scheduling Coordinator cannot be a scheduling coordinator for a supply resource unless it is a transmission provider subject to the Commission's standards of conduct set forth in 18 C.F.R. § 358.

EIM Participating Resources: The EIM Participating Resources are the owners or operators of EIM resources that wish to bid supply into the Real-Time Market. EIM resources can be generating units, participating load, demand resource providers, or other resources qualified to deliver energy or similar services, such as non-generation resources. Each type of resource that is eligible to participate in the current CAISO Real-Time Market is eligible to participate through the Energy Imbalance Market, but only if the EIM Entity supports participation by that type of resource and the resource meets the technical requirements for such participation pursuant to the terms and conditions of the CAISO tariff and the EIM Entity's open access transmission tariff.

EIM Participating Resource Scheduling Coordinator: The EIM Participating Resource Scheduling Coordinator is the entity through which the EIM Participating Resource participates in the Real-Time Market. To prevent the inappropriate sharing of information regarding transmission and generation, an EIM Participating Resource Scheduling Coordinator cannot be an EIM Entity Scheduling Coordinator unless it is a transmission provider subject to the Commission's standards of conduct set forth in 18 C.F.R. § 358.

To participate in the Real-Time Market through the Energy Imbalance Market, an entity must enter into a *pro forma* agreement with CAISO that sets out the parties' respective obligations with respect to the entity's role. The *pro forma* agreements are included in Appendix B of the tariff.

3.1 Implementing and Terminating the EIM Entity Participation

Prior to becoming an EIM Entity, an interested balancing authority must enter into an implementation agreement with CAISO. See Tariff Section 29.2(b). Each new EIM entity will be made public through the filing of *New EIM Entities*.

An EIM Entity may terminate participation in the EIM by providing 180 days' notice to CAISO. In addition, the EIM Entity may suspend operation of the EIM in its balancing authority area during the 180-day notice provision in accordance with Section 10.5 of this BPM.

4. SCHEDULING COORDINATOR CERTIFICATION

Welcome to the *Scheduling Coordinator Certification* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- An overview of how participants in the EIM transact with CAISO through a Scheduling Coordinator (SC).
- An overview of the process used for Scheduling Coordinator Certification.

There are two types of Scheduling Coordinators specific to participation in the EIM that are different from the Scheduling Coordinators listed in the **BPM for Scheduling Coordinator Certification and Termination**. The two types of Scheduling Coordinators that may transact in the EIM are:

- **EIM Entity Scheduling Coordinators:** Represent non-participating load and non-participating resources within the EIM. An EIM Entity Scheduling Coordinator may represent multiple EIM Entities if it has informed each EIM Entity of the multiple representations, and has completed an EIM Entity Scheduling Coordinator Representation Form and submitted it to CAISO in the manner noted on the form.
- **EIM Participating Resource Scheduling Coordinators:** Only represent resources that plan to participate in the EIM and may not be the EIM Entity Scheduling Coordinator.

The **BPM for Scheduling Coordinator Certification and Termination** outlines the processes and approximate associated timelines, including the training, testing, and informational submissions that an applicant must complete in order to become an eligible certified Scheduling Coordinator (SC) with CAISO. Both types of EIM Entity Scheduling Coordinators are also responsible for registering with CAISO the resources that they will represent as noted in the Full Network Model section of this BPM.

The **BPM for Scheduling Coordinator Certification and Termination** also addresses the responsibilities and status that an SC must maintain in order to participate in the markets operated by CAISO. To participate in the EIM, entities must request access to a variety of applications as noted in Section 5.3.4 of the **BPM for Scheduling Coordinator Certification and Termination**. While registration as an EIM

participant is part of the standard process to become an SC, if additional SC_IDs are desired, an EIM participant should refer to Section 5.5 of the **BPM for Scheduling Coordinator Certification and Termination** for more information.

For EIM Entity Scheduling Coordinators and EIM Participating Resource Scheduling Coordinators, certain activities outlined in Section 3 of the **BPM for Scheduling Coordinator Certification and Termination** do not apply to participation in the EIM. Specifically, those activities listed that reflect Inter-SC Trades, CAISO Balancing Authority Area Generating Units, CAISO Balancing Authority Area Load, and Convergence Bidding are not applicable to participation in the EIM.

4.1 Determination of SC Certification Requirements

An existing Certified Scheduling Coordinator with a valid Scheduling Coordinator Agreement (SCA) in place for the corporate parent of the EIM Entity may qualify for certification requirements for EIM Participating Resource Scheduling Coordinator and/or EIM Entity Scheduling Coordinator certification requirements. Please review the provision set forth in tariff section 29.4 and section 3 of the EIM BPM for determination of SC certification requirements:

Tariff section 29.4 Roles and Responsibilities; (c) 3 (b). An EIM Entity Scheduling Coordinator may not also be an EIM Participating Resources Scheduling Coordinator or a Scheduling Coordinator for a Participating Generator, Participating Load or Demand Response Provider, unless the EIM Entity Scheduling Coordinator is a transmission provider subject to the standards of conduct set forth in 18 C.F.R § 358.

The determination of requirements will depend on the corporate structure of the EIM Entity and EIM Participating Resources owned by the parent company. Discussions between CAISO legal counsel and EIM Entity legal counsel will be required. If it is determined that the EIM Entity does not meet the stated exception, the EIM Entity SC must complete the entire SC certification process which can take a minimum of 120 days. Please refer to the BPM for the requirements for SC certification.

If it is determined that the EIM Entity does in fact meet the stated exception, then the EIM entity SC will not need to complete the entire certification process.

- Business Practice Manual (BPM) Library: http://bpmcm.caiso.com/Pages/BPMLibrary.aspx

  (Scheduling Coordinator Certification and Termination)

5. AGREEMENTS

For entities that have signed an EIM implementation agreement, the purpose of this document is to provide the specific steps and appropriate links to obtain all the applicable agreements to be completed and executed in order to participate in the energy imbalance market. References made to the EIM BPM and CAISO tariff refer to the most current versions of these documents.

- Business Practice Manual (BPM) library: http://bpmcm.caiso.com/Pages/BPMLibrary.aspx under Energy Imbalance Market

  CAISO Conformed Tariff

The addition of a new balancing area to the EIM will typically involve the agreements listed below. The schedule for completion of these agreements will be developed during the initial project planning phases. It is recommended that the Implementation Agreement be executed 8-9 months prior to initial participation in order to begin the process for completing and executing the below agreements:

1. EIM Entity Agreement
2. EIM Entity Scheduling Coordinator Agreement
    a. Meter Service Agreement for Scheduling Coordinators
3. EIM Participating Resource Scheduling Coordinator Agreements
    a. Meter Service Agreement for Scheduling Coordinators
4. EIM Participating Resource Agreement
    a. (optional) Meter Service Agreement for CAISO Metered Entities

5.1 EIM Entity Agreement

1. Submit the Information Request Sheet for EIM Entity Agreement

   http://www.caiso.com/Documents/EnergyImbalanceMarketEntityAgreementInformationRequestSheet.doc

   Send submissions to: RegulatoryContracts@caiso.com

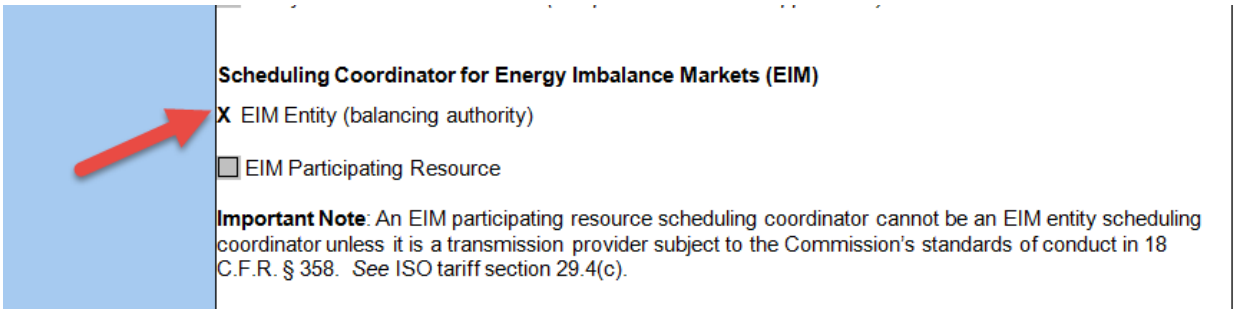
5.2 EIM Entity Scheduling Coordinator (Entity SC)

The submittals listed below should be sent to: SCRequests@caiso.com

1. EIM Entity will work with the CAISO to determine the SCID naming options. In addition to the SCID, there will be various other IDs that need to be set up for the EIM Entity and the EIM Entity SC. The CAISO will work with the EIM Entity to have these IDs set up in the MAPStage testing environment.
2. Submit the EIM entity SC application with the EIM entity (balancing authority) box checked per example below

http://www.caiso.com/Documents/SchedulingCoordinatorApplicationFormEIM-SelectionOptions.doc

Indicate designated SCID on page 1



1. Submit the Information Request Sheet for EIM Entity SC

   http://www.caiso.com/Documents/EnergyImbalanceMarketEntitySchedulingCoordinatorAgreementInformationRequestSheet.doc

2. Download the template from the CAISO website for the MSA/SC agreement for the EIM entity (balancing area). Submit the MSA/SC Information Request Sheet – (Specific verbiage will be provided by the CAISO for the Schedule 3)

After all the requirements have been met by the EIM entity SC, agreements are issued.

The following requirements to be met no later than 30 days prior to parallel operations.

3. Submit the updated Affiliate Form - (all SCs must have an up-to-date Affialiate form on file with the CAISO as affiliates change)

   http://www.caiso.com/Documents/ISOAffiliationResourceControlAgreementDisclosureForm.xls

4. Submit the Electronic Funds Transfer form – (if the EIM Entity SC plans on using a separate bank account different from the bank account currently on file with the CAISO)

   http://www.caiso.com/Documents/ISO_PaymentSelectionInstructions-EFT-Form.doc

   Required if EIM entity SC will be using a separate bank account from the EIM PR SC.

5. Submit an Emergency Plan – (If the EIM Entity SC plans on having a separate operations real time desk from what is currently on file with the CAISO)

   http://www.caiso.com/Documents/EmergencyPlanForm.doc

6. Perform Real Time Grid Ops test. The real time test is a series of 5 calls from the CAISO real time desk to the 24 hour number provided in the submitted Emergency Plan at any time or any day over a 7-10 period. (based on the submission of the Emergency Plan in #5)

5.3 EIM Participating Resource Scheduling Coordinator (EIM PR SC)

All of the following submittals should be sent to **SCRequests@caiso.com**

Special Note: For other EIM PR SCs not part of the EIM entity, there are steps and requirements. Refer to documentation posted on the CAISO web site:

1. Submit a request (email) for an additional SCID to SCRequests@caiso.com (indicating this is for EIM)

   Optional: A separate SCID for the EIM participating resource SC is not required, but it is recommended to have a dedicated SCID due to the fact the EIM Entity SC will have visibility to the resource data templates for all resources associated with the specified SCID.

2. The PR SC will be notified of approval of the requested SCID and will be instructed to submit the SCID request letter

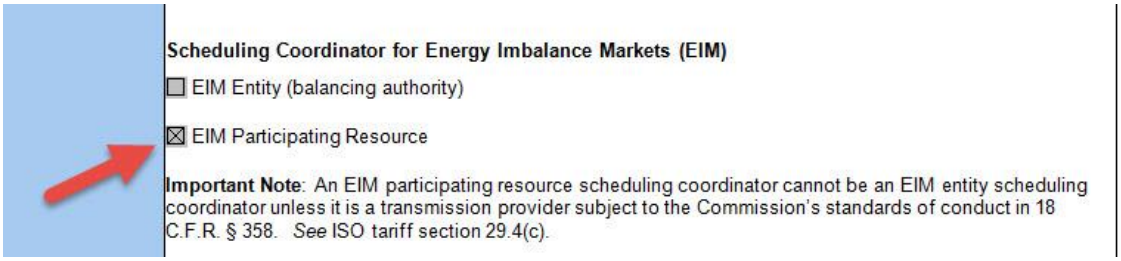
   http://www.caiso.com/Documents/ExistingSchedulingCoordinatorRequestsAdditionalSCID.doc

3. Submit Base Schedule Coordinator (BSC) ID request form -- CAISO will provide the BSCID based on a specific naming convention. This form should be submitted along with the Additional SCID request letter to have the same effective start date. The BSC ID is used for the submission of base schedules into the BSAP (base schedule application)

   - The master file is updated with an effective start date for the SCID and BSCID per this submission.

4. Submit the PR SC application with the EIM participating Resource box checked per example below.

   http://www.caiso.com/Documents/SchedulingCoordinatorApplicationFormEIM-SelectionOptions.doc



5. Submit the Information Request Sheet for EIM PR SC

   http://www.caiso.com/Documents/EnergyImbalanceMarketParticipatingResourceSchedulingCoordinatorAgreementInformationRequestSheet.doc

6. Download the template from the CAISO website for the MSA/SC agreement for the EIM Entity (balancing area)

   Submit the MSA/SC Information Request Sheet – (Specific verbiage will be provided by the CAISO for the Schedule 3)

- After all the requirements have been met by the EIM PR SC, agreements are issued.

The following requirements need to be met no later than 30 days prior to parallel operations.

7. Submit an updated Affiliate Form - (all SCs must have an up-to-date Affiliate form on file with the CAISO as affiliates change)

   http://www.caiso.com/Documents/ISOAffiliationResourceControlAgreementDisclosureForm.xls

8. Submit the SC Acceptance letter – This is submitted to indicate agreement to be the SC for specified EIM participating resources.

   http://www.caiso.com/Documents/NewSCAcceptanceLetter_Sept2014.doc

9. Submit the RDT (resource data template) with the SC Acceptance letter

5.4 EIM Participating Resource (PR)

All of the following submittals should be sent to: SCRequests@caiso.com

IMPORTANT: The PR needs to submit an application to the EIM entity and meet the requirements for that EIM Entity.

- The EIM Entity notifies the CAISO that the resource(s) have met the entities requirements and requests confirmation from the CAISO that the resource(s) have also met CAISO requirements.
- The PR needs to follow the steps below while working with the EIM Entity

1. Submit EIM Participating Resource Agreement Information Request sheet

   http://www.caiso.com/Documents/EnergyImbalanceMarketParticipatingResourceAgreementInformationRequestSheet.doc

2. Submit the Schedule 1 (the schedule 1 needs to match the RDT submitted by the EIM PR SC for the resource)

http://www.caiso.com/Documents/EnergyImbalanceMarketParticipatingResourceAgreementSchedule1.xls

NOTE: After all the requirements have been met by the resource for the EIM entity and the CAISO, agreements are issued.

- The EIM entity officially notifies the resource and the CAISO that the resource is an EIM participating resource.

3. Submit the Resource Owner SC Selection letter – This is submitted to indicate the selection of the SC that is to represent and schedule for the PR in the EIM.

   http://www.caiso.com/Documents/ResourceOwnerLetter_Sept2014.doc

6. CREDIT MANAGEMENT

Welcome to the *Credit Management* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- Summary of CAISO's Credit Management policies and processes within the context of the EIM.

EIM Participants must comply with all applicable aspects of CAISO's Credit Management Policy. The **BPM for Credit Management** describes the credit-related policies and processes used at CAISO to protect the financial integrity and effectiveness of the CAISO markets. For EIM participants, since Virtual Bidding, Reliability Must Run contracts, and Congestion Revenue Rights are not applicable to the EIM, these portions of the Financial Responsibilities outlined in the **BPM for Credit Management** are not applicable.

7. FULL NETWORK MODEL

Welcome to the *Full Network Model* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- Summary of the Full Network Model in the EIM.

- Information that describes the business processes used by CAISO to maintain the Full Network Model in the EIM.

CAISO maintains a Network Model for use by the CAISO markets. The **BPM for Managing Full Network Model** explains how the Full Network Model and its associated processes are used to support market operations. **The BPM for Managing Full Network Model** also describes the process Market Participants follow in providing data used to support the model and in gaining access to model data. The CAISO Network Model contains some, but not all, of the related information for neighboring Balancing Authority Areas within WECC.

Balancing Authority Areas participating in the EIM will maintain their own Network Model processes with resources within their BAA, and will export that information to CAISO on a regular basis for promotion into CAISO's Full Network Model and subsequent use by the EIM. Any issues identified by CAISO in the EIM Entity BAA's model information will be resolved before promoting the information into a model used by the CAISO markets. EIM Entities are responsible for coordinating their network model updates with other impacted parties, including neighboring Balancing Authorities and WECC as appropriate.

The CAISO Full Network Model timeline can be found in Section 5.1 of the **BPM for Managing Full Network Model**. Before every network model update, an EIM Entity will complete and provide a network model update template to CAISO. The document will contain a detailed description of the updates for communication between CAISO and the EIM Entity network model teams, and to the Real-Time operators. The document is posted on the Network and Resource Modeling section of the CAISO website and should contain any changes to the EIM Entity's network model including, but not limited to, new equipment, equipment commissioning/decommissioning, date/time, new system configurations, display changes, SCADA point changes, and interconnection changes.

The EIM Entity shall make the Network Model Update document available to CAISO before the commissioning/decommissioning of transmission or generation equipment. This will help resolve and cross the gap between the different cycles of network model updates among CAISO and the different EIM entities. The document is only used to synchronize the EMS network models between an EIM Entity and CAISO. It does not replace the existing requirement or processes in place to register participating and non-participating resources in an EIM Entity balancing area in the CAISO Market registry system or Master File.

An EIM Entity will export its EMS network model to CAISO along with an associated limits file. In order for CAISO to implement an EIM Entity's model into CAISO's full network model in a timely manner, the EIM Entity will send the required information to CAISO based on the full network model timeline in Section 5.1 of the **BPM for Managing Full Network Model**.

While an EIM Entity's model deployment cycle may differ from CAISO's network model update timeline, any EIM Entity market model changes should follow the effective timelines specified and maintained in the CAISO BPM Section 5.1 of the **BPM for Managing Full Network Model**. New resources must complete the interconnection processes of their host Balancing Authority Area (BAA) prior to being included in a Full Network Model build and participating in the EIM.

All resources within an EIM Entity must be included in the CAISO's Full Network Model. The New Resource Implementation guide posted on the CAISO website contains requirements for establishing new resources with CAISO. Resources participating in the EIM will be required to submit requisite information to CAISO via the Resource Data Template (RDT) process described in Section 5.4 of the **BPM for Managing Full Network Model**. Additional information regarding the specific information contained in the RDT can be found in Attachment B of the **BPM for Market Instruments**. All EIM Participating Resource Scheduling Coordinators must register the resources that they shall represent using the RDT process, update the information on a timely basis, and share that information with the EIM Entity Scheduling Coordinator in coordination with CAISO's network model update timeline. Also, an EIM Entity Scheduling Coordinator must register all non-participating resources, specifying the EIM Entity within which the resources exist, using the RDT process and update that information in accordance with CAISO's network model build process.

An EIM Entity shall update the EIM Transmission Service Information no less frequently than the timelines for updates to the Full Network Model as outlined in Section 5.1 of the **BPM for Managing Full Network Model**. Also, upon entering into an EIM Implementation Agreement, an EIM Entity shall establish and inform CAISO of the maximum EIM Transfer limit at least ninety days prior to the EIM Entity Implementation Date via the Full Network Model update process.

As previously described, the **BPM for Managing Full Network Model** explains how the Full Network Model and its associated processes are used to support market operations. For EIM participants, references to the IFM, Use Limited Resources, CRR Systems, Participating Transmission Ownership, Metered Sub-Systems, Utility Distribution Companies, Trading Hubs, and RUC Zones are not applicable to the EIM.

The section of the **BPM for Managing Full Network Model** relating to maintenance of the Full Network Model depicts the existing process, but is currently being evaluated for revisions necessary to appropriately incorporate updates from EIM Entity BAAs.

8. METERING

Welcome to the *Metering* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- Description of the process and procedures used by CAISO, CAISO Metered Entities, and Scheduling Coordinators for Scheduling Coordinator Metered Entities to obtain Settlement Quality Meter Data (SQMD) used for the Settlement of the CAISO markets within the EIM.

The **BPM for Metering** covers the metering responsibilities for CAISO, CAISO Metered Entities, Scheduling Coordinator (SC) Metered Entities, and Scheduling Coordinators representing Metered Entities for the meter installation, certification, and maintenance in addition to the creation of SQMD. The **BPM for Metering** also describes the process and procedures used by CAISO, CAISO Metered Entities, and Scheduling Coordinators for Scheduling Coordinator Metered Entities to obtain SQMD used for the settlement of the CAISO markets. SQMD is used for billable quantities to represent the energy generated or consumed during a Settlement Interval.

SQMD is obtained from two different sources:

- **CAISO Metered Entities:** Meter Data directly polled by CAISO
- **Scheduling Coordinator Metered Entities:** Meter Data submitted to CAISO by Scheduling Coordinators

Entities participating in the EIM may opt to be CAISO Metered Entities or Scheduling Coordinator Metered Entities. A determination must be made for each resource in an EIM Entity BAA, and the requisite requirements of Section 29.10 of the CAISO Tariff met, prior to that BAA participating in the EIM. If an EIM Participating Resource chooses to switch from one type to another, they must notify CAISO and complete the associated pieces of the *New Resource Interconnection Process*.

For Scheduling Coordinator Metered Entities that were not participating as such before April 10, 2017, or that repower, modify their Meter Data interval, or add generating capacity after April 10, 2017, Scheduling Coordinators must submit an SQMD Plan to ensure that the Scheduling Coordinator will submit and maintain the integrity of Meter Data submitted to the CAISO for that Scheduling Coordinator Metered Entity. The SQMD Plan will describe how the Scheduling Coordinator will collect, maintain, aggregate, and submit Settlement Quality Meter Data in accordance with CAISO Tariff and, where

applicable, Local Regulatory Authority metering and settlement standards. SQMD Plans will include detailed descriptions of the following, as applicable, for each Scheduling Coordinator Metered Entity or Scheduling Coordinator Metered Entity aggregation or calculation:

(1) The type, programming, and configuration of all associated metering devices;

(2) How the Scheduling Coordinator or its agent will collect, validate, aggregate, and submit associated Meter Data;

(3) Single-line diagrams with professional engineer stamps (or equivalent) depicting the physical elements and relationships among the metering device(s);

(4) Any calculation or algorithm to derive Settlement Quality Meter Data from the metering device(s);

(5) Processes for aggregating individual Scheduling Coordinator Metered Entities and Resource IDs; and

(6) Plans and schedules to perform regular tests of the metering devices and audit the associated Meter Data pursuant to CAISO Tariff requirements.

Proxy Demand Resources and Reliability Demand Response Resources may satisfy their SQMD Plan requirements through the demand response registration process.

With the exception of Section 9.2, no other portion of the metering configurations listed in Sections 9, 10, or 11, of the **BPM for Metering** is currently available to EIM participants.

All Scheduling Coordinators and other entities submitting meter data related to EIM resources for either generation not associated with Ancillary Services, interties, or load, must submit meter data in the following granularity levels as stated in section 10.3.2.2 of the CAISO Tariff:

a) Generation for participating generators at 5 or 15-minute intervals; non-participating generators at 5, 15 or 60-minute intervals.

b) Interties at 5-minute intervals.

c) Load at 5, 15 or 60-minute intervals.

9. TELEMETRY

Welcome to the *Telemetry* section of the CAISO *BPM for the Energy Imbalance Market.* In this section you will find the following information:

- Summary of telemetry requirements and the transfer of telemetry information for the CAISO markets as it relates to the EIM.

CAISO has specific requirements regarding the transfer of telemetry information for the CAISO markets. EIM entity is required to send CAISO Common Information Model (CIM) 15 compliant full network model with associated SCADA measurements. EIM entity will send real time telemetry using ICCP (Inter-Control Center Communications Protocol) to run power flow, state estimation and market applications. CAISO may require other SCADA measurements that are not related to network model using ICCP such as flow gate limits or aggregate generation.

ICCP is industry standardized communication protocol but does not eliminate the need for a direct Energy Communication Network (ECN) connectivity.

All other information security requirements remain effective as set forth in *CAISO Information Security Requirements for the ECN*

If additional requirements are required and agreed to between CAISO and an EIM Entity, a schedule of implementation of the additional requirements will be agreed to as well.

10. OUTAGE MANAGEMENT

Welcome to the *Outage Management* section of the CAISO BPM for the Energy Imbalance Market. In this section you will find the following information:

- Summary of the Outage Management process within the framework of the Energy Imbalance Market.

CAISO will implement transmission and Generation Outages approved by the EIM Entity through the Day-Ahead Market process. CAISO will also inform the EIM Entity Scheduling Coordinator of any anticipated overloads. The EIM Entity shall be responsible for performing engineering studies,

modeling, and approving Outages on transmission and generation facilities within the EIM Entity Balancing Authority Area. The EIM Entity will then submit the approved outages into the CAISO outage management system. CAISO will not evaluate or approve any outages submitted by the EIM Entity.

10.1 Objectives, Roles, Scope, and Participants

10.1.1 Outage Management Objective

The objective of the CAISO business processes related to Outage Management for EIM Entities is to reflect outage information in the CAISO markets as soon as possible in order to allow the EIM to accurately reflect their operations in the market results. EIM Entity approved Outages must be consistent with the Full Network Model.

10.1.2 CAISO Role

CAISO's role in the Outage Management business process for EIM is to provide an outage management system to allow the EIM Entity Scheduling Coordinator to submit notice of EIM Entity approved transmission and generation Outages for the EIM Entity BAA. This section describes the processes CAISO uses to perform this role.

10.1.3 Facility Owner Role

The EIM Entity, EIM Participating Resources, and EIM Transmission Service Providers remain solely and directly responsible for the performance of all maintenance work, whether on energized or de-energized facilities, including all activities related to providing a safe working environment in coordination with the EIM Entity. The EIM Entity is responsible for ensuring Outages have been studied, modeled, and approved prior to submission to CAISO.

The EIM Entity, EIM Participating Resources, and EIM Transmission Service Providers may elect to have an agent perform some or all of the activities required to meet their responsibilities related to Outage Management; however, the EIM Entity remains responsible for the successful completion of these activities. See Section 6, *Communication of Outage Maintenance Information,* of the **BPM for Outage Management** for a discussion of the requirement for an EIM Entity to establish a single point of contact, such as an EIM Entity SC.

10.1.4 Application to Parties

The *BPM for Outage Management* applies to CAISO and the following EIM parties:

- All associated with the EIM Entity

- Connected Entities, to the extent that the agreement between the Connected Entity and CAISO so provides
- EIM Entity Scheduling Coordinators for EIM Participating Resources
    - Notification of approved EIM Outages via the CAISO outage management system UI/API if the CAISO outage management system is unavailable
- EIM Entity for Transmission and EIM Non-Participating Resources
    - Notification of approved EIM Outages via the CAISO outage management system UI/API if the CAISO outage management system is unavailable

10.1.5 CAISO Outage Coordination Office

The CAISO Outage Coordination Office (OCO) operates Monday through Friday, except holidays. OCO personnel are located in Folsom, California. The location, contact information, and areas of responsibility for this office are detailed in the most recent version of the applicable CAISO *Operating Procedures* (Section 1.5, References-3210F), available through the CAISO website.

The OCO uses an electronic CAISO outage management system application to support the receipt and processing for new EIM approved Outages, as well as updates to existing Outages. The electronic application used by CAISO for Outage Management is referenced throughout this section of the BPM. CAISO does not approve outages in the EIM Entity areas as they retain the BAA functions for reliability.

The types of scheduled EIM Entity approved outages that are accepted and processed by the OCO outage management system are as follows (not an exhaustive list):

- Balancing Authority Area Interconnections work:
    - All Outages that affect interconnected systems will be coordinated between Interconnected Transmission Operators.
- All work on facilities forming the EIM Entity Controlled Grid, including associated control or protective equipment:
    - This refers to all Outages affecting EIM Entity equipment and Generators with an EIM Participating Resource agreement.
- All reportable Outages or partial curtailments of EIM Participating Resources and non-participating resources approved by and consistent with the outage management procedures of the EIM Entity.

- EMS work that disables any portion of the EIM Entity Grid monitoring, control, or protective equipment, including EMS equipment and communication circuits
- EMS work that affects Generator AGC or RIG equipment or communication circuits
- Interconnections with responsible entities outside the EIM Entity Balancing Authority Area

10.2 Requesting Maintenance Outages

For additional information, see Tariff Section 29.9 *Coordination of Outages and Maintenance*.

10.2.1 EIM Entity and EIM Entity Scheduling Coordinator Outage Request Process

The EIM Entity Scheduling Coordinator shall submit notice of approved transmission and generation Outages or revisions to approved maintenance Outages to CAISO.

10.2.1.1 Outage Scheduling Requirements

Transmission Outage Scheduling

The EIM Entity must submit a new approved Maintenance Outage or a revision to an approved Maintenance Outage to CAISO via the CAISO outage management system no later than seven days prior to the start date of the proposed Outage for Transmission facilities, as specified in the CAISO Tariff Section 9.3.6.3.1, for the Outage to be a planned maintenance Outage.

Note: The determination of a seven-day prior notice excludes the date of submission and the date of the Outage.

Notification by the EIM Entity Scheduling Coordinator of approved Transmission Outage must specify the following:

- Identification and location of the transmission system element(s) to be maintained
- Nature of the maintenance to be performed
- Modeled system Outage boundaries to facilitate the equipment Outage
- Date and time the Maintenance Outage is to begin
- Date and time the Maintenance Outage is to be completed

- Emergency Return Time – The time required to terminate the maintenance and restore the transmission system to normal operation, if necessary

Generation Outage Submission

The EIM Entity or EIM Entity Scheduling Coordinator must submit a new approved Maintenance Outage or a revision to an approved Maintenance Outage to CAISO via the CAISO outage management system no later than seven days prior to the start date of the proposed Outage as specified in CAISO Tariff Section 9.3.6.3.1 in order for the Outage to be a planned Maintenance Outage.

Note: The determination of seven-day prior notice excludes the date of submission and the date of the Outage.

For Generators, a request for an Outage must specify the following:

- Generating Unit or System Unit name and Location Code
- Nature of the maintenance to be performed
- Date and time the Outage is to begin
- Date and time the Outage is to be completed
- Emergency Return Time – The time required to terminate the Outage and restore the Generating Unit to normal capacity, if necessary

10.2.2 Generation Resource Start-Up Time

Generation Maintenance Outages should not include start-up time. Each generator's start-up time is documented in the Master File and is considered to begin once the generator has been called on by the EIM Entity or for a scheduled start up.

10.2.3 Confirmation and Acknowledgement of Receipt of Outage Request

CAISO outage management system acknowledges receipt of each new EIM Entity approved Outage request. EIM Entity and EIM Entity Scheduling Coordinator approved Outage requests and revisions must meet the minimum data requirements of the CAISO outage management system. If an Outage request or revision passes that validation, the Outage will automatically be processed and passed to the market systems without the CAISO OCO review or revision.

10.2.4 Withdrawal or Modification of Request

The EIM Entity and EIM Entity Scheduling Coordinator may withdraw an Outage at any time prior to actual commencement of the Outage. Outage modifications can be made via the CAISO outage management system and will automatically be processed if all data entries are valid.

10.2.5 Changes to Planned Maintenance Outages

The EIM Entity or EIM Entity Scheduling Coordinator may cancel a previously approved planned Maintenance Outage or submit a request to change a previously approved planned Maintenance Outage at any time prior to the Outage start. Requests for such changes must include the information required and be in accordance with the EIM Outage request timing requirements which are consistent with the CAISO **BPM for Outage Management**. Requests to cancel an Outage after the Outage start date and time have passed are not allowed. In that situation, the Outage must be returned to service even if no Outage activity actually occurred.

10.3 Management of Forced Outages

In the *Management of Forced Outages* Section you will find the following information:

- A description of how EIM approved Forced Outages or an extension of an approved Maintenance Outage is processed in the CAISO outage management system.

10.3.1 Forced Outages

Outage Scheduling

If the EIM Entity or the EIM Entity Scheduling Coordinator submits a new approved Maintenance Outage or a revision to an approved Maintenance Outage to CAISO via the outage management system less than seven days prior to the start date of the proposed Outage, the Outage will be a Forced Outage. The timely submission of outages directly impacts the network topology configuration, availability of the electrically connected resources, and/or the MW dispatch range of the available resources. Delays in submission of the forced outage information may result inaccurate real-time imbalance calculation for the look–ahead market intervals, and as a result price signals that may not represent the actual system conditions. Therefore, the timing requirements for submission of forced outages in the EIM entity BAA is set in accordance with the timing required for CAISO as described by the **BPM for Outage Management**, which is currently set at 60 minutes after the occurrence of the outage.

Note: The determination of seven-day prior notice excludes the date of submission and the date of the Outage.

10.3.2 Extended Scheduled Outage

If the EIM Entity or the EIM Entity Scheduling Coordinator wishes to continue to perform maintenance work beyond the date and time specified in an approved Maintenance Outage, the Owner may submit an approved revision to extend the approved Maintenance Outage.

10.4 Communication of Maintenance Outage Information

In the *Communication of Maintenance Outage Information* Section you will find the following information:

- A description of the need for a single point of contact for communication purposes.
- A description of methods of communication to be used as a part of the Outage Management business processes.
- A brief description of the outage management system.

Refer to Tariff Sections 9.3.4: *Single Point of Contact* and 9.3.5: *Method of Communication*.

10.4.1 Single Point of Contact

All EIM Entity Scheduling Coordinator communications concerning the notice of an approved transmission and generation Outage or to confirm or change an approved Maintenance Outage must occur between CAISO and the designated single point of contact for each EIM Entity. The EIM Entity must provide in its initial Outage notification and any subsequent changes to its Master File, the identification of the single point of contact who is responsible for all Outage Management related activities. This identification is confirmed in all communications with CAISO in relation to Outage notification, including any request to CAISO for confirmation, notification, and revision of approved Outages.

This section includes a discussion of the primary and backup mechanisms to communicate Outage Management information, a discussion of the need for some communications to be conducted with Control Center personnel, and a brief description of the CAISO outage management system.

10.4.1.1 Primary Mechanism

The CAISO outage management system is the primary method of communicating Outage Management related information. The outage management system, which is described in more detail in Section 6.2.1 of the **BPM for Outage Management**, provides an automated mechanism for parties and CAISO to communicate the information required for all aspects of Outage Management. The CAISO outage management system provides both a mechanism to communicate as well as a mechanism to confirm the receipt of information from users and from CAISO either by using the system user interface or by using an Application Program Interface (API).

10.4.1.2 Backup Mechanism

In the event that the CAISO outage management system is not operational, emergency capabilities are used to communicate with CAISO. The emergency capabilities that can be used as a back-up if the CAISO outage management system application is unavailable include:

- Electronic format (such as e-mail)
- Voice communication with Control Center Personnel

As discussed in this BPM, some outage management related communications by or with CAISO Control Center personnel are conducted on the telephone. These communications are described in detail in CAISO Operating Procedures (see Section 1.3, *References*).

10.4.1.3 Use of the CAISO outage management system

The CAISO outage management system is a secure software system that enables parties to interact with CAISO to complete the various transactions included in the outage management business processes. The CAISO outage management system includes a web client version for use by an individual and an Application Program Interface (API) version for use in computer-to-computer data transfers. Using the outage management system, an EIM Entity or EIM Entity Scheduling Coordinator can perform the following functions:

- Submit notification of new approved EIM Outage.
- Receive confirmation of notification from CAISO.
- Obtain status of an Outage.
- Enter Outage Cause Codes (NERC GADS, reason for Outage).
- Update an Outage.

- Search the database of completed, scheduled, or active Outages. This function allows an EIM Entity Scheduling Coordinator to review only their data and not the data of other owners.
- User instructions are available on the CAISO website.

Other functions provided for in the CAISO outage management system are listed in the CAISO outage management system materials shown in Section 1.3, *References*, of the **BPM for Outage Management**.

10.5 Records and Reports

In this section you will find the following information:

- Availability of and access to Outage records retention provided for by CAISO and the access provided to those records.
- A description of the various reports related to Outage Management that CAISO produces.
- Also refer to Tariff Sections 9.3, *Coordination of Outages and Maintenance*; and 9.5, *Records*.

10.5.1 Records of Approved Maintenance Outages

The CAISO OCO maintains a record of each approved Maintenance Outage as it is implemented. Such records are available for inspection at the CAISO OCO by EIM Entities or their designated representatives. Only those records pertaining to the equipment or facilities owned by the facility owner are made available for inspection at the CAISO OCO with notice at least 15 days in advance of the requested inspection date.

11. MARKET OPERATIONS

Welcome to the *Market Operations* section of the BPM for the Energy Imbalance Market. In this section you will find the following information:

- Summary of the EIM-specific rules, design, operational elements, and separation procedures of the CAISO markets.
- Operations information for those entities that expect to participate in the EIM, as well as those entities that interface with the EIM.

The operation of the EIM and the regular CAISO market are similar in many ways. Rather than repeat the description of those portions which are the same between markets, this section describes only the EIM-specific implementation details and the differences from the regular CAISO market. Therefore, it is

recommended that the reader review the **BPM for Market Instruments** and the **BPM for Market Operations** prior to reading this section.

11.1 About the Market

This section is intended to describe the features of the EIM.

11.1.1 Ancillary Services

EIM participants will be responsible for procuring and managing their own ancillary services in conformance with NERC and WECC requirements. RTM will protect the participating resource EIM Upward Available Balancing Capacity, EIM Downward Available Balancing Capacity, and EIM Reserves to Meet NERC/WECC Contingency Reserves Requirementsnot to be dispatched to meet EIM footprint energy needs. However when an infeasible power balance condition in an EIM BAA, other than CAISO, is detected by the CAISO's market clearing software, EIM Updward or Downward Available Balancing Capacity will be released to the market clearing process to balance the respective EIM BAA as explained in section 11.3.4 of this document. EIM Downward Available Balancing Capacity consists of any downward capacity from an EIM Participating Resources or a non-participating resource that an EIM Entity Scheduling Coordinator has identified in the EIM Resource Plan as available to address power balance and transmission constraint violations in the EIM Balancing Authority Area, which may include downward regulation capacity. EIM Upward Available Balancing Capacity consists of any upward capacity from an EIM Participating Resources or a non-participating resource that an EIM Entity Scheduling Coordinator has identified in the EIM Resource Plan as available to address power balance and transmission violations in the EIM Balancing Authority Area, which may include upward regulation capacity. EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements consists of any capacity that an EIM Entity Scheduling Coordinator has designated, in the EIM Resource Plan, as necessary to meet its NERC/WECC contingency reserves requirements in the applicable Trading Hour and which does not overlap with capacity designated in other parts of the EIM Resource Plan specified in Section 29.34(e)(3) of the CAISO Tariff, which may include operating reserves.

11.1.2 Interties Between BAAs

This section describes intertie modeling and the use of data related to interties. The intertie is oriented in the export direction with the "From" bus being the CAISO/EIM BAA bus.

11.1.2.1 Interchange Transactions and E-Tagging

Since the non-EIM Entities net schedule interchange (NSI) values are not submitted to CAISO but are required for the calculation of loop flow impact of external schedules on the CAISO and the EIM entities network, CAISO will receive/download automatically all raw tag data from Western Interchange Tool (WIT) for all external BAAs at a pre-defined frequency and time of day.

The data file will contain schedule and path information for every transaction schedule in WIT within the specified time period. Each transaction schedule will present the North American Energy Standards Board (NAESB) defined tag transaction type and composite state. The data will include the source and sink BAA information.

For e-tagging timelines and rules, please refer to the **BPM for Market Operations** Section 7.2.2.1.

11.1.3 EIM Transmission Services Information

The EIM Entity shall send to CAISO its EMS network model information including any flowgates, intertie definitions and physical limits on its transmission equipment and the available capacity limits for the EIM Entity internally enforced flowgates. The submission of the EIM Entity network model shall use the Common Information Model (CIM) industry standard protocol for exchanging network model data. The EIM Entity shall also send to CAISO SCADA and measurements mapped to the EIM Entity EMS network model. The process of submission of the EIM network model shall be consistent and in accordance to the already established CAISO FNM update process and its publically published deadlines for collecting network updates. Please refer to the **BPM for Managing Full Network Model** for a description of this process.

The EIM Entity shall send, via a direct interface to CAISO, the transmission limit updates due to planned or forced outages or derates for its internal major paths or flowgates that are usually posted on its OASIS system.

11.1.4 Maximum EIM Transfer Limits

EIM Entity Scheduling Coordinators shall send to the CAISO market system the EIM intertie Available Transfer Capacity (ATC) and any updates due to planned or forced outages or derates based on physical limits, schedule limits, and/or contract limits or rights owned by the EIM Entity on the EIM interties with neighboring BAAs. The CAISO shall enforce the limits in corresponding market optimization per

applicable Operating Procedures. The EIM Entity shall communicate these limits via direct interface to CAISO.

The EIM Entity shall communicate to the CAISO market system any real-time Dynamic Transfer Capability (DTC) limits enforced by any third party transmission provider that the EIM Entity utilizes its transmission or has transmission rights. The EIM Entity shall reflect the DTC limit in the transmission profile of the corresponding EIM transfer dynamic e-tag.

Each EIM Entity Scheduling Coordinator shall determine and send to the CAISO market system the EIM intertie transmission right limits, static limits, dynamic incremental limits and any updates through the EIMDynamicLimitData file submitted to CAISO as changes to these limits are required by the EIM Entity Scheduling Coordinators (*i.e.*, the EIM Transfer limit). This should be finished prior to the start of the next Dispatch Interval by the EIM Entity Scheduling Coordinator. The CAISO will use this information to calculate the Energy Transfer schedule limit according to Appendix A: Energy Transfer Schedule Limits. The CAISO will provide the EIM Entity Scheduling Coordinator with the Energy Transfer schedule information according to Appendix A: Energy Transfer Schedule Tags.

Specific procedures may be developed to document specific conditions, communication of EIM Entity, External BAA, or third party transmission provider as designed by EIM Entity.

If there are two or more EIM Entity Balancing Authority Areas that share the same EIM Internal Intertie, the CAISO's Security Constrained Economic Dispatch in the Real-Time Unit Commitment and Real-Time Dispatch will enforce the individual EIM Transfer limit for each EIM Entity Balancing Authority Area while allowing Energy to wheel through the EIM Entity Balancing Authority Areas based on the transmission made available for use in the Real-Time Market.

11.1.5 Energy Transfer Scheduling in Energy Imbalance Market

Energy Transfer Scheduling aims to determine the Energy Transfer schedules among the EIM BAAs and the CAISO from the optimal EIM Transfers of the BAAs in the EIM Area using the transmission rights available to the EIM without violating them. This is a part of the market optimization problem in Fifteen Minute Market and RTD of EIM.

The Appendix A Mathematical Formulation for EIM Transfers outlines how the CAISO enforces scheduling constraints in the market optimization to ensure the energy from base schedules and EIM Transfers in the FMM and RTD are consistent with intertie scheduling limits.

In calculating real-time neutrality by BAA, the System Marginal Energy Cost (SMEC) is used for the Energy Transfer (see Appendix A for an example).

11.1.5.1 Energy Transfer System Resources

For the convenience of modeling of the Energy Transfer Scheduling problem, Energy Transfer System Resources (ETSRs) are defined as aggregate resources at the EIM BAA Default Generation Aggregation Point (DGAP), which is an aggregation of all supply resources in the BAA. They are dedicated System Resources in each EIM BAA to anchor the Energy Transfer schedules from that BAA to other BAAs in the EIM Area for tracking, tagging, and settlement. Each ETSR is defined as either an import or an export resource, and it is associated with an EIM intertie with another EIM BAA, or a CAISO intertie with the CAISO. The associated intertie is one where the EIM Entity for the relevant EIM BAA has made transmission rights available for scheduling Energy Transfers from/to the other EIM BAA or the CAISO.

11.1.5.2 Base Schedules

Before EIM market optimization, base Energy Transfer schedules between EIM BAAs are submitted along with the generation and intertie base schedules. The base Energy Transfer schedules are assumed to be feasible. For each EIM BAA and CAISO, the base EIM Transfer, the base NSI, the base demand, the base generation and the base load are obtained from the base Energy Transfer schedules and RUC schedules. The base load for EIM BAA is adjusted in the ACPF to absorb the loss error. The base load for EIM BAAs is significant because it is used as a reference for imbalance energy settlement. Base schedules are also calculated for non-EIM BAAs to model unscheduled loop flow through the EIM area.

11.1.5.3 Energy Transfer Schedule Calculation

Additional variables and constraints are added to the market optimization problem for the Energy Transfer Scheduling problem. In the market optimization problem, the NSI variables for each BAA are used to derive the EIM Transfer for each EIM BAA and for the CAISO. The EIM Transfer Schedules represented by the ETSR variables are constrained by applicable EIM Transfer limits.

The base Energy Transfer schedules may be included in the optimal Energy Transfer schedules or specified separately. After the market solution is obtained, the base and optimal Energy Transfer schedules assigned to the corresponding ETSRs are tagged to the associated intertie using the corresponding ETSR identification. Including the base Energy Transfer in the optimal Energy Transfer allows the optimal dynamic Energy Transfer to counter flow on the base Energy Transfer maximizing transmission capacity use. If the base Energy Transfer is scheduled separately on dedicated ETSRs, the Base ETSRs, it is not optimized but kept constant in the market, unless modified by the EIM Entity SC after T–40' through the real-time intertie schedule interface. The transmission capacity consumed by the base Energy Transfer scheduled on Base ETSRs cannot be used for counter flow dynamic Energy Transfers. Schedules associated with pseudo tie or dynamic e-Tags for pseudo-tied resources or loads that involve one or multiple EIM Entity BAAs should not be included in base Energy Transfers between

EIM BAAs or intertie transactions between EIM and non EIM BAAs because these schedules have no effect on the NSI of the source/sink BAA or the NSI of intermediate BAAs.

In the mathematical formulation, without loss of generality, the base Energy Transfer schedules are included in the optimal Energy Transfer schedules, and the optimal Energy Transfer schedules are constrained by the EIM Transfer limits determined by the transmission limits, static limits and incremental dynamic limit. In other words, the amount of total intertie utilization is modeled to be constrained by the total transmission capacity, rather than the amount of incremental intertie utilization being constrained by the available transmission capacity. There are three different types of ETSRs defined in the Master File: Base ETSR, Static ETSR (15 min), and Dynamic ETSR (5 min). This is to distinguish between the base and dynamic Energy Transfers so that EIM Entity SCs can submit base Energy Transfers that will not be optimized by the market, while submitting ETSR limits that would apply to dynamic Energy Transfers only. The Static ETSRs are used only when dynamic transmission capability constraints apply in the ETSR contract path, necessitating separate limits for Static ETSRs in FMM and Dynamic ETSRs in RTD.

Base ETSRs are not optimized, thus they do not factor in the procurement of the Flexible Ramping Product (FRP), except for their contribution to the base net EIM Transfer. For example, for anon-optimized dynamic ETSR, the difference between its limit and its optimal value contributes to NIC/NEC for calculating FRP requirements; however, for a base ETSR, there is no such contribution because it is fixed.

11.1.5.4 Non-Generator Resource (NGR) Modeling Functionality

Refer to section 2.1.13 of the Market Operations BPM for details on the NGR modeling.

11.1.5.5 EIM Transfer Schedule Cost

To maximize the efficiency and robustness of Energy Transfer schedules without circulating Energy Transfer schedules, a small nominal cost, the EIM Transfer schedule cost, is included in the objective function of the market optimization problem for each optimizable (static and dynamic) ETSR. The EIM Transfer schedule cost will ensure the most optimal path or paths for the EIM Transfer are used by placing a higher priority on the most optimal path over less optimal paths. This approach will also minimize the number of e-tags which must be updated and reduces the complexity of settling the financial value of the EIM transfer used for neutrality calculations.

The CAISO determines the appropriate level of the transfer cost balancing the benefits of the transfer costs with the impact to locational marginal costs pursuant to Section 29.17(g)(2). The EIM Transfer Cost

shall be less than $0.01. The EIM Transfer Cost can be different for each Intertie. In case absent any priority defined by the entity and approved by the CAISO , the CAISO will set $0.0001 for the EIM Transfer schedule cost associated with each EIM Internal Intertie.

The CAISO may adjust the EIM Transfer schedule costs to maintain the path priorities established by the criteria in Section 29.17(g)(2) when an EIM Entity Balancing Authority Area is added or subtracted from the EIM Area, as seasonal transmission system ratings change or the transmission system topology changes.

11.1.6 Entitlement Constraints for Rate of Changes

The entitlement constraints limit power flow contributions from the dispatch of resources in an EIM Entity Balancing Authority Area (BAA), or the CAISO BAA, on interties or transmission corridors in external BAAs. Power flow contributions from intertie transactions participating in the EIM or DAM can also be constrained by entitlement constraints. The limit in an entitlement constraint represents either contractual rights or scheduling rights that have been agreed upon between BAAs. The difference between entitlement constraints and regular transmission constraints is that the former constraint only a subset of the resources that participate in a market, as opposed to the latter where all such resources are constrained. Furthermore, entitlement constraints in the EIM limit the rate of change only of the relevant power flow contributions across 5-minute dispatch intervals. All resources which are in either start-up, shutdown or transition status are excluded from the rate of change constraints. In addition, resources that are online without bids are excluded from the rate of change constraints.

Specific procedures may be developed to document specific conditions, communication of EIM Entity, External BAA, or third party transmission provider as designed by EIM Entity.

11.1.7 Constraint Relaxation

Constraint Relaxation refers to the process of allowing the MW quantity to exceed the constraint limit using ‘penalty’ prices, as opposed to hard constraints, in order to improve the quality of the optimization solution. Constraints will be relaxed if the shadow price of the constraint otherwise exceeds the penalty value. Based on CAISO Tariff Section 29.34 (o), please refer to Section 6.6.5 of the **BPM for Market Operations** for details on the penalty prices and pricing parameters used in the markets.

11.1.8 Transition Period Pricing

For a period of six months following the Implementation Date of a new EIM Entity, the provisions of CAISO Tariff Sections 27.4.3.2 and the second sentence of CAISO Tariff Section 27.4.3.4 shall not apply to constraints that are within Balancing Authority Areas of the new EIM Entity or affect EIM Transfers between the Balancing Authority Areas of the new EIM Entity and any other EIM Entity that is subject to CAISO Tariff subsection 29.27(b). For the those intervals that experience infeasibilities described in those provisions, the CAISO shall instead determine prices consistent with the provisions of CAISO Tariff Sections 27, 34, and Appendix C, that would apply in the absence of CAISO Tariff Section 27.4.3.2 and the second sentence of CAISO Tariff Section 27.4.3.4. In addition, when the power balance or transmission constraints are relaxed, the Flexible Ramping Constraint parameter in Section 27.10 of the CAISO tariff will be at an amount between and including $0 and $0.01. This enables the price to be set to the last economic bid cleared in the market as described above instead of the pricing parameter for the flexible ramping constraint as specified in Section 6.6.5 of the **BPM for Market Operations** and section 27.10 of the CAISO tariff that would otherwise apply.

The last economic signal is determined by the price discovery mechanism of the pricing run where the power balancing requirement is set to the relaxed scheduling level reduced by a small amount.

Since November 14, 2014, pursuant to FERC's order granting the ISO waiver of section 27.4.3.2 and 27.4.3.4 for PacifiCorp East and PacifiCorp West balancing authority areas, instead of setting prices based on the pricing parameter specified in those sections, the ISO has calculated prices using the last economic signal prior to constraint relaxation. With the activation of the available balancing capacity functionality, the price discovery mechanism will no longer be used, except for EIM entities that are in their transition period. Consequently, when a constraint relaxation occurs, such as in the cases of power balance constraint infeasibility, the clearing prices will be based on the pricing parameters.

11.1.9 Coordination with Reliability Coordinator and WECC Unscheduled Flow Mitigation

EIM's congestion management process will use its effective resources to remove congestion before curtailing any existing schedules, by being responsive to price differences resulting from congestion, rather than only to reliability-based curtailments. Flows resulting from the EIM dispatch will provide counter-flows for congestion, and thereby support scheduled flows that may otherwise need to be curtailed through WECC's Unscheduled Flow Mitigation Plan (UFMP). If the UFMP has not been initiated, the CAISO will manage congestion directly in the EIM dispatch by automatically enforcing constraints, using the transmission capacity available to EIM. EIM will dispatch only bids submitted by EIM Participating Resource Scheduling Coordinators, and will not adjust self-schedules outside the

submitted bid range. However, the EIM's purpose is not to directly resolve unscheduled flow. Coordinated reliability curtailments such as through UFMP or Reliability Coordinator intervention in mandating schedule curtailments remain the role of the EIM Entity.

The EIM will not automatically initiate the UFMP, but will alert EIM Entities to conditions that EIM has no effective bids to resolve, which may require the EIM Entity to initiate non-market procedures. An EIM Entity may choose to issue reliability curtailments using its own procedures, after the EIM CAISO notifies the EIM Entity that the CAISO observes congestion or other conditions that EIM cannot resolve, or separately before such conditions occur.

It is the responsibility of the EIM entity to communicate unscheduled flow mitigation orders on any of its BAA resources via updating the energy profile of the corresponding tag to reflect the unscheduled flow mitigation procedure cuts, as well as entering manual dispatches in the designated BAA operator's CAISO provided user interface or displays, or if these displays are not functioning, through other back up mechanisms such as phone or oral communications with the CAISO. Financial implications resulting from any uninstructed energy deviations due to manual dispatches and or lack of communication of the manual dispatches to the CAISO is the responsibility of the resource's registered scheduling coordinator.

Dynamic e-tags for EIM flows will be updated prior to real-time to show the expected EIM Transfers, to enable management by the UFMP, and be updated for actual EIM dispatch after the end of the operating hour. Any intra-hour reduction in EIM available transmission must be communicated to the CAISO by the EIM Entity.

When CAISO initiates curtailments through the UFMP, EIM Market Participant schedules in the Real-Time Market will be affected based on the CAISO unscheduled flow mitigation procedure located at: http://www.caiso.com/Documents/3510.pdf

11.1.10 Entitlement Constraints for EIM Incremental Flow[1]

The entitlement constraints for EIM Incremental Flow limit incremental power flow contributions from the dispatch of EIM participating resources in EIM Entity Balancing Authority Areas (BAAs), and all resources in the CAISO BAA. The incremental power flow contributions are measured from the base schedules for EIM participating resources and from the day-ahead schedules for CAISO resources. The EIM Incremental Flow limit will either result in EIM dispatches not exacerbating or relieving a System Operating Limit (SOL) in the non-EIM BAA. The difference between EIM Incremental Flow constraints

[1] EIM Incremental Flow is defined by the Coordinated Transmission Agreement as: The aggregate power flow contribution from the dispatch of EIM Participating Resources. *See* FERC Letter Order, Docket No. ER17-1493-000, June 20, 2017.

and regular transmission constraints is that the former constrains only the subset of resources that participate in the EIM, as opposed to the latter where all resources are constrained.

11.1.11 Entitlement Constraints for EIM Area Total Flow[2]

The entitlement constraints for EIM Area Total Flow limit the total power flow contributions from the dispatch of EIM participating and non-participating resources in EIM Entity Balancing Authority Areas (BAAs), and all resources in the CAISO BAA. The EIM Area Total Flow limit will result in EIM dispatches not violating the portion of the System Operating Limit (SOL) in the non-EIM BAA attributed to EIM flows. There is no difference between the EIM Area Total Flow constraints and other regular transmission constraints except that the former apply to transmission corridors in non-EIM BAAs.

11.2 Day-Ahead Operations

This section is intended to describe the actions taken by EIM participants in the Day-Ahead time frame. It is strongly recommended that readers first review Section 6 of the BPM for Market Operations, which describes the general operation and timeline of the Day-Ahead Market. By 10:00 a.m. on the day preceding the Operating Day, the EIM Entity Scheduling Coordinators on behalf of non-participating resources and EIM Participating Resource Scheduling Coordinators on behalf of EIM Participating Resources shall submit EIM Resource Plan, which must cover a seven-day horizon with hourly granularity beginning with the Operating Day.

- The EIM Resource Plan shall comprise
  - EIM Base Schedules of EIM Entities and EIM Participating Resources, which include hourly-level schedules for resources, and hourly-level scheduled Interchanges;
  - Energy Bids (applicable to EIM Participating Resources only);
  - EIM Upward Available Balancing Capacity
  - EIM Downward Available Balancing Capacity
  - EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements

[2] EIM Area Total Flow is defined by the Coordinated Transmission Agreement as: The aggregate power flow contribution of flows resulting from EIM Base Schedules, Day-Head Schedules, and EIM Area Incremental Flows. *See* FERC Letter Order, Docket No. ER17-1493-000, June 20, 2017.

- **EIM Scheduling Coordinators submit Base Schedules for External BAA Supply and Interchange as part of the EIM Resource Plan**
    - Base Schedule Coordinators (BSCs) submit Base Schedules and ancillary services schedules for EIM Participating and Non-Participating Resources and Interchanges through the Base Schedule Application Portal (BSAP).
    - The Base schedule submission may cover a seven-day horizon with hourly granularity beginning with the Operating Day.
    - Base Schedules must be submitted for all online generating resources in an EIM Entity BAA and all interchanges with tagged schedules with other BAAs, except CAISO. A Base schedule of zero (0 MW) may be submitted for an offline EIM Participating Resource with a three-part bid to be committed optimally.
    - Base schedules for online generating resources must include disaggregation of forward net export schedules to other BAAs, including RUC import schedules to CAISO.
    - Base import/export schedules to an EIM Entity BAA from BAAs other than CAISO must be submitted at the relevant intertie scheduling points.
    - If resource(s) are modeled as a Multi-Stage Generator (MSG), the Base Schedule(s) shall include the base MSG configuration.
- **CAISO performs Feasibility Test for Each EIM Entity BAA**
    - The EIM Base Schedules included in the EIM Resource Plan should be balanced with the Demand Forecast for each EIM Entity Balancing Authority Area.
    - CAISO will perform Day-Ahead and Base Schedule power flow feasibility test by 1:00 pm on the day before the Operating Day; if the Day-Ahead Market or the Base Schedules submitted for the Real-Time Market result in transmission violation in the EIM Entity Balancing Authority Area, then the test fails.
    - The test result will be broadcasted to the EIM Entity SC.
    - The Day-Ahead Market test result is for information only and will not have a settlement impact. The EIM Entity SC may adjust the components of EIM Resource Plan up to 75 minutes before the Operating Hour, when the submission of Real-Time EIM Base Schedules is due (see 11.3)
- **Other Considerations**
    - Bids may not be submitted for EIM Participating Resources in the Day-Ahead Market. Similarly, Bids may not be submitted at interties between EIM BAAs, or between EIM BAAs and Non-EIM BAAs in the Day-Ahead Market. Day-Ahead Bids may be submitted at

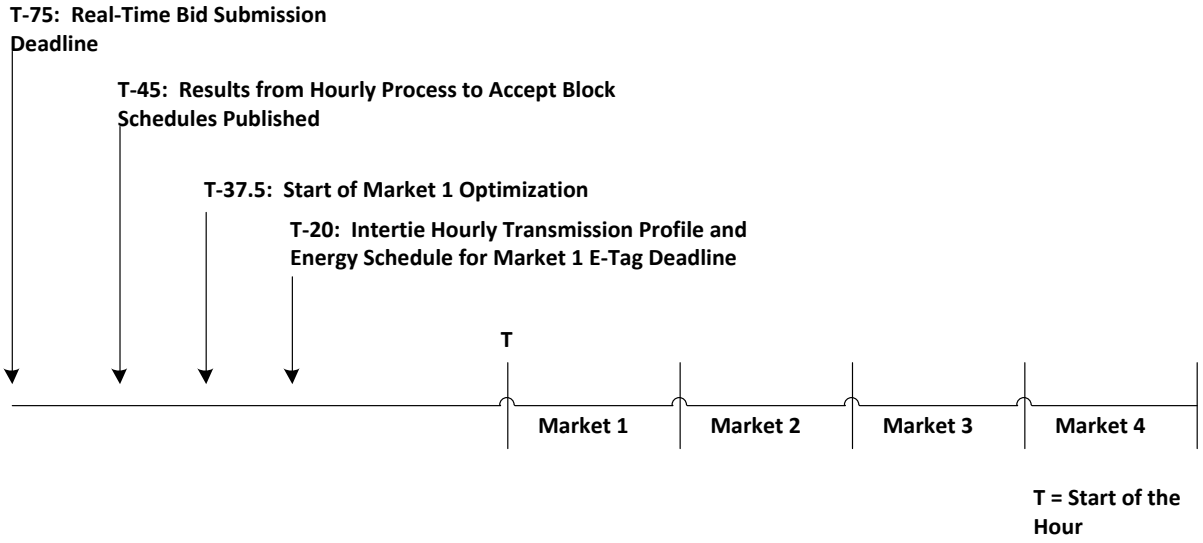
CAISO interties for import/export to/from the CAISO BAA at the relevant Scheduling Points.

- The Day-Ahead Market shall run with the Day-Ahead Base Schedule as a fixed injection without enforcing transmission constraints in the external BAAs and the EIM Entity BAAs.
- The CAISO will report any transmission overloads in the EIM Entity BAAs.
- The Day-Ahead Market will maintain historical generation, demand, and interchange schedules for all external BAAs in the EIM footprint. Also, it will harvest data from the State Estimator and WECC RC, and receive Area to Area Net Scheduled Interchange (AANSI) from WECC WIT and BAA load forecast.
- Since the actual non-EIM Entity BAA Day-Ahead supply schedules are unknown to CAISO but are required for a solution, CAISO will estimate the schedules based on the demand forecast and net scheduled interchange where supply, demand, and any known or historical net interchange are balanced for each BAA individually. The same process will also be performed for EIM Entity BAAs.
- Import/export bids to/from CAISO will be excluded from Base Schedule calculation.
- SIBR validates the energy bids and notify the applicable SCs.

11.3 Real-Time Operations

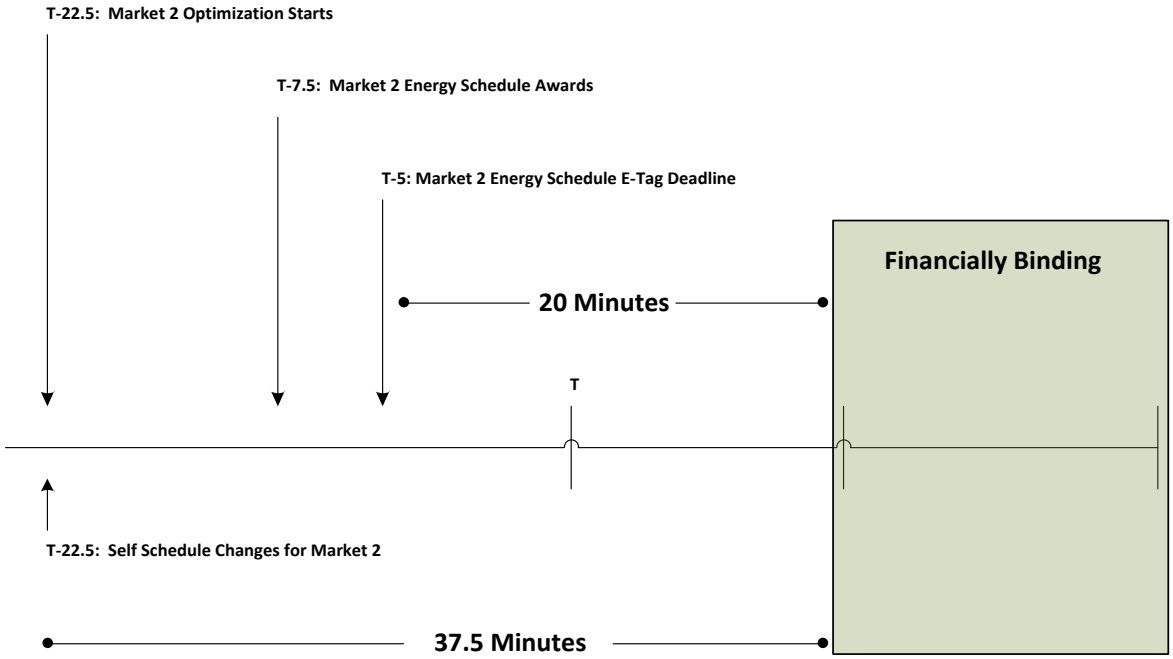
This section is intended to describe the actions taken by EIM participants in the Real-Time Market. Readers should review Sections 6 and 7 of the **BPM for Market Operations**, which describes the general operation and timeline of the Day-Ahead Market and Real-Time Market, respectively.

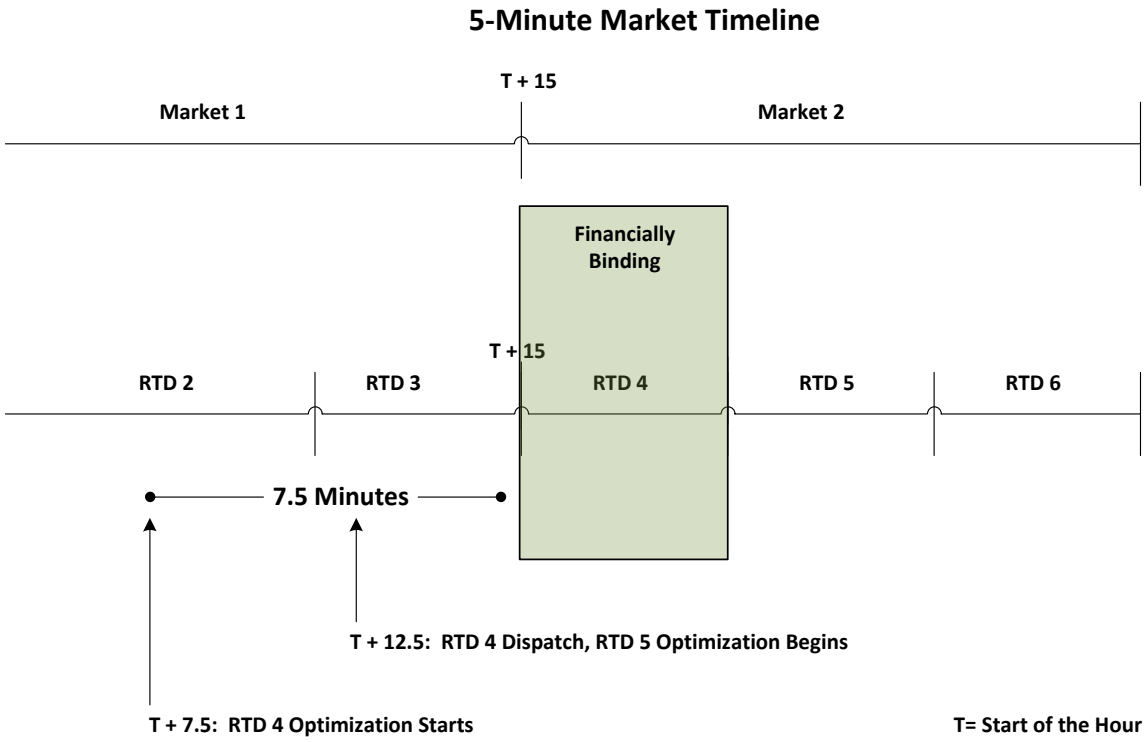
Hourly Process For Real-Time Market



No Hourly Financially Binding Schedules in Real-Time

15-Minute Market Timeline





11.3.1 Establishment of Hourly Base Schedules and Hourly Resource Plan

Entity Scheduling Coordinators, EIM Participating Resource Scheduling Coordinators, and non-participating resources in the EIM Entity Balancing Authority Area that wish to submit real-time hourly EIM Base Schedules, or, with regard to non-participating resources, wish to submit EIM Base Schedule information pursuant to Section 29.34(f)(4), must submit such schedules at least 75 minutes before the start of the Operating Hour.

The CAISO Markets systems will validate the EIM Resource Plan including any adjustments to the EIM Base Schedules within 15 minutes of the submission of EIM Base Schedules or adjustments to EIM Base Schedules and notify the EIM Entity Scheduling Coordinator about the result of the Resource Sufficiency Evaluation.

The EIM Entity Scheduling Coordinator has visibility to all elements of the EIM Resource Plan and the results of the various checks in the resource sufficiency evaluation described below, and is able to make changes to hourly Base Schedules to resolve unbalanced supply and demand, transmission flow overloads, insufficient EIM Participating Resource bid range, and ramping capability up to 55 minutes before the start of the Operating Hour (interim revision) and up to 40 minutes before the start of the

Operating Hour (final revision). This provides the EIM Entity Scheduling Coordinator with the opportunity to resolve any identified issues prior to the start of the EIM. At 40 minutes prior to the operating hour, the hourly EIM Resource Plan is approved by the EIM Entity Scheduling Coordinator and it becomes final.

These final hourly Base Schedules are used to balance against the load forecast and serve as the baseline for settling imbalance energy in the EIM.

In addition to hourly Base Schedules, EIM Participating Resources have the opportunity to submit bid offers and estimated Generator Distribution Factors (GDFs) for aggregate resources in SIBR by T–75. These factors are used to distribute aggregate energy schedules to the individual physical units in the aggregation.

For aggregate EIM non-participating resources, Base Schedule Coordinators can submit base GDFs in BSAP by T–75, T–55, and T–40. These factors are used to distribute aggregate energy schedules to the individual physical units in the aggregation.

If GDFs are not provided with the base schedule or bid for an aggregate resource, the registered default GDFs for that resource in the Master File, normalized for physical outages, will be used instead.

11.3.2 Resource Sufficiency Evaluation

The EIM does not include forward resource adequacy requirements or obligations for resources to submit bids, but instead includes several elements to ensure each EIM balancing authority has sufficient resources to serve its load while still realizing the benefits of increased resource diversity. Load conformance, transmission limit conformance and manual dispatch will not be considered in the Real Time Base Schedule Tests. For dispatch and when base schedule tests are performed, it will be assumed that base schedules and bid in capacity are adjusted to account for generation outages and ancillary services. *i.e.*, a 100 MW generator bids in full capacity, but has a 20 MW derate and 10 MW of SPIN. The base schedule tests will only count 70 MW and the real time market will only dispatch up to 70 MW.

The EIM design elements that ensure resource sufficiency include:

- **Load Base Schedule Adjustments:** If Base Schedules from generation and intertie resources in an EIM Resource Plan do not balance the load forecast, CAISO will adjust the load Base Schedule to equal the scheduled generation and interchange, reduced by transmission losses. The resulting difference will be settled through the EIM along with any applicable

under-scheduling or over-scheduling penalties as applicable. The load Base Schedule is only used as a reference for calculating load imbalance energy for settlement. The market solution will use the applicable demand forecast for each interval in the market horizon.

The forecasted demand for the trading hour may change based on the system conditions, so this information is updated up to 60 minutes before the trading hour. At 40 minutes before the trading hour, the forecast demand updated at 60 minutes before the trading hour is used to evaluate under-scheduling and over-scheduling penalties.

- **Under-Scheduling and Over-Scheduling Penalties and Resource Balancing Provisions:** For each trade hour, the EIM Balancing Test determines whether the BAA's ~~base transfer~~ sum of base schedules (generation~~,~~ and net scheduled interchange, including base transfers) ~~-~~is within a 1% margin (over or under) of the hourly demand forecast. The hourly imbalance values are calculated based on the absolute difference between the sum of base schedules ~~BAA's base transfer schedule~~ and the hourly demand forecast in the over or under direction. If an EIM balancing authority ~~uses~~ elects to use the CAISO Demand ~~f~~Forecast ~~but~~ and does not schedule resources within one percent of ~~the forecasted demand~~CAISO Demand Forecast or the EIM Entity elects their own demand forecast, then ~~it~~ the EIM balancing authority will be subject to over-scheduling or under-scheduling ~~penalties~~ assessment. ~~I~~if the over-scheduling or under-scheduling assessment determines the EIM balancing authority metered load is five percent more or less than its load Base Schedule for that hour, over-scheduling or under-scheduling penalties will be applied~~its actual load is five percent more or less than its load Base Schedule, respectively~~. If an EIM balancing authority does not use CAISO's forecast, then it will be subject to over-scheduling or under-scheduling penalties for actual load imbalances. The penalties collected will be allocated to the other balancing authorities who have not incurred a scheduling penalty for the Operating Day.

Examples:

No.	Scenario Description	Expected Results
1	EIM Balancing Test result fails (over): - BAA sum of base schedules ~~Base Schedule Transfer~~ = 3500 MW - BAA Hourly Demand Forecast = 3580 MW	Since absolute (3500 MW – 3580 MW) > 0.01 * 3580 MW, CMRI results shall provide records as follows: • Test Result: Fail • Imbalance Direction: UNDER • Imbalance Amount (MW): 80.0 • Imbalance Percentage (%): 2.23 • Requirement Amount (MW): 3,580.0

No.	Scenario Description	Expected Results
2	EIM Balancing Test result fails (over): - BAA sum of base schedules ~~Base Schedule Transfer~~ = 3500 MW - BAA Hourly Demand Forecast = 3400 MW	Since absolute (3500 MW – 3400 MW) > 0.01 * 3400 MW, CMRI results shall provide records as follows: • Test Result: Fail • Imbalance Direction: OVER • Imbalance Amount (MW): 100.0 • Imbalance Percentage (%): 2.94 • Requirement Amount (MW): 3,400.0
3	EIM Balancing Test result passes (over or under): - BAA sum of base schedules ~~Base Schedule Transfer~~ = 3500 MW - BAA Hourly Demand Forecast = 3480 MW	Since absolute (3500 MW – 3480 MW) < 0.01 * 3480 MW, CMRI results shall provide records as follows: • Test Result: Pass • Imbalance Direction: OVER • Imbalance Amount (MW): 20.0 • Imbalance Percentage (%): 0.57 • Requirement Amount (MW): 3,480.0

- CAISO shall set the histogram values described in Section 7.1.3 of the Market BPM to ensure the flexible ramp requirements stay within a reasonable level for a transitional period following implementation. This histogram value will be used until the ISO is able to collect sufficient production-quality data to accurately calculate the flexible requirements based on the historical information gathered from Production. These initial thresholds may be adjusted according to each balancing authority area's conditions including factors and data observed during market simulation and parallel operations. These thresholds will allow the Flexible Ramping Requirements to stay within a reasonable band during the transitional period until an accurate histogram can be calculated from Production data for the balancing authority area.

- **Capacity Test:** At T-75, T-55, and T-40 minutes p~~P~~rior to the start of the next ~~each~~trading hour, CAISO will ~~administer~~ independently evaluate all 15-minute intervals within the next trading hour for sufficient bid range capacity for both over and under capacity requirements.~~a capacity test if an EIM balancing authority uses the CAISO forecast and does not balance that forecast exactly with submitted Base Schedules.~~ There must be a sufficient EIM Participating Resource capacity bid range in the EIM through incremental or decremental energy bids above or below the Base Schedules to meet the ~~imbalance, positive~~imbalance, positive (represents insufficiency) or negative (represents sufficiency). If

the EIM balancing authority fails the capacity test for a 15-minute interval, it will automatically fail the flexible ramp sufficiency test for the same 15-minute interval in the same direction (Failed over capacity test will auto-fail upward flexible ramping sufficiency test. Failed under capacity test will auto-fail downward flexible ramping sufficiency test).The capacity test is applicable to the CAISO BAA.

Regardless of the capacity test pass/fail results, CAISO will publish the worst 15-minute interval results (i.e. interval with highest bid insufficiency amount, or lowest sufficient amount if all intervals are sufficient) of the trade hour for each insufficiency direction.

Examples:

<table>
<tr><th>No.</th><th>Scenario Description</th><th>Expected Results</th></tr>
<tr><td>1</td><td>BAA's EIM Capacity Test result fails for a single 15-min interval, where the following conditions occur for trade hour:
<table><tr><th>Value</th><th>:15</th><th>:30</th><th>:45</th><th>:60</th></tr><tr><td>sum of base ~~Base Transfer~~ Schedules</td><td>1100</td><td>1100</td><td>1100</td><td>1100</td></tr><tr><td>15-minute ~~Load~~Demand Forecast</td><td>975</td><td>1050</td><td>1125</td><td>1025</td></tr><tr><td>Imbalance Direction</td><td>Over</td><td>Over</td><td>Under</td><td>Over</td></tr><tr><td>Imbalance Amount</td><td>125</td><td>50</td><td>25</td><td>75</td></tr><tr><td>Bid Range Capacity (Up)</td><td>100</td><td>100</td><td>100</td><td>100</td></tr><tr><td>Bid Range Capacity (Down)</td><td>100</td><td>100</td><td>100</td><td>100</td></tr></table></td><td>CMRI reports will now provide Bid Range Capacity test results for both over and under directions each trade hour. In each direction, the most-insufficient 15-minute interval result (presented in blue text) will displayed and broadcasted (e.g. :15 for the over direction, :45 for the under direction). Only the intervals' trade hour will be identified in the report.
<table><tr><th>Value Description</th><th>:15</th><th>:30</th><th>:45</th><th>:60</th></tr><tr><td>Test Status (Over)</td><td>Fail</td><td>Pass</td><td>Pass</td><td>Pass</td></tr><tr><td>Insufficiency Direction (Over)</td><td>Over</td><td>Over</td><td>Over</td><td>Over</td></tr><tr><td>Insufficiency Percentage (%)</td><td>25.0</td><td>-50.0</td><td>-125.0</td><td>-25.0</td></tr><tr><td>Insufficiency Amount (MW)</td><td>25</td><td>-50</td><td>-125</td><td>-25</td></tr><tr><td>Test Status (Under)</td><td>Pass</td><td>Pass</td><td>Pass</td><td>Pass</td></tr><tr><td>Insufficiency Direction (Under)</td><td>Under</td><td>Under</td><td>Under</td><td>Under</td></tr><tr><td>Insufficiency Percentage (%)</td><td>-225.0</td><td>-150.0</td><td>-75.0</td><td>-175.0</td></tr><tr><td>Insufficiency Amount (MW)</td><td>-225</td><td>-150</td><td>-75</td><td>-175</td></tr></table>Since one of the 15-minute intervals failed the "over" capacity test, the BAA's Flexible Ramping Sufficiency Test fails for the same 15-minute interval in the upward direction, reducing the BAA's import EIM transfer limits</td></tr>
<tr><td>2</td><td>BAA's EIM Capacity Test result fails for at least one 15-minute interval for each direction in same trade hour, where the following conditions occur:
<table><tr><th>Value</th><th>:15</th><th>:30</th><th>:45</th><th>:60</th></tr><tr><td>sum of base ~~Base Transfer~~ Schedules</td><td>1100</td><td>1100</td><td>1100</td><td>1100</td></tr></table></td><td>For this scenario, CMRI shall report the most-insufficient 15-minute interval results (in blue text) for interval :30 results for the "over" direction, and interval :60 results for the "under" direction. Only the intervals' trade hour will be identified in the report.
<table><tr><th>Description</th><th>:15</th><th>:30</th><th>:45</th><th>:60</th></tr><tr><td>Test Status (Over)</td><td>Fail</td><td>Fail</td><td>Pass</td><td>Pass</td></tr><tr><td>Insufficiency Direction (Over)</td><td>Over</td><td>Over</td><td>Over</td><td>Over</td></tr></table></td></tr>
</table>

<table>
<tr><th>No.</th><th>Scenario Description</th><th>Expected Results</th></tr>
<tr><td></td><td>
<table>
<tr><td>15-minute ~~Load~~Demand Forecast</td><td>975</td><td>950</td><td>1110</td><td>1225</td></tr>
<tr><td>Imbalance Direction</td><td>Over</td><td>Over</td><td>Under</td><td>Under</td></tr>
<tr><td>Imbalance Amount</td><td>125</td><td>150</td><td>10</td><td>125</td></tr>
<tr><td>Bid Range Capacity (Up)</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
<tr><td>Bid Range Capacity (Down)</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
</table>
</td><td>
<table>
<tr><td>Insufficiency Percentage (%)</td><td>25.0</td><td>50.0</td><td>-110.0</td><td>-225.0</td></tr>
<tr><td>Insufficiency Amount (MW)</td><td>25</td><td>50</td><td>-110</td><td>-225</td></tr>
<tr><td>Test Status (Under)</td><td>Pass</td><td>Pass</td><td>Pass</td><td>Fail</td></tr>
<tr><td>Insufficiency Direction (Under)</td><td>Under</td><td>Under</td><td>Under</td><td>Under</td></tr>
<tr><td>Insufficiency Percentage (%)</td><td>-225.0</td><td>-250.0</td><td>-90.0</td><td>25.0</td></tr>
<tr><td>Insufficiency Amount (MW)</td><td>-225</td><td>-250</td><td>-90</td><td>25</td></tr>
</table>
Since the 15-minute intervals failed the BAA's capacity test (intervals :15 and :30 in over direction, interval :60 in under direction), the BAA's Flexible Ramping Sufficiency Test (FRST) automatically fails for the same 15-minute intervals in the associated direction. Intervals :15 and :30 will fail in the upward direction (reducing the import EIM Transfer Limit), and Interval :60 in the downward direction (reducing the export EIM Transfer Limit).
</td></tr>
<tr><td>3</td><td>
BAA's EIM Capacity Test result passes for all 15-minute interval for each direction in same trade hour, where the following conditions occur:
<table>
<tr><td>Value</td><td>:15</td><td>:30</td><td>:45</td><td>:60</td></tr>
<tr><td>sum of base ~~Base Transfer~~ Schedules</td><td>1100</td><td>1100</td><td>1100</td><td>1100</td></tr>
<tr><td>15-minute ~~Load~~Demand Forecast</td><td>1050</td><td>1075</td><td>1125</td><td>1150</td></tr>
<tr><td>Imbalance Direction</td><td>Over</td><td>Over</td><td>Under</td><td>Under</td></tr>
<tr><td>Imbalance Amount</td><td>50</td><td>25</td><td>25</td><td>50</td></tr>
<tr><td>Bid Range Capacity (Up)</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
<tr><td>Bid Range Capacity (Down)</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
</table>
</td><td>
For this scenario, CMRI shall report the most-insufficient 15-minute interval results (in blue text) (using interval :30 results for the over direction, interval :60 results for the under direction). Only the intervals' trade hour will be identified in the report.
<table>
<tr><td>Description</td><td>:15</td><td>:30</td><td>:45</td><td>:60</td></tr>
<tr><td>Test Status (Over)</td><td>Pass</td><td>Pass</td><td>Pass</td><td>Pass</td></tr>
<tr><td>Insufficiency Direction (Over)</td><td>Over</td><td>Over</td><td>Over</td><td>Over</td></tr>
<tr><td>Insufficiency Percentage (%)</td><td>-50.0</td><td>-25.0</td><td>-125.0</td><td>-150.0</td></tr>
<tr><td>Insufficiency Amount (MW)</td><td>-50</td><td>-25</td><td>-125</td><td>-150</td></tr>
<tr><td>Test Status (Under)</td><td>Pass</td><td>Pass</td><td>Pass</td><td>Pass</td></tr>
<tr><td>Insufficiency Direction (Under)</td><td>Under</td><td>Under</td><td>Under</td><td>Under</td></tr>
<tr><td>Insufficiency Percentage (%)</td><td>-150.0</td><td>-125.0</td><td>-75.0</td><td>-50</td></tr>
<tr><td>Insufficiency Amount (MW)</td><td>-150</td><td>-125</td><td>-75</td><td>-50</td></tr>
</table>
Since none of the 15-minute intervals failed the BAA's capacity test, no EIM transfer limits will be reduced for any of the intervals within the trade hour in either the import or export direction.
</td></tr>
</table>

- **Flexible Ramping Sufficiency Test:** At T-75, T-55, and T-40 minutes ~~Prior~~ prior to ~~commencing~~ start of the next trading ~~each~~ hour, CAISO will independently evaluate flexible

ramping sufficiency test for each BAA within the EIM area ~~on a~~for each 15-minute interval ~~basis for the entire~~of that trading hour. ~~Each of the 15-minute interval will be applied to the three underlying 5-minute intervals. calculate a flexible ramping requirement.~~ The flexible ramping requirement is based ~~up~~on the historical error in the CAISO load forecast~~,~~ and the CAISO variable energy resource forecast.~~,~~ The test assesses whether there is ~~and CAISO's historical assessment of the ramping~~sufficient ramping capability among all resources in the BAA~~needed~~ to meet ~~forecast uncertainty and variability~~the forecasted demand change across intervals plus a high/low percentile of the historical uncertainty.

A 1% (one percent) tolerance band threshold or 1 MW (one MW) will be applied to the flexible ramping uncertainty requirement (both upward and downward) for a given 15-minute interval for each EIM BAA. Resulting amount (both upward and downward) is calculated as follows;

The $\max(\epsilon_r\ FRUR_i, \varepsilon_a)$ will be subtracted from $FRUR'$ for flexible ramping up

The $\max(\epsilon_r\ FRDR_i, \varepsilon_a)$ will be subtracted from $FRDR'$ for flexible ramping down

Where:

εr Flexible Ramping sufficiency test relative tolerance (%).

εa Flexible Ramping sufficiency test absolute tolerance (MW).

FRURi is the flexible ramp up uncertainty requirement for a given 15-minute interval in the next hour for EIM Entity i without diversity benefit;

FRDRi is the flexible ramp down uncertainty requirement for a given 15-minute interval in the next hour for EIM Entity i without diversity benefit (negative);

FRUR'i is the cumulative flexible ramp up requirement from the last 15-minute interval of the current hour to a given 15-minute interval in the next hour for EIM Entity i; it includes the effects of EIM diversity benefit and credit; and

FRDR'i is the cumulative flexible ramp down requirement from the last 15-minute interval of the current hour to a given 15-minute interval in the next hour for EIM Entity i; it includes the effects of EIM diversity benefit and credit.

For each BAA in the EIM Area that fails ~~either~~ its Flexible Ramping Up or Flexible Ramping Down sufficiency test for a 15-minute interval in the next trading~~e~~ hour, the market shall limit the net EIM transfer from below (import) for upward failure and from above (export) for downward failure, to the less-restrictive of the following values:

- Base Transfer Schedule for the failed 15-minute interval; or
- Net EIM transfer schedule for the interval prior to the failed 15-minute interval as provided by the last successful FMM market run (i.e. the "last previous" 15-minute interval)

In addition, the following rules will be applied to the 15-minute interval sufficiency test;

- For the sufficiency test at T-75, RUC schedule is used for assessing CISO BAA. For the sufficiency test performed at T-55 and T-40, the latest FMM results are used for assessing CISO BAA.
- The same EIM transfer limit applied to the failed 15-minute interval shall also apply to its three corresponding 5-minute market intervals
- The last previous 15-minute interval will be the last 15-minute interval of the current hour if the 15-minute interval that fails the FRU/FRD test is the first 15-minute interval of the next hour
- Likewise, the same is true if the 15-min interval that fails the FRU/FRD test is the second, third, or fourth 15-minute interval in the second hour of the HASP time horizon for which there is no previous solution for the immediately prior 15-minute interval
- If a FMM run, other than HASP, fails, the EIM Transfer schedules from the last FMM run that has succeeded shall be used to derive the EIM Transfer limits for the 15-minute intervals that fail the FRU/FRD test
- If HASP or all prior FMM runs fail, the base EIM Transfer will be used.

~~An EIM balancing authority will have insufficient flexible ramping capacity if the ramping capability of EIM Participating Resources with submitted energy bids cannot meet the EIM balancing authority's upward or downward flexible ramping requirement. If the upward flexible ramping requirement is not met, the EIM Transfer during the next hour is bound from below at the lower of the base transfer for the current hour or the optimal transfer at the last 15min interval of the current hour. Additionally, in the flexible ramp capacity constraints during the next hour, that BAA must meet its own upward flexible ramp capacity requirements without diversity benefit, but reduced by any credit due to outgoing EIM transfers. If the downward flexible ramping requirement is not met, the EIM Transfer during the next hour is bound from above at the higher of the base transfer for the current hour or the optimal transfer at the last 15min interval of the current hour. Additionally, in the flexible ramp capacity constraints during the next hour, that BAA must meet its own downward flexible ramp capacity requirements without diversity benefit, but reduced by any credit due to incoming EIM transfers. The Flexible Ramping Sufficiency Test is applicable to CAISO BAA.~~

~~The capacity test and flexible ramping test is applied to the CAISO BAA at T–75 using RUC schedules and at T–55 and T-40 using HAS schedules. The test will ensure there is sufficient ramping capability within the CAISO to meet 15-minute net load changes following the HASP.~~

Examples:

This example shows how the EIM transfer limit will be curtailed for the 15-minute intervals and associated 5-minute intervals with failed FRU/FRD sufficiency test.

Market Run			15-min Interval				
Market	Run Time	Result	0 (*T*–7.5')	1 (*T*+7.5')	2 (*T*+22.5')	3 (*T*+37.5')	4 (*T*+52.5')
FMM	*T*–82.5'	EIM Transfer (MW)	–200				
RTBS	*T*–75'	Base Transfer (MW)		–300	–300	–300	–300
		FRU Test		Pass	Pass	Fail	Fail
FMM	*T*–67.5'	Transfer Limit (MW)				–300	–300
		EIM Transfer (MW)		–400	–320	–210	–300
RTBS	*T*–55'	Base Transfer (MW)		–100	–100	–100	–100
		FRU Test		Fail	Pass	Fail	Fail
FMM	*T*–52.5'	Transfer Limit (MW)		–200		–320	–210
		EIM Transfer (MW)		–200	–270	–180	–210
RTBS	*T*–40'	Base Transfer (MW)		–250	–250	–250	
		FRU Test		Fail	Pass	Fail	Fail
FMM	*T*–37.5'	Transfer Limit (MW)		–250		–270	–250
		EIM Transfer (MW)		–230	–350	–270	–250
FMM	*T*–22.5'	Transfer Limit (MW)		–250		–350	–270
		EIM Transfer (MW)		–240	–330	–300	–270
FMM	*T*–7.5'	Transfer Limit (MW)				–330	–300
		EIM Transfer (MW)			–280	–330	–300
FMM	*T*+7.5'	Transfer Limit (MW)				–280	–330
		EIM Transfer (MW)				–260	–330
FMM	*T*+22.5'	Transfer Limit (MW)					–260
		EIM Transfer (MW)					–260

11.3.2.1 Flexible Ramp Sufficiency Test Details

The individual EIM Entity BAA requirement for the flexible ramp sufficiency test will be calculated for the next hour (using algebraic notation) as follows:

$$FRUR'_i = \Delta D_i + \max\left(FRUR_i - NIC_i, FRUR_i \frac{FRUR}{TFRUR} - FRUC_i\right)$$

$$FRDR'_i = \Delta D_i + \min\left(FRDR_i + NEC_i, FRDR_i \frac{FRDR}{TFRDR} - FRDC_i \right)$$

Where:

i is the BAA index in the EIM Area;

$FRUR_i$ is the flexible ramp up uncertainty requirement for a given 15-minute interval in the next hour for EIM Entity *i* without diversity benefit;

$FRDR_i$ is the flexible ramp down uncertainty requirement for a given 15-minute interval in the next hour for EIM Entity *i* without diversity benefit (negative);

$FRUR'_i$ is the cumulative flexible ramp up requirement from the last 15-minute interval of the current hour to a given 15-minute interval in the next hour for EIM Entity *i*; it includes the effects of EIM diversity benefit and credit;

$FRDR'_i$ is the cumulative flexible ramp down requirement from the last 15-minute interval of the current hour to a given 15-minute interval in the next hour for EIM Entity *i*; it includes the effects of EIM diversity benefit and credit;

ΔD_i is the change in the demand forecast from the last 15-minute interval of the current hour to a given 15-minute interval in the next hour for EIM Entity *i*;

NIC_i is the available net import transfer capability of EIM Entity *i* at the last 15-minute interval of the current hour (negative);

NEC_i is the available net export transfer capability of EIM Entity *i* at the last 15-minute interval of the current hour (positive);

FRUR is the flexible ramp up uncertainty requirement for a given 15-minute interval in the next hour for the entire EIM Area;

FRDR is the flexible ramp down uncertainty requirement for a given 15-minute interval in the next hour for the entire EIM Area (negative);

TFRUR is the sum of the flexible ramp up uncertainty requirements of all BAAs in the EIM Area for a given 15-minute interval in the next hour;

TFRDR is the sum of the flexible ramp down uncertainty requirements of all BAAs in the EIM Area for a given 15-minute interval in the next hour (negative);

$FRUC_i$ is the flexible ramp up credit for a given 15-minute interval in the next hour for EIM Entity *i*, equal to the net EIM export transfer at the last 15-minute interval of the current hour; and

$FRDC_i$ is the flexible ramp down credit for a given 15-minute interval in the next hour for EIM Entity *i*, equal to the net EIM import transfer at the last 15-minute interval of the current hour (negative).

This requirement reflects a pro rata share of potential EIM Diversity Benefit and the flexible ramping credit, up to the available net import/export transfer capability. The EIM Diversity Benefit is the difference between the sum of the individual flexible ramping requirements of each BAA in the EIM Area and the flexible ramping requirement for the entire EIM Area taken as a whole.

The CAISO will perform a series of flexible ramping constraint sufficiency tests prior to each hour. The EIM Entity Scheduling Coordinator will have an opportunity to re-submit Base Schedules if it fails the flexible ramping constraint sufficiency test or to resolve congestion up to 40 minutes prior to the operating hour, which is just before the start of the first financially binding EIM 15-minute market for the operating hour. Thresholds are developed by the CAISO to cap the flexible ramp up and down uncertainty requirements to within historical bounds.

The flexible ramp sufficiency test is performed for each EIM Entity BAA after T-75', T-55', and T-40' for the trading hour starting at T. The test uses the initial schedules at T-7.5', variable energy resource (VER) forecast, EIM resources energy bids, ramp rates, manual dispatch constraints and operational de-rates. Since the VER forecast information is updated every five minutes, it is possible that VER forecast may change between the three flex ramp sufficiency tests. The VER forecast information is held fixed at the T-55', and T-40' such that the updated VER forecast information at T-55 is used for the T-40 flex ramp sufficiency test.

The test for meeting flexible ramp requirements is cumulative for each 15' interval of the hour. More specifically, for each interval, the flexible ramp requirement is the sum of the demand forecast change from T-7.5' to the relevant interval plus the flexible ramp uncertainty requirement for that interval. Since the load forecast information may be updated between the three flex ramp sufficiency test, load forecast information used to calculate the net load movement is held fixed at the T-55', and T-40' such

that the updated load forecast information at T-55 is used for the T-40 flex ramp sufficiency test. The net requirement for the flex ramp sufficiency test includes the effects of EIM diversity and credit, and it is calculated as:

- 15' ramp from T−7.5' to T+7.5' (1st 15' interval)
- 30' ramp from T−7.5' to T+22.5' (2nd 15' interval)
- 45' ramp from T−7.5' to T+37.5' (3rd 15' interval)
- 60' ramp from T−7.5' to T+52.5' (4th 15' interval)

The test passes if all four cumulative tests pass; the test fails if any of the four cumulative tests fail.

In Fifteen Minute Market and RTD, the flexible ramping capacity requirement constraints for the CAISO BAA, each EIM Entity BAA, and the total EIM footprint must be enforced:

- If the EIM Entity BAA fails the flexible ramp up sufficiency test or is deemed to have failed the test as specified in Section 10.3.2 because it failed the capacity (resource plan) test, the EIM Transfer during the next hour will be bounded from below at the lower of the base transfer for current hour or the optimal transfer at the last fifteen-minute interval of the current hour. Furthermore, the CAISO will enforce the individual EIM Entity BAA flexible ramp up uncertainty requirement in the EIM Entity BAA without diversity benefit, but the credit shall apply. If the EIM Entity BAA passes the flexible ramp up sufficiency test, the flexible ramp up uncertainty requirement without diversity benefit shall be reduced by the available net import transfer capability. The CAISO will enforce the constraint for each EIM Entity BAA, the CAISO BAA, and the total flexible ramp up uncertainty requirement for the EIM Area.
- If the EIM Entity BAA fails the flexible ramp down sufficiency test or is deemed to have failed the test as specified in Section 10.3.2 because it failed the capacity (resource plan) test, the EIM Transfer during the next hour will be bounded from above at the higher of the base transfer for current hour or the optimal transfer at the last fifteen-minute interval of the current hour. Furthermore, the CAISO will enforce the individual EIM Entity BAA flexible ramp down uncertainty requirement in the EIM Entity BAA without diversity benefit, but the credit shall apply. If the EIM Entity BAA passes the flexible ramp down sufficiency test, the flexible ramp down uncertainty requirement without diversity benefit shall be reduced by the available net export transfer capability. The CAISO will enforce the constraint for each EIM Entity BAA, the CAISO BAA, and the total flexible ramp down uncertainty requirement for the EIM Area.
- The market model will map the corresponding resources that can provide the flexible ramping capacity for the EIM Entity BAA.

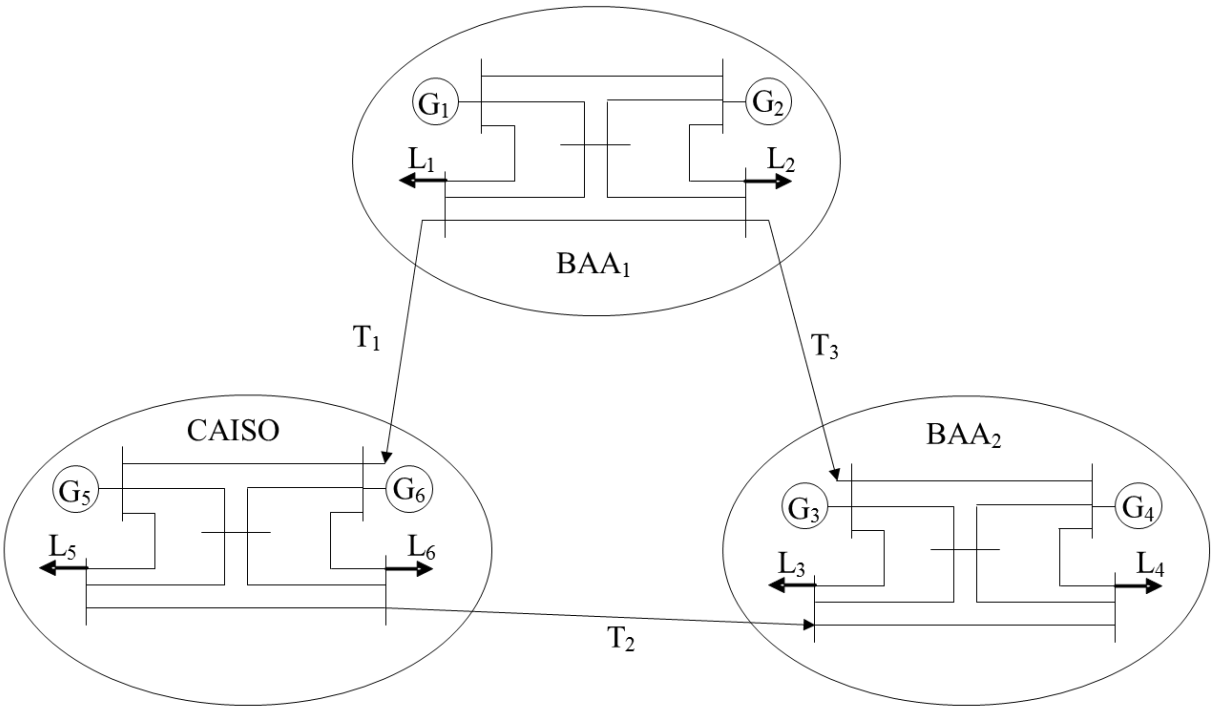
- The flexible ramp requirements for total EIM footprint can be potentially lower than the sum of individual requirements of each BAA, reflecting the benefits of reduced uncertainty and volatility across the BAAs.
- For a period of six months following the Implementation Date of a new EIM Entity, the CAISO shall set the Flexible Ramping Constraint parameter specified in Section 27.10, for pricing purposes, for the new EIM Entity Balancing Authority Area, at an amount between and including $0 and $0.01 only for when the transmission or power balance constraints are relaxed in the corresponding new EIM Entity Balancing Authority Area.
- CAISO will broadcast the resource flexible ramping awards to the relevant SCs.
- CAISO will publish the shadow prices of each flexible ramping constraint and associated BAA, and total EIM footprint. The flexible ramping capacity shall be managed in corresponding RTD for EIM market in the same manner as the current CAISO RTM. The RTD shall enforce the flexible ramping capacity requirement constraints. The requirement of each five-minute interval in the RTD run horizon will be preserved according to the pre-defined attenuation percentage of each interval, currently as 0%, 25%, 50%, 75%, 100%, 100%... The same percentage will apply to the effective requirement (reduced by the available net import capacity) for each EIM Entity BAA and EIM footprint constraints.

Example Assumptions

- CAISO BAA and two EIM Entity BAAs
- All interties rated at 10MW
- Two generators and two loads in each BAA
- Zero base schedules; no transmission losses
- Real−Time Unit Commitment run at *T*−37.5'
- Only upward flexible ramp capacity
- Flexible ramp capacity requirement determined by demand forecast change and historical assessment of ramping capability to meet forecast uncertainty

Example

15' Schedules at $T-7.5'$					
BAA_1		BAA_2		CAISO	
G_1	60	G_3	10	G_5	100
G_2	50	G_4	80	G_6	100
L_1	40	L_3	30	L_5	100
L_2	60	L_4	70	L_6	100
NSI_1	+10	NSI_2	−10	NSI_0	0
T_1	4	T_2	4	T_3	6



Available Flexible Ramp Capacity

BAA	Resource	Initial Schedule	UEL	Ramp Rate	15' FRC	30' FRC	45' FRC	60' FRC
BAA_1	G_1	60	100	1	15	30	40	40
	G_2	50	100	1	15	30	45	50
	Total	110	200		30	60	85	90
BAA_2	G_3	10	100	1	15	30	45	60
	G_4	80	100	1	15	20	20	20
	Total	90	200		30	50	65	80

Case 1: Flexible Ramp Sufficiency Test Pass

BAA		T-7.5'	T+7.5'	T+22.5'	T+37.5'	T+52.5'
CAISO	Total CAISO load	200	220	210	200	190
	Cumulative flexible ramp requirement		20	10	0	0
BAA1	L1 + L2	100	120	140	160	180
	Ramp need for forecast uncertainty		15	10	15	20
	EIM diversity benefit		0	0	0	-15
	Flexible ramp requirement credit		-10	-10	-10	-10
	Cumulative flexible ramp requirement		25	40	65	75
	Cumulative flexible ramp capacity		30	60	85	90
	Flexible ramp sufficiency test outcome		✓	✓	✓	✓
BAA2	L3 + L4	100	120	140	160	180
	Ramp need for forecast uncertainty		10	5	5	10
	EIM diversity benefit		0	0	0	-15
	Cumulative flexible ramp requirement		30	45	65	75
	Cumulative flexible ramp capacity		30	50	65	80
	Flexible ramp sufficiency test outcome		✓	✓	✓	✓
EIM	Total EIM load	400	460	490	520	550
	Cumulative flexible ramp requirement		85	105	140	130
	Sum of BAA flexible ramp requirement		85	105	140	160

Case 1: Flexible Ramp Capacity Constraints

For *T*+7.5'

- $FRC_0 \geq \max(0, FRR_0 - 20) = 0$
- $FRC_1 \geq \max(0, FRR_1 - 30) = 0$
- $FRC_2 \geq \max(0, FRR_2 - 10) = 20$
- $FRC_0 + FRC_1 + FRC_2 \geq FRR_{0,1,2} = 85$

Case 2: Flexible Ramp Sufficiency Test Fail

BAA		T-7.5'	T+7.5'	T+22.5'	T+37.5'	T+52.5'
CAISO	Total CAISO load	200	220	210	200	190
	Cumulative flexible ramp requirement		20	10	0	0
BAA1	L1 + L2	100	120	140	160	180
	Ramp need for forecast uncertainty		15	10	15	20
	EIM diversity benefit		0	0	0	-15
	Flexible ramp requirement credit		-10	-10	-10	-10
	Cumulative flexible ramp requirement		25	40	65	75
	Cumulative flexible ramp capacity		30	60	85	90
	Flexible ramp sufficiency test outcome		✓	✓	✓	✓
BAA2	L3 + L4	100	120	150	170	180
	Ramp need for forecast uncertainty		10	5	5	10
	EIM diversity benefit		0	0	0	-15
	Cumulative flexible ramp requirement		30	55	75	75
	Cumulative flexible ramp capacity		30	50	65	80
	Flexible ramp sufficiency test outcome		✓	×	×	✓
EIM	Total EIM load	400	460	490	520	550
	Cumulative flexible ramp requirement		85	115	150	130
	Sum of BAA flexible ramp requirement		85	115	150	160

Case 2: Flexible Ramp Capacity Constraints

For *T*+7.5'

- $FRC_0 \geq \max(0, FRR_0 - 20) = 0$
- $FRC_1 \geq \max(0, FRR_1 - 30) = 0$
- $FRC_2 \geq FRR_2 = 30$
- $NSI_2 \geq -10$
- $FRC_0 + FRC_1 + FRC_2 \geq FRR_{0,1,2} = 85$

11.3.2.2 Import/Export Hourly Block Schedule Difference Calculation

The CAISO will calculate and publish, for each EIM Entity BAA, the absolute and the relative hourly net inter-tie scheduling error of imports and exports whose final tagged schedules differ from either the EIM base schedule or, in the case of the CAISO BAA, the CAISO hourly schedules. The CAISO calculates two

histograms: one based on absolute hourly scheduling deviation and another based on relative hourly scheduling deviation. The hourly scheduling deviations over each month between the 15th day of the third prior month and the 15th day of the current month.

If an EIM Entity BAA has historical deviations in the net import/export schedule changes between T-40 and T-20, the CAISO will add an additional capacity requirement to the capacity test. This ensures that the bid range from EIM Participating Resources cover the difference between net EIM Base Schedules and the Demand Forecast for the Operating Hour, including the historical intertie over/under-scheduling within a 95% confidence interval .

In the event the historical net import/export calculation produces anomalous results, the CAISO will set the low histogram percentile, high histogram percentile, low absolute histogram percentile and high absolute histogram percentile described below to zero temporarily while it investigates the cause of the anomalous results.

The CAISO will calculate the histograms and the additional capacity requirement as follows:

- The CAISO will net imports and exports against each other in each Operating Hour.
- If net-tagged imports are greater than net imports in the EIM Base Schedules, the CAISO will add to the affected BAA in the EIM an additional downward capacity requirement. If net-tagged imports are less than net imports included in the EIM Base Schedules, the CAISO will add to the affected BAA in the EIM an additional upward capacity requirement.
- If net-tagged exports are greater than net exports included in the EIM Base Schedules, the CAISO will add to the affected BAA in the EIM an additional upward capacity requirement. If net-tagged exports are less than net exports included in EIM Base Schedules, the CAISO will add to the affected BAA in the EIM an additional downward capacity requirement.
- The CAISO will include only data for hourly Scheduled imports and exports and base EIM Transfers in the histogram. The following schedules will be excluded from the histogram: 15-minute intertie schedules, dynamic inter-tie schedules, and pseudo-ties.
- The CAISO will exclude any outlier data from the histogram calculations.
- Three months of production data is required to calculate the histogram. So, for all new EIM entities, the histogram percentiles will be set to zero until this information is available.

The CAISO will calculate the data samples for the absolute and relative histogram for the net hourly inter-tie schedules deviation between imports and exports scheduled at T-40 (net base inter-tie schedules) and the final tagged net imports at T-20 (net actual hourly inter-tie schedule) as:

Data sample for relative deviation: (net actual hourly inter-tie schedule – net base inter-tie schedule) / net base inter-tie schedule

Data sample for absolute deviation: net actual hourly intertie schedule – net base intertie schedule.

The CAISO will provide each EIM Entity the low- and high-end cutoff percentiles for both the absolute and the relative net inter-tie schedule deviation histograms (2.5% and 97.5%, configurable from each histogram). If either the high-end cutoff percentile or the high-end cutoff absolute value based on the histogram data is below zero, then it will be set to 0. Similarly, if either the low cutoff percentile or the low cutoff absolute value based on the histogram data is above zero, then they will be set to 0.

The CAISO will perform a bid range capacity test every hour. The CAISO will add additional incremental capacity requirements to the upward capacity test or additional decremental capacity requirements to the downward capacity test depending on the results of the balancing test results. If the sum of EIM Base Schedules from generation and intertie resources in an EIM Resource Plan is above the EIM Entity BAA load forecast, then an additional downward requirement is added to the capacity test. On the other hand, if the sum of EIM Base Schedules from generation and intertie resources in an EIM Resource Plan is below the EIM Entity BAA load forecast, then an additional upward requirement is added to the capacity test. The CAISO will calculate these additional requirements as follows:

The CAISO calculates additional upward capacity requirement using data from both the absolute and relative histograms. First, consider a scenario with net imports for a trade hour. In this case, the application considers the minimum of the highest expectation of the net import or the minimum of the absolute difference in net imports for the past 90 days. Second, consider a scenario with net exports for the hour under consideration. In this case, the application considers the minimum of the highest expectation of the net export or the minimum of the absolute difference in net imports for the past 90 days. The calculations for both these scenarios are captured in the equation below.
For Net Import:
Additional upward capacity requirement = min(–1*relative low percentile * net base intertie schedule, –absolute low percentile)
For Net Export:
Additional upward capacity requirement = min(–1*relative high percentile * net base intertie schedule, absolute high percentile)

-Similarly, the ISO calculates the additional downward capacity requirements in case of overscheduling using the equation captured below.

For net import:

Additional downward capacity requirement = max(–1*relative high percentile * net base intertie schedule, –absolute high percentile)

For net export:

Additional downward capacity requirement = max(–1*relative low percentile * net base intertie schedule, absolute low percentile)

11.3.3 Locational Marginal Prices

The CAISO Markets, including the EIM, are based on using a Full Network Model coupled with locational marginal pricing. This coupling is meant to ensure that the Locational Marginal Prices (LMPs) reflect both the physical system as well as the schedules produced by the market applications. A detailed explanation for how the LMPs are derived is contained in Section 3.2 of the **BPM for Market Operations**.

11.3.3.1 Accounting for Greenhouse Gas Regulation

Imports of energy into CAISO and generation of energy within CAISO from greenhouse gas emitting resources are subject to the California Cap on Greenhouse Gas Emissions regulated by the California Air Resources Board (CARB). According to CARB rules, energy generated outside of California that is not imported into California is not subject to this regulation.

The EIM design accounts for this regulation through the following:

- For generation within an EIM balancing authority, the cost of the greenhouse gas compliance obligation will be included in dispatching energy from resources located outside of the CAISO BAA that serve CAISO load as determined by the EIM market optimization, but will otherwise be excluded. Thus, for resources located outside CAISO that do not serve CAISO load under the EIM market optimization, the cost of the greenhouse gas compliance obligation will be excluded from dispatching energy from these resources.
- The energy produced by each generator within an EIM balancing authority that serves CAISO load will be calculated by CAISO. Through a market results interface, CAISO will provide EIM Participating Resource Scheduling Coordinators with summary reports listing the amounts of energy exported to CA as determined by the EIM market optimization, which will be the basis of their greenhouse gas regulation compliance obligation with the California Air Resources Board (CARB).
- EIM Participating Resource Scheduling Coordinators can include the costs of their greenhouse gas regulation compliance obligation as an adder to their energy bids.

The EIM has been designed so that the greenhouse gas compliance costs will not affect the locational marginal price in an EIM balancing authority area. Rather, the market optimization will calculate the marginal cost difference between EIM generation serving load in CAISO and serving load outside of CAISO. This difference will be the marginal greenhouse gas regulation compliance cost and will be the

rate CAISO will use to calculate a payment to each generator in an EIM balancing authority for its output that served CAISO imbalances. This payment will be funded through the price paid within CAISO for imbalance energy. CAISO will publish the marginal GHG compliance price.

11.3.3.2 Greenhouse Gas Methodology

The following methodology describes the real time optimal dispatch that accounts for the greenhouse gas allowance costs of resources in EIM Entity BAAs outside California:

- The net imbalance energy export from all EIM Entity BAAs outside California, exclusive of import/export imbalance energy schedules to non-EIM BAAs, is imbalance energy imported into the CAISO BAA and EIM Entity BAAs inside California. This energy would be allocated optimally to supply resources in the EIM Entity BAAs outside California.
- The net imbalance energy export allocation to supply resources in EIM Entity BAAs outside California does not depend on the location of these resources; no shift factors are used in this allocation. The rationale is that this allocation is an accounting problem, which is irrelevant to the actual flow of energy on the network; in other words, supply resources in EIM Entity BAAs outside California are only differentiated in terms of their respective energy and emission costs, as reflected by a greenhouse gas (GHG) bid adder, and not in terms of their physical location.
- On an hourly basis by T-75, the EIM participating resource SC in an EIM Entity BAA outside California may submit a single GHG bid capacity (MW) quantity and single GHG bid price ($/MWh) expressing its willingness for its energy to be deemed delivered to the CAISO BAA and EIM Entity BAAs inside California. The MW quantity is independent of the submitted energy bid curve.
- The GHG allocation will be limited by the GHG bid capacity, the optimal dispatch, and the difference between the upper economic limit (UEL) and the base schedule:

  GHG MW = max(0, min(GHG Bid , UEL - Base Schedule, Optimal Dispatch))

  for all EIM participating resources in EIM Entity BAAs outside California that submit a GHG bid.

  The UEL is the top of the energy bid after accounting for applicable derates and capacity reservation for upward ancillary services (regulation up, and spinning and non-spinning reserves).
- EIM participating resource can, through its GHG bid, accomplish the objective of not being considered for EIM transfers into the CAISO BAA and EIM Entity BAAs inside California by bidding zero GHG MW. In addition, the CAISO will set the default value of the MW bid to zero. If an EIM participating resource SC, does not submit a GHG bid, it will not be considered for EIM transfer into the CAISO BAA and EIM Entity BAAs inside California because the GHG MW quantity will be set to zero.

- Each EIM Participating Resource in an EIM Entity BAA outside California may submit a greenhouse gas bid adder that reflects the cost of procuring GHG allowances required by CARB for energy imports to California. This cost is added to the objective function for an efficient cost-effective imbalance energy dispatch.
- The CAISO will use a process similar to establishing the GHG cost adder included in the default energy bids of CAISO resources to determine EIM Greenhouse Gas Maximum Cost. This includes a variable cost option and a negotiated rate option. The negotiated rate option may be used for new participating resources that do not have an emission rate used by the CARB in assessing GHG compliance obligations. However, rather than calculating a GHG cost curve, the CAISO will calculate a single daily value based upon the maximum heat rate of the EIM participating resource.
- Under the variable cost option, on a daily basis, the CAISO will calculate a single EIM GHG maximum cost. The CAISO proposes to calculate each unit's greenhouse gas emissions maximum cost based on the unit's heat rate characteristics, as registered with the CAISO, the applicable GHG allowance price, and using the resource's emission rate. The standard GHG emission rate is documented in the US EPA Subpart C4 default emission factors. For example, the standard GHG emission rate for natural gas calculated under US EPA is 0.053072 mtCO2e/mmBTU. Similar to the default energy bids of CAISO resources, there will be a 10% adder to the calculated cost.
- An EIM participating resource SC must submit a GHG bid price equal to or less than its GHG maximum cost, but not less than zero. If an EIM participating resource SC submits a GHG bid price above the GHG maximum cost of the EIM participating resource, the GHG bid price will be set to the calculated GHG maximum cost. If a resource submits a MW quantity, but fails to submit a GHG bid price, the default will be the calculated GHG maximum cost.
- If an EIM entity for an EIM Entity BAA outside California allows economic participation in the FMM by imports on EIM external interties, the imports may also submit an hourly GHG MW quantity and bid price. If the import is registered as a resource specific resource, the GHG emissions rate authorized by CARB for the specific resource will be used in the calculation of the maximum GHG cost. If the import is registered as a system resource, the carbon dioxide equivalent emission rate of the resource with the highest such rate in the WECC region and the applicable Greenhouse Gas Allowance Price Index will be used in the calculation of the maximum GHG cost.
- An EIM participating resource SC may negotiate an alternative GHG maximum cost through the negotiated rate option procedures described in tariff section 39.7.1.3.1. An SC wishing to negotiate a GHG maximum cost may contact the CAISO by submitting a written request to ndeb@caiso.com.
- If the net imbalance energy export from all EIM Entity BAAs outside California as a group is negative or zero, there is no associated net imbalance energy export allocation or greenhouse

gas allowance cost. Otherwise the net imbalance energy export allocation constraint is binding and it may have a nonzero shadow price.

- Greenhouse gas allowance costs are reflected through the net imbalance energy export allocation shadow prices in the Locational Marginal Prices (LMPs) in the EIM Entity BAAs outside California through a fourth component that is the same for all locations in these EIM Entity BAAs. This LMP component can be seen as an adder to the marginal energy component that reflects the marginal cost of greenhouse gas allowance credits in EIM Entity BAAs. This LMP component is absent for locations in the CAISO BAA and EIM Entity BAAs inside California, because in these cases the cost of greenhouse gas allowance credits is included in the energy bids; hence it is already reflected in the marginal energy component.
- The absence of the fourth LMP component for locations in the CAISO BAA and EIM Entity BAAs inside California results in no impact on existing Market Participants that would not have to modify their systems.
- As a result of the imbalance energy settlement, the CAISO will collect greenhouse gas allowance revenue for the net imbalance energy export from the EIM Entity BAAs outside California at the respective net imbalance energy export allocation constraint shadow price, similarly to the congestion revenue. Distributing this revenue back to the optimal net imbalance energy export allocations in addition to the imbalance energy settlement at the LMP would adequately compensate supply resources in EIM Entity BAAs outside California for their energy and greenhouse gas allowance costs without a need for any side payments and uplift.
- This methodology is very general and robust and it does not depend on the particular network configuration or how the various BAAs are interconnected. Therefore, it is readily expandable to any number of BAAs in the Full Network Model (FNM) with any number of EIM Entity BAAs and any BAA interconnection pattern.

11.3.3.2.1 Mathematical Formulation

To illustrate the method, consider a simple network configuration that consists only of the CAISO and a single EIM Entity BAA. Furthermore, day-ahead and base schedules are ignored for simplicity, as well as ancillary services, transmission losses, and inter-temporal constraints, focusing on a single time period.

Notation

The following notation is used to formulate the problem:

i Node index in CAISO.

j Node index in EIM Entity BAA.

k Oriented transmission line index.

$\forall$ For all…

G_i Imbalance energy dispatch for generator at node *i*.

$G_{\mathrm{MIN}i}$ Minimum capacity for generator at node *i*.

$G_{\mathrm{MAX}i}$ Maximum capacity for generator at node *i*.

L_i Distributed load forecast at node *i*.

C_i Incremental energy bid for generator at node *i*.

C_{Gj} GHG bid adder for generator at node *j*.

$S_{i,k}$ Shift Factor of power injection at node *i* on transmission line *k*.

F_k Active power flow on transmission line *k*.

$F_{\mathrm{MAX}k}$ Active power flow limit on transmission line *k*.

E Net imbalance energy export from EIM Entity BAA.

E_S Net imbalance energy export surplus (cannot be allocated).

E_j Net imbalance energy export from EIM Entity BAA allocated to generator *j*.

$E_{\mathrm{MAX}j}$ GHG quantity bid for generator at node *j*.

LMP_i Locational Marginal Price at node *i*.

λ Shadow price of power balance constraint.

μ_k Shadow price of active power flow limit constraint on transmission line *k*.

η Shadow price of net imbalance energy export allocation constraint.

R_G Greenhouse gas allowance revenue.

R_{Gj} Greenhouse gas allowance revenue distribution to generator at node *j*.

M Penalty cost for net imbalance energy export surplus (E_S).

ε A small tolerance.

Optimization Problem

The mathematical formulation is as follows:

$$\min\left(\sum_i C_i\, G_i + \sum_j \left(C_j\, G_j + C_{Gj}\, E_j\right)\right)$$

subject to:

power balance: $\sum_i (G_i - L_i) + \sum_j \left(G_j - L_j\right) = 0$

transmission line flow: $F_k \equiv \sum_i S_{i,k}\,(G_i - L_i) + \sum_j S_{j,k}\,\left(G_j - L_j\right) \le F_{\mathrm{MAX}k}, \forall k$

net export allocation: $E \equiv \sum_j \left(G_j - L_j\right) \le \sum_j E_j$

generator limits: $G_{\mathrm{MIN}i} \le G_i \le G_{\mathrm{MAX}i}, \forall i$
$G_{\mathrm{MIN}j} \le G_j \le G_{\mathrm{MAX}j}, \forall j$

allocation limits: $0 \le E_j \le \min\left(G_j, E_{\mathrm{MAX}j}\right), \forall j$

When the net export *E* is zero or negative (import), the net export allocation constraint is not binding and all allocations E_j are zero.

The LMPs are determined as follows:

$$LMP_i = \lambda + \sum_i S_{i,k}\,\mu_k\,, \forall i$$

$$LMP_j = \lambda + \sum_j S_{j,k}\,\mu_k + \eta, \forall j$$

Where the marginal loss component is missing because transmission losses are ignored.

The greenhouse gas allowance revenue is calculated as follows:

$$R_G = -\eta\, E$$

This revenue is then distributed to the optimal net imbalance energy export allocations as follows:

$$R_{Gj} = -\eta\, E_j$$

11.3.3.2.2 Implementation Details

With non-EIM BAAs in the FNM, the net export allocation *E* in the formulation of §11.3.3.2.1 is the net EIM Transfer from all EIM BAAs, i.e., the opposite of the EIM Transfer for the CAISO BAA. When it is negative, i.e., an import to the EIM BAAs from the CAISO BAA, the net export allocation constraint is irrelevant (not binding) and its shadow price is zero. When it is positive, i.e., an export from the EIM BAAs to the CAISO BAA, the net export allocation constraint is binding and its shadow price may be nonzero. In the latter case, the positive EIM Transfer from all EIM BAAs must be allocated to EIM Participating Resources. There should be no allocation to EIM Non-Participating Resources because these resources do not bid in the EIM, thus they do not submit a GHG compliance bid.

Specifically, in RTUC, since the net base EIM Transfer from all EIM BAAs is zero, the positive 15-minute net EIM Transfer must be allocated to the 15-minute schedule of EIM Participating Resources. This allocation considers the entire 15-minute schedule and not only the incremental portion above the base schedule. This is because the energy from these resources is used for meeting imbalance energy requirements in the EIM BAAs as well as supplying energy exports to the CAISO BAA. Therefore, it can be argued that these resources could potentially be decremented below their base schedule absorbing negative imbalance energy to meet imbalance energy requirements in the EIM BAAs, while producing positive imbalance energy to supply exports to the CAISO BAAs. Hence, it is conceivable that the imbalance energy export allocation quantity that receives GHG compliance revenue at the 15-minute marginal GHG compliance price could exceed the 15-minute incremental imbalance energy that receives a 15-minute imbalance energy settlement, both on an EIM Participating Resource level, and overall.

In RTD, the mathematical formulation is no different than in RTUC: the positive 5-minute net EIM Transfer must be allocated to the 5-minute dispatch of EIM Participating Resources. Similarly, to the RTUC allocation, the 5-minute allocation considers the entire 5-minute dispatch and not only the incremental portion above the 15-minute schedule or the base schedule. However, the settlement for the 5-minute GHG compliance revenue at the 5-minute marginal GHG compliance price is for the algebraic deviation of the imbalance energy export allocation between the 5-minute and the 15-minute quantities. If the 5-minute allocation is lower than the 15-minute allocation, the participant will buy back the difference at the 5-minute marginal GHG compliance price. Nevertheless, since the imbalance energy export allocation is optimally determined in both RTUC and RTD based on the GHG compliance

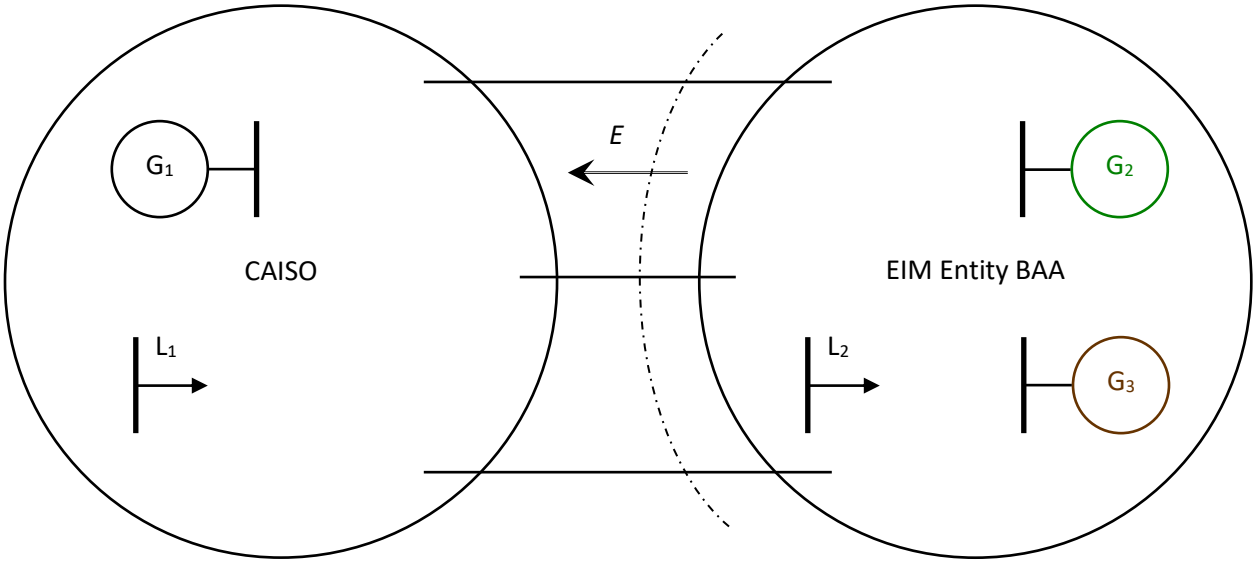
bids, the net settlement will not result in a financial loss. The participant will be required to report to CARB only the 5-minute imbalance energy export allocations from RTD, for which they may need to acquire emission credits.

11.3.3.2.3 Examples

The following examples show the application of this method:

Example 1

One generator and a load are in the CAISO, and two generators and a load are in the EIM Entity BAA, as shown in the figure below.



The power transfer (*E*) between the BAAs is limited to 100MW. The resource data is as follows:

Load	Forecast (MW)
L_1	200
L_2	50

Generator	Minimum (MW)	Maximum (MW)	Energy Bid ($/MWh)	GHG Compliance Bid Adder ($/MWh)
G_1	0	300	50	-
G_2	0	200	35	0
G_3	0	200	30	6

Generator G_2 is a non-emitting resource with a GHG compliance bid adder of zero, whereas G_3 is an emitting resource with a GHG compliance bid adder of $6.00. They are both less expensive than G_1. Therefore, the power export from the EIM Entity BAA to the CAISO is binding at the optimal solution at 100MW. The optimal dispatch and export allocation are as follows:

Resource	Dispatch (MW)	Export Allocation (MW)	LMP ($/MWh)
G1	100	-	50
G2	100	100	30
G3	50	0	30
L1	200	-	50
L2	50	-	30

Example 1: μ = –$15/MWh; η = –$5/MWh

Generator G_3 is the least expensive resource for serving Load L_2, and as such it sets the LMP in the EIM Entity Area to $30/MWh. However, for serving Load L_1, a $6/MWh additional GHG compliance cost would be incurred to G_3, making G_2 more effective for that purpose. Consequently, G_2 is dispatched with its energy all exported to the CAISO at the limit of the power transfer capability. The balance of 100MW of L_1 can only be served by G_1, which sets the LMP in the CAISO to $50/MWh.

The LMP difference of $20/MWh is made up by the marginal congestion cost of $15/MWh and the marginal GHG compliance cost of $5/MWh. The marginal congestion cost can be easily verified if the power transfer limit is relaxed by 1MW to 101MW, in which case one additional MWh from G_2 will displace 1MWh from G_1 for a net benefit of $15. The marginal GHG compliance cost can be easily verified if the export allocation (which carries the GHG compliance cost) is relaxed by 1 MW to 99MW, in which case one additional MWh from G_3 will displace 1MWh from G_2 for a net benefit of $5. It is interesting to note that there is a non-zero marginal GHG compliance cost in the optimal solution even when all the exported energy is allocated to the non-emitting resource G_2 who bid zero. This is because the cost of that export to California is $5/MWh higher than otherwise available energy from G3.

The marginal congestion cost of $15/MWh and the marginal GHG compliance cost of $5/MWh on a 100MWh energy export result in a congestion revenue of $1,500 and a GHG compliance revenue of $500, respectively. Assuming that the GHG compliance revenue is distributed to the optimal export allocations, the settlement is as follows:

Resource	Energy Cost	GHG Compliance Cost	Total Cost	Energy Payment	GHG Compliance Payment	Total Payment
G_1	$5,000	-	$5,000	$5,000	-	$5,000
G_2	$3,500	$0	$3,500	$3,000	$500	$3,500
G_3	$1,500	$0	$1,500	$1,500	$0	$1,500
L_1				–$10,000		
L_2				–$1,500		
Congestion Revenue				$1,500		
GHG Compliance Revenue				$500		

Where it is assumed that GHG compliance costs for G_1 are included in the energy bid (cost) and recovered through the energy payment, and as such they are not shown explicitly. It can be seen in the settlement results above that the total payment to each generator is sufficient to cover the respective energy and GHG compliance costs.

Example 2

This is a variation on the first example where G3 reduces its bid price to $28 to become a more competitive exporter to the CAISO compared to G2, taking into account the additional GHG compliance bid of $6/MWh. In this case, the optimal dispatch and export allocation are as follows:

Resource	Dispatch (MW)	Export Allocation (MW)	LMP ($/MWh)
G_1	100	-	50
G2	0	0	28
G_3	150	100	28
L1	200	-	50
L2	50	-	28

Example 2: μ = –$16/MWh; η = –$6/MWh

G3 is the least expensive resource for serving L2, and as such it sets the LMP in the EIM Entity Area to $28/MWh. It is also the least expensive resource for serving L1 at $34/MWh (including the $6/MWh GHG compliance cost). Consequently, G3 is dispatched at 150MW with 100MW exported to the CAISO at the limit of the power transfer capability. The balance of 100MW of L1 can only be served by G1, which sets the LMP in the CAISO to $50/MWh.

The LMP difference of $22/MWh is made up by the marginal congestion cost of $16/MWh and the marginal GHG compliance cost of $6/MWh. The marginal congestion cost can be easily verified if the power transfer limit is relaxed by 1MW to 101MW, in which case one additional MWh from G3 will displace 1MWh from G1 for a net benefit of $16. The marginal GHG compliance cost can be easily verified if the export allocation (which carries the GHYG allowance cost) is relaxed by 1 MW to 99MW, in which case 1MWh from G3 will not incur GHG allowance costs for a benefit of $6.

The marginal congestion cost of $16/MWh and the marginal GHG compliance cost of $6/MWh on a 100MWh energy export result in a congestion revenue of $1,600 and a GHG compliance revenue of $600, respectively. Assuming that the GHG compliance revenue is distributed to the optimal export allocations, the settlement is as follows:

Resource	Energy Cost	GHG Compliance Cost	Total Cost	Energy Payment	GHG Compliance Payment	Total Payment
G_1	$5,000	-	$5,000	$5,000	-	$5,000
G_2	$0	$0	$0	$0	$0	$0
G_3	$4,200	$600	$4,800	$4,200	$600	$4,800
L_1				–$10,000		
L_2				–$1,400		
Congestion Revenue				$1,600		
GHG Compliance Revenue				$600		

It can be seen in the settlement results above that the total payment to each generator is sufficient to cover the respective energy and GHG allowance costs.

Example 3

This is a variation on the second example where the available maximum capacity of G3 is reduced to 75MW in addition to reduced bid price of $28/MWh as in Example 2. In this case, G2 is dispatched to make up for the remaining 75MW and the optimal dispatch and export allocation are as follows:

Resource	Dispatch (MW)	Export Allocation (MW)	LMP ($/MWh)
G_1	100	-	50
G_2	75	75	29
G_3	75	25	29
L1	200	-	50
L2	50	-	29

Example 3: μ = –$15/MWh; η = –$6/MWh

G3 is the least expensive resource for serving L2; one additional MW of L2 will divert 1MW of G3 export to L2 saving $6/MWh on GHG compliance costs and that export will be made up by one additional MW from G2 at a net cost of $29/MWh, which is the LMP in the EIM Entity BAA. The balance of 100MW of L1 can only be served by G1, which sets the LMP in the CAISO to $50/MWh.

The LMP difference of $21/MWh is made up by the marginal congestion cost of $15/MWh and the marginal GHG compliance cost of $6/MWh. The marginal congestion cost can be easily verified if the power transfer limit is relaxed by 1MW to 101MW, in which case one additional MWh from G2 will displace 1MWh from G1 for a net benefit of $15. The marginal GHG compliance cost can be easily verified if the export allocation (which carries the GHG compliance cost) is relaxed by 1 MW to 99MW, in which case 1MWh from G3 will not incur GHG compliance costs for a benefit of $6.

The marginal congestion cost of $15/MWh and the marginal GHG compliance cost of $6/MWh on a 100MWh energy export result in a congestion revenue of $1,500 and GHG compliance revenue of $600, respectively. Assuming that the GHG compliance revenue is distributed to the optimal export allocations, the settlement is as follows:

Resource	Energy Cost	GHG Compliance Cost	Total Cost	Energy Payment	GHG Compliance Payment	Total Payment
G_1	$5,000	-	$5,000	$5,000	-	$5,000
G_2	$2,625	$0	$2,625	$2,175	$450	$2,625
G_3	$2,100	$150	$2,250	$2,175	$150	$2,325
L_1				–$10,000		
L_2				–$1,450		
Congestion Revenue				$1,500		
GHG Compliance Revenue				$600		

It can be seen in the settlement results above that the total payment to each generator is sufficient to cover the respective energy and GHG compliance costs.

Example 4

This is a variation on the third example where a new resource G4 is introduced in the EIM Entity BAA with a generating capacity of 100MW, a GHG compliance bid adder of $3.00/MWh, and an energy bid of $30/MWh, while the power transfer capability is increased to 300MW. Therefore, the resource data is as follows:

Generator	Minimum (MW)	Maximum (MW)	Energy Bid ($/MWh)	GHG Compliance Bid Adder ($/MWh)
G_1	0	300	50	-
G_2	0	200	35	0
G_3	0	75	28	6
G_4	0	100	30	3

The purpose of this example is to show that the LMP in the CAISO would include the GHG compliance costs for imports; this effect was masked in the previous examples because the more expensive resource G1 was setting the LMP in the CAISO. In this case, without a binding power transfer limit, G2, G3 and G4 are dispatched to serve both loads L1 and L2. The optimal dispatch and export allocation are as follows:

Generator	Dispatch (MW)	Export Allocation (MW)	LMP ($/MWh)
G_1	0	-	35
G_2	75	75	29
G_3	75	25	29
G_4	100	100	29

Example 4: μ = $0/MWh; η = –$6/MWh

G3 is the least expensive resource for serving L2 and G4 is the least expensive resource for serving L1; consequently, both resources are dispatched at their maximum capacity. G2 is marginal for serving L1 and sets the LMP in the CAISO to $35/MWh. One additional MW of L2 will divert 1MW of G3 export to L2 saving $6/MWh on GHG compliance costs and that export will be made up by one additional MW from G2 at a net cost of $29/MWh, which is the LMP in the EIM Entity BAA.

Since there is no transmission congestion, the LMP difference of $6/MWh amounts to the marginal GHG compliance cost of $6/MWh. The marginal GHG compliance cost can be easily verified if the export allocation (which carries the GHG compliance cost) is relaxed by 1 MW to 199MW, in which case 1MWh from G3 will not incur GHG compliance costs for a benefit of $6.

The marginal GHG compliance cost of $6/MWh on a 200MWh energy export results in a GHG compliance revenue of $1,200. Assuming that the GHG compliance revenue is distributed to the optimal export allocations, the settlement is as follows:

Resource	Energy Cost	GHG Compliance Cost	Total Cost	Energy Payment	GHG Compliance Payment	Total Payment
G_1	$0		$0	$0		$0
G_2	$2,625	$0	$2,625	$2,175	$450	$2,625
G_3	$2,100	$150	$2,250	$2,175	$150	$2,325
G_4	$3,000	$300	$3,300	$2,900	$600	$3,500
L_1				–$7,000		
L_2				–$1,450		
Congestion Revenue				$0		
GHG Compliance Revenue				$1,200		

It can be seen in the settlement results above that the total payment to each generator is sufficient to cover the respective energy and GHG compliance costs. Furthermore, all export allocations receive the marginal GHG compliance cost irrespective of the resource's GHG compliance bid.

11.3.3.3 Impact of EIM Transfer Cost on LMPs

The impact of EIM Transfer Cost on LMPs is *de minimus* since the maximum of EIM Transfer schedule cost is less than $0.01. Thus the transfer cost will be included in the Marginal Cost of Congestion and not explicitly settled.

11.3.3.4 Marginal Cost of Congestion (MCC)

MCC is the component of the Locational Marginal Price that reflects the sensitivity of relieving congestion by increasing supply at the location balanced by an equal increase in demand at the reference bus. The impact of the EIM Transfer Cost on the LMP will be included in the MCC calculation to help address the issues concerning allocation of congestion revenues at interties.

Notation:

The following notation is used in this section:

i	Node index.
j, k, r	BAA indexes; zero (0) is used for CISO.
l	Intertie or Energy Transfer schedule index; in the latter case, it is the corresponding ETSR index (ETSR pair for Energy Transfers between BAAs in the EIM Area).
m	Transmission constraint index.
n	Component index in transmission constraint m.
$\forall$	For all…
$\in$	Member of…
$\wedge$	…and…
N_m	Set of components for transmission constraint m (only one component for simple constraints, but there may be multiple components for nomograms).
EIM	Set of CISO and all EIM BAAs; the EIM Area.
BAA_j	Set of nodes in BAA j.
$L_{j,k}$	Set of interties between BAAs j and k.
LPF_i	Loss penalty factor at node i.
$LPF_{j,k,l}$	Loss penalty factor at the Scheduling Point for import/export schedule l to/from BAA j from/to BAA k.
$a_{m,n}$	Coefficient for component n of transmission constraint m (1.0 for simple constraints with a single component).
$SF_{m,n,i}$	Shift factor for injection at node i on component n of transmission constraint m.
$SF_{m,n,j,k,l}$	Shift factor for import/export schedule l to/from BAA j from/to BAA k on component n of transmission constraint m.

λ	Shadow price of the system power balance constraint.
λ_j	Shadow price of the power balance constraint for BAA *j*.
φ_j	Shadow price of the energy transfer distribution constraint for BAA *j*.
μ_m	Shadow price of transmission constraint *m*.
ψ	Shadow price of GHG regulation export allocation constraint.
$\zeta_{j,k,l}$, $\eta_{j,k,l}$	Shadow prices of upper/lower scheduling limits on intertie *l* to BAA *j* from BAA *k*, on interties with energy transfers.
ν_j, ξ_j	Shadow prices of upper/lower bound constraints on EIM transfer of EIM BAA *j*.
$\rho_{j,k,l}$, $\sigma_{j,k,l}$	Shadow prices of upper/lower bound constraints on export energy transfer schedule *l* from BAA *j* to BAA *k*.
LMP_i	LMP at node *i*.
$LMP_{j,k,l}$	SP-TIE LMP for import/export schedule *l* to/from BAA *j* from/to BAA *k*.
SMEC	System marginal energy cost (SMEC).
MCL	Marginal cost of losses (MCL).
MCC	Marginal congestion cost (MCC).
MGC	Marginal greenhouse gas regulation cost (MGC).
$MCC_{i,r}$	MCC component for BAA *r* at node *i*.
$MCC_{j,k,l,r}$	MCC component for BAA *r* for import/export schedule *l* to/from BAA *j* from/to BAA *k*.
b_m	Power flow limit for transmission constraint *m*.
T_j	Net EIM Transfer of BAA *j*; positive for export and negative for import.
$ET_{j,k,l}$	Export energy transfer (ETSR) schedule *l* from BAA *j* to BAA *k*.
R_m	Congestion revenue from transmission constraint *m*.
R_{Tj}	Congestion revenue from EIM transfer scheduling limits for BAA *j*.
$R_{j,k,l}$	Congestion revenue from ETSR $ET_{j,k,l}$.
R_{Dj}	Congestion revenue from the EIM transfer distribution constraint for BAA *j*.
R_D	Congestion revenue from all EIM transfer distribution constraints.
$R_{CTj,k,l}$	Congestion revenue from the transmission cost of the energy transfer schedule *l* between BAAs *j* and *k*.
$R_{ETj,k,l}$	Congestion revenue from the upper/lower bound constraints on ETSR $ET_{j,k,l}$.
$R_{SLj,k,l}$	Congestion revenue from the upper/lower scheduling limits on intertie *l* to BAA *j* from BAA *k*, on interties with energy transfers.

$f_{m,r}$ Congestion revenue distribution factor from transmission constraint *m* on BAA *r*.

$f_{T,j,r}$ Congestion revenue distribution factor from EIM transfer scheduling limits for BAA *j* on BAA *r*.

$f_{CT,j,k,l,r}$ Congestion revenue distribution factor from transmission cost of the energy transfer schedule *l* between BAAs *j* and *k* on BAA *r*.

$f_{ET,j,k,l,r}$ Congestion revenue distribution factor from upper/lower bound constraints on export energy transfer schedule *l* from BAA *j* to BAA *k* on BAA *r.*

$f_{SL,j,k,l,r}$ Congestion revenue distribution factor from upper/lower scheduling limits on intertie *l* to BAA *j* from BAA *k* on BAA *r*.

f_{Dr} Distribution factor for the shadow price of the energy transfer distribution constraint of any BAA in the EIM Area on BAA *r*.

11.3.3.4.1 Congestion Revenue Allocation (MCC Decomposition)

The LMP decomposition is used in neutrality cost allocation. Before presenting the MCC decomposition, it is useful to present all LMP components first. The LMP can be decomposed to the following components:

a) the System marginal energy cost (SMEC) component;

b) the marginal cost of losses (MCL) component;

c) the marginal congestion cost (MCC) component; and

d) the marginal greenhouse gas cost (MGC) component.

These LMP components are as follows:

$$LMP_i = SMEC + MLC_i + MCC_i + MGC_i, \qquad \forall i \in BAA_j \wedge j \in EIM$$

$$LMP_{j,k,l} = SMEC + MLC_{j,k,l} + MCC_{j,k,l} + MGC_{j,k,l}, \qquad \forall j \in EIM \wedge k \neq j \wedge l \in L_{j,k}$$

$$\left.\begin{aligned} SMEC &= \lambda \\ MLC_i &= \lambda\left(\frac{1}{LPF_i} - 1\right) \\ MCC_i &= -\sum_m \sum_{n \epsilon N_m} a_{m,n}\, SF_{m,n,i}\, \mu_m \\ MGC_i &= 0 \end{aligned}\right\}, \qquad \forall i \in BAA_0$$

$$\left.\begin{aligned} MLC_i &= (\lambda + \lambda_j - \psi)\left(\frac{1}{LPF_i} - 1\right) \\ MCC_i &= \lambda_j - \sum_m \sum_{n \epsilon N_m} a_{m,n}\, SF_{m,n,i}\, \mu_m \\ MGC_i &= -\psi \end{aligned}\right\}, \qquad \forall i \in BAA_j \wedge j \in EIM \wedge j > 0$$

$$\left.\begin{aligned} MLC_{0,k,l} &= \lambda\left(\frac{1}{LPF_{0,k,l}} - 1\right) \\ MCC_{0,k,l} &= -\sum_{m}\sum_{n\epsilon N_m} a_{m,n}\, SF_{m,n,0,k,l}\, \mu_m - \zeta_{0,k,l} + \eta_{0,k,l} \\ MGC_{0,k,l} &= 0 \end{aligned}\right\}, \qquad \forall k > 0 \wedge l \in L_{j,k}$$

$$\left.\begin{aligned} MLC_{j,k,l} &= (\lambda + \lambda_j - \psi)\left(\frac{1}{LPF_{j,k,l}} - 1\right) \\ MCC_{j,k,l} &= \lambda_j - \sum_{m}\sum_{n\epsilon N_m} a_{m,n}\, SF_{m,n,j,k,l}\, \mu_m - \zeta_{j,k,l} + \eta_{j,k,l} \\ MGC_{j,k,l} &= -\psi \end{aligned}\right\},$$
$$\forall j \in EIM \wedge j > 0 \wedge k \notin EIM \wedge l \in L_{j,k}$$

Where the MCC contributions from FRP requirement constraints are not shown for simplicity.

For the MCC Decomposition, the allocation of congestion revenue to corresponding BAAs in the EIM area is based on the congestion revenue distribution factors set up for each constraint whose shadow price contributes to the MCC. The congestion revenue distribution factors for BAA constraints of all types are defined in the Master File (MF) and these congestion distribution factors are used in the market.

Example:

BAA	Intertie Schedule/EIM Transfer/Constraints	Congestion Revenue Distribution Factor
BAA 1	Tie 1-Scheduling limit	1
BAA 1	Tie 1-EIM transfer: ETSR (BAA 1)	0.5
BAA 2	Tie 1- EIM transfer ETSR (BAA 2)	0.5

For transmission constraints that do not affect energy transfers (generic transmission constraint *m*), the congestion revenue is allocated as follows:

$$R_m = \mu_m\, b_m = \sum_{r\in EIM} f_{m,r}\, \mu_m\, b_m\,, \qquad \forall m$$

Where:

$$\sum_{r\in EIM} f_{m,r} = 1, \qquad \forall m$$

This is accomplished by decomposing the corresponding MCC contributions using the congestion revenue distribution factors, as follows:

$$-\sum_{m}\sum_{n\epsilon N_m} a_{m,n}\, SF_{m,n,i}\, \mu_m = -\sum_{r\in EIM}\sum_{m}\sum_{n\epsilon N_m} a_{m,n}\, SF_{m,n,i}\, f_{m,r}\, \mu_m\,, \qquad \forall i \in BAA_j \wedge j \in EIM$$

$$-\sum_{m}\sum_{n\epsilon N_m} a_{m,n}\, SF_{m,n,j,k,l}\, \mu_m = -\sum_{r\in EIM}\sum_{m}\sum_{n\epsilon N_m} a_{m,n}\, SF_{m,n,j,k,l}\, f_{m,r}\, \mu_m\,,$$
$$\forall j \in EIM \wedge k \notin EIM \wedge l \in L_{j,k}$$

This is equivalent to distributing the transmission constraint shadow price across BAAs in the EIM Area. Typically, the congestion revenue distribution factors for these constraints allocate the congestion revenue 100% to a single BAA, the one the constraint resides in, or if it is an intertie constraint, the BAA at the intertie definition side where the constraint is enforced.

If the constraint is located in a non-EIM BAA (e.g., Rate of Change constraints or EIM flow limits in BPAT pursuant to the Coordinated Transmission Agreement), the congestion revenue distribution factors for these constraints allocate the congestion revenue among the EIM Area BAAs responsible for the limits in proportion to the transmission rights made available by the relevant EIM BAAs through the non-EIM BAA, which are generally those EIM BAAs that have made transmission rights through the non-EIM BAA available to the EIM model.

EIM BAA	Non-EIM BAA	Transmission Rights (MW)			CDF
		Import	Export	Total	
PACW	BPAT	400	400	800	0.4
PSEI	BPAT	300	300	600	0.3
PGE	BPAT	300	300	600	0.3

This methodology can be extended to the shadow prices of the EIM transfer scheduling limits (ν or ξ). The congestion revenue from the EIM transfer scheduling limits is allocated as follows:

$$R_{Tj} = -\left(-\nu_j + \xi_j\right) T_j = -\sum_{r\in EIM} f_{Tj,r}\left(-\nu_j + \xi_j\right) T_j\,, \qquad \forall j \in EIM \wedge j > 0$$

Where:

$$\sum_{r\in EIM} f_{Tj,r} = 1, \qquad \forall j \in EIM \wedge j > 0$$

This is accomplished by decomposing the corresponding MCC contributions using the congestion revenue distribution factors, as follows:

$$-\nu_j + \xi_j = \sum_{r\in EIM} f_{Tj,r}\left(-\nu_j + \xi_j\right), \qquad \forall j \in EIM \wedge j > 0$$

The congestion revenue distribution factors for these constraints allocate the congestion revenue 100% to the BAA for which the constraint is formulated:

$$\left.\begin{matrix} f_{Tj,r} = 1 & \therefore r = j \\ f_{Tj,r} = 0 & \therefore r \neq j \end{matrix}\right\}, \qquad \forall j \in EIM \wedge j > 0$$

MCC contributions from FRP requirement constraints for specific BAAs (due to the dependency on the available net import/export capability) are similarly distributed 100% to the BAA for which the constraint is formulated.

The only remaining MCC component after the allocation of the shadow prices of generic transmission constraints (μ), EIM transfer scheduling limits (ν or ξ), and FRP requirement constraints, is the shadow price of the EIM transfer distribution constraint (φ). The same allocation process is used, but instead of allocating the congestion revenue at the BAA level, the allocation is performed for each BAA intertie instead. The congestion revenue collected at the BAA level through φ is equal overall to the congestion revenue collected from each intertie with ETSRs due to the ETSR transmission cost (*CT*), the shadow price of the ETSR schedule limit (ρ or σ), and the intertie scheduling limit (ISL or ITC) shadow price (η or ζ).

$$R_D = -\sum_{j \in EIM} \varphi_j \, T_j = \sum_{\substack{j,k \in EIM \\ j \neq k}} \sum_{l \epsilon L_{j,k}} R_{j,k,l}$$

The congestion revenue from each ETSR ($R_{j,k,l}$) can be separated to its contributions from the ETSR transmission cost (*CT*), the shadow price of the ETSR schedule limit (ρ or σ), and the intertie scheduling limit shadow price (η or ζ) as follows:

$$\left.\begin{matrix} R_{j,k,l} = R_{CTj,k,l} + R_{ETj,k,l} + R_{SLj,k,l} \\ R_{CTj,k,l} = CT_{j,k,l} \, ET_{j,k,l} \\ R_{ETj,k,l} = \left(\rho_{j,k,l} - \sigma_{j,k,l}\right) ET_{j,k,l} \\ R_{SLj,k,l} = -\left(\zeta_{j,k,l} - \eta_{j,k,l} - \zeta_{k,j,l} + \eta_{k,j,l}\right) ET_{j,k,l} \end{matrix}\right\}, \qquad \forall j,k \in EIM \wedge k \neq j \wedge l \in L_{j,k}$$

Each of these contributions can be distributed to BAAs in the EIM Area using configurable distribution factors as follows:

$$\left.\begin{matrix} R_{CTj,k,l} = \sum_{r \in EIM} f_{CTj,k,l,r} \, CT_{j,k,l} \, ET_{j,k,l} \\ R_{ETj,k,l} = \sum_{r \in EIM} f_{ETj,k,l,r} \left(\rho_{j,k,l} - \sigma_{j,k,l}\right) ET_{j,k,l} \\ R_{SLj,k,l} = -\sum_{r \in EIM} f_{SLj,k,l,r} \left(\zeta_{j,k,l} - \eta_{j,k,l}\right) ET_{j,k,l} + \sum_{r \in EIM} f_{SLk,j,l,r} \left(\zeta_{k,j,l} - \eta_{k,j,l}\right) ET_{j,k,l} \end{matrix}\right\}, \quad \forall j,k \in EIM \wedge k \neq j \wedge l \in L_{j,k}$$

Where:

$$\left.\begin{aligned}\sum_{r\in EIM} f_{CT\,j,k,l,r} &= 1\\ \sum_{r\in EIM} f_{ET\,j,k,l,r} &= 1\\ \sum_{r\in EIM} f_{SL\,j,k,l,r} &= 1\end{aligned}\right\}, \qquad \forall j,k \in EIM \wedge k \neq j \wedge l \in L_{j,k}$$

The congestion distribution factors for the ETSR transmission cost ($f_{CT\,j,k,l,r}$) are set to 50% for each of the two BAAs of the associated ETSR. The congestion distribution factors for the ETSR scheduling limits ($f_{ET\,j,k,l,r}$) are set to 50% for each of the two BAAs of the associated ETSR if they have transmission rights through the intertie (typical case for ETSRs between EIM BAAs), or 100% to the BAA that has transmission rights to, but not through, the intertie (typical case for ETSRs between an EIM BAA and the CISO). The congestion distribution factors for the intertie scheduling limit (ISL or ITC) ($f_{SL\,j,k,l,r}$) are set to 100% for the BAA that manages the limit.

The total congestion revenue from all interties can be distributed to the BAAs in the EIM Area as follows:

$$\begin{aligned}R_D = \sum_{r\in EIM} R_{Dr} &= \sum_{\substack{j,k\in EIM\\ j\neq k}} \sum_{l\epsilon L_{j,k}} R_{j,k,l} = \sum_{\substack{j,k\in EIM\\ j\neq k}} \sum_{l\epsilon L_{j,k}} \left(R_{CT\,j,k,l} + R_{ET\,j,k,l} + R_{SL\,j,k,l}\right)\\ &= \sum_{\substack{j,k\in EIM\\ j\neq k}} \sum_{l\epsilon L_{j,k}} \sum_{r\in EIM} \Big(f_{CT\,j,k,l,r}\, CT_{j,k,l} + f_{ET\,j,k,l,r}\left(\rho_{j,k,l} - \sigma_{j,k,l}\right)\\ &\quad - f_{SL\,j,k,l,r}\left(\zeta_{j,k,l} - \eta_{j,k,l}\right) + f_{SL\,k,j,l,r}\left(\zeta_{k,j,l} - \eta_{k,j,l}\right)\Big)\, ET_{j,k,l}\\ &= \sum_{r\in EIM} \sum_{\substack{j,k\in EIM\\ j\neq k}} \sum_{l\epsilon L_{j,k}} \Big(f_{CT\,j,k,l,r}\, CT_{j,k,l} + f_{ET\,j,k,l,r}\left(\rho_{j,k,l} - \sigma_{j,k,l}\right)\\ &\quad - f_{SL\,j,k,l,r}\left(\zeta_{j,k,l} - \eta_{j,k,l}\right) + f_{SL\,k,j,l,r}\left(\zeta_{k,j,l} - \eta_{k,j,l}\right)\Big)\, ET_{j,k,l} \Rightarrow\end{aligned}$$

$$\begin{aligned}R_{Dr} = \sum_{\substack{j,k\in EIM\\ j\neq k}} \sum_{l\epsilon L_{j,k}} &\Big(f_{CT\,j,k,l,r}\, CT_{j,k,l} + f_{ET\,j,k,l,r}\left(\rho_{j,k,l} - \sigma_{j,k,l}\right) - f_{SL\,j,k,l,r}\left(\zeta_{j,k,l} - \eta_{j,k,l}\right)\\ &+ f_{SL\,k,j,l,r}\left(\zeta_{k,j,l} - \eta_{k,j,l}\right)\Big)\, ET_{j,k,l}, \qquad \forall r \in EIM\end{aligned}$$

Therefore, all shadow prices of the EIM Transfer distribution constraints can be decomposed to BAA contributions using a global distribution vector as follows:

$$\varphi_j = \sum_{r\in EIM} f_{Dr}\, \varphi_j, \qquad \forall j \in EIM$$

Where:

$$f_{Dr} = \frac{R_{Dr}}{R_D}, \qquad \forall r \in EIM$$

And:

$$\sum_{r \in EIM} f_{Dr} = 1$$

Finally, all BAA MCC contributions can be summed up to yield the MCC decomposition to BAA components:

$$MCC_{i,r} = -\sum_{m} \sum_{n \epsilon N_m} a_{m,n}\, SF_{m,n,i}\, f_{m,r}\, \mu_m\,, \qquad \forall i \in BAA_0$$

$$MCC_{i,r} = -\sum_{m} \sum_{n \epsilon N_m} a_{m,n}\, SF_{m,n,i}\, f_{m,r}\, \mu_m + f_{Tj,r}\left(-\nu_j + \xi_j\right) + f_{Dr}\, \varphi_j,$$
$$\forall i \in BAA_j \wedge j \in EIM \wedge j > 0$$

$$MCC_{0,k,l,r} = -\sum_{m} \sum_{n \epsilon N_m} a_{m,n}\, SF_{m,n,0,k,l}\, f_{m,r}\, \mu_m - f_{SL0,k,l,r}\left(\zeta_{0,k,l} + \eta_{0,k,l}\right), \qquad \forall k > 0 \wedge l \in L_{j,k}$$

$$MCC_{j,k,l,r} = -\sum_{m} \sum_{n \epsilon N_m} a_{m,n}\, SF_{m,n,j,k,l}\, f_{m,r}\, \mu_m - f_{SLj,k,l,r}\left(\zeta_{j,k,l} + \eta_{j,k,l}\right) + f_{Tj,r}\left(-\nu_j + \xi_j\right) + f_{Dr}\, \varphi_j,$$
$$\forall j \in EIM \wedge j > 0 \wedge k \notin EIM \wedge l \in L_{j,k}$$

Where the contributions from FRP requirement constraints are not shown for simplicity.

11.3.3.5 Marginal Cost of Losses (MCL)

Marginal Cost of Losses is a component of the Locational Marginal price that considers the System Marginal Energy Cost (SMEC), and the Loss Penalty Factor (LPF) at the PNode (Physical Node). The MCL at a particular PNode may be positive or negative, depending on the submitted bids. At a Particular PNode, the MCL accounts for the real power marginal losses as measured between a CNode (Connection Node) and the distributed load reference. The LPF is derived by the market optimization software (IFM/RTM).

11.3.3.5.1 Marginal Cost of Losses Decomposition as LMP Component

The MCL as a component of the LMP is calculated on the Node price and the SP-Tie Price. Mathematically expressed as below:

Node Price:

$$LMP_i = SMEC + MCL_i + MCC_i + MGC_i, \qquad \forall i \in BAA_j \wedge j \in EIM$$

SP-Tie Price:

$$LMP_{j,k,l} = SMEC + MCL_{j,k,l} + MCC_{j,k,l} + MGC_{j,k,l}, \qquad \forall j \in EIM \wedge k \neq j \wedge l \in L_{j,k}$$
$$SMEC = \lambda$$

A. CAISO Nodal MCL Component

The MCL component of the LMP at any bus *i* within the ISO BAA is calculated in the Real-Time Market (RTM) and represented mathematically as below:

$$SMEC = \lambda$$
$$MCL_i = \lambda \left(\frac{1}{LPF_i} - 1\right) \ \forall i \in BAA_0$$

B. EIM Nodal MCL Component

The Nodal MCL component of the LMP at any bus *i* within an EIM BAA is calculated in the RTM. This component takes the BAA j power balance shadow price λ_j and GHG shadow price . It is mathematically represented as below:

$$SMEC = \lambda$$
$$MCL_i = \left(\lambda + \lambda_j - \psi\right)\left(\frac{1}{LPF_i} - 1\right) \ \forall i \in BAA_j \wedge j \in EIM \wedge j > 0$$

C. ISO SP-Tie MCL Component

This is the MCL component of the LMP at a scheduling point (SP) within the ISO BAA for import/export *l* to/from ISO BAA from/to BAA *k.* It is mathematically represented as below:

$$SMEC = \lambda$$
$$MCL_{0,k,l} = \lambda\left(\frac{1}{LPF_{0,k,l}} - 1\right) \forall k > 0 \wedge l \in L_{j,k}$$

D. EIM SP-Tie MCL Component

This is the MCL component of the LMP at a scheduling point within the EIM BAA *j* for import/export *l* to/from EIM BAA *j* from/to BAA *k.* this is calculated with BAA *j* power balance shadow price λ_j and GHG shadow price ψ . It is mathematically represented as below:

$$SMEC = \lambda$$

$$MCL_{j,k,l} = (\lambda + \lambda_j - \psi)\left(\frac{1}{LPF_{j,k,l}} - 1\right)$$

$$\forall j \in EIM \wedge j > 0 \wedge k \notin EIM \wedge l \in L_{j,k}$$

11.3.4 Using EIM Available Balancing Capacity to Resolve Infeasible Power Balance Conditions in EIM BAAs

The EIM entity scheduling coordinator may identify any available balancing capacity that it wishes the Energy Imbalance Market to utilize to address any infeasibility in its balancing authority area in the fields labelled as “regulation up” and “regulation down” of its resource plans.

11.3.4.1 Available Capacity Bid Curve

EIM participating resources and non-participating resources for which the EIM Entity Scheduling Coordinator has identified EIM Upward Available Balancing Capacity and/or EIM Downward Available Capacity in the EIM resource plan submission can provide available balancing capacity to designated EIM.

To be able to dispatch any available balancing capacity, in applicable EIM, the market optimization requires the EIM Base schedule, and an Energy Bid Curve from the resource identified as available balancing capacity by the EIM Scheduling Coordinator. In order to make the designated available balancing capacity participate in the applicable EIM area, the EIM participating resources scheduling coordinator must also submit an economic bid for that resource for the relevant trading hour. For non-participating resources, the EIM entity scheduling coordinator established Default Energy Bids with the

CAISO consistent with the rules in Section 39.7.1 of the CAISO tariff. The CAISO creates Energy Bid Curves based on the Default Energy Bids created for non-participating resources. The allocation of the energy bid portions to ancillary services and available balancing capacity is described below, and is done differently than for CAISO's resources (see 4.2.5 in BPM for Market Operations).

Energy Bid Curves for EIM Available Balancing Capacity

For each trading hour, CAISO determines the resource's overall available capacity based on any updated outage information. Then CAISO determines if the submitted Energy Bid Curve for participating resources or the Default Energy Bid Curve for non-participating resources is sufficient to cover all the services identified in the Resource Plan in the following priority:

1) If the EIM Resource Plan includes EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements, the Energy Bid portion equal to the base EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements schedule (MW) just below the URL (if base EIM Upward or Downward Available Balancing Capacity schedules are specified) or the Upper Operating Limit (UOL), whichever lower, and above the base EIM Energy Base Schedule is reserved for EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements. If there is insufficient capacity to allocate all of the base EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements schedule, the latter shall be reduced accordingly.
2) If the EIM Resource Plan includes Non-Spinning Reserve, the Energy Bid portion equal to the base Non-Spinning Reserve schedule (MW) just below the allocated portion for Spinning Reserve, if any, otherwise below the URL (if base Regulation schedules are specified) or the Upper Operating Limit (UOL), whichever lower, and above the base EIM Energy Base Schedule is reserved for Non-Spinning Reserve. if there is insufficient capacity to allocate all of the base Non-Spinning Reserve schedule, the latter shall be reduced accordingly.
3) If the EIM Resource Plan includes EIM Upward Available Balancing Capacity, the Energy Bid portion equal to the Regulation Up (MW) just below the allocated portion for EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements, if any, otherwise below the URL (if base EIM Upward or Downward Available Balancing Capacity schedules are specified) or the Upper Operating Limit (UOL), whichever lower, and above the base EIM Energy Base Schedule is reserved for Regulation Up. If there is insufficient energy bid range to allocate all of the base EIM Upward Available Balancing Capacity schedule, the latter shall be reduced accordingly.
4) If the EIM Resource Plan includes EIM Downward Available Balancing Capacity, the Energy Bid portion equal to the EIM Downward Available Balancing Capacity (MW) just above the Lower Operating Limit (LOL), or the Lower Economic Limit (LEL), whichever higher, and below the base EIM Energy Base Schedule is reserved for Regulation Down. If there is insufficient energy bid range to allocate all of the base EIM Downward Available Balancing Capacity schedule, the latter shall be reduced accordingly.

5) The remaining portion of the Energy Bid, if any, is used for Dispatch.

6) For EIM Non-Participating Resources, the Default Energy Bid (DEB) is used for EIM Resource Plan's capacity allocation. The allocation is similar to that for EIM Participating Resources, except that after the allocation, EIM Upward Available Balancing Capacity and EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements slides down and EIM Downward Available Balancing Capacity slides up to the base Energy schedule so that there is no remaining energy bid range available for Dispatch.

7) The energy bid ranges reserved for base EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements and base EIM Upward and Downward Available Balancing Capacity shall not be considered available in the capacity and flexible ramp sufficiency tests for EIM BAAs.

11.3.4.2 Use of EIM Available Balancing Capacity

The CAISO's market clearing software calculates the optimal solution in two passes, referred to as the scheduling and pricing run. The scheduling run is a full optimization run where constraints may be relaxed at a penalty price to avoid infeasibility. The pricing run is a simple economic dispatch, initialized from the scheduling run solution, where penalty prices are replaced by administrative prices and the problem is constrained so that the primal solution does not drift far away from the primal solution of the scheduling run. Both binding schedules and prices are obtained from the pricing run.

Scheduling Run

To effectively reserve EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements from Dispatch and dispatch EIM Upward and Downward Available Balancing Capacity after the dispatch of all available economic bids and before violating power balance or transmission constraints, the EIM applications make EIM Upward and Downward Available Balancing Capacity for dispatch at penalty prices. Those penalty prices are economically differentiated for the energy bid portions allocated to base EIM Upward and Downward Available Balancing Capacity schedules prices to maintain the economic merit order reflected in the energy bid prices of the allocated energy bid portions. The penalty prices are contained within a configurable penalty price range. The penalty price range for EIM Upward and Downward Available Balancing Capacity is sufficiently above the bid ceiling and below the self-schedule penalty, the power balance and transmission constraint violation penalties.

The economically differentiated penalty prices for EIM Upward and Downward Available Balancing Capacity are determined by a linear transformation into the relevant configurable penalty price ranges as follows:

1) If the configurable penalty price range for EIM Upward Available Balancing Capacity is sufficiently wide to accommodate the range of economic prices of the energy bid segments allocated to base EIM Upward Available Balancing Capacity schedules among all EIM Resources, these segments are elevated by a positive penalty offset so that the lowest economic price among these segments will be equal to the bottom of the configurable penalty price range.

2) Otherwise, each energy bid segment allocated to a base EIM Upward Available Balancing Capacity schedule is scaled by an upward scaling factor and then elevated by a positive penalty offset so that the lowest economic price among these segments will be equal to the bottom of the configurable penalty price range, while the highest economic price among these segments will be equal to the top of the configurable penalty price range.

3) If the configurable penalty price range for EIM Downward Available Balancing Capacity is sufficiently wide to accommodate the range of economic prices of the energy bid segments allocated to base EIM Downward Available Balancing Capacity schedules among all EIM Resources, these segments are lowered by a negative penalty offset so that the highest economic price among these segments will be equal to the top of the configurable penalty price range.

4) Otherwise, each energy bid segment allocated to a base EIM Downward Available Balancing Capacity schedule is scaled by a downward scaling factor and then lowered by a negative penalty offset so that the highest economic price among these segments will be equal to the top of the configurable penalty price range, while the lowest economic price among these segments will be equal to the bottom of the configurable penalty price range.

5) For multi-stage generation units (MSG) if the penalty prices are left in place, it will prevent economical transitions. In order to avoid this problem, the economic cost instead of the penalty cost of regulation will be associated with the decision variables for transitions such that the optimization can determine optimally economical transitions.

To limit EIM Upward and Downward Available Balancing Capacity dispatch only to the amount required to resolve power balance infeasibility in the native EIM BAA, two constraints are included in the problem formulation for each EIM BAA, one for limiting EIM Upward Available Balancing Capacity dispatch and the other for limiting EIM Downward Available Balancing Capacity. The first constraint prevents EIM Upward Available Balancing Capacity dispatch when the net optimal transfer is higher than the base net transfer for the EIM BAA (exporting above base). The second constraint prevents EIM Downward Available Balancing Capacity dispatch when the net optimal transfer is lower than the base net transfer for the EIM BAA (importing below base).

These constraints, in conjunction with the economically differentiated penalty prices for Regulation Up and Down, result in an optimal solution where EIM Upward or Downward Available Balancing Capacity in an EIM BAA are dispatched only if that is necessary to remove power balance infeasibility in that BAA, while not violating transmission constraints when doing so.

If the available EIM Upward or Downward Available Balancing Capacity is fully dispatched in an EIM BAA and infeasibility conditions persist, the relevant surplus variable in that BAA's power balance constraint will normally take value at the applicable power balance relaxation penalty price.

Pricing Run

Only energy bid portions allocated to base EIM Upward and Downward Available Balancing Capacity schedules that were dispatched in the scheduling run are available for dispatch at the corresponding economic energy bid prices at the pricing run. EIM Upward and Downward Available Balancing Capacity schedules that were not dispatched in the Scheduling Run and energy bid portions allocated to base EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements are not available for dispatch in the pricing run.

LMP

To calculate an economic optimal solution in an EIM BAA where EIM Upward and Downward Available Balancing Capacities dispatched to resolve power balance infeasibility, the demand forecast shall be reduced or increased in the Pricing Run by a small tolerance, respectively, so that the marginal economic bid would set the price. The marginal bid at the pricing run may be from an energy bid allocated to EIM Upward and Downward Available Balancing Capacity or to capacity that is normally available for dispatch in EIM, or even an energy bid outside the EIM BAA, in which case the EIM Transfer would move off its limit. If the dispatched EIM Upward and Downward Available Balancing Capacity was insufficient to resolve the power balance infeasibility in an EIM BAA in the Scheduling Run, the relevant surplus variable in that BAA's power balance constraint will be normally priced at the applicable bid ceiling or floor, respectively, thus setting the administrative price.

Expected Energy Calculation

RTD passes to MQS the energy bid used for Imbalance Energy and EIM Upward and Downward Available Balancing Capacity dispatch in the Pricing Run for the 5min RTD binding interval. The applicable DEB shall be passed for EIM Non-Participating Resources.

MQS calculates and allocates Expected Energy using the DOPs and the applicable energy bid. Expected Energy from EIM Upward and Downward Available Balancing Capacity dispatch from EIM Participating

Resources is accounted as Optimal Energy. EIM Non-Participating Resources are treated similarly to any resource and therefore, Expected Energy from EIM Upward and Downward Available Balancing Capacity dispatch from EIM Non-Participating Resources is also accounted as Optimal Energy.

Appendix B presents Mathematical Formulation for using regulation to resolve infeasible power balance conditions in EIM BAAs.

11.3.5 EIM Market Power Mitigation

CAISO is authorized to adjust a resource's submitted energy bid downward to the level of the resource's cost based bid, or Default Energy Bid, when the resource has been determined to wield Local Market Power. The Local Market Power Mitigation procedure is administrated by an automated process integrated into the Day-Ahead and Real-Time Market systems. This section describes the Local Market Power Mitigation procedure as it is applied to the EIM market. Applicable portions of Sections 6 and 7 of the **BPM for Market Operations** describe the general operation and timeline of the Local Market Power Mitigation process for the Day-Ahead and Real-Time Markets, respectively.

As mentioned in the previous section, the Default Energy Bid is a resource's cost-based bid that may be used in the event that the CAISO markets determine that the resource wields Local Market Power. See also the **BPM for Market Instruments** Appendix Attachment D for additional details.

11.3.5.1 EIM Market Power Mitigation Procedure

- CAISO will use the same dynamic competitive path assessment (DCPA) and LMPM methodology to mitigate energy bids from EIM Participating Resources in the RTM. DCPA will be conducted for each transmission constraint separately in each EIM Entity BAA, and LMPM may mitigate EIM Participating Resource bids for binding congestion separately in each EIM Entity BAA. Interties between BAAs are not subject to market power mitigation, except for groups of interties which make up an EIM Transfer constraint, as explained further in section 10.3.4.3.

11.3.5.2 Dynamic Competitive Path Assessment

CAISO shall conduct the dynamic competitive path assessment to determine for each EIM Entity Balancing Authority Area whether a path is competitive or non-competitive, consistent with Tariff Section 39.7.2, except that:

- EIM Participating Resource Scheduling Coordinators shall submit information required by CAISO to perform dynamic competitive path assessment.

- The dynamic competitive path assessment shall not exclude EIM Participating Resources from the test used to determine the competitiveness of Transmission Constraints on the basis that they may be net buyers of energy in the Real-Time Market.

- CAISO may establish different Reference Buses for each Balancing Authority Area, which need not be within the Balancing Authority Area, for calculating the LMP Decomposition which is used to trigger Bid mitigation, based on the topology of each Balancing Authority Area and consideration of the bus at which the Marginal Cost of Congestion component of Locational Marginal Prices is least influenced by market power. With that said, CAISO will use a common Reference Bus for both the EIM and CAISO areas upon commencement of EIM operations. See the **BPM for Market Operations**, Section 6.5.1, for more information on Reference Bus selection.

- In case EIM Upward and Downward Available Balancing Capacity is dispatched in an EIM BAA to resolve power balance infeasibility in that BAA, the EIM Transfer for that EIM BAA will be constrained in the import direction. If this constraint is assessed to be non-competitive, the energy bids of all EIM Participating Resources in that EIM BAA would be subject to Market Power Mitigation (MPM). Therefore the energy bids used for EIM Upward Available Balancing Capacity dispatch would be mitigated. Note that according to existing MPM rules, the entire energy bid would be mitigated for the entire Trading Hour irrespective of the amount of EIM Available Balancing Capacity dispatch.

11.3.5.3 Locational Marginal Price Decomposition

CAISO shall perform the Locational Marginal Price decomposition for each EIM Entity Balancing Authority Area using the results of the dynamic competitive path assessment and the Congestion pricing results of the pre-market run to determine which resources may have local market power due to Congestion on a non-competitive Transmission Constraint, consistent with CAISO Tariff Sections 34.2.3 and 39.7, except that:

- CAISO will not mitigate resource bids for scheduling limit constraints with Balancing Authority Areas that do not participate in the EIM;

- The Locational Marginal Price decomposition shall only be triggered if the resource is effective at relieving an uncompetitive constraint within the same Balancing Authority Area in which the resource is located, except as described in Tariff Section 29.39(c)(4);

- EIM Resources shall be mitigated to relieve congestion on uncompetitive constraints within the same Balancing Authority Area in which the EIM Resources are located except as described in Tariff Section 29.39(c)(4); and

- EIM Transfer constraints into an EIM Entity Balancing Authority Area on an EIM Internal Intertie shall be included in the Market Power Mitigation procedures if CAISO determines that EIM Entity Balancing Authority Area market power exists based on a structural competitiveness assessment of an individual or group of EIM Balancing Authority Areas in the EIM Area, provided such authority has been granted by the CAISO Governing Board based on the assessment of structural competiveness.

- EIM Transfer constraints that are included in the market power mitigation procedures are represented in the LMP decomposition by the EIM BAA specific power balance constraints. The shadow price of the BAA specific power balance constraint is equal to the sum of the shadow prices of the relevant set of EIM transfer constraints. The shadow price on the EIM BAA specific power balance constraint will be included in the LMP decomposition as either competitive congestion costs or non-competitive congestion costs depending on whether the constraint is deemed competitive or non-competitive.

11.3.6 Default Energy Bids

CAISO shall use the methods and standards set forth in Section 39.7 of the CAISO Tariff to determine Default Energy Bids for EIM Participating Resources. Please note that default energy bids are also used for EIM Non Participating Resources that the EIM Entity Scheduling Coordinator has identified as available balancing.

11.3.7 Compensating Injections in the RTM

Compensating Injections will be modeled at applicable points defined at the Full Network Model (FNM) boundary in the Real-Time Market (RTM). These Compensating Injections would be calculated by a methodology that would adjust the Compensating Injections in Real-Time so that the net schedule contributions on interties match the corresponding intertie measurements. See the BPM for Market Operations, Section 7.5.1.1 for a description of how compensating injections are used in the market.

11.3.8 Auto-Match of Import/Export Schedule Changes

The auto-match feature facilitates the management of base intertie schedulechanges after T–40'. It is limited to EIM Non-Participating Resources (EIMNPR), namely System Resources (SRs), including Energy Transfer System Resources (Base ETSRs) and Mirror System Resources (MSRs).

If the schedule of an EIM System Resource changes from its base schedule after –40' for an EIM BAA, the CAISO will automatically match that schedule change from a pre-selected available EIMNPR in the same EIM BAA. The net of multiple System Resource schedule deviations at the interties of an EIM BAA can be matched by the same pre-selected EIMNPR in the same BAA, and different pre-selected EIMNPRs can be used to match different System Resource schedule changes. The pre-selected EIMNPRs and their associated System Resources must be registered in the Master File for the auto-match feature by the relevant EIM Entity Scheduling Coordinator.

Schedule deviations from System Resources registered for auto-match will be ignored from the historical data used in compiling the intertie over/under-scheduling histogram. Additionally, the corresponding schedules will be excluded from the gross import or export base schedule for the purpose of calculating additional capacity test requirements associated with intertie over/under-scheduling for the corresponding EIM BAA.

No Manual Dispatch Instructions or ABC are allowed for EIMNPRs that are registered for the auto-match feature since their schedules are determined by the market.

11.3.9 Auto Mirror of CAISO Import/Export Schedule Changes

The auto-mirror feature facilitates the mirroring of intertie schedules with CISO (CAISO BAA) at CAISO intertie Scheduling Points from System Resources (SRs) and Tie-Generators (TGs) when the associated energy is generated, consumed, or wheeled through an EIM BAA. The CAISO will automatically mirror the gross import/export schedule changes after T-40' from specified SRs and TGs at a CAISO intertie Scheduling Point by adjusting the schedule of an associated Mirror System Resource (MSR) at the same Scheduling Point. An import MSR may only be associated with export SRs, and an export MSR may only be associated with import SRs and TGs at the same CAISO Scheduling Point. The MSRs and their associated SRs and TGs must be registered in the Master File for the auto-mirror feature by the relevant EIM Entity Scheduling Coordinator.

MSRs may also be registered to participate in the auto-match feature, but only when the mirrored CISO intertie schedules are submitted as Self-Schedules without bids.

No real-time schedule change submission is allowed for MSRs registered for the auto-mirror feature since their schedules are determined by the market.

11.3.10 Manual Dispatch

Manual dispatches refer to a manual override of an EIM market dispatch in cases where the EIM Entity BAA recognizes a need to adjust the dispatch. Reasons for a manual dispatch include, but are not

limited to: congestion management not otherwise handled by the EIM market systems, response to contingency events, implementation of unscheduled loop flow procedures, or to comply with orders from a reliability coordinator, or to address operational issues in the EIM BAA that the CAISO Market is not able to address through the EIM auto-match feature.

EIM Entity BAA must inform CAISO RTM of any manual dispatch within its area which includes both participating and non-participating resources in the EIM BAA. The market will reflect the dispatch in the next RTD run whenever possible. CAISO will provide a software tool that will allow the EIM Entity operator to enter a Manual Dispatch. The manual dispatch will include information such as resource name, start and end time, and megawatt constraint values. The EIM Entity operator shall enter this information as soon as possible. Once entered, the EIM Entity operator has the ability to modify the instruction while it is still active; for example, extending the time of the dispatch.

Once received by CAISO, CAISO will dispatch the resource in the next applicable market interval in accordance with the manual dispatch. Note that the market systems will still honor resource constraints. For example, the market systems may take several intervals to dispatch a resource to be within the manual dispatch constraint range if the resource is limited by ramp rate capability.

11.3.11 Load Forecast Operator Adjustments

The EIM BAA operators, like the CAISO operators may adjust –upwards or downwards- the load forecast of either the fifteen- and five-minute market used in the market clearing process to reflect the system needs and conditions. However, the operator adjustments to load forecasts tend to be coarse adjustments and the the operator cannot know at the time the adjustment is made exactly what will be the system ramp. Therefore, in making the adjustment, the operator could cause the load forecast to exceed the system's ability to respond. Such coarse adjustments, if more than necessary, can produce unnecessary infeasible market solutions. To prevent such over-adjustments, the CAISO employs a feature that limits the load forecast adjustment in the CAISO and EIM balancing authority areas, which automatically limits the course operator adjustment to what is feasible as long as the quantity of the infeasibility is less than the operator adjustment and is in the same direction as the operator adjustment.

The collects from each EIM BAA entity relevant data about load bias, including the frequency, volume and reasons for load bias in the fifteen- and five-minute markets, as well as any alternatives considered (e.g., use of manual dispatch).

Note: Please refer to Market Operations Appendices BPM Attachment M for details on load forecast conformances.

11.3.12 Contingency Dispatch

The Real-Time Contingency Dispatch (RTCD) mode of operation is run in response to a significant Contingency event, such that waiting until the next normal Real-Time Economic Dispatch (RTED) run is not adequate.

RTCD produces an optimized set of Dispatch Instructions for a single five-minute Dispatch Interval for EIM Entity BAA. It is possible that Dispatch Instructions are issued more than once in the same five-minute Interval, once from RTED and later from RTCD. Resources must respond to RTCD Dispatch Instructions as soon as possible. The Dispatch Instructions from RTCD override any previously issued Dispatch Instructions from RTED.

11.3.12.1 In the Event of a Contingency in CAISO

- RTUC shall isolate the CAISO BAA from the rest of the EIM Area by fixing the EIM Transfer between the CAISO BAA and the EIM Entity BAAs at the last non-contingency market solution for binding and advisory intervals.
- RTD shall use prior advisory interval results for EIM Participating Resources while RTCD or RTDD is invoked for CAISO, unless curtailments of the EIM Transfer have occurred. In this case, the EIM Transfer will be capped at the minimum of the curtailed limit or the advisory dispatch from the last non-contingency market solution for the duration of the contingency status. The advisory results come from the last RTD before the contingency event, and shall be sent through the Automatic Dispatching System (ADS).
- This process will persist for the duration of the contingency status until RTD runs are reinstated.
- The contingency dispatch instructions for CAISO internal or CAISO dynamic resources shall be sent through ADS normally.
- Any contingency reserves dispatched in RTCD/RTDD from Intertie Resources shall be included in the CAISO BAA Net Scheduled Interchange.

11.3.12.2 In the Event of a Contingency in an EIM Entity Area

Contingencies in an EIM Entity area are generally handled by that EIM Entity, since the EIM Entity manages their own operating reserves. Thus RTCD will not be used in this case. However, the regular market systems, RTUC and RTD, will adjust available resources within the affected area to help manage the contingency situation.

- In the event of a contingency, the EIM Entity Operator will electronically communicate the contingency status to RTM.
- RTD shall isolate that EIM Entity Area from the rest of the EIM Area by fixing the EIM Transfer between the CAISO BAA and the EIM Entity BAAs at the last non-contingency market solution for binding and advisory intervals.
- The contingency flag of the EIM Entity BAA shall be published through ADS.
- The EIM Entity Operator for the EIM Entity BAA that is under contingency may dispatch manually contingency reserves from resources (participating or not) in the BAA or Interchanges through interties with other BAAs outside the EIM Area; these manual dispatch instructions must be sent to RTM. Any interchange schedules changes shall be included in the EIM Entity BAA NSI.
- RTD shall be run with the latest operating conditions and any manual dispatch instructions. Within the affected EIM Entity area, RTD will adjust available resources and manually dispatched resources in order to help manage the contingency event.
- RTD/RTPD will set and broadcast Flex Ramp UP and Flex Ramp Down requirements to zero in the EIM BAA(s) undergoing contingency.
- RTD/RTPD will not use any existing Flex Ramp UP and Flex Ramp Down awards from the EIM BAA(s) undergoing contingency.
- RTD/RTPD will subtract the Flex Ramp Up requirements from the EIM BAA(s) undergoing contingency with pro rata diversity factor from the overall EIM area requirement, such that the adjusted EIM area's Flex Ramp UP and Flex Ramp Down requirement with one or more EIM BAA undergoing contingency is:

Adjusted EIM Area Requirement = max{M, [(Original EIM Area Requirement) – (Diversity Factor) * Σ(Original Requirement of BAAs under contingency)]}

Where:

M = max(Original Requirement of BAAs without contingency)

Diversity Factor = (Original EIM Area Requirement) / Σ(Original BAA Requirement of all BAAs in the EIM Area)

- Designated interval(s) in which an EIM BAA(s) experienced a contingency event will be published on OASIS.

For EIM Entities that represent multiple EIM Entity BAAs, the functionality described above is also supported at the each BAA; therefore, the contingency signal will specify either the EIM Entity BAA or the EIM Entity BAA group.

11.3.13 FMM Interchange Schedules based on RTSI

Markets translate pre-hour interchange schedules into 15-minute schedules. The FMM calculates schedules reflective of the expected outcomes and align with the 5-minute real-time market using the following logic:

FMM Market Interval	*Calculated Fifteen-Minute Schedule (based on RTSI Schedule Submissions)*
:00 to :15	*The schedule submission for 5-minute interval value at end time :15*
:15 to :30	*Average of the schedule submissions for 5-minute intervals beginning at minutes :15, :20, and :25 of trade hour (i.e. each 5-minute interval spanning from :15 to :30)*
:30 to :45	*Average of the schedule submission for 5-minute intervals beginning :30, :35, and :40 (i.e. each 5-minute interval spanning from :30 to :45)*
:45 to :00	*The schedule submission for 5-minute interval value at start time :45*

11.4 Contingencies and Corrective Actions

With the implementation of the EIM, measures must be in place to ensure a smooth transition from the current CAISO markets to include the co-optimization with EIM Entities. These measures must consider grid reliability, market stability, and other system conditions for all market participants. Although CAISO will do everything possible to assure a successful transition and operation of the EIM, problems may arise which would require the EIM Entity to be suspended and potentially revert back to a previous state.

A monitoring strategy is necessary to evaluate whether or not the EIM is performing according to market design and system requirements. In the event that either the market design or the software systems are not performing as expected, a series of pre-defined steps will need to be followed to address the situation and all resulting impacts.

This section of the EIM BPM covers the overview of the criteria used to arrive at the decision to revert back and to provide a high level plan to ensure a reliable and orderly termination.

11.4.1 Recovery Approach

In the event that data exchange and/or communication between CAISO and the EIM Entity BAA are disrupted, the following steps may be implemented to handle such disruptions:

1. When certain input data becomes unavailable and there is a recent history that can be used by the market applications, the latter can continue to function producing approximate, acceptable market results. For example, if demand forecast becomes unavailable, the last available demand forecast for that period could be used for the market horizon and for several market runs. Similarly, if telemetry becomes unavailable, the last SE solution can be used in the next market run. This recovery approach can be used until the data is considered too old to produce reasonable market results. The time cutoff depends on the nature and importance of the data and will be determined separately for each data stream.
2. When a market run fails, advisory market results from the last successful market run can be used. This recovery approach can be used until all advisory intervals run out.
3. When certain input data becomes unavailable, the affected BAA can be isolated from the EIM by freezing the Net Scheduled Interchange, the demand, and the dispatch at the last market solution within the hour, and at the base for future hours, and also by ignoring bids in that BAA. The market applications will still produce market results for the remaining BAAs in EIM. The affected BAA operator must balance the BAA outside EIM through regulation and dispatch instructions issued directly to resources, following pre-EIM protocols. LMPs will be calculated for that BAA and will be used to settle Uninstructed Imbalance Energy. This disruption is not expected to last more than one trading day.
4. If disruption is prolonged, an additional option can be enabled to suppress settlement statements for the affected BAA.
5. When market runs continuously fail and the above disruptions are no longer applicable because the advisory dispatches are exhausted and the market application cannot run, the fallback is the Day-Ahead schedules for the CAISO BAA and the Base Schedules for the EIM Entity BAAs; each BAA operator will balance the BAA through regulation and dispatch instructions issued directly to resources. Administrative prices will be used to settle imbalance energy. The CAISO will use the Open Access Transmission Tariff (OATT) approved price used by the EIM Entity during a market suspension to settle imbalance within the EIM Entity BAA.

Corrective Actions

Summary of Authority to Address Contingencies	
Period	CAISO Corrective Action(s)
Initial 60 days from Implementation Date	Discontinuation: per Tariff Section 29.1(d)(1): ➢ Prevent EIM Transfers ➢ Suspend EIM settlements ➢ Terminate participation of EIM Entity (if resolution is not achieved within Tariff timeframes)
After 60 days from Implementation Date (ongoing operations)	EIM Disruption: per Tariff Section 29.7(j) ➢ Prevent EIM Transfers ➢ Communications failure measure ➢ Market run failure measure ➢ Establish administrative prices ➢ Suspending EIM settlements is not available CAISO option, but CAISO will respond to request from EIM Entity for termination of EIM participation
After EIM Entity Notice of Termination (180 day notice period)	Termination for this time period not at election of CAISO. CAISO would respond to Termination of EIM Entity with the following measures: ➢ Prevent EIM Transfers (day 1 of 180 day period) ➢ EIM Entity is switched to "non-EIM Entity" (day 2 of 180 day period)

11.5 Separation of the EIM Entity

In the event the EIM Entity needs to separate from the EIM, CAISO will take appropriate steps to restrict operations and suspend settlements within the market.

11.5.1 EIM Entity Separation from Market

When a separation is activated by CAISO, the followings will apply:

- SIBR will reject any energy bids from the resources that belong to the EIM Entity BAAs. As a result, there will be no unit commitment or economic dispatch for EIM resources in the real-time market.
- The flexible ramping requirement will be set equal to zero for the EIM Entity BAA. Also, the flexible ramping requirement will be set to fail for EIM Entity BAA.
- To avoid imbalance energy settlement under separation, EIM Entity is responsible to submit base schedules and meter data.
- There will be no incremental transfer between EIM Entity BAA and the CAISO BAA.
- There will be no congestion management and no transmission constraint enforcement for the EIM Entity BAA.
- The EIM Entity SC shall submit meter in alignment with T+55B Recalculation Statement (Final Meter Submittal T+48B).
- EIM Entity SC shall submit the meter equal to the total expected energy for all the EIM Entity BAA resources.
- As normal process, the settlement produces statements at T+3B and T+12B using estimation of meter, which is the total expected energy from the market. If an EIM Entity BAA activates the separation flag, the expected energy calculated from the market will equal to the Base Schedule for all the resources/loads/interties that belong to this BAA. Therefore, the estimation of meter will equal to Base Schedule. The EIM imbalance energy will equal to zero.

Note: The EIM Entity will be responsible for Base Schedule, meter submission, and imbalance energy settlement if the meter is not equal to the Base Schedule.

11.6 Advanced Load Forecasting System (ALFS)

11.6.1 Requirements for Load Forecasting

CAISO forecasts load demand for each hour of the next nine Operating Days utilizing advanced utility industry accepted neural-network forecasting software for each load forecast zone. In order to accurately forecast the load zone, the software requires historical load profiles and utilizes an ensemble of weather forecasting data sources for each zone.

CAISO's forecasting software requires the following:

- Defined EIM Entity Balancing Authority Areas to forecast.
- Defined national weather stations within EIM Entity Balancing Authority Areas
    - CAISO will contract to receive hourly weather data from weather forecast vendor (s) for stations and historical weather data, to use as an input for EIM load forecast.
- The five-minute average historical load data (at least two years) to train the forecast software.
- PI tags for EIM load data points as input to collect five-minute average data that feeds into software.

Using the above data for input into the neural-network forecasting software, CAISO will create and continually monitor its load and weather forecasting results to ensure the average forecast error is minimized.

11.7 Variable Energy Resource (VERs)

This section is based on CAISO Tariff Sections 4.6.1.1, 4.8, 9.3.10; Appendix F, *Rate Schedules*; and Appendix Q, *Eligible Intermittent Resources Protocol (EIRP*).

11.7.1 Forecast Fee

11.7.1.1 Variable Energy Resource Forecast Charge

In general CAISO will charge EIM Entity Scheduling Coordinators and EIM Participating Resource Scheduling Coordinators a fee for the Variable Energy Resource forecasting services in accordance with Appendix F, Schedule 4.

CAISO will waive the Variable Energy Resource forecast charge if an EIM Entity has an independent forecast for its Variable Energy Resources and provides the independent forecast to CAISO.

11.7.2 EIM Variable Energy Resource Forecasting

EIM Variable Energy Resources, both participating and non-participating, may provide the CAISO with an independent third party forecast of energy output or through the CAISO forecasting service. . In addition, if an EIM Entity certifies to the CAISO that it produces its own Variable Energy Resource forecast to operate its EIM Entity Balancing Authority Area and the CAISO is able to verify the accuracy of the forecast initially and on an ongoing basis, this forecast will be accepted by the CAISO as independent. The forecast granularity produced by an EIM Entity approved forecast service provider must be produced in five-minute intervals and updated every five minutes. The forecast of EIM Variable Energy Resources must be automatically submitted to the CAISO forecast system.

EIM VER resources shall submit base schedules and/or bids to the markets. The forecasts will be used to adjust the base schedule (if no bid) or the bid curve to reflect the forecast. The dispatch from CAISO real-time application will be the financial binding schedules.

If the EIM Variable Energy Resource elects the CAISO forecast, the EIM Variable Energy Resource must make metrological data available at minimum 30 days in advance of a forecast being produced the CAISO system can do the forecast for EIM Variable Energy Resources.

If the EIM Entity elects the VER Persistence Market Model Forecast within the RTD market for solar resources, the EIM Variable Energy Resource must provide 1 year of metrological/production data. This data is to compute reference curves used in creating the forecast. If the EIM Entity elects the VER Persistence Market Model Forecast within the RTD market for wind resources, the 30-day minimum of metrological/production data is adequate.

The VER Persistence Market Model Forecast cannot be elected for fuel types outside of wind/solar, and is only available to resources that have similar response to weather conditions or other variables relevant to forecasting renewable energy. For example, if a solar resource has a Pmax of 300 MW and 50 MW can be moved with gas support, it is not eligible.

In addition, the EIM participating resource, similar to VER resources located in the CAISO BAA, may elect to use SC forecast option that will allow it to submit its five-minute output forecast to CAISO SIBR system. The SC forecast will be used as the financially binding forecast under this election.

12. SETTLEMENTS AND BILLING

Welcome to the *Settlements and Billing* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- The processes of Settlements and Billing within the context of the Energy Imbalance Market.

The business process for settlement of the fiscal results of participation in the EIM is outlined in the **BPM for Settlements and Billing**. That BPM provides an overview of the settlement, billing, invoicing, and financial clearing business functions, an overview of key settlement and billing principles, and an overview of the settlement and invoicing cycles.

12.1 Charge Codes

CAISO maintains the CA*ISO Market Charge Codes Matrix* which can be found by navigating to the Settlements subheading under the Market & Operations portion of the CAISO website. This matrix highlights which Charge Codes are applicable to the various forms of resources participating in the markets operated by CAISO. A detailed description of each settlement Charge Code or predecessor Pre-Calculation, including business rules and specific data calculation formulas, can be found in the *BPM Configuration Guide* documents posted under the Settlements and Billing section of the BPM Document Library on the CAISO website. Section 8 of the **BPM for Settlements and Billing** provides details on how to use and read a *BPM Configuration Guide*.

Settlements concepts unique to participation in the EIM include settlements related to Over- and Under-Scheduling of EIM Base Schedules, the EIM Initial Fee, and EIM Administrative Charges. As documented in Sections 29.11, 29.26, and 29.32 of the CAISO Tariff, calculations of some settlement Charge Codes have EIM-specific implications referencing the submitted EIM Base Schedules or the transfer of energy between BAAs participating in the EIM. In addition, the calculation of the settlement of the Real-Time Congestion Offset will incorporate the respective pieces of the congestion component of the LMP for PNode in each EIM BAA as noted in the formulas contained in the Configuration Guide for the Real-Time Price Pre-Calc. However, CAISO will not calculate and invoice charges related to FERC fees or NERC/WECC fees for EIM participants. In addition, there will be no charge between CAISO and EIM balancing authorities for use of transmission to support EIM Transfers for the first year of EIM operation. During this time, as stakeholders gain operational experience and additional balancing authorities consider joining the EIM, CAISO will coordinate with stakeholders to consider various alternatives for a long-term transmission rate design.

12.2 Disagreements

Any disagreements with the published results of CAISO's settlement process for the EIM must be submitted to CAISO by the Scheduling Coordinator with which CAISO settled and are governed by the dispute process outlined in Section 2.3.5 and Section 5 of the **BPM for Settlements and Billing**. Disputes by a non-participating resource of amounts calculated by CAISO and distributed to it by an EIM Entity Scheduling Coordinator are between the non-participating resource and the EIM Entity Scheduling Coordinator, not with CAISO. If an EIM Entity Scheduling Coordinator disagrees with the amounts

calculated by CAISO for EIM non-participating resources, the EIM Entity Scheduling Coordinator is responsible for submitting a settlement dispute through the process outlined in Section 2.3.5 and Section 5 of the **BPM for Settlements and Billing**.

12.3 Suspension

In the case where there is a suspension of EIM participation by an EIM Entity, as described in Section 10.5.1 of this BPM, a Market Notice will be issued by CAISO to alert all market participants. The EIM Entity will still be required to submit Base Schedules during the period of the suspension along with meter data matching those values. CAISO will manually suspend the calculation of Unaccounted For Energy (UFE) for the EIM Entity BAA, but will continue to generate and publish settlement statements utilizing the Base Schedule and meter data information submitted by the EIM Entity.

13. READINESS

Welcome to the *Readiness* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find:

- Descriptions of the established readiness criteria categories
- A listing of readiness criteria, metrics and thresholds
- Information on the process for readiness determination, reporting and certification.

13.1 Readiness Criteria Categories

The readiness criteria are intended to support readiness certification prior to implementation. Leading to certification, the EIM Entity and CAISO will conduct appropriate steps to ensure that each criteria is evaluated compared with the metric and threshold.

- EIM Entity Full Network Model Integration – in order to participate in EIM, the prospective EIM Entity's full network model is integrated into CAISO full network model. This activity precedes testing and is demonstrated during market simulation. The incorporation of the EIM Entity's network model into CAISO's production full network model follows the standard promotion process and timing.

- Agreements – prior to the established implementation date, the prospective EIM Entity must execute all necessary agreements in accordance with the timelines described in section 5 of the EIM Business Practice Manual.
- Training –CAISO provides training for prospective EIM Entity operators before and during market simulation. All training is to be completed prior to the start of parallel operations.
- Forecasts – forecasting capabilities are established and measured during the market simulation.
- Balanced Schedules– balanced schedule capabilities are measured during the market simulation.
- Operating Procedures - the prospective EIM Entity and CAISO will review and test applicable operating procedures prior to the start of parallel operations.
- System Readiness & Integration - the prospective EIM Entity and CAISO will perform functional and system testing and system integration testing.
- Market Simulation - the CAISO will conduct a market simulation for the prospective EIM Entity and any participating resource scheduling coordinators registered with the prospective EIM Entity prior to that new prospective EIM Entity entering EIM.
- Settlements – the CAISO submits a settlement statement to the prospective EIM Entity including EIM participating and non-participating resources and load. The prospective EIM Entity will verify the accuracy of the CAISO settlement statement to the prospective EIM Entity. Prior to financially binding operations, the prospective EIM Entity will demonstrate it can produce allocations of the CAISO settlement to its customers that are verifiably accurate against available data.
- Monitoring – the CAISO ensures that the CAISO Market Analysis Team and the Department of Market Monitoring have the data that is required to adequately monitor market performance.
- Parallel Operations Planning – the CAISO and prospective EIM Entity ensure that systems, processes and staff are prepared for deployment of systems, parallel operations, and support beyond parallel operations for issues that may arise.
- Communication - the CAISO and prospective EIM Entity ensure all tools and procedures used for communication between the CAISO and prospective EIM Entity are in place and tested before the implementation date
- EIM Available Balancing Capacity – the CAISO and the prospective EIM Entity register resources that the prospective EIM Entity intends to identify as EIM Available Balancing Capacity in the EIM Resource Plan.

13.2 Readiness Metrics, Criteria, and Thresholds

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
1	Prospective EIM Entity Full Network Model Integration	Generation, Interchange and Load comparison	Load, EIM Internal Intertie and EIM External Interties, and Generating Unit definition in the Full Network Model is consistent with the Load, EIM Internal Intertie and EIM External Interties, and Generating Unit definition in the exported prospective EIM Entity network model file that it delivered to the CAISO.	Data matches within 10%, measured in MW capacity to start parallel operation, and within 5% before full activation. Discrepancies, if any, are accounted for in terms of imbalance adjustment
2	Prospective EIM Entity Full Network Model Integration	Comparison of SCADA measurement	SCADA measurements used in prospective EIM Entity EMS model match the measurements observed by the CAISO through the CAISO EMS model	Critical and used SCADA measurements match 90% to start parallel operation and 95% before full activation, measured in MW, outside of any exception in EMS model
3	Prospective EIM Entity Full Network Model Integration	State Estimator solution	CAISO state estimator solution is equivalent or superior to the prospective EIM Entity state estimator solution for its Balancing Authority Area.	State Estimator solutions converge >90% of the time in two days before parallel operation and three days before full activation. Solution differences within 10% before parallel operation and 5% before full activation measured in MW or justified due to different external BAA modeling
4	Prospective EIM Entity Full Network Model Integration	Non-Conforming Load, Behind-the-Meter Generation, Pseudo Ties, and Dynamic Schedules	Physical representation of the prospective EIM Entity's network matches the Base Market Model that accounts for non-conforming load, behind-the-meter generation, pseudo-ties, and dynamic schedules, and third party transmission	Prospective EIM Entity major non-conforming loads > 5% of prospective EIM Entity total actual load in MW are modeled separately from conforming load in market model

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
			service provider and path operator information that supports EIM Transfers and Real-Time Dispatch in the Energy Imbalance Market, as applicable	
5	Agreements	Execution of Necessary Agreements	The prospective EIM Entity has executed all necessary agreements.	The prospective EIM Entity will execute all agreements, as outlined in Section 5 of the EIM BPM within the required timelines outlined in Section 5.
6	Operations Training	Completion of mandatory training courses	Prospective EIM Entity operators who will have responsibility for EIM operations, transactions and settlements, will complete CAISO training modules.	Prospective EIM Entity operators will complete training and close-of-training assessment in the appropriate timeframes as outlined in • "100 series"– an introduction to Energy Imbalance Market training • "200 series"– the specific hourly and daily tasks and duties for normal operation training module; and • "300 series"– the assessment of market results and response to contingencies and abnormal situations training module.
7	Forecasting Capability	Load forecast capability	Definition of EIM demand forecast boundaries based on the conforming and non-conforming load characteristics, as applicable	All Plant Information (PI) tags and historical data for defined load area(s), and non-conforming load, if applicable, compared with load forecasts provided from CAISO (if CAISO load forecast used).

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
			• Accuracy of the CAISO forecast of EIM demand based on historical actual load data for the defined EIM demand forecast boundaries. • Identification of weather station(s) locations used in forecasting, if applicable,	
8	Forecasting Capability	Variable Energy Resource (VER) forecast capability	Identification of the source of VER forecasts. (If a participating wind or solar unit requires a CAISO forecast, then BPM and Tariff requirements apply.)	Forecasting entity must demonstrate delivery of Unit MW forecast at 5 min intervals for at least three hours ahead. Forecasting entity must also provide base schedule by T-75, T-55 and T-40. EIM Entity provides to CAISO real-time MW production PI tags.
9	Forecasting Capability	Flexible capacity requirements	CAISO has established flexible capacity requirements for the prospective EIM Entity Balancing Authority Area and the combined EIM Area including the prospective EIM Entity	The CAISO has received and stored all historical data from the prospective EIM Entity necessary and sufficient for the CAISO to perform the flexible ramp requirement.
10	Balanced Schedules	Base schedule balancing capability	The prospective EIM Entity Scheduling Coordinator demonstrates its ability to balance EIM demand and EIM supply for the prospective EIM Entity's Balancing Authority Area	90% or greater of base schedules balance tests during monitored hours are within 10% average imbalance of load forecast over one day period before parallel operation, and 5% average over five full days before full activation. The CAISO will provide examples of MW thresholds for each prospective EIM Entity to indicate a reasonable threshold

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
				as it applies to a given EIM Entity and indicate the potential implications of a swing from 5% over to 5% under forecast in one hour to the next.
11	Balanced Schedules	Flexible ramping sufficiency test capability	The prospective EIM Entity \ Scheduling Coordinator demonstrates its ability to pass the flexible ramping sufficiency test	Passes 90% of the time or greater over monitored hours of one day before parallel operation and five non-consecutive days before full activation
12	Balanced Schedules	Capacity test capability	The prospective EIM Entity Scheduling Coordinator demonstrates its ability to pass capacity test	Passes 90% of the time or greater over monitored hours of one day before parallel operation and five non-consecutive days before full activation. The CAISO will explain the implications of any potential issues with the reliability of an EIM Entity to meet its capacity requirements.
13	Operating Procedures	CAISO operating procedures (relevant to EIM operations)	The prospective EIM Entity signs CAISO non-disclosure agreement and receives appropriate CAISO "public" and "restricted" operating procedures	Operating procedures NDA signed by the prospective EIM Entity. The prospective EIM Entity receives CAISO operating procedures four months prior to the parallel operations date.
14	Operating Procedures	Prospective EIM Entity operating procedures	The prospective EIM Entity operating procedures are defined, updated, and tested for the EIM Entity Scheduling Coordinator	The prospective EIM Entity operating procedures are updated tested and implemented prior to parallel operations date.

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
15	System Readiness & Integration	Functional Testing	The prospective EIM Entity and the CAISO will test the functional and system elements in accordance with functional and system testing documentation posted on the CAISO website	All tasks identified in the functional and system testing documentation are completed and will not have any issues deemed significant. Any exceptions will be explained or have an interim solution that is functionally equivalent.
16	System Readiness & Integration	System Integration	The prospective EIM Entity and CAISO will test system integration testing in accordance with the system integration testing documentation posted on the CAISO website	All tasks identified in the system integration testing documentation are completed and will not have any issues deemed significant. Any exceptions will be explained or have an interim solution that is functionally equivalent.
17	System Readiness & Integration	The prospective EIM Entity system access complete	All prospective EIM Entity employees who require system access to perform EIM-related job functions identified and have necessary certificates.	All prospective EIM Employees performing job functions for EIM market are identified. All CASIO issued certificates are requested within the appropriate timeframes. All identified employees provided the necessary EIM system access certificates.
18	System Readiness & Integration	ISO - prospective EIM Entity interfaces	Data interfaces between prospective EIM Entity's systems and CAISO systems are tested	ISO and prospective EIM Entity identify significant data interface issues.

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
				EIM Entity and CAISO executives to approve exceptions.
19	Market Simulation	Day in the life simulation	The prospective EIM Entity operators are able to meet the market timelines	The prospective EIM Entity grid operations staff complete end-to-end daily market workflow with no critical defects.
20	Market Simulation	Structured scenarios simulation	The prospective EIM Entity operators execute and pass all structured scenarios provided by CAISO	All significant issues resolved or have an interim solution that is functionally equivalent.
21	Market Simulation	Unstructured scenarios simulation	The prospective EIM Entity operators execute and pass all unstructured scenarios provided by prospective EIM Entity	All significant issues resolved or have an interim solution that is functionally equivalent.
22	Market Simulation	Market results reports	Market results are appropriate based on inputs	The prospective EIM Entity and CAISO executive project sponsors approve the market results reports during market simulation
23a	Market Simulation	Market quality review	Prices are validated based on input data	Market simulation prices and MWs schedules/dispatches are validated by CAISO market quality team for entry into parallel operation
23b	Parallel Operations	Market quality review	Prices are validated based on input data	Parallel operations prices and MWs schedules/dispatches are validated by the CAISO market quality team

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
24	Market Simulation	The prospective EIM Entity Identification	Validation of SCID's and Resource ID's	The CAISO has established and the prospective EIM Entity has tested all necessary SCIDs and Resource IDs established for the prospective EIM Entity's Balancing Authority Area
25	Settlements	ISO Settlement Statements and Invoices published to the prospective EIM Entity and EIM Participating Resources	The CAISO Settlement statements and invoices match the operational data published to stakeholders or fed into settlement system and the resulting calculations correspond to the formulas defined in ISO's tariff and BPMs	Monthly settlement statement and invoice with corresponding daily statements produced during market simulation and parallel operations are verifiably accurate against available data.
26	Settlements	The prospective EIM Entity settlement statements and invoices reflect accurate allocations to the prospective EIM Entity customers prior to financially binding operations.	Verification that settlement statements and invoices accurately reflects system and market data	The prospective EIM Entity settlement statements and invoices that allocate charges and credits to its customers accurately reflect system and market data during parallel operations.
27	Monitoring	Data monitoring	Sufficient and adequate data is available to the CAISO and the Department of Market Monitoring	All required market monitoring data is available during testing and during post go-live for the key metrics (any exceptions will be addressed). CAISO will provide a market report that will provide publicly available information to all market participants.
28	Parallel Operations Plan	Deployment plan	Parallel operations run consistently and in accordance with the timeframe set forth in the prospective EIM Entity	Parallel operations runs consistently within normal production CAISO Market disruption tolerances.

Readiness Criterion Identifier	Readiness Category	Criteria	Measurable Elements	Threshold*
			specific parallel operation plan	
29	outage management system	Transmission and generation outage submittal and retrieval	The prospective EIM Entity will verify its ability to submit and retrieve outage information with the CAISO	The prospective EIM Entity validate their ability to submit and retrieve transmission out-of-service outages, generation Pmax derates, generation Pmin rerates, and generation out-of-service outage tickets within the required timelines.
30	Communications between the CAISO and the prospective EIM Entity	Voice and/or electronic messaging	Implemented process and procedures used for voice and/or electronic messaging	The process and procedures are incorporated into the prospective EIM Entities business processes before the start of market simulation.
31	Communications between the CAISO and the prospective EIM Entity	Communication tools	Staff are trained on communication procedures and tools	The prospective EIM Entity operations staff who will have responsibility for EIM operations, transactions and settlements are trained on the relevant operating procedures and tools used for EIM related communications before the start of parallel operations
32	Communications between the CAISO and the prospective EIM Entity	3rd party transmission service provider	The third party transmission service provider information that supports EIM Transfers and Real-Time Dispatch included in the Full Network Model is available during parallel operations	The CAISO provides third party transmission service provider and path operator information to the prospective EIM Entity through parallel operations
33	EIM Available Balancing Capacity	Identification of EIM Available Balancing Capacity	Participating resources and non-participating resources for EIM Available Balancing Capacity.	The prospective EIM Entity has identified EIM participating resources and non-participating resources that it intends to designate in the EIM Resource Plan as EIM Available Balancing Capacity

Exceptions to Thresholds

Any exceptions to the adherence to the thresholds listed above will be considered by the CAISO and prospective EIM Entity in accordance with the procedures for granting exceptions outlined below, explained fully in stakeholder calls, noted on the readiness dashboard that is posted on the CAISO website. Exceptions will also be explained in the certification statements of the CAISO and the EIM Entity. With each prospective EIM Entity implementation, the CAISO will revisit the readiness thresholds and make modifications based on stakeholder feedback.

Any exception to a threshold would be reviewed by the responsible staff, escalated to the senior officers ultimately responsible for certification, and then documented in the readiness report that supports the certification. The CAISO and the prospective EIM Entity will engage in a collaborative approach to satisfy the readiness criteria and endeavor to make decisions based on consensus between the parties. Both parties will strive to avoid exceptions by providing comprehensive updates and proactively managing issues and risks. When an exception is required, it will be defined by specifying what is not conforming and why an exception is necessary.

13.3 Readiness Reporting, Determination & Certification

Welcome to the *Readiness Certification* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- Timeline in which CAISO will report on the status of readiness criteria
- Timeline in which the CAISO and the EIM Entity Initiate will determine readiness
- Timelines in which CAISO and the EIM Entity Initiate will submit readiness certification to the Federal Energy Regulatory Commission

Readiness Reporting

CAISO will report at least monthly during market simulation and at least twice a month during parallel operations on the status of the readiness criteria. The reporting will be on the public CAISO web site (www.caiso.com), and will consist of current progress towards readiness thresholds and any exceptions or deviations from the readiness thresholds.

Readiness Determination

No later than 30 days prior to the prospective EIM Entity's Implementation Date, the CAISO will determine, in consultation with the prospective EIM Entity, whether the systems and processes of the prospective EIM Entity will be ready for participation in the Energy Imbalance Market. Readiness will be determined by the thresholds specified in section 2.1of the Business Practice Manual, with any exceptions for the certifying prospective EIM Entity.

Readiness Certification

CAISO and the prospective EIM Entity will track their progress and report on readiness criteria prior to filing for EIM readiness certification. Both parties will file a market readiness certificate with the Federal Energy Regulatory Commission 30 days in advance of the prospective EIM Entity established implementation date. The readiness certification will cover the following information:

- That the processes and systems of the prospective EIM Entity have satisfied or will have satisfied the readiness criteria as outlined above.
- Any known issues requiring resolution prior to the established EIM Implementation Date.
- Any exceptions from the readiness thresholds as outlined above.

That the EIM Implementation Date is conditional upon the resolution of any known issues identified in the certificates filed with FERC and any unforeseen issues that arise that undermine the satisfaction of the readiness criteria. If, subsequent to readiness certification the CAISO or the prospective EIM Entity determines they cannot proceed with implementation on the Implementation Date, the CAISO and the prospective EIM Entity will notify the Federal Energy Regulatory Commission of the delay, the reason for the delay, the new Implementation Date if it can be determined, and whether it will need to re-issue a portion or all of the readiness certification.

14. RULES OF CONDUCT

Welcome to the *Rules of Conduct* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- Summary of the behavior that is subject to Sanction under the CAISO Tariff Rules of Conduct (CAISO Tariff Section 37).

Participants in the CAISO markets are expected to comply with the provisions of the CAISO Tariff as well as requirements contained within its Business Practice Manuals. The process that CAISO undertakes to

ensure compliance with these documents is described in the **BPM for Rules of Conduct Administration**. A participant in the EIM is also subject to these rules as defined by their specific participation in the EIM.

15. CHANGE MANAGEMENT

Welcome to the *Change Management* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- Information relating to requests for additions, edits, deletions, revisions, or clarifications to a BPM, including any attachments and exhibits to a BPM that are expressly incorporated by reference.

The Business Practice Manuals (BPMs) developed by CAISO are intended to contain implementation detail consistent with and supported by the CAISO Tariff, including: instructions, rules, procedures, examples, and guidelines for the administration, operation, planning, and accounting requirements of CAISO and the markets operated by CAISO. Changes to the information provided in the BPMs posted by CAISO are governed by the process outlined in the **BPM for Change Management**.

16. DEFINITIONS AND ACRONYMS

Welcome to the *Definitions and Acronyms* section of the CAISO *BPM for the Energy Imbalance Market*. In this section you will find the following information:

- A list of defined terms, abbreviations, and acronyms that are used in the CAISO BPM for the Energy Imbalance Market.

The **BPM for Definitions & Acronyms** serves as a general reference for readers of the CAISO BPMs. It lists definitions used in the BPMs, including both newly defined terms and pertinent terms from the CAISO Tariff Appendix A. **The BPM for Definitions & Acronyms** also provides a list of acronyms used in CAISO BPMs, as well as acronyms associated with the remainder of the defined terms in Appendix A, regardless of whether they appear in the BPMs.

16.1 Acronyms

In this section you will find abbreviations and acronyms that are used in the CAISO EIM BPM.

Acronym	Definition
AANSI	Area to Area Net Scheduled Interchange
API	Application Program Interface
BPM	Business Practice Manual
CAISO	California Independent System Operator Corporation
CAISO BAA	The Balancing Authority Area of California Independent System Operator
DAM	Day-Ahead Market
DB	EIM diversity benefit
EIM	Energy Imbalance Market
EIM Entity BAA	The Balancing Authority Area of Entity that is participating in the Energy Imbalance Market
External BAA	The Balancing Authority Area of Entities that are not CAISO BAA. External BAA includes EIM Entity BAA, non-EIM Entity BAA, and boundary BAA that are not modeled in the FNM.
HVDC	High-Voltage Direct Current
Non-EIM Entity BAA	The Balancing Authority Area of Entity that is not participating in the Energy Imbalance Market
NSI	Net Scheduled Interchange
OCO	Outage Coordination Office
OMS	outage management system
PSE	Purchasing Selling Entity
RDT	Resource Data Template
RTM	Real-Time Market
WECC RC	Western Electricity Coordinating Council Reliability Coordinator

16.2 Definitions

In this section you will find terms and definitions that are used in the CAISO EIM BPM.

Term	Definition
Base Schedule	A forward energy schedule, with hourly granularity, that is the baseline to measure deviations for settlement through the EIM. Base Schedules include the hourly forecasts of load, hourly generation schedules, and hourly interchange schedules.
EIM Entity	A Balancing Authority that represents one or more EIM Transmission Service Providers and that enters into an EIM Entity Agreement with CAISO to enable the operation of the Real-Time Market in its Balancing Authority Area (BAA).
EIM Entity Scheduling Coordinator	The EIM Entity or a third party designated by the EIM Entity that is certified by CAISO and that enters into an EIM Entity Scheduling Coordinator Agreement, under which it is a Scheduling Coordinator and a Market Participant and is responsible for meeting the requirements specified in Section 29 on behalf of the EIM Entity.
EIM BAA	Individual EIM BAA, include CAISO
EIM footprint	Includes all EIM BAAs and CAISO
EIM Net Imbalance Interchange	The net energy transfer of real time between an EIM Entity BAA and the CAISO BAA or between EIM Entity BAAs as a result of EIM market optimization. It is calculated after the EIM market optimization, excluding Base Schedule. **EIM Transfer out** is the net imbalance energy export from the EIM Entity BAA**. EIM Transfer in** is the net imbalance energy import to the EIM Entity BAA**.**
EIM Participating Resource	An owner of, operator of, or seller of Energy from an EIM Resource that elects to participate in the Real-Time Market and enters into an EIM Participating Resource Agreement, under which it is responsible for meeting the requirements specified in Section 29 of the Tariff.

Term	Definition
EIM Participating Resource Scheduling Coordinator	The EIM Participating Resource, or a third-party designated by the EIM Participating Resource, that is certified by CAISO and enters into an EIM Participating Resource Scheduling Coordinator Agreement, under which it is a Scheduling Coordinator and is responsible for meeting the requirements specified in Section 29 of the Tariff on behalf of the resource.
EIM Transfer	The transfer of Energy in Real Time between an EIM Entity Balancing Authority Area and the CAISO Balancing Authority Area or between EIM Entity Balancing Authority Areas using transmission capacity made available to the Real-Time Market through the Energy Imbalance Market.
Energy Imbalance Market (EIM)	The rules and procedures in Tariff Section 29 governing CAISO's operation of the Real-Time Market in Balancing Authority Areas outside of the CAISO Balancing Authority Area and the participation of EIM Market Participants in the Real-Time Market.
Non-Participating Loads	The EIM Entity SC shall receive the settlement for the non-participating load. CAISO will settle EIM non-participating load UIE as the algebraic difference between the hourly meter data and the calculated Base Schedule at the applicable hourly Real-Time LAP price using volumetric weighted average LMP of 15-minute and 5-minute markets in that hour for the relevant LAP. The weights in the calculation are as follows: For the 15-minute LMP, it is the difference between 15-minute demand forecast and the demand forecast that was used to calculated base load at T-40 (Load + Loss). For the 5-minute LMP, it is the difference between 5-minute and 15-minute demand forecast. The LMP is bounded by Max/Min LMP over the hour: For Hourly LMP , is the sum of (15-minute LMP * 15-minute demand forecast deviation from the demand forecast that was used to calculate the base load at T-40) over four 15-minute intervals + Sum of (5-minute LMP * 5-minute demand forecast deviation from the 15-minute demand forecast) over twelve 5-minute intervals divided by The sum of [15-minute demand forecast deviation from the demand forecast that was used to calculate base load at T-40 over four 15-minute

Term	Definition
	intervals + the sum of (5-minute demand forecast deviation from the 15-minute demand forecast) over twelve 5-minute intervals]
Non-Participating Resource	A resource located within an EIM Entity that chooses not to make its resource available for dispatching in the Real-Time Market. The Entity Scheduling Coordinator must ensure that these resources are accounted for when determining balanced Base Schedules.
NSI Forecast	Net-Scheduled Interchange Forecast
Operating Day	The day when the Real-Time Market runs and Energy is supplied to Load.
Participating Resource	A resource located within an EIM Entity that elects to participate in the EIM. Through their Participating Resource Scheduling Coordinator, these resources submit bids to the CAISO which convey their availability in the Real-Time Market.
Participating Resource Scheduling Coordinator	An entity certified by CAISO that submits economic bids and is responsible for financial settlements for one or more Participating Resources.
Resource Plan	Hourly resource components must may cover a up to seven-day horizon beginning with the Operating Day, and must cover at least five hours.. The Resource Plan consists of a combination of load Base Schedules, generation Base Schedules, interchange Base Schedules, ancillary services plans of the EIM Entity, transmission available for EIM Transfers, and the bid range voluntarily submitted by EIM Participating Resources. Also, if an EIM Entity Scheduling Coordinator is not using CAISO demand forecast, then it includes demand forecast. Resource Plans balance demand and supply and are used in the resource sufficiency evaluation.
System Resource	A group of resources, single resource, or a portion of a resource located outside of the CAISO Balancing Authority Area, or an allocated portion of a Balancing Authority Area's portfolio of generating resources that are either a static Interchange Schedule or directly responsive to that Balancing Authority Area's Automatic Generation Control (AGC) capable of providing Energy and/or Ancillary Services to the CAISO Balancing Authority Area, provided that if the System Resource is providing Regulation to CAISO it is directly responsive to AGC.

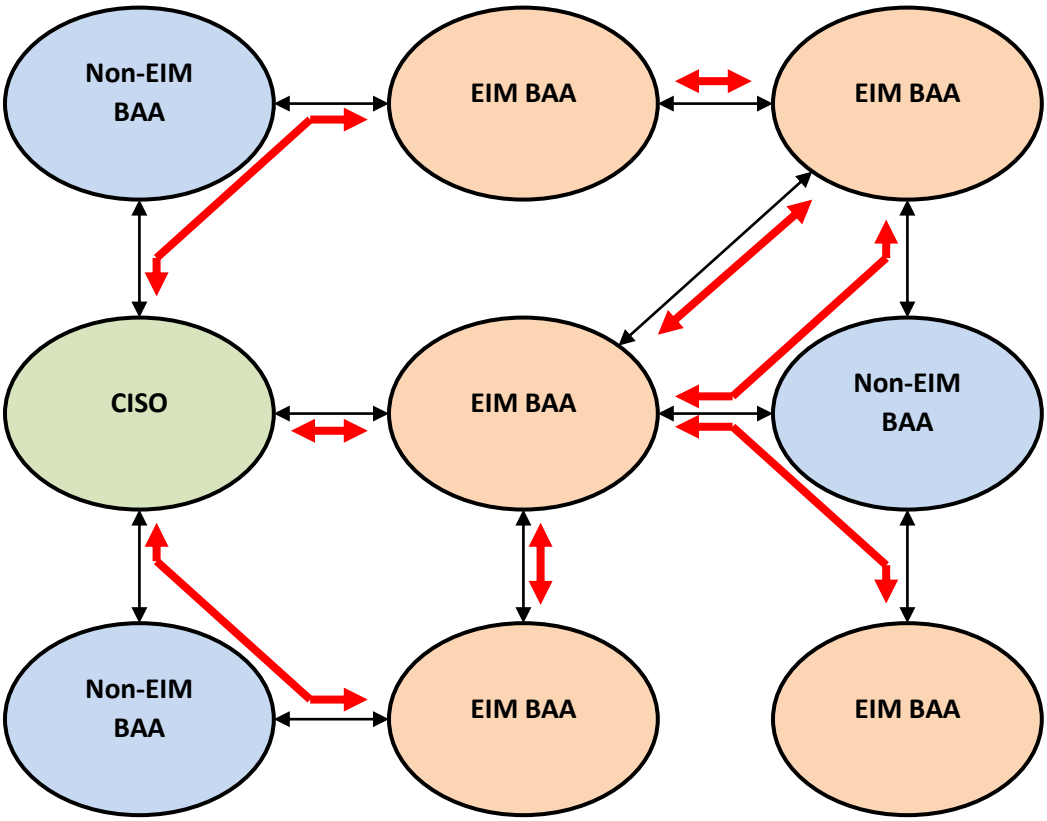
Term	Definition
EIM Reserves to Meet NERC/WECC Contingency Reserves Requirements	Any capacity that an EIM Entity Scheduling Coordinator has designated, in the EIM Resource Plan, as necessary to meet its NERC/WECC contingency reserves requirements in the applicable Trading Hour and which does not overlap with capacity designated in other parts of the EIM Resource Plan specified in Section 29.34(e)(3) of the CAISO Tariff.
EIM Downward Available Balancing Capacity	Any downward capacity from an EIM Participating Resources or a non-participating resource that an EIM Entity Scheduling Coordinator has identified in the EIM Resource Plan as available to address power balance and transmission constraint violations in the EIM Balancing Authority Area.
EIM Upward Available Balancing Capacity	Any upward capacity from an EIM Participating Resources or a non-participating resource that an EIM Entity Scheduling Coordinator has identified in the EIM Resource Plan as available to address power balance and transmission violations in the EIM Balancing Authority Area.

Appendix A: Mathematical Formulation for EIM Transfer

Energy Transfer Scheduling in Energy Imbalance Market

16.2.1.1.1 Introduction

This technical paper describes the calculation of Energy Transfer schedules between Balancing Authority Areas (BAAs) in the Energy Imbalance Market (EIM) Area from the optimal EIM Transfer calculated for each BAA in the EIM Area by the Real-Time Unit Commitment (RTUC) and the Real-Time Dispatch (RTD) applications. The methodology in this document is general to account an arbitrary network configuration of EIM and non-EIM BAAs in the Full Network Model (FNM), such as the example shown below:



EIM BAAs may be interconnected with the CISO directly, through another EIM BAA, through a Non-EIM BAA, or a combination thereof. The EIM Entity for an EIM BAA may have made available transmission rights on a direct interconnection with the CISO, on a direct interconnection with another EIM BAA, or on an indirect interconnection with the CISO or another EIM BAA through one or more non-EIM BAAs.

The red arrows in the example above illustrate such transmission rights. These transmission rights are essential to the EIM Transfers for each BAA in the EIM Area as they both allow and constrain the optimal exchange of imbalance energy among the BAAs in the EIM Area.

The EIM Transfer is an algebraic quantity (positive for export and negative for import) for the net energy exchange between a given BAA and the remaining BAAs in the EIM Area. The problem at hand is to determine the Energy Transfer schedules among the EIM BAAs and the CISO from the optimal EIM Transfers of the BAAs in the EIM Area using the available transmission rights without violating them. These Energy Transfer schedules can then be tagged to the relevant interties among the BAAs.

16.2.1.1.2 Energy Transfer System Resources

Although not necessary for implementation, it is convenient to define dedicated System Resources in each EIM BAA to anchor the Energy Transfer schedules from that BAA to other BAAs in the EIM Area for tracking, tagging, and settlement. These Energy Transfer System Resources (ETSRs) are defined as aggregate resources at the EIM BAA Default Generation Aggregation Point (DGAP), which is an aggregation of all supply resources in the BAA. Each ETSR is defined as either an import or an export resource, and it is associated with an EIM intertie with another EIM BAA, or a CISO intertie with the CISO. The associated intertie is one where the EIM Entity for the relevant EIM BAA has made transmission rights available for scheduling Energy Transfers from/to the other EIM BAA or the CISO.

At least two ETSRs must be defined in a BAA for each Energy Transfer schedule with another BAA in the EIM Area: one for import, and the other for export. An aggregate intertie may be used if there are multiple interties under the transmission rights that are made available. It may be necessary to define ETSRs for each intertie separately if the transmission rights are different for each one of them. It may also be necessary to define multiple ETSRs for each Transmission Service Provider (TSP) whose transmission rights are made available. Finally, it may be necessary to define different ETSRs for static 15min Energy Transfer schedules and dynamic 5min Energy Transfer schedules. The applicable transmission right limits can then be modeled as upper operating limits on the corresponding ETSRs.

For Energy Transfer schedules between BAAs in the EIM Area, the relevant ETSRs in these BAAs must be associated in import-export pairs since an Energy Transfer schedule between the BAAs is an import to one and an export to the other.

16.2.1.1.3 Notation

The following mathematical notation is used in this paper:

i	Node index.
j, k	BAA indexes; zero (0) is used for the CISO.
l	Intertie or Energy Transfer schedule index; in the latter case, it is the corresponding ETSR index (ETSR pair for Energy Transfers between BAAs in the EIM Area).
$\bar{}$	Accent denoting base schedule (RUC schedule for the ISO BAA).
$\hat{}$	Accent denoting gross tagged or forecasted interchange schedule between non-EIM BAAs.
$\sim$	Accent denoting initial values from the last AC Power Flow (ACPF) solution.
Δ	Denotes incremental values from the last ACPF solution.
$\forall$	For all…
$\in$	Member of…
$\wedge$	…and…
EIM	The set of CISO and all EIM BAAs.
BAA_j	The set of nodes in BAA j.
G_i	The generation at node i.
L_i	The load at node i.
$I_{j,k,l}$	The import schedule l into EIM BAA j from BAA k.
$E_{j,k,l}$	The export schedule l from EIM BAA j to BAA k.
D_j	The demand (load plus losses) forecast in BAA j.
$Loss_j$	The transmission loss in BAA j.
LPF_i	The loss penalty factor at node i.

$LPF_{j,k,l}$ The loss penalty factor at the Scheduling Point for intertie schedule *l* between BAA *j* in the EIM Area and non-EIM BAA *k*.

NSI_j The Net Scheduled Interchange of BAA *j*; positive for export and negative for import.

T_j The EIM Transfer of EIM BAA *j*; positive for export and negative for import.

$IT_{j,k,l}$ The import Energy Transfer schedule *l* of EIM BAA *j* from BAA *k* in the EIM Area.

$ET_{j,k,l}$ The export Energy Transfer schedule *l* of EIM BAA *j* to BAA *k* in the EIM Area.

$IT_{MAXj,k,l}$ The applicable limit of the import Energy Transfer schedule *l* of EIM BAA *j* from BAA *k* in the EIM Area.

$ET_{MAXj,k,l}$ The applicable limit of the export Energy Transfer schedule *l* of EIM BAA *j* to BAA *k* in the EIM Area.

$IT_{TRj,k,l}$ The transmission right for the import Energy Transfer schedule *l* of EIM BAA *j* from BAA *k* in the EIM Area.

$ET_{TRj,k,l}$ The transmission right of the export Energy Transfer schedule *l* of EIM BAA *j* to BAA *k* in the EIM Area.

$IT_{MAX15j,k,l}$ The static limit for the import Energy Transfer schedule *l* of EIM BAA *j* from BAA *k* in the EIM Area.

$ET_{MAX15j,k,l}$ The static limit of the export Energy Transfer schedule *l* of EIM BAA *j* to BAA *k* in the EIM Area.

$IT_{MAX5j,k,l}$ The dynamic incremental limit for the import Energy Transfer schedule *l* of EIM BAA *j* from BAA *k* in the EIM Area.

$ET_{MAX5j,k,l}$ The dynamic incremental limit of the export Energy Transfer schedule *l* of EIM BAA *j* to BAA *k* in the EIM Area.

$C_{j,k}$ The transmission cost of the Energy Transfer schedules of EIM BAA *j* from/to BAA *k* in the EIM Area.

16.2.1.1.4 Mathematical Formulation

This section describes the relevant calculations and mathematical formulae.

Base Schedules

The base Energy Transfer schedules between EIM BAAs are submitted along with the generation and intertie base schedules ahead of the market run. The base Energy Transfer schedules between EIM BAAs and the CISO are the corresponding intertie schedules from the Residual Unit Commitment (RUC)[3] and need not be submitted since they are known:

$$\left.\begin{array}{l}\overline{IT}_{j,0,l} = \bar{E}_{0,j,l} \\ \overline{ET}_{j,0,l} = \bar{I}_{0,j,l}\end{array}\right\} \ \forall j \in EIM \wedge j > 0$$

The base Energy Transfer schedules between EIM BAAs on the same intertie must be matching:

$$\overline{IT}_{j,k,l} = \overline{ET}_{k,j,l} \ \ \forall j,k \in EIM \wedge j \neq k \wedge j,k > 0$$

The base Energy Transfer schedules on a given intertie between two BAAs are submitted only for the ETSRs of one BAA, whereas the base Energy Transfer schedules for their ETSR counterparts of the other BAA are set to match. An ETSR attribute in the Master File is used to designate the ETSRs for which base Energy Transfer schedules are submitted and used for tagging, as explained in §11.1.5.

It is assumed that the base Energy Transfer schedules are feasible:

$$\left.\begin{array}{l}0 \leq \overline{IT}_{j,k,l} \leq IT_{MAXj,k,l} \\ 0 \leq \overline{ET}_{j,k,l} \leq ET_{MAXj,k,l}\end{array}\right\} \ \forall j,k \in EIM \wedge j \neq k \wedge j > 0$$

For efficiency, there should not be both an import and an export base Energy Transfer schedule on a given intertie; at least one of them ought to be zero.

The base EIM Transfer for each EIM BAA is the net of all base Energy Transfer schedules:

$$\bar{T}_j = \sum_{\substack{k \in EIM \\ k \neq j}} \sum_{l} \left(\overline{ET}_{j,k,l} - \overline{IT}_{j,k,l}\right) \ \ \forall j \in EIM \wedge j > 0$$

[3] Currently, RUC intertie schedules are not part of the base EIM Transfer because no scheduling is allowed from EIM BAA Scheduling Hubs in the Day-Ahead Market, and intertie schedules from existing CISO Scheduling Points in EIM BAAs are not considered EIM transactions; hence the base Energy Transfer schedules with the CISO and the base EIM Transfer for the CISO are all zero.

The base EIM Transfer for the CISO is simply the negative sum of the base EIM Transfers of all EIM BAAs:[1]

$$\bar{T}_0 = -\sum_{\substack{j \in EIM \\ j>0}} \bar{T}_j$$

The base NSI for each EIM BAA is the net of the EIM Transfer and the submitted base intertie schedules with non-EIM BAAs:

$$\overline{NSI}_j = \bar{T}_j + \sum_{k \notin EIM} \sum_{l} \left(\bar{E}_{j,k,l} - \bar{I}_{j,k,l}\right) \quad \forall j \in EIM \wedge j > 0$$

The base demand in each EIM BAA is derived to achieve power balance with the submitted base generation schedules and the base NSI:

$$\bar{D}_j = \sum_{i \in BAA_j} \bar{G}_i - \overline{NSI}_j \quad \forall j \in EIM \wedge j > 0$$

The base load in each EIM BAA is obtained initially by reducing the base demand with an assumed initial transmission loss and then distributing it to the load nodes in the BAA using Load Distribution Factors (LDFs); the base load is then adjusted to absorb the loss error by an AC Power Flow (ACPF) using distributed load slack and Area Interchange Control (AIC) to maintain the base NSI:

$$\bar{D}_j = \sum_{i \in BAA_j} \bar{L}_i + \overline{Loss}_j \quad \forall j \in EIM \wedge j > 0$$

The base generation and load for the CISO are initialized at the RUC schedules; the CISO base load is also adjusted in the ACPF to account for generation and transmission outages occurred after RUC, and to absorb loss error as the CISO base NSI is maintained.

The base load for EIM BAAs is significant because it is used as a reference for imbalance energy settlement; however, the base load for the CISO is not important since for the CISO the reference for imbalance energy settlement is the day-ahead schedules from the Integrated Forward Market (IFM); nevertheless, it is used in the ACPF to balance the CISO, and the FNM overall, for calculating the power flows on EIM BAA transmission branches to identify any transmission limit violations for the feasibility test.

For the same reason, base schedules are also calculated for non-EIM BAAs to model unscheduled loop flow through the EIM Area. The approach for the non-EIM BAA base schedules is somewhat different because they are not submitted; instead, the demand forecast and the tagged or forecasted interchange

schedules with other non-EIM BAAs are used to supplement the information available for the EIM BAAs and the CISO. Specifically, the base NSI for non-EIM BAAs is derived as follows:

$$\overline{NSI}_j = \sum_{\substack{k \notin EIM \\ k \neq j}} \sum_{l} \left(\hat{E}_{j,k,l} - \hat{I}_{j,k,l}\right) - \sum_{k \in EIM} \left(\bar{E}_{k,j,l} - \bar{I}_{k,j,l}\right) \;\; \forall j \notin EIM$$

The base generation in each non-EIM BAA is derived as the sum of the demand forecast and the base NSI, and it is distributed to the generating resources in the BAA using Generation Distribution Factors (GDFs), renormalized for generation outages:

$$\sum_{i \in BAA_j} \bar{G}_i = \bar{D}_j + \overline{NSI}_j \;\; \forall j \notin EIM$$

The base load in each non-EIM BAA is calculated similarly to the base load in EIM BAAs.

The base NSI for the CISO is simply the negative sum of the base NSIs of all BAAs in the FNM:

$$\overline{NSI}_0 = -\sum_{j>0} \overline{NSI}_j$$

Optimal NSI and EIM Transfers

The optimal NSI for each BAA in the EIM Area, as calculated by RTUC and RTD, is the result of the optimal dispatch of resources within the BAA:

$$NSI_j = \sum_{i \in BAA_j} (G_i - L_i) - Loss_j \;\; \forall j \in EIM \wedge j > 0$$

Linearizing from the previous ACPF solution:

$$\left.\begin{aligned} NSI_j &= \widehat{NSI}_j + \Delta NSI_j \\ \widehat{NSI}_j &= \sum_{i \in BAA_j} \left(\tilde{G}_i - \tilde{L}_i\right) - \widehat{Loss}_j \\ \Delta NSI_j &= \sum_{i \in BAA_j} \frac{(\Delta G_i - \Delta L_i)}{LPF_i} \end{aligned}\right\} \forall j \in EIM$$

Where the optimal changes in generation and load are adjusted for marginal losses. Note that the load is not dispatched unless there is an outage or it is a dispatchable load, e.g., a hydro pump.

The optimal EIM Transfer for each EIM BAA is derived from the optimal NSI by subtracting the next export interchange with non-EIM BAAs:

$$T_j = NSI_j - \sum_{k \notin EIM} \sum_{l} \left(E_{j,k,l} - I_{j,k,l}\right) \quad \forall j \in EIM \wedge j > 0$$

Linearizing from the previous ACPF solution:

$$\left.\begin{aligned} T_j &= \tilde{T}_j + \Delta T_j \\ \tilde{T}_j &= \widetilde{NSI}_j - \sum_{k \notin EIM} \sum_{l} \left(\tilde{E}_{j,k,l} - \tilde{I}_{j,k,l}\right) \\ \Delta T_j &= \sum_{i \in BAA_j} \frac{(\Delta G_i - \Delta L_i)}{LPF_i} - \sum_{k \notin EIM} \sum_{l} \frac{\left(\Delta E_{j,k,l} - \Delta I_{j,k,l}\right)}{LPF_{j,k,l}} \end{aligned}\right\} \forall j \in EIM \wedge j > 0$$

Note that marginal loss contributions from network branches external to the EIM Area are ignored in the Loss Penalty Factors; consequently, the effect of intertie schedules between non-EIM BAAs and BAAs in the EIM Area on the EIM Area losses is the same as if the energy was generated or consumed at the EIM Area boundary.

The optimal EIM Transfer for the CISO is simply the negative sum of the optimal EIM Transfers of all EIM BAAs:

$$T_0 = - \sum_{\substack{j \in EIM \\ j>0}} T_j$$

The aggregate interchange dispatch at non-EIM BAA Scheduling Points/Hubs determines the NSI deviation (from the base NSI) of non-EIM BAAs and it is distributed to the generating resources of the relevant Generation Aggregation Point (GAP) using the applicable GDFs:

$$NSI_j - \overline{NSI}_j = - \sum_{k \in EIM} \sum_{l} \left(\Delta E_{k,j,l} - \Delta I_{k,j,l}\right) = \sum_{i \in BAA_j} (G_i - \bar{G}_i) \quad \forall j \notin EIM$$

The NSI is maintained for each BAA in the ACPF by adjusting the load using distributed load slack and AIC. Therefore, the NSI, EIM Transfer, and generation for EIM BAAs in the ACPF solution are always equal to the optimal solution in the last iteration.

Energy Transfer Schedules

The EIM Transfer for each EIM BAA is distributed optimally to the applicable Energy Transfer Schedules:

$$\sum_{\substack{k \in EIM \\ k \neq j}} \sum_{l} \left(ET_{j,k,l} - IT_{j,k,l} \right) = T_j \;\; \forall j \in EIM \wedge j > 0$$

Where:

$$IT_{j,k,l} = ET_{k,j,l} \;\; \forall j,k \in EIM \wedge j \neq k \wedge j,k > 0$$

Without violating the applicable transmission right limits:

$$\left. \begin{array}{l} 0 \leq IT_{j,k,l} \leq IT_{MAXj,k,l} \\ 0 \leq ET_{j,k,l} \leq ET_{MAXj,k,l} \end{array} \right\} \;\; \forall j,k \in EIM \wedge j \neq k \wedge j > 0$$

For efficiency, there should not be both an import and an export Energy Transfer schedule on a given intertie; at least one of them should be zero.

It is assumed that the transmission limits are symmetric:

$$IT_{MAXj,k,l} = ET_{MAXk,j,l} \;\; \forall j,k \in EIM \wedge j \neq k \wedge j,k > 0$$

To clarify, Energy Transfer schedules are variables in the market optimization calculated optimally subject to the above constraints. The base Energy Transfer schedule is included in the optimal Energy Transfer schedule; in other words, the optimal Energy Transfer schedule on any given intertie may completely back down a base Energy Transfer schedule and the energy transfer may reverse, resulting in efficient use of interconnecting transmission capacity.

To reduce the problem dimensionality and potential degeneracy, for Energy Transfer schedules between two BAAs on a given intertie, only the ETSRs of one BAA are included in the problem formulation; their ETSR counterparts of the other BAA can be eliminated. An ETSR attribute in the Master File is used to designate the ETSRs that are optimized and used for tagging, as explained in §11.1.5.

Note: When calculating ETSR schedules where one of the associated BAAs is the ISO BAA, the EIM Entity/Entities should not submit pre-hour or after-the-fact interchange schedules. As these are tags with the ISO BAA, the CAISO will use the tag to determine the scheduled quantities needed.

Energy Transfer Schedule Limits

Normally, Energy Transfer schedules are dynamic and the same ETSRs and transmission limits are used in both RTUC and RTD. However, if some Energy Transfer schedules must be differentiated between RTUC and RTD, static ETSRs will be used for the 15min Energy Transfer schedules in RTUC and dynamic ETSRs will be used for the incremental 5min Energy Transfer schedules in RTD. In this case, the base Energy Transfer schedule is included in the 15min Energy Transfer schedule, and the transmission limit

for the 5min Energy Transfer schedule is zero in RTUC and incremental (from the optimal 15min Energy Transfer schedule) in RTD. For a uniform treatment of all ETSRs to simplify implementation, the applicable Energy Transfer schedule limits in RTUC and RTD can be derived from the transmission right, static limit, and incremental dynamic limit, as follows:

$$\text{RTUC: } \left.\begin{cases} IT_{MAXj,k,l} = \min\left(IT_{TRj,k,l}, IT_{MAX15j,k,l}\right) \\ ET_{MAXj,k,l} = \min\left(ET_{TRj,k,l}, ET_{MAX15j,k,l}\right) \end{cases}\right\} \forall j,k \in EIM \wedge j \neq k \wedge j > 0$$

$$\text{RTD: } \left.\begin{cases} IT_{MAXj,k,l} = \min\left(IT_{TRj,k,l}, IT_{j,k,l} + IT_{MAX5j,k,l}\right) \\ ET_{MAXj,k,l} = \min\left(ET_{TRj,k,l}, ET_{j,k,l} + ET_{MAX5j,k,l}\right) \end{cases}\right\} \forall j,k \in EIM \wedge j \neq k \wedge j > 0$$

Where the Energy Transfer schedules used in the calculation of the applicable Energy Transfer schedule limit in RTD are the optimal 15min Energy Transfer schedules from RTUC. With these generic formulae, the static limit is what is made available from the transmission right in RTUC, and the dynamic limit is additional transmission capacity that can be used in RTD. If there is no distinction between static and dynamic Energy Transfer schedules, both static and dynamic limits should be equal to the transmission right to maximize transmission capacity use across RTUC and RTD.

For Energy Transfer schedules between two BAAs on a given intertie, the Energy Transfer schedule limits are submitted only for the ETSRs of one BAA. The EIM Entity of that BAA is responsible for submitting base Energy Transfer schedules and the associated Energy Transfer schedule limits, as well as for tagging base and optimal Energy transfer schedules between the relevant BAAs. An ETSR attribute in the Master File is used to designate the ETSRs that are used for tagging and for which Energy Transfer schedule limits are submitted, as explained in §11.1.5.

Energy Transfer Schedule Tags

The base and optimal Energy Transfer schedules are assigned to the corresponding ETSRs and are tagged by the EIM Entity Scheduling Coordinator to the associated intertie using the corresponding ETSR identification. The EIM Entity Scheduling Coordinator should obtain a unique identifier to list as the "Purchasing Selling Entity" if at all possible. If that is not possible, designated agents, e.g., the EIM Entity Scheduling Coordinator, may list the EIM Entity as the "Purchasing Selling Entity" on such tags for convenience provided the EIM Entity has authorized its agent to do so and the tag identifies that relationship as the basis for doing so.

For static ETSRs, the tag is a static 15-minute tag that includes the base Energy Transfer. For dynamic ETSRs, the tag is a dynamic 5-minute tag; if there is no distinction between static and dynamic Energy

Transfers on a given intertie, there is no static tag and the base Energy Transfer schedule is included in the dynamic 5-minute tag. Because the Energy Transfer schedules between two EIM BAAs are duplicated as import and export counterparts seen from each EIM BAA, only the ETSRs of one EIM BAA will be tagged between the two EIM BAAs. An ETSR attribute in the Master File is used to designate the ETSRs that are used for tagging. The same attribute is used to indicate the ETSRs for which base Energy Transfer schedules and limits are submitted, as well as the ones that are included in the problem formulation.

Intertie Transmission Cost

The distribution of the Energy Transfer for a BAA over the various interties to adjacent BAAs in the EIM Area is not influenced by network impedance or transmission losses, and as such it does not represent actual power flows on these interties; it resembles the classical problem of transferring goods from supply centers to demand centers over a road network. The Energy Transfer schedule limits are scheduling limits and they resemble road throughput capacity. Physical intertie limits need to be enforced separately to constrain actual power flows on the interties, including loop flow contributions from base schedules in non-EIM BAAs.

In a problem like that, there is often not a unique solution, particularly if many intertie scheduling limits are not binding, i.e., there may be multiple ways to transfer the goods from the supply centers to the demand centers without violating any road constraints. To obtain a robust and efficient solution without circulating Energy Transfer schedules, a small nominal cost should be included in the objective function for each ETSR, as follows:

$$\min\left(\ldots+\sum_{\substack{j,k\in EIM\\ k\neq j\\ j>0}} C_{j,k}\sum_{l}\left(ET_{j,k,l}+IT_{j,k,l}\right)\right)$$

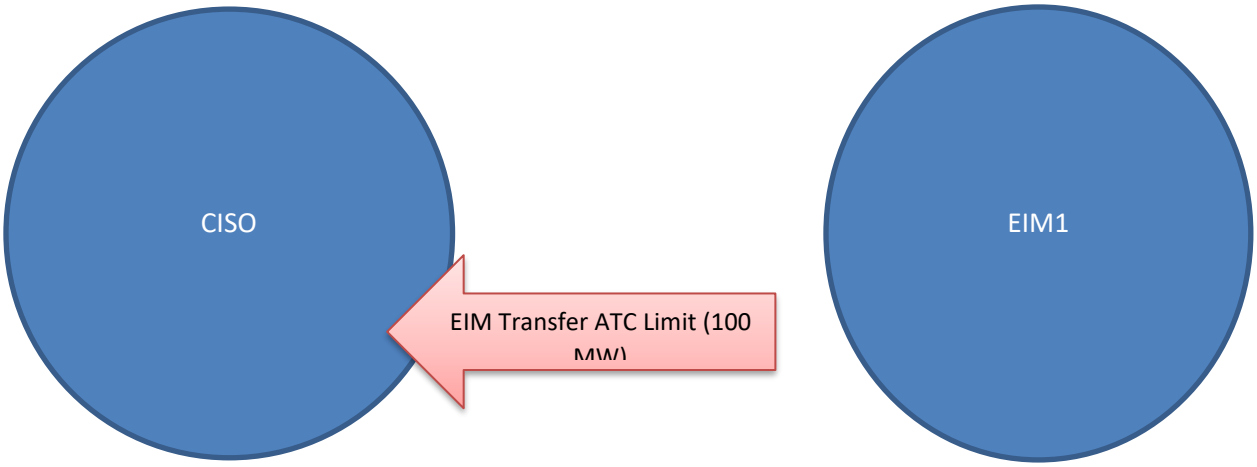
This cost resembles tolls paid on the roads connecting the supply and demand centers. Introducing this cost will also guarantee that Energy Transfer schedules between two BAAs in the EIM Area will always be unidirectional, i.e., either the export or the import will take value, but never both. This cost may ultimately reflect applicable wheeling or transmission access fees depending on agreed transmission pricing methods among the BAAs in the EIM Area.

Energy Transfer Financial Value

In calculating real-time neutrality by BAA, a financial value is required for the Energy Transfer, which must be considered to balance the BAA. Currently, the financial value is determined by pricing the EIM Transfer at the LMP of the metered end of the intertie used for tagging the relevant EIM Transfer schedule. With the introduction of multiple interties (multiple ETSRs) for a given BAA where the Energy Transfer can be optimally distributed based on the presented methodology, a more robust and uniform price is the System Marginal Energy Cost (SMEC), which is the same in any location in the network and does not include the marginal cost of losses or congestion. This is a more appropriate price because it is independent from the particular way an Energy Transfer is distributed to Energy Transfer schedules on the various interties.

Examples

EIM Transfer Constraint Congested/Intertie Scheduling Limit Not Congested



In the example presented below, the Real Time Market receives Bids from EIM1 Generator and CISO Generator in order to serve EIM1 Load and CISO Load. The Real Time Market Conditions have determined that there is 100 MWs Available Transmission Capacity between EIM1 and CISO with an EIM Transfer Cost of $0.01. Based upon these conditions, the Real Time Market has dispatched a Generator in the EIM1 Balancing Authority Area (BAA) to serve 50 MWs of EIM1 Load and 100 MWs of CISO Load. The Real Time Market also dispatched a Generator in the CISO BAA to serve an additional 100 MWs of internal Load. Market Conditions has determined that marginal unit is CISO Generator, the EIM Transfer Constraint is congested, and the Intertie scheduling Limit Constraint is not congested.

Based upon the above mentioned Market Conditions, Settlement calculations will be as follows:

Bids

Resource	Quantity (MW)	Energy Bid Price ($/MW)	GHG Bid Price ($/MW)	All-in Bid Price ($/MW)
EIM1Gen	200	$ 35.00	$ -	$ 35.00
CISOGen	300	$ 50.00	$ -	$ 50.00

Load Forecast

Resource	Quantity (MW)
EIM1Load	50
CISOLoad	200

Market Dispatch (RTD)

Resource	Quantity (MW)	LMP
EIM1Gen	150	$ 34.99
CISOGen	100	$ 50.00

Location Marginal Pricing (RTD)

Location	Energy	Congestion*	Losses	GHG	Price
EIM1Gen	50	(15.01)	-	-	34.99
CISOGen	50	-	-	-	50
PACLoad	50	(15.01)	-	-	34.99
CISOLoad	50	-	-	-	50
EIM Transfer	50	-	-	-	50

* Congestion is based upon the EIM Constraint ($15) plus Intertie Scheduling Limit ($0) plus the EIM Transfer Costs ($0.01).

Settlement:

Charge Code	Resource	Qty	Price	(Payment)/Charge
CC 64700	EIM1Gen	150	$ 34.99	$ (5,248.50)
CC 6470	CISOGen	100	$ 50.00	$ (5,000.00)
CC 64750	EIM1Load	50	$ 34.99	$ 1,749.50
CC 6475	CISOLoad	200	$ 50.00	$ 10,000.00

RTCO Calculation	QTY	MCC(EIM1)*	Amount	MCC(CISO)	Amount
EIM1Gen	150	$ (15.01)	$ 2,251.50	$ -	$ -
CISOGen	100	$ -	$ -	$ -	$ -
EIM1Load	-50	$ (15.01)	$ (750.50)	$ -	$ -
CISOLoad	-200	$ -	$ -	$ -	$ -
Total			$ 1,501.00		$ -

RTCO Allocation	QTY	MCC(EIM1)**	Amount	MCC(CISO)**	Amount
EIM1Gen	150	$ (7.51)	$(1,125.75)	$ (7.51)	$(1,125.75)
CISOGen	100	$ -	$ -	$ -	$ -

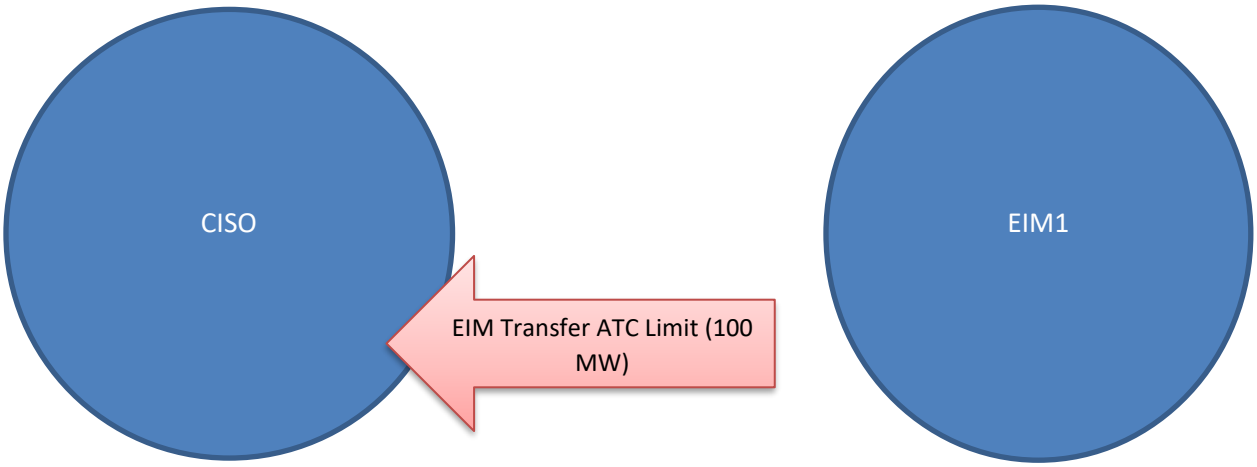
EIM1Load	-50	$ (7.51)	$ 375.25	$ (7.51)	$ 375.25
CISOLoad	-200	$ -	$ -	$ -	$ -
CC 67740 CC 6774			$ (750.50)		$ (750.50)

** Sum of the Intertie Scheduling Limit plus product of EIM Transfer Costs and the EIM Transfer Cost Ratio Share (50/50) plus the product of EIM Constraint and the EIM Transfer Constraint Ratio Share (50/50)

RTIEO Charge/Payment	Charge Code	EIM1	CISO
	CC 64700	$(5,248.50)	
	CC 6470		$ (5,000.00)
	CC 64750	$ 1,749.50	
	CC 6475		$ 10,000.00
	EIM Financial Value***	$ 5,000.00	$ (5,000.00)
	RTCO Calculation	$ 1,501.00	$ -
	RTLosses	0	0
RTIEO		$ -	$ -

*** EIM Transfer is settled at the System Marginal Energy Costs

EIM Transfer Constraint Not Congested/Intertie Scheduling Limit Congested



In the example presented below, the Real Time Market receives Bids from EIM1 Generator and CISO Generator in order to serve EIM1 Load and CISO Load. The Real Time Market Conditions have determined that there is 100 MWs Available Transmission Capacity between EIM1 and CISO with an EIM Transfer Cost of $0.01. Based upon these conditions, the Real Time Market has dispatched a Generator in the EIM1 Balancing Authority Area (BAA) to serve 50 MWs of EIM1 Load and 100 MWs of CISO Load. The Real Time Market also dispatched a Generator in the CISO BAA to serve an additional 100 MWs of internal Load. Market Conditions has determined that marginal unit is CISO Generator, the EIM Transfer Constraint is not congested, and the Intertie scheduling Limit Constraint is congested.

Based upon the above mentioned Market Conditions, Settlement calculations will be as follows:

Bids

Resource	Quantity (MW)	Energy Bid Price ($/MW)	GHG Bid Price ($/MW)	All-in Bid Price ($/MW)

EIM1Gen	200	$ 35.00	$ -	$ 50.00
CISOGen	300	$ 50.00	$ -	$ 50.00

Load Forecast

Resource	Quantity (MW)
EIM1Load	50
CISOLoad	200

Market Dispatch (RTD)

Resource	Quantity (MW)	LMP
EIM1Gen	150	$ 34.99
CISOGen	100	$ 50.00

Location Marginal Pricing (RTD)

Location	Energy	Congestion*	Losses	GHG	Price
EIM1Gen	50	(15.01)	-	-	34.99
CISOGen	50	-	-	-	50
PACLoad	50	(15.01)	-	-	34.99
ISOLoad	50	-	-	-	50
EIM Transfer	50	(15.01)	-	-	34.99

* Congestion is based upon the EIM Constraint ($15) plus Intertie Scheduling Limit ($0) plus the EIM Transfer Costs ($0.01).

Settlement:

Charge Code	Resource	Qty	Price	(Payment)/Charge
CC 64700	EIM1Gen	150	$ 34.99	$ (5,248.50)
CC 6470	CISOGen	100	$ 50.00	$ (5,000.00)
CC 64750	EIM1Load	50	$ 34.99	$ 1,749.50
CC 6475	CISOLoad	200	$ 50.00	$ 10,000.00

RTCO Calculation	QTY	MCC(EIM1)*	Amount	MCC(CISO)	Amount
EIM1Gen	150	$ (15.01)	$ 2,251.50	$ -	$ -
CISOGen	100	$ -	$ -	$ -	$ -
EIM1Load	-50	$ (15.01)	$ (750.50)	$ -	$ -
CISOLoad	-200	$ -	$ -	$ -	$ -
Total			$ 1,501.00		$ -

RTCO Allocation	QTY	MCC(EIM1)**	Amount	MCC(CISO)**	Amount
EIM1Gen	150	$ (0.005)	$ (0.75)	$ (15.005)	$(2,251.50)
CISOGen	100	$ -	$ -	$ -	$ -
EIM1Load	-50	$ (0.005)	$ 0.25	$ (15.005)	$ 750.25
CISOLoad	-200	$ -	$ -	$ -	$ -
CC 67740 CC 6774			$ (0.50)		$ (1500.50)

** Sum of the Intertie Scheduling Limit plus product of EIM Transfer Costs and the EIM Transfer Cost Ratio Share (50/50) plus the product of EIM Constraint and the EIM Transfer Constraint Ratio Share (50/50)

RTIEO Charge/Payment	Charge Code	EIM1	CISO
	CC 64700	$(5,248.50)	
	CC 6470		$ (5,000.00)
	CC 64750	$ 1,749.50	
	CC 6475		$ 10,000.00
	EIM Financial Value***	$ 5,000.00	$ (5,000.00)
	RTCO Calculation	$ 1,501.00	$ -
	RTLosses	0	0
RTIEO		$ -	$ -

*** EIM Transfer is settled at the System Marginal Energy Costs

Appendix B: Mathematical Formulation for using Available Capacity resolving infeasible power balance conditions in EIM BAAs

Introduction

This appendix describes the mathematical formulation of the market software feature that enables the EIM entity to identify available balancing capacity for resolving infeasible power balance conditions in the applicable EIM BAAs.

The available balancing capacity feature is configured to ensure the energy from capacity designated as available balancing capacity does not exit relevant EIM entity's BAA through the EIM Transfer. The capacity identified as the available balancing capacity will be released only to the extent necessary to resolve power balance infeasibility and should not be used to displace other capacity made available in the BAA for EIM participation. It should be noted that if the infeasibility persists after dispatching all the capacity designated as available balancing capacity for the relevant EIM entity BAA , the price will be set consist with rules in Section 27.4.3.4.

For purposes of this appendix, the capacity designated as EIM Upward or Downward Available Balancing Capacity will be referred to herein as Regulation Up or Down.

Technical Description

The CAISO's market clearing software calculates the optimal solution in two passes, referred to as the scheduling and pricing run. The scheduling run is a full optimization run where constraints may be relaxed at a penalty price to avoid infeasibility. The pricing run is a simple economic dispatch, initialized from the scheduling run solution, where penalty prices are replaced by administrative prices and the problem is constrained so that the primal solution does not drift far away from the primal solution of the scheduling run. Both binding schedules and prices are obtained from the pricing run.

Mathematical Formulation

This section contains the mathematical formulation for the new elements introduced in the Scheduling and Pricing Run for dispatching Regulation to resolve power balance infeasibility in EIM BAAs.

The following notation is used in this section:

i	EIM Resource index.
k	EIM BAA index.
t	Time period index (0 for initial condition).
N	Number of time periods in the time horizon.
K	Number of EIM BAAs.
R_k	Set of EIM Resources for BAA *k*.
$\forall$	For all…
$\rightarrow$	Leads to…
$T_{k,t}$	EIM Transfer of BAA *k* in time period *t* (positive for export and negative for import).
$\overline{T}_{k,t}$	Base EIM Transfer of BAA *k* in time period *t*.
$RU_{i,t}$	Regulation Up schedule of Resource *i* in time period *t*.
$RD_{i,t}$	Regulation Down schedule (non-positive) of Resource *i* in time period *t*.
$\overline{RU}_{i,t}$	Base Regulation Up schedule of Resource *i* in time period *t*.
$\overline{RD}_{i,t}$	Base Regulation Down schedule (non-positive) of Resource *i* in time period *t*.
$\widehat{RU}_{i,t}$	Regulation Up schedule of Resource *i* in time period *t* from the Scheduling Run used as upper limit in the Pricing Run.
$\widehat{RD}_{i,t}$	Regulation Down schedule of Resource *i* in time period *t* from the Scheduling Run used as lower limit in the Pricing Run.
C	Objective function.
$CRU_{i,t}(p)$	Incremental energy cost function allocated to Regulation Up schedule of Resource *i* in time period *t*.
$CRD_{i,t}(p)$	Incremental energy cost allocated to Regulation Down schedule of Resource *i* in time period *t*.
PU_H	High penalty price for Regulation Up.
PU_L	Low penalty price for Regulation Up; $0 \ll PU_L \leq PU_H$.
PD_H	High penalty price for Regulation Down.
PU_L	Low penalty price for Regulation Down; $PD_L \leq PD_H \ll 0$.

A_U	Linear penalty price transformation coefficient for Regulation Up.
B_U	Constant penalty price transformation for Regulation Up.
A_D	Linear penalty price transformation coefficient for Regulation Down.
B_D	Constant penalty price transformation for Regulation Down.

The contribution of Regulation dispatch in the Scheduling Run objective function is as follows:

$$C = \cdots + \sum_{t=1}^{N}\sum_{k=1}^{K}\sum_{i\in R_k}\int_{0}^{RU_{i,t}} \left(A_U\, CRU_{i,t}(p) + B_U\right) dp \; + \sum_{t=1}^{N}\sum_{k=1}^{K}\sum_{i\in R_k}\int_{0}^{RD_{i,t}} \left(A_D\, CRD_{i,t}(p) + B_D\right) dp$$

Where the linear transformation parameters for the economically differentiated penalty prices are derived as follows:

$$A_U = \min\left(1, \frac{PU_H - PU_L}{\max\limits_{i,t}\left(CRU_{i,t}(p)\right) - \min\limits_{i,t}\left(CRU_{i,t}(p)\right)}\right)$$

$$B_U = PU_L - A_U \min_{i,t}\left(CRU_{i,t}(p)\right)$$

$$A_D = \min\left(1, \frac{PD_H - PD_L}{\max\limits_{i,t}\left(CRD_{i,t}(p)\right) - \min\limits_{i,t}\left(CRD_{i,t}(p)\right)}\right)$$

$$B_D = PD_H - A_D \max_{i,t}\left(CRD_{i,t}(p)\right)$$

Regulation Up/Down dispatch in the Scheduling Run is prevented when the EIM Transfer is higher/lower than the base EIM Transfer for the EIM BAA as follows:

$$\left.\begin{aligned} T_{k,t} > \bar{T}_{k,t} \rightarrow \sum_{i\in R_k} RU_{i,t} = 0 \\ T_{k,t} < \bar{T}_{k,t} \rightarrow \sum_{i\in R_k} RD_{i,t} = 0 \end{aligned}\right\}, \forall k, t$$

Regulation Up/Down dispatch in the Scheduling Run is also limited by the base Regulation schedule as follows:

$$0 \le RU_{i,t} \le \overline{RU}_{i,t}, \forall i, t$$

$$0 \ge RD_{i,t} \ge \overline{RD}_{i,t}, \forall i, t$$

Whereas the Regulation dispatch in the Pricing Run is limited by the optimal dispatch in the Scheduling Run as follows:

$$0 \leq RU_{i,t} \leq \widehat{RU}_{i,t}, \forall i,t$$

$$0 \geq RD_{i,t} \geq \widehat{RD}_{i,t}, \forall i,t$$