Agenda

- Housekeeping
- What is the California ISO
- What is BPA
- What is a Balancing Authority
- What is the EIM
- Governance
- Transmission
- Roles and Definitions
- Market Activities
- Base Schedules + Bids + Market Timing
- Resource Sufficiency Tests
- Settlements
We have muted all calls on entry, if you have a question, you will need to unmute by using *6, then please identify yourself by name and organization.

Please do not put this call on hold OR take other calls while you are dialed into this one.

Noisy lines may be disconnected from the meeting.
Format of EIM 101 Workshop

• There is a lot of material to present today

• We plan to leave time at the end for an open Q&A

• After each topic we will provide an opportunity to ask clarifying questions, as time permits

• We welcome feedback on the workshop – please send any to techforum@bpa.gov and reference “EIM 101 Workshop” in the subject
Upcoming EIM Stakeholder Meetings

• Oct. 11, 2018, 9 a.m.-12 noon, BPA Rates Hearing Room and by WebEx
• Nov. 20, 2018, time TBD, BPA Rates Hearing Room and by WebEx
• For more information please visit www.bpa.gov/goto/EIM
Purpose of EIM 101 Workshop

• Provide a common understanding of how the EIM currently works so that all stakeholders can engage in future meetings/workshops

• Help identify policies and business practices that may impact BPA’s potential EIM participation
Credits & Disclaimers

• Several slides in this presentation have been reproduced *(occasionally with modifications)* with permission from the CAISO and Utilicast.

• Information provided is believed to be accurate as of the publication date of this presentation.

• The CAISO market rules and processes are under continual development.

• Additional [resources](#) and information are available in the [appendix](#) of this presentation.
What is the California ISO?
The California ISO (CAISO, CISO, ISO)

- One of nine independent grid operators in North America
- One of 39 balancing authorities in the western interconnection
- Operates markets for wholesale electricity – Day Ahead and Real Time
- Manages the California transmission system
- Manages new power plant interconnections in California
- Plans grid expansions in California
- Operates the Western Energy Imbalance Market (EIM)
What is the Bonneville Power Administration?
Bonneville Power Administration

- BPA is a Federal Power Marketing Agency located in the Pacific Northwest.
Bonneville Power Administration

Transmission System and Federal Dams

**LEGEND**
- BPA Transmission Line
- Federal Dam
- Non-BPA Line
- BPA Service Area
What is a Balancing Authority?
What is a Balancing Authority?

• A Balancing Authority (BA) is the entity that integrates resource plans ahead of time, maintains Demand and resource balance within one or more Balancing Authority Areas, and supports Interconnection frequency in real time.

• A Balancing Authority Area (BAA) is the collection of generation, transmission and loads within the metered boundaries (interchanges or tie-lines) of the balancing authority where load/resource balance is maintained.

• 39 BAAs in the Western Interconnection

• While interconnected, each BAA operates independently.
What is AGC

Automatic Generation Control (AGC) is used to manage the BAA’s Area Control Error (ACE) per the following basic equation (deemphasizing tie-line meter error, and ATEC):

\[ \text{ACE} = (\text{NI}_A - \text{NI}_S) - 10B (\text{FA} - \text{FS}) - I_{ME} + I_{ATEC} \]

Where:

- \( \text{NI}_A \) = Net Actual Interchange - The algebraic sum of actual megawatt transfers across all Tie Lines, including Pseudo-Ties, with all Adjacent BAAs within the same Interconnection.
- \( \text{NI}_S \) = Net Scheduled Interchange - The algebraic sum of all scheduled megawatt transfers, including Dynamic Schedules, with all Adjacent BAAs within the same Interconnection, including the effect of scheduled ramps.
- \( B \) = Frequency Bias Setting (MW/0.1Hz).
- \( \text{FA} \) = Actual Frequency.
- \( \text{FS} \) = Scheduled Frequency.
- \( I_{ME} \) = Interchange Meter Error.
- \( I_{ATEC} \) = Automatic Time Error Correction.
BPA’s Balancing Authority Area

BPA Has 253 points of interchange (tie-lines) with 18 adjacent BAAs
What is the EIM?
What is the EIM?

• An intra-hour centralized energy market used to economically and securely dispatch participating resources to efficiently balance supply, transfers between participating Balancing Authority Areas (EIM Entity BAAs), and load across the market’s footprint (EIM Area).
  – The EIM does this every 5-minutes!

• An extension of the CAISO’s Real-Time Market (RTM) in response to the efforts of the Western Interstate Energy Board (WIEB) and the PUC EIM group
What is the EIM?

• EIM’s priority is to serve load and imbalance at the lowest possible cost (Economic Dispatch).

• It does so while simultaneously ensuring generation, and transmission limitations are respected (Security Constrained).

• It utilizes Bid Ranges (INC/DEC) from voluntarily offered participating resources to come up with the most economical and reliable/secure solution of generation to meet load and interchange demands.

• No penalty for promptly communicated reliability actions (Manual Dispatch); imbalance settlements still apply
What is the EIM?

• What is Included in EIM?
  – Unit commitment for short start resources
  – Forward looking congestion management - will respond to forced and planned outages
  – 15min market (FMM or RTPD)
    • Advisory market awards published for 4-7 FMM intervals
  – 5min dispatch (RTD)
    • Advisory market awards published for 9-13 RTD intervals

• What is NOT included in EIM?
  – Capacity Ancillary Services (regulation, spin, non-spin)
    • Ancillary Services Base Schedules are supported
  – Optimal Contingency Dispatch
    • Manual Dispatch of Contingency Reserves is supported
EIM Area Map

Existing Entities:
- PAC
- NVE
- APS
- PSE
- PGE
- PWX
- IDP

Upcoming Entities:
- BANC/SMUD (2019)
- LADWP (2020)
- SCL (2020)
- SRP (2020)
- PNM (2021)
EIM Summary

**Without EIM:**
Each BA must balance loads and resources within its borders.

**With EIM:**
The market dispatches resources across BAAs to balance demand.

### EIM Benefits
- Reduce costs by serving imbalance and load from most economic resources
- Enhances reliability by improving system visibility and responsiveness to planned and unplanned events
- Results in more efficient dispatch of resources within/between BAAs
- Leverages geographical diversity of loads and resources in the market footprint
- Congestion Management
## EIM Summary

### What an EIM **IS:**

- An intra-hour **real-time** energy market to serve load and imbalance across participating Balancing Authorities (EIM Entities) and the CAISO (a.k.a. the EIM Area)

- A tool for centralized 5-minute dispatch of generators that have been **voluntarily** offered to the market (at a price)

- **Economically dispatches** offered resources

- **Security-constrained,** meaning transmission and reliability constraints are not exceeded, improving grid reliability, reducing energy supply cost and enhancing integration of renewable resources

### What an EIM is **NOT:**

- An RTO (with planning, day-ahead markets, BA consolidation)

- A centralized unit commitment tool

- A capacity market

- A replacement for the current contractual bi-lateral business structure
Are these EIM things new?

• Nope! They’ve been around for years. They aren’t always called an EIM, but most organized energy markets (RTOs/ISOs) run a regional SCED based 5-minute market
  – PJM (RT SCED)
  – MISO (Real-Time and Operating Reserves Market)
  – SPP (Real-Time Balancing Market)
  – NYISO (Real-Time Market)
  – ISO-NE (Real-Time Energy Market)
  – ERCOT (Real-Time Market)
  – CAISO (Real-Time Market)
EIM Governance
EIM governance structure designed by transitional committee of western stakeholders

- **EIM Governing Body (GB)**
  - 5 independent (non-stakeholder) members
  - delegated authority over EIM-related market rules
  - selected by S/H nominating committee, confirmed by ISO Board
  - provides western entities a decision-making voice

- **EIM Body of state regulators (BOSR)**
  - advises EIM Governing Body and ISO Board on matters of interest
  - currently 8 state officials from EIM states
  - provides a state regulatory perspective

- **Regional Issues Forum (RIF)**
  - public vehicle for discussion of EIM-related issues, including impacts to neighboring balancing authority areas
  - organized by ten self-selected sector liaisons
  - may produce opinions for EIM governing body or ISO Board of Governors
Transmission
Transmission Access

• Transmission is provided in the EIM consistent with non-discriminatory Open Access principles.

• There is no explicit charge for transmission usage in the EIM.

• Transmission is currently provided in two ways:
  – Unused transmission provided directly by Transmission Service Providers (TSP) at no charge
  – Reserved transmission donated by Merchants
EIM Transfer Schedules

• The EIM primarily uses **dynamic schedules** to transfer energy between EIM BAAs
  – One exception is on the COI where separate 15-minute normal schedules and 5-minute dynamic schedules are used due to DTC issues

• The EIM Transfer for an EIM BAA 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 facilitated by the EIM

Energy Transfer System Resources (ETSR)

• System Resources are defined 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.
  – Analogous to a Source or Sink on an e-Tag
• ETSRs are defined as aggregate system 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 CAISO intertie with the CAISO.
EIM Transfers (Today)

- Transfers between EIM Entities are currently limited to these transfer paths.
- EIM will facilitate **wheeling** of EIM energy through EIM Entities (e.g., CAISO → NVE → PACE → PACW → PSEI) when more efficient transmission paths are constrained.
Roles and Definitions
Roles and Definitions

• **EIM** is the operation of the ISO’s real-time market to manage transmission congestion and optimize procurement of energy to balance supply and demand for the CAISO and EIM BAAs combined (EIM Area)

• **Market Operator** is the CAISO
Roles and Definitions

• **EIM Entity** is a Balancing Authority that
  
  – Represents one or more Transmission Service Providers that make transmission available for EIM
  
  – Enters into the pro forma EIM Implementation Agreement to enable the EIM in its BAA
  
  – Determines the resources and the transmission service required for eligibility to participate in the EIM
  
  – By enabling the EIM, real-time load and generation imbalances within the EIM BAA will be settled through the EIM
Roles and Definitions

• **EIM Participating Resource (EIMPR)** is a resource located within the EIM Entity BAA that
  – Is eligible and elects to participate in the EIM
  – Enters into the pro forma EIM Participating Resource Agreement
  – Receives 15-minute schedule and 5-minute dispatch

• **EIM Non-Participating Resource (EIMNPR)** is a resource that elects to not participate in the EIM
  – Hourly resource and import/export schedules
Roles and Definitions

• **EIM Entity Scheduling Coordinator** is the EIM Entity (or a designated third-party) that
  – Is certified by the ISO
  – Enters into the pro forma EIM Entity Scheduling Coordinator Agreement, under which it is responsible for:
    • Approving resource plans for the EIM Entity BAA
    • Submits Settlement Quality Meter Data (SQMD)
    • Uninstructed imbalance energy settlement of resources not participating in EIM
    • Distributing costs or revenues from uplift allocations to the EIM Entity BAA
Roles and Definitions

- **EIM Participating Resource Scheduling Coordinator** is the participating resource (or a designated third-party) that:
  - Is certified by the ISO
  - Enters into the pro forma EIM Participating Resource Scheduling Coordinator Agreement
  - Interfaces with the Market Operator to
    - Submit resource plans
    - Receive dispatch instructions and market awards
    - Receive settlement statements and bills
Roles and Definitions

- **EIM Transmission Service Provider** is a transmission owner or customer (may be a 3\textsuperscript{rd} party separate from the EIM Entity) that
  - Controls transmission in the EIM Entity BAA
  - Can voluntarily inform the EIM Entity that it is making its transmission available for EIM

- **EIM Transfer** is an exchange of real-time energy between a BAA in the EIM Area and the rest of the EIM Area using transmission capacity made available for the EIM
Roles and Definitions

• **Base Schedule** is a forward hourly energy schedule
  – It is the *reference for measuring imbalance deviations* for EIM settlement
  – It includes generation and interchange schedules, and load forecast

• **Resource Plan** is the combination of
  – Base schedules
  – Energy bids
  – Ancillary services schedules
Roles and Definitions

• **Base Schedule Coordinator** is the participating or non-participating resource (or a designated third-party) that submits base schedules and ancillary services schedules.

• **EIM Entity Base Schedule Coordinator** is the EIM Entity (or a designated third-party) that submits base schedules and ancillary services for EIM non-participating resources, and all EIM resources after T–55'.
Break
Market Activities
Market Activities

Compile Hourly Resource Plan

- Demand Forecast
- Variable Energy Forecast
- Transmission Outages
- Generation Outages
- Transmission Limits
- Participating resource hourly base schedule
- Participating resource energy bid range
- Non-participating resource hourly base schedule
- Hourly interchange schedules

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Market Activities

Hourly Base Schedules

Resource Sufficiency Evaluation

Test Results

Final Hourly Resource Plan

9/13/2018 BPA EIM 101 Workshop 44
Market Activities

Economic Bids
Demand Forecast
Variable Energy Forecast
Transmission Outages
Generation Outages
Transmission Limits

EIM
15-Minute Schedule
Unit commitment for short-start resources
Market Activities

- Economic Bids
- Demand Forecast
- Variable Energy Forecast
- Transmission Outages
- Generation Outages
- Transmission Limits
- State Estimator

EIM 5-Minute Dispatch

Dispatch Instructions
Market Activities

Hourly Base Schedule

15-Minute Schedule

5-Minute Dispatch

Meter

EIM Settlement

EIMPR SC Settlement Statement

EIM Entity SC Settlement Statement for EIMNPR

EIM Entity SC Settlement Statement for EIM BAA Neutrality

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Base Schedules + Bids + Timing
Base Schedule

• Generation and Interchange must equal Load.
  \[ G + I = L \]

• Submitted T-75, T-55, and T-40 ahead of the hour.

• Solely used as initial starting points of units and to pass hourly sufficiency tests.
Bids

- Non-Participating vs Participating Resources
  - Bids submitted by T-75
    - Cannot change bid after T-75
    - Locked for 135 minutes
Bids

The graph illustrates the bidding range for energy prices per MWh (\$/MWh) against MW capacity. The green line represents the 'Economic Bid' at various price points, while the red dashed line indicates the upper bid limit. The graph shows a step-wise increase in price with a stepdown at certain MW capacities.
Bids are locked 75 minutes before the hour
- Participants’ Base Schedules deadline is 55 minutes before the hour
- EIM Entity’s Base Schedules deadline is 40 minutes before the hour

*Used for proof that market is not performing BAL compliance for the Entity BA*
Base Schedule Timing

T-75: Base schedules and energy bids due (Resources)

T-55: Updated base schedules are submitted if necessary (Resources)

T-40: Updated base schedules are submitted if necessary (Entity SC)

T-20: E-tagging deadline (Entity SC)

T-22.5: 15-minute scheduled awards published

T-37.5: Start of 15 minute market

T-45: Results of sufficiency test published

T-60: Results of sufficiency test published

EIM Market Participants

Market Operator
One RTD 5-Minute Run

- Market begins calculation 7.5 minutes prior to the 5-minute market interval and publishes results 1-2 minutes prior to ramp
- Solution provides the target for the middle of the interval that resources are expected to ramp to (i.e., Dispatch/Desired Operating Target or DOT)
Continuous RTDs

- RTD Run
  - Interval 1
  - Interval 2
  - Interval 3
- Ramp 1
- Ramp 2
- Ramp 3

xx:05 xx:00
xx:55 xx:50
xx:15 xx:10 xx:05 xx:00

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Within the Hour

Bid Deadline and PRSC BS Deadline

Base Schedule Deadline

RTPD Snapshot

RTPD Results Published

WECC e-Tag Deadline

RTD Snapshot

Ramp Interval 1


T-55     T-40     T-37.5     T-22.5     T-20     T-7.5     T-2.5

RTD Run Interval 1

RTD Run Interval 2

RTD Run Interval 3

RTD Run Interval 4

RTD Run Interval 5

RTD Run Interval 6

RTD Run Interval 7

RTD Run Interval 8

RTD Run Interval 9

RTD Run Interval 10

RTD Run Interval 11

RTD Run Interval 12

Ramp 1

Ramp 2

Ramp 3

Ramp 4

Ramp 5

Ramp 6

Ramp 7

Ramp 8

Ramp 9

Ramp 10

Ramp 11

Ramp 12

Interval 1

Interval 2

Interval 3

Interval 4

Interval 5

Interval 6

Interval 7

Interval 8

Interval 9

Interval 10

Interval 11

Interval 12


9/13/2018 BPA EIM 101 Workshop 56
Resource Sufficiency
Why Perform Resource Sufficiency Evaluation

- On an hourly basis, the CAISO performs a series of Resource Sufficiency (RS) tests to determine if an EIM Entity is leaning on the EIM for capacity, flexibility or transmission.

- Resource sufficiency helps ensure each EIM Entity can fulfill their own reliability obligations.

- If the EIM Entity passes the RS evaluation, it will have access to other EIM resources to meet its load and uncertainty for the next operating hour.

- If the EIM Entity fails the RS evaluation for the next operating hour, then incremental EIM transfers during the hour will not be allowed in the direction of the failure.
  - The EIM Market will still optimize resources/bids within the EIM Entity’s area.
Resource Sufficiency Tests

• Performed for each EIM BAA and the CAISO
  • After $T-75'/T-55'/T-40'$ for the Trading Hour starting at $T$

• Consist of the following four tests:
  1. Balancing Test
  2. Bid Capacity Test
  3. Flexible Ramping Sufficiency Test
  4. Feasibility Test (also performed in Day Ahead Market)
Balancing Test

• Ensures that each EIM Entity is balanced prior to the operating hour
• Compares BAA base schedules (Generation Base Schedules plus Interchange Base Schedules) with hourly demand forecast
• If EIM Entity elects ISO demand forecast option:
  – Pass: BAA imbalance within 1%
  – Fail: BAA imbalance greater than 1%
    • Over-scheduling/under-scheduling penalty applies if actual demands delta is above 5%
• If EIM Entity elects own demand forecast option:
  – Success (always)
    • Over-scheduling/under-scheduling penalty always applies
Balancing Test

- Forecasted Demand
- Base Schedules (+ Interchange)

Graph showing balance between forecasted demand and base schedules with interchange.
Bid Capacity Test

• Comparison of aggregate INC/DEC energy bid range from Participating Resources within the BAA on top of Base Schedules versus the demand forecast plus historical inter-tie deviations
  – Pass: sufficient bid capacity
  – Fail: insufficient bid capacity
    • Automatically fails Flexible Ramp Sufficiency test
    • Limited EIM transfers in direction of failure
Bid Capacity Test

- INC Bids
- DEC Bids
- Resource Schedules + Intertie Schedules
- Import Uncertainty
- Export Uncertainty
- Demand Forecast

VS
Flexible Ramping Sufficiency Test

• Ensures that each balancing area has enough ramping resources across each hour to meet expected upward and downward ramping needs
• INC and DEC ramping capability are considered separately
• Each 15’ interval tested separately
• Formulated for all BAAs in the EIM Area individually and for the entire EIM Area
  – Pass: resource ramp capabilities are above the requirements
    • Requirement is reduced by diversity benefit, limited to the available net import/export capability
  – Fail: resource ramp capabilities are below the requirements
    • EIM Transfer is limited to the net import/export level from the last 15-min schedule before the hour (at T−7.5’)
    • Possible to fail in only one direction (INC or DEC), limiting market actions only in that direction.
Flexible Ramping Sufficiency Test

• Data used:
  – Initial Participating Resource operating points used as the last FMM for the prior hour (at \( T-7.5' \))
    • Advisory solutions from FMM at \( T-75' \) and \( T-55' \) are used
    • Binding solution from FMM at \( T-40' \)
  – Participating Resources energy bids and ramp rates
  – VER and Demand Forecasts at 15’ intervals
  – 15' Flexible Ramp Uncertainty up/down requirements
    • Historical Load net VER difference from last Advisory 15-min run versus Binding 5-min market runs within that Hour of the Day
    • Reduced by a prorated EIM diversity benefit
    • Reduced by any credit for net outgoing/incoming EIM transfer at \( T-7.5' \)
    • Reductions limited by the available net import/export capability
Flexible Ramping Sufficiency Test

- INC/DEC bids must cover Expected Load + “Uncertainty”
- Uncertainty is an estimate of unforeseen variations in VERs and Load (2.5/97.5 percentiles of histogram)
- Individual BAA requirement will be reduced by a pro rata share of overall EIM diversity benefit.

INC/DEC flexible ramping capability is the same for all 15min intervals (it is evaluated separately for each ramp to a 15min interval – see next slide)
Flexible Ramping Sufficiency Test

• EIM Entity’s Participating Resource ramping abilities are subject to a cumulative test for each 15' interval of the hour
  – 15' ramp from \( T-7.5' \) to \( T+7.5' \) (1\textsuperscript{st} 15' interval)
  – 30' ramp from \( T-7.5' \) to \( T+22.5' \) (2\textsuperscript{nd} 15' interval)
  – 45' ramp from \( T-7.5' \) to \( T+37.5' \) (3\textsuperscript{rd} 15' interval)
  – 60' ramp from \( T-7.5' \) to \( T+52.5' \) (4\textsuperscript{th} 15' interval)

• Test passes if all four cumulative tests pass
• Test fails if any of the four cumulative tests fail
Feasibility Test

• Feasibility test are performed:
  – On the day before the Operating Day using Day Ahead Market (DAM) Base Schedules
  – Prior to each operating hour using the Resource Sufficiency timeline (T-75’, T-55’ and T-40’)
    • Uses Base Schedules submitted to the RTM
    • DAM Base Schedules are not used in RTM
  – Pass: no transmission limit violations
  – Fail: transmission limit violations identified
  – Consequences: None – informational only
Available Balancing Capacity

• Reserved capacity up/down on participating and non-participating resources
• Declared as Regulation up/down in base schedules
• Conditionally dispatched by the EIM to avoid a power balance constraint violation within the EIM Entity’s BA only when the net EIM Transfer is at its limit
  – Only available to your own BAA
• Does not contribute to Available Flexible Ramping Capacity
• Submitted Energy Bid is used for EIM Participating Resources (EIMPR)
• Default Energy Bid (DEB) is used for EIM Non-Participating Resources (EIMNPR)
Contingency Dispatch

• Contingency in CAISO
  – Suspend RTD; invoke Real-Time Contingency Dispatch (RTCD)
  – Isolate CAISO from the EIM Area
    • Freeze CAISO EIM Transfer at last RTD advisory solution
  – Send previous advisory 5min dispatch for EIMPR

• Contingency in an EIM BAA
  – CAISO does not perform Contingency Dispatch for EIM Entities
  – EIM BAA Operator notifies ISO of contingency status
  – Isolate EIM BAA from the EIM Area
    • Freeze EIM Transfer for EIM BAA at last RTD advisory solution
  – Incorporate Manual Dispatch instructions in RTD
EIM Settlements
What are EIM Settlements?

- Processes related to, and resulting in, the invoicing of charges and credits for participation in the EIM.
  - Pre-Settlements & Market Operations Feedback
  - Settlements-Related Data Submission and Collection
  - Shadow Settlements (validation)
  - Invoicing of EIM Charges/Credit to EESC and PRSC
  - Payment and Receipt of Funds for EIM Charges and Credits
  - Settlements-Related Dispute Management
EIM Settlements Basics

For Transmission Customers transacting within an EIM BAA, the financially binding base schedule, typically at T-57, forms the basis for settlement of imbalance energy charges:

• **Load**: difference between scheduled demand and metered demand is settled at the load aggregation point (LAP) price for period of deviation.

• **Non-participating generators**: difference between base schedule and metered generation is settled at Locational Marginal Price (LMP) for applicable pNode.

• **Participating Resources**: settle directly with CAISO at their LMP for awards and deviations from their operating targets.

• **Interchange**: The difference between e-Tag, typically at T-57, and any subsequent tag changes before/during hour are settled as instructed imbalance energy (IIE)
  – Auto-matching is a feature that can be used by EIM Entities to self-balance non-dynamic schedule deviations tag changes after T-40 with non-EIM BAAs.
EIM Settlement Basics

• CAISO settles on about 60 billing determinants
  – 26 with the Participating Resource Scheduling Coordinator (PRSC)
  – 34 with the EIM Entity Scheduling Coordinator (EESC)

• Approximately 70-80% of the EIM settlement dollars reside in 3 charge codes (CC)
  – Instructed Imbalance (PRs & NPRs)
    • Difference between Base Schedules and 15-min Market Schedule (FMM IIE)
      – CC 64600
    • Between 15-min Market Schedules (FMM) and 5-min Real Time Market Dispatch (RTD IIE)
      – CC 64700
  – Uninstructed Imbalance (PRs, NPRs, and Loads)
    • Difference between hourly meter and base schedule for EIM non-participating load;
      between meter and expected energy (i.e., RTD DOT) for other EIM resources (RTD UIE)
      – CC 64750

EIM Settlements Basics

• Settlement statements are posted daily by CAISO for at least 3, and up to 7, versions
  – Trade Day + 3 Business Days (T+3B)
  – T+12B
  – T+55B
  – T+9M (Months)
  – T+18M
  – T+33M
  – T+36M

• Settlement statements are included on the Invoice following the statement posting date

• CAISO has a formal dispute process whenever there are questions or discrepancies with the settlement statements or invoices
Other Settlement Categories

• **Under / Over Scheduling Load**: assigned to EIM entity
  – Could be charges or payments
  – Typically allocated by EIM Entity
  – Not charged if using CAISO load forecast

• **EIM Uplifts**: Typically allocated by EIM entities to load on basis of measured demand (metered demand plus interchange exports)
  – Market neutrality
  – Congestion offset
  – Marginal losses offset
  – Neutrality Adjustments
  – Bid Cost Recovery
Questions?
Upcoming EIM Stakeholder Meetings

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Thank You

• We welcome feedback on the workshop
• please send any to techforum@bpa.gov and reference “EIM 101 Workshop” in the subject
Appendix
On-line Resources

• **Western EIM Website**
• **Western EIM online training**
  – Introduction to EIM (CBT)
  – How EIM Works (CBT)
  – Base Scheduling (CBT)
  – Metering (CBT)
  – Settlements (CBT)
• **EIM Resource Sufficiency**
• **EIM Business Practice Manual**
With & Without an EIM
Without an EIM

- Outside of emergency situations, each BA must balance their own area and cannot use resources and load in another area to balance or manage congestion unless pre-arranged bi-laterally ahead of time.

- Example: BA1 must serve its internal load (L1+L2) and scheduled export obligation (S1+S2)
With an EIM

- The EIM economically and securely rediscpatches participating resources every 5 minutes across the entire market footprint (BA1+BA2+BA3) sufficient to serve the total market load and net market exports (S4+S5).

- Net Scheduled Interchange (NSI) for each Balancing Authority is dynamically adjusted to account for dispatches from the EIM and the resulting EIM Transfers.

- The dispatch of participating resources honors transmission limits and EIM energy transfers between BAAs are constrained to the amount of transmission made available to the market via dynamic schedules.
What are Locational Marginal Prices?
LMP

• Locational Marginal Pricing (LMP) are the result of the EIM optimization and represent the marginal cost of providing the next increment of energy demand (i.e., cost to serve the next MW of load) at thousands of pricing points, or pNodes, within the EIM Area.

• LMPs provide price signals that account for the additional costs of electricity caused by 1) congestion and 2) line loss at various points on the electricity grid and 3) Green House Gas (GHG) compliance for serving California load.

• LMPs allow the EIM to efficiently determine the interaction of energy supply and energy demand
LMPs & GHG

• GHG compliance cost component of the LMP is the rate the market uses to calculate a payment to each generator in an EIM BAA for its output that is determined to serve ISO imbalances. This payment is funded through the price paid within the ISO for imbalance energy embedded in the system marginal cost of energy.

• For resources in an EIM entity’s BAA, there are no GHG compliance costs when the resources serve load outside of the ISO. The EIM design allows EIM participating resources to submit two bids: (1) an energy bid and (2) a GHG bid adder.

• To avoid charging EIM entities for GHG compliance outside of California, the LMP of nodes in the EIM footprint outside of the ISO balancing authority area will include a negative GHG component if there is an EIM transfer into the ISO; otherwise, the value is zero.
The marginal cost of energy in zone 1 is higher ($35) than in zone 2 ($20).

Demand is higher in zone 1 (600 MWh) than in zone 2 (200 MWh)

There is a transmission line between the two zones & we are ignoring losses

Assume each generator is serving their local demand

Assume each generator, G1 and G2, has sufficient capacity to serve the total demand (800 MWh)
LMP Example (unconstrained)

• If the transfer of energy between the two zones is unconstrained
  – G2 would serve the local 200 MWh of demand and the 600 MWh of demand in zone 1
  – There would be a transfer of 600 MWh from zone 2 to zone 1
• The LMP (i.e., cost to serve the next increment of demand) at both zone 1 and zone 2 would be $20/MWh
• G1 would pay $20/MWh for the replacement energy from G2, saving $15/MWh
• G2 would be paid $20/MWh for the additional 600 MWh of energy produced to serve zone 1’s demand
• If the transfer of energy between the two zones was limited to 400 MW
  – G2 would serve the local 200 MWh of demand, but could only transfer 400 MWh to zone 1 due to the constraint
  – G1 would have to service the remaining 200 MWh of demand in zone 1
  – The marginal cost of energy (LMP) in zone 2 would be $20/MWh
  – The marginal cost of energy (LMP) in zone 1 would be $35/MWh
• G1 would pay $35/MWh for the 400 MWh energy from G2
• G2 would be paid $20/MWh for the additional 400 MWh of energy produced to serve zone 1’s demand
• EIM would collect from G1 $14,000 ($35 x 400)
• EIM would pay G2 $8,000 ($20 x 400)
• EIM collected excess revenue of $6000 ($14,000 - $8,000) - this excess revenue is called "congestion revenue."
LMP Example (G2 Derate)

What if G2 could only generate 100 MWh due to a real-time derate?
- G1 would need to serve the last 100 MWh or load in zone 2
- The marginal cost of energy (LMP) in zone 2 would be $35/MWh
- The marginal cost of energy (LMP) in zone 1 would be $35/MWh

- G2 would pay $35/MWh for the 100 MWh energy from G1
- G1 would be paid $35/MWh for the additional 100 MWh of energy produced to serve zone 2’s demand
- EIM would pay G1 $3,500 ($35 x 100)
- EIM would collect from G2 $3,500 ($35 x 100)
- EIM is revenue neutral ($3,500 - $3,500) – No Congestion Revenue
LMP Price Map

http://www.caiso.com/PriceMap/Pages/default.aspx
EIM Settlement Example
(Participating Resource)
Settlement Example for PR (one 15-minute interval)

• Scenario:
  – Resource has an hourly Base Schedule of **350 MWh** and an hourly bid of **$20.00/MWh**
  – Resource receives an **FMM Schedule/Award** of **385 MW (INC of 35)** for FMM interval 2 (XX:15-XX:30) with an **LMP of $22.50**
  – Resource receives an **RTD 5-minute market dispatch** of:
    • **400 MW (INC of 15 MW)** for RTD interval 4 (XX:15-XX:20)
      – LMP of $23.50
    • **355 MW (DEC of 30 MW)** for RTD interval 5 (XX:20-XX:25)  
      – LMP of $20.75
    • **320 MW (DEC of 65 MW)** for RTD interval 6 (XX:25-XX:30)  
      – LMP of $17.50
  – Resource **Meter Actuals**:
    • **405 MW (INC of 5 MW)** for RTD interval 4 (XX:15-XX:20)
    • **360 MW (INC of 5 MW)** for RTD interval 5 (XX:20-XX:25)
    • **310 MW (DEC of 10 MW)** for RTD interval 6 (XX:25-XX:30)
Settlement Example for PR (one 15-minute interval)

• Credits & Debits:
  – FMM 15-30 (Interval 2)
    • Credit of $196.88 \(\frac{35 \text{ MW} \times 22.50}{4}\) \(\leftarrow\) FMM IIE 64600
  – RTD 15-20 (Interval 4)
    • Credit of $29.38 \(\frac{15 \text{ MW} \times 23.50}{12}\) \(\leftarrow\) RTD IIE 64700
  – RTD 20-25 (Interval 5)
    • Debit of $51.88 \(\frac{30 \text{ MW} \times 20.75}{12}\) \(\leftarrow\) RTD IIE 64700
  – RTD 25-30 (Interval 6)
    • Debit of $94.79 \(\frac{65 \times 17.50}{12}\) \(\leftarrow\) RTD IIE 64700
  – Meter 15-20 (Interval 4)
    • Credit of $9.79 \(\frac{5 \text{ MW} \times 23.50}{12}\) \(\leftarrow\) RTD UIE 64750
  – Meter 20-25 (Interval 5)
    • Credit of $8.65 \(\frac{5 \text{ MW} \times 20.75}{12}\) \(\leftarrow\) RTD UIE 64750
  – Meter 25-30 (Interval 6)
    • Debit of $14.58 \(\frac{10 \times 17.50}{12}\) \(\leftarrow\) RTD UIE 64750

• Total Settlement: $83.45 \(\$196.88 + \$29.38 - \$51.88 - \$94.79 + \$9.79 + \$8.65 - \$14.58\)