ISO Markets Overview

Jenny Pedersen and Julie Riessen
Client Training
Customer Services Department
Introductions

• ISO Introduction
• Class Introductions
  – Name
  – Department
  – What you do (Title)
  – How long you’ve done it
Ground Rules

- Objectives and Schedule
- Informal Atmosphere
- Materials
- Ask Questions
- Breaks and Lunch
- Facilities – exits, restrooms, smoking
- Please silence cell phones
- Schedule is flexible and subject to change
Agenda

• What is the ISO?
• Wholesale Energy Procurement
  – Bilateral Arrangements and Markets
  – Products and Services
• Day-Ahead and Real-Time Markets
  – Timelines
  – Processes
• Post Market Processes
Course Objectives

By the end of this training, you will be able to:
- Describe interaction between our clients and our business units within the ISO
- Describe the purpose of the ISO
- Describe the Day-Ahead Market timeline
- Name the three Day-Ahead Market processes
- Describe the different kinds of capacity products the ISO procures and why
- Describe the purpose of the Real-Time Market
- Describe the post-market processes
ISO Markets and Operational Overview

Who is the ISO?
A Little Electric Restructuring History

- Previously - 3 IOU CPUC Regulated Monopolies
- Higher California electric rates drive for third party “Direct Access” and customer choice
- 1996 - AB 1890 Passed
- Creation of Cal PX (wholesale power pool) and ISO
- ISO start up - March 31, 1998
- ISO created to manage “Independent” operation of:
  - Grid Access – Transmission Market
  - Energy and Capacity Markets
  - Consolidated Control Area Operations
- “Reliability through Markets”
System Operations – Before & After

Utility Owned GENERATION

INDEPENDENT GENERATORS

SCHEDULING COORDINATORS

CALIFORNIA ISO

UTILITY

POWER MARKETERS

CUSTOMER
ISO Markets and Operational Overview

Becoming Familiar with the ISO
California ISO Vision

California ISO strives to be a
• world-class electric transmission organization
• built around a globally-recognized and inspired team
• providing cost-effective and reliable service,
• well-balanced and transparent energy market mechanisms,
• and high-quality information for the benefit of our customers.
California ISO Mission

For the benefit of our customers, we:

• Operate the grid reliably and efficiently
• Provide fair and open transmission access
• Promote environmental stewardship
• Facilitate effective markets and promote infrastructure development
• All through the provision of timely and accurate information.
The California ISO as a Corporate Entity

• Is a “non-profit for public benefit” corporation regulated by the Federal Energy Regulatory Commission (FERC)
• 5-Member governing board appointed by Governor and confirmed by State Senate
• Business units to support the operation of the corporation’s business
  – Human Resources, Legal, Corporate Services, Policy and Client Services
• Business units to support the actual operation of the business
  – Market and Infrastructure Development, Operations, Technology
The California ISO as a Business

- Provides open, non-discriminatory access to over 25,000 miles of transmission (ISO Grid)
- Facilitates transmission, wholesale energy and capacity (Ancillary Services and RUC) markets
- Complies with all WECC and NERC reliability standards
- Is a Balancing Authority Area (Control Area) which operates the transmission grid serving about 82% of California
Some Statistics of the ISO’s Business In 2009

- Served 46,042 megawatts of peak demand
- Processed $6.4 billion annual billings
- Managed 25,526 circuit-miles of transmission lines
- 30 million people served
- 600+ employees
- 286 billion kilowatt-hours of power delivered annually
- 54,436 megawatts of power plant capacity
- 1300 power plant units
The ISO helps to ensure reliable operation of the Western Interconnection by working with neighboring control areas to:

- Schedule Forward Energy
- Balance Load, Generation and Net Interchange
- Dispatch Ancillary Services
- Automatic Generation Control
- Coordinate Equipment Outages
- Provide Emergency Assistance
- Coordinate Operations with the Western Interconnection
Overview of the Western Interconnection

- Includes 14 western states, British Columbia and part of Mexico
- California - 40% of peak load
- All one interconnected system
Redundancy Lowers Impact of Threats

- Two Separate Control Rooms – 500 miles apart
- Redundant Energy Management System and Market, software and hardware
- Diversified, secured communications networks
- Cross-trained system operators with specific responsibilities
Summary - Who is the ISO?

- Created in 1997 to manage transmission allocation for energy and capacity and to facilitate the imbalance energy market
- Assists with transmission infrastructure planning and interconnection
- Facilitates the wholesale Energy and Ancillary Services Markets for buyers and sellers
- Maintains system reliability in real-time by dispatching generation optimally to meet the instantaneous system demand
ISO Markets Overview

Products and Services
Products and ServicesProcured
Module Objectives

By the end of this section, you will be able to:

• State the types of products and services the ISO procures through the Day-Ahead Market
• Describe the purpose of capacity procurement
• State the types of Capacity Products procured by the ISO
• State the difference between the types of capacity products
• State the difference between energy and capacity
Products and Services

- Energy
  - Day-Ahead or “forward” energy (physical)
  - Virtual bids for energy
  - Supplemental or “balancing” energy

- Capacity
  - Ancillary Services (A/S) – 10 Regions
    - Regulation Up and Regulation Down – on AGC
    - Operating Reserves
    - Procured by region and local as necessary
  - Residual Unit Commitment – Regions align with load zones
Day-Ahead Market Products and Services - Energy

- The ISO facilitates the Day-Ahead Market for energy.
  - Energy is the electricity needed to meet the needs of the California consumers – industrial, commercial, and residential alike.
- CAISO Forecast of CAISO Demand establishes how much energy is required for the day.
- Supply is generally procured through bilateral contracts outside of the ISO markets.
- Additional energy can be procured through the market at an agreed price and volume.
• The ISO procures capacity from the Day-Ahead Market.

• Capacity comes in the form of two different kinds of services, and is a “reservation” for energy.
  – Ancillary Services used to maintain grid reliability.
  – Residual Unit Commitment used to meet the forecasted demand

• Capacity Procurement Mechanism procure capacity for local area requirements or for grid reliability as needed. Not procured as part of the Day-Ahead Market process.
Day-Ahead Market Products and Services – Ancillary Services Capacity

• Ancillary Services ensures reliability in the event of a grid disturbance.
• Ancillary Services are categorized into Regulation and Operating Reserves
  – Regulation Up and Regulation Down are capacity products under ISO control (AGC).
  – Two types of Operating Reserves: Spinning Reserve on the grid in 10 minutes or less and Non-spinning Reserve on the grid within 10 minutes but not synchronized to the grid.
Day-Ahead Market Products and Services – Residual Unit Commitment Capacity

• Load Serving Entities are required to procure Resource Adequacy up to 115% of peak monthly load.
• “Resource Adequacy Contracts” are capacity procurement contracts.
• Contracted capacity is an obligation to the ISO and will be committed as needed to meet forecasted demand.
• Residual Unit Commitment capacity ensures supply available to meet the forecasted demand.
Day-Ahead Market Products and Services – Residual Unit Commitment Capacity

![Diagram showing self-scheduled supply and demand bids, with market clearing price and total cleared demand.](image-url)
Day-Ahead Market Products and Services Procurement Targets

- Ancillary Services procurement targets established by the Western Electrical Coordinating Council and uses the ISO Forecast of ISO Demand (CFCD)
- Residual Unit Commitment procurement based on total ISO Forecast of ISO Demand for the system
A/S Regions – Internal including Interties

<table>
<thead>
<tr>
<th>Region Description</th>
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<tbody>
<tr>
<td>ISO System Region</td>
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<tr>
<td>ISO System Region + Expanded</td>
</tr>
<tr>
<td>North of Path 15 + Expanded</td>
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<tr>
<td>North of Path 26 + Expanded</td>
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<tr>
<td>South of Path 15 + Expanded</td>
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<tr>
<td>South of Path 26 + Expanded</td>
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</tbody>
</table>
RUC Procurement Region

System Region for ISO

Regional requirements align with PG&E, SCE and SDG&E service territories
Products and Services Procured in the Day-Ahead Markets - Summary

- Ancillary Services is a capacity product and is used for grid reliability and stability.
- Ancillary Services products include Regulation Up, Regulation Down, Spinning and Non-Spinning Reserve.
- Residual Unit Commitment ensures enough supply will be online to meet the forecasted demand in Real Time.
Products and Services Procured in the Day-Ahead Markets - QUIZ

• Select the products and services that the ISO procures from the Day-Ahead Market
  – A. Energy and Ancillary Services Capacity Only
  – B. Ancillary Services and Residual Unit Commitment Capacity Only
  – C. Energy and Residual Unit Commitment Capacity Only
  – D. Energy, Ancillary Service and Residual Unit Commitment Capacity

• Ancillary Services capacity is used for
  __________________________________________
  – A. Grid Reliability
  – B. To meet the difference between what clears economically and the ISO Forecast of ISO Demand
What does the ISO use as a baseline to determine the Ancillary Services and Residual Unit Commitment Capacity Requirements?

- A. ISO Forecast of ISO Demand
- B. WECC Procurement Targets
- C. Residual Unit Commitment Regional Requirements

Select the types of Ancillary Services the ISO procures from the Day-Ahead Market:

- A. Regulation Up and Regulation Down Only
- B. Spinning Reserve and Regulation Down Only
- C. Regulation and Operating Reserves
ISO Markets Overview

Wholesale Energy Procurement
How does a Load Serving Entity Procure energy?

- Long-term and/or short-term bilateral contracts
  - Merchant Generators
  - Importers
- Energy trader
- ICE (Inter-Continental Exchange)
- Forward Market (Day-Ahead Market)
- Spot Market (Real-Time Market)
Bilateral Agreements
Contracts, ICE, Traders

- Buyers seek out supply to meet their base load
  - Establish contracts for either long-term or short-term supply
  - Seasonally
- Parties on both sides use ISO grid to supply and consume energy
- ISO unaware of bilateral transactions but requires parties to schedule/bid in supply or demand
- Supply receives a payment from ISO and Demand is charged by ISO
- ISO’s Inter-SC Trade mechanism “flips” the money
Forward and Spot Markets

• ISO’s Day-Ahead Energy Market
  – Enables suppliers to offload excess supply in the form of energy or Ancillary Services
  – Enables Load Serving Entities the ability to secure pricing for load due to changes in load forecasts or for incremental changes in demand

• ISO’s Real-Time Energy Market
  – Spot Market intended to meet instantaneous demand
  – Non-participating load cannot bid into the Real-Time Market
  – Participating demand and demand response may bid into the Real-Time Market
ISO Markets Overview

Day-Ahead Market Concepts
Market Concepts
Module Objectives

By the end of this section, you will be able to:

• Describe the basic components of an economic curve
• Explain the basic nature of supply curves
• Explain the basic nature of demand curves
Market Concepts

- Suppliers offer using **monotonically increasing** bid curves.
- Suppliers offer a range in megawatts for a specific price. For example, as the megawatt values increase, so do the prices.
- Buyers use **monotonically decreasing** bid curves.
- Buyers use bid curves to specify a volume range for price that they are willing to pay. For example, as the megawatt values increase, the prices decrease.
Market Concepts
Energy Bid Example

Provides the CAISO an economic signal when what participant is willing to accept or pay for energy in the Day Ahead Market

**SUPPLY**
Up to 10 segments, monotonically INCREASING

**DEMAND**
Up to 10 segments, monotonically DECREASING
Market Concepts: Submitting an Energy Bid for Supply (or Import)

The Bid curve MUST start at either the Self-Schedule or the Pmin. The Quantity is a RANGE: You read the down the first two quantities, then read UP to the price:

In this example, the Pmin is 50.

If the ISO wants 5 more MW (wants my unit to generate between 50 and 55), they must pay me at least $45.

If the ISO want me to move my unit from 55MW to 60, they must pay me at least $55.

If the ISO wants the last 5 MWs the must pay me at least $125.00
Market Concepts: Submitting an Energy Bid for Demand (or Export)

The Bid curve MUST start at either the Self-Schedule or zero.
The Quantity is a RANGE: You read the down the first two quantities, then read UP to the price:

In this example, the Self Schedule is 11MW.
If the price is less than $75, I will buy 1 more MW to export/serve demand.
If the price is less than $65, I will purchase 1 more MW to export/serve my load.
If the price is less than $50, I will purchase enough to serve 14MW load/export.
Market Concepts
Price Takers

• Suppliers and Buyers who self schedule their supply or demand are deemed to be Price Takers
• Price takers are at the very beginning of the economic curves.
• Economic curves illustrate available supply and demand volume and pricing points.
• The market clears where the demand curve and supply curve intersect.
Types of Energy Bids

- **Physical**
  - Physical delivery of electricity onto the ISO grid
  - May be bid in or self scheduled
  - May occur in the Day-Ahead or Real-Time Market
  - Supply eligible for Bid Cost Recovery

- **Virtual**
  - Financial positions taken at specific locations only in the Day-Ahead Market
  - May not be self scheduled
  - Positions liquidated in Real-Time Market
Illustrated below is an example of an economic curve for the energy markets.
Market Concepts - Summary

- The California ISO facilitates the wholesale electricity market.
- The market allows buyers and sellers to interact in a market-based commodity exchange.
- Energy Suppliers use monotonically increasing bid curves to provide an economic signal for their supply.
- Buyers use monotonically decreasing bid curves to describe how much they are willing to pay to meet their demand.
Market Concepts - QUIZ

• Energy suppliers use monotonically ____________ bids in the market.
  – A. Increasing
  – B. Decreasing

• On the economic curve, those participants who self schedule their demand or supply are called:
  – A. Economic Takers
  – B. Price Takers
  – C. Price Setters

• True or False:
  – The energy market clears at the intersection of the supply and demand curves.  **TRUE**
ISO Markets Overview

Inputs into the Day-Ahead Markets
Inputs into the Day-Ahead Market

Categories of Data
- System Parameters
- Resource Parameters
- Outage Information
- Default Energy Bids
- Bid Information

Requirements
- Ancillary Service Requirements
- RUC Requirements
- ISO Forecast of ISO Demand
- Manual RMR Determinations
- Transmission Interface Limits

Day Ahead Energy Schedules
Virtual Awards
AS Awards
RUC Capacity
Inputs into the Day-Ahead Market
- Categories of Data

• System Parameters - actual nodal system and utilizes the Full Network Model
• Resource Parameters - actual resource-specific conditions unique to resources in Master File.
• Outage Information - overlays generation or transmission re-rates or derates onto the Full Network Model as reported in SLIC by participants.
Inputs into the Day-Ahead Market - Categories of Data

- Default Energy Bids used in the Market Power Mitigation process.
- Proxy Bids are generated by the ISO based on Master File information.
- Schedules or Economic Bids that suppliers or buyers submit into the market.
- The Full Network Model shows where energy is injected into the grid or taken off the grid.
Inputs into the Day-Ahead Market
- Data Requirements

- ISO Forecast of ISO Demand (CFCD)
- Ancillary Service Requirements based on the CFCD and Western Electrical Coordinating Council requirements.
- RUC Requirements are based on the CFCD.
- Manual “Reliability-Must-Run” (RMR) Determinations for voltage support or regional/local stability requirements
- Transmission Interface Limits show the physical limitations on lines between neighboring control areas.
Inputs into the Day-Ahead Market
- Summary

• The ISO uses many inputs to run the Day-Ahead Market.
• Data generated by Participants include:
  – Bids for Ancillary Services, Residual Unit Commitment, as well as physical and virtual Energy
  – Master File for resource specific information
  – Outage Information submitted through SLIC for generator or transmission outages, de-rates or re-rates.
• Data requirements from the ISO include:
  – Ancillary Services and Residual Unit Commitment Requirements by system and region
  – ISO Forecast of ISO Demand
  – Transmission Interface Limits
Inputs into the Day-Ahead Market
QUIZ

• From the list below, select an input that is submitted by a Market Participant:
  – A. Ancillary Services Requirement
  – B. ISO Forecast of ISO Demand
  – C. Master File Resource Information
  – D. Transmission Interface Limits

• The Full Network Model shows:
  – A. Where energy is injected and removed from the grid
  – B. Bids from buyers and sellers
  – C. Energy schedules
Inputs into the Day-Ahead Market QUIZ

• Master File Information tells the ISO:
  
  A. The operating parameters of the resources within a Market Participant’s portfolio.
  
  B. Outage Information
  
  C. Default Energy Bids

• True or False
  – The Ancillary Services capacity requirement and the Residual Unit Commitment capacity requirement both use the ISO Forecast of ISO Demand as a starting point for establishing procurement targets.  TRUE
ISO Markets Overview

Convergence (Virtual) Bids
Defining Convergence (Virtual) Bidding Project

Module Objective

By the end of this section, you will be able to:

• Describe the purpose of virtual bidding
• Describe what a virtual demand bid is and how it differs from a virtual supply bid
• List the Day-Ahead Market process that uses virtual bids
Defining Convergence (Virtual) Bids

- Financial positions taken in the Day-Ahead Market and liquidated in the Real-Time Market
- Virtual Demand
  - Bid to buy at Day-Ahead price and offer to sell at Real-Time price
  - Looks like price sensitive demand
- Virtual Supply
  - Bid to sell at Day-Ahead price and buy at real-time price
  - Looks like a dispatchable supply resource
Defining Convergence (Virtual) Bids

- Supported in Day-Ahead Market only
- Bid to buy (Virtual Demand) is charged the Day-Ahead LMP and is considered a “long” position
- Bid to sell (Virtual Supply) is paid the Day-Ahead LMP and is considered a “short” position
- Virtual Supply offers and Virtual Demand bids may be submitted at any eligible pricing node in CAISO system
- Does not require any physical generation or load
How Convergence Bids Affect the Physical Market

- Virtual bids compete with physical bids and clear the Day-Ahead Market based on economics
- Virtual bids can set the price
- Virtual bids can impact how physical supply is committed in the Day-Ahead Market
- Virtual Awards paid or charged the Day-Ahead LMP and are liquidated at the Real-Time LMP.
How Convergence Bids Affect the Physical Market

• No physical energy is delivered or consumed with virtual bids
• Virtual bids are not backed by physical assets
• Virtual bids have no link between physical supply or physical demand bids submitted by the same SC
How Convergence Bids Affect the Physical Market

- Virtual bids are **not** used in the Day-Ahead Market processes that use physical bids for grid reliability
  - Market Power Mitigation/Reliability Requirements Determination (MPM-RRD)
  - Residual Unit Commitment (RUC)
- Virtual bids **ARE** used in the Integrated Forward Market process
- Virtual bids impact how physical supply is committed in both the Integrated Forward Market and in the Residual Unit Commitment process
Purpose and Benefits of Convergence Bidding at the Nodal Level

Convergence Bidding at the nodal level helps:

• Mitigate market power
• Increase market liquidity
• Lower costs due to more efficient Day-Ahead commitment
• Minimize the differences between Day-Ahead and Real-Time prices
• Improve grid operations
Purpose and Benefits of Convergence Bidding at the Nodal Level

Convergence Bidding provides Convergence Bidding Entities (CBEs) a financial mechanism to:

• Hedge against unit trip in real time
• Hedge against exposure to Real-Time pricing for load
• Earn revenues or risk losses between the Day-Ahead and Real-Time prices

Convergence bidding operates successfully in all the other US Independent System Operator markets
Why Implement Convergence Bidding?

- FERC requirement
- Operate consistently with other nodal markets
- Proven to contribute to market liquidity which helps discipline the market power of physical suppliers
Defining Convergence (Virtual) Bidding Project Module Quiz

True or False:

1. A virtual demand bid is a bid to buy in the Day-Ahead Market and sell in the Real-Time Market.  TRUE

2. A virtual supply bid is a bid to sell in the Day-Ahead Market and buy back in the Real-Time Market.  TRUE

3. Virtual bids have a direct correlation to physical bids submitted by the same SC.  FALSE
ISO Markets Overview
Day-Ahead Market

Day-Ahead Market Timeline and Processes
Purpose of Day-Ahead Market

- Enables sellers and buyers of energy to be matched up based on economic signals provided
- Allows the ISO to schedule space on the transmission system by using the Full Network Model to enable the energy to flow
- Allows the ISO to meet the forecasted demand through the energy schedules and additional online capacity, as needed
- Allows the ISO to ensure grid reliability through procured Ancillary Service products
Day-Ahead Market Timeline and Processes

- **DAM Process Begins**: Pull data from external sources, including: SIBR, Master File, Outage FNM.
- **Run MPM-RRD**: Evaluate Bids for Market Power based on the Full Network Model and mitigate Bids that are deemed to have Market Power.
- **Run IFM**: Will clear bid-in Supply with bid-in Demand plus procure 100% of the Ancillary Service requirement.
- **Run RUC**: Will procure additional capacity, based on CFCD as required to meet locational requirement.
- **Publish Results**: DAM Results published to ISO Market Results Interface.
- **Inter SC Trades**: Inter SC Trades do not affect the optimization process – Input required by 1200.
ISO Markets Overview
Day-Ahead Market
Market Power Mitigation – Reliability Requirements Determination Process
Day-Ahead Market Processes
Market Power Mitigation – Reliability Requirements Determination (MPM-RRD)

• MPM-RRD used to ensure resources do not have the ability to exercise market power based on their physical location
• Determines whether Reliability Must Run (RMR) units are running under an RMR contract or as a market resource
• Uses ISO Forecast of ISO Demand (CFCD) against submitted Supply Bids and solves for the system
• Establishes schedules on the system using the CFCD (with competitive constraints activated)
Day-Ahead Market Processes
Market Power Mitigation – Reliability Requirements Determination (MPM-RRD)

- Moves schedules from the Competitive Constraint Run (CCR) to resolve local constraints in the All Constraint Run (ACR)
- Enables Operators to turn on RMR Units for stability/voltage control
- Process results in mitigated bids used in the Integrated Forward Market Process
Market Power Mitigation Process

Competitive Constraint Run
P15/P26 and Ties

ZONE NP15

ZONE ZP26

ZONE SP15

All Constraint Run
Uses P15/P26 and Ties
and all internal lines
With Competitive Constraints active, the Competitive Constraint Run will determine Energy Schedules and AS Awards to meet the ISO Forecast of the ISO Demand.
The All Constraint Run will consider Energy Schedules and AS Awards from the Competitive Constraint Run as Self-Schedules, and with all the constraints active, the All Constraint Run will determine Schedules and Awards to meet the ISO Forecast of the ISO Demand and honor all transmission constraints.

Units that are INCREASED between the CCR and the ACR are subject to mitigation.
So, why are we doing all this?

- Ensure Units can not exercise Market Power by nature of where they reside
- Units that are moved between the CCR and the ACR are subject to mitigation
- The results of the MPM process are mitigated bids used by the IFM
- NOTHING is Scheduled or Dispatched as a result of this process
Example of Mitigated Bid: Resulting Bid Curve
Mitigated Bid Curve
Group Example 1

AC Level

CC Level

Submitted Bid Curve
Default Bid Curve

PMax

$70
$65
$60
$55
$50
$45
$40
$35

50 100 150 180 200 240

Slide 78
Mitigated Bid Curve
Group Example 1
Mitigated Bid Curve
Group Example 2
Mitigated Bid Curve
Group Example 2

AC Level

CC Level

MW

PMax

Submitted Bid Curve
Default Bid Curve

$70
$65
$60
$55
$50
$45
$40
$35

50
100
150
180
200
240

$40
$35
$45
$50
$55
$60
$65
$70
Mitigated Bid Curve
Group Example 3

MW

$70
$65
$60
$55
$50
$45
$40
$35

CC Level

AC Level

Submitted Bid Curve
Default Bid Curve
Mitigated Bid Curve
Group Example 3
# Understanding Mitigation

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<tr>
<th>Resource</th>
<th>CCR Level Dispatch</th>
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ISO Markets Overview
Day-Ahead Market
Integrated Forward Market Process
Day-Ahead Market Timeline and Processes
Purpose of Integrated Forward Market

- Clears Bid-In Supply against Bid-In Demand while honoring resource and transmission constraints
  - IFM Energy SCHEDULES
  - Virtual Awards

- Allocates 100% Ancillary Services
  - IFM Ancillary Service AWARDS

- Unit Commitment
  - ISO Commitment
  - Self Commitment

- ISO Market Results Interface (CMRI)
  - Binding AS Awards and RUC Schedules and Awards
  - Financially Binding Energy Schedules
  - Financially Binding Virtual Awards
  - LMP and ASMP Prices on OASIS
Integrated Forward Market
What Clears in the IFM?

Bid-in Supply with Bid-in Demand PLUS 100% of the AS Requirement

What if the Total Demand from the IFM does not meet the forecast?
ISO Markets Overview
Day-Ahead Market
Residual Unit Commitment Process
Day-Ahead Market Timeline and Processes
Residual Unit Commitment Purpose

• Procures capacity from additional supply in the market to be available in Real-Time
• Selects capacity from Resource Adequacy obligations as well as Availability Bids entered with an economic signal
• Provides a method of ensuring reliability of the grid for the entire system and for regional areas
• All resources committed in the Residual Unit Commitment process and/or any resource under an contracted capacity obligation must submit an energy bid in the Real-Time Markets
Integrated Forward Market
What Clears in the IFM?

Bid-in Supply with Bid-in Demand PLUS 100% of the AS Requirement

When the total cleared demand from the IFM does not meet the forecasted demand, the ISO procures capacity to meet the load forecast.
ISO Markets Overview
Day-Ahead Market
Publication of Market Results
Day-Ahead Market Timeline and Processes

Market Results

- Can be found in the ISO Market Results Interface (CMRI) section of the Market Participants Portal
- Market results provide information on prices, energy schedules, Virtual Awards, Ancillary Service Awards, and RUC commitment status and awards.
- Prices shown in CMRI are resource-specific Locational Marginal Prices for energy, resource-specific Ancillary Services prices, and resource-specific RUC prices.
- Market results are published at 13:00 and triggers the opening of the Real-Time Market
ISO Markets Overview
Day-Ahead Market

Day-Ahead Market Summary
Day-Ahead Market Timeline and Processes Summary

• Day-Ahead Market opens 7 days prior to Trade Date and closes at 10am the day prior to the Trade Date
• There are three processes in the Day-Ahead Market:
  – Market Power Mitigation-Reliability Requirements Determination
  – Integrated Forward Market
  – Residual Unit Commitment
• Market Results are published at 13:00 and may be found in the ISO Market Results Interface on the Portal
ISO Markets Overview
Real-Time Market

Real-Time Market Concepts
Module Objectives:
By the end of this section, you will be able to:
• State the purpose of the Real-Time Market
• State the types of products that the ISO procures from the Real-Time Market
Real-Time Market Concept

• The Real-Time Market is used:
  – To procure “balancing” energy to meet the instantaneous demand that draws energy from the grid
  – To reduce supply if there is not enough demand on the grid
  – In extreme conditions, to curtail demand based on economic signals when supply is exhausted or unavailable.
  – To procure Ancillary Services in Real Time as needed.

• Day-Ahead schedules make up the foundation of the energy used in Real-Time.

• Real-Time energy bids come from resources with Day-Ahead RUC schedules or capacity obligations under a Resource Adequacy contract or through changes from Day-Ahead awards.
Real-Time Market Concept

Bids for Supplemental Energy

• Energy bids are submitted from Generators, Curtailable Loads, and at Scheduling Points.
• Bids for supplemental energy can also come from available supply that was not committed in the Day-Ahead Market.
• Bids for energy can be submitted to either increase supply or to reduce supply.
• The ISO accepts bids and schedules for Real-Time energy and stacks up the bids in economic order for dispatching of supplemental energy.
• The ISO uses energy bids to manage the instantaneous demand movement on the grid.
Real-Time Market Concept

- In the event of a grid disturbance, the ISO manages the stability of the grid through the conversion of Ancillary Services Capacity into energy.
- The ISO also accepts bids for Ancillary Services in the Real-Time Market due to:
  - Changes to load forecast
  - Replacement of converted capacity
  - Additional requirements in regional areas
- AS Capacity awarded in Real-Time is designated as Contingency Only capacity
- Non-Participating Demand cannot schedule or bid in the Real-Time Market
- Participating Demand can bid and schedule in the Real-Time Market
Ancillary Services Procurement in Real-Time

- Procured as a contingency-only product
- ISO procures Ancillary Services in the Hour-Ahead Scheduling Process from Non-Dynamic System Resources
- For Ancillary Services procured in the 15-intervals, capacity is held for a 15-minute interval even though it is a 10-minute product
- Ancillary Services procured in the 15-minute interval is settled at the resource-specific LMP for the 15-minute interval
The purpose of the Real-Time Market is to procure balancing energy to meet the instantaneous demand that shows up or drops off the grid.

The ISO procures balancing energy and Ancillary Services in Real-Time.

In the event of a grid disturbance or a scarcity of imbalance energy supply on the grid, the ISO manages the stability of the grid by converting Ancillary Services capacity into energy in Real Time.
ISO Markets Overview

Real-Time Market

Real-Time Market Inputs, Timeline, and Processes
Real-Time Market Timeline and Processes

- The Real-Time Market opens at 13:00 the day prior to the Trading Day, or when the Day-Ahead Market Results are published.
- The Real-Time Market closes 75 minutes before the Trade Hour.
- The Real-Time Market utilizes many similar data inputs from the Day-Ahead Market, but also includes new energy bids submitted for the Real-Time Market and data from the State Estimator, showing Real-Time generation and transmission system readings.
Inputs into the Real-Time Market

Day-Ahead System Info
Day-Ahead Energy Schedules
Day-Ahead AS Awards
Day-Ahead RUC Awards
Master File

Real-Time System Info – State Estimator
Supplemental Energy and AS Bids
SLIC
Transmission Interface Limits

Real-Time Dispatches
AS Awards
Start-up/Shut down
Via Automated Dispatch System (ADS)
Real-Time Market Timeline and Processes

Real Time is a continuous process:
Looking at a single hour:

- T-75: RT Market Closes: Gather Data and Bids for the New Trade Hour
- T-52.5: STUC runs
- T-57.5: RT MPM is run
- T-62.5: HASP is run
- T-45: RT IST closes

Every 15 min: RTUC runs
Every 5 min: RTED runs

New Trade Hour
Real-Time Market Timeline and Processes

- MPM-RRD
- Hour-Ahead Scheduling Process (HASP)
  - Pre-dispatches Non-Dynamic System Resources
- Short Term Unit Commitment (STUC)
  - Issues start-up instructions to medium and short start units
- Real-Time Unit Commitment (RTUC)
  - Issues start-up/shut down instructions to short and quick start units
  - Procures Ancillary Services as needed
- Real-Time Dispatches
Real-Time Market Timeline and Processes

- Real-Time Economic Dispatch
  - Meets very short term load forecast with Supply
- Types of Real-Time Dispatches
  - Economic Dispatch
  - Contingency Dispatch
  - Exceptional Dispatch
  - Manual Dispatch
Real-Time Market Timeline and Processes

• All binding dispatches are issued through the Automated Dispatch System (ADS).

• Real-Time Market Results may be found in the ISO Market Results Interface (CMRI).
  – Confirmation of self-schedule adjustments
  – Advisory Schedules for Generation (non-binding)
  – HASP Results – may not be accurate as presented. HASP binding dispatches are received through ADS prior to the publication of the Real-Time Market Results.
  – Published 45 minutes before the Trade Hour
Real-Time Market Timeline and Processes

Summary

• Real-Time Market opens at the publication of the Day-Ahead Market results at 13:00 the day prior to the Trade Date.
• The Real-Time Market closes at 75 minutes prior to the Trading Hour.
• Real-Time MPM-RRD process is similar to the Day-Ahead MPM-RRD process except bid is examined in 15-minute intervals and mitigated for an entire hour
• HASP issues binding instructions to Non-Dynamic System Resources
Real-Time Market Timeline and Processes

Summary

• The Short Term Unit Commitment (STUC) process examines the forecasted demand over a 4-1/2 hour period and commits medium start units to meet the anticipated load pull.

• The Real-Time Unit Commitment (RTUC) process examines the forecasted load in 15-minute intervals. This process commits short start units and de-commits units as necessary. This process also procures Ancillary Services as needed in Real-Time.
Real-Time Market Timeline and Processes Summary

- **Real-Time Economic Dispatch (RTED)** is the 5-minute dispatch of balancing energy to meet the very short term load forecasts.

- **Contingency Dispatches** are used to stabilize the grid in the event of a grid disturbance or in the event of the total utilization of available imbalance energy.

- **Exceptional Dispatches** are also known as Out of Sequence or Out of Market dispatches and can be issued according to the Tariff Section 34.9.

- **Manual Dispatches** are used as a last resort and are dispatched in merit order without regard to where they are on the network.
ISO Markets Overview
Real-Time Market

Real-Time Market Results
Real-Time Market Results

- All Real-Time Market Results can be found in the ISO Market Results Interface (CMRI)
- Binding Real-Time results will be dispatched through the ADS system. This includes results for energy and Ancillary Services.
- CMRI shows if self schedule changes are accepted
- Non-Binding or Advisory schedules for generators can be located on CMRI.
- Real-Time LMPs can be located on OASIS
ISO Markets Overview

Locational Marginal Prices
**DEFINITION:**

- The marginal cost of serving the next increment of Demand at that PNode consistent with existing transmission facility constraints and the performance characteristics of resources. (CAISO Tariff definition)

- All schedules from the Day-Ahead Market will be settled.

**IN GENERAL:**

- Supply resources will be paid the LMP at the Pnode where the resource resides
- Demand resources will pay the LMP at the LAP level
Locational Marginal Prices

- Over 3,500 price nodes throughout the system
- Supply resources has a price calculated based on their location on the system.
- In general, demand is charged at a price associated with a Load Aggregation Point, an average of the demand node prices within specific zones, which correlate to the load zones of PG&E, SDG&E, and SCE.
- Imports and Exports have prices associated with their scheduling point, the interface point where the power comes in or goes out of the system.
Three (3) Components of LMP (Tariff Definitions)

- The System Marginal Energy Cost (SMEC)
  - The component of the LMP that reflects the marginal cost of providing Energy from a designated reference location. (The CAISO will utilize a distributed Reference Bus whose constituent PNodes are weighted throughout the system.)

- The Marginal Cost of Congestion (MCC).
  - The component of LMP at a PNode that accounts for the costs of congestion, as measured between that Node and a Reference Bus

- The Marginal Cost of Losses (MCL)
  - The component of LMP at a PNode that accounts for the marginal real power losses as measured between that Node and a Reference Bus
ISO Markets Overview

Determining Locational Marginal Pricing
LMP: Energy Example #1

If the need for Energy is 300 MW and two generators are offering at $40 and $60, what is the least cost solution? (Assume no losses or Congestion)
LMP: Energy Example #1

The most economic choice is 300 MW at $40 from G1

Node 1
- Bid: 500 MW @ $40
- Demand: 0 MW
- LMP = $40

Node 2
- Bid: 500 MW @ $60
- Demand: 0 MW
- LMP = $40

Node 3
- Demand: 300 MW
- LMP = $40

The most economic choice is 300 MW at $40 from G1.
LMP: Energy Example #2

If the need for Energy is 300 MW and two generators are offering at $40 and $60, EXCEPT the transmission line between G1 and the Demand is limited to 150MW, what is the most economic solution? (Assume no losses)

Demand: 300 MW

Node 3

Node 2

G2

Demand: 0 MW

Bid: 500 MW @ $60

Node 1

G1

Demand: 0 MW

Bid: 500 MW @ $40

Limit = 150 MW

? MW
LMP: Energy Example #2

The most economic solution, that honors the line limit: 150 MW from G1 and 150 MW from G2. The LMP at G1 = $40, the LMP at Node 3 = $60 (assuming no losses).
If the need for Energy is 400 MW and three generators are offering at $40, $50 and $60, and the transmission line between G1 and the Demand is limited to 150MW, what is the most economic solution? (Assume no losses)
LMP: Energy Example #3

Answer

If the need for Energy is 400 MW and three generators are offering at $40, $50, and $60, and the transmission line between G1 and the Demand is limited to 150 MW, what is the most economic solution? (Assume no losses)

Node 1
- Bid: 500 MW @ $40
- Demand: 0 MW
- LMP = $40

Node 2
- Bid: 200 MW @ $50
- Demand: 0 MW
- LMP = $60

Node 3
- Bid: 500 MW @ $60
- Demand: 400 MW
- LMP = $60

Limit = 150 MW

G1
- LMP = $40
- 150 MW

G2
- LMP = $60
- 50 MW

G3
- LMP = $60
- 200 MW

G1, G2, G3 offer a total of 850 MW but only 150 MW can flow. The most economic solution is to bid 200 MW @ $50 from G2 in Node 2 and 200 MW @ $60 from G3 in Node 3. This satisfies the 150 MW transmission limit, and the total cost is $700 MW.
Actual losses are calculated by the use of the Full Network Model and the optimal power flow solution and will affect the LMP calculated by the IFM program.

The loss component of the LMP is based on the MARGINAL losses. That is, the amount of losses incurred when serving an additional MW of load at a Node.

The marginal losses are based on loss sensitivity factors produced by the IFM program.
Locational Marginal Pricing - Summary

• LMP is comprised of 3 components
  – System Marginal Energy Cost is the same at all locations
  – Marginal Cost of Congestion reflects the cost to move the energy across the transmission lines due to the physical limits and demand on the line
  – Marginal Cost of Losses is the cost associated with losses as energy moves across the system

• Supply resources in the ISO system will have a price node associated with it.

• In general, Demand pricing is aggregated at the Load Aggregation Point correlating to the PG&E, SCE, and SDG&E service areas.

• Imports and Exports will have the same LMP reflected at the same location.

• There are over 3,500 price nodes in the ISO system.
Inter-SC Trades for Energy

Section 28 of the CAISO Tariff
Market Instruments BPM
Objectives:

By the time you are finished with this section, you will be able to:

• State why an Inter-SC Trade may be used
• Identify the difference between an Aggregate Price Node (APN) Trade and a Physical (PHY) Trade
• Name the three validations that occur with a Physical Inter-SC Trade
Bilateral Agreements
Contracts, ICE, Traders

- Bilateral transactions created outside of ISO Markets
- Parties on both sides of the agreement need to use ISO grid to deliver and consume energy
- ISO requires supply and demand to schedule or bid into the Day-Ahead Market
- Supply receives a payment from ISO
- Demand is charged by ISO
- ISO’s Inter-SC Trade mechanism “flips” the money
Example of Bilateral Contract and Scheduling Process

This is Beth. She owns a load serving entity and serves 100MW of load every day. This is her “base load.”

This is Charlie. He owns a generator and can produce about 300MW of generation every day. The minimum operating level of his resource is 30MW.
Beth goes to Charlie to negotiate a supply contract. Charlie agrees to sell 100MW of supply to Beth for a price of $28.00 per MW for energy. Beth pays Charlie $2,800.

Charlie agrees to sell 100MW of supply to Beth for a price of $28.00 per MW and receives a payment of $2,800.
Example of Bilateral Contract and Scheduling Process

$2,800 Charge from Charlie

$2,800 Payment from Beth
Beth must now schedule the 100MW load on the ISO Grid. She self-schedules her 100MW load at the DLAP where her load is located in PG&E’s service territory. The ISO charges Beth $65.00 (LMP) at the DLAP for a charge of $6,500.

Charlie self-schedules his 100MW generation at his Price Node location. The ISO pays Charlie $55.00 (LMP) for a payment of $5,500.
Example of Bilateral Contract and Scheduling Process

$2,800 Charge from Charlie
$6,500 Charge from ISO

$9,300 out of pocket

($2,800) Payment from Beth
($5,500) Payment from ISO

($8,300) in pocket
Example of Bilateral Contract and Scheduling Process

Settling the Money

• Settle outside of the ISO Markets
  – Usually agreed in the contract negotiations
• Settle using the ISO Market mechanism by submitting in Inter-SC Trade
  – APN Trade allows participants to settle at the Hub price or at the LAP price
  – Physical Trade allows participants to settle at the Generator Pnode price
Inter-SC Trades for Energy

- Financial settlement service ONLY
- Can be used to offset “double settlement” caused by the CAISO Market
- Inter-SC Trades are ONE choice – not required by the CAISO
- Inter-SC Trade does NOT physically schedule energy on the grid.
- The Day-Ahead Market closes at 10am, the Inter-SC Trade process closes at 12pm
Inter-SC Trades for Energy

- Two types of Inter-SC Trades for Energy
  - Aggregate Price Node (APN) Trade
    - 3 Default Load Aggregation Points (LAPs)
    - 3 EZ Generation Trading Hubs (NP15, ZP26, SP15)
  - Physical Inter-SC Trades
    - Will NOT physically schedule MW on the grid, but requires validation of Schedules
    - Only at a Generator Node
    - Generator must exit the Day-Ahead Market with a Schedule that supports all Trades sourcing the Generator
- No Trades allowed at Scheduling Points
AGGREGATE PRICE NODES (APN) TRADES
APN Trades

- Participants can settle a trade at one of the following locations:
  - Generation Hub corresponding with NP15, SP15, ZP26
    - Aggregation of generation price nodes in the corresponding area
  - Load Aggregation Point (LAP) corresponding with PG&E, SCE, SDG&E service territories
    - Aggregation of load price nodes in the corresponding area
PHYSICAL TRADES
Physical Trades

• The Trade Location is a Generator Pnode
• The Trade price is the LMP at the Generator Pnode
• Generator must have a
  – Day-Ahead Schedule to support all Physical Trades on the Unit
  – HASP Advisory Schedule to support all the Physical Trades on the Unit for RT Trades
• Validation: 3 phases
  – Submittal screening
  – Pre-Market
  – Post-Market
Simple PHY Validation

Submittal screening

Pmax = 100MW

Trade Status - Rejected

Trade for 105MW

Pre-Market

Pmax = 100MW

Trade for 100MW

Bid for 90 MW

Trade Modified: 90MW Trade, 10MW CUT

Post-Market

Pmax = 100MW

Bid for 100 MW

Trade Modified: 80MW Trade, 20MW CPT

Scheduled for 80MW
EXAMPLES OF SETTLING TRADES
Evaluating the Options

- The price for the energy is the same for all Price Nodes within the same pricing interval.
- The difference in prices are due to the cost of congestion and losses.
Example of Settlement Process for Inter-SC Trade
Aggregate Price Node Trade

• If Beth and Charlie agree to settle at the PG&E DLAP where Beth scheduled her load, then Charlie would pay Beth the exact amount that Beth was charged by the ISO.
• The LMP at the DLAP was $65.00
• Quantity was 100MW
Example of Settlement Process for Inter-SC Trade
Aggregate Price Node Trade – Load Aggregation Point

$2,800 Charge from Charlie
$6,500 Charge from ISO

($6,500) Inter-SC Trade from Charlie

$2,800 Out of Pocket

($2,800) Payment from Beth
($5,500) Payment from ISO

$6,500 Inter-SC Trade to Beth

($1,800) In Pocket
Example of Settlement Process for Inter-SC Trade
Aggregate Price Node Trade

• If Beth and Charlie agree to settle at the NP15 Generator Hub in the area of Charlie’s generator, then Charlie would pay Beth the HUB price.
• The LMP at the NP15 Hub was $60.00
• Quantity was 100MW
Example of Settlement Process for Inter-SC Trade
Aggregate Price Node Trade – Generator Hub

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>$2,800 Charge from Charlie</td>
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<tr>
<td>$6,500 Charge from ISO</td>
<td></td>
</tr>
<tr>
<td>($6,000) Inter-SC Trade from Charlie</td>
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</tr>
<tr>
<td>$3,300 Out of Pocket</td>
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<tr>
<td>($2,800) Payment from Beth</td>
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<td>($5,500) Payment from ISO</td>
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<tr>
<td>($6,000) Inter-SC Trade to Beth</td>
<td></td>
</tr>
<tr>
<td>($2,300) In Pocket</td>
<td></td>
</tr>
</tbody>
</table>
Example of Settlement Process for Inter-SC Trade Physical Trade

• If Beth and Charlie agree to settle at Charlie’s generator Pnode, then Charlie would pay Beth the exact amount that he received from the ISO.
• The LMP at the Charlie’s Pnode was $55.00
• Quantity was 100MW
Example of Settlement Process for Inter-SC Trade
Aggregate Price Node Trade – Generator Hub

$2,800 Charge from Charlie
$6,500 Charge from ISO

($5,500) Inter-SC Trade from Charlie

$3,800 Out of Pocket

($2,800) Payment from Beth
($5,500) Payment from ISO

$5,500 Inter-SC Trade to Beth

($2,800) In Pocket
Evaluating the Options

Net Charge

Settling at a LAP = $2,800
Settling at a Hub = $3,300
Settling at a Generator Pnode = $3,800

Net Revenue

Settling at a LAP = $3,800
Settling at a Hub = $3,300
Settling at a Generator Pnode = $2,800
Why Does A Participant Choose to Use an Inter-SC Trade Mechanism through the ISO Market?

• Mitigates credit collateral requirement for the Load Serving Entity.

Self-schedules 100MW to come off the grid at PG&E DLAP @ $65.00 MW

• Liability to the Market = $6,500
• Credit collateral based on outstanding liability
• Offsetting credit from trade reduces LSE’s liability exposure to the ISO
Module Summary

- Load serving entities procure supply through bilateral contracts.
- Both supply and demand schedule or bid their energy in the Day-Ahead Market.
- Inter-SC Trade mechanism allows the participants to “flip the money” and potentially reverse the “double settlement” caused by the ISO Markets.
Inter-SC Trades Quiz

True or False:

• Inter-SC Trades are used as a financial settlement service ONLY
  – True

• Can be used to offset “double settlement” caused by the CAISO Market
  – True

• Inter-SC Trades are required by the CAISO
  – False
Inter-SC Trades Quiz

True or False:
• Inter-SC Trades are allowed at Scheduling Points
  – False
• Inter-SC Trades are available for both the Day-Ahead Market and the HASP (Real-Time) Market
  – True
• Inter-SC Trades are NOT affected by Real-Time performance of any supply resource
  – True
ISO Markets Overview

Post-Market Processes
ISO Markets Overview

Metering Requirements
Meter Data Submission Overview

- Settlement Quality Metered Data (SQMD) is used for billable quantities to represent the Energy generated or consumed during a Settlement Interval.
- SQMD is obtained from two different sources:
  - ISO Metered Entities (Meter Data directly polled by ISO)
  - Scheduling Coordinator Metered Entities (Meter Data submitted to ISO by SCs)
- Late Meter Data impacts settlement statements for the entire market
Meter Data Submission Timeline

• OMAR Meter Data Submission Timeline
  – Estimated or Actual Meter Data submitted by T+5B
  – ISO Meter Data Estimation at T+7B for data not submitted
  – Actual Meter Data submission by T+43C to be “on time”
  – Actual Meter Data final submission by T+61B is considered “late” and may be subject to penalty due to non-compliance with the ISO tariff

• Meter Data determines how much energy is attributable to Instructed Imbalance Energy and Uninstructed Imbalance Energy based on Real-Time dispatch instructions
ISO Markets Overview

Settlement Statements and Invoicing Timeline
Daily Settlement Statements Timeline

- T+7B (initial)
- T+38B (First Recalculation)
- T+76B (Second Recalculation)
- T+18M (Recalculation)
- T+35M (optional)
- T+36M (Final – Sunset Provision)
  - T+36M only shows incremental changes from the T+35M invoice
Invoicing

- Invoicing
  - Semi-Monthly (twice per month)
  - Floating date based on settlement calendar date of TD+7B after 15th & EOM.
  - Initial Statements invoiced semi-monthly – includes 1-15th and 16th–EOM.
  - Recalculation Statements invoiced monthly and included on one of the two semi-monthly invoices along with initial billing period.
  - Interest will be assessed on any deviations and show-up on next scheduled invoice.
**Invoice Example – Using December Trade Month**

### December 2009

<table>
<thead>
<tr>
<th>SUN</th>
<th>MON</th>
<th>TUES</th>
<th>WED</th>
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**Initial Invoice for TD 12/1-12/15**

Issued on 12/24/09

Invoice due on January 4, 2010

### January 2010

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<td>Feb 1</td>
<td>Feb 2</td>
<td>Feb 3</td>
<td>Feb 4</td>
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</tbody>
</table>

**Initial Invoice for TD 12/16-12/31**

Issued on 1/12/10

Invoice due on January 20, 2010
ISO Markets Overview

Settling the Market
Settling the Day-Ahead Market

- All Day-Ahead market transactions are financially binding regardless of Real-Time performance.
- Physical supply paid the Day-Ahead LMP for all schedules, at the price node where the transaction is scheduled or bid.
- In general, all physical Demand is charged the Day-Ahead LMP where the default Load Aggregation Point (LAP) is scheduled.
- Virtual Demand Awards are charged the Day-Ahead LMP at the location where the transaction is bid.
- Virtual Supply Awards are paid the Day-Ahead LMP at the location where the transaction is bid.
Settling the Day-Ahead Market

• Imports or Exports are paid or charged, respectively, at their scheduling point.
• Ancillary Services are paid the MW value that is awarded at the Ancillary Services Marginal Price (ASMP), which is a resource-specific price.
• Capacity procured from the RUC process is paid the resource-specific capacity LMP, if applicable.
Example 1: Generating Resource (without contract self schedule)

<table>
<thead>
<tr>
<th>Generator 1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFM DA Schedule</td>
</tr>
<tr>
<td>LMP at Generator 1 Pnode</td>
</tr>
<tr>
<td>Energy</td>
</tr>
<tr>
<td>Congestion</td>
</tr>
<tr>
<td>Loss</td>
</tr>
</tbody>
</table>

\[
= (-1) * [\text{DA Energy Schedule w/o Contract} \times \text{DA LMP})
\]

\[
= (-1) * [(100 \text{ MW} \times $50)
\]

\[
= (-1) * ($5,000 + $0) = $-5,000
\]

Payment to Generator 1 in CC 6011
Example 1: Demand Resource (without contract self schedule)

= (-1) * [(DA Energy Schedule w/o Contracts) * DA LMP)

= = (-1) * [(- 95 MW * $60)]

= = (-1) * ($5,700) + ($0) = $5,700.00

Charge to Demand 2 in CC 6011

<table>
<thead>
<tr>
<th>Demand 2</th>
<th>IFM DA Schedule</th>
<th>LMP at Default LAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-95[^1] MW</td>
<td>Energy = $45</td>
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<tr>
<td></td>
<td></td>
<td>Congestion = $10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loss = $5</td>
</tr>
<tr>
<td></td>
<td>$60</td>
<td></td>
</tr>
</tbody>
</table>

\[^1\] Demand Energy Schedule quantities for load, export, or participating load when consuming Energy are negative

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Settling the Real-Time Market

- Real-Time Market transactions are independent of and incremental to the Day-Ahead Market transactions
- Energy scheduled in the Day-Ahead Market but not delivered in Real-Time is subject to buy-back at Real-Time prices
- Ancillary Services awarded in the Day-Ahead Market and not delivered are subject to No-Pay.
- Real-Time Market is settled based on Real-Time dispatch compared to metered data
Summary – Settling the Markets

- All schedules from the Day-Ahead Market are financially binding regardless of Real-Time performance.
- Day-Ahead transactions are settled independent from Real-Time transactions.
- Real-Time transactions are incremental to the Day-Ahead transactions.

In General:
- All supply resources will be paid the LMP at the Pnode where they are bid or scheduled.
- All physical demand resources will be charged the LMP at the Load Aggregation Point where they are bid or scheduled.
ISO Markets Overview

Bringing It All Together
ISO Market Overview
Summary

- Day-Ahead Markets open 7 days before the Trade Date and close at 10am one day prior to the Trade Date.
- The ISO procures energy, Ancillary Services, and RUC capacity from the Day-Ahead Market to meet the load forecast.
- The three processes used in the Day-Ahead Markets are:
  - Market Power Mitigation and Reliability Requirements Determination (MPM-RRD)
  - Integrated Forward Market (IFM)
  - Residual Unit Commitment (RUC)
ISO Market Overview

Summary

• Participants submit bids and/or schedules with economic signals for supply and demand.
• Day-Ahead Market results are published around 13:00 which triggers the opening of the Real-Time Markets
• Real-Time Market closes at TH-75 and consists of the following RT processes
  – MPM-RRD
  – Hour-Ahead Scheduling Process (HASP)
  – Short-Term Unit Commitment (STUC)
  – Real-Time Unit Commitment (RTUC)
  – Real-Time 5-minute dispatches
ISO Market Overview
Summary

• Locational Marginal Prices are resource-specific and are comprised of three components:
  – System Marginal Energy Cost
  – Marginal Cost of Congestion
  – Marginal Cost of Losses
ISO Markets Overview

Wrapping It Up
ISO Markets Overview Quiz

True or False:

A. The main purpose of the ISO is to maintain the reliability of the electrical system (ISO Control Area) by procuring energy and Ancillary Services at the least cost. **TRUE**

B. The Day-Ahead Market closes at 1:00 p.m. **FALSE**

C. The Day-Ahead Market processes consist of MPM, HASP, IFM, RUC **FALSE**

D. Ancillary Services are procured in order to protect the grid in the event of a disturbance on the grid. **TRUE**
Select the correct statement to complete the following sentence: The Locational Marginal Price is comprised of…

A. the System Marginal Cost of Energy, the Marginal Cost of Congestion and the Marginal Cost of Losses

B. the System Marginal Cost of Energy, the Marginal Cost of Congestion only

C. the System Marginal Cost of Energy, the Marginal Cost of Losses only
ISO Markets Overview Quiz

True or False:
A. The opening of the Real-Time Market is triggered by the closing of the Day-Ahead Market.  **FALSE**
B. The results of the Day-Ahead Market are not financially binding.  **FALSE**
C. Meter data is used to determine Real-Time settlement charges or payments.  **TRUE**
ISO Markets Overview

References and Additional Information
Additional information may be found in the following locations:

- **Day-Ahead Market Timeline and Processes**
  - Tariff Section 31
  - Business Process Manual (BPM) for Market Operations Section 6

- **Day-Ahead Market Inputs**
  - Business Process Manual (BPM) for Market Operations Section 2.5

- **Locational Marginal Prices**
  - Tariff Section 27.1
  - Business Process Manual (BPM) for Market Operations Section 3.2
Additional information may be found in the following locations:

- **Real-Time Market Timeline and Processes**
  - Tariff Section 34
  - Business Process Manual (BPM) for Market Operations Section 2.3.2, Section 7

- **Hour-Ahead Scheduling Process (HASP)**
  - Tariff Section 33

- **Real-Time Market Inputs**
  - Tariff Section 34

- **Ancillary Services Procurement in Real Time**
  - Tariff Section 33.7
  - Business Process Manual (BPM) for Market Operations Section 4.3.2
ISO Markets Overview

If you have any questions or would like additional information, send an email to:

MarketTraining@caiso.com

Thanks for attending this class.