Welcome
Our presentation will begin shortly.

Today’s Trainer:
Heidi Holmberg Carder, Lead Customer Education Trainer
Why are we here?

To prepare resource owner/operators to effectively manage their battery resources to maintain market efficiency & grid reliability

It requires a partnership to ensure the safety and reliability of the grid!
What Will I Be Learning?

• How do my battery resources fit in the Bulk Electric System?
• What are my battery resource capabilities?
• What are my requirements for physical management of my battery resource?
• What are my communication responsibilities?
• What are the reliability consequences of not following my instructions?
• Where can I learn more?
Housekeeping

- Keep yourself muted to minimize background noise
- Unmute to ask verbal questions or write questions in the chat pod
- Raise your hand using WebEx interactivity tools

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What’s next?

- This training is being recorded
- Recordings and presentations will be posted on the ISO Learning Center within 3 business days
- Questions gathered during this course will be collected and turned into a comprehensive Q&A guide after the conclusion of the 4 training course series
- The Storage computer based training course will be updated and republished in mid-June
- This is the second training in a series focused on efforts to create a Resource Owner/Operator training track – stay tuned!
Foundational Information

How do you fit into the overall picture?
System reliability requires a constant and instantaneous match between supply and demand.
Bulk Electric System
ISO Market and Reliability Footprints

ISO BAA

RC West

WEIM
Participation with the ISO depends on the service to be provided

There is a great deal of coordination required to maintain system reliability
Storage

How does it work?
Battery

Energy

Storage

System
Energy storage systems enhance power system flexibility and enable higher levels of renewable energy integration.

Excess solar energy may be used to charge batteries during the day when supply may be greater than demand.

When net demand increases and solar resources can no longer generate, the batteries can discharge to meet system needs.
2023 Statistics from Today’s Outlook

- **Peak Demand**: 44,534 MW
  - August 10 at 5:59 p.m.
  - Previous year: 35,081 MW on September 18 at 4:37 p.m.

- **Solar Peak**: 16,056 MW
  - Sept 26 at 11:32 a.m.
  - Previous year: 14,352 MW on June 7 at 12:16 p.m.

- **Wind Peak**: 6,317 MW
  - May 28 at 5:59 p.m.
  - Previous year: 6,465 MW on May 28 at 5:59 p.m.

- **Peak Net Imports**: 10,480 MW
  - May 20 at 11:36 p.m.
  - Previous year: 11,465 MW on Feb 10 at 5:29 p.m.

- **Added Installed Storage Capacity**: 2,684 MW
  - Previous year: 1,984 MW

- **Total Installed Storage Capacity**: 7,188 MW

- **Installed Renewable Resources (as of 02/01/2024)**
  - **Breakdown**:
    - Solar: 60.8%
    - Wind: 27.5%
    - Geothermal: 5.3%
    - Small Hydro: 3.9%
    - Biofuels: 2.6%

- **Megawatts**:
  - Solar: 18,517
  - Wind: 8,358
  - Geothermal: 1,610
  - Small Hydro: 1,180
  - Biofuels: 778
  - **TOTAL**: 30,443

- **Installed Battery Capacity**:
  - 7,261 MW

*As of 02/07/24; subject to change.*
ISO’s storage resource models are continuing to evolve in order to accommodate the unique operating and technical characteristics of battery resources.

**Standalone**
- Independent resources connected directly to the grid
- Individual Resource ID

**Co-located**
- Different energy technologies at same generating facility
- Shared grid point of interconnection
- Separate Resource IDs, bids and dispatch instructions

**Hybrid**
- Different energy technologies at same generating facility
- Shared grid point of interconnection
- Single Resource ID, bids and dispatch instructions
- Energy source determined by SC/Resource Operator

**Regulation Energy Management**
- Bid capacity into the ISO day-ahead regulation markets only
- Awarded for regulation up and regulation down
- Cannot bid any other services
Co-Located Resources and Aggregate Capability Constraint

ACC is needed here because the sum of the co-located resources’ MW is greater than the transmission capacity at the POI.

POI Max: 225 MW

ACC = 225 MW

50 MW

100 MW

100 MW

Created to prevent co-located resources from exceeding the capacity limit of their shared Point of Interconnection

Enhanced CBT mid-June 2024
Off Grid Charge Indicator

- Created by the ISO to enforce the Charging Constraint within SIBR, allowing a co-located storage resource to elect not to charge beyond the output of its associated co-located variable energy resource (VER)
- Does not change existing policy or CAISO tariff requirements on the feasibility of bids or must-offer obligation for RA capacity
- Completely at the SC’s risk and discretion

Tariff section 37.3.1.1
Managing State of Charge (SOC)
State of Charge (SOC) represents a battery’s level of charge relative to its capacity.

- $P_{\text{min}}$ is a negative value that is the maximum a storage resource can charge.

- $P_{\text{max}}$ is a positive value that is the maximum a storage resource can discharge.

Ranges from complete discharged to fully charged.
Managing a resource’s State of Charge (SOC)

**Day-Ahead Market**

Requires the resource to submit its SOC for HE01 into SIBR

- REM
  - The REM SOC is 50% so they have equal upward/downward mobility

- Non-REM
  - The market tracks a resource’s SOC and uses it to determine when to charge/discharge in order to optimize it across the 24-hour period

**Real-Time Market**

- Monitors the resource’s SOC using telemetry, which is the measurement of flow on the lines
- Ensures that sufficient SOC is reserved to support market awards

SOC requirements vary based on participation
Managing a Resource’s State of Charge (SOC)

**Battery**

**Reserves**
- Spin/Non-Spin awards ensure that 30 minutes of SOC is reserved in the FMM and RTD

**Regulation**
- Reg-Up/Reg-Down awards ensure that 30 minutes of SOC is reserved in FMM/RTD and 20 minutes of SOC for RTCD*

**Self-Schedules**
- Self-Schedules are respected by reserving SOC for Self-schedules outside of the RTD horizon
- RTD ensures that SOC is reserved to meet the Self-Schedule for the hour

* For the 1st RTCD the market reserves 20 minutes and releases 10 minutes
* For the 2nd and beyond it releases all
Learning Activity

• What is a key takeaway from this section? Write it in the chat.
Management of Resources

Expected Response to Dispatch and Operating Instructions
Resource Management Priorities

1. Immediately follow Operating Instructions when issued by the ISO
2. Notify the ISO immediately if your resource is incapable of following your Dispatch Operating Target
3. Ramp linearly to follow Dispatch Operating Points mid interval to mid interval
4. Follow Dispatch Operating Targets accurately

SCs and Resource Owner/Operators must work together
Resource instructions are sent via Automated Dispatch System (ADS)

- For each **fifteen-minute interval** the market is:
  - Starting-up or shutting down resources
  - Transitioning multi-stage generators

- For each **five-minute interval** the market is:
  - Issuing real-time dispatch instructions
Automated Dispatch System (ADS)

Options Menu and System Messages Grid

Batch Status and Interval Grid

Resource Data Grid

Trajectory Plot for Specified Resource

Instruction Details Grid for a Specified Resource
Optimal dispatch representing a single point on the Dispatch Operating Point trajectory

Daily Instructions

- Received via ADS
- Resources expected to perform as instructed and, for Eligible Intermittent Resources (EIRs) only, “produce as capable” unless they receive an Operating Instruction
Optimal dispatch representing a single point on the Dispatch Operating Point trajectory
Command by Operators to preserve the state, status, output or input of a Bulk Electric System resource

Operating Instructions

• May be received via EMS and/or verbal communication
• May be received via ADS as a result of Operator intervention
• Required to be followed within given timelines and ramp requirements unless physically impossible
Example of Operating Instruction

- Note Field will indicate “Do not exceed DOT due to <Reason>”

- Resource obligated to comply with Operating Instruction within 10 minutes, ramping linearly with DOT.
  - The acknowledgement should be visible when the first user from the SC organization acknowledges the pop up.

- The message shall only pop up once per user per time horizon of the instruction, and will remain until acknowledged by the user.
What Are Some Steps You Can Take To Improve Visibility?

Make These 6 Columns Visible To See Flags When Resources Are Not Following DOTs

This may significantly reduce the length of time resources fail to follow their DOTs
Ancillary Services
Ancillary services ensure reliability as electricity is moved from generating sources to customers

- **Regulation**
  - Regulation up
  - Regulation down

- **Contingency Reserves**
  - Spinning reserve
  - Non-spinning reserve

- **Constant adjustments under ISO control through automatic generation control (AGC)**
  - Supply that is either synchronized or not synchronized to the grid and can provide energy within 10 minutes
Market instructions for energy and ancillary services from ADS and AGC

Awards for Energy and A/S will operate together

<table>
<thead>
<tr>
<th>Type</th>
<th>Awarded MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>30 MW</td>
</tr>
<tr>
<td>Regulation Up</td>
<td>10 MW</td>
</tr>
<tr>
<td>Regulation Down</td>
<td>5 MW</td>
</tr>
</tbody>
</table>

Provide regulation within range of 25 – 40 MW

30 MW DOT

Automated Dispatch System (ADS)
- Sends Dispatch Operating Targets (DOTs) for energy
- Sent every 5 minutes based on optimization instructions

Automatic Generation Control (AGC)
- Sends signals to manage regulation instructions
- Sent every 4 seconds based on Reg Up / Reg Down range
Expectations for Ancillary Services (A/S) Certified Resources

In order to provide Regulation, be able to:

- ramp on and off Automatic Generation Control (AGC) to DOP in linear fashion

- stay on AGC for entire duration of A/S award and have manual controls to place on AGC
  - The ADS AGC flag is a courtesy feature for AGC notification; however, the resource must have the capability to have manual control to place on AGC
    - Note: Do not program your controllers to rely on the ADS AGC feature alone

- follow 4 second set points accurately

- show that regulation range reflects accurate capability

- ensure Outage Management System (OMS) reflects true capability and availability of resource
  - Resource cannot be on AGC providing Regulation with failed Telemetry
    - OMS Metering Telemetry card required with A/S fields set to 0 availability
What steps does the ISO take if you cannot perform and have not communicated your resource limitations?

Performance for Reliability

- CAISO Generation Dispatcher will create internal tickets flagging a resources inability to perform:
  - CAISO will issue the following:
    - an official letter stating importance of reliability and adhering to regulatory standards, requesting;
    - completion of training
    - detailed root cause analysis that led to inability to perform and what has been done to rectify the situation
    - potential Ancillary Service (AS) block preventing AS awards
    - potential removal from market
    - for repeat offenders; potential referral to Department of Market Monitoring (DMM)

Resolution requires submission of proof through CIDI and approval from ISO Operations Management
• How could grid reliability be at risk by not following Dispatch and Operating Instructions? Write it in the chat.
Outages
What tool is used to communicate your outage?

- The Outage Management System (OMS) is the primary method of communicating Outage related information. OMS provides an automated mechanism for parties to communicate all aspects of Outage information.

- OMS should be used for all physical limitations at the plant.
  - Early submission is highly encouraged.
  - Non-urgent outages should be scheduled based on the practices established in the Outage Management BPM.
    - Reference § 8.2 Outage Management BPM for Real-Time Outage Submissions.
What Information Is Required For Outages?

Battery Example – Additional Info Required

- Your SCID
- Market Resource ID
- Refer to Procedure 3220 Section 3.3.1 Nature of Work (NOW) Categories
- Availability (P_max) = Discharge Capability
- Load Max (P_min) = Charging Capability
- Regulator Up, Regulator Down Spin/Non-Spin
  - Can your resources provide their awards?
  - If not, Enter 0 for the appropriate product
- Min Energy = Minimum SOC (MWh)
- Max Energy = Maximum SOC (MWh)

Be as detailed as possible in describing the issue with your resource.
Nature of Work

- All Outage requests submitted to the CAISO OMS must have an associated NoW category assigned to it.
- Captures relevant data for outage coordination, and increase consistency in the level of information reported.
- Use of certain NoW categories will determine whether an Outage de-rate for an RA resource will be subject to Resource Adequacy Availability Incentive Mechanism (RAAIM) provisions.

Refer to Procedure 3220 Section 3.3.1 Nature of Work (NOW) Categories.

Refer to the Outage Management Business Practice Manual.
Ramping
Ramping in Accordance with Operator Instructions

Linear Ramp Rate

- The set point will increment linearly from starting point to target at an agreed upon ramp rate.

- Set points will increment every 4 seconds from start to finish.
  - Resource expected to respond linearly as instructions are received.

- Resource response must never “Step” above its expected ramp rate during testing or normal operations.

- Default ramp rate should be a controlled value.
Example: 250 MW Battery
Pmax: 250 MW
Pmin: -250 MW

Linear Ramping

Discharge (+)

Charge (-)

Linear Ramp NOT instantaneous

Linear Ramp NOT instantaneous

250 MW

0 MW

0 MW

-250 MW
Responding to Frequency Changes
Definitions

Primary Frequency Response (PFR)

- the first stage of frequency control and is the response of generator governors and loads to arrest locally detected changes in frequency

Droop (FERC Order 842)

- the variation in real power (MW) output due to variations in system frequency and is typically expressed as a percentage (e.g., 5% droop)
- reflects the amount of frequency change from nominal (e.g., 5% of 60 Hz is 3 Hz) necessary to cause the main prime mover control mechanism of a generating facility to move from fully closed to fully open

Deadband (FERC Order 842)

- represents a minimum frequency deviation (e.g., ±0.036 Hz) from nominal system frequency (i.e., 60 Hz in North America) that must be exceeded in order for the generating facility to provide primary frequency response
Overview of Primary Frequency Response

- Primary Frequency Response (PFR) is an Essential Reliability Service
  - First line of defense against a frequency event – critical for system stability
  - FERC mandated PFR for generators (Order 842 – Pro forma LGIA)
  - Necessary for BAL-003 (PFR) and BAL-001 (power balancing) compliance

- MW Response of a Resource is a function of
  - Droop setting
  - Available stored energy
  - Available headroom
  - Physical or manually set restriction on the resource
  - Control mode of the resource
PFR Needs to be the Primary Control Mode

- Most Battery storage facilities have AGC as the primary control mode
- PFR must be the **primary control mode and be additive** to other control modes

Two Similarly Sized Battery Storage Units on AGC at the Time of Frequency Event
A great deal of coordination and appropriate communication is required to maintain reliability.
Responding to verbal operating instructions requires three-part communication

This is the ISO Generation Dispatcher and I need for you to take Unit ABC_123 offline within the next 10 minutes.

This is the ISO Resource Operator and I understand you are instructing me to take Unit ABC_123 offline within the next 10 minutes.

That is correct. Thank you.
Maintain situational awareness of how your resource may impact the system
Compliance
Possible Implications of Non-Response

Settlements

Regulatory

Enforcement

Economic Consequences

Contractual Consequences

Report or referral to FERC, NERC/WECC, CAISO DMM
Learning Activity

• What is a key takeaway from this section? Write it in the chat.
Reference

Where can you learn more?
Rules, guidelines and instructions define market and reliability processes

- Reliability and safety requirements
  - Federal and Regulatory Standards

- Rules and stakeholder guides
  - ISO Tariff and Business Practice Manuals

- Step-by-step instructions
  - Operating Procedures and Job Aids

www.caiso.com
New reference guide to help Resource Owner/Operators find important information

Includes helpful links such as:

- Training Resources
- Knowledge Articles
- Policies & Procedures
- New Resource Implementation Documents

Available on the ISO Learning Center under the Market and Operations Learning Track

California ISO - Learning center (caiso.com)
Provides guidance & ways to connect to help you through get your resource connected to the grid
Resource Operations Readiness Training

Training Goal: to prepare customers in advance of summer to meet ISO expectations for successful resource management, especially during tight conditions.

These courses build on concepts shared during the May 1st Resource Interconnection Fair.

- **Resource Performance Expectations**
  - May 7th
  - Dispatch/Operating instruction response
  - Hybrid resource management
  - Outage cards completion
  - Flex Alerts/EEA response

- **Battery Performance Expectations**
  - May 15th
  - Resource capabilities
  - Correct Nature of Work
  - Off-Grid Charging Indicator
  - Physical management requirements

- **Managing Intertie Transactions**
  - May 16th
  - Wheel-through concepts
  - Export priority
  - Tagging expectations
  - Flex Alert/EEA

- **WEIM Resource Performance Expectations**
  - May 22nd
  - Assistance Energy Transfer
  - Demand Response process for WEIM


Contact CustomerReadiness@caiso.com with questions.

Share this information with your staff!
Annual Summer Loads and Resources Assessment helps prepare for summer system operations to maintain grid reliability

- evaluates expected 2024 summer supply and demand conditions for the California Independent System Operator (ISO) balancing authority area (BAA)

- indicates continued improvement in resource availability for the upcoming summer driven by accelerated resource development

Available on the Reports and Bulletins webpage on www.caiso.com
Stakeholder Engagement & Customer Experience

Joanne Serina
Vice President

Stakeholder Affairs

Stakeholder Experience

Customer Readiness

Customer Experience

Onboarding
Provide guidance to becoming a CAISO customer

Education
Share new information and continuing education

Customer Support
Respond to market participant needs

Stakeholder meetings
Inform customers on stakeholder initiative activities

Outreach
Inform customers of emerging issues

Account Management
Proactively work with stakeholders on strategic and policy matters
Wrap Up

Summary, Q&A
To Recap: It Takes All Of Us To Maintain Safety and Reliability of the Grid!

• Know the intricacies of your battery resource and its impact on the bulk electric system
• Communicate between SC and Resource Operator to ensure adequate control of resources 24X7
• Inform the ISO of any resource changes or physical limitations
• Actively monitor your resources
• Respond to Operating Instructions within required time parameters, consistent with Tariff requirements

Share information with your colleagues!
Thank you for your participation!

For more detailed information on anything presented, please visit our website at: www.caiso.com or send an email to: CustomerReadiness@caiso.com.

For resource specific questions or concerns, please submit a CIDI ticket.