



Congestion Revenue Rights Enhancements

Working Group Meeting #2


January 28, 2025

9 am – 4 pm

Reminders

- This call is being recorded for informational and convenience purposes only. Any related transcriptions should not be reprinted without ISO's permission.
- The meeting is structured to stimulate dialogue and engage different perspectives.
- Please keep comments professional and respectful.
- Please try to be brief and refrain from repeating what has already been said so that we can manage this time efficiently.

Instructions for raising your hand to ask a question

- Open the Participant and Chat panels from the bottom right.
- If you are connected to audio through your computer or used the “call me” option, select the raise hand icon  located on the bottom of your screen.
 - **Note:** *3 only works if you dialed into the meeting.
- Please remember to state your name and affiliation before making your comment.
- You may also send your question via chat to either **Brenda Marquez** or to all panelists.
- If you need technical assistance during the meeting, please send a chat to the event producer.

Today's agenda

| Time | Topic | Presenters |
|---|---|-----------------------------------|
| 9:00 – 9:05 am | Welcome + today's agenda | Brenda Marquez |
| 9:05 – 9:25 am | Opening comments and review of feedback on the discussion paper and 11/14 working group meeting | Partha Malvadkar Hilary Staver |
| 9:25 am – 12:00 pm <i>(10 minute break included)</i> | More detailed discussion of the current CRR program <ul style="list-style-type: none"> • General Overview of CRRs • CRR Allocation Overview • CRR Auction Overview • CRR Modeling Practices • Simultaneous Feasibility Test • CRR Settlements | Philip Roth Hilary Staver |
| 12:00 – 1:00 pm | Lunch | |
| 1:00 – 3:00 pm | Stakeholder presentations <ul style="list-style-type: none"> • Seth Cochran, Vitol Inc. • Abram W Klein, Appian Way Energy Partners • Joshua Reichert, Morgan Stanley • Cathleen Colbert, Vistra Corp. | Various |
| 3:00 – 4:00 pm | Open discussion + next steps | Partha Malvadkar |

Stakeholder Feedback on Working Group Process

- Most stakeholders supported the proposed timeline, with some stakeholders suggesting more time is needed to sufficiently incorporate necessary voices into policy
- Key areas of interest for further discussion included revenue inadequacy, auction efficiency, outages, storage resources as eligible load/sinks, auction participation, and underfunding allocation
- Several stakeholders requested that the ISO benchmark current practice and results with other ISO/RTOs
- Some stakeholders advocated moving quickly towards specific reforms (e.g. Willing Buyers/Sellers Proposal)

Congestion Revenue Rights Precedent at FERC and CAISO



Provide open access transmission

Allocate fairly transmission revenues to customers paying the imbedded costs of the transmission system

Allow hedging of congestion costs in the context of a Day-Ahead energy



California ISO

Distribute congestion rents created from congestion pricing in the LMP market

Support equitable allocation of costs and benefits of using transmission system

Facilitate long-term contracting by LSEs and generators

Updated Working Group Schedule

Nov. 14, 2024



Working Group Scoping Discussion

Jan. 28, 2025



CAISO CRR Program

Deeper dive into the current CRR program structure and function; stakeholder perspectives and experiences

Feb. 27, 2025



Analysis

Root cause analysis discussion

March 2025



Benchmarking to Other CRR Programs

CRR structures used by other ISOs

April/May, 2025



Policy Scope and Problem Statements

Discussion of proposed problem statements and scope for upcoming initiative

CAISO CRR PROGRAM

Agenda

- In this presentation we will discuss the following topics related to Congestion Revenue Rights:
 - General Overview of CRRs
 - CRR Allocation Overview
 - CRR Auction Overview
 - CRR Modeling Practices
 - Simultaneous Feasibility Test
 - CRR Settlements

General Overview of CRRs

Topics

- CRR Definition
- CRR Types – Obligations and Options
- CRR Terms and TOU Definition

CRR Definition

- Congestion Revenue Rights (CRRs) are financial instruments that enable holders of such instruments to manage variability in congestion costs that occur under Congestion Management protocol that is based on locational marginal pricing (LMP)
- CRRs settle on the Marginal Cost of Congestion (MCC) of the Day-Ahead Locational Marginal Pricing (LMP) for each respective hour

CRR Definition

- Congestion in the forward markets occurs when there is insufficient available transmission capacity to accommodate all preferred energy schedules simultaneously.
- CRRs help manage congestion variability in the Day Ahead market.
- The ISO allocates CRRs to entities that maintain the transmission system.
- The ISO auctions unallocated transmission capacity to registered CRR entities that post the required minimum collateral.

CRR Types

CRR Obligation

- Entitles CRR Holder to a CRR Payment if Congestion is in the same direction of the CRR and requires a charge if Congestion is in the opposite direction of the CRR
- Acquired through allocation or auction

CRR Option

- Entitles CRR Holder to a CRR Payment if Congestion is in the same direction as the CRR, but requires no payment if Congestion is in the opposite direction of the CRR
- Available to project sponsors of a merchant transmission facility that do not elect some form of regulatory cost recovery, or converted merchant transmission facilities

CRR Terms

Terms of CRRs

- Seasons are defined on a quarterly basis
 - Season 1 = Jan, Feb and Mar
 - Season 2 = Apr, May and June
 - Season 3 = Jul, Aug and Sep
 - Season 4 = Oct, Nov and Dec
- Long Term CRRs extend nine years after annual term for a total of ten years (Allocation only)
- Months are calendar months (January, February, ...)

Example

A PTP CRR for season 1, on-peak applies to all hours in season 1 that are defined as on-peak

CRR Time of Use

CRR Time of Use Definition

- The on-peak period
 - Consists of the hours from 6 am (HE7) to 10 pm (HE22) for Monday, Tuesday, Wednesday, Thursday, Friday and Saturday, (assuming these days are non-holidays)
- The off-peak period
 - Consists of the hours from 10 pm (HE23) to 6 am (HE6) for Monday, Tuesday, Wednesday, Thursday, Friday and Saturday

CRR Time of Use

CRR Time of Use Definition (cont.)

- The off-peak period
 - All 24 hours for days that are Sunday and holidays
 - Holidays are New Year's day, Memorial Day, Independence day, Labor Day, Thanksgiving Day, Christmas Day
 - If the holiday falls on a Sunday, the first following Monday is treated as if it were a Sunday (i.e., all hours are off-peak)

CRR Allocation Overview

- Topics
 - Eligibility to Participate
 - Calculating Eligible Quantities
 - Annual Processes
 - Monthly Processes
 - TOR and ETC Modeling
 - Load Migration

Eligible Allocation Participants

Allocation

- Must be classified as one of the following:
 - Load Serving Entity (LSE), which includes:
 - Entities serving load within the ISO Control Area
 - Metered Subsystems – Gross and Net election
 - Out of Balancing Authority Area Load Serving Entity (OBAALSE), which includes:
 - Load external to the ISO Balancing Authority Area being served with internally owned or contracted generation that is subject to Congestion on the ISO controlled grid
 - Subject to other conditions, such as prepayment of WAC

Eligible Allocation Participants (cont.)

Merchant Transmission

- Will be eligible for MT CRRs only if such entity has turned over the qualifying facilities to the ISO and has elected not to recover costs of its investments through a regulated cost recovery mechanism
- May request up to five nominations for each TOU
- Three step process for releasing MT CRRs
 - Determine the capability of the existing Transmission System
 - Determine the mitigation of impacts on existing encumbrances
 - Determine the incremental Merchant Transmission CRRs
- Duration of MT CRRs will be 30yrs or pre-specified intended life of facility
- MT holders can elect to receive CRR Options or Obligations

Calculating Eligible Quantities

- Once a Candidate CRR Holder has registered and becomes eligible to participate in the CRR Allocation process the ISO will require the entity to submit either historical or forecast Load data
 - Which is used to determine either the Seasonal CRR Eligible Quantity or Monthly CRR Eligible Quantity, respectively
 - For entities with load that fluctuates based on hydrological conditions, monthly data can be forecast or historical.

Calculating Eligible Quantities (cont'd.)

Seasonal CRR Eligible Quantity

1. Start with historical load duration curves, to derive the 0.5% exceedance level for CRR Load Metric which is based on season, time of use and load area.
OBAALSEs will submit similar data but associated with usage of export points and the level of load subject to ISO congestion
2. Subtract load served by TOR and ETC to determine the Adjusted Load Metric (ALM)
3. Multiply result by 75%
4. This value is the Seasonal CRR Eligible Quantity

Calculating Eligible Quantities (cont'd.)

Long Term Eligible Quantity

- Limited up to fifty (50) percent of the Adjusted Load Metric
- Nominations are validated against cleared CRRs from the Priority Nomination Tier of the annual process for the current CRR year

Calculating Eligible Quantities (cont'd.)

Monthly Eligible Quantity

1. Start with forecasted load duration curves to derive the 0.5% exceedance for the CRR Load Metric based on month, time of use and load area
2. Subtract load served by TOR and ETC
3. Subtract seasonal allocated CRRs from the annual and long term CRR processes that correspond to the month in which the allocation is to be run
4. Validated against the CEC 60-day ahead forecast
5. This value is the Monthly CRR Eligible Quantity

Calculating Eligible Quantities – (cont'd.)

OBAALSE Eligibility

- Before calculating the eligible quantity for an OBAALSE, it must demonstrate eligibility to participate in the CRR Allocation by the following:
 - Show legitimate need by demonstrating the entity holds an existing contract with or owns Generation external to the ISO Control Area
 - Pre-pay the appropriate Wheeling Access Charge based on the amount of CRRs being nominated
 - Confirm that the external load for which the CRRs are being nominated is not served under Transmission Ownership Rights (TORs) or Existing Transmission Contract (ETC) rights and is exposed to the ISO Congestion charges
 - All CRR nominations in all CRR years must be source verified

Calculating Eligible Quantities (cont'd.)

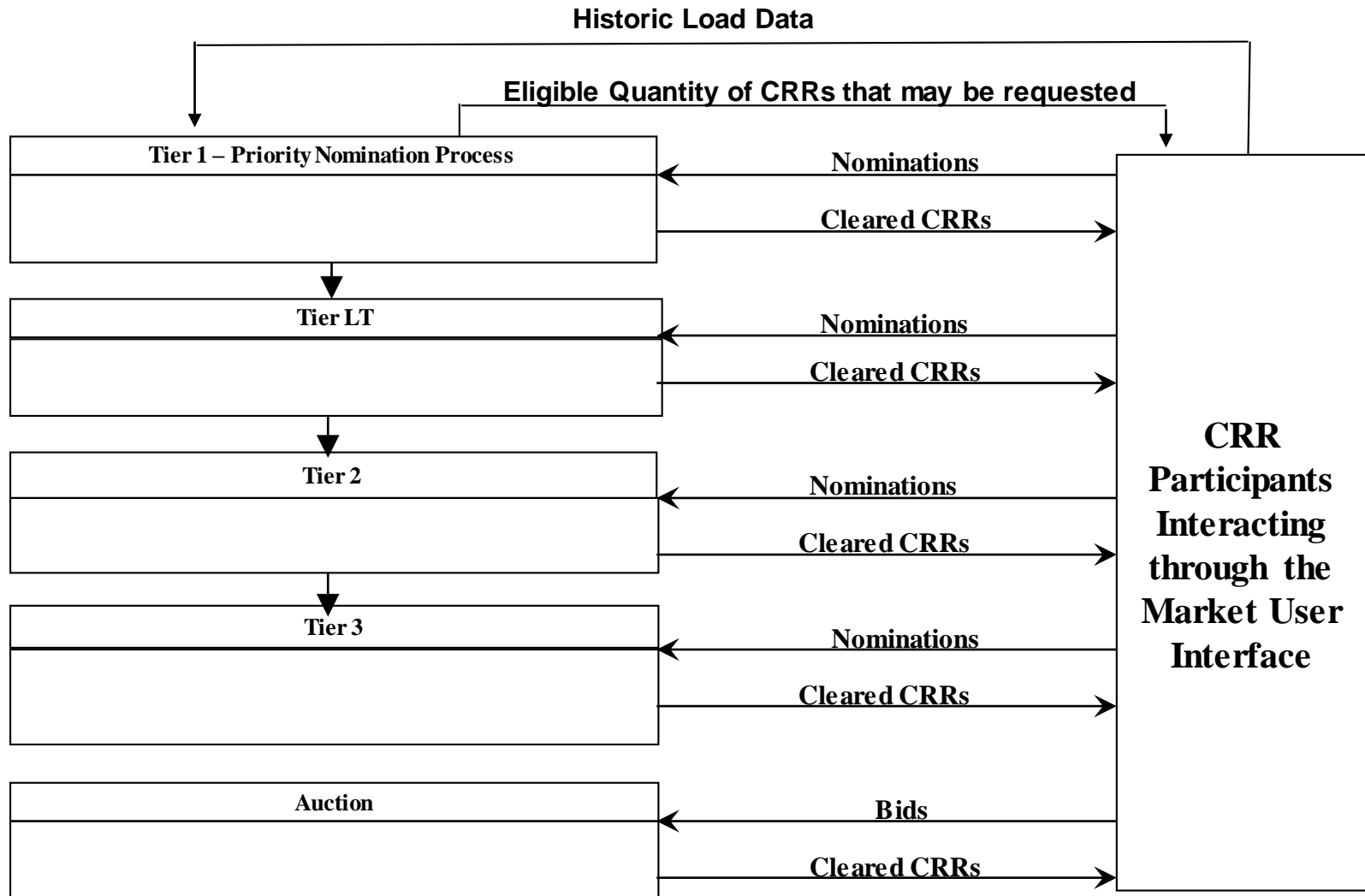
OBAALSE Eligibility (cont'd.)

- The OBAALSE will submit two sets of hourly data from which the CRR system will construct load duration curves for determining the Seasonal and Monthly CRR Eligible Quantities. Their eligible quantity will be based on the lesser of the 0.5% exceedance point on the duration curves generated by the following data:
 - Historical hourly exports at the Scheduling Point (s) for which the CRR request will be sunk at, summed for all Scheduling Points being requested, or
 - Hourly data that reflects the prior years hourly metered load associated with the load that was subject to the ISO Congestion Charges for use of the ISO Controlled Grid

CRR Allocation – Annual Process

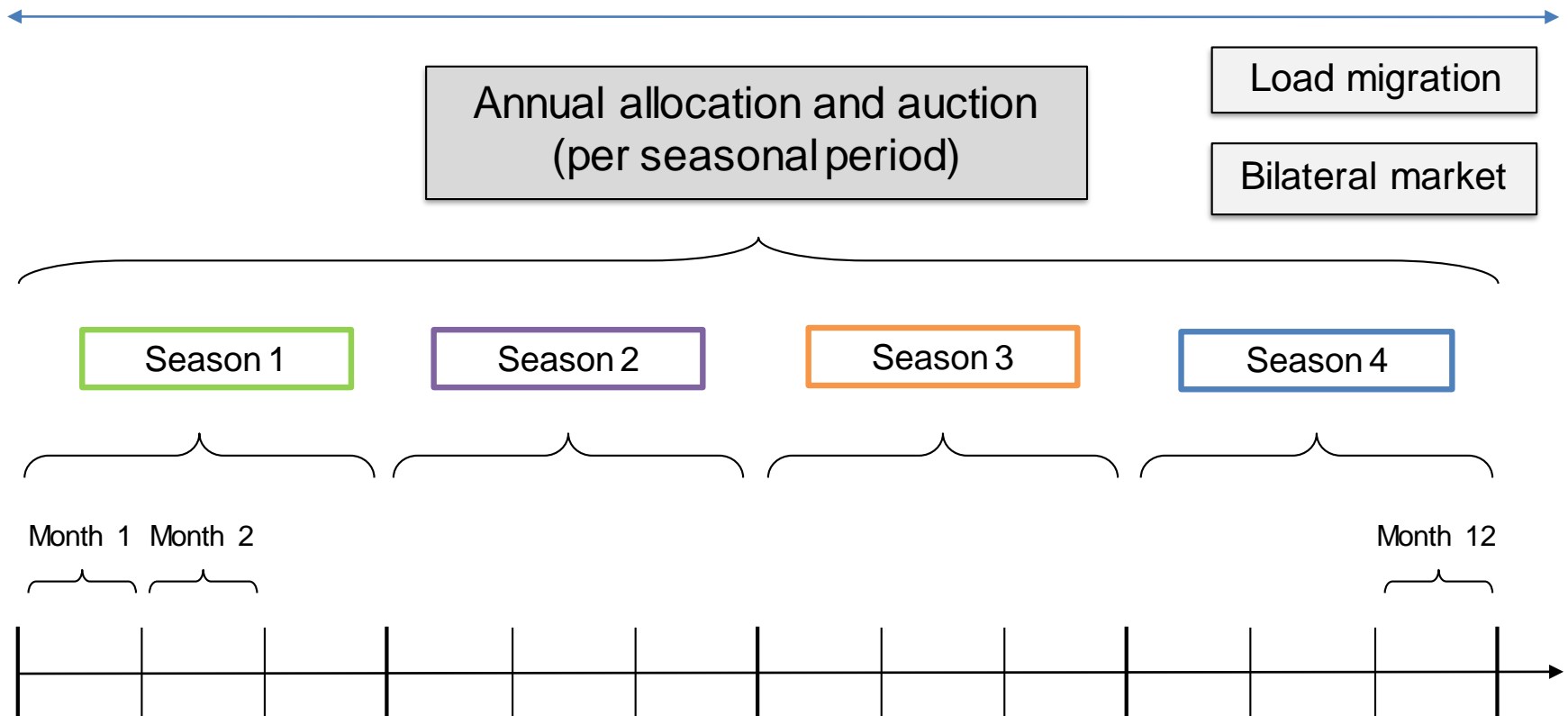
- Approximately 4-5 months before the start of each year, the CRR annual process begins, which produces seasonal/TOU CRRs for the year
- The annual process is illustrated in the annual process figure on the next slide

CRR Allocation and Auction – Annual Process



CRR Allocation and Auction Process

Long-term – up to 10 Years



CRR Allocation – Annual Process

- For the annual allocation process Tier 1 will be the Priority Nomination Process (PNP)
- CRR Holders may nominate the same CRRs that they were allocated in the immediately previous annual CRR Allocation process.

CRR Allocation – Annual Process (cont.)

- In the PNP an LSE or OBAALSE may make nominations up to the lesser of:
 - Two-thirds of its Seasonal CRR Eligible Quantity, minus the quantity of Long Term CRRs for each season, time of use period and CRR Sink for that year; and minus the net MW amount of load migration CRRs valid for each season, time of use period and CRR sink for that year or,
 - The total quantity of Seasonal CRRs allocated to that LSE in the previous annual CRR Allocation; plus the net quantity of load migration CRRs associated with the immediately preceding Seasonal CRR Allocations for the corresponding season, time of use, and CRR sink location; minus the quantity of Long Term CRRs allocated in the immediately preceding Seasonal CRR Allocation for each season, time of use period and CRR Sink; and minus the net MW amount of load migration CRRs valid for each season, time of use period and CRR sink for that year

CRR Allocation – Annual Process (cont.)

- In the PNP, CRR nominations are all Signature validated
 - Meaning the CRR source-sink pairs have to have been allocated in the immediately previous annual CRR Allocation process and cannot exceed the MW amounts that were allocated
- In the PNP, CRR nominations with the Trading Hub as a source are allowed
- In the PNP, CRR nominations with the Sub-LAP as a sink are not allowed

CRR Allocation – Annual Process (cont.)

- Tier LT is limited to a maximum of 50% of its Adjusted Load Metric (ALM), minus the quantity of previously allocated Long Term CRRs that are valid for that year.
- CRR nominations are all Signature validated
 - Meaning the CRR source-sink pairs have to have been allocated in the immediately preceding PNP and cannot exceed the MW amounts allocated

CRR Allocation – Annual Process (cont.)

- Tier 2 is limited to two thirds of its Seasonal CRR Eligible Quantity for each season, time of use and CRR sink, minus the quantity of:
 - CRRs allocated to that LSE or OBAALSE in tier 1,
 - Long Term CRRs previously allocated that are valid for the CRR term currently being allocated,
 - the net MW amount of long-term Load Migrations CRRs assigned to the LSE that are valid for the term currently being allocated.
- CRR nominations with the Trading Hub as a source are allowed
- Sub-LAPs will be eligible CRR sinks provided that the Sub-LAP is within the nominating entities Default LAP

CRR Allocation – Annual Tiered Process (cont.)

- After Tier 2 of the annual allocation a process is performed to set-aside 50% of the residual import capacity on the interfaces, this is referred to as the set-aside process
- The set-aside amounts are made public prior to the opening of tier 3 of the annual allocation
- For example, if an interface has an import limit of 100MW and 60MW is taken up by previously awarded CRRs then there would be a residual import amount of 40MW, of which 20MW would be the set-aside value. This 20MW would reduce the import limit going into tier 3, leaving a limit of 80MW. The auction limit would be increased back to the original 100MW.

CRR Allocation – Annual Tiered Process (cont.)

- An LSE in Tier 3 is limited to 100% of its Seasonal CRR Eligible Quantity for each season, time of use and CRR sink, minus quantity of:
 - Any Tier 1 and 2 allocated CRRs,
 - Long Term CRRs previously allocated that are valid for the CRR term currently being allocated,
 - the net MW amount of long-term Load Migration CRRs assigned to the LSE that are valid for the term currently being allocated.
- CRR nominations with the Trading Hub as a source are allowed
- Sub-LAPs will be eligible CRR sinks provided that the Sub-LAP is within the nominating entities Default LAP

CRR Allocation – Monthly Tiered Process

- In the monthly allocation process there is not a PNP
- In Tier 1 of the monthly allocation LSEs and OBAALSEs can nominate up to 100% of the difference between its Monthly CRR Eligible Quantity and the total of any Seasonal CRRs allocated in the annual CRR Allocation and any holdings of Long Term CRRs that are valid for the month and time of use of the CRRs being nominated
- Trading Hubs are allowed as sources
- Sub-LAPs will be eligible CRR sinks provided that the Sub-LAP is within the nominating entities Default LAP

CRR Allocation – Monthly Tiered Process (cont.)

- In Tier 2 of the monthly allocation LSEs and OBAALSEs can nominate up to 100% of the difference between its Monthly CRR Eligible Quantity and the total of any Seasonal CRRs allocated in the annual CRR Allocation and any holdings of Long Term CRRS that are valid for the month and time of use of the CRRs being nominated minus the number on Monthly CRRs allocated in Tier 1
- Trading Hubs are allowed as sources
- Sub-LAPs will be eligible CRR Sinks provided the Sub-LAP is within the entities Default Lap

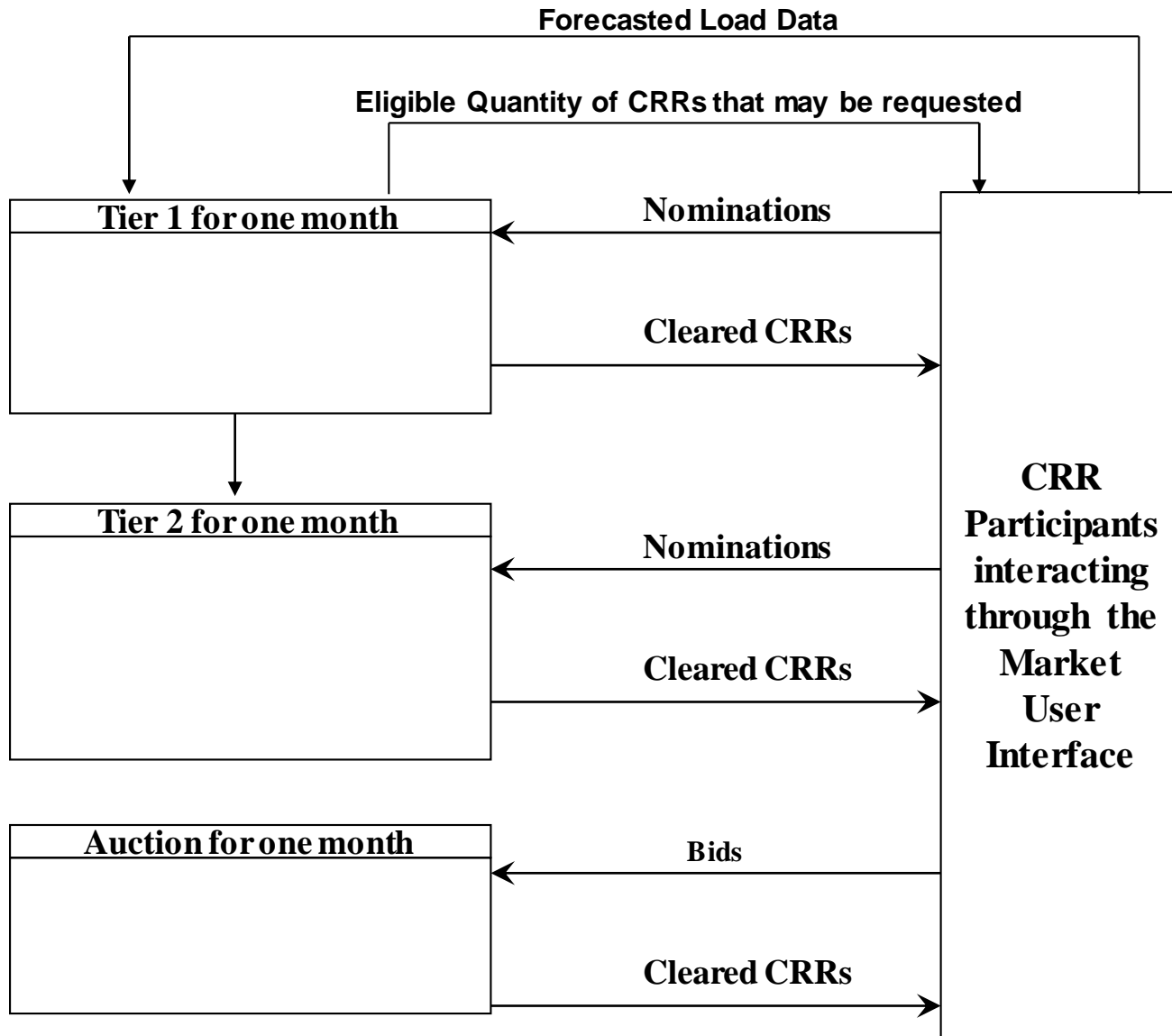
CRR Allocation – Monthly Tiered Process (cont.)

- After tier 1 of the monthly allocation a process is performed to set-aside 50% of the residual import capacity on the interfaces, this is referred to as the set-aside process (pursuant to tariff section 36.8.4.2.2)
- The set-aside amounts are made public prior to the opening of tier 2 of the monthly allocation

CRR Allocation and Auction – Monthly Timeline

- Approximately 6 weeks before the start of any month, the CRR monthly process begins, which produces monthly/TOU CRRs for the month
- For each monthly process there are typically four CRR FNM releases
 - Version 0 – Full data set without outages reflected
 - Version 1 – Initial list of outages for review
 - Version 2 – Updated files with outage data incorporated
 - Version 3 – This version includes the set-aside limit updates
- The monthly process is illustrated in the monthly process figure

CRR Allocation and Auction – Monthly Process



TOR and ETC Modeling

- There are two basic types of transmission rights that the ISO models through the CRR process
 - Transmission Ownership Rights (TORs)
 - Existing Transmission Contracts (ETCs)
- These rights are defined through the Transmission Rights Transmission Curtailment (TRTC) procedures
- When the ISO models these rights the intent is to remove capacity, which has a “perfect hedge”, so that CRRs are not allocated or auctioned on this capacity
- The ISO holds these CRRs, not the rights holder

TOR, ETC Modeling (cont'd.)

Modeling of Transmission Rights

Transmission Ownership Rights (TORs) Modeling

- Exempt from all ISO congestion charges if schedules are within rights (“perfect hedge”)
- The ISO will remove capacity from the FNM by modeling TORs as Point-to-Point CRR Options (do not provide counter-flow)
 - levels based on contractual rights

TOR, ETC Modeling (cont.)

Modeling of Transmission Rights (cont.)

Existing Transmission Contract (ETC) Rights

- Exempt from all ISO congestion charges if schedules are within rights (“perfect hedge”)
- The ISO will model CRRs to account for the congestion charge exemption of ETCs, so as to ensure CRR revenue adequacy
- ETCs are modeled as Point-to-Point CRR Obligations (provide counter-flow)
 - levels based on contractual rights and historical usage

Load Migration

What is Load Migration?

- Load Migration is the process of tracking the transfer of load between a pair of Load Serving Entities (LSEs).
- The ISO will receive monthly records from each UDC reflecting transfer of customers between LSEs.
- The calculation for the transfer of allocated CRRs held by the load-losing LSE is computed for each source to sink combination in the load-losing LSE's portfolio of allocated CRRs, by season and TOU. Only CRRs with the same path can be netted.
- It is designed to transfer the appropriate quantity of CRRs between LSEs involved in load migration. In other words, when load moves from one LSE to another, allocated CRRs must be transferred to follow the load.

Load Migration

What is Load Migration? (cont.)

- Load migration only applies to LSEs, and only for annual allocated CRRs (not monthly allocated CRRs), i.e., seasonal and LT CRRs will be transferred.
- The primary purpose for implementing the Load Migration process is to ensure that each Market Participant's (MP) CRR portfolio would be accurate in the event of transfer of load between LSEs
- Typically small impact to CRR holders but large operational burden

CRR Auction Overview

- Auction Eligibility
- Auction Overview
- Auction Clearing Prices
- Bid Structure
- Maximum Purchase Amount
- Pre-Auction Credit Requirement
- Credit Margin

CRR Auction Eligibility

All entities can participate in the auction that have:

- Registered as a Candidate CRR Holder with the ISO
- Post minimum required collateral for participation
 - Minimum collateral for annual auction - \$500,000
 - Minimum collateral for monthly auction - \$100,000

CRR Auction Overview

- Bid-based market that produces market clearing prices (MCP) for each CRR and every APNode
- Based on the MCP for each CRR awarded, the holder may
 - Incur a charge (positive MCP)
 - Incur no charge (the MCP is zero for the CRR)
 - Be paid by the ISO (negative MCP)
- Monthly Auction begins after the 2-tiered monthly Allocation process
 - CRRs are awarded in 1-month durations
- Annual Auction begins after the 4-tiered annual Allocation process
 - CRRs are awarded in four 3-month durations (to equal 12 months)

CRR Auction Overview

- In the auction, participants can submit buy offers subject to the source-sink limitations in the next slide
- In addition, auction participants can submit sell offers for any CRRs that they acquired in a prior allocation or auction market

CRR Auction: Auction Overview (cont'd.)

Allowable CRR Auction Sources & Sinks

| | | SINK LOCATIONS | | | |
|------------------|-----|----------------|-----|----|----|
| | | LAP | GEN | TH | SP |
| SOURCE LOCATIONS | GEN | X | | X | X |
| | TH | X | | | X |
| | SP | X | | X | |

LAP – Includes DLAPs, Sub-LAPs, MSS Laps, CLAPs

GEN – Generator PNode and APNode locations

TH – Trading Hub

SP – Scheduling Points associated with interfaces/ties

CRR Auction: Auction Overview (cont'd.)

- All bids submitted into the auction process are subject to:
 - Initial validations of maximum portfolio credit exposure against Aggregate Credit Limit
 - A Simultaneous Feasibility Test with all previously allocated CRRs for the same period and TOU modeled as fixed injections and withdrawals
- Bids may not be withdrawn after the submission window has closed

CRR Auction: Auction Clearing Prices

- All CRR APNode market clearing prices (MCPs) will be published after each market
- In general, the clearing price of a CRR is the MCP at the source minus the MCP at the sink

CRR Auction: Bid Structure

- Bid must contain:
 - The associated season and time-of-use period
 - The associated CRR Source and CRR Sink
- All CRR bids are piecewise linear
- MW portion must be greater than or equal to zero and denominated in thousandths of MW
- CRR bid price input in \$/MW (per month or season)
 - Price may be negative
 - The first MW quantity used in the bid must be 0
 - The second MW quantity must be greater than 0

CRR Auction: Bid Structure (cont'd.)

CRR bid

- Each CRR bid must contain at least two price point pair
- Bid must be monotonically decreasing
 - (MW increase, \$ decrease)
- Each price point (\$/MW) on the CRR bid curve represents the maximum price the bidder is willing to pay for the next increment of CRR MW quantity

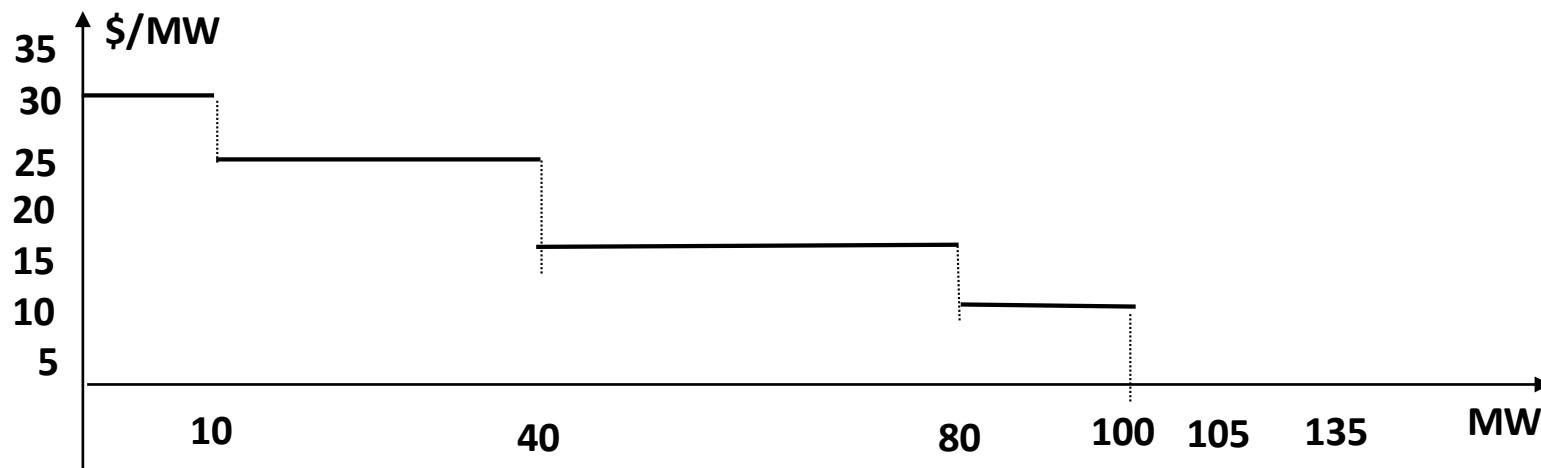
CRR Auction: Maximum Purchase Amount

Maximum Purchase Amount

- Can be calculated before the CRR Auction is processed (before the actual MCPs are determined) since it is based off the bid curve submitted
- It is the maximum MW by price value across all bid segments of a bid.
- It is used as an upper bound for the actual purchase amount, which may not exceed the Aggregate Credit Limit.

CRR Auction: Maximum Purchase Amount

Example: Maximum Purchase Amount



| Maximum Price (\$/MW) To Pay for All MW Purchased | Buying at Least This Many MW | Buying at Most This Many MW | Potentially Maximum Amount to Pay (\$) for MW Purchased $\max(0, \text{Price} \times \text{Quantity})$ |
|---|------------------------------|-----------------------------|--|
| 30 | 0 | 10 | 300 = 30 x 10 |
| 25 | 10 | 40 | 1,000 = 25 x 40 |
| 15 | 40 | 80 | 1,200 = 15 x 80 |
| 10 | 80 | 100 | 1,000 = 10 x 100 |

CRR Auction: Pre-Auction Credit Requirement

Pre-Auction Credit Requirement Overview

- Calculates the maximum possible credit exposure of each bid should the market participant win the bid made in the auction and includes the credit margin
- Evaluated against Available Secured Credit on a portfolio basis
 - A portfolio can contain multiple bids
 - Available Secured Credit = Aggregate Secured Credit Limit (“ASCL”) – $\max(\text{CRR Estimated Aggregate Liability (“EAL”)}, 0)$
- Minimum secured credit requirement for participating in an auction is:
 - Annual - \$500,000
 - Monthly - \$100,000
- Exceeding available secured credit results in the rejection of the entire portfolio

Secondary Registration System - Overview

- The Secondary Registration System (SRS) is built into the CRR System to help facilitate the trading of CRRs through a bilateral mechanism
- Information about CRRs that an entity wants to buy and sell is made available on a “bulletin board” in SRS
- In order to have access to the SRS and to effect trades both entities must be fully registered
- The SRS does not settle transactions but merely facilitates the recording of the owner of record
- Financial settlement is done outside of the SRS

Secondary Registration System – Credit Check

- As part of the CRR Holding Requirements the CRR System will perform a credit check on both the trading (“selling) and receiving (“buying”) parties in a SRS trade.
- This credit check will ensure that the receiving party has sufficient collateral to add the SRS trade to their CRR portfolio
- This credit check will also ensure that the trading party, if the CRR is positively valued, has sufficient collateral to remove the SRS trade from their CRR portfolio
- Minimal usage in current CRR system

CRR Modeling Practices

- Overview of Modeling Practices
- Key Elements of CRR Model
 - Full Network Model
 - Operating Constraints and Contingencies
 - Outages
 - APNodes
 - Distribution/Allocation Factors
- Retirement Process

CRR Modeling Practices

- When the CAISO conducts its CRR Allocation and CRR Auction, the CAISO shall use the most up-to-date DC FNM which is based on the AC FNM used in the Day-Ahead Market
- The FNM used here is similar to the FNM used in the DA IFM
 - Topology
 - Constraints Limits
- Each CRR Auction will release CRRs having the same seasons, months and time of use specifications as the CRRs released in the corresponding CRR Allocation

CRR Modeling Practices

- The CRR Allocation and CRR Auction process will provide CRRs for terms of one season/TOU and one month/ TOU, so choosing the proper set of underlying data for the SFT can be difficult
- When setting up the process for the CRR Allocation or CRR Auction the following data must be used within the SFT process
 - FNM topology (from which the shift factors are derived)
 - APNodes and their allocation factors
 - Constraint limits
- Given a CRR Allocation or CRR Auction process that will create a bundle of CRRs for a particular term/TOU
 - Every CRR created will be tested by an SFT that has one FNM, one set of allocation factors for each APNode, and one set of Constraint Limits

CRR Modeling Practices

For CRR purposes, certain simplifying assumptions are made about the FNM to make it a linear model

- All resistances are set to zero (no transmission losses)
- All voltage magnitudes are set to 1.0 per-unit
 - Reactive power is ignored
- The flow across a transmission branch is assumed to be a linear function of the bus angles, which are at either end of the line
 - This results in a linear model, i.e., the injection of power at a bus to the change in flow over a given branch is a linear relationship (i.e., the shift factor) and this relationship is only dependent upon the reactance of the transmission branches
- Only active power (MW) flowing over transmission branches can be calculated in the DC FNM

CRR Modeling Practices

- The FNM for the Long Term process will include sixty (60) percent of the Seasonal Available CRR Capacity that is used in the annual process
- The FNM for the annual process will include sixty five (65) percent of the Seasonal Available CRR Capacity that is in service for the start of the annual CRR allocation and auction processes
- Adjustments made to the constraint limits used in the **monthly** CRR processes:
 - Global De-rate Factor (GDF) – This adjustment is reflected through the monitored facilities to account for unplanned outages and the impact on internal transmission elements
 - Local De-Rate Factor (LDFR) – This adjustment is reflected through the interface limits file to account for unplanned outages and is adjusted on an interface-by-interface basis.

CRR Modeling Practices

- Constraints enforced in the CRR process should be consistent with those used in Integrated Forward Market (IFM), as much as possible, but due to timing differences and the use of a DC model in the CRR process there are some inherent differences
 - Coordinate with IFM team on Interface, branch group and nomogram constraints, thermal constraints and contingency constraints recognizing timing and modeling differences
- Constraint limit values will be based on operating procedures utilized by the IFM
- **Adjustments will be made to constraint limits to take into consideration the absence of reactive power and losses**
 - Monitored facilities limits reduced to account for reactive power (3%) and losses (2%)
 - Interface limits include reduced to account for losses (2%)
- CRR models Nodal Group constraints to enforce $P_{Max} * 110\%$ at each source associated with a resource

CRR Modeling Practices

Outages

- Requests for planned Outages that may have a significant effect upon CRR revenue adequacy must be submitted to ISO Outage Coordination at least 30 days prior to the start of the calendar month for which the outage is planned to begin
- Operators shall also provide their CRR Transmission Maintenance Outages plan by July 1 of each year, for Outages they plan to take the following year
- This rule is intended to provide good outage data far enough in advance to allow the ISO to reflect them in the network model used for releasing CRRs and thereby minimize impacts to the revenue adequacy of CRRs

CRR Modeling Practices

Outages

- CRR Transmission Maintenance Outages are those Outages that may have a significant effect upon CRR revenue adequacy, which are defined as outages that affect transmission facilities on the CAISO Controlled Grid that:
 - are rated above 200 kV; or
 - are part of any defined flow limit as described in a CAISO Operating Procedure; or
 - were out of service in the last three (3) years and for which the CAISO determined a special flow limit was needed for real-time operation.

CRR Modeling Practices

Outages

- CRR Transmission Maintenance Outages consist only of outages that:
 - meet the criteria specified in the previous slide
 - involve system configuration changes that affect power flow in the CRR DC FNM
 - cannot be initiated and completed within a twenty-four (24) hour period
- CRR Outage Modeling based on duration:
 - < 24 Hours: Not modeled
 - Short duration (≥ 24 Hours): Modeled as In Service but de-rate equipment
 - Long duration: Model equipment as Out of Service
- Outages causing islanding of any Source/Sink will be re-energized

CRR Modeling Practices

Aggregated Pricing Nodes (APNodes)

- Most sinks used in defining CRRs are APNodes
- APNodes are also used in the IFM for bidding purposes

Allowable Sources and Sinks (PNodes or APNodes)

- The list of allowable Sources (Injections) and Sinks (Withdrawals) will be made available on the ISO website and the CRR System prior to running any allocation or auction markets

CRR Modeling Practices

Aggregated Pricing Nodes (APNode)

- A group of PNodes that may represent such items as a Load Aggregation Point or a Trading Hub
- The term PNode is a location in the FNM, typically a bus
- The main purpose of an APNode is that it represents physical scheduling resources in the IFM that connect to the FNM at more than one location
 - Through the IFM an LMP is determined for each of the different APNodes that are Bid into the IFM

CRR Modeling Practices

- APNodes can also be defined for non-bidding purposes
 - A Trading Hub is not bid into the IFM, but an LMP is still calculated
- The CRR Sources and CRR Sinks are modeled as either PNodes or APNodes in the CRR SFT process

CRR Modeling Practices

Two Attributes of Aggregated Pricing Node

- A set of two or more PNodes
 - Each PNode provides a mapping back to the underlying FNM
 - An LMP is calculated by the IFM for each PNode in this set
- A set of allocation factors, one allocation factor for each PNode
 - These are also referred to as either Load or Generator Distribution Factors for Load or Generator Aggregation Points
 - For the CRR SFT, they are generally called allocation factors
 - The properties of the allocation factors are:
 - Each allocation factors is greater than or equal to 0.0
 - Each allocation factors is less than or equal to 1.0
 - The allocation factors for a particular APNode sum to 1.0

CRR Modeling Practices

Distribution Factors

- Distribution Factors for Load Aggregation Points will be based on historical load patterns as seen through the running of the DAM – applies to:
 - Default Load (DLAP) Aggregation Points
 - Sub Load (SLAP) Aggregation Points
 - Metered Subsystem Load (MLAP) Aggregation Points
 - Custom Load (CLAP) Aggregation Points
- Trading Hubs
 - Distribution factors are based on the weighted average generation output, for the prior full year of historical data, of all Generating Units within a Trading Hub

CRR Modeling Practices

Trading Hub

- For the CRR Allocation, CRR nominations with Trading Hubs as sources will be disaggregated into Point-to-Point CRRs each of whose CRR Source is a Generating Unit PNode that is an element of the Trading Hub
 - Each nomination will equal the MW quantity of the CRR nomination multiplied by the weighting factor of the corresponding Generating PNode
- The Trading Hub allocation factors will be updated once a year to coincide with the CRR annual processes
- Due to disaggregation of the Trading Hub and the .001 MW limit for CRRs, it is possible that the total disaggregated MW amount could be less than the nominated amount after the SFT is run
 - In addition, awards less than .001MW will be truncated to zero

CRR Modeling Practices

- Starting from January 2011 CRR monthly process for all allocation markets, trading hub CRRs are re-aggregated after the SFT process
- The re-aggregation is performed to reduce the number of awarded CRRs
- The process of re-aggregation is explained here with a simple example
- Consider a simple trading hub which consists of five PNodes A through E the disaggregation and re-aggregation of CRRs are shown in the following slide

Retirement Process

- Driven by IFM change
 - Generator Retirement
 - Model Change
- Impacts to CRR
 - Existing CRRs which have source/sink located at the retired PNodes/APNodes will be mapped to the closest electrically connected CRR biddable location
 - Retirement notices will be sent to CRR Market Participants
 - An updated list of CRR Source and Sink APNodes will be posted at <http://www.caiso.com/market/Pages/ProductsServices/CongestionRevenueRights/Default.aspx>
 - An updated CRR APNode Name Change Mapping file will be posted at <http://www.caiso.com/market/Pages/ProductsServices/CongestionRevenueRights/Default.aspx>

Retirement Process

- Impacts to CRR
 - Should the retirement of a PNode/APNode be related to a change in system topology, i.e. the CRR source or sink is no longer within the ISO BAA then after the reconfiguration a SFT is performed to ensure feasibility of the reconfigured CRRs
 - If the reconfigured CRRs are not feasible then they will be reduced until feasibility is achieved

Simultaneous Feasibility Test

Simultaneous Feasibility Test

- Overview of SFT process
- Weighted Least Square
- Shift Factors

Simultaneous Feasibility Test

- This optimization formulation is used in both the CRR Allocation and CRR Auction process
 - The objective function is slightly different in each
 - The topology and constraints are the same
- The objective functions in the CRR Allocation and CRR Auction process
 - CRR Allocation: Starting from January 2011 monthly CRR process the objective function has been modified to utilize the weighted least squares (WLS)
 - CRR Auction: the objective function used in the CRR Auction process is to maximize the bid based value of the awarded CRRs

Simultaneous Feasibility Test - Allocation

- For the monthly/annual allocation tiers, the objective function is to minimize the weighted least squares (WLS)

$$\min \left(\sum_{i=1}^N \alpha_i \left(\bar{X}_i - X_i \right)^2 \right)$$

- With WLS there is a sharing of the reduction as compared to the old methodology which was to maximize the CRR MW amount in which the most effective control variable is reduced/removed first.

Simultaneous Feasibility Test - Auction

- For the monthly/annual auction process, the objective function is to maximize the bid value of the awarded CRRs
- With the allocation process, participants only request MW amounts for the CRR source/sink pairs being nominated while for the auction participants also provide a bid curve.
- A simple example of how the auction optimization works is provided after the example on WLS later in this presentation

Simultaneous Feasibility Test – Weighed Least Square

- The WLS formula for deriving the reduction of a nomination is noted below

\bar{X}_i denote nominated MW for CRR i

$SF_{i,k}$ be shift factor of CRR i wrt constraint k

$\Delta V_{k,i}$ Reduction in each nomination be

ΔV Total overload

$\Delta V_{k,i}$ reduction in flow because of CRR i

$$\Delta V_{k,i} = R_{i,k} \cdot \Delta V$$

$$R_{i,k} = \frac{\bar{X}_i \cdot SF_{i,k}^2}{\sum_{i=1}^N (\bar{X}_i \cdot SF_{i,k}^2)}, \text{ where } \sum_{i=1}^N R_{i,k} = 1$$

Simultaneous Feasibility Test – Weighed Least Square

- Prior to WLS the objective function for the allocation was to maximize the number of awarded CRRs, which reduced nominations with the highest SF first.
- In the WLS formulation, the reduction on the flow on the constraint is pro-rated based on squares of the shift factors and the weight of the nomination amount (one over nominated MW amount)
- WLS distributes the curtailment across all CRR nominations that are effective in relieving the congestion, and thus spreads the curtailment among multiple allocation participants
- The WLS was implemented as a more equitable formulation for the CRR allocation process; in that CRR nominations share the available capacity

Simultaneous Feasibility Test – Shift Factors

- Shift Factors are also known by other names
 - Power transfer distribution factors (PTDFs)
 - Power distribution coefficients (PDCs)
 - Effectiveness factors
 - Impedance factors
- This shift factor definition is:
 - **SF_{ji} = shift factor for bus i (with respect to the reference location) on constraint j**
 - i.e., the incremental amount of power flow on constraint j when an additional unit of power is injected at bus i and withdrawn from the reference location
 - Shift factors are dependent upon the network topology of the FNM from which they are derived

Settlements

- Overview
- Notional Value
- CRR 1B Offset Revenue Calculation
- CRR Services Charge
- CRR Bid Transaction Fee

CRR Notional Value

CRR Notional Value Formula

$$[(LMP_{MCC} \text{ at Sink}) \text{ minus } (LMP_{MCC} \text{ at Source})] * \text{CRR MW}$$

- CRR Notional Value Example: 10MW CRR from A to B

CRR Source at A $LMP_{MCC} \text{ A} = \$5$

CRR Sink at B $LMP_{MCC} \text{ B} = \$15$

Congestion from A to B of \$10 (15 – 5)

$$[(LMP_{MCC} \text{ at Sink}) \text{ minus } (LMP_{MCC} \text{ at Source})] * \text{CRR MW}$$

$$(\$15 - \$5) * 10\text{MW} = \$100 \text{ Payment to CRR Holder}$$

Track 1b Changes to Revenue Inadequacy Allocation

- Prior to 2019, the difference between notional CRR value and congestion revenue, i.e. revenue inadequacy, was charged to load.
- The Track 1b reforms replaced this with a pro rata allocation of the shortfall to CRR holders.
 - The ISO now assigns revenue shortfalls to CRR holders on a constraint-by-constraint basis pro rata based on the CRRs with implied flow over each constraint in the direction of congestion.
 - The ISO first nets the implied flows that all CRRs within a CRR holder's CRR portfolio have on a given constraint.

CRR Related Grid Management Charges

- There are two types of CRR related GMC charges: CRR Services Charge and CRR Bid Transaction Fee.
- CRR Services Charge (Charge Code 4562)
 - It is designed to recover costs the ISO incurs for running the CRR markets.
 - It is applied to each CRR holder's net MW holdings of CRRs that are applicable to each hour.
 - The rate is calculated by dividing the annual GMC revenue requirement allocated to CRR service category by forecasted annual sum of awarded MW of CRRs per hour.

CRR Related Grid Management Charges

- CRR Bid Transaction Fee (Charge Code 4516)
 - It is designed to recover CRR costs on a transactional basis.
 - It applies to both the CRR allocation process and the CRR auction process.
 - The rate is applied on a per nomination or per bid basis, without consideration of the number of segments.
 - GMC rates can be updated intra-year to reflect actual cost collection. The current rates can be found under Market and Administrative Charges / Grid Management Charge

LUNCH BREAK

STAKEHOLDER PRESENTATIONS

DISCUSSION AND NEXT STEPS

Open Discussion

- Overall responses to today's presentations
- Does today's meeting raise new thoughts or questions around:
 - Current CAISO CRR functions
 - Schedule for future working group meetings
 - Problem statements

Updated Working Group Schedule

Nov. 14, 2024



Working Group Scoping Discussion

Jan. 28, 2025



CAISO's CRR Program

Deeper dive into the current CRR program structure and function; stakeholder perspectives and experiences

Feb. 27, 2025



Analysis

Root cause analysis discussion

March 2025



Benchmarking to Other CRR Programs

CRR structures used by other ISOs

April/May, 2025



Policy Scope and Problem Statements

Discussion of proposed problem statements and scope for upcoming initiative

Next Steps

- Comments on today's meeting will be due February 11th
- Join us for the next working group meeting on February 27th, which will focus on the results of the ISO's root cause analysis of current CRR program performance
- If you would like to present at or request topics for future working group meetings please reach out to Brenda Marquez at bmarquez@caiso.com or ISOstakeholderaffairs@caiso.com

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