Appian Way
Energy Partners

CRR Market Design

How CRRs Benefit End-use Customers
CRR Financial Integrity in CAISO

CAISO Enhancements Initiative
Stakeholder Session #2

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Discussion Topics

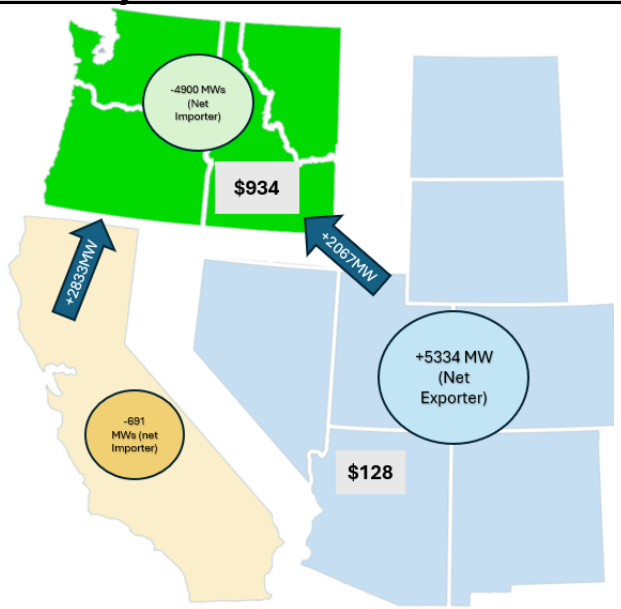
- CRR Property Rights in a Market Design Context
  - Do Transmission Ratepayers Experience "Losses" from the CRR Auction?
  - Consumer Benefits from CRR Market Design
- Revenue Inadequacy/Underfunding Causes and Cost Allocation
  - Revenue Adequacy & CRR Financial Integrity
  - Use of Congestion Surpluses
  - DLAP Aggregate Modelling Challenges and Unintended Consequence of Reducing Permitted Sink Nodes
  - CRR Underfunding and Cost Causation

CRR Property Rights in Context

Do Transmission Ratepayers Experience "Losses" from the CRR Auction?

FERC Order 888 Required TOs to offer non-discriminatory open access to facilitate electricity market competition and more efficient transmission usage of the power grid. Competition brings lower costs to consumers.

January 2024 Cold Weather Event



Prices are the average ICE on-peak prices for Jan 13th for Paloverde and Mid-C
Flow is the average MW flow across the winter event Jan 12th – Jan 16th taken from WRAP Assessment of January 2024 Cold Weather Event.

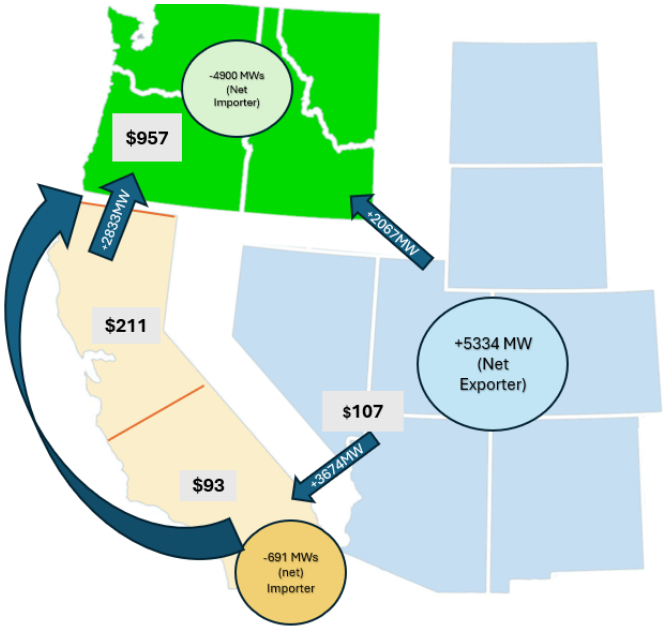
- In bilateral (non-ISO) markets, participants with physical rights to transmission wheel power from low priced areas (Palo Verde) to high priced areas (MidC)
- Participants that wheel power are paid the MidC price for delivered power
- Participants pay the TO the postage stamp rate for transmission (not the price difference)

CRR Property Rights in Context

Do Transmission Ratepayers Experience "Losses" from the CRR Auction?

ISO-coordinated dispatch with LMP results in more efficient (least-cost) dispatch and efficient usage of transmission. But participant access to transmission is no longer financially guaranteed by physical transmission rights, and can only be provided through access to financial transmission rights (CRRs)

January 2024 Cold Weather Event



Prices are the average RTPD on-peak prices from CAISO on Jan 13 at PV, SP15, NP15 and Malin
Flow is the average MW flow across the winter event Jan 12th – Jan 16th taken from WRAP Assessment of January 2024 Cold Weather Event.

- Participants that wheel power from Palo Verde through CAISO get charged congestion (CAISO price at Malin – CAISO price at Palo Verde) of $850/MWh instead of receiving the price at MidC delivery point in exchange for a postage stamp rate
- Compared to the previous bi-lateral markets system, allocation of congestion rents to load as ARRs is a *great benefit* for load
- If the participant wheeling power through CAISO buys a CRR to hedge their transaction, is it right to deem this a "loss" to transmission ratepayers in this circumstance?
- Open access to CRRs via an auction mechanism is a critical and integral part of competitive market design under the LMP system

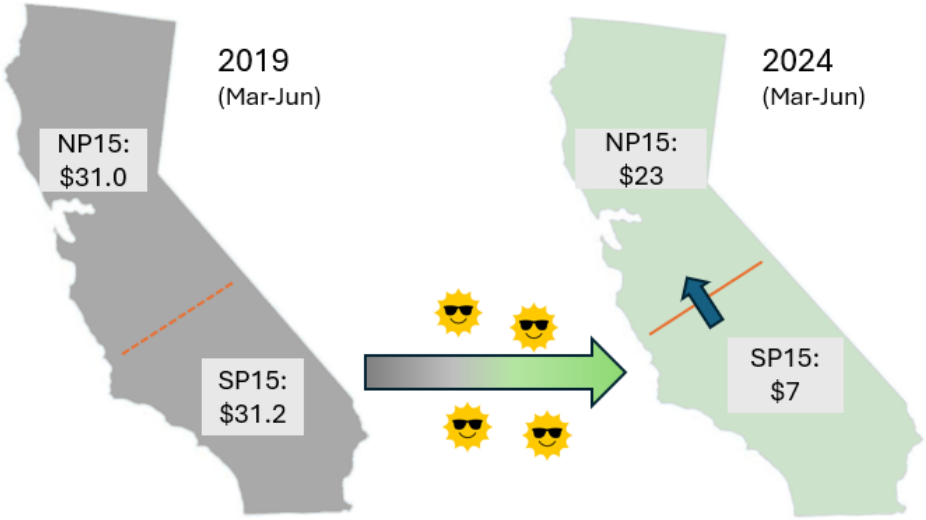
CRR Property Rights in Context

Do Transmission Ratepayers Experience "Losses" from the CRR Auction?

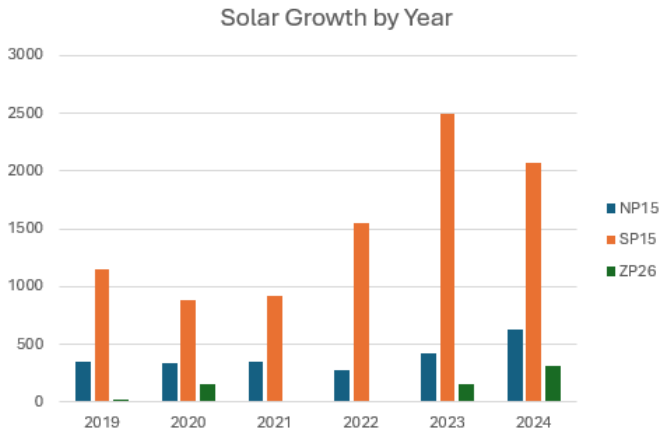
Misconception: "Load pays the congestion and therefore load is entitled to ALL the congestion rent"

Counterpoint 1: When there is congestion, it's not possible to say whether load is paying "more," or suppliers are being paid "less"

Context: CAISO renewable growth has led to lower spot prices for load (i.e. suppliers being paid less) and highlights the importance of access to congestion hedges to manage delivery risk for IPPs, LSEs that contract for remote generation, and the financial intermediaries that transact with each of them



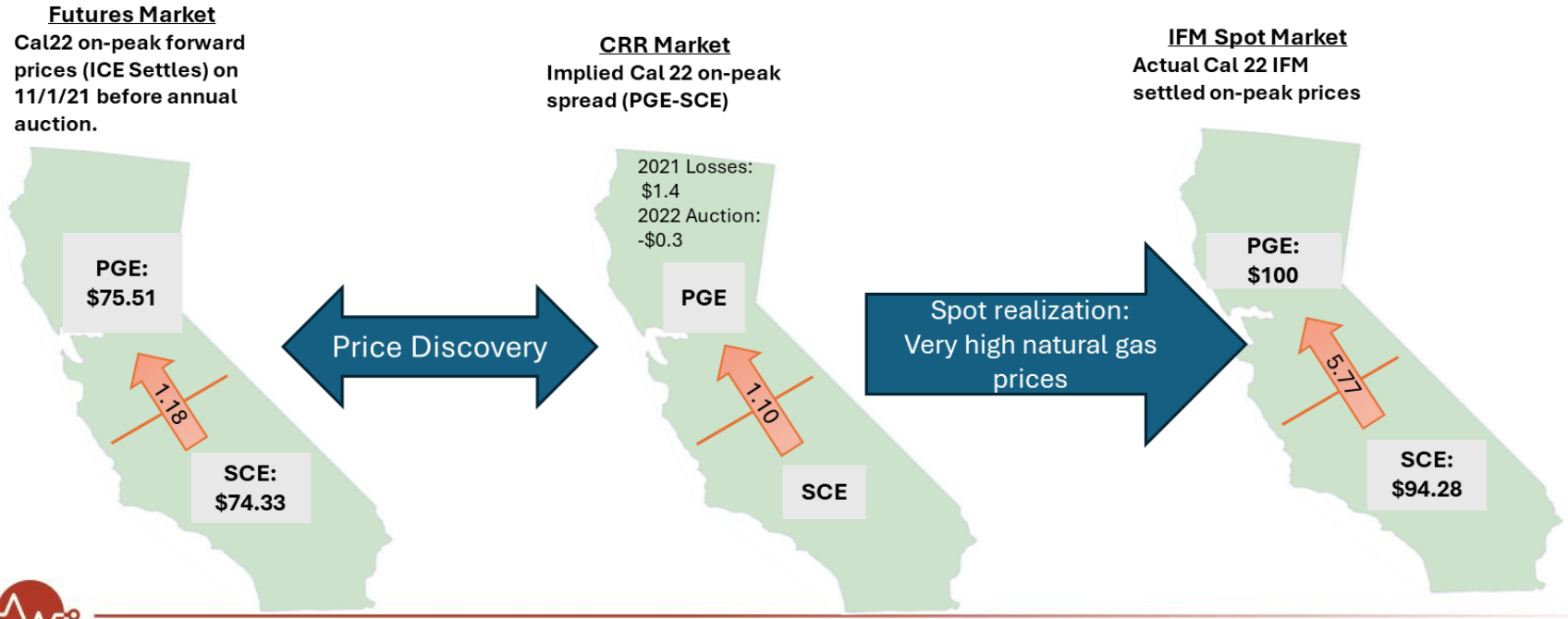
Average on-peak RTDP price for March-June of 2019 vs 2024
IFM prices were $26.6 and $26.5 in 2019, and $23.1 and $7.9 in 2024



CRR Property Rights in Context

Labeling Aggregate CRR Profitability as "Auction Inefficiency"* is Misleading

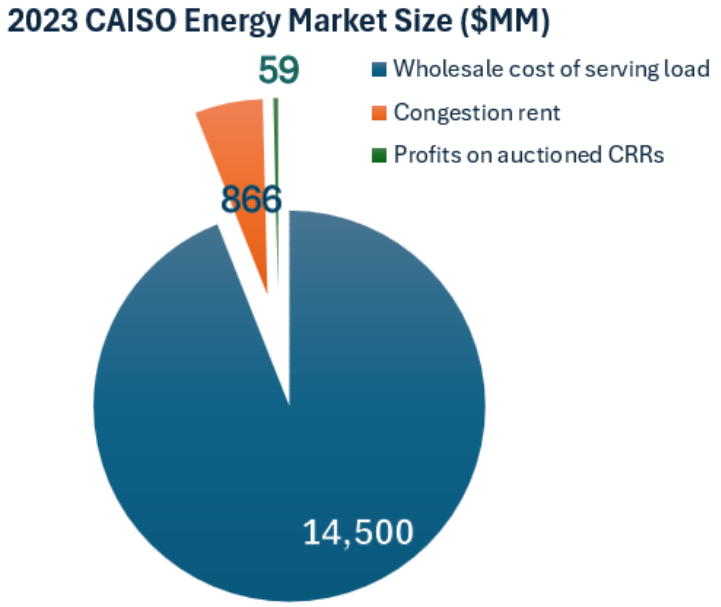
- **CRR markets are competitive and efficient predictors for "futures market" price spreads and visa versa**
- **CRR (and futures market) prices represent the market's "*expected value*" of all the potential outcomes for spot prices. Electricity markets are volatile and realized spot market prices usually differ widely from the markets' ex ante expected value**
- **In the example below, CRR auction prices in 2022 efficiently matched market futures prices for the PGE/SCE spread but did not for realized spot prices. The latter mismatch is not "inefficiency" but rather that the ex post price turned out to be at the higher end of the ex ante expected price range**



* CAISO defines "auction inefficiency" as payouts to CRRs sold in the auction minus auction revenues; i.e. a measure of the profitability of auctioned CRRs.

CRR Property Rights in Context

Dual Purpose of CRRs – Both Benefitting End-use Customers



- Congestion is a small part of the overall energy market but a crucial part of the market design for "getting the prices right" and sending efficient market signals for entry, exit and bi-lateral contracts.

Dual Purpose of CRRs

1) Allocate the right to electricity network congestion to transmission customers
   - **Auction Revenue Rights (ARRs)** accomplish this
   - ARRs allow LSEs to convert to those CRRs that match their business needs and get ARR $$ for the remainder
   - Market is intentionally not structured to ensure 100% of spot congestion rent is returned to load
     - Congestion rent is great benefit for load compared to pre-ISO open access market design
     - Load also benefits from gen pocket congestion through lower prices

2) Serve as the financial equivalent of firm transmission in an LMP system and facilitate creation of a market for congestion hedging that allows for non-discriminatory open access that enables competition
   - **CRR Auctions** accomplish this
   - Load also benefits when competitive suppliers are able to obtain congestion hedges to mange risk/lower risk premia and pass on the resulting lower cost of serving load in the form of more competitive offers

** Data on the CAISO market size from the 2023 DMM Annual Report.

Consumers Benefit from Well-Functioning CRR Markets

PJM Review of ARR/FTR Market Design and LEI Report

CRR markets provide both liquidity and transparency, facilitate competition and transactions in bi-lateral and futures markets and lower prices for consumers

- LEI Report* -- PJM Commissioned an independent ARR/FTR market review at the request of PJM States and other stakeholders. It found that FTRs and ARRs benefit load by returning congestion charges back to load (via the assignment of ARRs) and by improving the efficiency of the competitive market through enhanced liquidity, transparency and facilitation of hedging.
  - "FTR auction results provide a granular understanding of expected network congestion, which helps market participants hedge congestion risk more effectively"
  - "Price discovery emanating from FTR auctions supports liquidity in forward markets, which reduces the transaction costs of hedging and bilateral contracting"
  - "In the long run, load benefits from a liquid and efficient forward market through lower transaction costs, lower financing costs and optimal reallocation of risk"
- LEI estimated annual benefit to load of between $523 million and $1.2 billion in PJM.

* https://pjm.com/-/media/committees-groups/task-forces/afmtf/postings/lei-review-of-pjm-arrs-and-ftrs-report.ashx; https://www.pjm.com/-/media/committees-groups/task-forces/afmtf/postings/updated-lei-presentation.ashx

Consumers Benefit from Well-Functioning CRR Markets

Congress, the Courts and FERC Support the ARR/CRR Market Design

- ER22-797 Order Accepting PJM filing:
  - *Consistent with Commission precedent, we reiterate that "[t]he purpose of FTRs to serve as a congestion hedge has been well established." **FTRs were designed to serve as the financial equivalent of firm transmission service and play a key role in ensuring open access to firm transmission service by providing a congestion-hedging function**.*
    - Commissioners Glick, Danly, Clements, Christie and Phillips, 3/11/22
- EL16-6 Order on Rehearing (upheld on appeal by the DC Circuit Court of Appeals):
  - ***We reject the arguments that the sole purpose of FTRs is to return congestion revenue to load and the market should therefore be redesigned to accomplish that directive**. FTRs were designed to serve as the financial equivalent of firm transmission service and play a key role in ensuring open access to firm transmission service by providing a congestion hedging function. The purpose of FTRs to serve as a congestion hedge has been well established. In the Energy Policy Act of 2005, Congress added section 217(b)(4) to the FPA, directing the Commission to exercise its authority to "enable load serving entities to secure firm transmission rights (or equivalent tradable or financial rights) on a long-term basis for long-term power supply arrangements made, or planned, to meet such needs." In Order No. 681, the Commission clearly emphasized the significance of FTRs in hedging congestion price risk.*
    - Commissioners LaFleur, Bay and Honorable 1/31/17
- The CRR/ARR Market Design is Part of a Larger Market Design Context:
  - "Now all organized wholesale markets in the United States are built around the essential elements of bid-based, security-constrained, economic dispatch with locational prices and **financial transmission rights**. The success and wide adoption of this market design reflects the basics of the underlying electricity system and the requirements of open markets. In short, this successful market design is the only way to organize a short-term electricity market that adheres to the principles of open access and nondiscrimination. [For the Commission,] the most important thing to remember is the critical role of this fundamental market design. There is no other way to organize system operations and adhere to the Commission's mandate. Furthermore, the broad policy objectives of the green energy agenda only serve to reinforce this conclusion. **The penetration of intermittent resources, such as solar and wind, often located far from load, increases the need for real-time coordination of dispatch across larger regions**."
    - Comments of William W. Hogan, Docket No. AD17-11

Discussion Topics

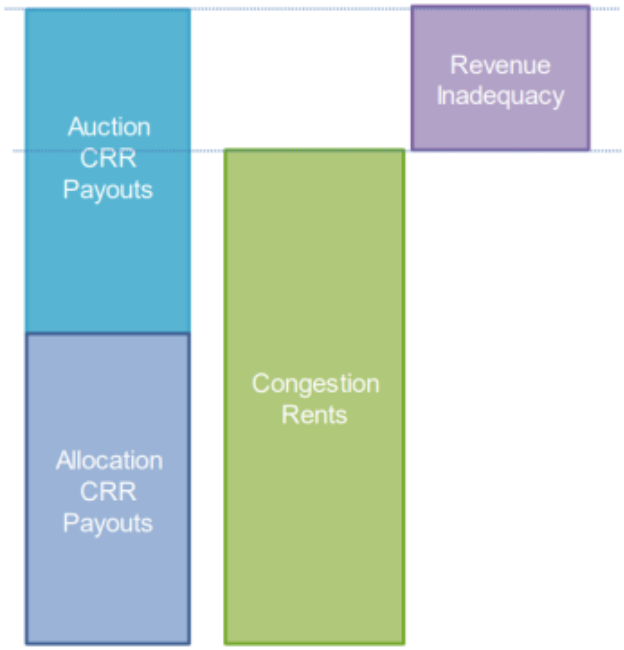
Revenue Inadequacy/Underfunding Causes and Cost Allocation

- Revenue Adequacy & Financial Integrity of CRR product
- Use of Congestion Surpluses
- DLAP Aggregate Modelling Challenges and Unintended Consequence of Reducing Permitted Sink Nodes
- CRR Underfunding and Cost Causation

Revenue Adequacy

First Principles & Model Alignment: Physical = Financial

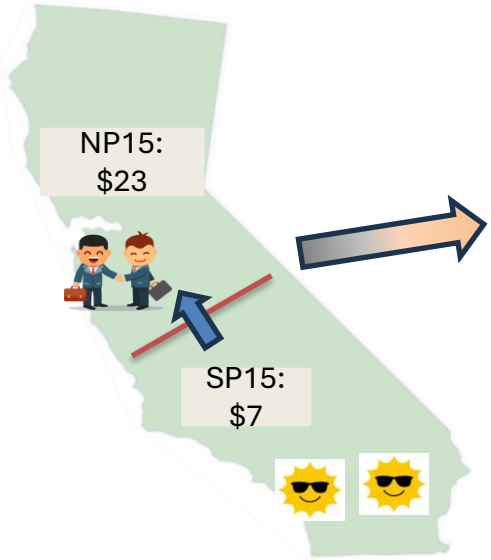
- Revenue adequacy occurs when the ISO-collected congestion rents are sufficient to fund auctioned and allocated CRRs
- Revenue Adequacy Theorem & Simultaneous Feasibility Test
  - As long as financial rights do not exceed the physical capacity of the system, then the ISO will always collect enough congestion rents from the operation of the spot market to fund the financial rights regardless of which CRRs are purchased
  - The ISO's CRR team ensures that the auctioned and allocated CRRs are feasible given the constraints represented in the Full Network Model
  - The goal is to ensure that there will be sufficient congestion revenues from the normal operation of the IFM to fund all the CRR payments
- Global Derate Factor (GFD)
  - The ISO derates the CRR Full Network Model to improve revenue adequacy



Revenue Adequacy is about how well CRR processes converge to DA market

CRR Financial Integrity

- **Revenue inadequacy has been extreme on the internal high voltage constraints separating SP15 from NP15.**
- **Extreme underfunding raises costs for Northern California LSEs' hedging of renewable generation delivered from the south as well as renewable IPPs in the south who need CRR contracts to hedge their congestion exposure, and financial intermediaries that serve both these IPPs and LSEs. These higher costs are passed on to consumers in the form of increased costs to contract for generation and higher risk premia in bilateral transactions**
- **Underfunding uncertainty increases risk and lowers the expected CRR value in the auction, depressing CRR bid prices and reducing the value of ARRs. Ultimately, load also pays for compromised CRR financial integrity by way of lower ARR value.**



March-June 2024			
Constraint	Notional Revenue ($)	Under Funding ($)	Percentage Underfunding
30055_GATES1 _500_30060_MIDWAY _500_BR_1 _1	20,654,209	(11,655,330)	56%
30050_LOSBANOS_500_30055_GATES1 _500_BR_1 _2	11,966,621	(1,050,742)	9%
30040_TESLA _500_30050_LOSBANOS_500_BR_1 _1	1,678,512	(300,334)	18%
6410_CP10_NG	1,442,755	(1,112,253)	77%

Average CAISO on-peak IFM price for March-June 2024

CRR Financial Integrity

- Financial integrity of financial products has inherent value
- CAISO has extreme levels of underfunding not experienced in any other market

2024 Notable Constraints over 75% underfunded			
Constraint	Notional Revenue ($)	Under Funding ($)	Percentage Underfunding
32214_RIO OSO _115_30330_RIO OSO _230_XF_1	27,722,879	(28,999,393)	105%
7820_TL23040_IV_SPS_NG	14,753,617	(15,370,068)	104%
7820_TL 50002_IV-NG-OUT_TDM	4,598,334	(4,927,911)	107%
32056_CORTINA _60.0_30451_CRTNA M_ 1.0_XF_1	(1,640,055)	(11,976,189)	730%
89 Additional Constraints with Underfunding over 75%	26,802,314	(31,314,130)	117%

- What happens if congestion revenues are assigned directly to load with no CRR auction, or if the CRR product's integrity as a financial instrument is compromised?
  - Cost and risk premia for supplying illiquid locations go up
  - Generators' options for managing risk compromised
  - Market less robust weathering an extreme weather event
  - Futures markets at congested zones more volatile and costly
  - With higher "risk," the competitive market price goes up, increasing cost to consumers and suppliers

Use of Congestion Surplus

Netting may be appropriate if it is not possible to have very granular and precise cost-causation-based allocation

The fundamental factors that may cause congestion surplus may be the same factors causing underfunding on a different path. Netting may be appropriate.

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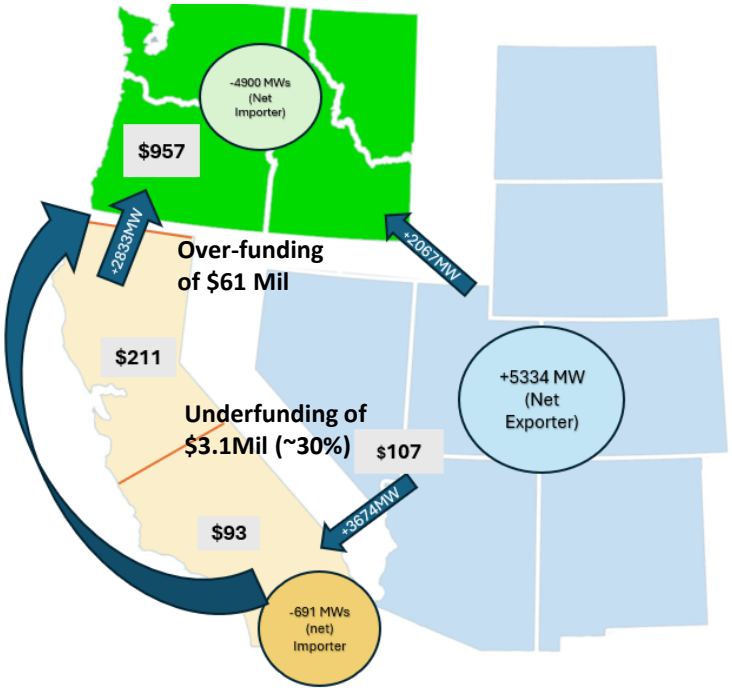

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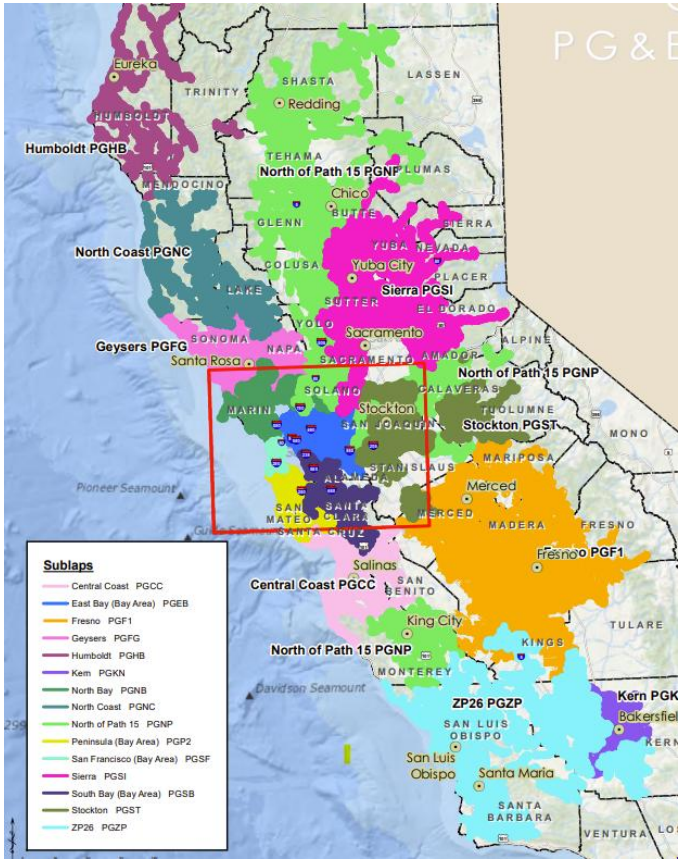
- The very same fundamental factors that may be causing congestion surplus may also be simultaneously causing underfunding on a different constraint. In these cases, netting may be appropriate.
- For instance, in January, 2024, CAISO collected $96 MM in surplus congestion on the COI interface while simultaneously underfunding CRRs crossing Path15 by approximately $11.1 MM.
- Fundamentally, it is likely that both surplus and deficit were caused by heavy power flows from Southern CA and AZ to the PAC NW.
- Jan 12-16, represented at left, accounted for $61 MM in surplus with $3.1 MM in deficit.

DLAP Aggregate Modelling Challenges

Potential Unintended Consequence of Reducing Permitted Sink Nodes

- The upcoming root cause analysis by CAISO staff should assess whether large DLAPs in CAISO, and the reduction in available nodes from track 1b reforms, may be exacerbating differences in CRR transfer capacity between the auction and IFM
- PJM has this problem and addresses this by settling load zone FTRs at a different price from their DAM LMP
- If market participants were allowed more locations for CRRs that sink at static nodes or aggregates, fewer CRRs would exist that distort flows between the CRR and IFM models (to the extent this turns out to be a problem)
- CRRs that are required to be on a path where the impact on market flows can vary materially depending on load conditions, and where modelling of large loads within a zone can also materially distort transmission flows, may be problematic for CRR funding levels.
- Ironically,[1] track 1B logic to require sinks only at "physical load" locations may be exacerbating modelling differences



1 - The irony is that banning certain paths based on a purported better representation of the physical market (source at generation; sink at load) actually creates a worse representation of the physical market flow. It would be better the allow CRR paths that do not distort market flows

CRR Underfunding and Cost Causation

- Critical to have data and root cause analysis from CAISO staff before determining "problem statement" for stakeholders to address underfunding. However, in principle, can we distinguish?:
  - Cost-causation-based reasons for underfunding
    - Overselling transfer capacity in the CRR Auction
    - Transmission outages reported in accordance with the BPM that cause a physical network reduction in transfer capacity below that in the CRR model
  - Non-CRR-causation-based reasons for underfunding
    - CAISO participants or external entities not paying for congestion that they cause
      - The Shift Factor Threshold Issue from ER23-2020 (CAISO did not apply the fix to scheduling points or large generators)
      - Loop flows
      - Other, as yet unknown, reasons that may be identified in the root cause analysis
    - CAISO artificially tightening limits due to factors unrelated to physical network limits
    - Late outage reported that cannot be modelled in the CRR auction