Western Interstate Energy Board

Investigating Existing Resource Adequacy Frameworks and Reliability Opportunities in the West

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Project Overview

- **Motivation:** As the Western Interconnection faces large load growth forecasts and the resource mix evolves, the West faces unprecedented resource adequacy challenges. Two programs have emerged to solve this:
  - **Slice-Of-Day:** Mandatory program for all California Public Utility Commission (CPUC) - jurisdictional load serving entities (LSEs). Went live in Jan 2025.
  - **Western Resource Adequacy Program (WRAP)**: Voluntary, regional reliability program across the West. Currently operating and in non-binding phase.
- **Project Goal**: Develop a comparative analysis of these RA frameworks to assess their impacts on regional planning and reliability. Identify opportunities for alignment and growth.
- **Methodology**: Conducted 30 interviews with load serving entities (7), regulators (8), market operators (8), developers (3), and RA experts (4).

Key Takeaways

California's Slice-Of-Day: Part of an effort to quickly improve CA's reliability and but opportunities remain to lower costs.

WRAP: Lowers costs through regional collaboration but reliability benefits depend on continued participation.

Slice-Of-Day and WRAP Harmonization: Two programs can coexist effectively – harmonization opportunities exist at seams to prevent double counting and streamline imports.

Presentation Overview

1. **History and Comparisons of Slice-of-Day and WRAP**
2. Regional Perspectives on Benefits & Challenges of Slice-of-Day and WRAP
3. Transmission Rights across CAISO-WRAP Seams
4. Current and Forward-Looking Developments for Slice-of-Day & WRAP
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Origins of California's Slice-of-Day RA Program

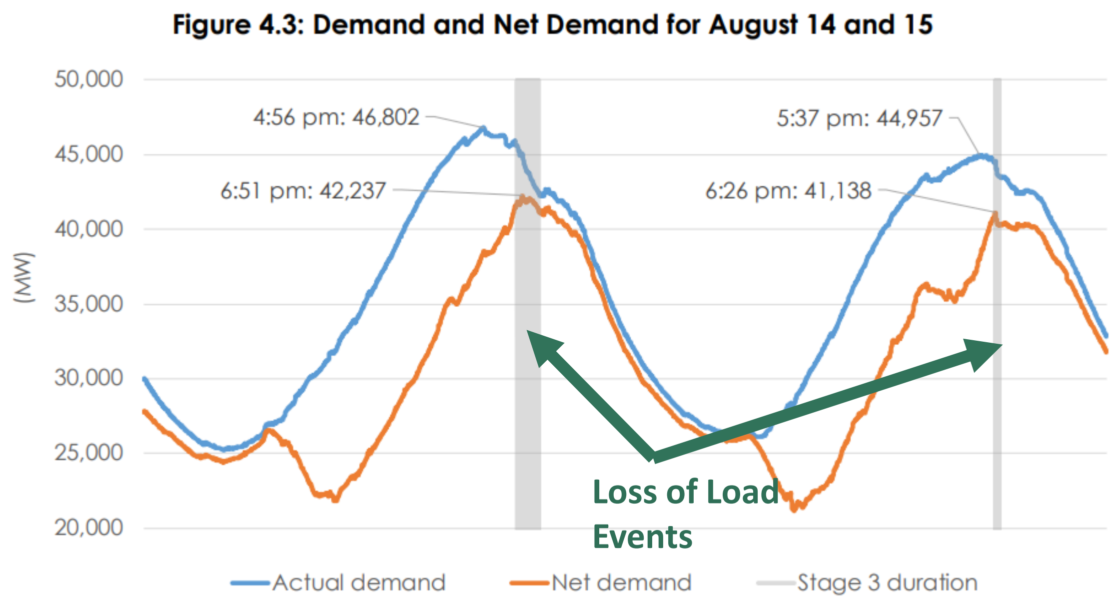
After 2020 rolling blackouts, regulators were prompted to act.

1. Solar and wind resources "underperformed" during outage relative to their Effective Load Carrying Capabilities (ELCCs).[1]

2. Marginal ELCCs shift with portfolio changes and are harder to predict, creating revenue uncertainty for developers and grid planners.[2]

3. Batteries lacked a mechanism to ensure sufficient hourly state-of-charge modeling.[3]

CPUC: California Public Utility Commission; LSEs: Load Serving Entities



CAISO, "Root Cause Analysis- Mid-August 2020 Extreme Heat Wave (January 13th, 2021)".

Outages occurred at net peaks in 2020 after most solar was offline.

1. CAISO, https://www.caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf, pg 46.
2. Union of Concerned Scientists, https://blog.ucs.org/mark-specht/to-understand-energy-storage-you-must-understand-elcc/
3. CPUC, https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M553/K679/553679354.PDF

Origins of WRAP

Historically, most load-serving entities (LSEs) in WRAP footprint planned independently and with PNW entities relying on abundant hydro power.

WRAP Origin Timeline-

- **2001**: Hydro Draught– Curtailment payments to large load customers.
- **2011**: Northwest Power and Conservation Council identifies risk of outages exceeding 5%, that continue to increase each year.
- **2019**: Northwest Power Pool commissions "Resource Adequacy in the Pacific Northwest" study, rigorously outlining the region's exposure to outages.
- **2019**: WRAP is initiated as a voluntary program and now could account for 2/3 of non-CA Western Interconnection Load.

Slice-of-Day and WRAP Comparison Matrix

	CA Slice-of-Day	WRAP
Governance	Mandatory program for all CPUC-jurisdictional LSEs, designed by the CPUC with stakeholder input	Voluntary stakeholder driven program, administered by Western Power Pool (WPP)
Program Structure	**RA Filing:** Shifts RA requirements from monthly to hourly	**Forward Showing (FS):** Filings to show compliance with reliability requirements
	Operations: Solely an RA showing program, the real-time market handles energy deployments	**Operations (Ops) program:** Capacity and energy trading between participants
Filing Period	Annual filing: 90% of target met Monthly filing: 100% of target met	Summer: June 1 - September 15 Winter: November 1 – March 15 Requires 100% accredited generation, 75% accredited transmission

- CPUC- Resource Adequacy Homepage
- WRAP Detailed Design Document

Capacity Accreditation Comparison

	CA Slice-of-Day	WRAP
Solar and Wind	Exceedance methodology	Effective Load Carrying Capability (ELCC)
Thermal Generation	Assigned a value based on Pmax and a derating based on forecasted temp	Unforced capacity (UCAP)
Energy Storage	Assigned a single value based on Pmax	Effective Load Carrying Capability (ELCC)
Demand Response	Hourly value depending on its capacity on the worst day of the month	Can be used to reduce P50 load or counted as a capacity resource

- WRAP Detailed Design Document
- 2025 Resource Adequacy and Slice-of-Day Guide

Slice-of-Day: Exceedance Methodology

Figure 1: August Solar Exceedance Profiles

- Capacity accreditation is calculated for each hour of all months to create a 24-hour profile.
- Uses 6 years of historical data using the top 5 days from each month[1] to create a profile.

Figure 2: Exceedance Level Selection

- CPUC Staff chose exceedance level to minimize overcounting in loss-of-load-expectation (LOLE) hours.

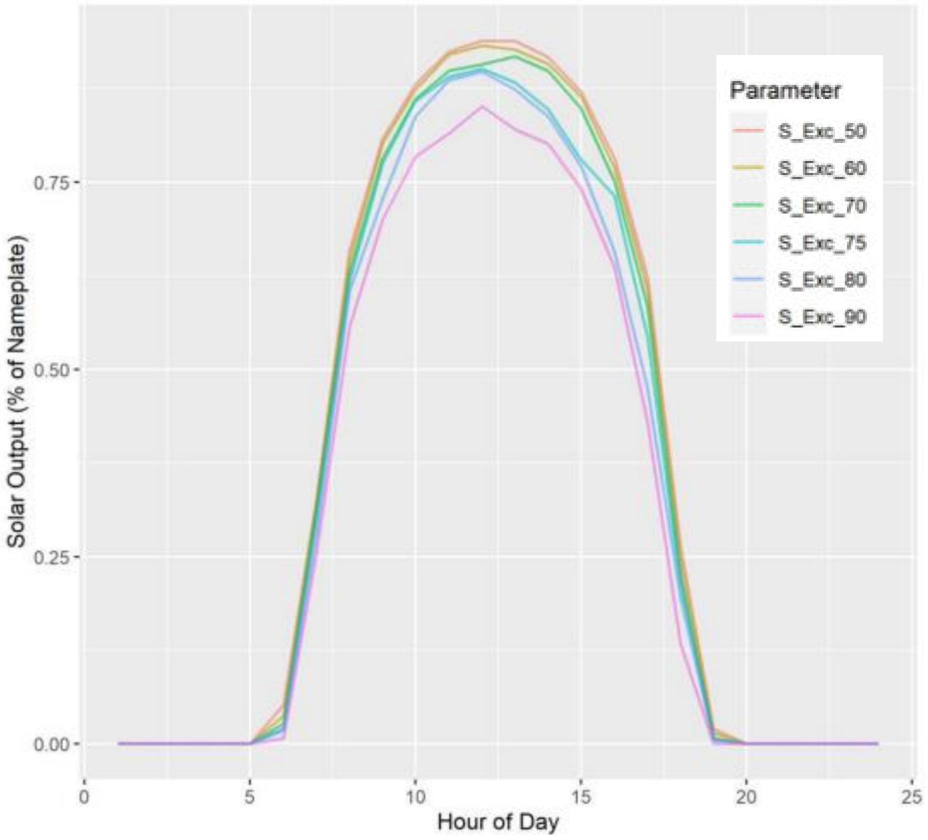


Figure 1: August Solar Exceedance Profiles[2]

Solar Output
52.0%
52.0%
49.4%
49.4%
46.8%
45.5%
42.9%
41.6%
41.6%
41.6%
41.6%
40.3%
40.3%
39.0%
39.0%
37.7%
37.7%
37.7%
37.7%
36.4%
36.4%
36.4%
31.2%
31.2%
29.9%
28.6%
27.3%
26.0%
24.7%
15.6%
9.1%

70%

30%

Figure 2: Exceedance Level Selection[2]

1. CPUC- Report on Resource Adequacy Slice of Day Implementation and Year Ahead Showings
2. CPUC- Slice of Day Resource Counting- Exceedance

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Slice-of-Day Benefits for California

- Quickly mandated reliability for CA LSEs.
- Ensures batteries are sufficiently charged for accreditation hours.
- Capacity accreditations are more stable.
- Provides CA markets with sufficient capacity to operate.

CPUC Jurisdiction: https://cal-cca.org/cca-map

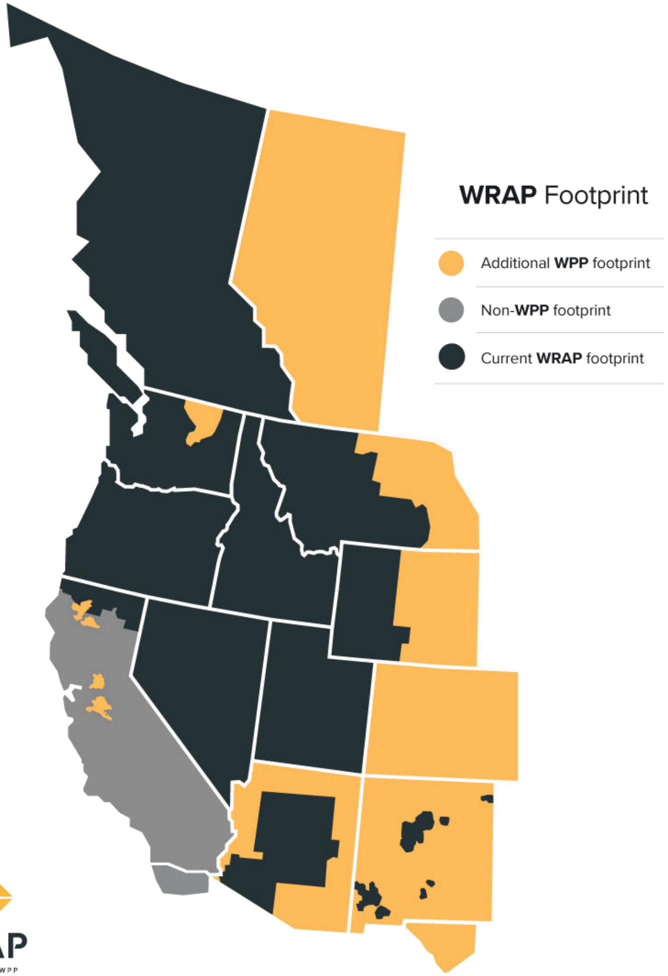
Slice-of-Day Stakeholder Concerns

	Concern		Response
1	The reliability impact of having **two separate RA frameworks**.	→	Reliability is not hindered since both frameworks are tuned to 0.1 LOLE. Each is reliable independently.
2	**Exceedance** does not value resources for their ability to mitigate loss of load events	→	The stability of exceedance and its reflection of hourly output is simpler.
3	**Departure from ELCC**, which is widely used, could create uncertainty for developers.	→	Developers said the only outcome that matters is accredited capacity price.
4	**Unused hourly surplus** for some LSEs in Slice-of-Day.	→	Suggest the CPUC revisit hourly RA obligation trading as Slice-of-Day matures.[1]

1. https://cal-cca.org/ra-transactability/

Regional Benefits of WRAP

- Enables diverse resource sharing which unlocks a lower PRM and ultimately lower costs.
- A standardized and transparent regional reliability metric verified by an independent party.
- Sends an economic signal to LSEs to make prudent investments in additional resources.
- Incentivizes LSEs to meet resource sufficiency for regional market access.



WRAP Stakeholder Concerns

	Concern	Response
1	Completing the Joint Contract Accreditation Form (JCAF) and performance testing is administratively complex.	While cumbersome, no evidence that JCAF compliance is a long-term barrier to WRAP.
2	Supply is tightening as load grows.	No easy solution, but WRAP was specifically designed to address this.
3	The deficiency charge is high and likely rate-payer funded.	There is a 75% discount for Winter 27/28 and a 50% discount for Summer 2028 and Winter 28/29.[1]
4	WRAP relies on voluntary participation.	Ensure benefits of WRAP outweigh costs for each LSE.

1. WPP, https://www.westernpowerpool.org/private-media/documents/2.27_RAPC_Meeting_Materials.pdf

WRAP Participation Decision Framework

Market Selection		Decision Factors
Markets+		WRAP Participation Required
Long on Capacity	No Market	WRAP Ops Program
Long on Capacity	EDAM	WRAP Ops Program & Market Benefits
Short on Capacity	No Market	WRAP Ops Program – Deficiency Charge
Short on Capacity	EDAM	WRAP Ops Program & Market Benefits - Deficiency Charge

Individualized Benefits for Short LSEs

WRAP Benefits

- Economic signals for generation investment.
- Ops program- A fast way to ensure reliability.
- Transparency on how short the LSE is and how to improve.

EDAM Reliability Benefits

- Access to diverse regional resources for energy imports.
- The Resource Sufficiency Evaluation (RSE) incentivizes **some** capacity procurement.

WRAP Benefits with EDAM

- Ensures long-term reliability while the RSE ensures hourly reliability.
- Access to additional energy imports outside of the EDAM footprint.
- Further enables entities to pass the RSE.

Key Takeaway: While EDAM provides some short-term reliability benefits, WRAP ensures entities will have suite of available resources in the West at its disposal in constrained hours in addition to long-term reliability.

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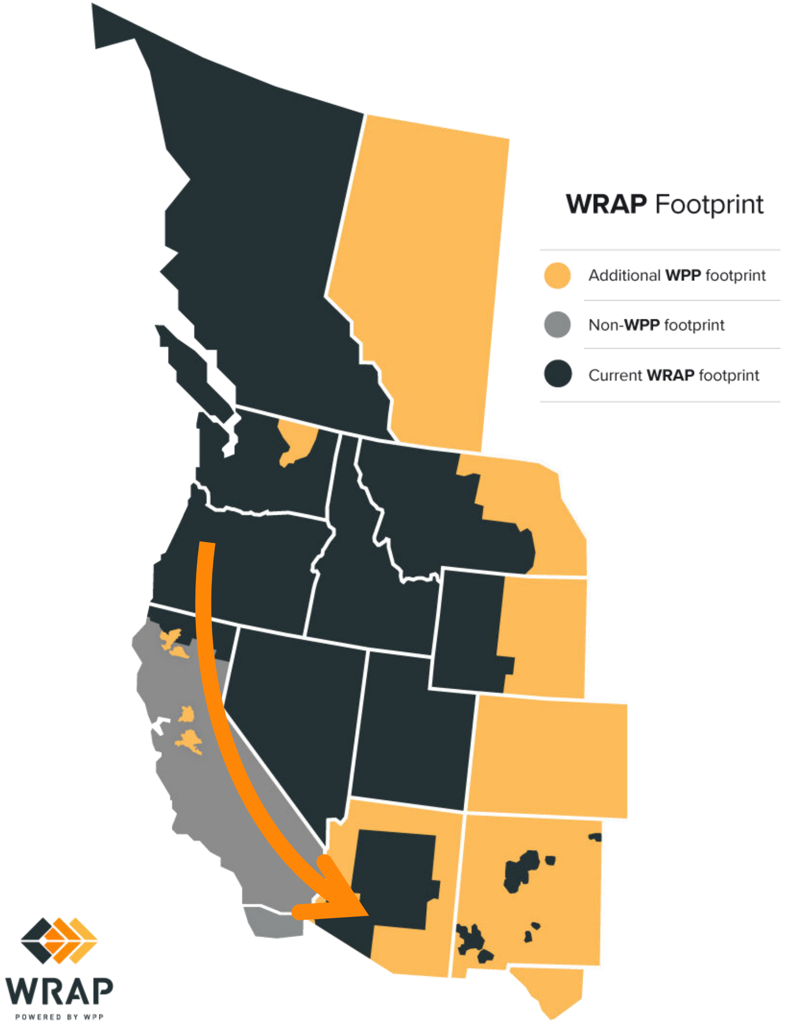
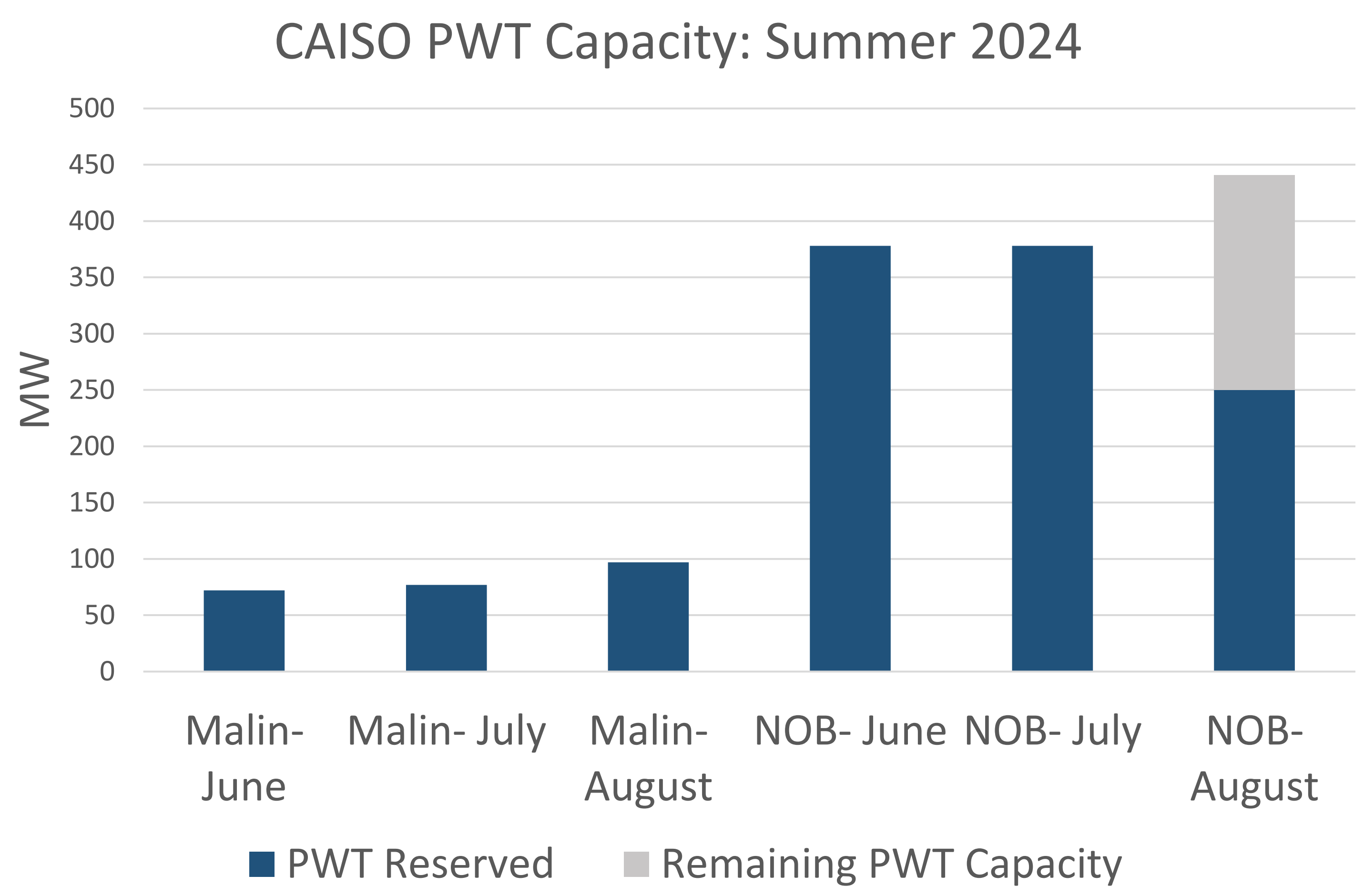
WRAP Interoperability with CAISO Transmission



Implications

- CAISO transmission is separate from WRAP. It doesn't use NERC priorities.
- Usage of CAISO transmission for WRAP requires reserving priority wheel-throughs (PWTs).
- The FS program would require a monthly reservation while the Ops program would require a daily reservation.
- **WRAP Task Force- CAISO Transmission:** Changing the WRAP tariff language so that "WRAP Qualifying Transmission" will include PWTs through CA transmission.

WRAP Interoperability with CAISO Transmission

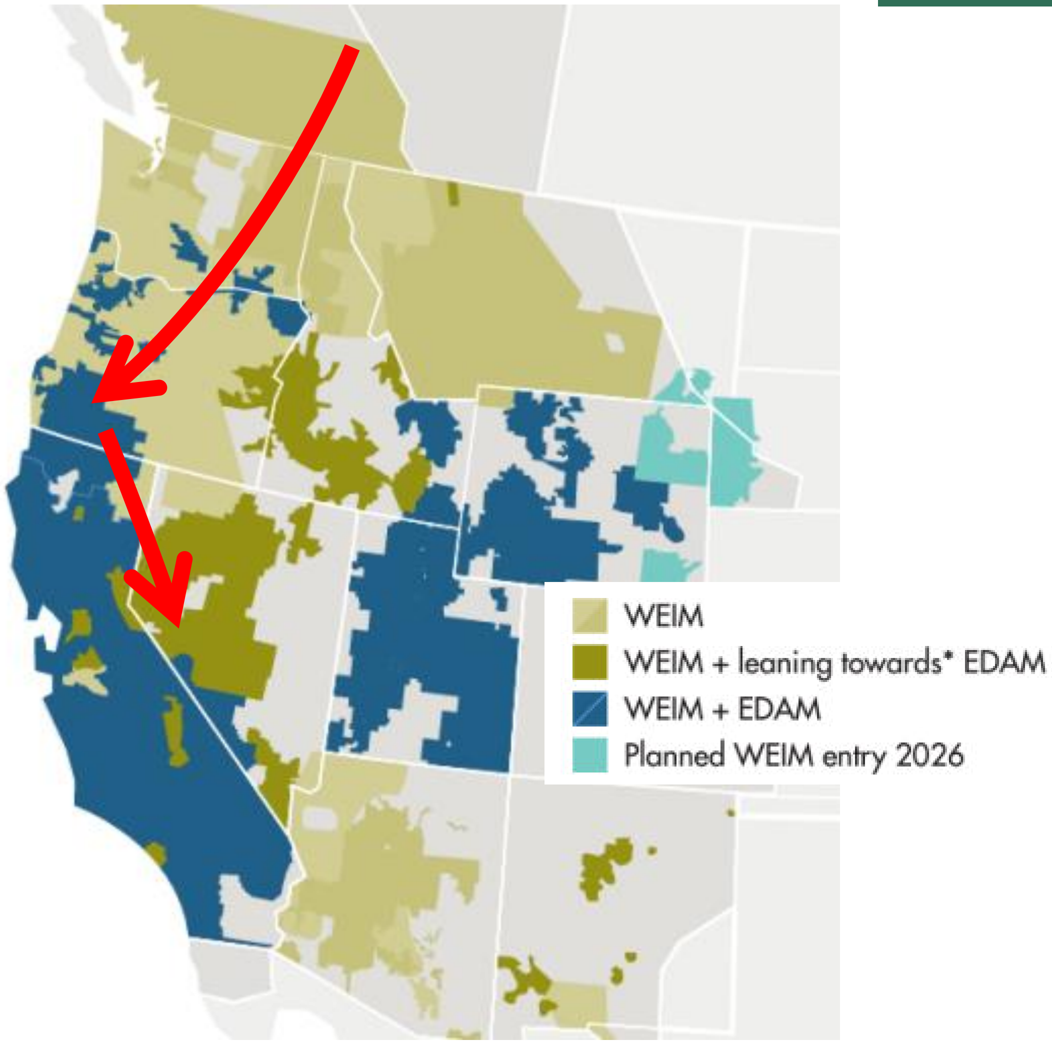


- Malin and Nevada-Oregon Border (NOB) are the two main interties used for PWTs.
- PWTs in CAISO are limited in summer months.
- For some, concerns remain for WRAP participants to procure more resources to compensate for lack CAISO transmission capacity.

Data from: [CAISO- Q2 2024 Report on Market Issues and Performance]

EDAM Transmission: Late Self-Schedule Energy Deployments

- Holders of firm OATT transmission rights can self-schedule **up to the day-ahead market** across EDAM/non-EDAM interfaces.
- Between day-ahead and real-time markets, CAISO will re-dispatch these schedules; if infeasible, WRAP energy deployments risk losing priority in WEIM[1].
- WRAP EDAM entities proposed using **holdbacks** of transmission capacity to protect OATT rights and WRAP deployments.



WRAP Energy deployment from outside of EDAM, through EDAM, then back out of EDAM.

1. https://www.westernpowerpool.org/private-media/documents/WPP_WRAP_Interoperability_with_Markets_June_2023.pdf
2. Image from https://www.caiso.com/documents/pge-presentation-decision-to-join-the-extended-day-ahead-market-and-or-the-western-energy-imbalance-market-feb-2025.pdf

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WRAP Interoperability with Regional Day-Ahead Markets

WRAP
POWERED BY WPP

2019
WRAP discussions begin

January 2023
FERC approves WRAP tariff[1]

May 2024
WRAP initial binding decision deadline. Delayed to 2025.[3]

MARKETS+

Extended-Day-Ahead Market (EDAM)

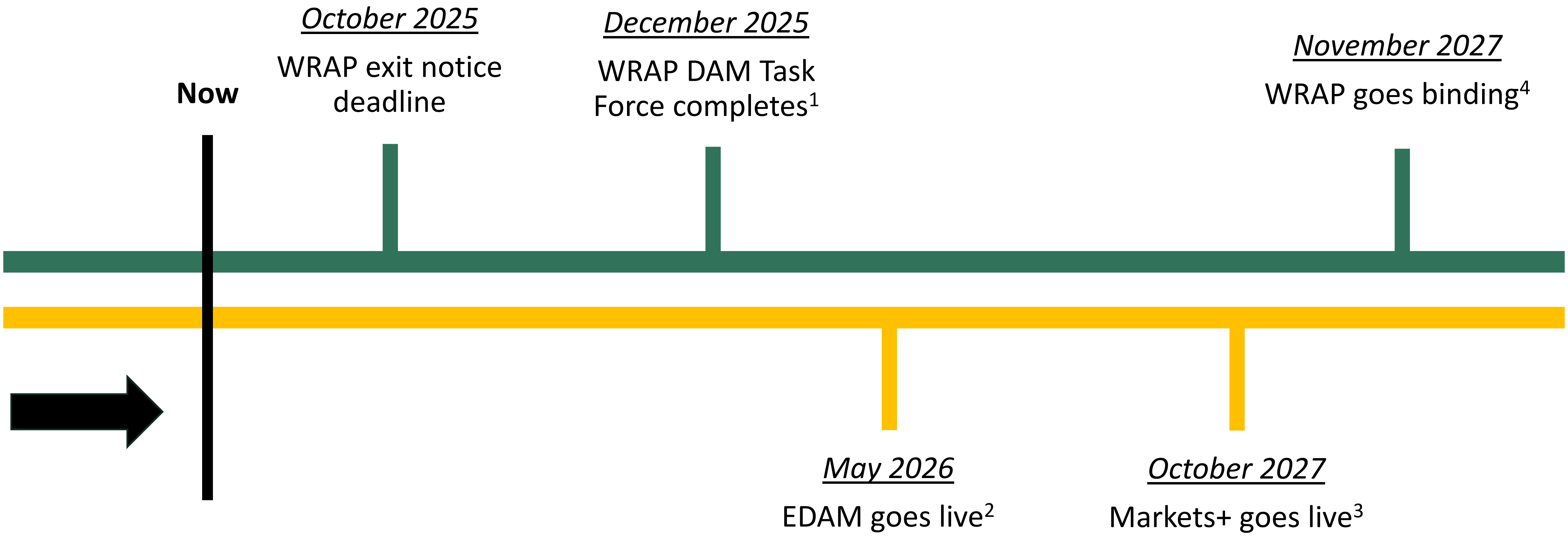
December 2023
FERC approves EDAM tariff[2]

January 2025
FERC approves Markets+ tariff[4]

Key Takeaway: While WRAP originated first, it is now adapting as regional markets progress.

1. FERC, https://www.ferc.gov/media/wpp-western-resource-adequacy-program
2. FERC, https://www.ferc.gov/media/caiso-extended-day-ahead-market
3. WRAP, https://s3.documentcloud.org/documents/24601514/wrap-rapc-participant-letter-4-22-24_final.pdf
4. FERC, https://ferc.gov/media/e-1-er24-1658-000

WRAP Interoperability with Regional Day-Ahead Markets

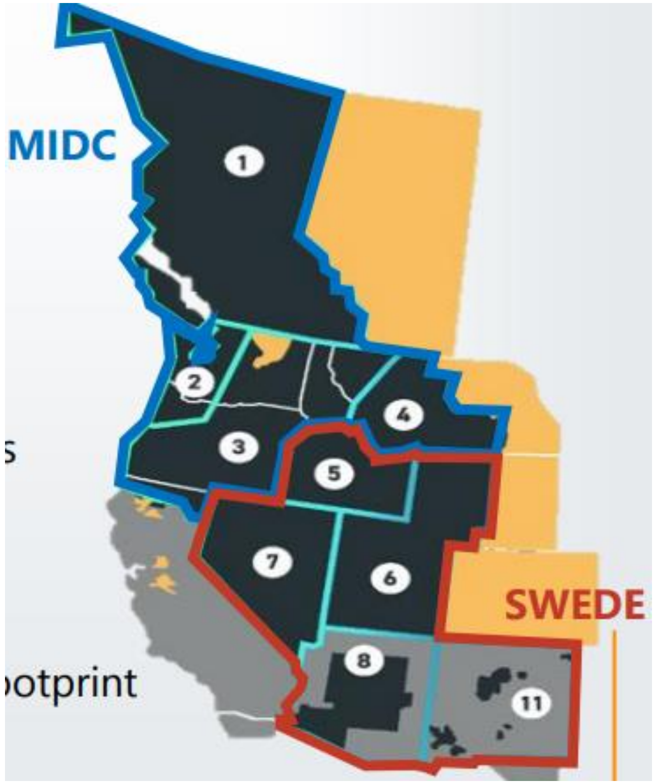


Key Takeaway: WRAP participants will need to decide whether to leave the program before information is fully available on WRAP integration with regional markets.

1. WRAP, https://www.westernpowerpool.org/private-media/documents/PRC_Task_Force_Charter_-_01_-_DAM.pdf
2. CAISO, https://www.westerneim.com/Documents/Extended-DayAheadMarketOnboardingandImplementationUpdate-ISOPresentation-May2024.pdf
3. SPP, https://www.spp.org/marketsplus
4. WPP, https://www.westernpowerpool.org/news/wrap-committee-approves-new-transition-plan-looks-

Market Based Operation Subregions (MBOS)

- **Stakeholder Proposal for MBOS:**
  - Align footprints with markets
  - Other participants are assigned a subregions
  - Concept Paper from WRAP DAM task force
- **Sharing calculation**
  - No significant change (pro-rata within both subregions)
  - Net sharing calculation between market footprints
- **Energy Deployments:**
  - Left to markets to optimize
  - Obligation remains with WRAP participant
- **Settlement**:
  - Capacity: WRAP operated
  - Energy: Market operated

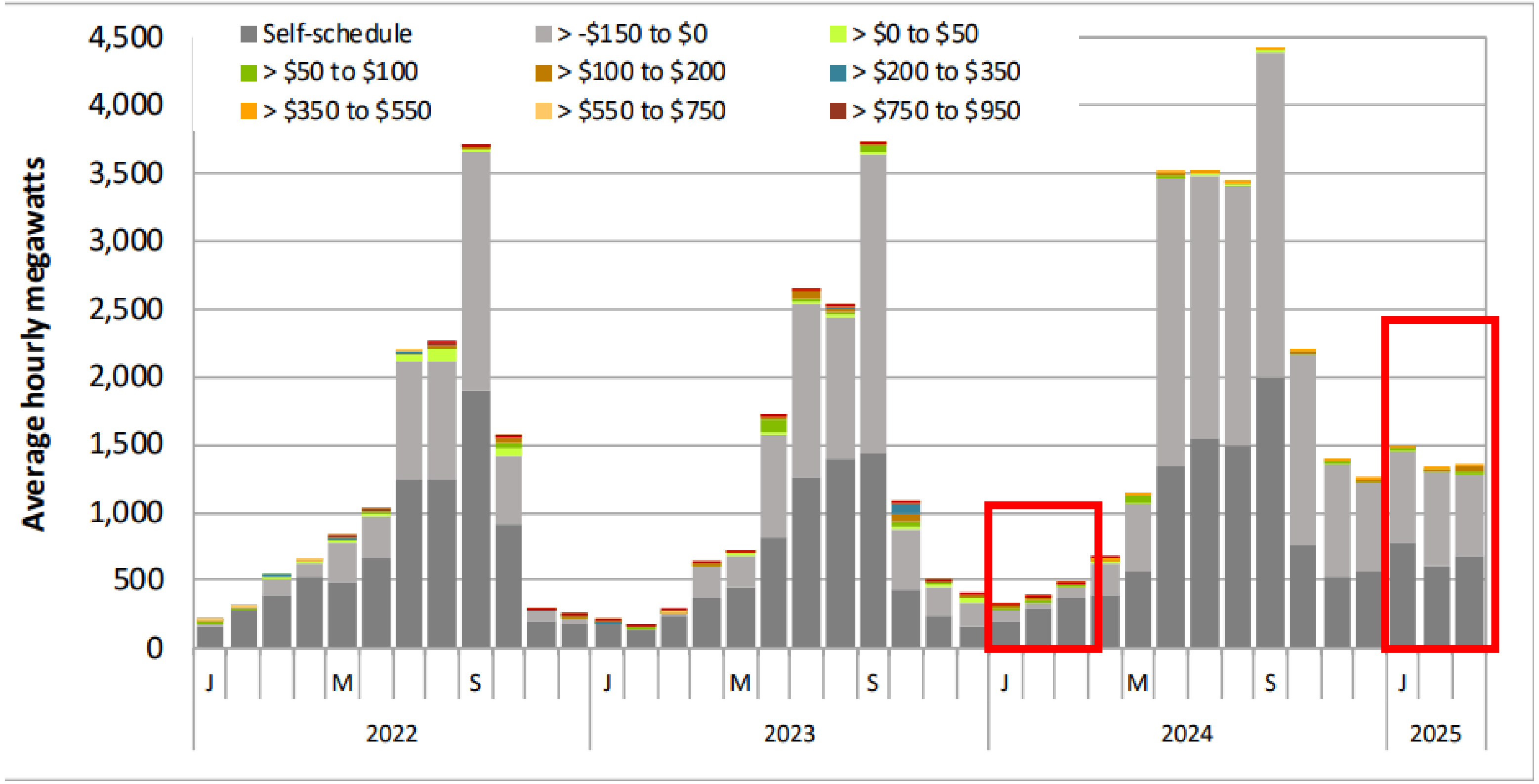


WRAP is currently organized into geographic subregions

1. WPP https://www.westernpowerpool.org/private-media/documents/2025-07-31_DAM_Task_Force.pdf

CA Import RA Bids Since Introduction of Slice-of-Day (2025)

Figure 12.1 Average hourly resource adequacy imports by price bin



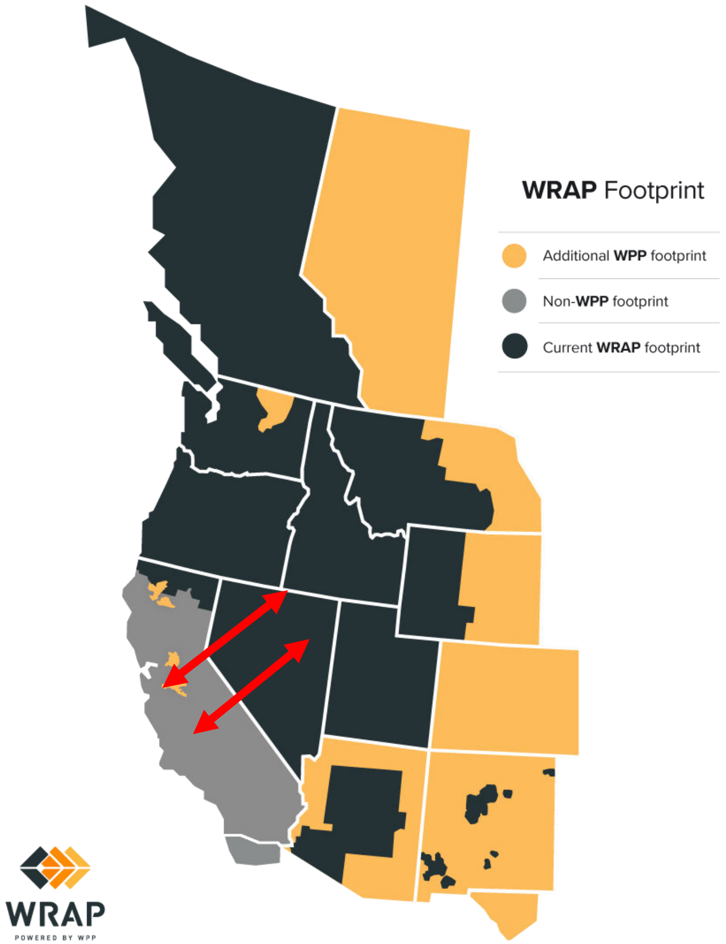
Jan 2025 had a **>3x increase** in CA monthly import RA bids compared to Jan 2024.

The Western RA market could be tightening faster than anticipated.

WRAP achieving its binding phase could limit the extent to which Western RA imports are available to CA LSEs.

California Perspectives: Increasing Transactability with WRAP

- An RA program decision on the extent to which lower cost imports can be trusted for reliability.
- CAISO Resource Adequacy Working Group Goals:
  - "A comprehensive review of the CPUC's Slice-of-Day reform and the translatability and transactability of WRAP"[1] .
  - "Allow for efficient trade of capacity products between California and WRAP"[2].
- Delayed goals until WRAP becomes binding.
- Supported by many CA stakeholders in public comments, especially for when WRAP becomes binding.



1. CAISO- Resource Adequacy Working Group- Meeting Slides (2/23/24)
2. CAISO- Resource Adequacy Working Group- Discussion Paper (4/29/24)

Suggestions from California Stakeholders

Align CA generators with WRAP generator requirements

A joint mechanism to increase RA capacity data transparency

Re-evaluate the $0 bid requirement and Maximum Import Capability (MIC)

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WRAP: Lowers costs through regional collaboration but reliability benefits depend on participation and adaptability to markets.

Slice-Of-Day and WRAP Harmonization: Two programs can coexist effectively – smaller harmonization opportunities exist at seams to prevent double counting and streamline imports.

Final Considerations

California's Slice-of-Day:

- Alignment of CA generators with WRAP generators.
- Reconsider hourly trading of RA obligations in future.
- Re-evaluate 0$/MW bid requirement for imports and MIC allotments.

WRAP:

- Weigh the impacts of a further delayed or modified deficiency charge with the benefits the charge provides for RA accountability.
- Ensure WRAP remains dynamic and flexible with committed participants as markets evolve, with direction that can be refined as market details finalize.

Slice-of-Day and WRAP Harmonization:

- Joint mechanism between Slice-of-Day and WRAP for increased data transparency on available capacity and double counting prevention.

Q&A

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Thank You