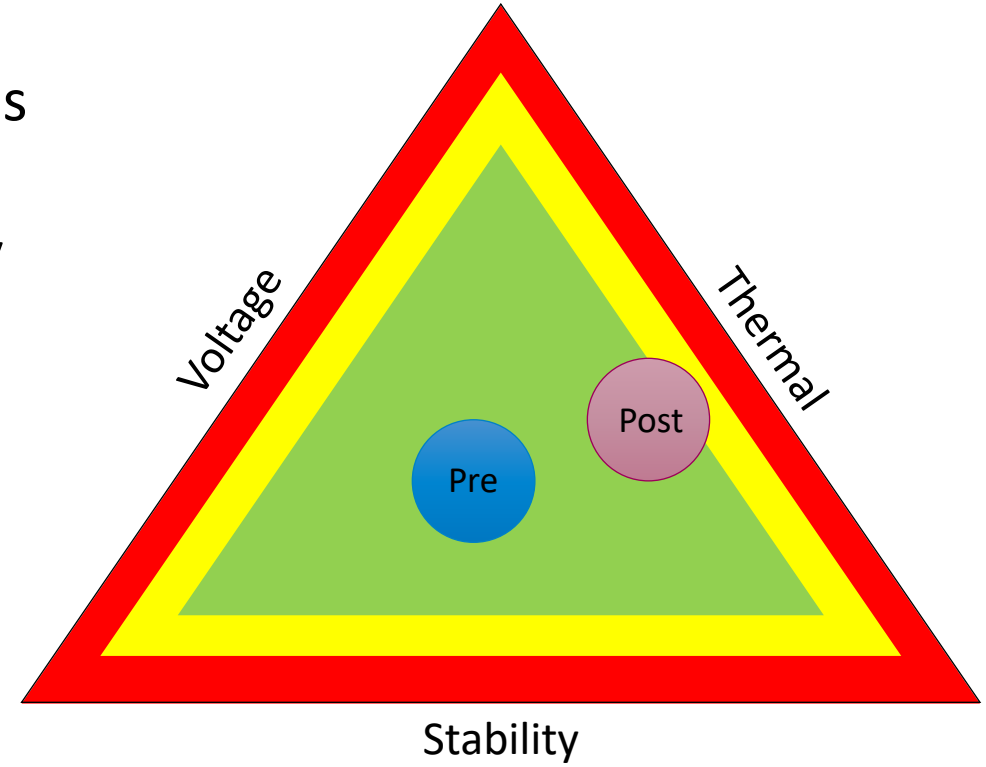
Congestion Management in Real-Time Operations

Four Corners SOL Exceedance

Adam Bow

- Two SOL exceedances occurred on 12/4/21
  - Four Corners-Moenkopi 500kV line > continuous rating (N-0)
  - Four Corners-Cholla #2 500kV line > emergency rating (N-1)
- APS mitigated the N-0 exceedance, but did not mitigate the N-1 exceedance until later
- Lessons Learned
  - Operations and Engineering practices
  - Network models
  - Coordination with external entities



Tools Available for SOL Mitigation

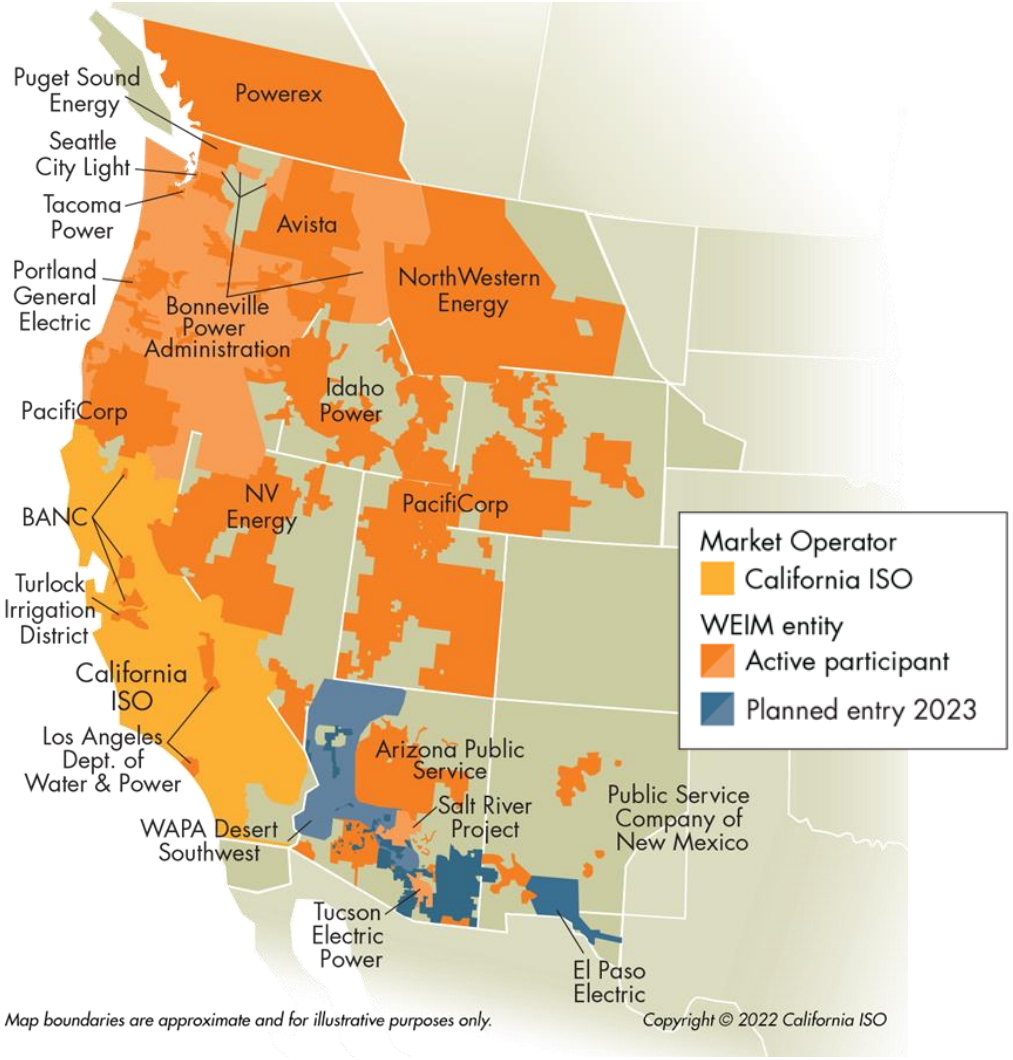
Adam Bow

- Legacy Methods
  - Transmission solutions
  - Generation solutions
  - Load solutions
  - Remedial Action Schemes (RAS)
  - Transmission Projects
- Market Tools - Dede
- Transmission Services - Doug

Western Energy Imbalance Market (WEIM)

Dede Subakti

- WEIM is a real-time market that does Security Constrained Unit Commitment and Economic Dispatch (SCUC/SCED)
- The current design on WEIM allows for both Contract Path methodology and flow-based methodology
- The SCUC/SCED are done for "forward-looking" time frame



Western Energy Imbalance Market (WEIM) Contract Path Methodology

California ISO

- Contract Path limit is modeled by using the concept of Intertie Transmission Constraint (ITC)
- Similar to other scheduling limit, the ITC can be set to limit the sum of export and import as provided by WEIM entity
- There can be one-to-one or one-to-many correlation between ITC and ATC Path
- The ITC limit is enforced in the WEIM SCUC/SCED regardless of actual flow. It only utilizes the schedule/tags information and it has 100% impact/shift factor.
- WEIM entity is then required to provide hourly limit for each ITC for each direction (export/import)

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Western Energy Imbalance Market (WEIM) Flow based congestion management

California ISO

- Flow based congestion management are largely modeled in three ways:
  - Base case (Pre-contingency) flow limitation on a transmission facility (a flowgate)
  - Base case (Pre-contingency) flow limitation on a set of transmission facilities (a Branch Group/a Transmission Corridor)
  - Post-contingency flow limitation on a transmission facility for a specific pre-defined contingency scenario
- Limits have a default limit based on the network model submitted to CAISO:
  - Pre-contingency flow limit on a transmission facility is based on Normal Rating on the facility (MVA)
  - Pre-contingency flow limit on a Branch Group/Transmission corridor is based on default limit submitted in the model (in MW)
  - Post-contingency flow limit on a transmission facility is based on Emergency Rating on the facility (MVA)
  - These limits can be modified "on the fly" for every 15-minute SCUC and for every 5 -minute SCED. Limits can be modified by WEIM Entity Operators

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Western Energy Imbalance Market (WEIM) Flow based congestion management

California ISO

- Input to the SCUC/SCED:
  - Network topology from State Estimator
  - Planned outage switching information
  - Limits
  - Variable Energy forecast
  - Load forecast
  - Bid and offers from resources
- In Real Time market, the SCUC/SCED also utilizes the CAISO Day Ahead market output, the WEIM Base Schedule, and any supplemental bids/offers from resources
- The WEIM SCUC/SCED are multi-interval forward looking time frame
  - SCUC runs every 15 min & looks ahead in 15 min intervals spanning the current & next hour
  - SCED runs every 5 min & looks ahead in 5 min interval for the next interval and as many as 12 future intervals
- These are all inputs into the real-time market, from which comes the real-time dispatches, Start-up and shut down instructions, and multi-stage generator transitions, as well as ancillary service award for CAISO's BAA
  - These are dispatched via the Automated Dispatch System (ADS)

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WEIM Base Schedule

- Forward energy schedules
- Include hourly forecasts of load, hourly generation schedules, and hourly interchange schedules
  - Base schedules include the operating hour and at least two subsequent operating hours.
- Base schedules are used to communicate a resource's hourly planned operation. For:
  - Participating resources
  - Non-participating resources
  - Import/Export
  - Base load
- Base schedules must be submitted by 75 minutes before the operating hour.
- These are used as a baseline for financial settlements.

Western Energy Imbalance Market (WEIM) Costs to manage constraint

California ISO

- Based on the inputs to the SCUC/SCED, market award feasible schedules to resources:
  - Locational marginal price will reflect the congestion:
    - Price will be higher in the receiving end (where energy is needed)
    - Price will be lower in the sending end (where there is surplus of energy that cannot be delivered)
  - Self-schedule are not curtailed until it hits penalty price

- Common challenges in input accuracy:
  - Network topology from State Estimator for incorrect non-telemetered switches
  - Incorrect planned outage switching information (late outages start or end)
  - Incorrect limits
  - Variable Energy Forecast and Load Forecast

- WEIM Entity System Operator can adjust limits (use of conformance) up and down.
  - For example, conformance to reduce limit and reduce market flow to have sufficient reliability margin to protect for input accuracy

- All market costs are settled through WEIM settlement
  - Differences between base schedule and real time dispatch can create offset costs

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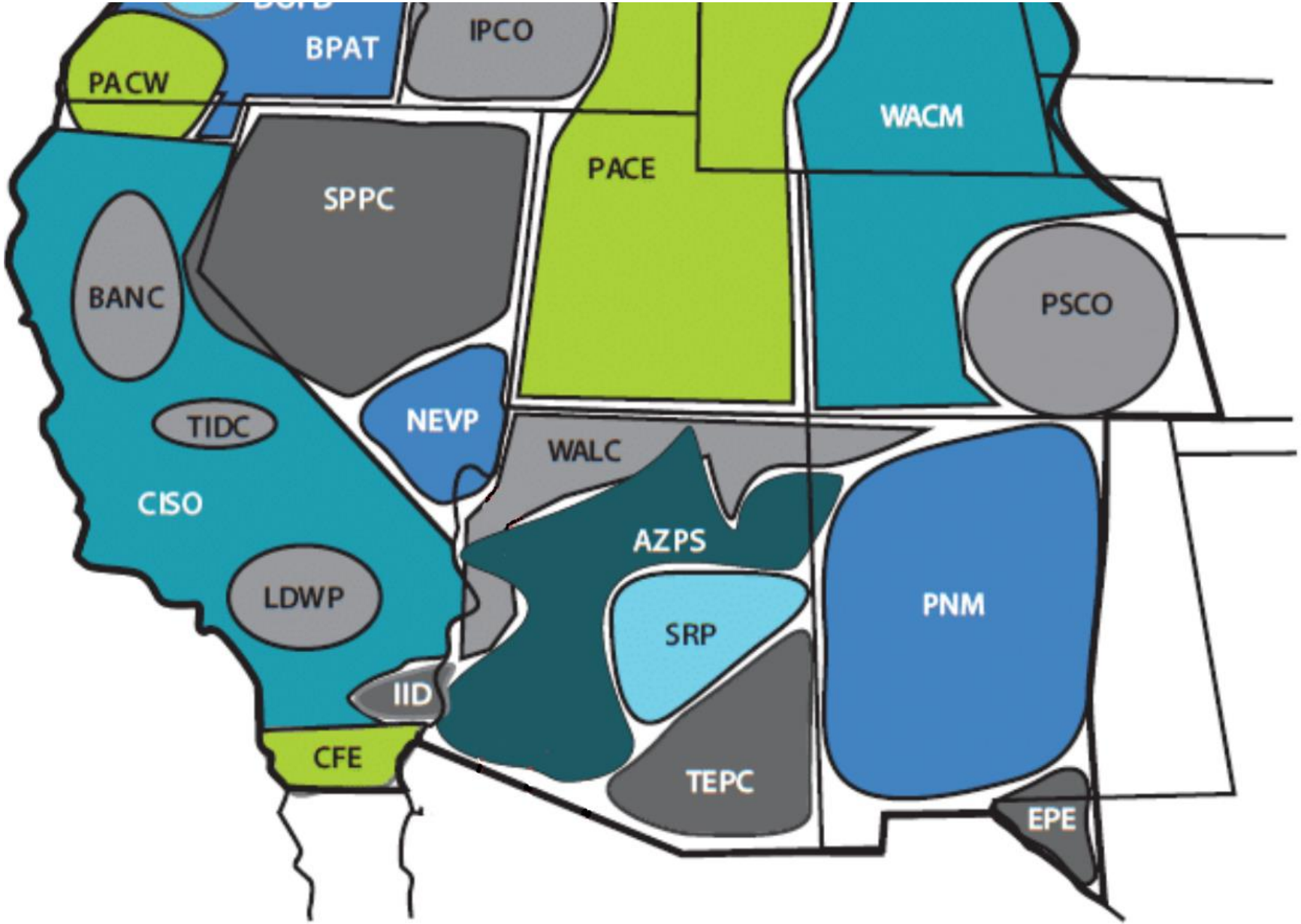
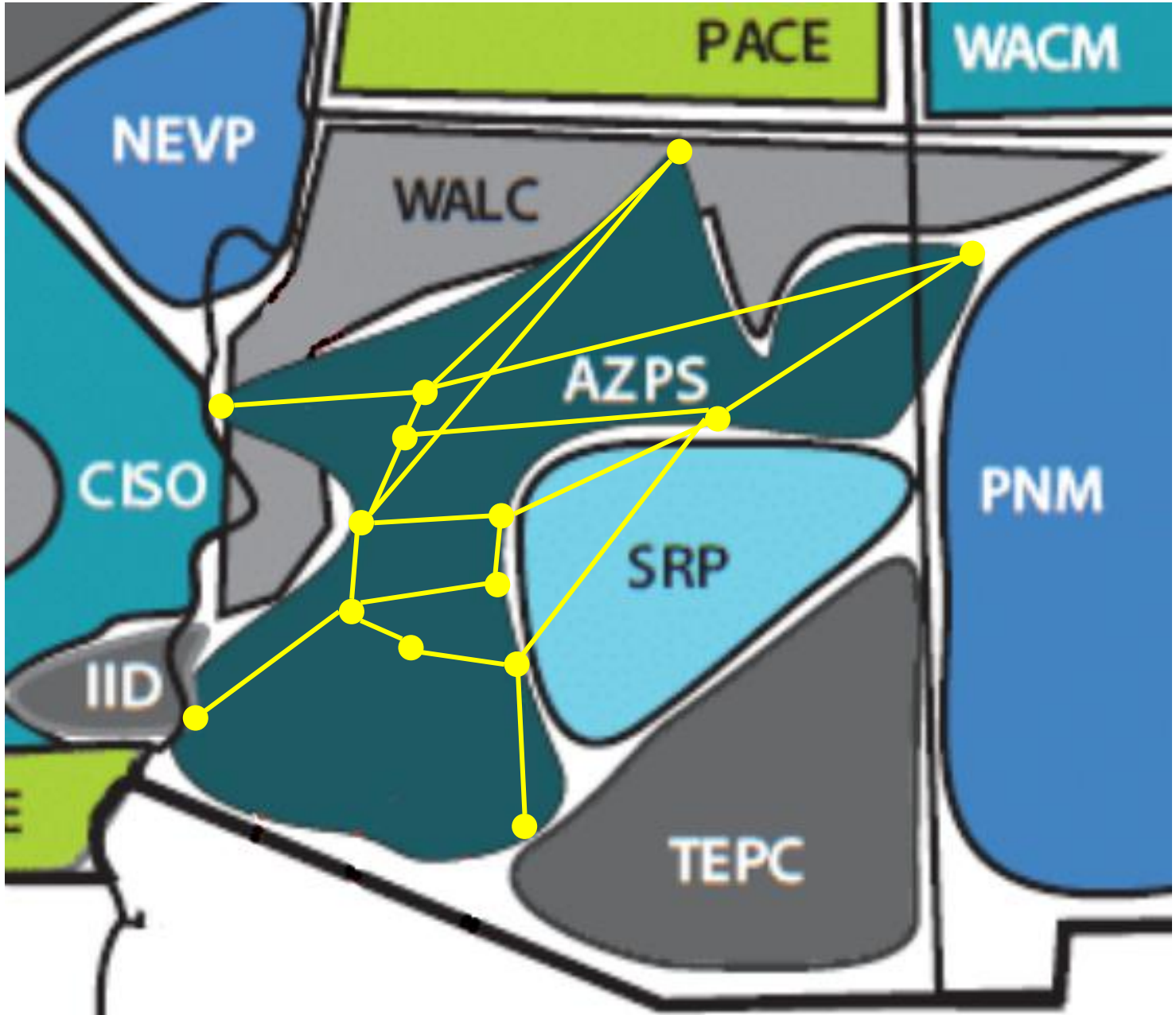
Flowgate Methodology

Doug Campbell

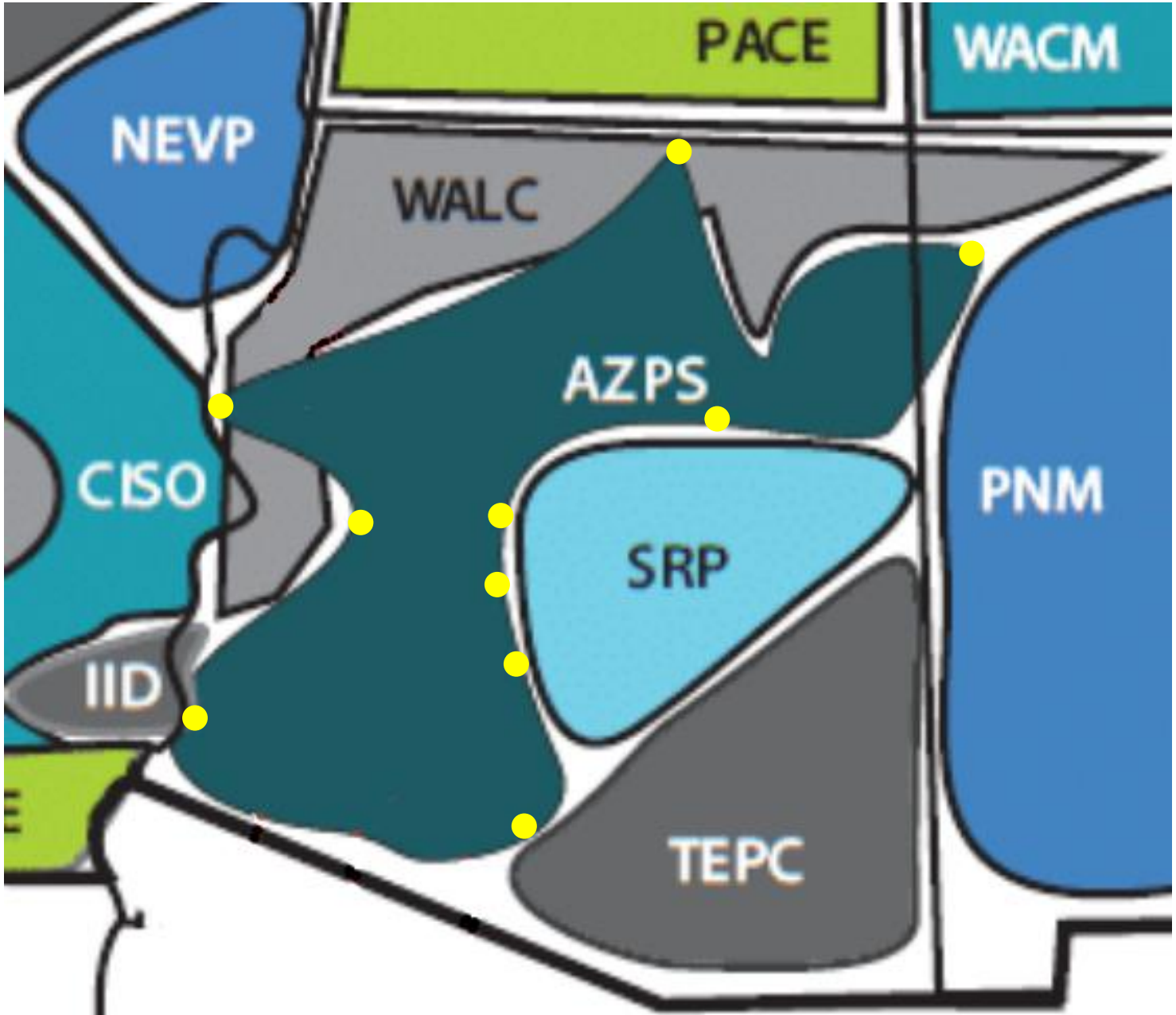


APS Under MOD 029



- ATC derived from a static TTC
- Only on path reservations are considered when determining ATC.

APS Under MOD 030



- ATC derived from the most limiting flowgate at any given time.
- The most limiting flowgate and its impact to ATC is dynamic.
- Unlike MOD 029, On system and off system reservation impacts are considered in ATC calculations.

APS Congestion Management with Flowgate Current State

- AFC and Real Time Contingency Analysis
- Visibility of Limiting Flowgates and impacting reservations
  - On system
  - Off system
- Curtailment of Tags into and out of AZPS
  - Transactions out of major hubs (Palo Verde/Four Corners)
  - BA to BA transactions

APS Congestion Management with Flowgate
Future State

- Ability to curtail tags based on impact to flowgates experiencing real-time congestion.
  - Transactions on APS system
  - Transactions external to APS system
    - WebECC tool

APS Congestion Management with Flowgate
Pros and Cons

- Pros
  - ATC derived from how power actually flows
  - More accurate ATC compared to MOD 029
  - Better visibility of most impactful reservations causing congestion.
- Cons
  - Significant Tag curtailment may be needed compared to other methods.
  - APS has no “qualified” paths, so no external tag curtailment available.

Q&A

"WECC and industry can collaborate to create guidelines and share best practices."