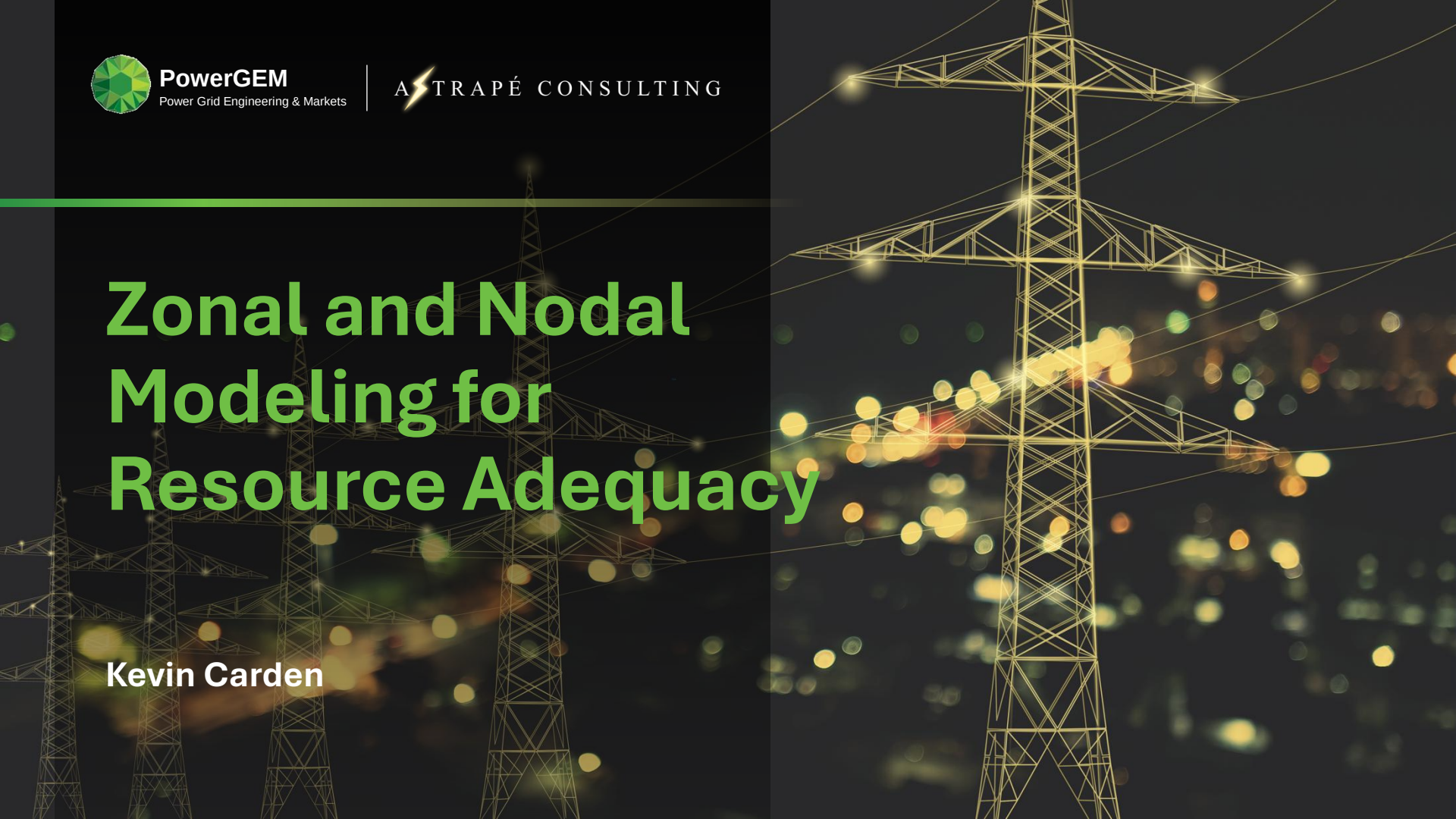


PowerGEM
Power Grid Engineering & Markets

ASTRAPÉ CONSULTING

Zonal and Nodal Modeling for Resource Adequacy

Kevin Carden

Agenda

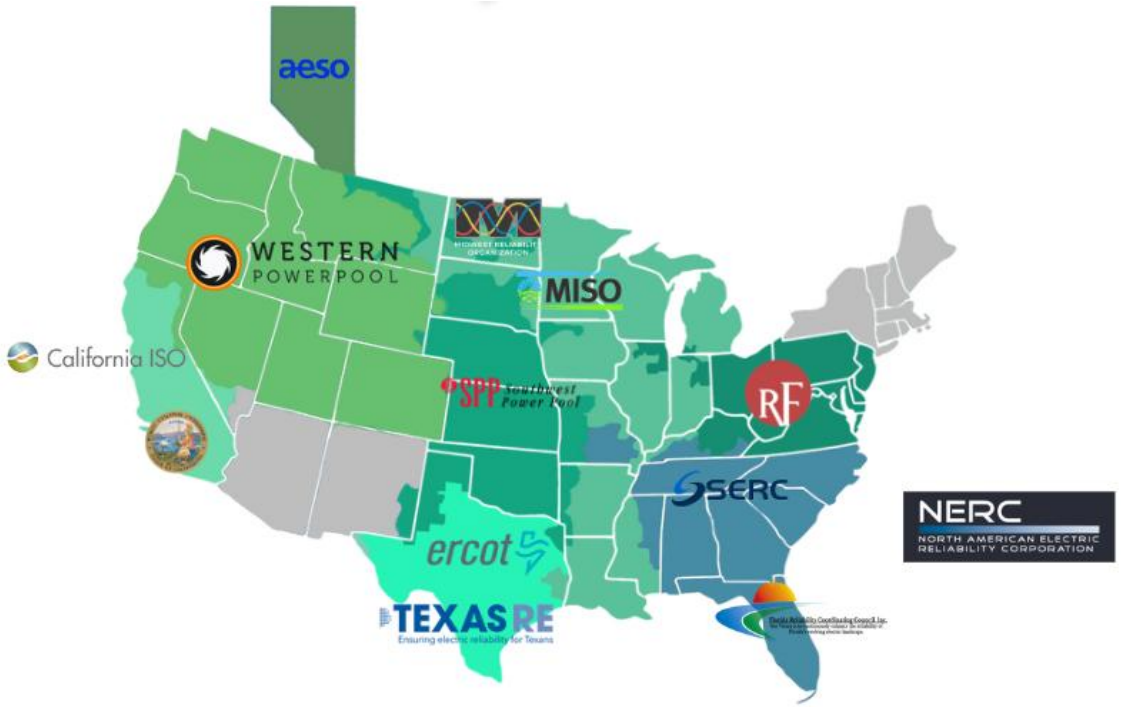
- Model Intro
- Nodal (TARA) → Zonal (SERVM)
  - Transfer limit analysis
  - Use of clustering functionality in TARA to define zones
- Zonal (SERVM) → TARA (TARA/PROBE)
  - Heuristic to identify hourly snapshots
  - Contingency sampling
- Composite reliability metrics

SERVM (Strategic Energy Risk Valuation Model)

- Powerful and Fast Production Cost Modeling and Reliability Tool
- Hourly Chronological and Intra-Hourly Time Scales
- Zonal Model
- Allows for thousands of scenarios
  - Weather Uncertainty
  - Load Uncertainty
  - Resource Performance Uncertainty

SERVM Footprint

Used by utilities, RTOs/ISOs, developers, consultants, and regional reliability organizations



SERVM Case Study: North Plains Connector

- SERVM used to analyze the reliability value of 1500MW transmission line to multiple regions

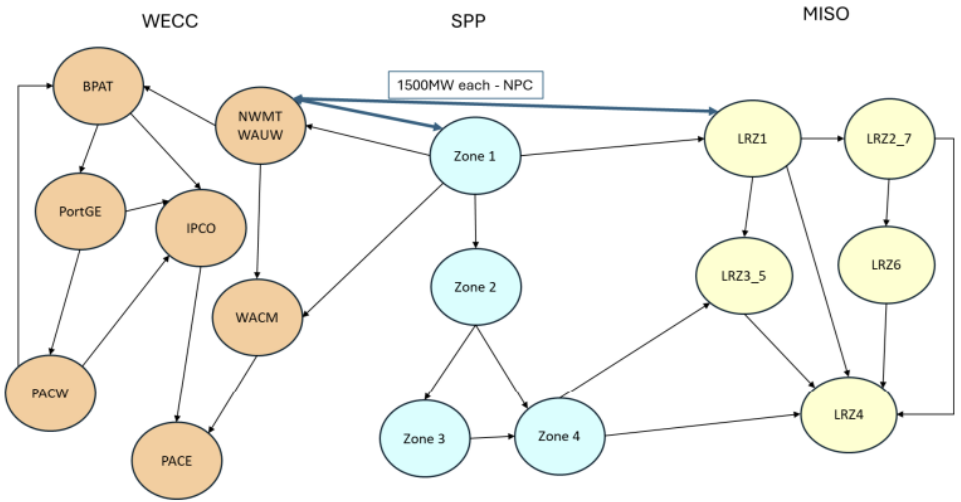


Figure 3. Topology of the Interconnected System Including NPC

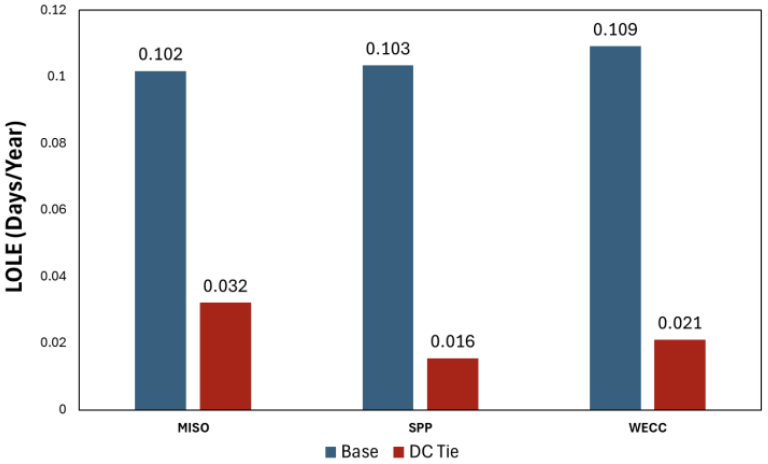


Figure 15. NPC Regional LOLE Impact

*https://www.gridunited.com/wp-content/uploads/2024/06/North-Plains-Connector-Evaluation_Final-Report_Astrape-Reviewed_FINAL.pdf

Clustering Functionality in TARA

- Clustering has many meanings - **do not get confused!**
- With FERC order 2023 "**cluster**" became one of the most popular engineering words in the industry
  - Mentioned 1,000+ times in the order

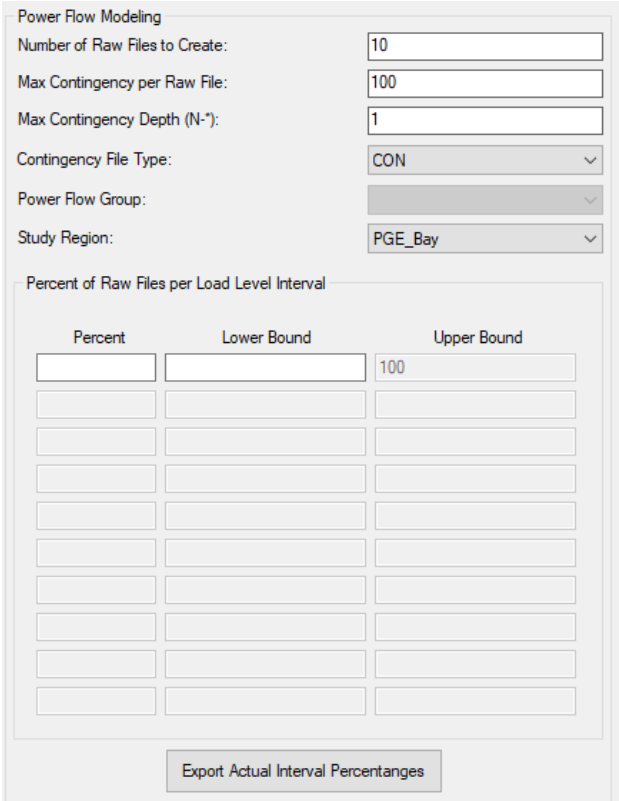
1. FERC 2023 requires running interconnection **clustered** studies by analyzing groups (clusters) of units in the same queue
2. TARA Worst **Cluster** TrLim (new in 2023) dynamically groups harmer units in a **cluster** with similar impact on a selected constraint
   - Basis for HeatMap and firm generation deliverability (PJM, MISO, CAISO)
3. TARA **clustering** (developed 15+ years ago) groups buses/generators in a clusters with the similar impact on multiple constraints
   - **Topic of this discussion**
   - TARA clustering was used to redefine MISO reserve zones … many years back.

TARA→ SERVM Target Outcomes

- Better Representation of Zones by Electrical Proximity
  - Clustering functionality
- Better Representation of Zonal Constraints
  - Consideration of load level/dispatch patterns
- Ability to recreate zone for new constraint appears
- Yields Better Zonal ELCC and PRMs

SERVM→TARA

- Heuristic to Identify Hourly Snapshots
  - Sample based on:
    - Load
    - Modified Load
    - Net Load
    - Renewable Output
    - Unit Category Output
    - State of Charge
    - Forced Outages
    - Remaining Reserves
    - Imports
    - EUE



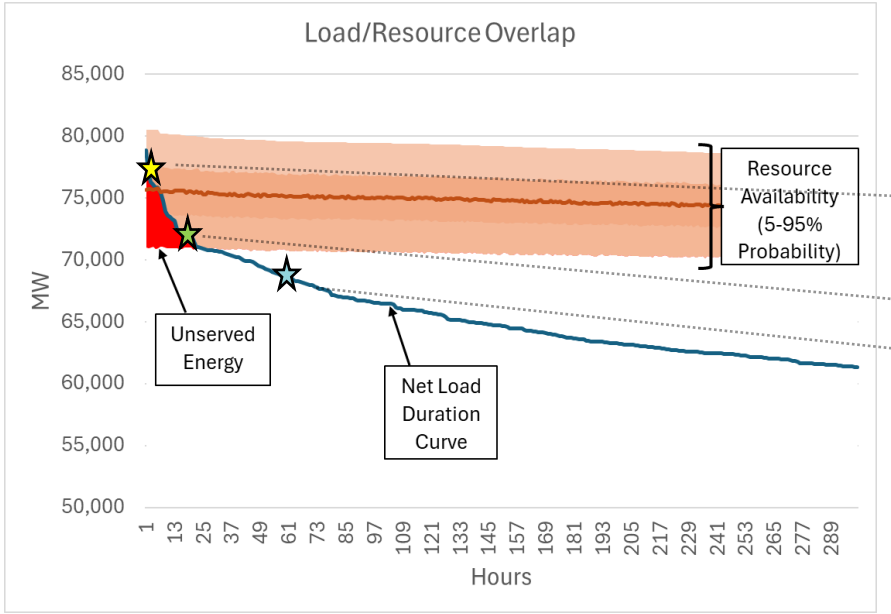
SERVM→TARA

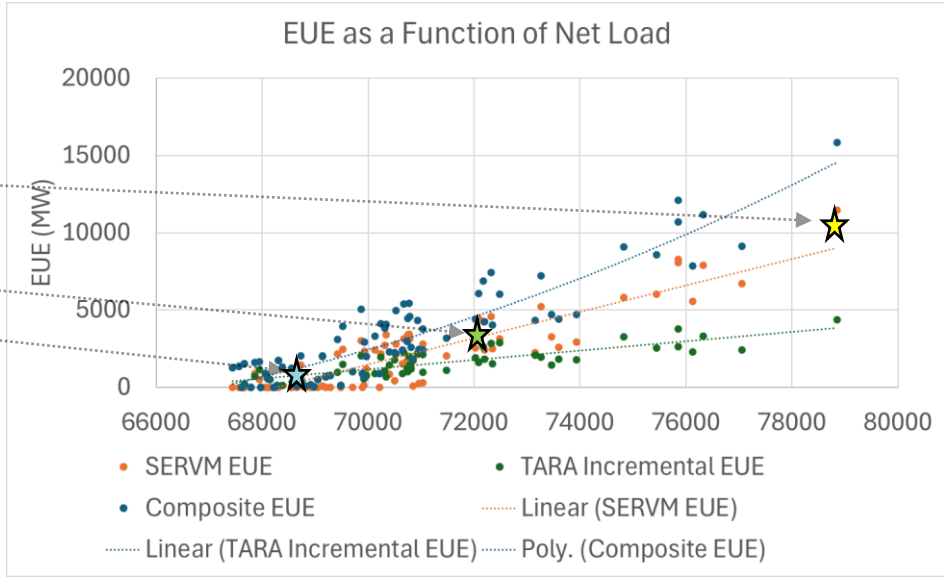
- SERVM generates INCH file
  - Zonal load
    - TARA will adjust bus level loads to match SERVM zonal loads
  - Bus-level renewable generation
  - Set availability of energy-limited resources according to modeled state of charge in SERVM
- SERVM generates CON file
  - User determines number of iterations

```
Contingency 1 / Total Units Out: 2 Total Components Out: 2
DISCONNECT BRANCH FROM BUS 2775 TO BUS 6911 CKT 1
DISCONNECT BRANCH FROM BUS 2944 TO BUS 2945 CKT 1
REMOVE UNIT N4 FROM BUS 150084
REMOVE UNIT C5 FROM BUS 150205
END
Contingency 2 / Total Units Out: 5 Total Components Out: 0
REMOVE UNIT N3 FROM BUS 150083
REMOVE UNIT C4 FROM BUS 150204
REMOVE UNIT N2 FROM BUS 150712
REMOVE UNIT N2 FROM BUS 150722
REMOVE UNIT C1 FROM BUS 150904
END
```

Composite Reliability Metrics

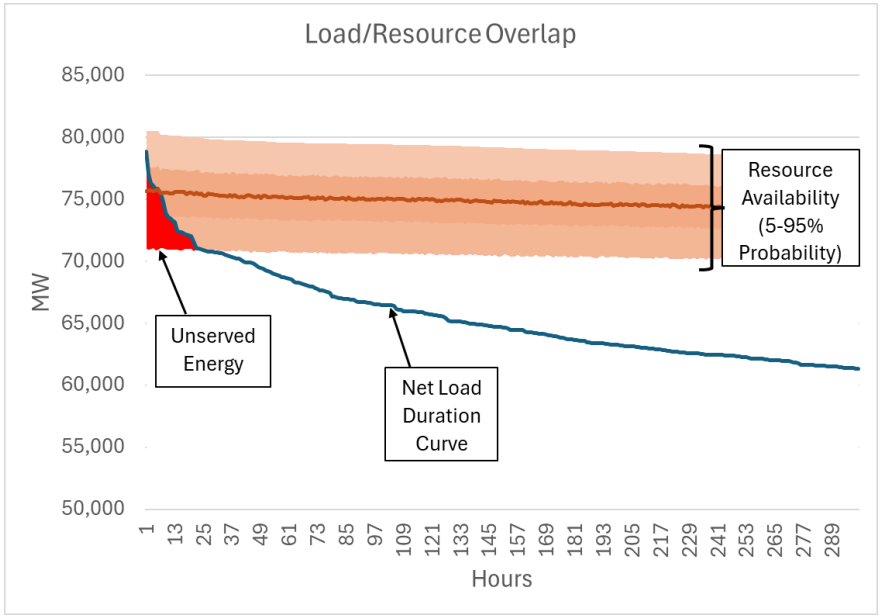
- Select adequate number of snapshots to produce convergent composite reliability metrics



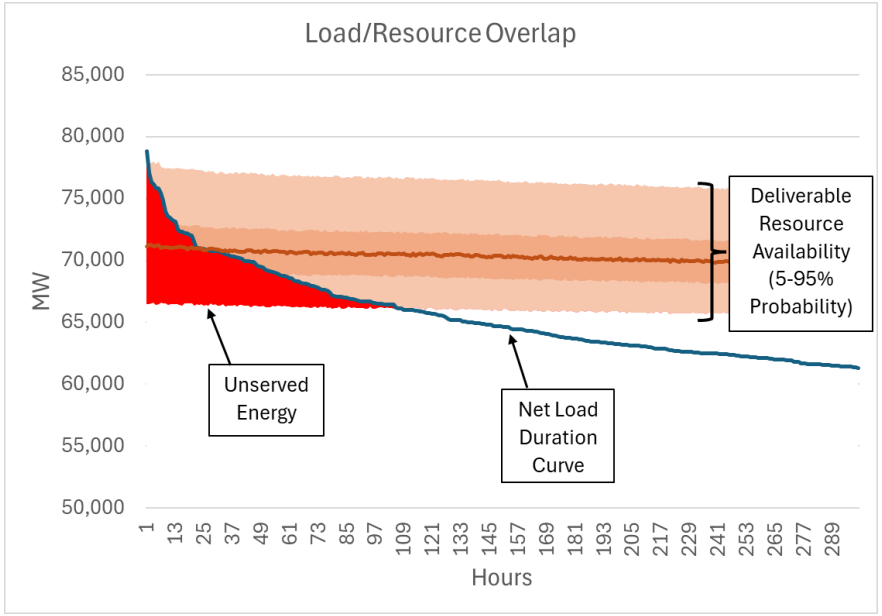


Composite Reliability Metrics

SERVM Standalone



SERVM/TARA Composite



SERVM→TARA

- Solve for 0.1 LOLE while respecting all nodal constraints
- Convergent reliability metrics generally require 50,000 or more 8760 simulations
  - Zonal/Nodal linked models provides the ability to determine convergent reliability metrics that respect all constraints