

# Correlated Outage Impact on Resource Reliability Contribution

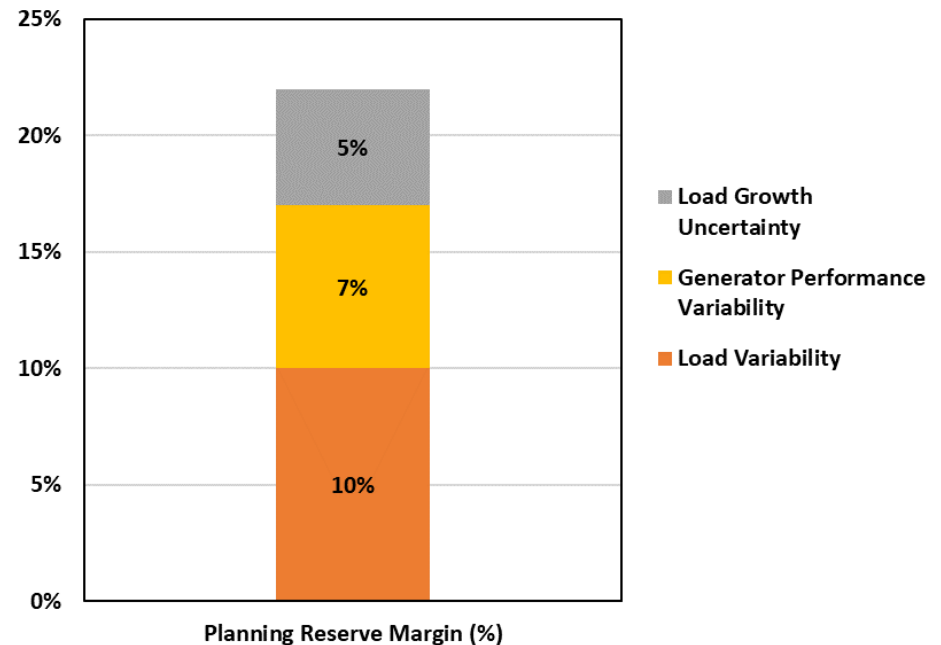
## Key Work Activity #2

Kevin Carden  
Astrapé Consulting LLC  
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# Resource Accreditation

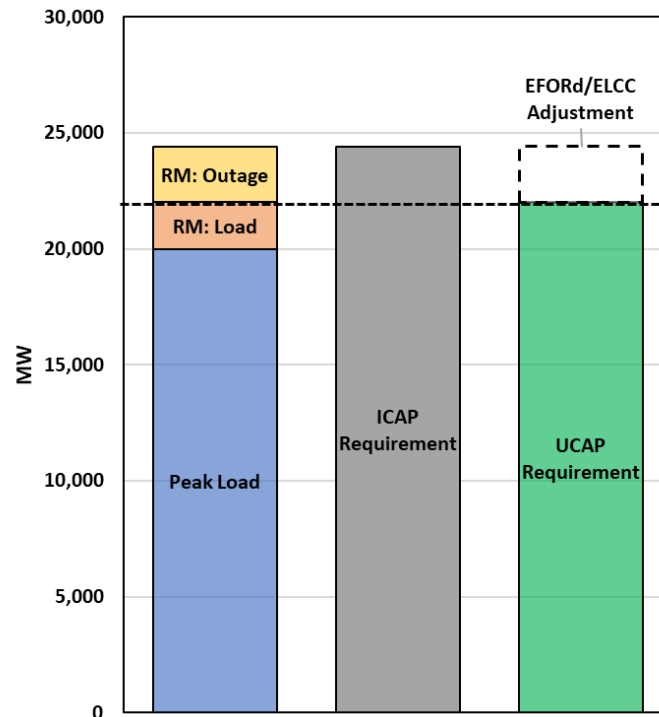
- **Planning Reserve Margin (PRM) to maintain 0.1 LOLE based on three main uncertainty factors**
  - Load variability (weather/customer usage patterns)
  - Load growth uncertainty
  - Generator outage variability
- **Disconnect: Generator performance variability included in PRM while renewable variability addressed via ELCC analysis**

**ICAP Planning Reserve Margin Components (Illustrative)**



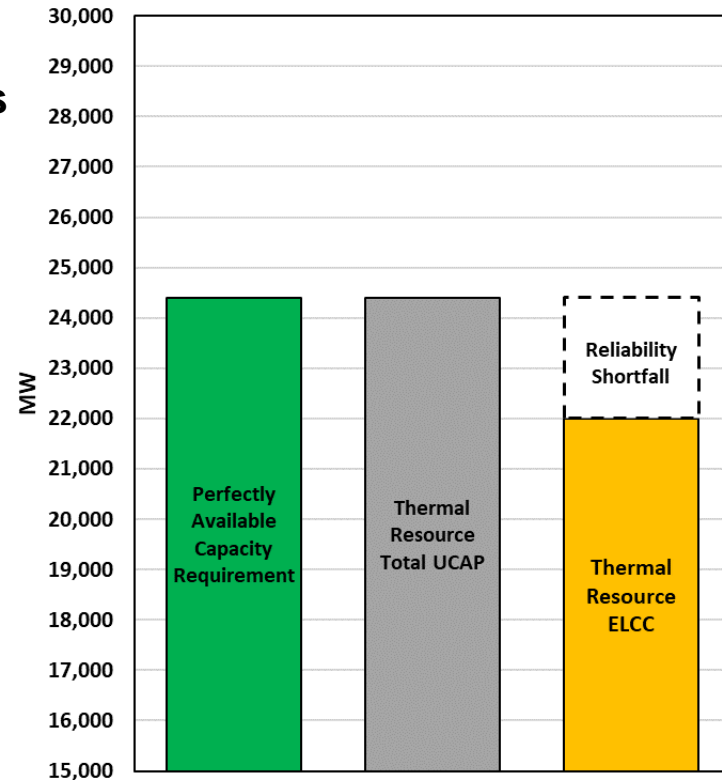
# Resource Accreditation

- Under a UCAP accreditation market, resource accreditation is converted to a perfectly available capacity equivalent value
  - Thermal resources:  $UCAP = ICAP * (1 - EFORd)$
  - Renewable/energy limited resources: Effective Load Carrying Capability (ELCC)
- In theory, when normalizing for perfectly available capacity, only load uncertainty drives the UCAP RM



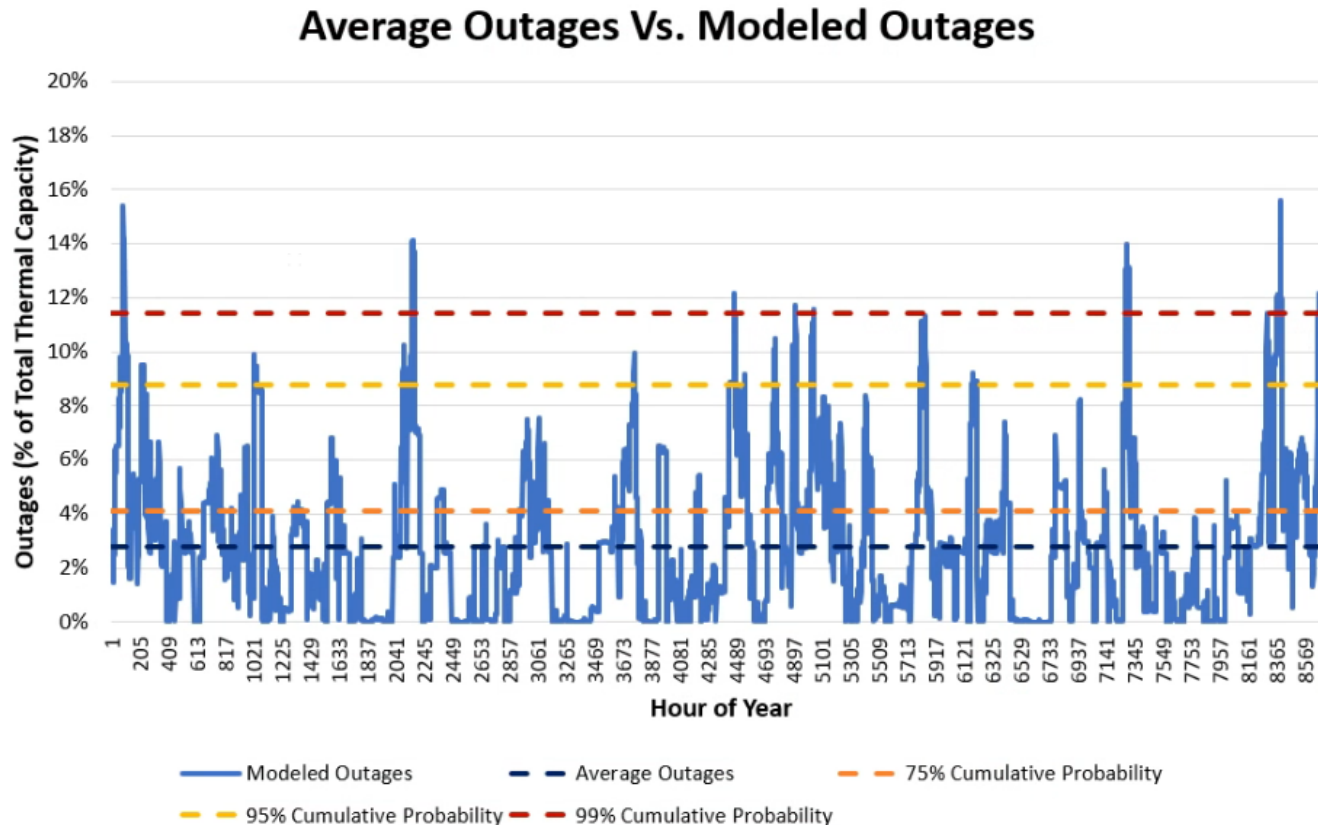
# Resource Accreditation

- However, UCAP accreditation may not be a good proxy for perfectly available capacity when accounting for fleet wide phenomenon of thermal resources
- Sum of all individual thermal resource UCAP values may be greater than the actual fleet wide contribution towards reliability (i.e., the thermal resource ELCC)
  - May or may not affect PRM
- Key fleet wide correlated outage categories include:
  - Outage asymmetry
  - Common mode failures
  - Weather dependent outages
  - Fuel availability outages



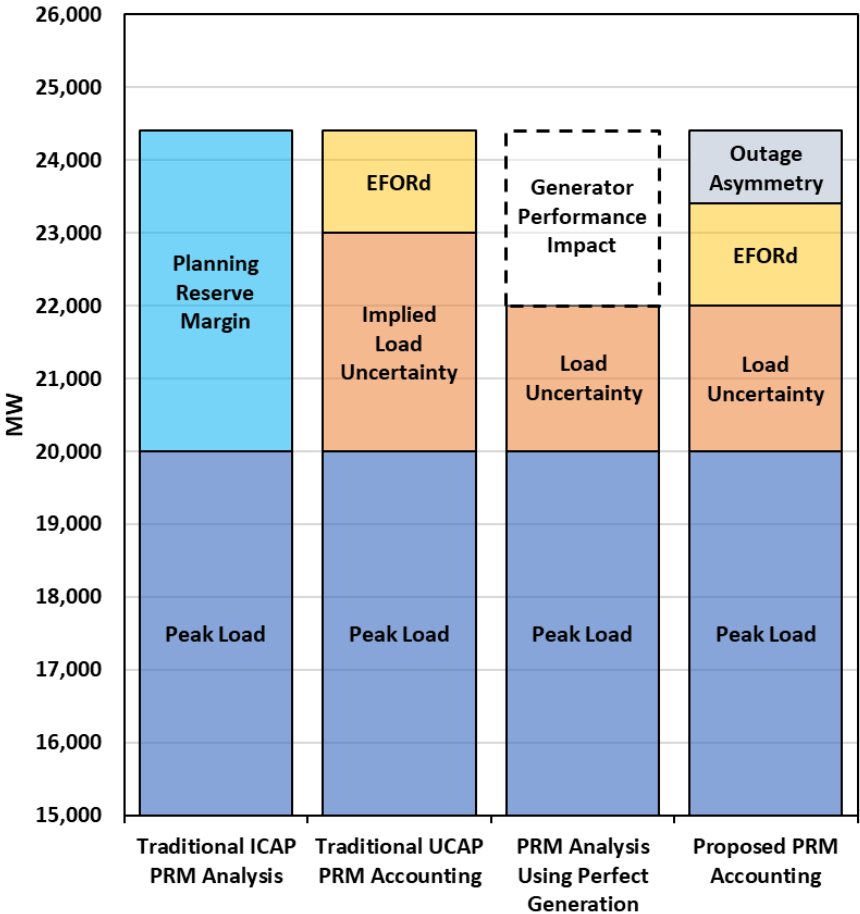
# Correlated Outage Impact #1: Outage Asymmetry

- **What level of reserves are needed to cover the impact of outages?**
  - UCAP accounting using EFORd presumes only average outages need to be addressed.



# Correlated Outage Impact #1: Outage Asymmetry

- Asymmetry is generally hidden in the PRM assessment.
- This issue would not be expected to affect PRM, only resource accreditation

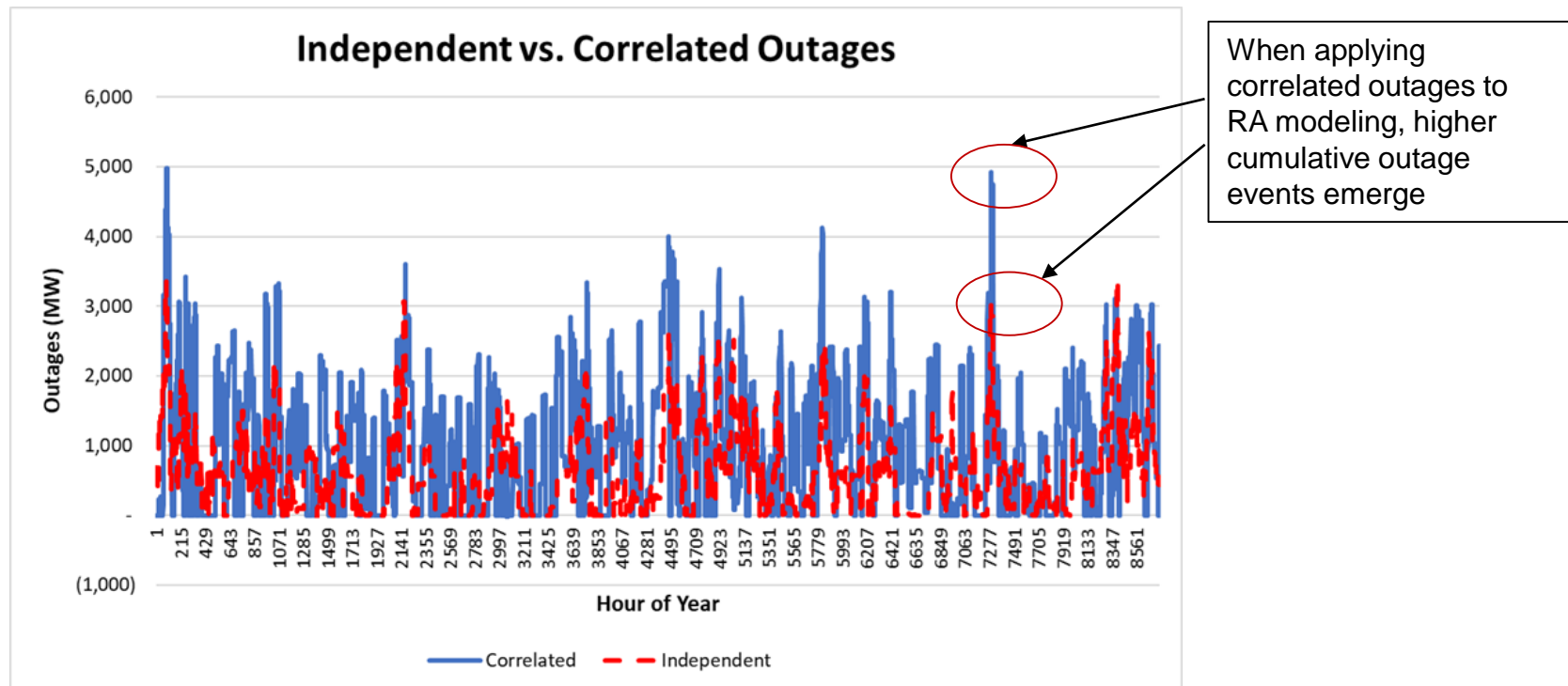


# Proposed Solution for Outage Asymmetry

- **Accreditation of conventional resources could be adjusted to properly reflect their contribution to reliability**
  - E.g. Conventional Generator ELCC =  $(1 - EFORd - ADJ_{Asym})$
- **Preliminary analysis suggests  $ADJ_{Asym}$  could be 2-5%.**
- **Similar adjustments proposed for other correlated outage effects.**

# Correlated Outage Impact #2: Common Mode Failure

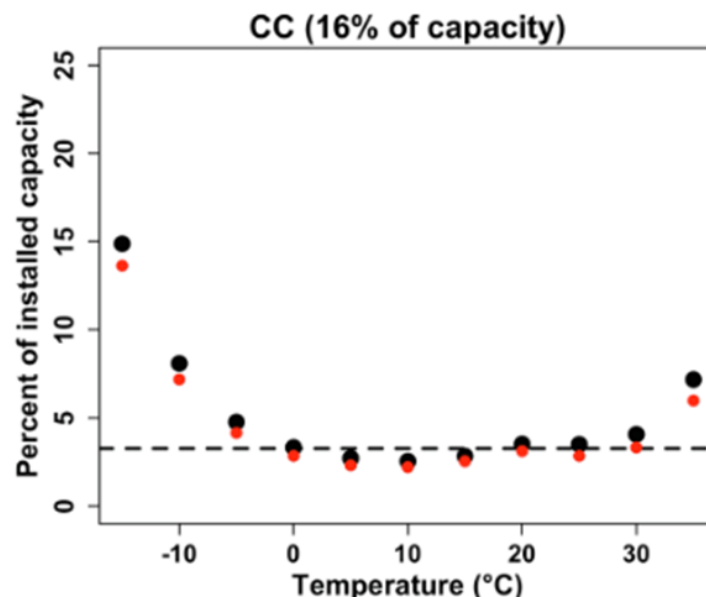
- Most resource adequacy modeling randomly assigns availability status for each resource independently
- In reality, outages can be correlated between resources due to common mode failures (e.g. shared step up transformers)





# Correlated Outage Impact #3: Weather Dependent Outages

- **Additional correlated outage impacts observed in historical data based on weather impacts**
  - Cold weather events: frozen lines, frozen valves, critical sensor failures
  - Hot weather events: extended run times, heat stress on components
- **Example of historical PJM generator performance**
  - Combined cycle outage rate as a function of median (black series) and 90% temperature observation (red series)
  - At  $-10^{\circ}\text{C}$ , CCs experienced ~4% higher forced outage rate than at  $0^{\circ}\text{C}$



Source: Murphy, Sinnott, et. al. "A time-dependent model of generator failures and recoveries captures correlated events and quantifies temperature dependence."

# Correlated Outage Impact #4: Fuel Availability Outages

- **Natural gas supply constraints known to occur during cold weather**
- **As much as 10% of natural gas supply can become unavailable at temperatures of 0F (based on review of ERCOT 2021 event, 2014 Polar Vortex, 2011 FERC report on cold weather outages)**
- **Leads to an increase in cumulative outages for specific resource classes such as CTs and CCGTs**

# Modeling Results (Winter)

- **Impact of incremental outages quantified as percentage adjustment factors (ADJ) to approximate the thermal resource ELCC value**
  - $ELCC_{Thermal\ Resource} = (1 - EFORd - ADJ)$

Correlated Outage Category	Adjustment Factor (%)
Outage Asymmetry	2-5%
Common Mode Failure Outages	2-3%
Weather Dependent Outages	8-10%
Fuel Availability Outages	6-10%

# Recommendations

- **Review historical data related to correlated outages within the PJM region**
- **Explore modeling practices to account for correlated outages**
  - Requires definition of resource classes for thermal resources, analogous to renewable/storage ELCC calculations
  - Individual resource accreditation adjustments should be considered to appropriately distribute weather/fuel outage impacts in proportion to a unit's impact on the overall resource class ELCC

# Questions?

**Kevin Carden**

**[kcarden@astrape.com](mailto:kcarden@astrape.com)**