Probabilistic Resource Adequacy Assessment: Extreme Weather Implications

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What is Resource Adequacy (RA)?

“A condition in which … in aggregate, utilities or other load serving entities (LSE) have acquired sufficient resources to satisfy forecasted future loads reliably.”

– Northwest Power and Conservation Council

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"reliable": defined in terms of some adequacy or risk metric (e.g. planning reserve margin, LOLE)

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- attempt to study a comprehensive (or at least representative) set of possible system operating conditions, and quantify the likelihood of those conditions occurring
- yield descriptive statistics for the distribution of possible outcomes (e.g. LOLE, EUE)
- aren't usually intended to study system adequacy under a predetermined scenario or event ("conditional" resource adequacy), although the same modeling tools can often be used for that purpose

Elements of Probabilistic RA

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Typical probabilistic RA analysis

Traditional generator outages are easy to model probabilistically

> Been doing this for 60+ years now

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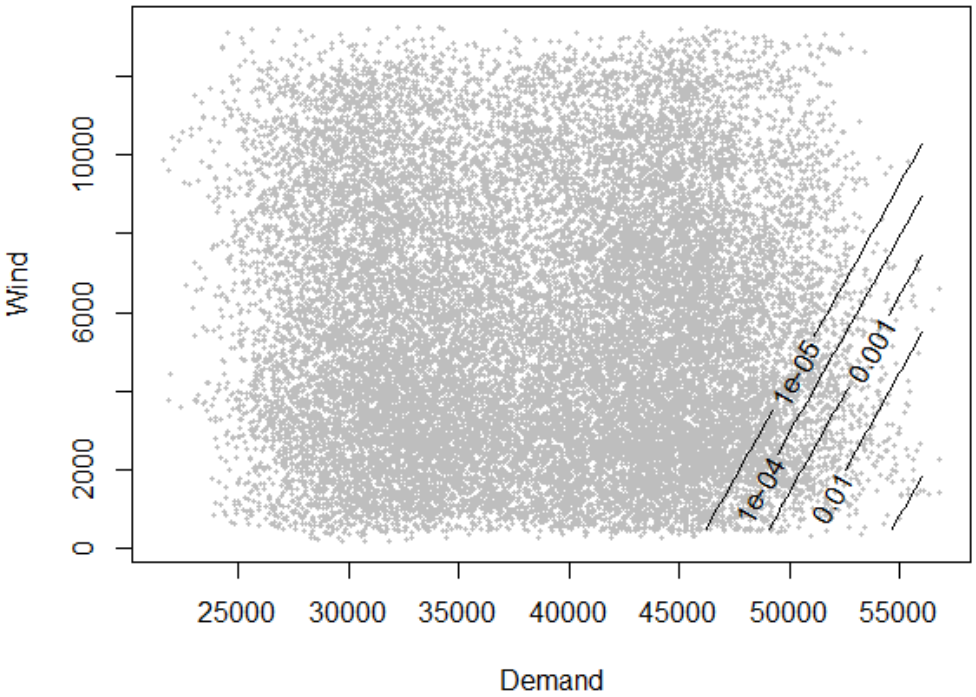
Load and variable resources are hard to model probabilistically

> Need serially-correlated, hourly probabilistic forecasts, years or decades in advance (!)
> Typical approach: assume future resembles historical load + weather
  - Pros: simple, transparent
  - Cons: limited data available (especially for risky periods of interest)

Typical probabilistic RA analysis



Wilson and Zachary, "Using extreme value theory for the estimation of risk metrics for capacity adequacy assessment", 2019. https://arxiv.org/abs/1907.13050

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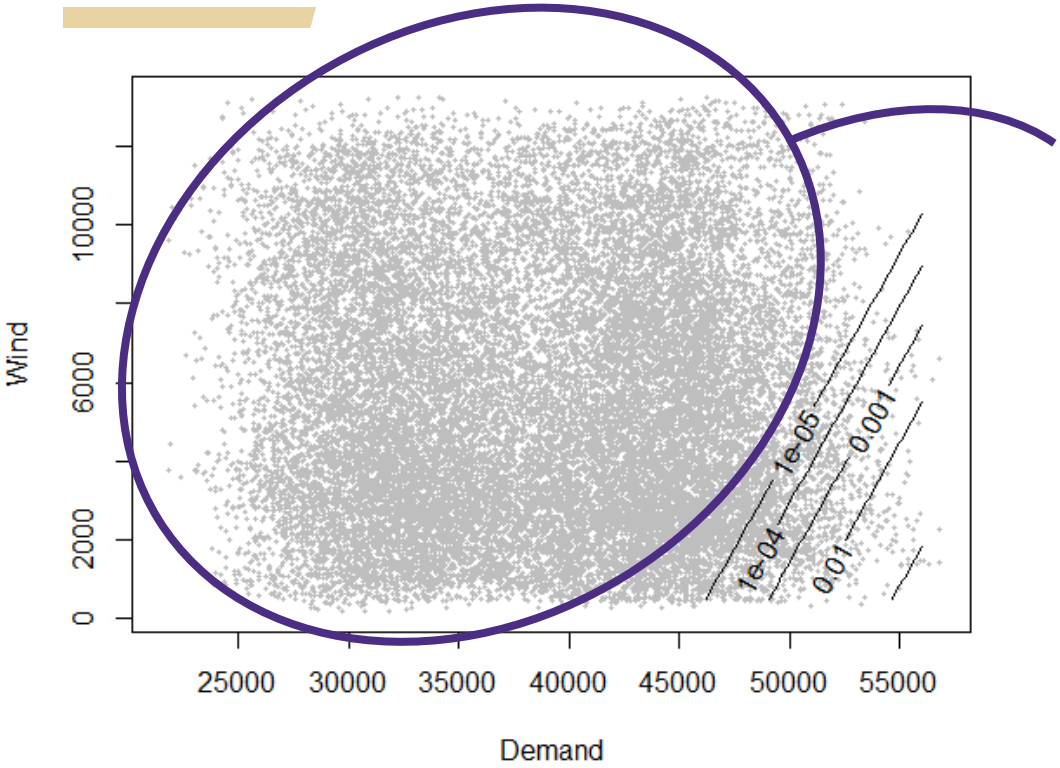

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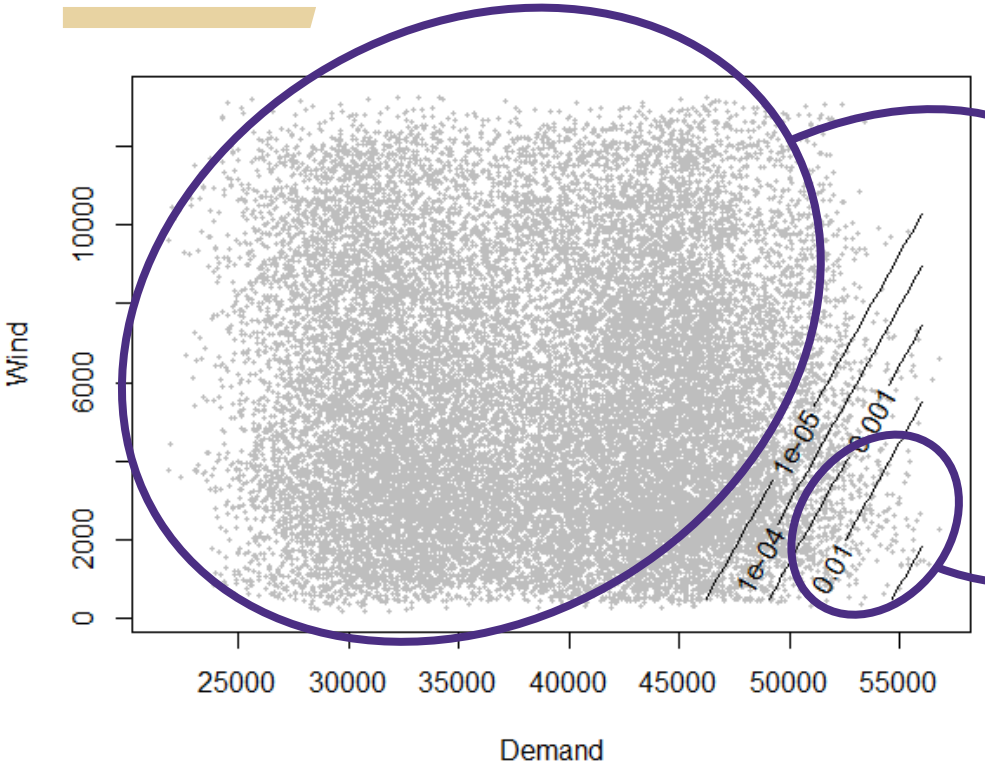

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"Extreme event" data limited by definition: any resulting model will be noisy / results may be driven by outliers

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Potential solutions

Just use more historical data

- Useful for capturing interannual variability
- Difficult to normalize for load growth / shifts in underlying consumption patterns

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Fit a statistical time series model

> Can draw unlimited samples!
> Lots of new and likely-subjective assumptions involved
> Model is still only as good as the (limited) training data

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Extrapolate tail events via Extreme Value Theory

- Same shortcomings as any other statistical model
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Communicate uncertainty arising from data limitations

> If there's no easy fix, at least be transparent about the problem
> Statistical bootstrap methods can help quantify potential impact of limited event data

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Risk Metrics

Popular RA risk metrics are based on expected outcomes

- LOLE: Average total count of periods with dropped load
- EUE: Average unserved energy
- Extreme events considered, but impacts are attenuated due to lower likelihood of occurrence

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Do we only care about "average" outcomes?

- "How bad could it get" seems like a reasonable question to ask
- Should we also be using tail metrics such as CVaR (expected value in worst x% of outcomes)?

Conclusion

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- We need to improve extreme event characterization in RA models
- We need to quantify the potential impacts of our data limitations
- We should consider RA metrics that communicate the possibility of extreme events

Stay in touch!

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