**Objectives**
- Quantify resilience to cascading failure
- Deliverable: Case studies of monitoring or mitigating cascading

**Importance**
- Keep the lights on as we transform the grid
- Any new technology that causes blackouts will be curtailed

**Uses**
- Monitoring & managing risk of cascading blackouts

**Monitor resilience from standard TADS utility data reported to NERC**
- Cascading = initial outages + propagation
- Estimate propagation $\lambda$ from $\sim$1 year of line outage times

**Monitor area stress by combining PMU measurements along border**
- New concept: angle across area

**Probability distribution of total number of line outages assuming 5 initial line outages**

**Probability distribution of total number of outages**

**An area $R$ in 225 bus WECC**

**Area angle**
- Base case $\hat{\theta}_{ab} = 10.9$ degree
- $b_{ab} = 91.6$ p.u.

**100 MW transfer inside area gives +0.25 degree**

**100 MW transfer through area gives +0.60 degree**

**100 MW transfer line trip inside area gives +2.51 degree**

**100 MW transfer line trip outside area gives +0.38 degree**

**Notes**
- Branching Process Calculation