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Sandia National Laboratories

Overall Capacity Assessment of Distribution Feeders with Different Electric Vehicle Adoptions

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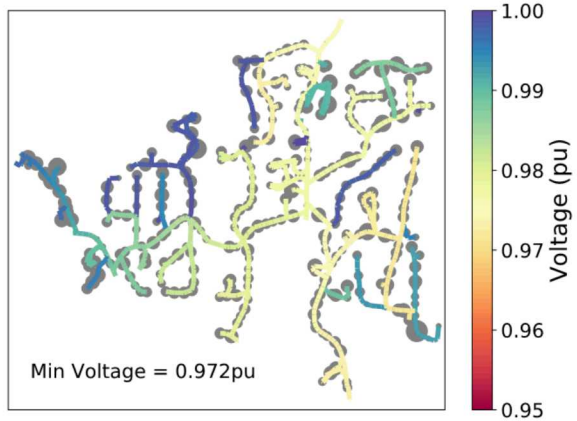
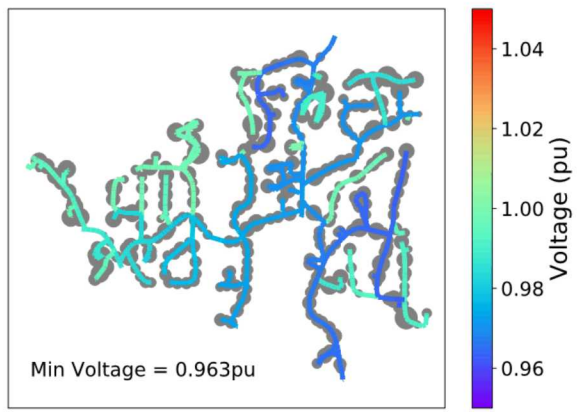
Background

- What?
  - Performed electric feeder stochastic hosting capacity analysis for different EV types.
  - Analyzed correlations between hosting capacity results and X/R ratios using Principal Component Analysis
- Why?
  - Identify Electric Vehicle (EV) charge penetration levels that create a voltage violation
  - Predict EV penetration capabilities using feeder X/R ratios only
- Hypothesis
  - Voltage capacity will increase when reactive power control is enabled.
  - Principal Component groups will correspond with the voltage response to increased EV penetrations.

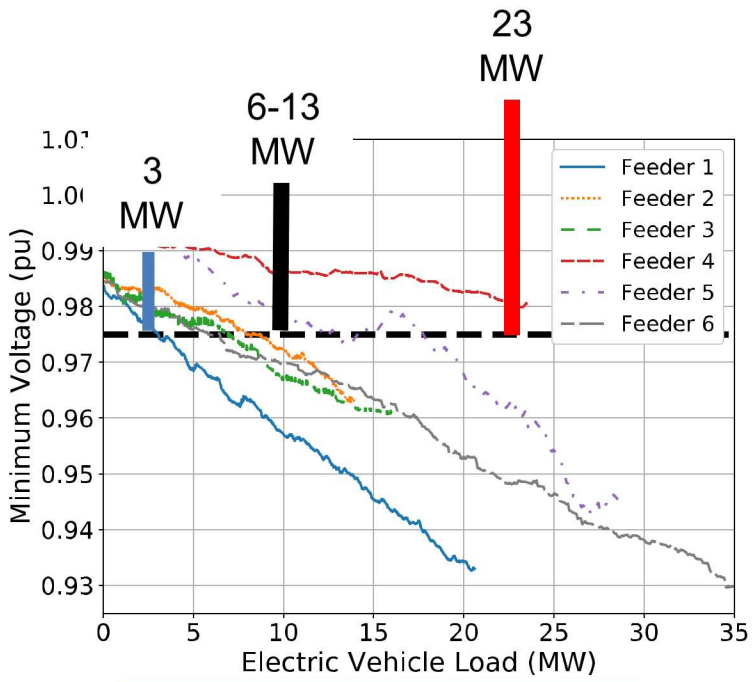
50% of Loads w/ EV



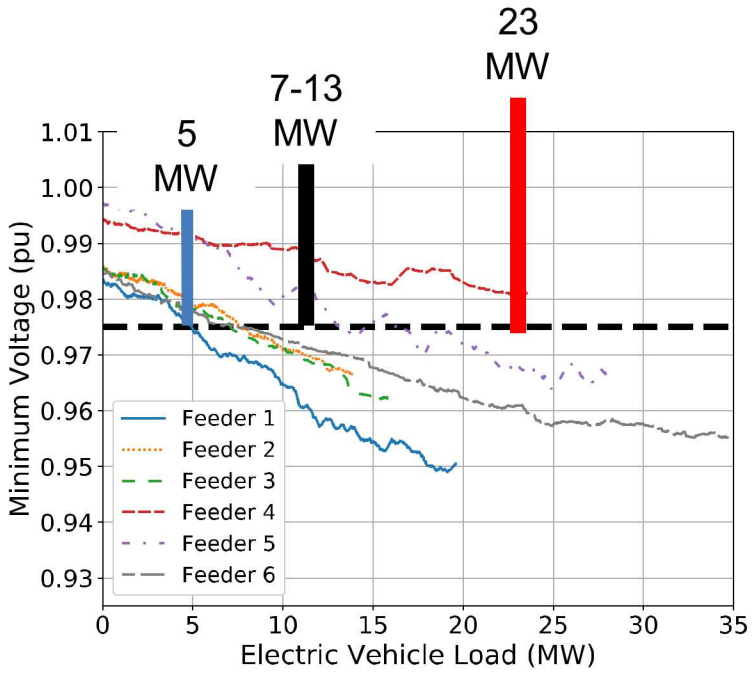
90% of Loads w/ EV



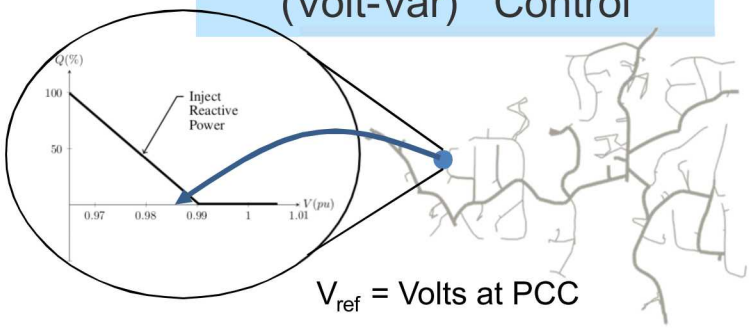
Results – Voltage Capacity Analysis



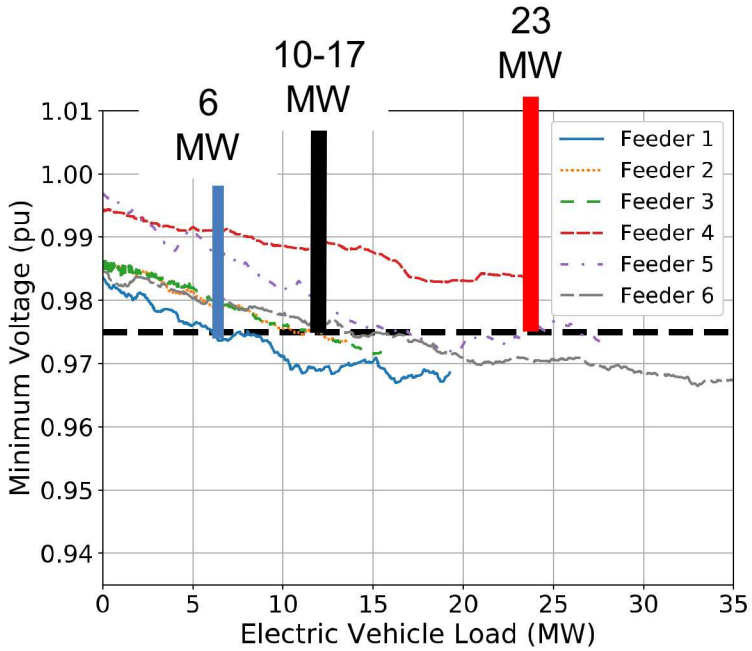
Uncontrolled



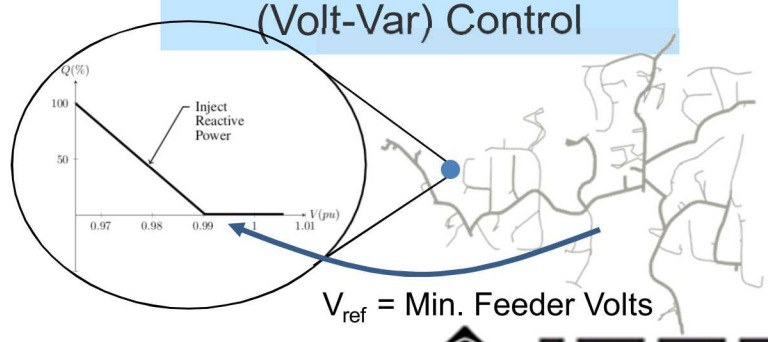
Local reactive power (Volt-Var) Control



V_{ref} = Volts at PCC



Global reactive power (Volt-Var) Control



V_{ref} = Min. Feeder Volts

Electric Vehicle Charger Equipment demanding only active power

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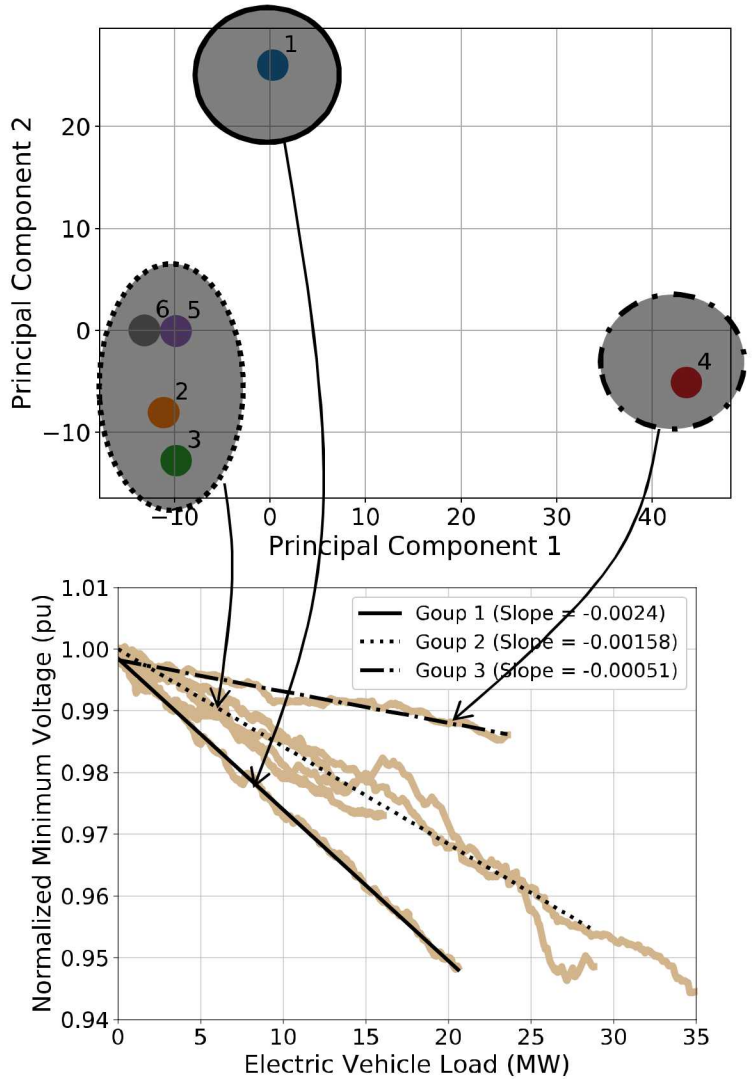
Results – Capacity Classification

- X/R Ratio
  - Relationship between reactance and resistance for each line
- Principle Component Analysis
  - Dimensionality reduction that maintains the X/R ratio data's integrity
- Uncontrolled Voltage Response
  - Minimum voltage at different EV charging levels



Conclusions/Recommendations

- Stochastic hosting capacity analysis identified the point at which a voltage violation occurs
- The analysis quantified the increase in capacity due to reactive power control
- Accurately classified six feeder's behaviors using X/R ratios
- Future Work:
  - Incorporate line loading into the analysis
  - Implement different control strategies
  - Evaluate integration of EV with PV support
  - Consider driving patterns of EVs
  - Use different EV integration types (home, work, or extreme fast charging dominate)