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Optimal Dispatch of Reactive Power for Voltage Regulation and Balancing in Unbalanced Distribution Systems

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Background

- OPF formulations for balanced systems utilize convex relaxations or approximations
- Many approaches based on DistFlow and LinDistFlow models in seminal work of Baran and Wu[1]
- Second order cone relaxations difficult to extend to 3 phase systems
- Semidefinite relaxations fail to converge in many situations
- Lack of suitable linearizations that relate voltages to complex power flows

[1] Mesut E Baran and Felix F Wu., "Optimal sizing of capacitors placed on a radial distribution system.", *IEEE Transactions on Power Delivery*, 4(1):735–743, 1989.

Results

- Developed a linearized model of unbalanced power flow that relates voltage magnitudes to complex power flows
- LinDist3Flow - This approximation can be viewed as an extension of the LinDistFlow model to 3 phase systems
- LinDist3Flow model allows problems to be addressed which hitherto could not be addressed with OPF techniques
- Here, we incorporate the LinDist3Flow model into an OPF that uses reactive power resources to balance voltage magnitude across phases and provide voltage support
- Simulations conducted on the IEEE 13 node feeder

Conclusions/Recommendations

- LinDist3Flow model is a good approximation for power flow equations in OPF formulations
- Allows formulation of OPF approaches to enable new types of functionality:
  - Voltage balancing (in this paper)
  - 3 Phase Voltage phasor reference tracking
  - Stochastic OPF formulations