

Utility Perspective

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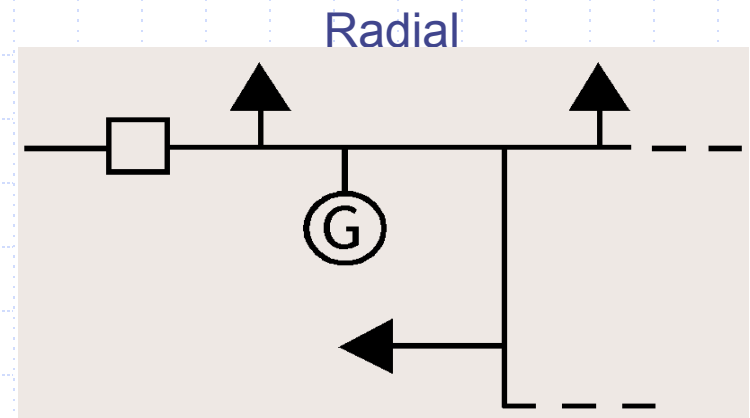
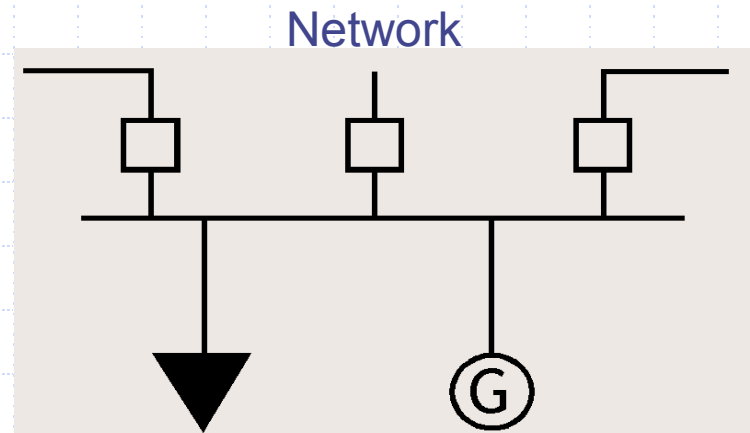
Southern California Edison

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Fundamentals

Network vs. Radial

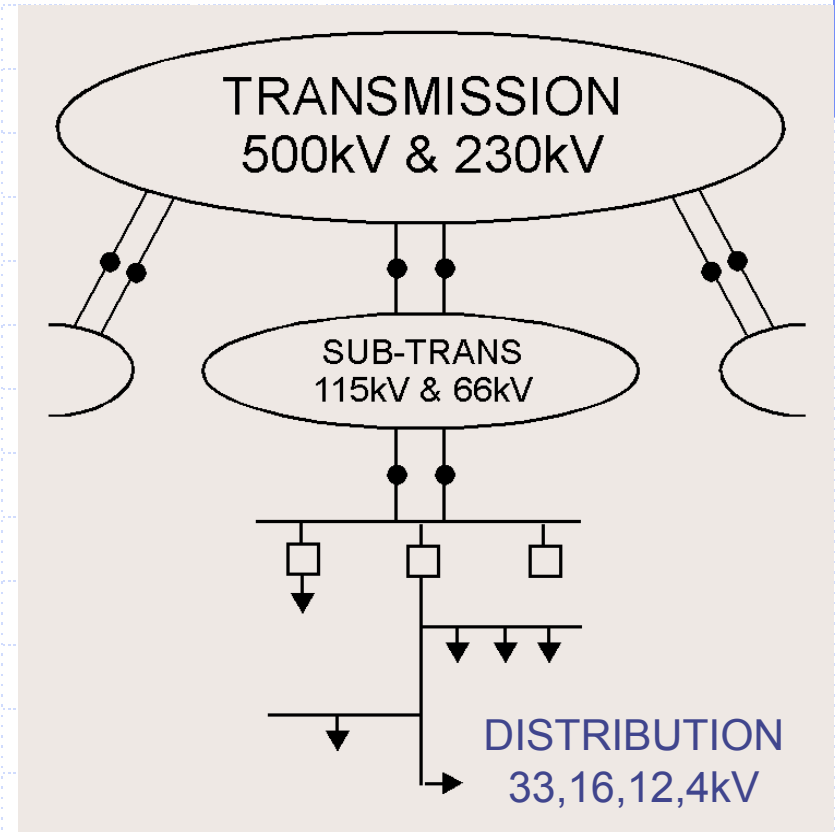
- Networks are designed for two way power flow
 - Directional trips
 - Hard to lose, hard to recover
- Radial systems are designed for one way power flow
 - Simple overcurrent trips
 - Easy to lose, easy to recover



Fundamentals

Our System Design

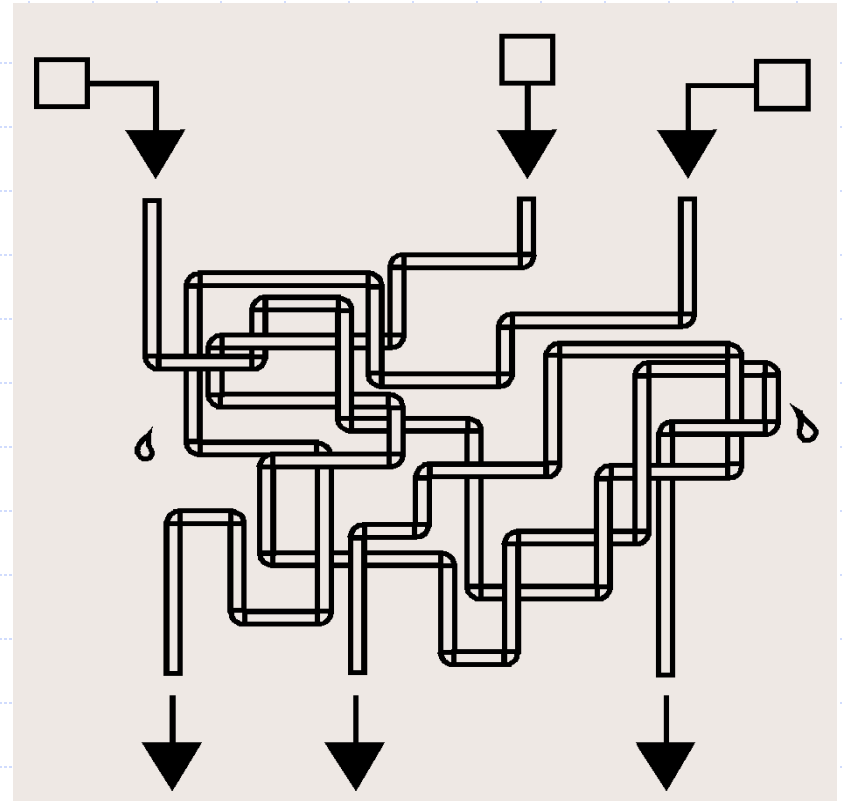
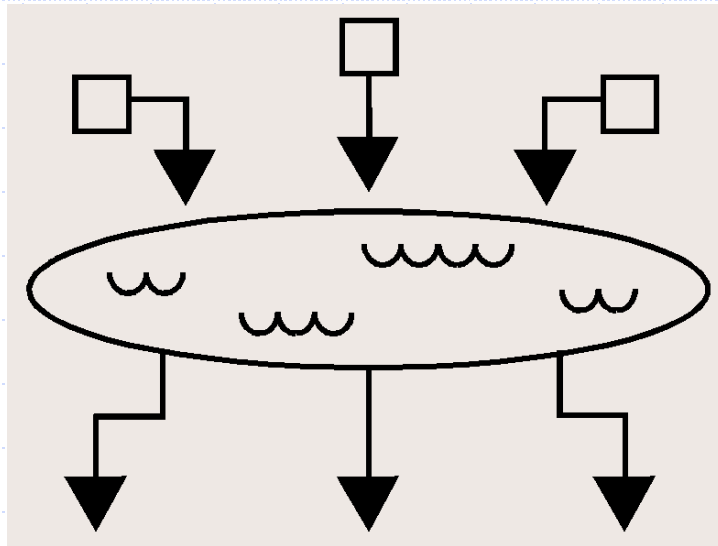
- Transmission and sub-transmission are typically networks
- Distribution systems are typically radial



Fundamentals

Lake Model vs. Network of Pipes

- Dream vs. reality

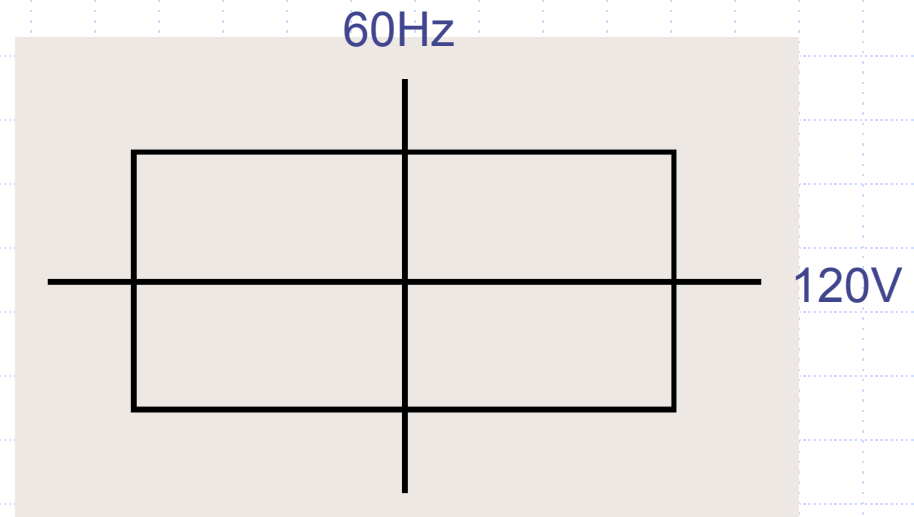


Issues Raised by DG

Safety and Reliability

- Backfeed
- Trips
 - Ground faults
 - Window trips
 - Transfer trips
- Anti-islanding
- Reclosing

Window Tripping



Issues Raised by DG

Other Issues

- Utility has obligation to serve
- Balancing generation and load
 - Time availability of sun, wind
 - Spinning reserve
- Local vs. global availability of DG resource
- Voltage control

Tehachapi Situation

Most Wind Generation is NOT Distributed!

- Existing transmission system cannot handle additional generation
- Low voltage experienced due to reactive power demand of wind turbines
- Existing models do not accurately represent the electrical system capability

Tehachapi Situation

Future Plans

- Collaborative process with wind developers and Edison to determine needs
- Developers want to install up to 2.5 GW of additional wind turbines in area
- Edison need to build adequate transmission facilities
- Determine system operations implications – spinning reserve

Tehachapi Situation

Claremont Graduate Univ. Study

- Done as part of graduate student project
- Use differential equations to model the behavior of the system
- Input wind speed variations
- Look for unstable situations
- Model is rough and needs some additional work to be useful

Tehachapi Situation

NREL/SCE Joint Study Project

- Investigate how to properly model the wind parks and turbines
 - Model system low voltage behavior
- Collect additional wind and system data to validate the models
- Apply model results to design of system for the proposed Tehachapi expansion and elsewhere

Tehachapi Situation

Other Cooperative Work?