Typical Distribution Systems

- Passive
  - System distributes power to loads
  - Unidirectional power flow
- Overcurrent relaying
  - Coordinated with fuses
- Voltage regulation fairly simple
  - Controlled at substation

Distributed Generation Protection

- What is DG (or DR)?
  - Synchronous generators
  - Induction generators
  - Power electronically coupled generators
  - Connected to distribution circuit
  - Typically less than 5MVA (some bigger approaching 10MVA)
  - Supply owners load, not rest of circuit
- Connection similar to a load
Impacts

- Addition voltage source not provided from substation
  - Fault current source
  - Backfeed to other circuits
  - Impact voltage regulation
- Restoration of feeder after outage
- Power quality

IEEE Standards

- IEEE 1547-2003: Standard for Interconnecting Distributed Resources with Electrical Systems
  - Amendment 1, 2014
- 1547.1: Conformance test procedures
- 1547.2: Application Guide for 1547
- 1547.3: Guide for monitoring, information exchange and control
IEEE Standards

- IEEE 1547.4: Guide for design, operation and integration of DR Island Systems
- IEEE 1547.6: Interconnecting Distributed Resources with Electric Power Systems Distribution Secondary Networks
- IEEE 1547.7: Conducting DR Impact Studies
- IEEE 1547.8 (draft): Supplemental support for implementation strategies for expanded use of IEEE 1547

Protection Considerations

- IEEE 1547-2003: Standard for Interconnecting Distributed Resources with Electrical Systems
  » Defines protection at PCC/POI, not generator
  » Disconnect for voltages outside of range
  » Disconnect for frequencies out of range
  » Stay disconnected until feeder restored
Protection Considerations

- IEEE 1547-2003: continued
  - Voltage magnitude fluctuation on synchronization < 5%
  - Detect unintentional islanding
  - DG doesn’t cause overvoltages
  - DG doesn’t cause miscoordination of protection
  - Disconnect for faults on feeder

Utility perspective

- Protect system from DG
- 51P/51G impacts
- Coordinate with DG protection for facility faults
- Transfer trip (if necessary—more likely with higher ratings)
- Don’t reclose with DG connected
Utility perspective: Back feed issues

- Downstream loads see larger currents
- Transfer trip to avoid having it feed faults
- Directional protection
- Communication aided protection

DG owner perspective

- Protect generator from grid
- Stay connected while meeting IEEE 1547
- Disconnect from utility for system level disturbances and supply on site loads
- Minimum set of standard generator protection
1547 requirements

- Sense VLL on feeder side of PCC/POI
  - Overvoltage (59)
  - Undervoltage (27)
    - Specific clearing time
- Disconnect for frequencies out of range
  - 810 and 81U

- Stay disconnected until voltage on feeder between 88% and 110%
  - And frequency 59.3-60.5 Hz
  - Both for 5 minutes
- Detect unintentional island
  - Disconnect within 2 sec
- Difficult as DG gets large relative to load
Transfer Trip (ANSI 25)

- From Utility to DG
- Comms
  » Radio
  » Direct Fiber
  » Telecom
  » Data network