PSEG Long Island's
Distributed Energy Resource (DER) Direct Transfer Trip (DTT) Requirements

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Disclaimer

Requirements for interconnection of DER to the LIPA system are defined in the *PSEG Long Island's Smart Grid Small Generator Interconnection Technical Requirements and Screening Criteria for Operating in Parallel with LIPA's Distribution System* document, as currently published. This presentation is intended to be informative, only, and does not modify, supplement, or interpret the requirement document as currently published.

Background

- Distribution feeders must be de-energized by opening their circuit breaker at the substation to:
  - Clear faults
  - Eliminate dangerous conditions
  - Perform maintenance (where live-line work cannot be performed)
  - Reconfigure circuits
- Conventional distribution systems have been designed assuming that the utility substation is the sole source of energization
- Interconnection of DER[1] presents the potential for "islanding"; i.e., energization of disconnected circuits by DER
- In certain circumstances with substantial risk of islanding, PSEG-Long Island requires implementation of "direct transfer trip" (DTT)
- DTT is a communicated signal transmitted when the substation circuit breaker is going to open, telling DER to turn off

[1] DER = Distributed Energy Resource, inclusive of generation and storage connected to the distribution system

When is DTT required?

- For any DER, of any technology or size[1] when DER penetration exceeds 50% of applicable load (Screens P8 & S1)
  - Penetration measured as ratio of aggregated DER capacity to load between substation and next ASU downstream
  - Applicable load is daytime minimum load (10 am – 4 pm) for solar, overall minimum load for other DER types
- For synchronous generators > 500 kVA
- For inverter-based generation ≥ 1,000 kVA regardless of penetration, or as otherwise deemed necessary
- For induction generators, as determined necessary

[1]DER less than 50 kVA are not subject to technical review and are thus excluded

Why is DTT required?

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DTT is required solely for protection of the LIPA system and its other customers

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Feeder reclosing practices

- Automatic circuit breaker reclosing is used on all overhead feeders in the LIPA system
- Sequence:
  - Short circuit fault occurs
  - Feeder protection detects fault and opens feeder breaker
  - Breaker is reclosed after a short delay to test if fault is still present
  - If fault remains, process repeated several more times with longer delays
- Delays used on LIPA system for the first reclose:
  - Electromechanical reclosers have no intentional delay, i.e. “instantaneous” which actually is ≈ 200 ms.
  - Microprocessor relays set to 300 ms delay

Why is reclosing used?

- The large majority of overhead distribution feeder faults are "temporary" in nature
  - If a circuit with a temporary fault is de-energized, the fault will "self heal"
  - Temporary fault causes:
    - Flashover across an open-air gap, such as from a lightning strike
    - Animal across an insulator
    - Swaying tree branches
- Reclosing is critical to maintaining customer reliability
  - Majority of faults are eliminated without an "outage"
  - Yields a substantial increase in the SAIFI metric on which utility performance is evaluated

DER coordination with feeder reclosing

- The feeder must be essentially de-energized when feeder is reclosed to avoid severe transient impacts
- Doesn't the fault "de-energize" the feeder? NO!
  - Most faults are on one or two phases, leaving unfaulted phases energized
  - Arcing faults may self-interrupt when the strong short-circuit source provided by substation is disconnected
- Therefore, DER must not continue energization of feeder beyond the short "instantaneous" reclosing delay
- Coordination of DER with utility feeder reclosing is clearly required by IEEE 1547 (both 2003 and 2018 versions)

Won’t DER trip due to the fault?

- Faults detectable by utility protection systems may not dip feeder voltage more than 10% - 20%,
  - Particularly at DER locations on the main feeder and/or near the feeder head
- The undervoltage clearing time specified by PSEG-LI for voltages between 50% and 88% of nominal is 5.0 seconds
- More sensitive or faster tripping times are not feasible or acceptable
  - Eliminates capability for DER to ride through transmission disturbances
  - Widespread loss of DER output can threaten bulk power system security

What about built-in inverter anti-islanding functions?

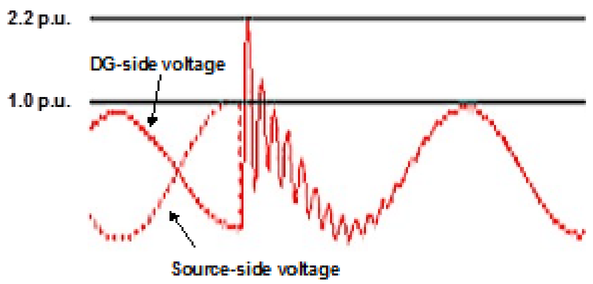
- DER tested for compliance to UL-1741 are only evaluated for island detection in 2.0 seconds
  - There are no certifications of AI (anti-islanding) performance for shorter times
  - AI testing is limited to single DER with a load
- Many DER AI schemes use some form of destabilization to drive voltage or frequency to trip points
  - Shortest trip points are 0.16 seconds; 40 ms margin is far too little time for the destabilization to succeed
- Research testing indicates typical AI detection times in the hundreds of milliseconds even with substantial generation/load imbalance
- Inverter anti-islanding functions are not effective in coordinating with instantaneous reclosing

What can happen if DER maintains energization?

- The primary concern regarding DER reclosing mis-coordination is the substantial risk of out-of-phase reclosing
  - With feeder islanded, there is nothing to keep the island in phase with the grid
  - Island phase angle can drift 1260°/second without hitting the shortest frequency deviation trip point
  - Angle deviation can be up to 252° at time of LIPA breaker reclose
  - Worst-case is 180° deviation = twice normal voltage across LIPA breaker when it recloses

But aren't inverters self-protected from this?

- Unlike synchronous generators, which can easily be damaged by out-of-phase reclosing, inverters are designed for self-protection
- However, this is not the issue. Out-of-phase reclosing can damage LIPA system assets and customer load devices



  – Severe transient overvoltages
    - Theoretically, up to three times nominal
    - Realistically, 2 – 2.5 times nominal
    - Potential damage to surge arresters and customer loads

  – Motor load mechanical system torque transients
  – Large transformer and motor inrush currents, potentially causing protective device nuisance operation

Why are DTT requirements based on DER size?

- Risk of islanding depends on the aggregate DER capacity, relative to load, on the feeder
- DTT implementation costs are independent of DER rating
- Requiring DTT for small DER that drive the aggregate DER rating over the penetration threshold for islanding creates an undue and disproportionate burden on the small DER
- Requiring DTT for large DER preserves hosting capacity for small DER

Summary

- It is essential that DER coordinate with LIPA distribution system reclosing, as required by IEEE 1547
- Inverter anti-islanding functions do not coordinate with the reclosing delays used on LIPA system feeders
- Direct transfer trip (DTT) is necessary to protect the LIPA system and its customers when even transient DER islanding is possible

Questions?