IEEE 1547 STANDARD (FULL REVISION)

UTILITY WORKING GROUP MEMBERS PERSPECTIVE

Overview of Distribution grid concerns – and consents with respect to Protection, Reliability and other areas of interest – voiced during the revision process

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Agenda

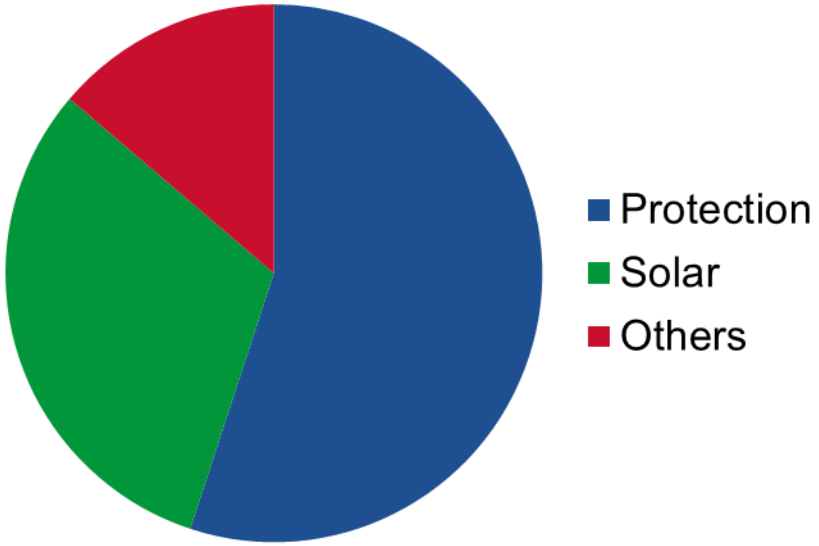
- Background Information
- Overview of Concerns expressed by Electric Utilities during IEEE 1547 Standard Revision process
    - Protection concerns
    - Reliability and other concerns
- Examples of some Protection and Reliability concerns are addressed in IEEE 1547-2018 Standard
- Other perspectives on the impact of DER on the electric distribution power system
- Conclusion

Background

- 2 years with Renewable Energy Startup
- 9 ½ years with Dominion Energy
    - 7 years as a System Protection Engineer
    - 2 ½ as DER Planning Engineer
- Involved with IEEE 1547 since late 2012 / early 2013
    - Member of IEEE 1547.8 Working Group (WG)
    - Member of IEEE 1547a and IEEE 1547.1a WG (i.e. “a” stands for amendment)
    - Member of IEEE 1547.1 (full revision) WG
    - Member of IEEE 1547 (full revision) WG (initiated April 2014)

Distribution Grid Operators Concerns with respect to IEEE 1547 (Full Revision)

- Protection related concerns
- Reliability related concerns
- Other concerns



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Protection related Concerns

- DER masking Faults on Area EPS
- Desired behavior during Fault Condition: Cease to energize vs galvanic separation
- Detection of open phase condition (including Delta winding) and definition of limitations (with or without load connected, with or without island)
- Default clearing time not being defined as the lowest value of the range of adjustability
- Ridethrough potentially inhibiting islanding detection (including 299s frequency ride-through time

Protection related Concerns (continued)

- DER coordination with Automatic Reclosing Practices:
  - who is responsible for ensuring proper coordination ?
  - Since no method of islanding detection for DER has been specified, this system design requirement assuring that reclosing coordination could be impractical and/or not possible, especially for small scale DER.
- DER active Islanding function remaining active or efficient with ride through
  - Enabling voltage and frequency ride though, and active voltage regulation, complicates island detection. Concerns further capabilities or methods for island detection are not specified.
  - Need for development of adequate and reliable test procedures for unintentional islanding detection in **IEEE P1547.1**, considering the interaction of multiple DERs on a feeder and feeders with motor loads

Reliability and other related Concerns

- DER Malfunction during Ride-through
- DER coordination with Load Shedding practices
- Net-metering types DER not receiving the same scrutiny as Large scale DER
  - Policing Ride-through applications can be problematic for smaller interconnections
  - State Rules and Procedures for Interconnection not up to date with respect to new technologies and challenges
- Average Load Calculations: different for all utilities and 8760 data not always available especially for new facilities)

Reliability and other related Concerns (continued)

- Point of Electrical Connection (POC) vs Point of Common Coupling (PCC) reference may not cover all possible iterations (e.g. Generators with large loads)
    - IEEE 1547 Standard is being used for both exporting and non-exporting DER. Thus we ought to get POC vs PCC concept right

How concerns are addressed in IEEE 1547 -2018

1. **Protections Concerns**: some are addressed mostly under Sections 6, 8 and Appendices

2. **Reliability Concerns**: some addressed in Section 4.2 and in Appendices

With regard to ride-through as specified in 6.4.2 and 6.5.2 and methods utilized to meet the unintentional islanding detection as specified in 8.1, the following shall apply:

— While the DER is connected to an Area EPS that is connected to a *bulk power system*, any requirements for ride-through as specified in 6.4.2 and 6.5.2 shall not be falsely inhibited by any methods or design features utilized to meet the unintentional islanding detection as specified in 8.1 when an actual *unintentional island* condition does not exist.

— Conversely, the unintentional islanding detection requirements specified in 8.1 shall not be inhibited by ride-through as specified in 6.4.2 and 6.5.2 during valid unintentional islanding conditions.[74]

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How concerns are addressed in IEEE 1547 -2018 (continued)

For short-circuit faults on the Area EPS circuit section to which the DER is connected, the DER shall *cease to energize* and *trip* unless specified otherwise by the Area EPS Operator.[79] This requirement shall not be applicable to faults that cannot be detected by the Area EPS protection systems.

Appropriate means shall be implemented to help ensure that Area EPS automatic reclosing onto a circuit remaining energized by the DER does not expose the Area EPS to unacceptable stresses or disturbances due to differences in instantaneous voltage, phase angle, or frequency between the separated systems at the instant of the reclosure (e.g., out-of-phase reclosing).[81]

Operation in *momentary cessation* operating mode meets this *cease to energize* requirement. *Restore output* behavior shall be coordinated with Area EPS reclosing timing.

[81] *Appropriate means may include, for example,* ***Area EPS measures*** *to block reclosing if the circuit remains energized, or existence of low DER penetration and DER technology-types such that energization would not be maintained for as long as the time of reclosing, or* ***means to cease energization by DER when the Area EPS is isolated*** *(e.g., transfer trip, or reliance on islanding detection requirements as specified in 8.1).*

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How concerns are addressed in IEEE 1547 -2018 (continued)

The characteristics of the Local EPS and DER shall determine the *reference point of applicability* (RPA). Except as otherwise stated in this standard, the RPA for all performance requirements of this standard shall be the *point of common coupling* (PCC).

Alternatively, for Local EPSs where zero sequence continuity[27] between the PCC and PoC is maintained and either of the following conditions apply, the RPA for performance requirements of this standard may be the *point of DER connection* (PoC), or by mutual agreement between the *Area EPS* Operator and the *DER Operator*, at any point between, or including, the PoC and PCC:

a) Aggregate DER nameplate rating of equal to or less than 500 kVA, *or*

b) Annual average load demand of greater than 10% of the aggregate DER nameplate rating, and where the Local EPS is not capable of, or is prevented from, exporting more than 500 kVA for 2 longer than 30 s.

[28] As calculated by Area EPS Operator.

		1st prosal	2nd proposal	Draft 6 language	Final Proposal
Generator in KVA	Load in KVA	PCC if >500 or annual load < 10% of Gen.	POC if <500 or max demand < 10% of Gen.	PCC if >500 and load < 10% of Gen.	PCC if >500 and load < 10% of Gen or net gen > 500kva
400	10	POC	POC	POC	POC
550	10	PCC	PCC	PCC	PCC
550	100	PCC	PCC	POC	POC
400	100	POC	PCC	POC	POC
4000	1000	PCC	PCC	POC	PCC
4000	50	PCC	PCC	PCC	PCC
400	350	PCC	POC	POC	POC
10	1000	PCC	POC	POC	POC
550	1500	PCC	PCC	POC	POC
2000	10000	PCC	PCC	POC	POC

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How concerns are addressed in IEEE 1547 -2018 (continued)

Unexpected individual DER malfunctions may cause field problems and will also be difficult to predict in screening or studies. If there is a dispute about cause and effect, DER or grid, then field measurements and application of IEC 61000-3-7 allocation methods may be helpful.

[c] This time shall be chosen to coordinate with typical regional under-frequency load shedding programs and expected frequency restoration time.

For an *unintentional island* in which the DER energizes a portion of the Area EPS through the PCC, the DER shall detect the island, *cease to energize* the Area EPS and trip within 2 s of the formation of an island.[116] False detection of an *unintentional island* that does not actually exist shall not justify non-compliance with ride-through requirements as specified in Clause 6.

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Other perspectives on the impact of DER on the electric distribution power system

- Operation and control
  - DER typically not located on distribution bus but near load center or deep into circuit
  - Distribution Grid DER Operation may not match local distribution load variation
  - DER operation may impact Transmission but it will impact distribution power system (voltage variation, PQ, islanding detection) before any impact is potentially felt at the Bulk system level

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Other perspectives on the impact of DER on the electric distribution power system (continued)

- Stability & Predictability
  - Traditional Electric Distribution system design allowed predictability of issues such as voltage drop (higher impedance with increased distance to substation). With DER, there is no predictability and complexity also increases
  - Statutory requirements requires limitations on DER to ensure safety and reliability of the electric distribution power system

Conclusion

- Several new addition to IEEE 1547-2018 including requirements to have ride-through capabilities on all DER
- Lack of “real world” field and/or operational or insufficient practical experience on feasibility and impact on distribution: Safety, Reliability, Stability, etc.
- Every EDC (Electric Distribution Companies) electric distribution system is different, in term of need, size, stiffness and possibly statuatory requirements, thus impacting operating practices
- Distribution system is complex and dynamic in that its configuration may change without notice
- No one size fit all approach is possible with respect to defining or determining acceptable ride through criteria
- DER connected on the electric distribution power system will have an impact on Distribution before it can potentially have an effect (if any) on the Bulk Power System
- Implementation of any DER capability need to consider optimal impact on both distribution power system and bulk power system
- Dominion Energy believes in careful and methodical approach to the implementation of smart inverter functions such as ride through.

Thank you

Combined Cycle Generator

Solar Farm

Wind Farm

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QUESTIONS

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Dominion Energy is built on a proud legacy of public service, innovation and community involvement.