Can IEEE 1547 Meet Future Industry Needs?

PV Grid Integration Workshop

Co-hosted by DOE, EPRI, SNL, SEPA, and NREL

Panel Session 4 -- Interconnection Standards: Utility & Industry Perceptions

moderated by Thomas.Basso@NREL.gov

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IEEE 1547 IS:

A Technical Standard – Functional Requirements For
- the interconnection itself
- the interconnection test

Technology neutral, e.g., does not specify particular equipment nor type

A single (whole) document of mandatory, uniform, universal, requirements that apply at the PCC.

Should be sufficient for most installations.

IEEE 1547 Is NOT:
- **a design handbook**
- **an application guide**
- **an interconnection agreement**
- **prescriptive, e.g., does not address DR self-protection, nor planning, designing, operating, or maintaining the Area EPS.**

IEEE 1547.1 is:
Test Procedures for Conformance to1547

IEEE 1547 Interconnection Standards Use:

Federal, Regional, State and Local Authorities/Jurisdictions

IEEE 1547
Interconnection System and Test Requirements
- Voltage Regulation
- Grounding
- Disconnects
- Monitoring
- Islanding
- etc.

IEEE 1547.1
Interconnection System Testing
- O/U Voltage and Frequency
- Synchronization
- EMI
- Surge Withstand
- DC injection
- Harmonics
- Islanding
- Reconnection

UL 1741*
Interconnection Equipment
- 1547.1 Tests
- Construction
- Protection against risks of injury to persons
- Rating, Marking
- Specific DR Tests for various technologies

NEC
Article 690 PV Systems:

Article 705: interconnection systems (shall be suitable per intended use per UL1741)

PJM Interconnection, Inc.
Small Generator Interconnection Standards
FERC approved
(0-to<10MW and 10-to-20 MW; incorporate 1547 and 1547.1)

* UL 1741 supplements and is to be used in conjunction with 1547 and 1547.1

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Interconnection Standards: Industry & Utility Perceptions
Can IEEE 1547 Meet Future Industry Needs?

Panel kickoff questions:

IEEE Std 1547
- What does it do for you?
- What does it not do for you?
- What would you like it to do?

Panel Members

Mike Grant, Duke Energy

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Elie Nasr, SMA America

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IEEE SCC21 1547 Workshop: May 17-18, 2012

- **Location**: IEEE HQ, 445 Hoes Lane; Piscataway, NJ 08854
- **Registration required (no later than May 3):**
https://web.memberclicks.com/mc/quickForm/viewForm.do?orgId=iecs&formId=115634
- **Registration fee**: $150 before 26 April 2012 and
$200 after this date.
- **IEEE 1547 Workshop Technical Ideas Submittal:**
Deadline: May 7, 2012
you must use the Technical Idea Submittal Form at
http://www.surveymonkey.com/s/STD1547

- **More information is at**:
http://grouper.ieee.org/groups/scc21/1547.8/email/

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IEEE 1547 and High Penetration PV

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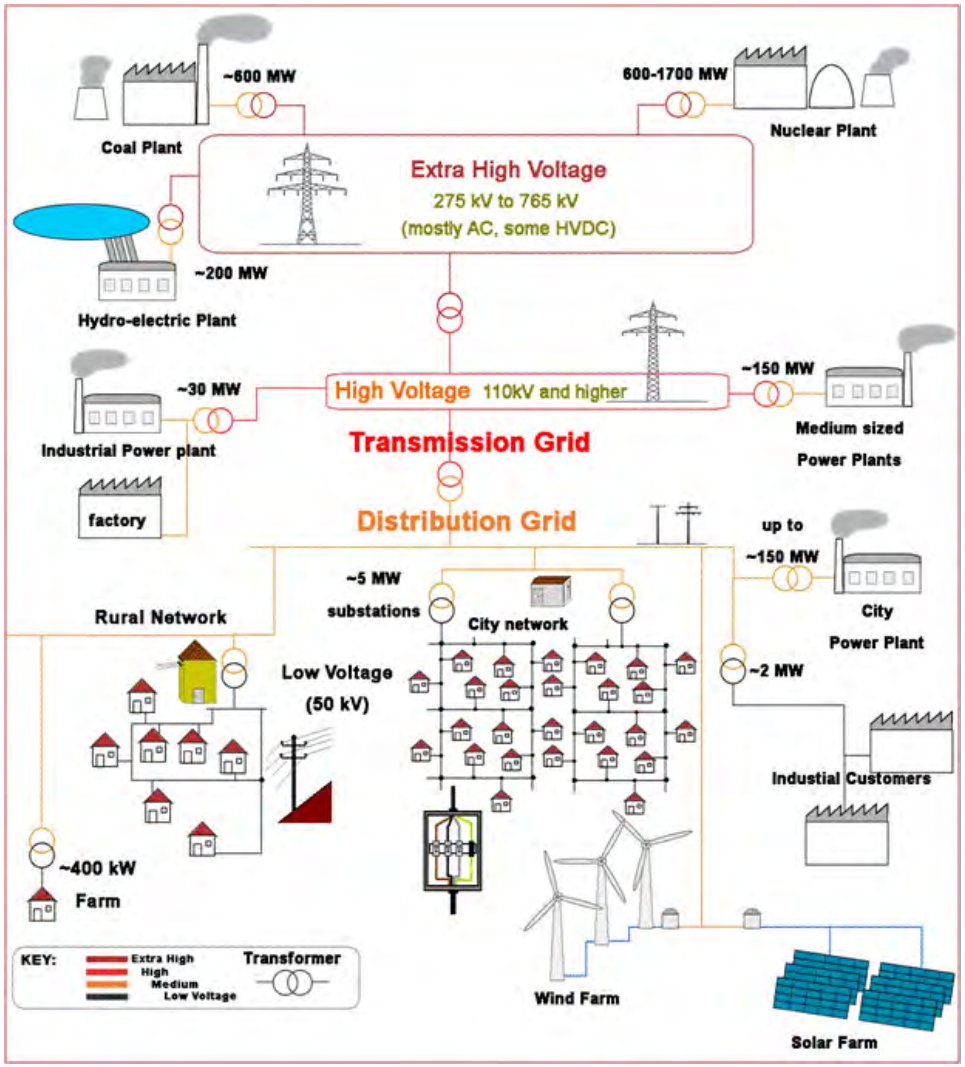
One system, different rules



Bulk System Guidelines
NERC, FERC
ANSI, IEC, NESC

Plenty of technical and jurisdictional overlap, confusion, contradiction…

Distribution System Guidelines
IEEE 1547, PUC/PRC
ANSI, IEC, NEC

IEEE 1547 – Key Provisions

- Voltage and frequency trip thresholds

Voltage Range (% Nominal)	Max. Clearing Time (sec) *
V < 50%	0.16
50% ≤ V < 88%	2.0
110% < V < 120%	1.0
V ≥ 120%	0.16

(*) Maximum clearing times for DER ≤ 30 kW; Default clearing times for DER > 30 kW

Frequency Range (Hz)	Max. Clearing Time (sec)
f > 60.5	0.16
f < 57.0 *	0.16
59.8 < f < 57.0 **	Adjustable (0.16 and 300)

(*) 59.3 Hz if DER ≤ 30 kW

(**) For DER > 30 KW

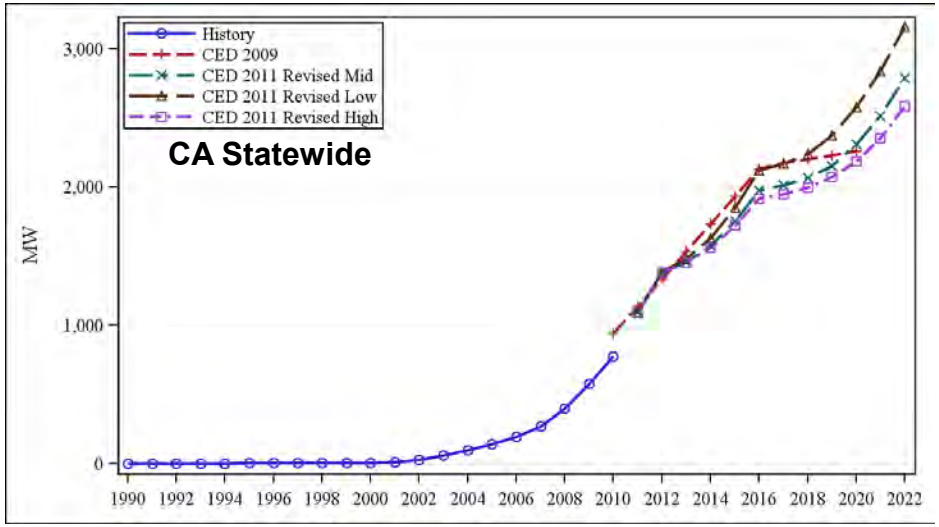
- Additional disconnection requirements
  - Cease to energize for faults on the Area EPS circuit
  - Cease to energize prior to circuit reclosure
  - Detect island condition and cease to energize within 2 seconds of the formation of an island (“anti-islanding”)

Opposite Points Of View

- Distribution System – IEEE 1547 Domain
  - Bulk generation and voltage support is “infinite” – who cares!
  - Main concern is protection coordination, power quality, and safety during and after distribution system events
  - **DG must trip** outside specified voltage vs. time and frequency vs. time envelope
- Bulk Power System – NERC Domain
  - Distributed generation capacity is too small – who cares!
  - Main concern is maintaining frequency and local voltage (grid security) during and after transmission system events
  - **Generators must not trip** inside specified voltage vs. time and frequency vs. time envelope

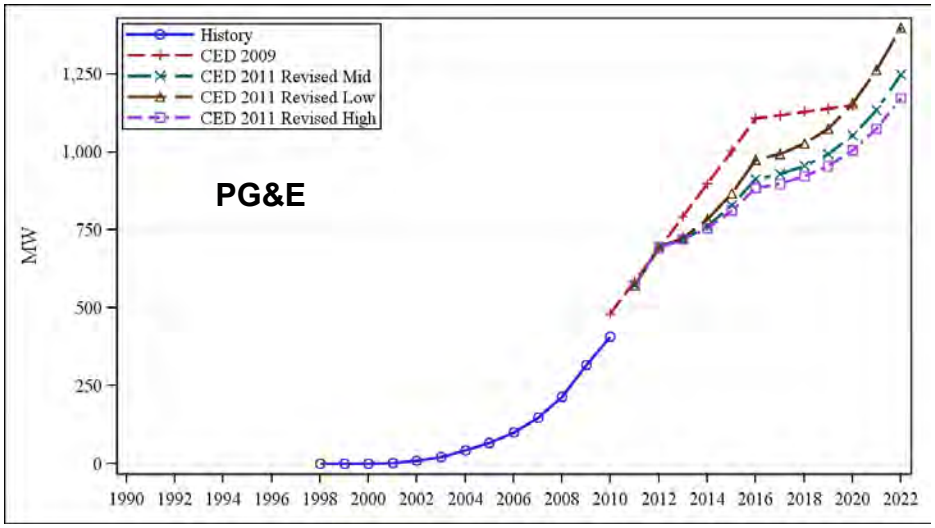
As DG penetration increases, these opposing points of view must be reconciled.

High Pen Distributed PV Scenario Developing!



Data for distributed PV in CA

Message: We are on a steep part of the growth curve



Source: Gautam, California Energy Demand 2012-2020 – Revised Staff Forecast, IEPR Committee Workshop – Feb 2012.

Why is This an Issue… Now?

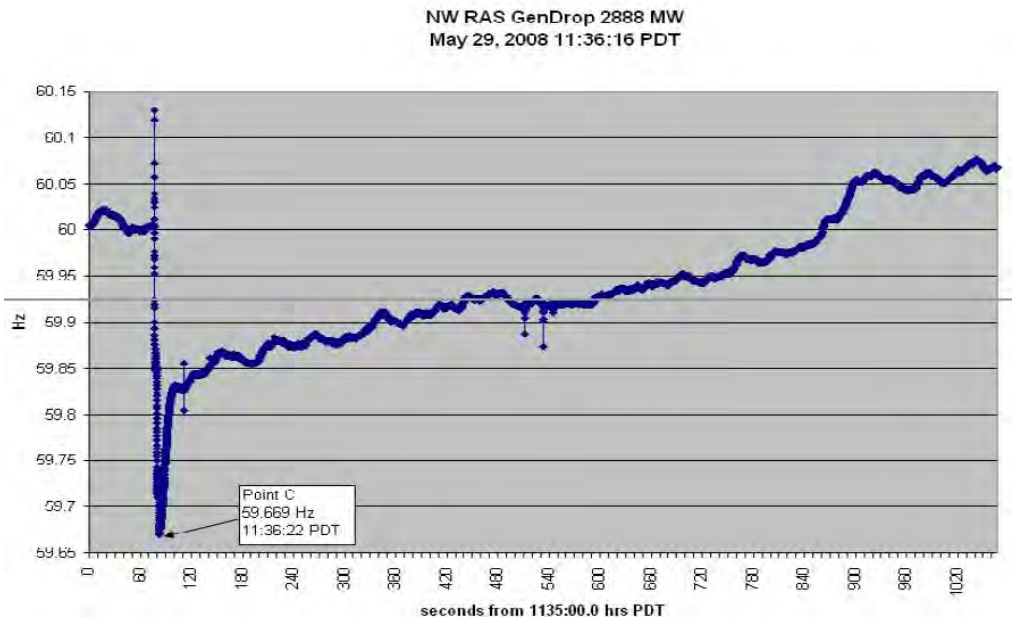
- Address growing exposure to tripping of large amounts of DG due to system disturbances

Two specific drivers:

1. Maintain bulk grid stability (e.g., disturbance tolerance per NERC requirements)
   - Voltage Stability, Frequency Stability
2. Generation supply reliability and cost
   - DG contribution to capacity and other ancillary services
   - Cost of additional spinning reserves

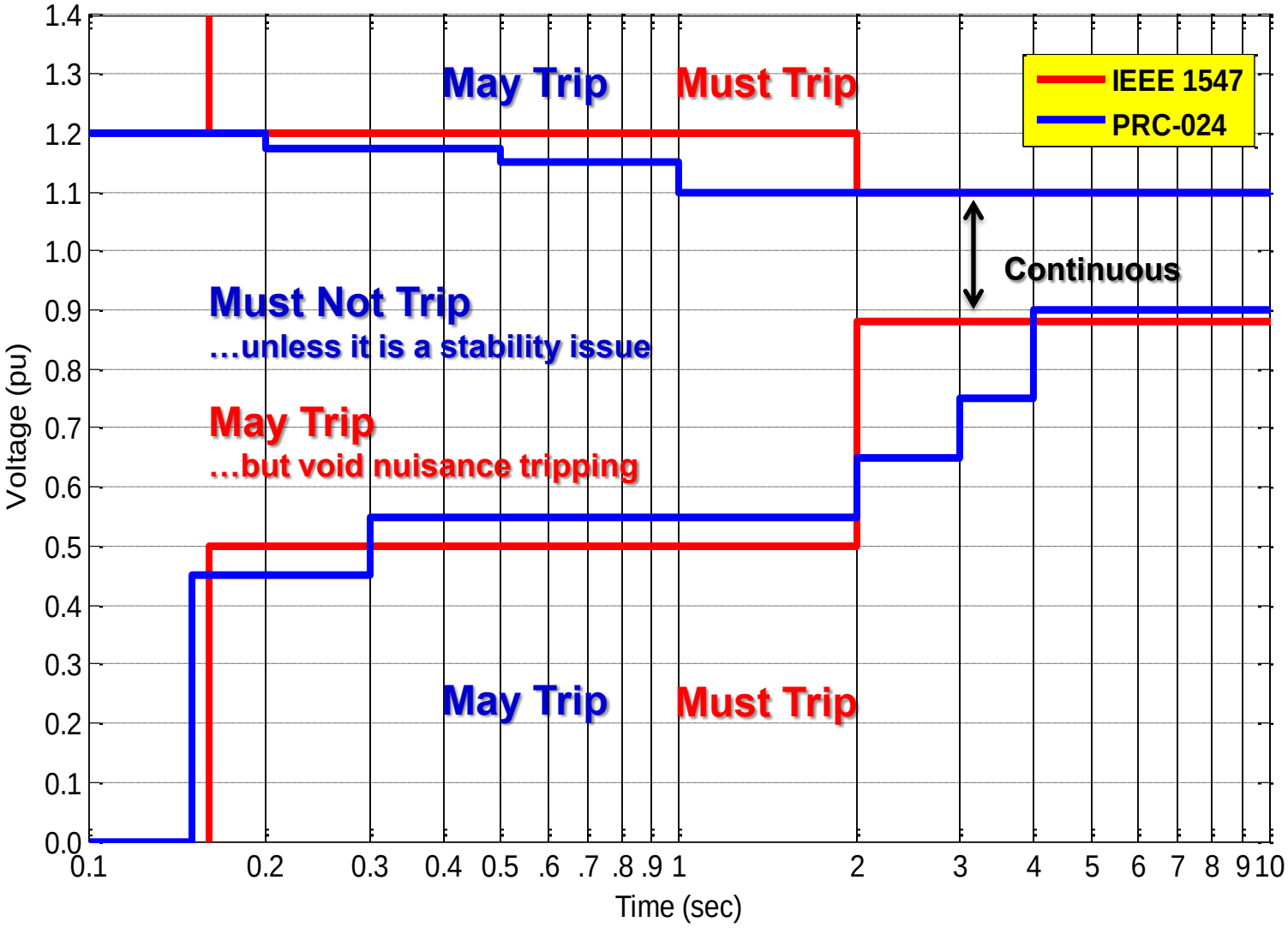
Tolerance to Frequency Events

- Excessive DG tripping during a high or low frequency could affect interconnection frequency performance
  - Could impact spinning reserves
  - High frequency tripping is currently a concern in Germany
    - Recent standard revisions: High-frequency droop, higher trip level



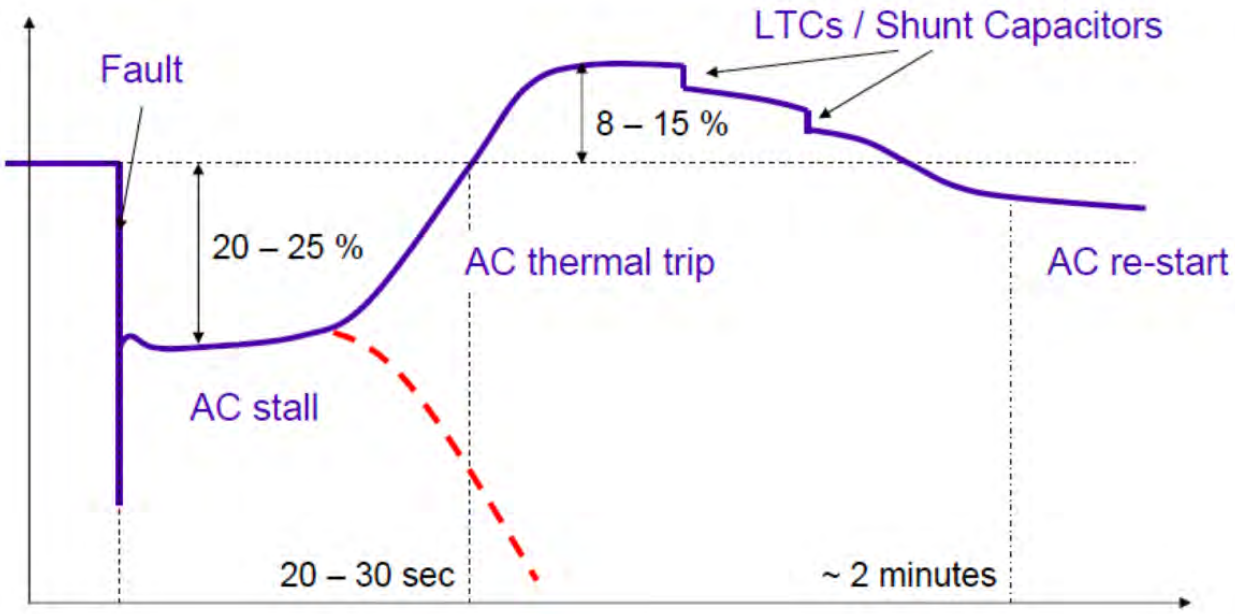
Example of generator trip event and low frequency in WECC (2008)

Voltage: IEEE 1547 Vs. NERC PRC-024



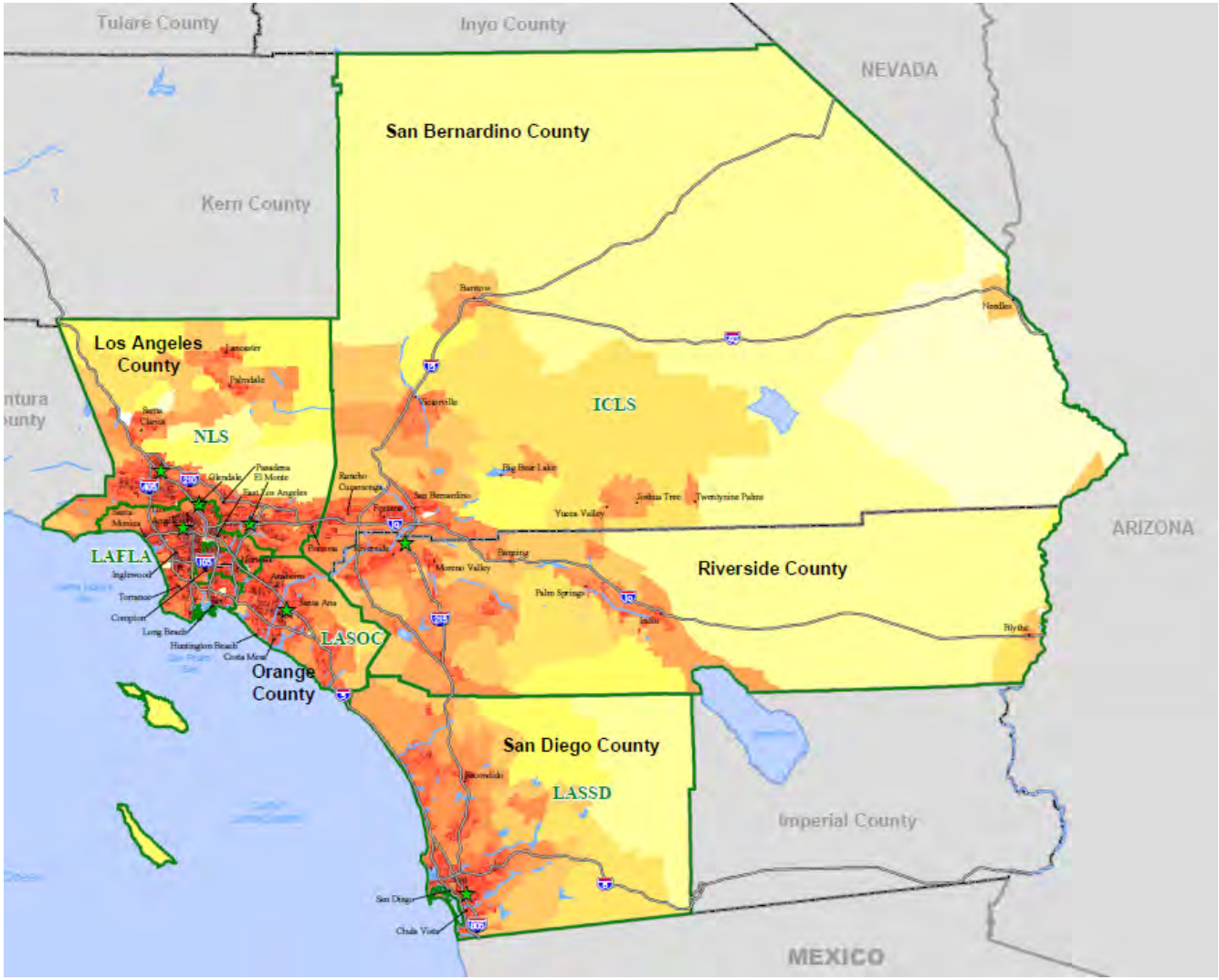
VRT and Voltage Stability

- Excessive DG tripping due to lack of fault tolerance could cause or exacerbate voltage instability
  - Net active/reactive load post-fault would be larger than pre-fault
  - Could exacerbate fault-induced delayed voltage recovery (FIDVR)



FIDVR event in Southern California Following a 230-kV Transmission Fault

How widespread can a LV event be?

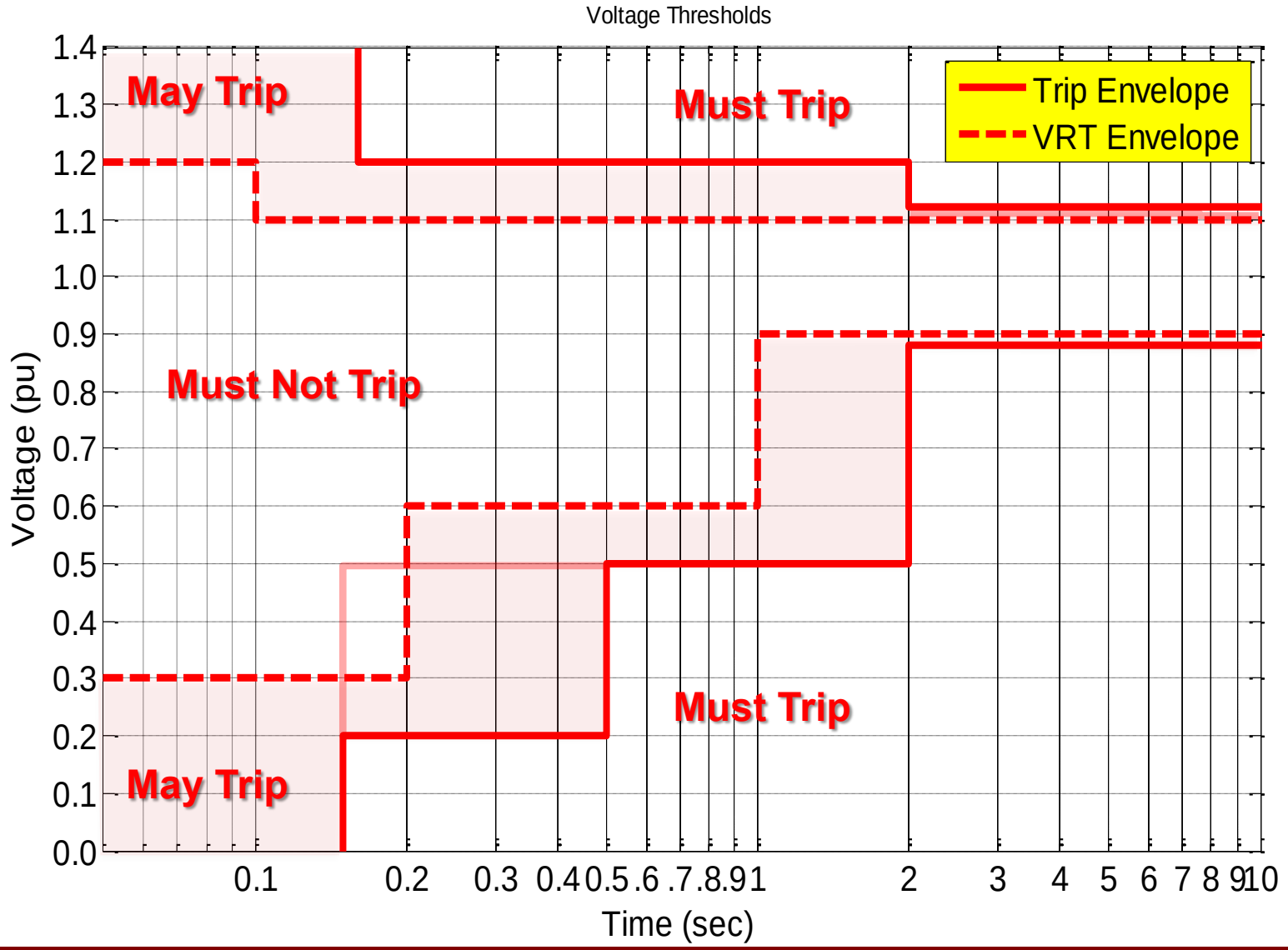


http://en.wikipedia.org/wiki/File:LACountyPopDensity.png

Some IVGTF 1.7 Ideas (unofficial)

- Some VRT capability is needed
  - No need for ZVRT considering DG density
  - VRT can co-exist with anti-islanding and volt/var capability (requirements involve different time frames)
- May need to keep a Must Trip curve as well
  - Must Trip voltage/freq. thresholds used in anti-islanding
  - Could be existing IEEE 1547, with some adjustments
    - Consider relaxing low voltage threshold (for fault tolerance)
    - Consider relaxing continuous high voltage threshold (address inverter nuisance tripping)
- Need a reasonable "buffer" between VRT and Must Trip envelopes (both time and voltage dimensions)

Some IVGTF 1.7 Ideas (unofficial)



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Thank You!

More information:

http://energy.sandia.gov/pv

http://energy.sandia.gov/wind

http://www.sandia.gov/ess

https://solarhighpen.energy.gov