# IEEE 1547 Standard for Interconnecting Distributed Energy Resources with Electric Power Systems,

## for Sandia National Laboratories' "Enabling Advanced Power Electronics Technologies for the Next Generation Electric Utility Grid",

### Session 6, …economics, standards, and safety considerations

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Albuquerque, NM
7/18/2018

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# Disclaimer

- *This presentation on IEEE 1547-2018 are the author's views and are not the formal position, explanation or position of the IEEE or MEPPI*

- *The author acknowledges the contribution of the IEEE 1547-2018 Working Group and Officers*

# Panel Presentation Outline

1) IEEE 1547 Background

2) Revised 1547 & Overcoming Integration Challenges

3) Two examples of future advanced power tech enabling ES applications and improved economics



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# IEEE 1547 Uses

**IEEE 1547 is:**

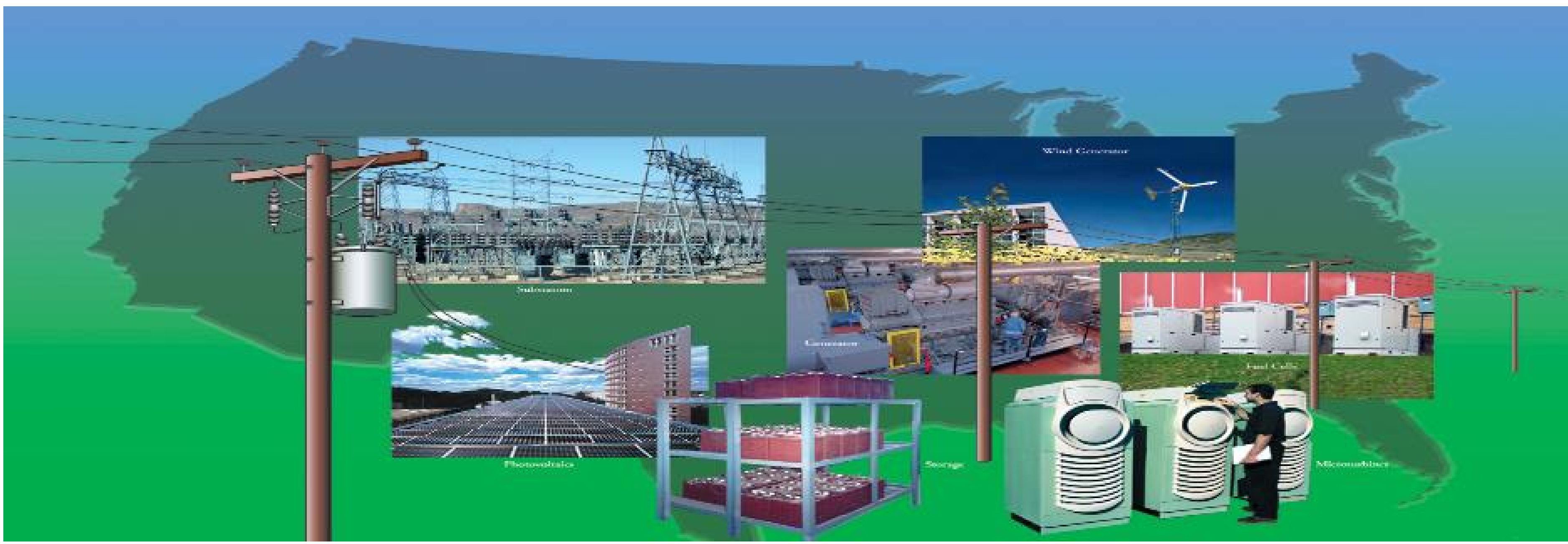
- A technical standard—functional requirements for the interconnection itself and interconnection testing
- A single (whole) document of mandatory, uniform, universal, requirements that apply at the point of common coupling (PCC) or point of DER connection (PoC)
- Technology neutral—i.e., it does not specify particular equipment or type
- Should be sufficient for most installations

**IEEE 1547 is not:**

- A design handbook
- An application guide (see IEEE 1547.2)
- An interconnection agreement
- Prescriptive—i.e., it does not prescribe other important functions and requirements such as cyber-physical security, planning, designing, operating, or maintaining the area EPS with DER

# Importance of IEEE 1547

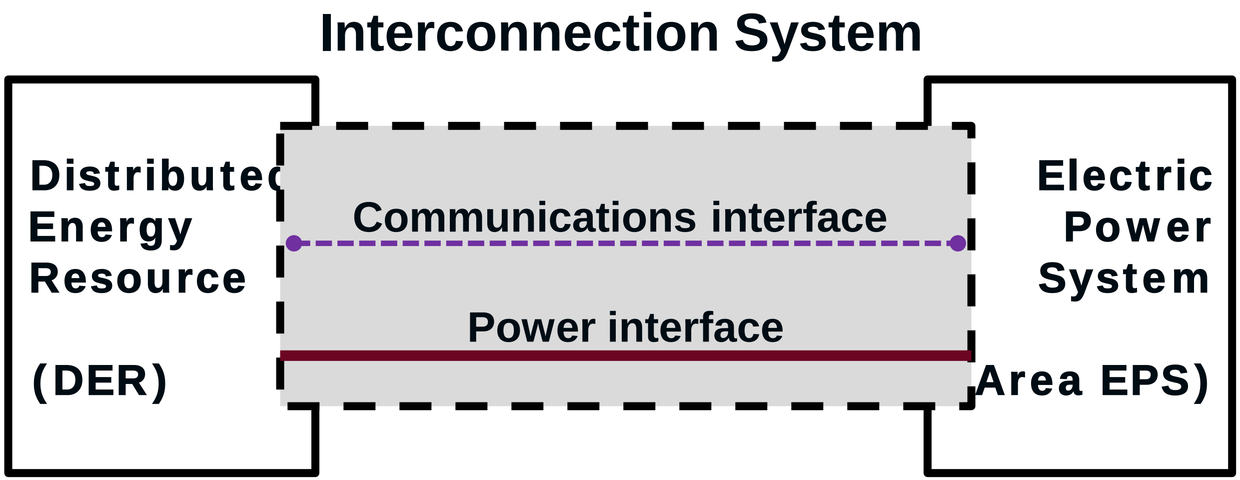
- Energy Policy Act (2005) Cites and requires consideration of IEEE 1547 Standards and Best Practices for Interconnection; all states use or cite 1547.
- Energy Independence and Security Act (2007) IEEE cited as a standards development organization partner to NIST as Lead to coordinate framework and roadmap for Smart Grid Interoperability standards and protocols {IEEE 1547 & 2030 series being expanded};
- Adoption by the majority of jurisdictional entities across N. America that set DER interconnection rules



# IEEE 1547 Scope and Purpose

***Title:*** *Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*

***Scope:*** *This standard establishes criteria and requirements for interconnection of distributed energy resources (DER) with electric power systems (EPS), and associated interfaces.*




***Purpose****: This document provides a uniform standard for the interconnection and interoperability of distributed energy resources (DER) with electric power systems (EPS). It provides requirements relevant to the interconnection and interoperability performance, operation, and testing, and, safety, maintenance and security considerations.*

*Image based on IEEE 1547-2018*

*Interconnection system: The collection of all interconnection equipment and functions, taken as a group, used to interconnect DERs to an area EPS. Note: In addition to the power interface, DERs should have a communications interface.*

*Interface: A logical interconnection from one entity to another that supports one or more data flows implemented with one or more data links.*

# IEEE 1547 Evolution of Grid Support Functions

| | |
|---|---|
| **IEEE 1547-2003** | • Shall NOT actively regulate voltage<br>• Shall trip on abnormal voltage/frequency |
| **IEEE 1547a-2014 (Amendment 1)** | • **May** actively regulate voltage<br>• **May** ride through abnormal voltage/frequency<br>• **May** provide frequency response[1] (frequency-droop) |
| **IEEE 1547-2018** | • **Shall be capable of** actively regulating voltage<br>• **Shall** ride through abnormal voltage/frequency<br>• **Shall be capable of** frequency response[2]<br>• **May** provide inertial response[3] |

[1]Frequency response is capability to modulate power output as a function of frequency
[2]Mandatory capability for Categories II and III under high frequency conditions, Mandatory for Categories II and III under low frequency conditions, optional for Category 1
[3]Inertial response is capability for DER to modulate active power in proportion to the rate of change of frequency

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# Evolving Standards Support Accessing DER's Value Stack

## ES Applications – from CA AB2514,

| Category | Storage "End Use" |
|---|---|
| ISO/Market | • Frequency regulation<br>• Spin/non-spin/replacement reserves<br>• Ramp<br>• Black start<br>• Real time energy balancing<br>• Energy price arbitrage<br>• Resource adequacy |
| VER Generation | • Intermittent resource integration: wind (ramp/voltage support)<br>• Intermittent resource integration: photovoltaic (time shift, voltage sag, rapid demand support)<br>• Supply firming |
| Transmission/ Distribution | • Peak shaving: off-to-on peak energy shifting (operational)<br>• Transmission peak capacity support (upgrade deferral)<br>• Transmission operation (short duration performance, inertia, system reliability)<br>• Transmission congestion relief<br>• Distribution peak capacity support (upgrade deferral)<br>• Distribution operation (Voltage Support/VAR Support)<br>• Outage mitigation: micro-grid |
| Customer 7 | • Time-of-use /demand charge bill management (load shift)<br>• Power quality<br>• Peak shaving (demand response), Back-up power |

1547-2003 vs. new CA 21 & 1547Revision

Source(table): CPUC Staff, AB2514 workshop, 3/25/2013

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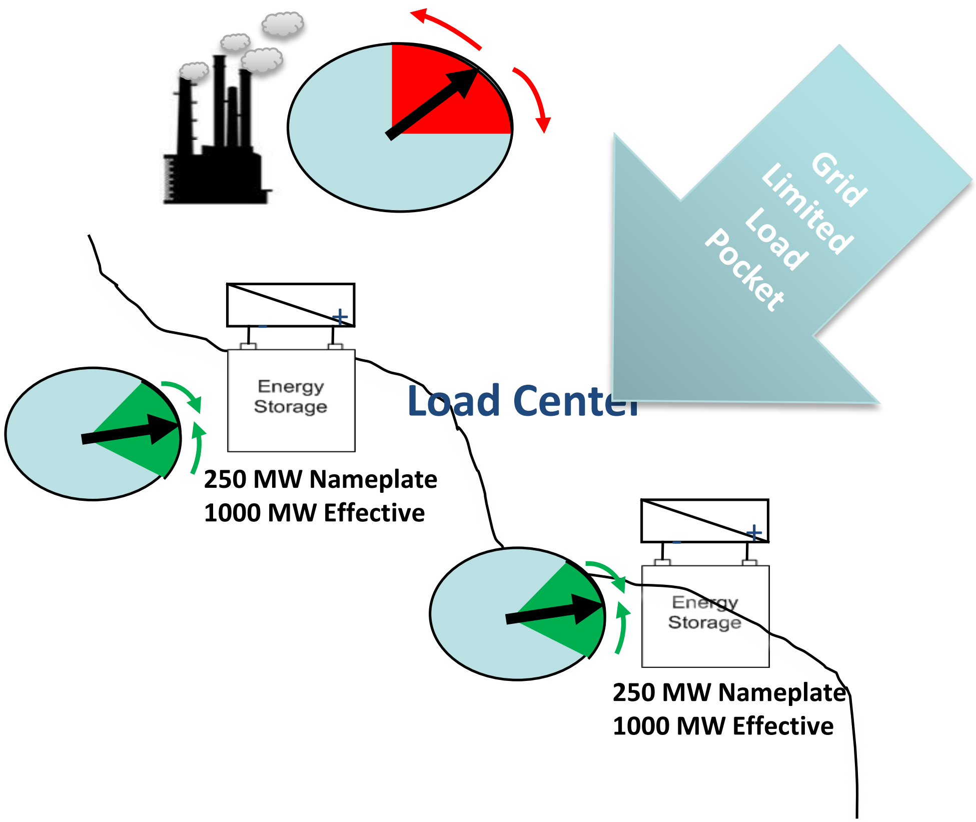
# Improve Transmission Asset Utilization **by Lifting Stability Limit Constraint, with Synthetic Inertia**

**Constraint:**
Loss of system inertia reduces the amount of power that can be imported into a stability-limited load pocket.

**Solution:**
Add synthetic inertia functionality to BESS's located in the load pocket to increase total system stability.

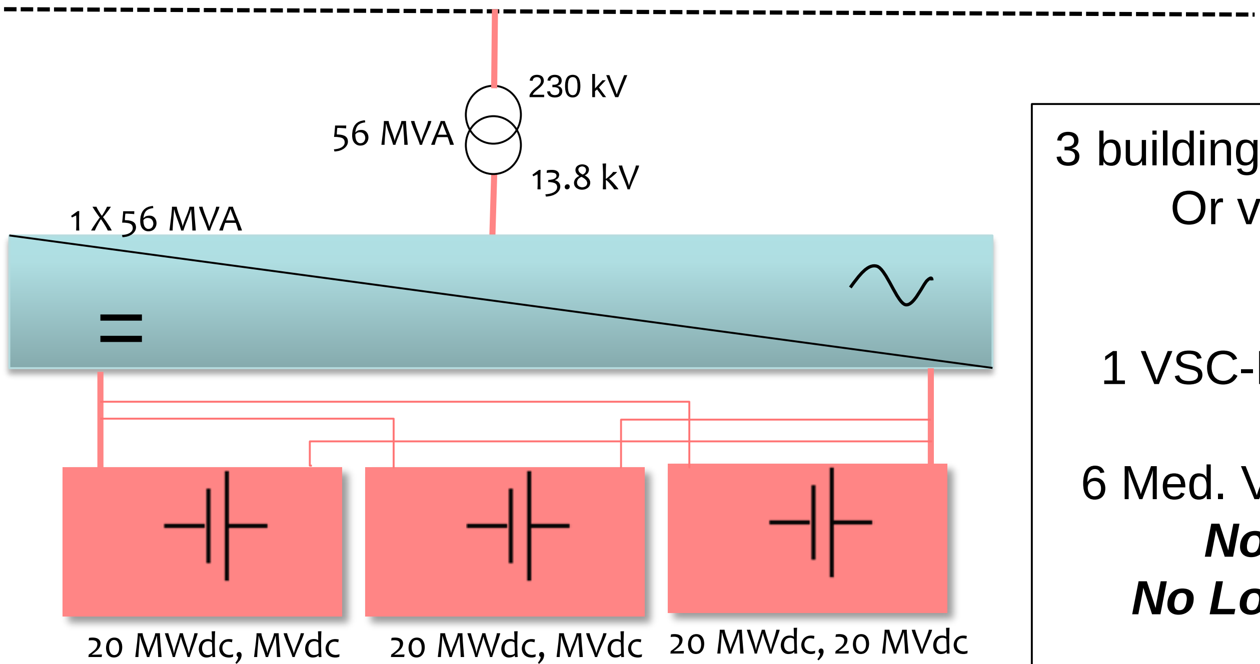
**Comments:**
Project scale is 50-250 MW, but effective capacity is multiples of nameplate capacity.

Appropriate BESS capacity with synthetic inertia functionality can also contribute to meeting NERC Frequency Responsive Reserves compliance requirement.




*SiC with short term OL, used w/ ES, has 4X benefit per MVA installed. Leverages new FRR requirements!*

# Future, FACTS-based Grid Interface




3 building-housed battery strings,
Or very large PV array
(60MWdc total)

1 VSC-MMC FACTS system

6 Med. V DC cable or bus runs
***No LV/MV XFMR's***
***No Low V DC cable runs***

Project footprint,
125,000 sq ft.
2.9 acres,
***17% reduction in land used, per 50 MW 'module'***

Assumed base battery scope is one series-parallel (S-P) string. Rated 20 MWdc, 20 kVdc at 100% State of Charge. 15 second to 4-hr discharge duration depending on the applications delivered. 4-hr discharge needed for some firm capacity applications.

# Thanks!

http://grouper.ieee.org/groups/scc21/1547/1547_index.html

https://standards.ieee.org/findstds/standard/1547-2018.html

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