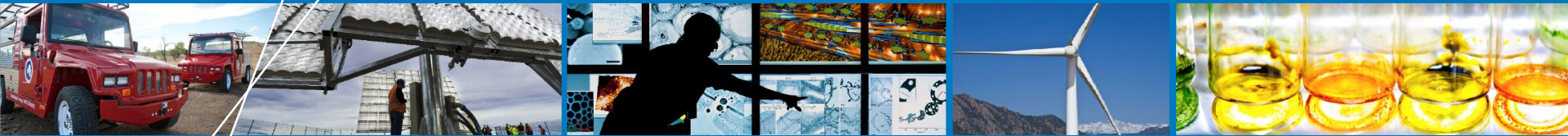


IEEE 1547 Revision Will You Be Ready?



Small Wind Conference

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Introduction

- **What is the IEEE 1547 standard?**
- **Why is IEEE 1547 being revised?**
- **What will the new requirements look like?**
- **Why will there be multiple categories with different requirements?**
- **What is the impact on DW?**

IEEE 1547 Interconnection Standard

- **IEEE 1547 is the standard for the interconnection of distributed energy resources (DER) to the utility grid**
- **Original version was completed in 2003**
 - DER was insignificant to grid stability
 - Only allowed DER response to grid event was tripping
- **DER penetration on the grid is now high in some places**
 - DER support of grid stability is becoming essential

Is the future here now?

- **California and Hawaii have already enacted their own enhanced interconnection standards**
- **New York is working on a new interconnection standard**
- **IEEE has fast tracked 1547 revision to head off a profusion of interconnection standards**
 - Imagine the burden of certifying your inverters and other devices to many state standards

Experience with Hawaii and Enphase

- **Enphase provided detailed data on grid operating conditions to Hawaiian Electric Company (HECO)**
- **HECO and Enphase agreed on inverter programming changes**
- **Enphase inverters were all reprogrammed in 48 hours (140 MW of capacity)**
- **Hawaii lifted the penetration limits from 120% to 240% of minimum daytime load**

Enhanced Levels of Ride-Through

- **Specifications for categories that provide an enhanced level of grid support are being developed**
- **IEEE 1547 will not specify the category required**
 - Selection of allowed category is for the grid operator to determine
 - Allowed categories may vary by feeder or even location on feeder
- **IEEE 1547 will provide guidance on application of the standard**
 - It does not have authority to control how the standard is used

The Shape of Things to Come (draft)

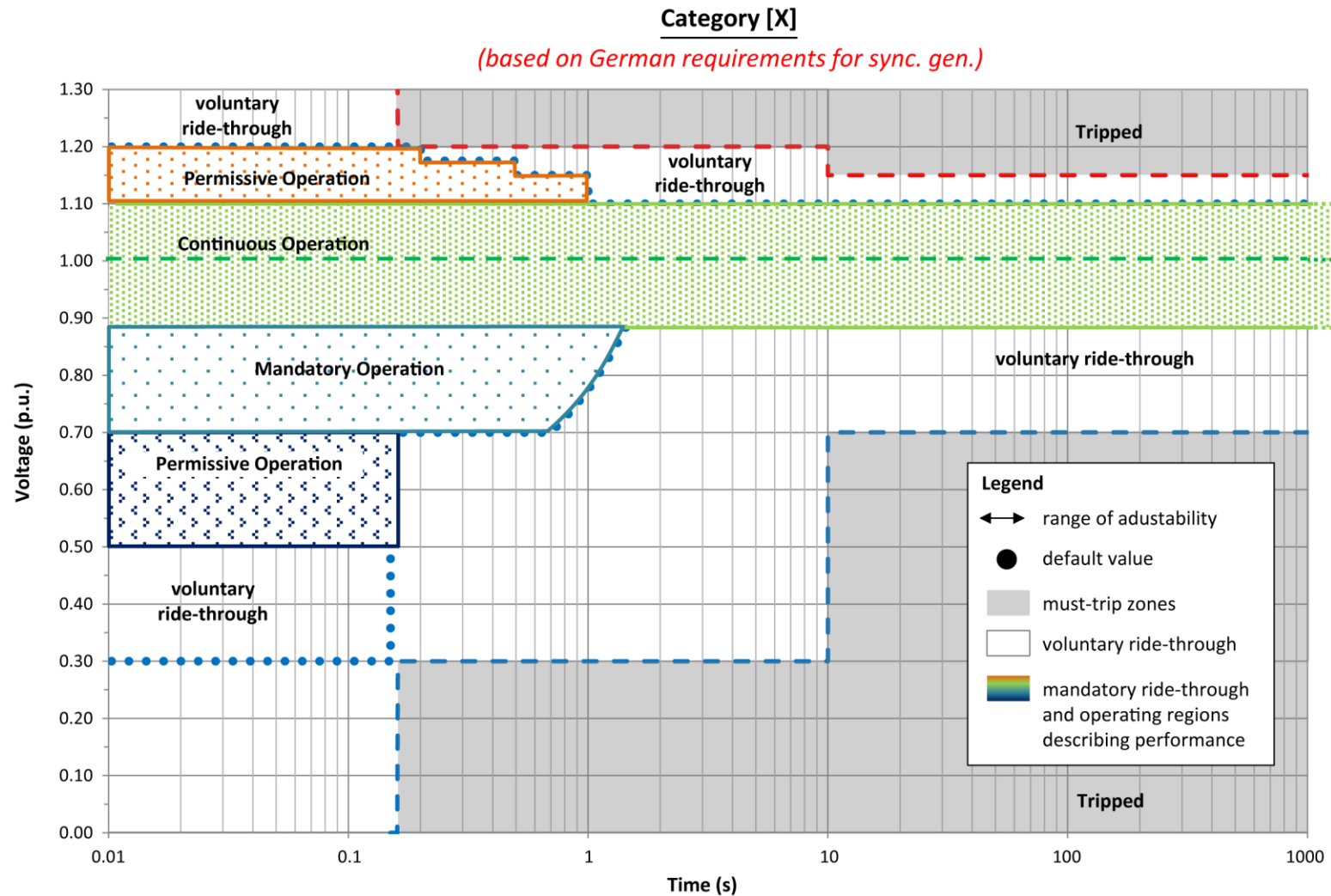
This is all under development and subject to change.

- **Three categories of distributed energy resources (DER)**
 - Guided by technology capabilities – not technology specific
 - Guided by grid support needs in high penetration
- **Requirements can be met at the DER, at the point of common coupling, or in between**

Operating Regions

- **Current standard has only trip limits and times**
- **New standard will have regions of continuous operation, mandatory operation, permissive operation, voluntary operation, and trip limits**
 - Permissive operation requires that DER stay on line but can cease to energize
 - Voluntary operation allows DER to stay on line or trip

One Category of Voltage Ride Through



Basic Description of Categories

- **One category covers the level of grid support needed by the bulk grid with high penetration,**
- **One category provides less support and may only be allowed when it provided another value** (similar to German MV code for synchronous DER)
- **One level provides more support that will improve grid feeder stability and allow higher penetration** (similar to California Title 21 smart inverter requirements)

Synchronous Generators Have Limits

- Synchronous generators are very common and have physical limits for ride-through in under-voltage events and kilovar support
- Category with minimum requirements has to accommodate these limits
- Photovoltaic systems with inverters can provide much more grid support
- For high penetration systems, all DER at minimum level may not be sufficient for grid stability

Reactive Power Modes

- **Four reactive power modes have been proposed**
 - Two have power factor that varies with voltage
 - One has power factor constant at required point that can be changed when requested
 - One has power factor change with power generation (this one would be optional)

Impact on Distributed Wind

- **Inverter designs will need to be updated to provide the functions required by the new IEEE 1547**
- **A separate subgroup will develop testing requirements for the new standard**
- **Induction generator based systems could have a problem**
 - Especially stall-regulated systems
 - How can stall-regulated induction generator systems stay excited and in phase?

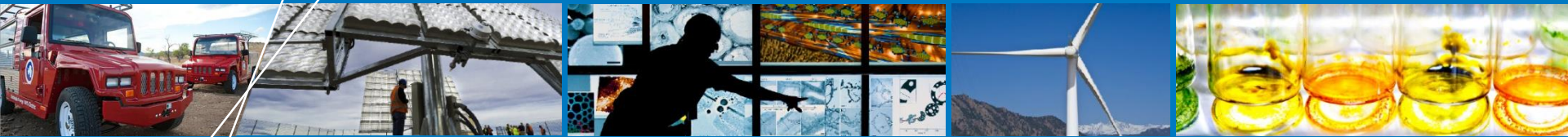
Conclusions

- **IEEE 1547 revision is the foundation of a future grid with high penetration of DER**
- **All DER will be required to provide grid support functions**
- **The standard will provide flexibility for different technologies**
- **Impact on DW will likely be small for inverter based systems but could be large for induction generators**

Thank You

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