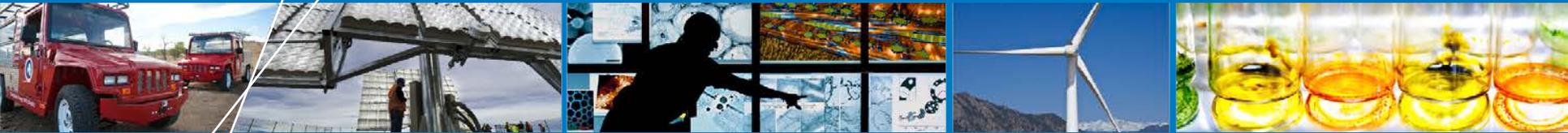


# IEEE 1547 Revision Will You Be Ready?



**Small Wind Conference**

**Stevens Point, Wisconsin**

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# Introduction

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- **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?

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- **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

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- **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)

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**This is all under development and subject to change.**

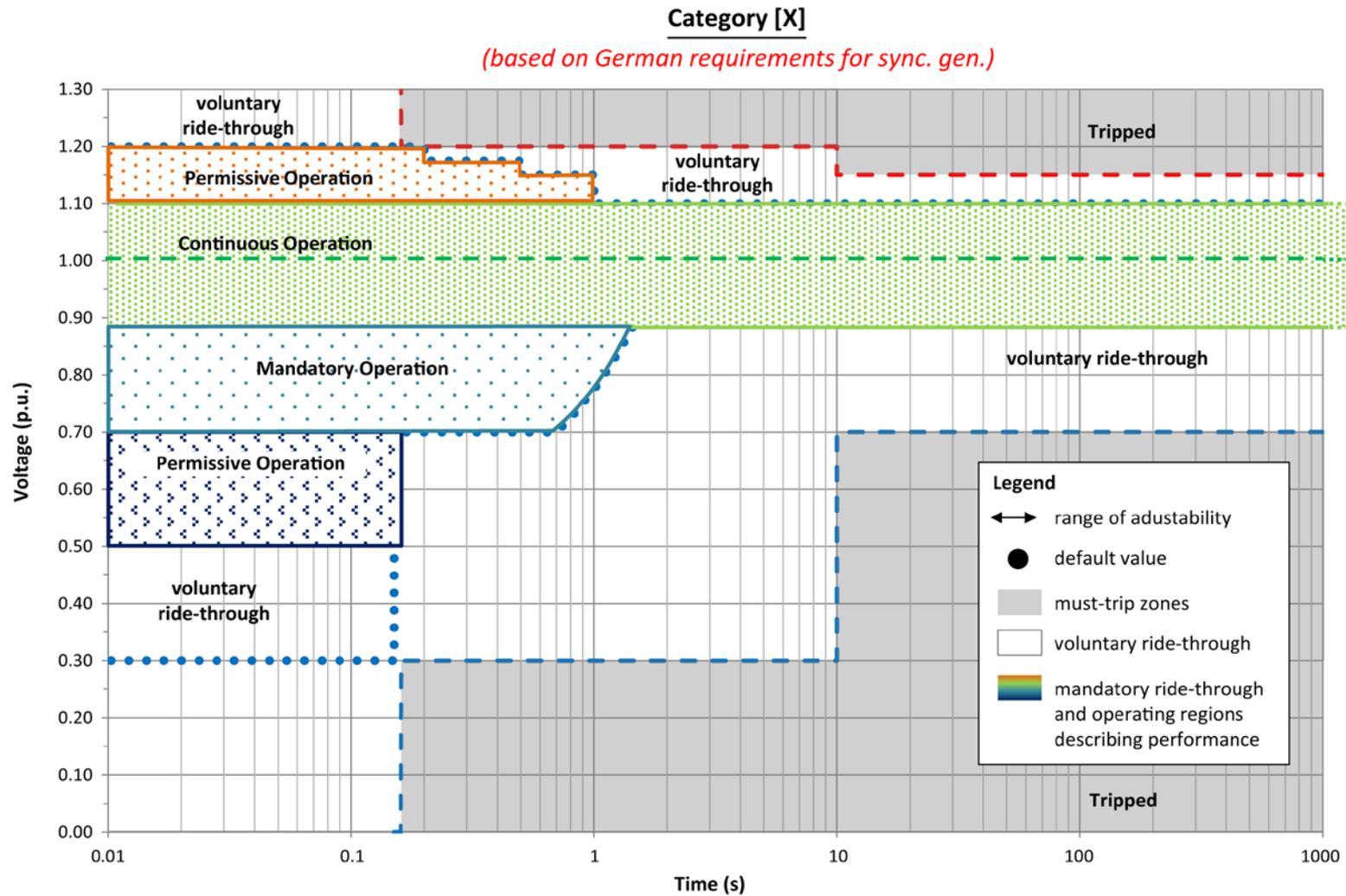
- **Three categories of distributed energy resources (DER)**
  - Guided by technology capabilities – not technology specific
  - Guided by grid support needs in high penetration
- **Requirements can be met at the DER, at the point of common coupling, or in between**

# Operating Regions

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- **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

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- **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

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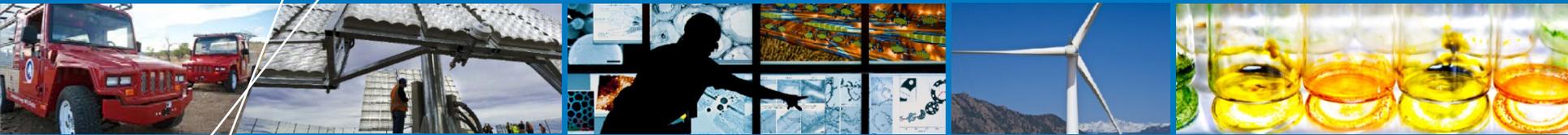
- **IEEE 1547 revision is the foundation of a future grid with high penetration of DER**
- **All DER will be required to provide grid support functions**
- **The standard will provide flexibility for different technologies**
- **Impact on DW will likely be small for inverter based systems but could be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

# Thank You

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The authors are solely responsible for any omissions or errors contained herein.



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