

# IEEE 1547: The DG Interconnection Standard

Utah Public Service Commission  
Distributed Generation Interconnection Workshop  
December 4, 2007  
Wayne Shirley  
Director



*The Regulatory Assistance Project*

50 State Street, Suite 3  
Montpelier, Vermont USA 05602  
Tel: 802.223.8199  
Fax: 802.223.8172

27 Penny Lane  
Cedar Crest, New Mexico USA 87008  
Tel: 505.286.4486  
E-Fax: 773.347.1512

110 B Water St.  
Hallowell, Maine USA 04347  
Tel: 207.623.8393  
Fax: 207.623.8369



# Introduction

## Regulatory Assistance Project

RAP is a non-profit organization, formed in 1992, that provides workshops and education assistance to state government officials on electric utility regulation. RAP is funded by the Energy Foundation, US EPA & US DOE.

### Our Mission:

*RAP is committed to fostering regulatory policies for the electric industry that encourage economic efficiency, protect environmental quality, assure system reliability, and allocate system benefits fairly to all customers.*



# Interconnection: High Level Context

- There are two major categories of issues for interconnection:
  - Technical and engineering standards which addressing physical interconnection and operational parameters for DG
  - An application process which provides minimizes unnecessary reviews and studies, while assuring safe and non-disruptive operation of DG – (later today)




# IEEE 1547 and 2005 Energy Act

- Federal Energy Policy Act of 2005 calls for state commissions to consider certain standards for electric utilities.
- Section 1254 of the act: “Interconnection services shall be offered based upon the standards developed by the Institute of Electrical and Electronics Engineers: IEEE Standard 1547 for Interconnecting Distributed Resources With Electric Power Systems, as they may be amended from time to time.”



# Overview of IEEE 1547

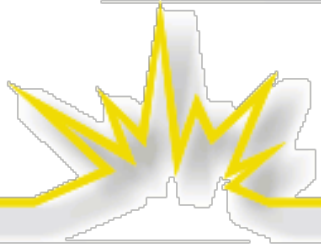
- What it is
- What it isn't
- How it was developed
- What's in it



# IEEE1547: What it is...

---

- Technical standards for:
  - Interconnection itself
  - Interconnection testing
- Technology neutral
- Mandatory, uniform, universal requirements
- Should suffice for most installations
- Key concept: Point of common coupling (PCC)



# IEEE 1547: Useful Definitions

- **Distributed Resource (DR)** – sources of electric power that are directly connected to a bulk power transmission
- **Electric Power System (EPS)** – facilities that deliver power to a load
- **Area EPS** – the electric system outside of the Local EPS (i.e. the utility system)
- **Local EPS** – the electric system associated with directly serving the customer load
- **Interconnection** – the result of the process of adding DR to an area EPS
- **Interconnection equipment** – individual or multiple devices used in an interconnection system
- **Interconnection System** – the collection of all interconnection equipment, taken as a group, used to interconnect DR unit(s) to an area EPS
- **Point of Common Coupling (PCC)** – the point where a Local EPS is connected to an Area EPS



# IEEE 1547: What it isn't...


- Design handbook
- Application guide
- Interconnection agreement or PPA
- Interconnection application or process
- Does not address:
  - DR self-protection
  - Planning
  - Operation
  - Maintenance



# IEEE 1547:

## How it was developed


- IEEE began work in 1999 to develop consensus interconnection standards that could be used nationwide
  - Stakeholder process open to interested stakeholders
  - Consensus oriented process
  - Engineering based process
- Resulted in identification of seven separate standards to be developed: 1547 & 1547.1-1547.6



# IEEE 1547 Series:

## IEEE 1547

- IEEE 1547 is the basic technical/engineering interconnection standard
  - After four year process, published as an official IEEE standard in July 2003
  - Addresses Two Key Areas:
    - Technical Requirements For Systems < 10 MW
    - Test Requirements
- Approved as an American National Standard in October 2003



# IEEE 1547 Series:

## IEEE 1547.1


- “Standard for Conformance Tests  
Procedures for Equipment Interconnecting  
Distributed Resources with Electric Power  
Systems”
  - Published in July 2005
  - Delineates test conformance requirements for  
IEEE 1547



# IEEE 1547 Series:

## IEEE 1547.2


- IEEE P1547.2 Draft Application Guide for IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems
- Scope: Provides technical background and application details to support the understanding of IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.
- Purpose is facilitate the use of IEEE 1547 by characterizing the various forms of distributed resource technologies and the associated interconnection issues
- Discusses background and rationale of the technical requirements in terms of the operation of distributed resource interconnections with the electric power system
- Includes technical descriptions and schematics, applications guidance, and interconnection examples to enhance the use of IEEE 1547



# IEEE 1547 Series:

## IEEE 1547.3


- “Guide For Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems”
- Published as an IEEE standard in 2007
- Provides guidelines for monitoring, information exchange, and control for distributed resources (DR) interconnected with electric power systems (EPS).
- Facilitates the interoperability of one or more distributed resources interconnected with electric power systems.
- Describes functionality, parameters and methodologies for monitoring, information exchange and control for the interconnected distributed resources with or associated with electric power systems.



# IEEE 1547 Series:

## IEEE 1547.4


- “Draft Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems”
- Provides alternative approaches and good practices for the design, operation, and integration of distributed resource (DR) island systems with electric power systems (EPS).
  - Includes the ability to separate from and reconnect to part of the area EPS while providing power to the islanded local EPSs.
  - Includes the distributed resources, interconnection systems, and participating electric power systems.
- Intended to be used by EPS designers, operators, system integrators, and equipment manufacturers.
- Addresses engineering concerns of DR island systems



# IEEE 1547 Series:

## IEEE 1547.5

- “Draft Technical Guidelines for Interconnection of Electric Power Sources Greater than 10MVA to the Power Transmission Grid”
- Provides guidelines regarding the technical requirements, including design, construction, commissioning acceptance testing and maintenance/performance requirements, for interconnecting dispatchable electric power sources with a capacity of more than 10 MVA to a bulk power transmission grid.




# IEEE 1547 Series:

## IEEE 1547.6


- “Draft Recommended Practice For Interconnecting Distributed Resources With Electric Power Systems Distribution Secondary Networks”
- Establishes recommended criteria, requirements and tests, and provides guidance for interconnection of distribution secondary network system types of area electric power systems (Area EPS) with distributed resources (DR) providing electric power generation in local electric power systems (Local EPS)
- Focuses on distribution secondary networks with a local DR generation
- Provides recommendations relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection considering the needs of the Local EPS to be able to provide enhanced service to the DR owner loads as well as to other loads
- Addresses the technical concerns and issues of the Area EPS
- Identifies communication and control recommendations
- Provides guidance on considerations that will have to be addressed for secondary network interconnections





# IEEE 1547: What's in it?

- Interconnection technical specifications:
  - General requirements
  - Response to Area EPS
  - Abnormal conditions
  - Power Quality
  - Islanding



# IEEE 1547: What's in it?

- Testing specifications and requirements:
  - Design tests
  - Production tests
  - Interconnection installation evaluation
  - Commissioning tests
  - Periodic interconnection tests



# IEEE 1547:

## In context

- IEEE 1547 focuses on two primary safety and operational issues:
  - What happens when DG or EPS are operating out of nominal parameters (voltage, frequency, etc.)?
  - What happens during normal operating conditions (voltage, frequency, harmonics, flicker, etc.)?
- Collateral issues addressed: connecting, disconnecting, reconnecting and synchronizing to the electric system
- Directed to interconnection equipment itself and conditions at the PCC
- Does not reach the DG equipment or the Area EPS
- One “major” shortcoming: Limited to 10 MW, while some rules (e.g. FERC) go up to 20 MW – (see IEEE 1547.5)



# IEEE 1547: Design Tests

- Temperature stability
- Response to abnormal voltage or frequency
- Synchronization
- DC Injection
- Unintentional islanding
- Reverse Power
- Cease to energize functionality and loss of phase
- Reconnect time
- Harmonics and Flicker

# UL 1741:

## A Companion to IEEE 1547

- UL 1741 is a standard for inverters
- Provides a basis for certification of inverter-based systems, sometimes called “pre-certified”
- Goes beyond IEEE 1547 to include:
  - Construction, materials, wiring, component spacing, etc.
  - Protection against risks of injury to persons
  - Output characteristics and utility compatibility
  - Ratings and labeling
  - Specific DR Tests for various technologies (PV, Wind, microturbines, fuel cells and engines)



# Relationship to Interconnection Rules

- IEEE 1547 is essentially the “law of the land” for interconnections because:
  - It is the accepted engineering standard
  - Federal law all but mandates its use
  - It works
- As a result, it can be treated essentially as a regulatory “black box” incorporated by reference in the interconnection process



Thanks for your attention

➤ Questions?