



**Perspective on P1547
Interconnection Standard
Development:
Completing the Standard
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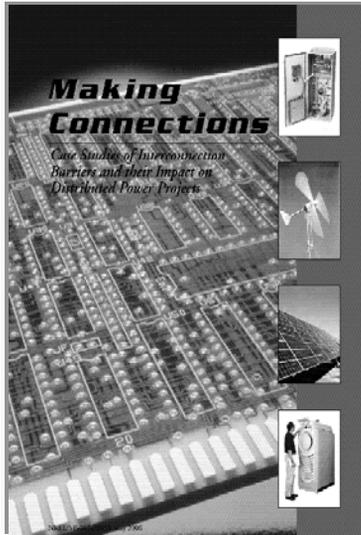
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OUTLINE

- **BACKGROUND**
- **IEEE P1547 INTERCONNECTION
STANDARD**
- **COMPLETING P1547**
- **MOVING FORWARD**



“Making Connections” Report



- Released May 1, 2000
- 90 DG projects identified, 65 surveyed, 26 summarized in report
- Projects ranged from 0.3 kW (PV) to 26 MW (gas turbine)
- Available on the Web at:
<http://www.eren.doe.gov/distributedpower/barriersreport/>



Making Connections – Ten-Point Action Plan

- **Reduce Technical Barriers**
 - Adopt uniform technical standard for interconnecting
 - Develop testing and pre-certification procedures for DG equipment
 - Develop distributed power control technology
- **Reduce Business Practice Barriers**
 - Establish standard commercial practices for utility review
 - Establish standard business terms for interconnection agreements
 - Develop tools for utilities to assess the value and impact of distributed power at any point on the grid
- **Reduce Regulatory Barriers**
 - Develop new regulatory principles for distributed power choices in both competitive and utility markets
 - Adopt regulatory tariffs and utility incentives for DP
 - Establish expedited dispute resolution processes
 - Define the conditions necessary for a right to interconnect



P1547 Interconnection Standard

Title: IEEE P1547 Draft

***Standard for Interconnecting
Distributed Resources
with Electric Power Systems***



P1547 Development Approach

- **Voluntary consensus standard**
 - **Hallmark of the standards process**
 - **Open to all dedicated parties**
 - **IEEE ballot member categories:**
 - General Interest, Producer, User**
- **Fast-track schedule**
 - **April 1999 -- IEEE approved P1547 project**
 - **Ballot draft development meetings held every 2 months**



P1547 Interconnection Standard

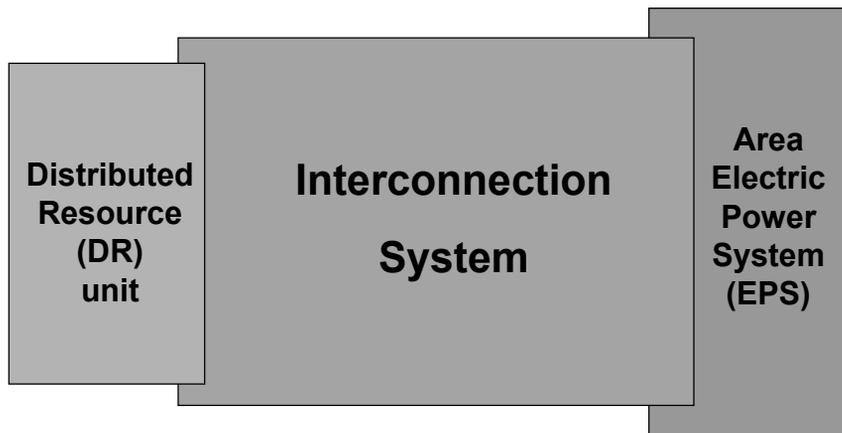
Scope: This standard establishes criteria and requirements for interconnection of distributed resources (DR) with electric power systems (EPS).

Purpose: Provide a uniform standard for interconnection of distributed resources with electric power systems, and requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.

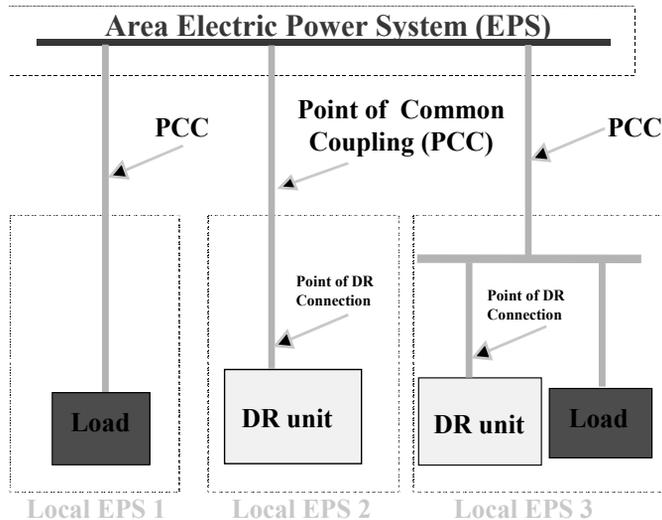
Sponsor: IEEE SCC21 -- *Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage*; Chair, R. DeBlasio.



P1547: Interconnection Is The Focus



P1547 Interconnection Terms



Note: There can be any number of Local EPSs.



P1547 Technical Requirements Fall Into Several Categories

- **General Requirements**
- **Response to Area EPS Abnormal Conditions**
- **Power Quality**
- **Islanding**
- **Test Specifications and Requirements**



IEEE P1547/D9 Contents

- **INTRODUCTION**
- **1.0 OVERVIEW**
- **2.0 REFERENCES**
- **3.0 DEFINITIONS and ACRONYMS**
- **4.0 INTERCONNECTION TECHNICAL SPECIFICATIONS & REQUIREMENTS**
- **5.0 TEST SPECIFICATIONS & REQUIREMENTS**
- **ANNEX A (INFORMATIVE) BIBLIOGRAPHY**



IEEE P1547/D09 Contents

INTRODUCTION

1.0 OVERVIEW

- 1.1 Scope**
- 1.2 Purpose**
- 1.3 Limitations**

2.0 REFERENCES

3.0 DEFINITIONS



IEEE P1547/D09 Contents

4.0 INTERCONNECTION TECHNICAL SPECIFICATIONS AND REQUIREMENTS

- 4.1 General Requirements**
- 4.2 Response to Area EPS Abnormal Conditions**
- 4.3 Power Quality**
- 4.4 Islanding**

5.0 TEST SPECIFICATIONS AND REQUIREMENTS

- 5.1 Interconnection Test**
- 5.2 Production Tests**
- 5.3 Interconnection Installation Evaluation**
- 5.4 Commissioning Tests**
- 5.5 Periodic Interconnection Tests**

ANNEX A (INFORMATIVE) BIBLIOGRAPHY

IEEE P1547 Development Status

- **March 2001: Completed initial ballot action (Draft 7)**
 - 167 Ballot members; Too few affirmatives to move forward
 - Draft 7 reworded to Draft 8 for recirculation ballot
- **October 2001: Completed ballot recirculation (Draft 8)**
 - Too few affirmatives to move Draft 8 forward
- **January 2002: Last P1547 WG Meeting**
 - Body of Standards
 - Expanded P1547 Writing Group
- **February – May 2002:**
 - Developed new P1547 Draft 9;
 - P1547 Working Group at 350 members
- **June 2002:**
 - Interconnection Standards Meeting, Vail Colorado



IEEE P1547 Interconnection Standard Ballot Status

Requirements for adoption: 75% ballot return, 75% affirmative

<u>Round 1-- Draft 7</u>			<u>Round 2 -- Draft 8</u>		
<ul style="list-style-type: none"> • Balloting completed 4/1/01 • 91% ballot returns • 66% affirmative • Addressed negative comments 			<ul style="list-style-type: none"> • Recirculation completed 10/2/01 • 96% ballot returns • 66% affirmative • New Draft TBD 		
<u>Voter Category</u>	<u>Affirm</u>	<u>Negative</u>	<u>Voter Category</u>	<u>Affirm</u>	<u>Negative</u>
- User	30	23	- User	25	33
- Producer	35	12	- Producer	43	6
- General Interest	28	15	- General Interest	35	14



SOME KEY ISSUES

- **Minimum vs Maximum Requirements**
- **Field Testing vs Type Testing**
- **Secondary Grid and Spot Networks**
- **Grid/DG Monitoring and Control**
- **Voltage Regulation/Stability**
- **Grounding/Faults**
- **DG Penetration/Aggregation**



Some Concerns

**May be addressed in a Guide (P1608)
and Not addressed in a Standard (P1547)**

- 1. EPS Impacts and Analysis (is it necessary and when)**
- 2. Penetration (ideal allowable aggregation)**
- 3. Safety (functional vs operational modes)**
- 4. Re-Fit EPS (What to do)**
- 5. Cost of EPS Re-Fit (How and Who Pays)**
- 6. Operation (which standard and who is in control)**
- 7. Reliability (operational issues – durability vs availability)**
- 8. Federal/State Implementation and Impacts (Rules)**
- 9. Misunderstanding/application (limited experience/knowledge)**
- 10. User disagreement (not all utilities and DGs are alike)**



Working Group Broader-DER Interconnection Concerns and Issues

1. Fully Commercialized/Certified Products
2. After Sale Service Support/Warranties
3. Liability (DG vs Grid Operators)
4. Full-Scale remote/unattended Operation (Autonomous vs Semi-Autonomous)
5. Integrated Controls & Protective Relaying (design/location)
6. Functionality of Interconnection package (always more to add)
7. Where to include the Interconnection capabilities (“black box”, generator control, etc.)
8. Interface Standards between DER and Interconnection package (equipment manufacturing design standards)
9. Issues of Scaling to different power levels
10. Lower interconnection system cost



COMPLETING THE P1547 STANDARD



IEEE Standards Classification

1. **Standards**: documents with mandatory requirements (**shall**)
2. **Recommended Practices**: documents in which procedures and positions preferred by the IEEE are presented (**should**)
3. **Guides**: documents in which alternative approaches to good practice are suggested but no clear-cut recommendations are made (**may**)



P1547 Joint Working & Ballot Group Meetings

- **April 2001: Draft 7-reword recommendations**
- **Oct. 2001: Draft 8-reword recommendations**
- **Jan. 2002: Draft 8 pointed & focused review**
 - **Follow WG fundamental principles**
 - mandatory requirements
 - universally needed for interconnection
 - technology neutral
 - aggregate size up to 10 MVA
 - **Recognition that some comments and content go beyond the P1547 principles**
- **June 2002: Draft 9 Pre-ballot Discussion**

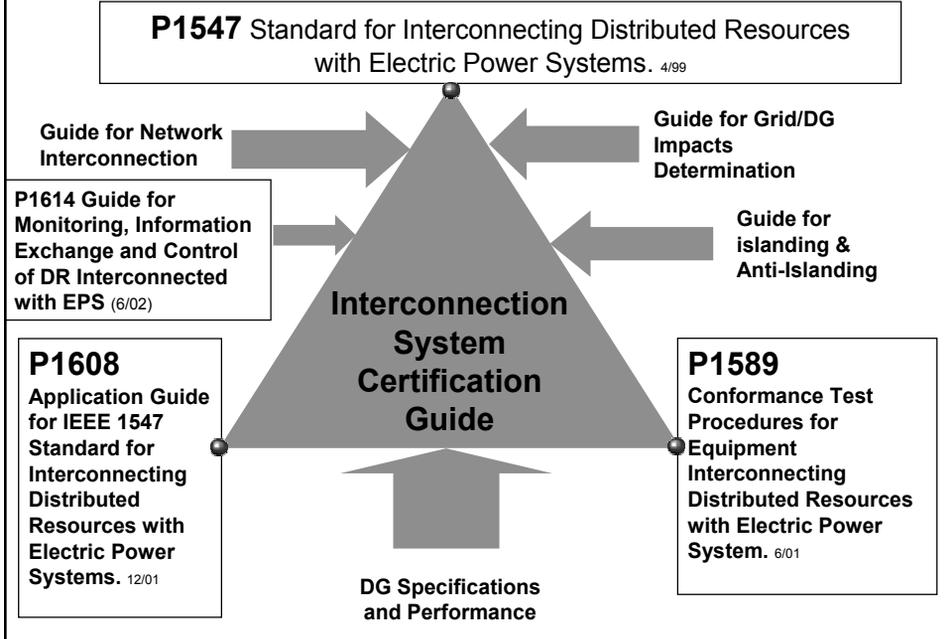


P1547 New Draft Development Clause-by-Clause Review

- **Remove Draft 8 Information**
 - › Procedure requirements
 - › Application Guidance
 - › Safety practices
 - › Equipment-specific criteria
 - › Operating considerations
 - › Regulatory aspects
 - › Other information
 - Move information to other standards
 - Move information for technical or regulatory review or study
- **Remain in P1547 Draft 9**
 - Reword as mandatory requirements



Body of Standards



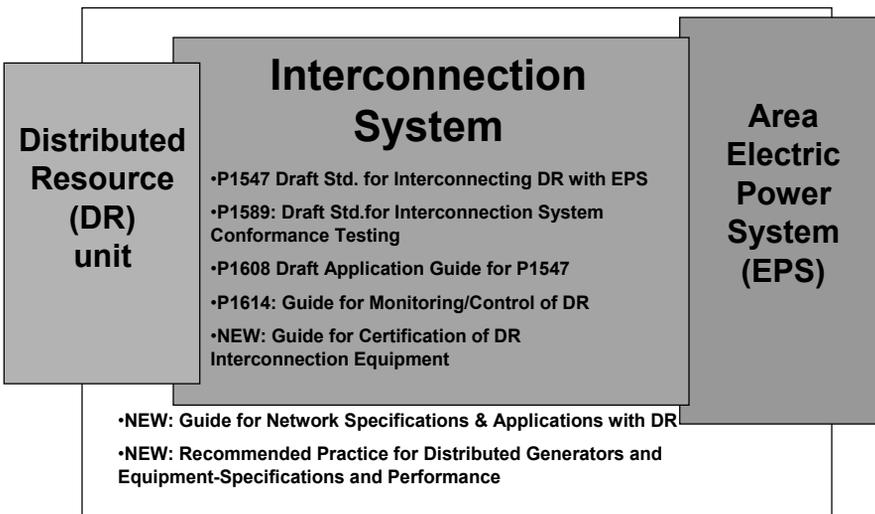
Current SCC21 Interconnection Projects

Title	Scope
P1547 <u>Standard</u> for Interconnecting Distributed Resources with Electric Power Systems.	This <u>Standard</u> establishes criteria and requirements for interconnection of distributed resources (DR) with electric power systems (EPS).
P1589 <u>Standard</u> for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.	This <u>Standard</u> specifies the type, production, and commissioning tests that shall be performed to demonstrate that interconnection functions and equipment of a distributed resource (DR) conform to IEEE Std 1547.
P1608 <u>Application Guide</u> for IEEE Standard 1547 for Interconnecting Distributed Resources with Electric Power Systems	This <u>Guide</u> provides technical background and application details to support the understanding of IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.
P1614: <u>Guide</u> for Monitoring, Information Exchange and Control of Distributed Resources Interconnected with Electric Power Systems	{proposed} This document provides guidelines for monitoring, information exchange, and control for DR interconnected with EPS. Examples of DR are fuel cells, PV, microturbines, and other dispersed generators and energy storage systems.

MOVING FORWARD



Ongoing & Prospective IEEE DR Activities



NREL Distributed Power Systems Integration Activities

Engineering and Test Development

Research on advanced interconnection systems including hardware and software for DR interconnected with electric power systems



Standards and Codes

Development of standards and codes that address safety, reliability, power quality, and interconnection issues related to the integration of distributed resources with power systems

IEEE P1547
Draft Standard for Interconnecting Distributed Resources with Electric Power Systems

Regulatory and Institutional Issues

Working with industry, state and local government organizations to eliminate unnecessary barriers to the use of distributed power



NREL Distributed Power Program Testing Activities* Interconnection, Integration, and Validation

(* NREL-In-house and Industry Partnerships)

Simulation and Modeling

University of Wisconsin
Orion - University of Massachusetts (Lowell)
Industry Partners - DTE, GE, NiSource

Characterization R&D

NREL - DER Test Facility
EPRI - PEAC
University of Wisconsin

Certification

EPRI-PEAC
Underwriters Laboratories

Field Testing and Validation

Nevada Test Site
Distributed Utility Integration Test - DUA
Industry Partners - GE, NYSERDA, GRI, NRECA, NiSource, Real Energy, DTE



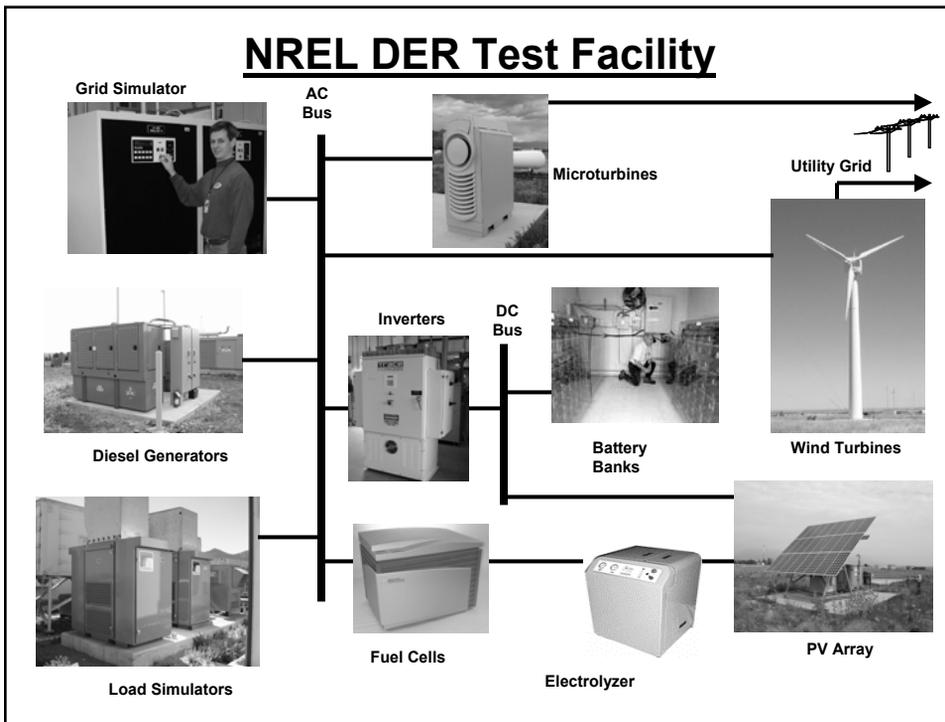
NREL DER Test Facility

Interconnection and Systems Integration



Testing includes:

- Validate IEEE P1547 Requirements;
- Develop IEEE P1589 Test Procedures;
- Currently testing microturbines and inverters.

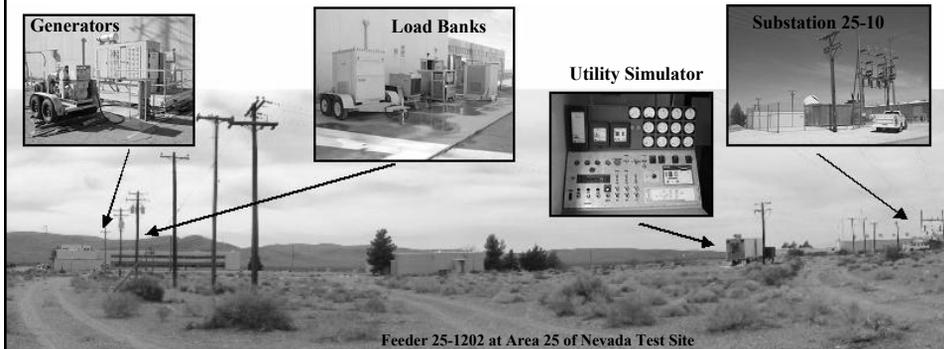




DOE Distributed Power Program

Field Validation Test at the Nevada Test Site

- Exploratory field tests to validate interconnection and commissioning tests in IEEE P1547 Interconnection Standard
- NREL is also developing a long-term testing plan for NTS.
- Testing has been conducted on 2 different types of DG:
 1. Inverter (5kW Inverter with PV array and Battery Bank)
 2. Synchronous generator (100kW diesel gensets w/ paralleling package).



ACKNOWLEDGMENTS

- **IEEE SCC21 P1547 -- 350 Working Group Members**
- **DOE -- Joe Galdo Program Manager**
- **NREL Distributed Power Program**
 - R. DeBlasio -- Technology Manager NREL DPP
 - B. Kroposki -- Technical Lead: Integration Engineering & Testing
 - G. Nakarado -- Technical Lead: Policy & Regulatory Analysis
 - H. Thomas -- Technical Lead: Interface Applications
 - T. Basso -- Technical Lead: Interconnection Engineering & Standards
 - NREL Subcontractors and Additional Partners
- **NREL DOE Contract Operators**
 - Midwest Research Institute, Battelle, and Bechtel



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- **NREL -- <http://www.nrel.gov>**
- **IEEE SCC21 -- IEEE Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, & Energy Storage**
 <http://grouper.ieee.org/groups/scc21/>
- **P1547 Standard for Interconnecting Distributed Resources with Electric Power Systems -- web site and archives**
 <http://grouper.ieee.org/groups/scc21/1547>
 <http://grouper.ieee.org/groups/scc21/1547/archives/>
- **DOE Distributed Power Program**
 <http://www.eren.doe.gov/distributedpower>

