

Overview of DER Laboratory Network Activities



NREL

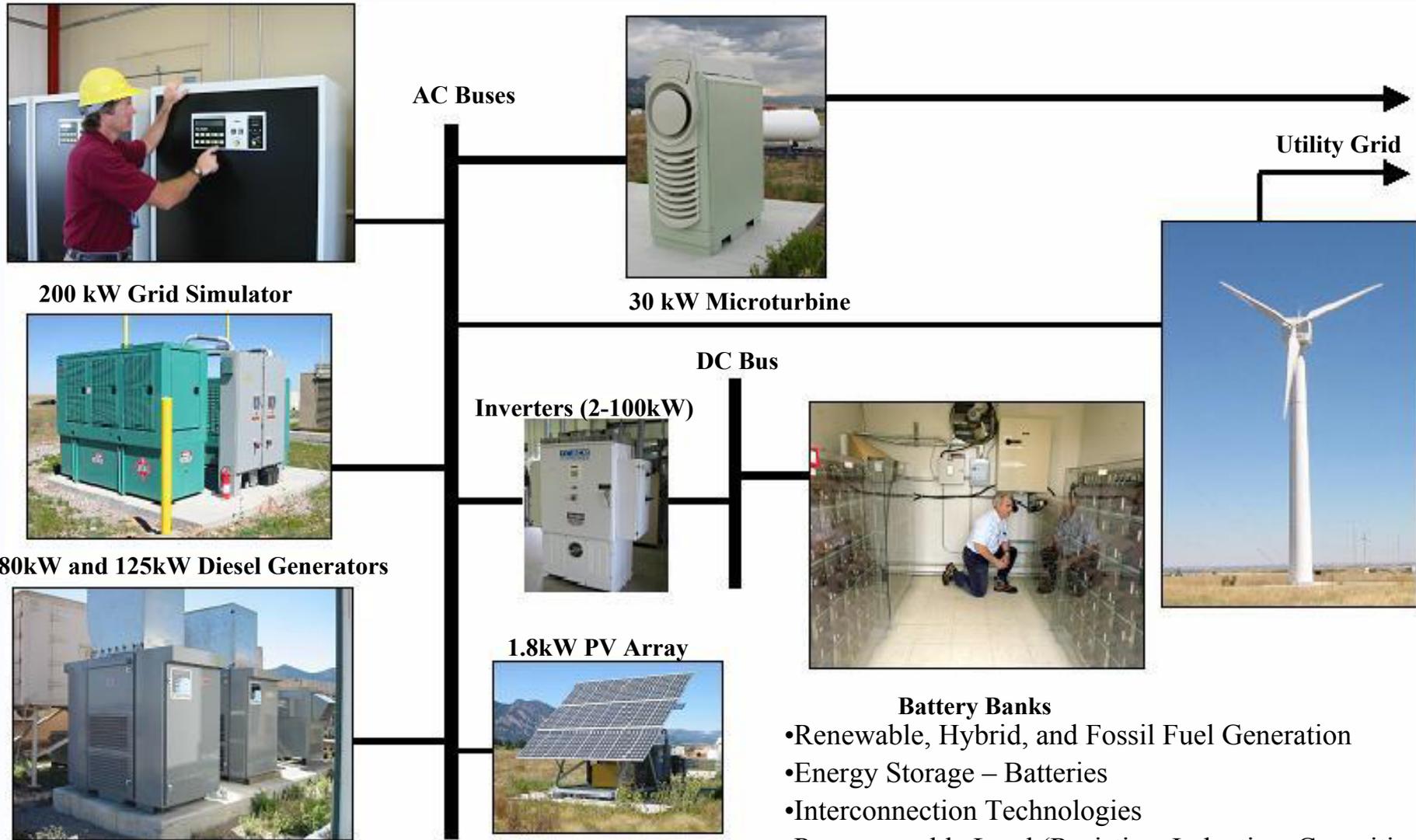
National Renewable Energy Laboratory

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY



Sandia National Laboratories

NREL DER Test Facility – Distributed Power Systems Testing



- Renewable, Hybrid, and Fossil Fuel Generation
- Energy Storage – Batteries
- Interconnection Technologies
- Programmable Load (Resistive, Inductive, Capacitive)
- Utility Power and Grid Simulators

DER Distributed Power Program - (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

DG Test Pads



Surge Tester



DAS Equipment



200kW Grid Simulator



Test Equipment

- Distributed Generation
- Distributed Storage
- Protective Equipment
- Switches
- Electronics
- Communications and Controls

Measurements

- Power Quality
- Stability
- Response to Disturbances
- Performance/ Functionality

Specific Tests

- Validation of P1547 Requirements
- Development of P1589 Procedures
- Over/Under Voltage
- Over/Under Frequency
- Islanding
- Surge Withstand

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).



Generators



Load Banks



Utility Simulator



Substation 25-10





Thermal Test Facility (TTF) is used to simulate and test the performance of building materials and fabricated components.



Advanced HVAC Test Facility houses state-of-the-art humidity and pressure sensors for testing larger devices such as enthalpy exchange and liquid desiccant systems. →

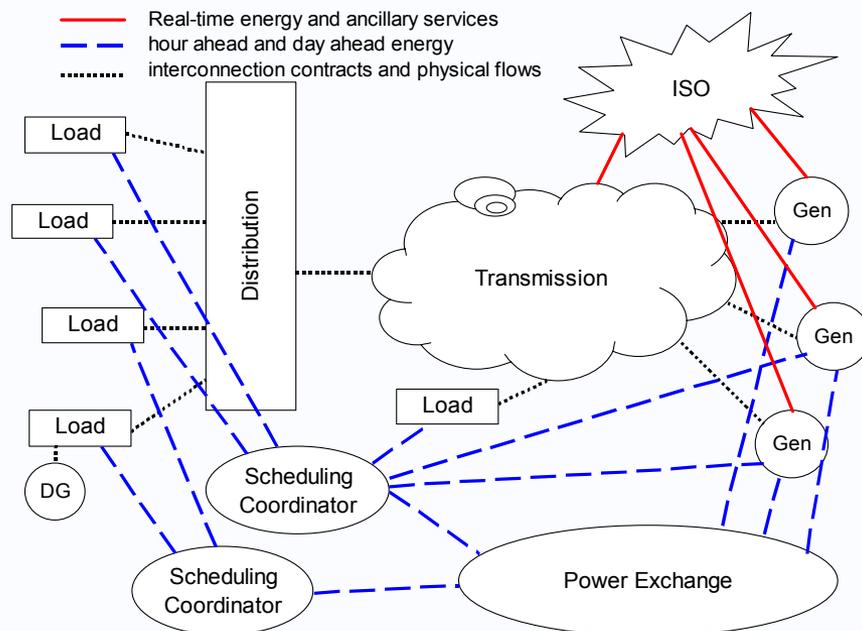


An experimental desiccant-assisted heat-pipe unit is being evaluated using a computer-controlled data acquisition system in the HVAC Test Facility.

- **Power Systems and Ancillary Services from multiple perspectives, user, central control authority, and market system.**
- **Cooling and Heating Systems Technology – Integration of DER with a range of thermal technologies such as heat recovery thermally-activated absorption and desiccant systems.**
- **Power Electronics Conditioning – ORNL is developing novel concepts and innovative technologies for interfacing DER with the distribution system and grid.**
- **Emissions Testing – ORNL is developing methods for reducing emissions from diesel engines to levels that are at the threshold of detection.**



- Tests and demonstrations of grid and distribution reliability and ancillary service methods.
- ORNL addresses the perspectives of the generator, system operator, transmission owner, utility, regulator, power marketer and load.





Integration of electric/thermal recovery, and thermally activated components.

Objectives: Benchmarking microturbine/thermal system performance and emissions. Optimize overall DC-CHP system performance/cost. Working with seven industry teams to develop CHP systems.

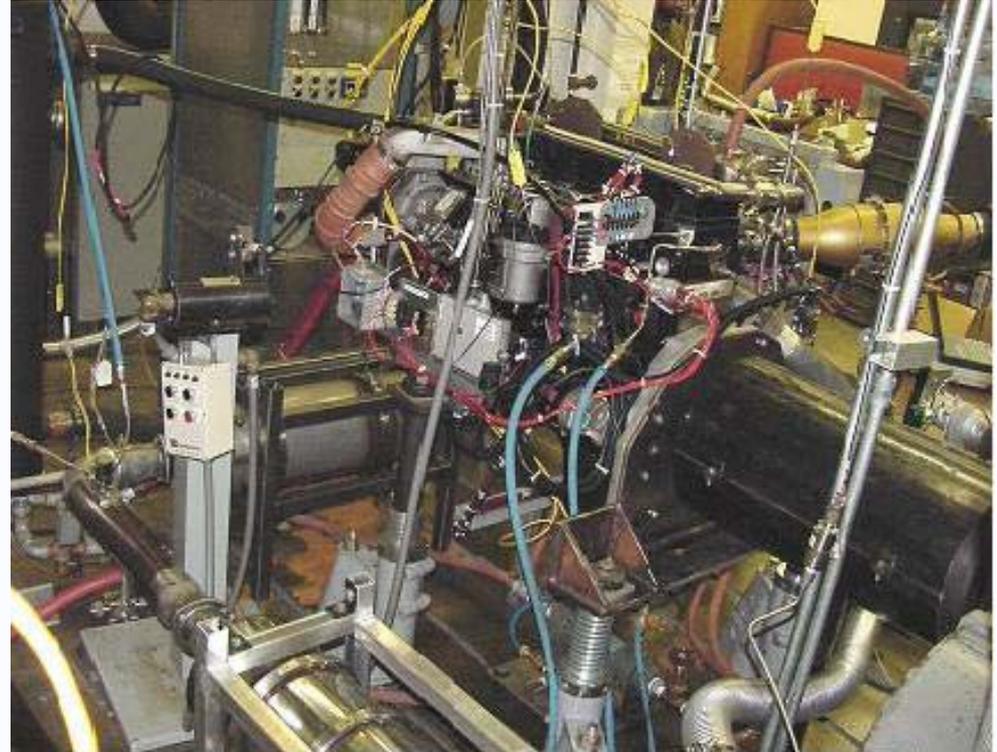


Activity: ORNL is designing, building and testing a power electronic utility interface that will provide total control over power flow.

Objective: This power electronic interface will enable DER to supply power quality services on the customer and the utility side of the meter and will enable the connection of large numbers of DER.

Partnerships: Several major manufacturers are presently teaming on new methods.

- **Objective:** Decrease fuel consumption & emissions from reciprocating engines
- **Characterization:** Advanced emissions controls, real-time emissions measurement technology, exhaust species analysis, alternative fuels, & electronic engine controls.
- **Partnerships:** Several of the major reciprocating engine manufacturers are teaming to develop new methods for engine control strategies, catalysts, etc.



Secure Grid

Secure SCADA Lab



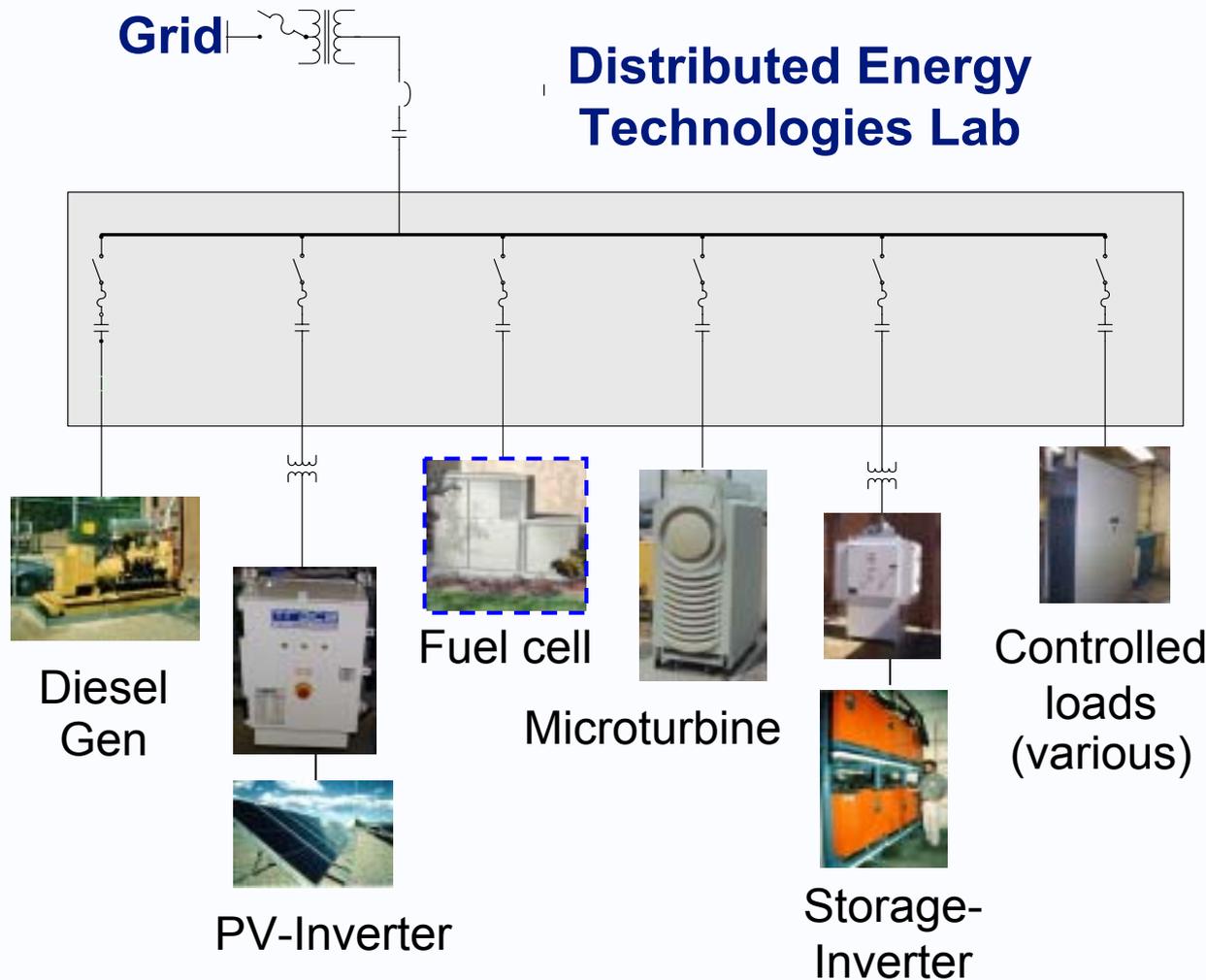
data/control

Other Remote DER sites

Grid and System Performance

Grid

Distributed Energy Technologies Lab



System Integration and Device Testing



Storage



Inverters



Sources



• Testing

- Islanding
- Interaction
- Performance
- Utility Interactions

• Testing

- Integration
- Performance
- Lifetime
- Utility Interactions



Specialized Tests



Traceable Calibrations



Voltage sags



Radio frequencies



Lightning surges

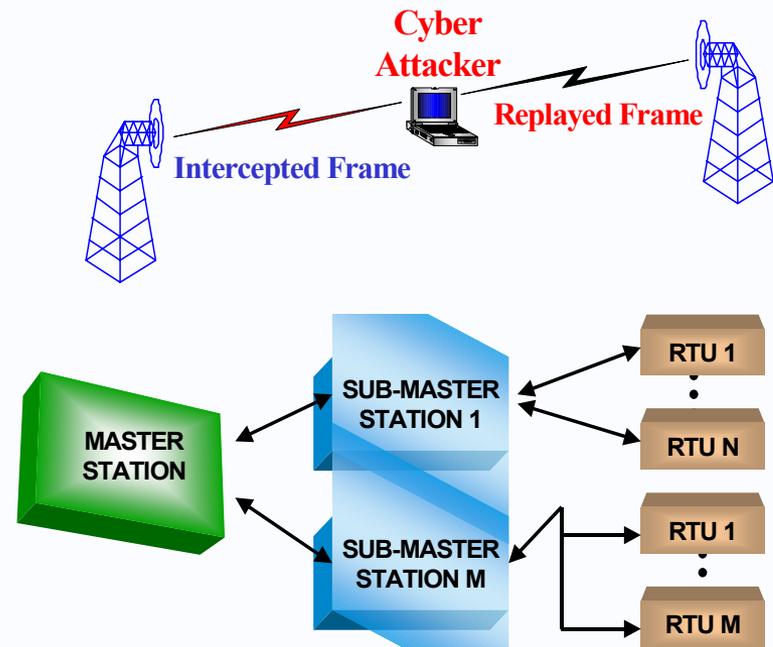


Multi-inverter islanding

Sandia Secure SCADA

High Surety SCADA Project Supports Reliable Communications and Controls

- The SCADA Testbed allows real-world problems to be modeled, replicated, simulated, and corrected
- Utility and vendor assessment of vulnerabilities and remediation options
- Evaluate all common SCADA protocols
- Develop operational security procedures
- Extending this capability to DG sources
- Developing communication standards for DG sources



Communication and Control security will be required

Salt River Project (Funds-in CRADA)

Models and tests DER interconnection and penetration issues

Public Service Co. of NM (Funds-in CRADA)

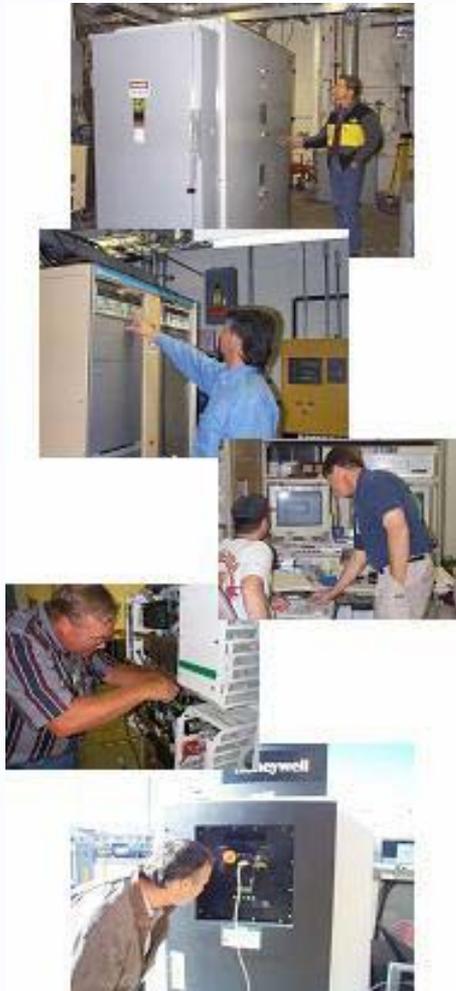
Tests micro-turbines for islanding, utility interconnection and compatibility

FEMP DER/Micro-turbine Training

Trains facility managers in DER operations

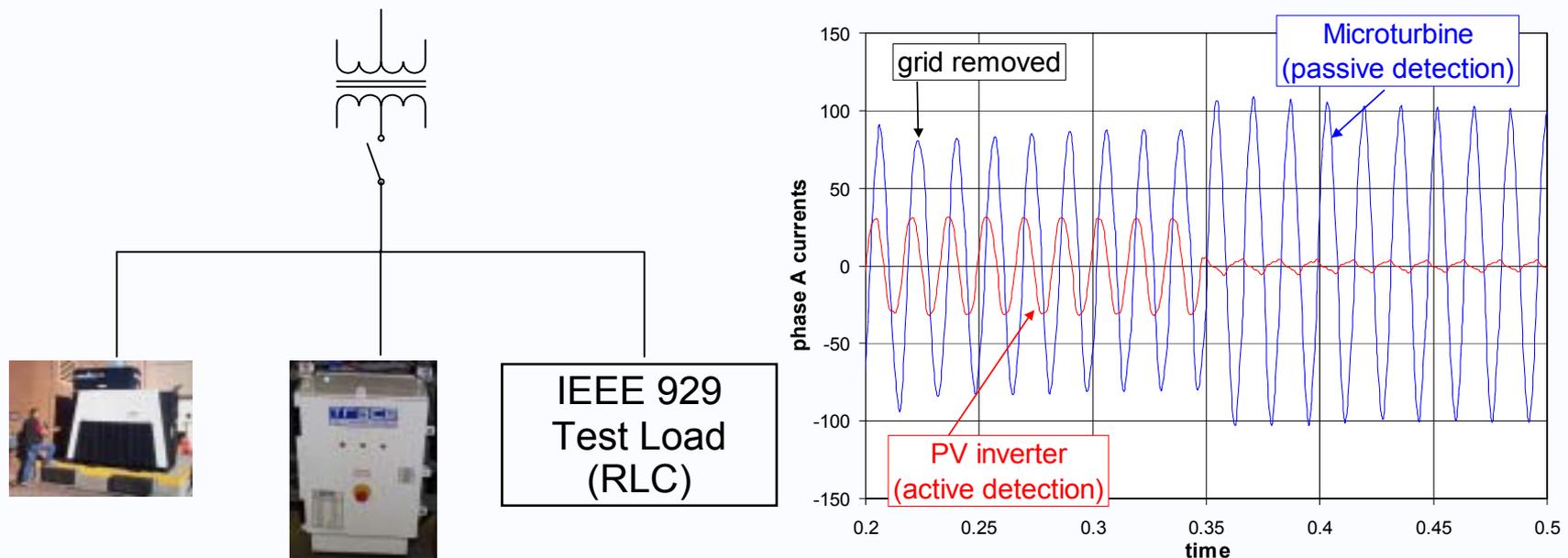
S&C Electric “Purewave”

Integrated energy storage & power electronics



Applied IEEE 929-2000/UL 1741 to DER technology

- Supporting DER manufacturer and interconnection activities
- SNL led definition of non-islanding inverter & test procedure which significantly eased the interconnection of PV



Passive anti-islanding detection can be fooled