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Microgrid V2G Charging Station Interconnection Testing




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17 July 2013

Electric Power Research Institute (EPRI)
Infrastructure Working Council
Palo Alto, California

NREL/PR-5400-59200

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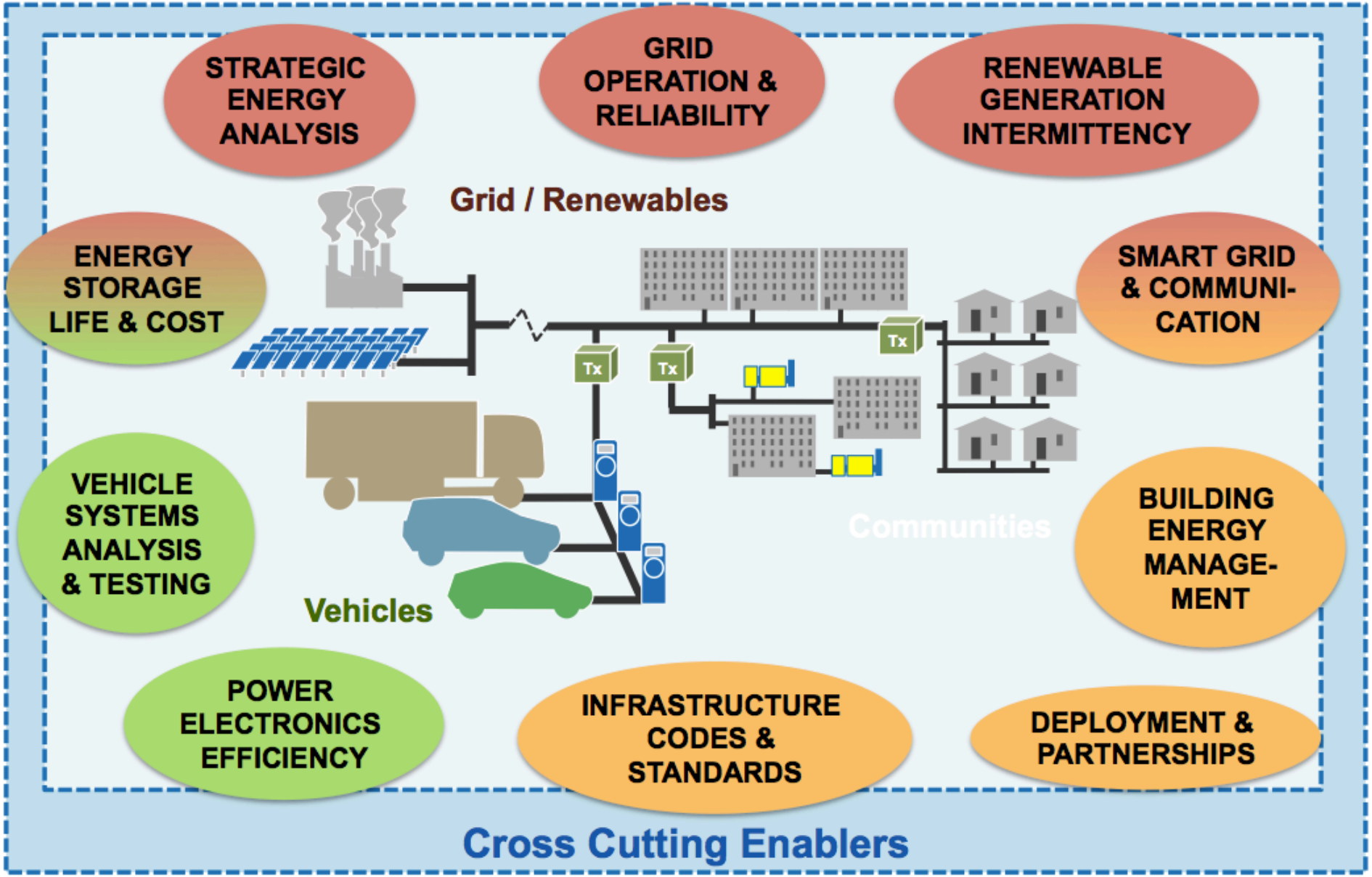
Agenda

- NREL Electric Vehicle Grid Integration (EVGI) Background
- SPIDERS and Military Microgrids
- Previous Work
- Energy Systems Integration Facility
- Test Setup
- Results

What is Electric Vehicle Grid Integration (EVGI)?



SPIDERS: JCTD

- **Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS)**
  - Joint Command Technology Demonstration (JCTD)
    - NORTHCOM + PACOM
  - Demonstrate:
    - Cyber-security of electric grid
    - Smart Grid technologies & applications
    - Islanded micro-grid
    - Demand-side management
    - Redundant back-up power systems
    - Integration of distributed/intermittent renewables
- **Ft. Carson:** "Triple Net Zero" Installation
  - Currently have 2-MW Solar array on-base
    - Demo-ing several other RE tech on-site
  - Project goal is to demonstrate:
    - Large-scale renewables
    - Smart micro-grid
    - *Vehicle-to-Grid (V2G) with Plug-in Electric Vehicles (PEVs)*

Ft. Carson 2MW Solar Array

NREL PIX 17394

Smith Newton Electric Truck; NREL PIX 17631

SPIDERS PEV Charge Interface

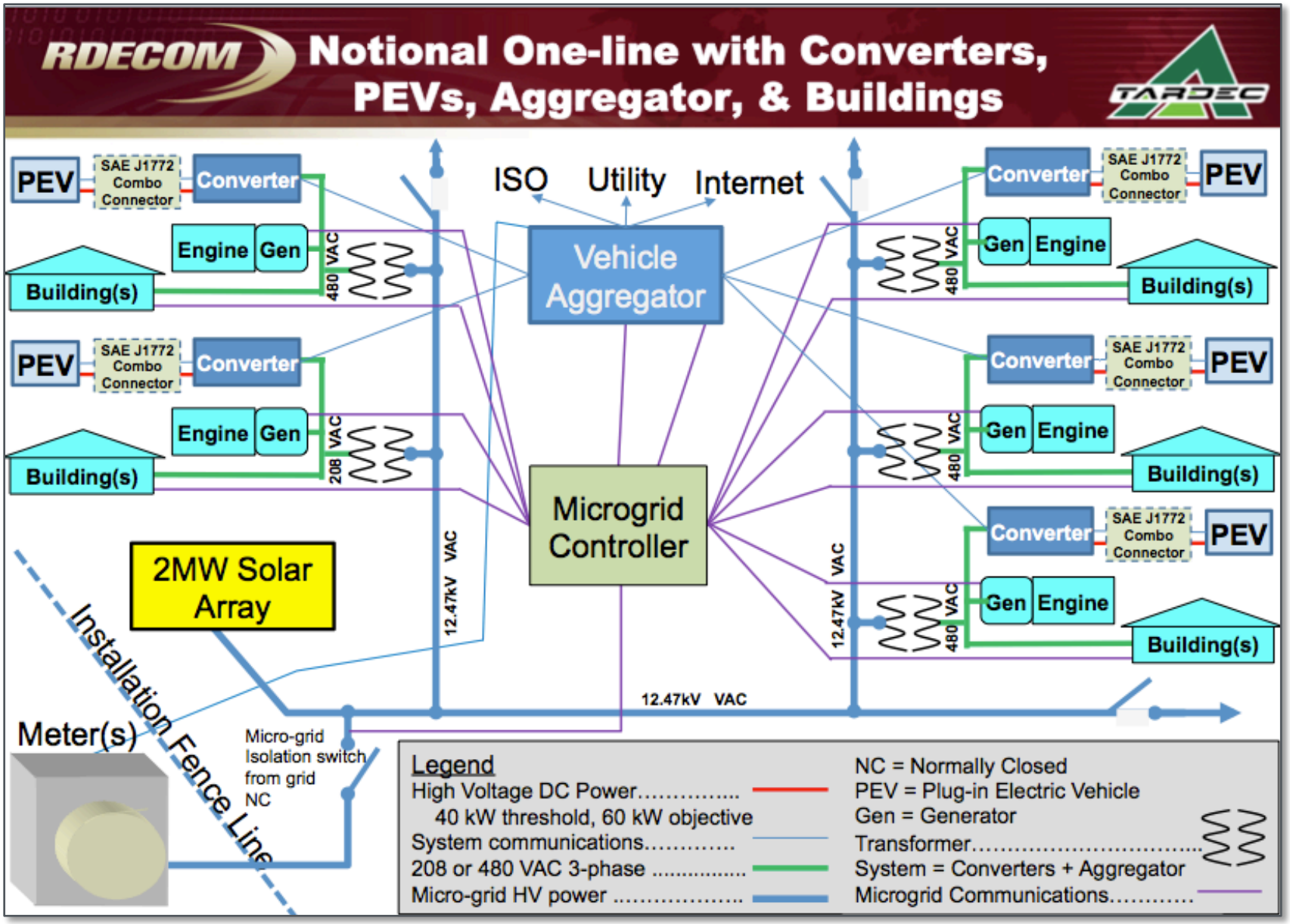
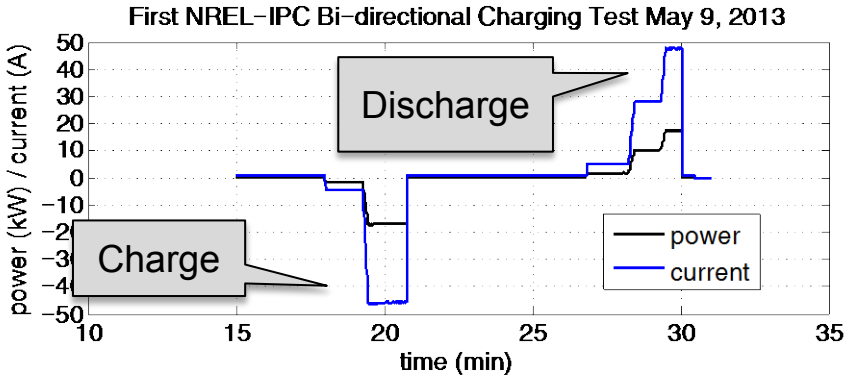
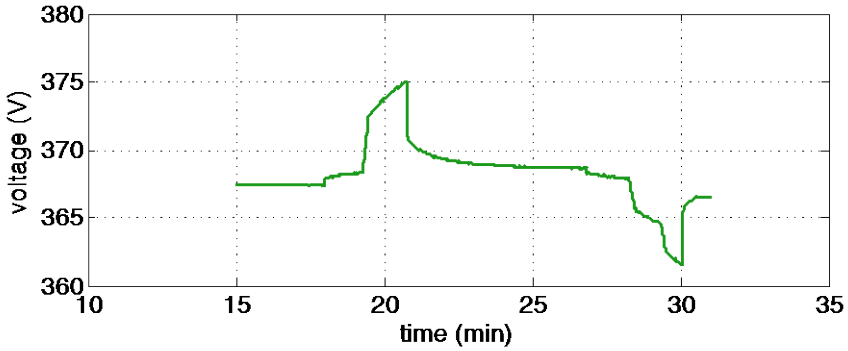


Diagram courtesy Dean McGrew, TARDEC

NREL Off-board DC V2G Testbed

- 2-port Ideal Power Converters unit provides bi-directional power flow with grid using Transit Connect Electric vehicle
- Operated at 60-A IPC limit; ~1°C rate with no observed temperature affect
- Rate control from -20 kW to +20 kW through MODBUS interface
- Tests use J1772 combo connector





Bi-Directional EVSE

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Electrical Specifications	
Continuous AC power	60 kW
AC connection to grid	3-phase (no neutral)
Nominal AC voltage	480 Vac
Maximum fault current contribution (to grid)	1700 A for 3ms
Maximum continuous AC current	133 A
AC voltage operating range	480 Vac +/-10%
DC voltage operating range	280-600 Vdc
Frequency range	57.0 – 60.5 Hz
Maximum DC fault current	600 Adc
Maximum operating DC current	285 Adc
Physical Specifications	
Weight	2450 lbs
Dimensions	48” W x 36” D x 100” H
Environmental/Cooling Specification	
Cooling type	Closed Loop A/C

NREL PIX 26450

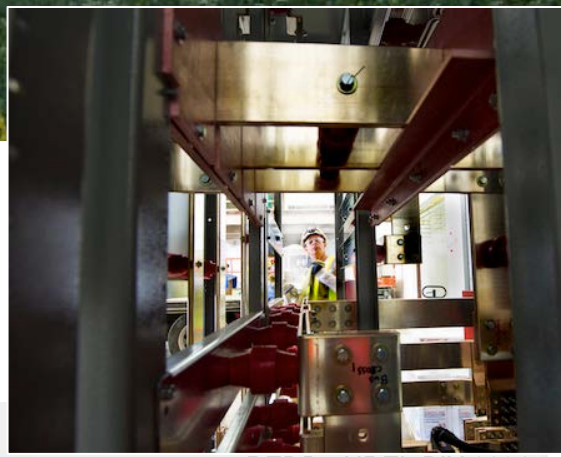
Touchscreen GUI Snapshot

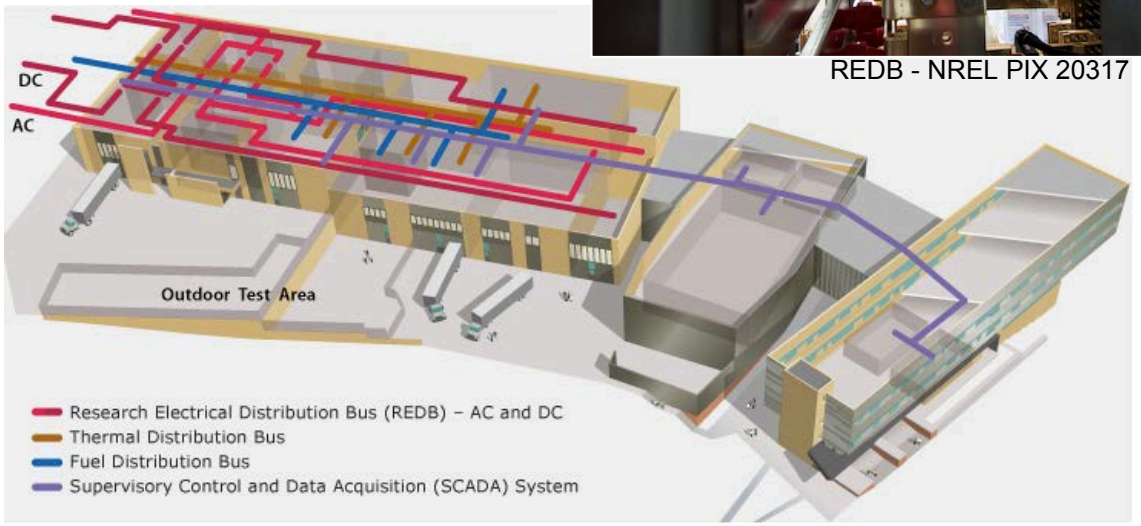
Energy Systems Integration Facility

- 182,500 sq. ft.
- 1-MVA bi-directional grid simulator
- Low Voltage Distribution Bus
- Medium Voltage Outdoor Test Area
- Full Power Hardware in the Loop (PHIL) testing
- Petascale High Performance Computing (HPC)

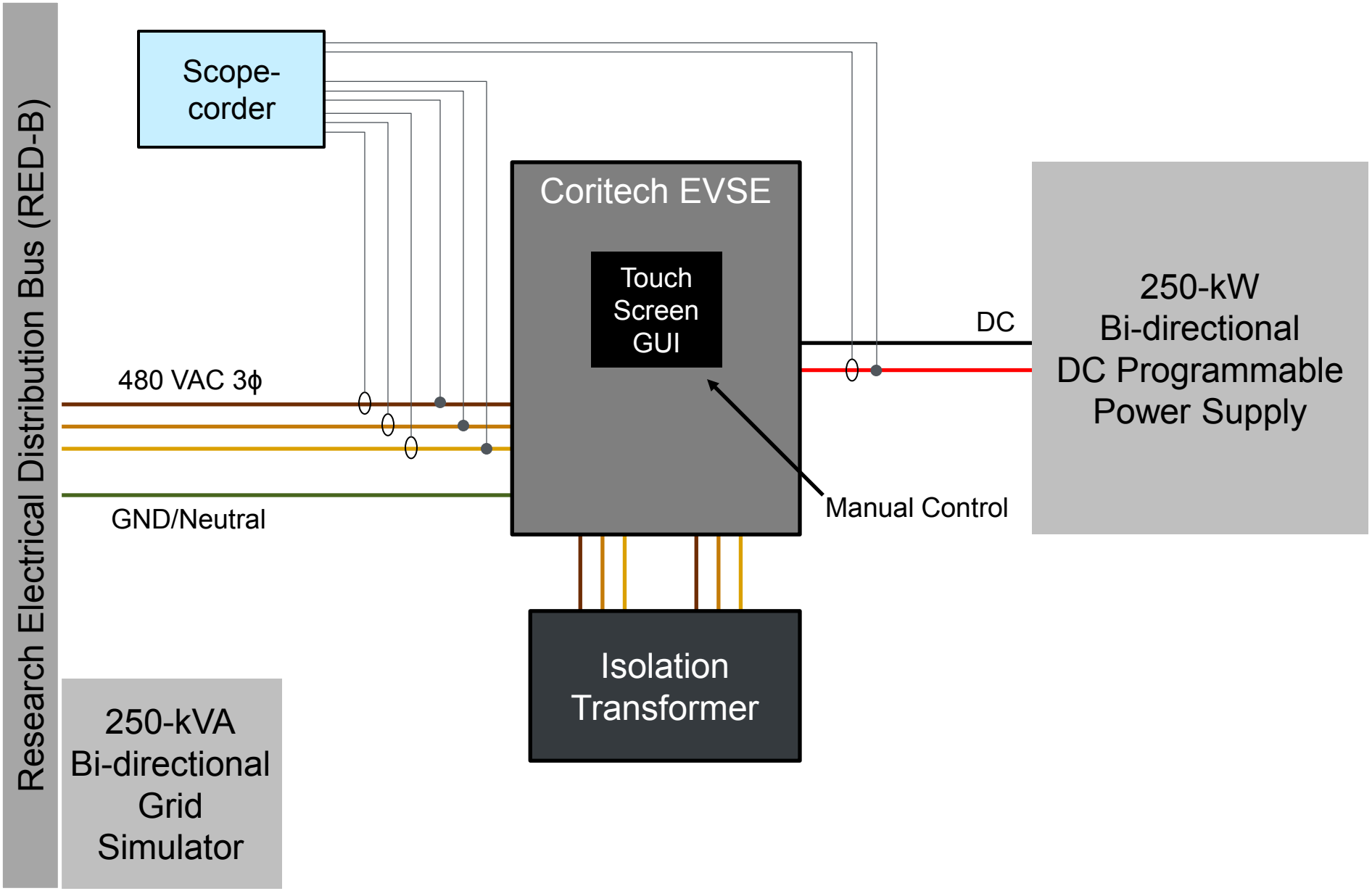
Research Electrical Distribution Bus (MW)

AC (600 V)	**DC** (±500 V)
• 250 A	• 250 A
• 1600 A	• 1600 A

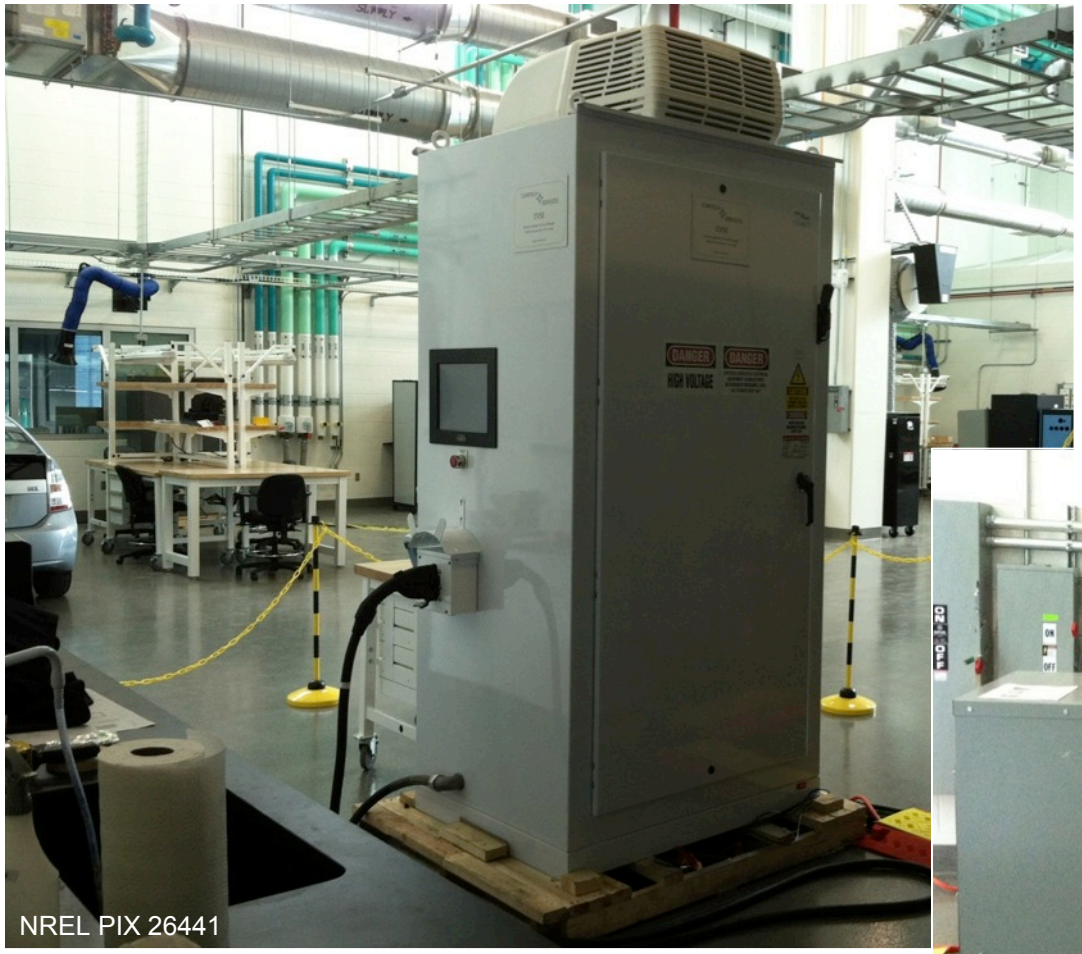

REDB - NREL PIX 20317



SPIDERS Test Setup



SPIDERS EVSE Test Setup (continued)



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Application of V2G Interconnection Test Procedure

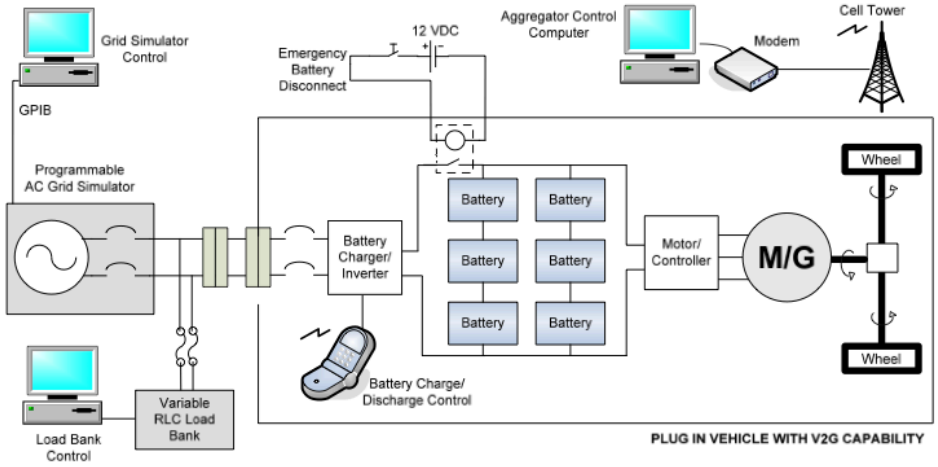
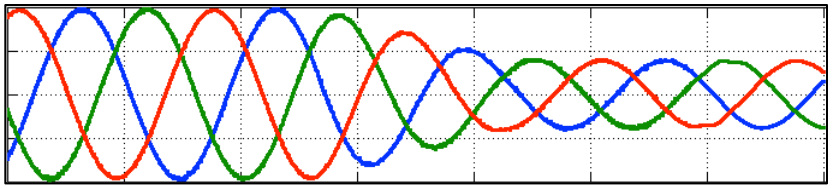


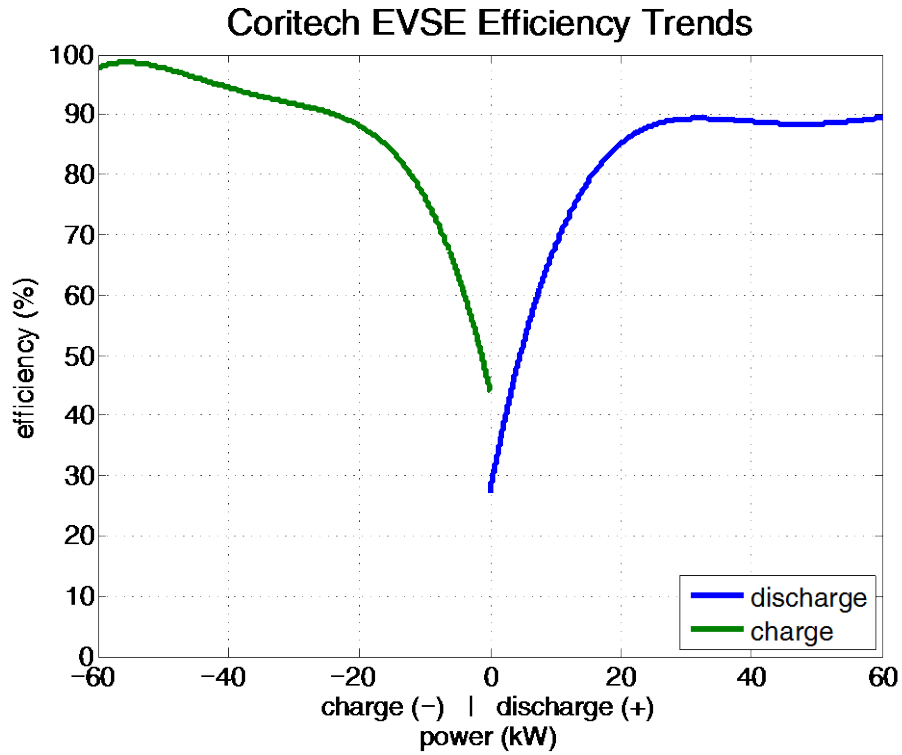
Figure 2. Example of V2G test setup

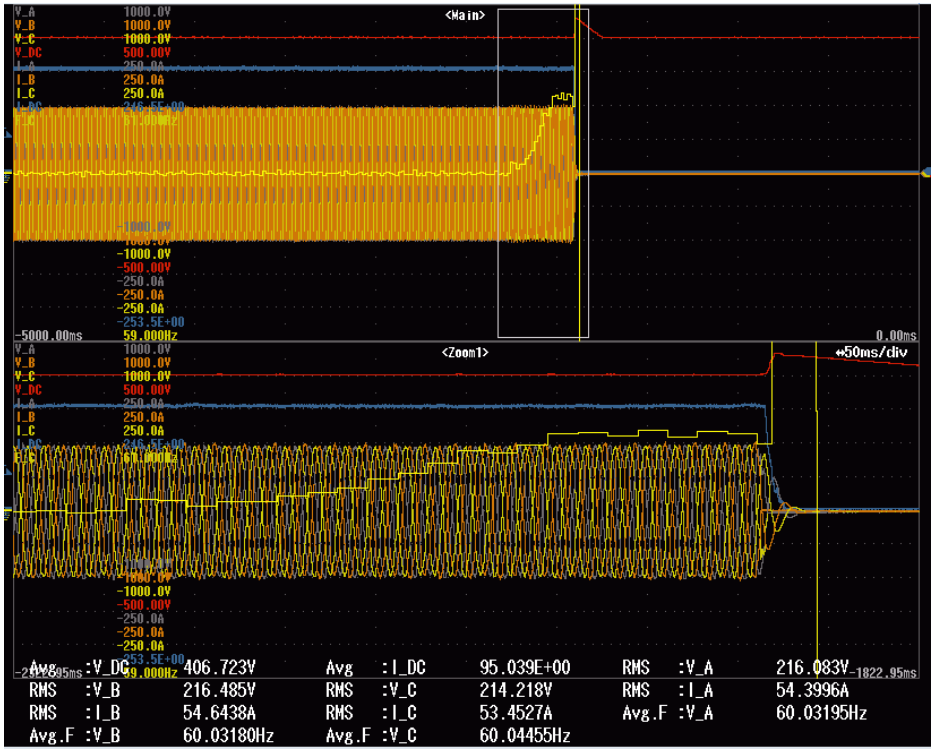
- Based on IEEE1547.1 Distributed Generation Interconnection Conformance Testing
- Validates safe interconnection during:
  - Abnormal Voltage/Frequency
  - Synchronization
  - Unintentional Islanding
  - Open-phase
- Measures performance:
  - Efficiency
  - Distortion



Interconnection Test Results

- Early results show EVSE demonstrates most key interconnection compliance criteria.
- Still analyzing scope captures to determine final performance.





Coritech EVSE Unintentional Islanding Test Data: Pass 6/20/13

Relevance

- Testing high power V2G using J1772 combo connecter
- Quantifies potential operational challenges prior to field deployment
- Applies existing interconnection standards to future vehicle opportunities
- Aligns with DOE mission including expanded role of electric vehicles in future grid operations

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Questions?

Special thanks to:

Our sponsor —

- Merrill Smith, *Office of Electricity, U.S. Department of Energy*

Project collaborators —

- Dean McGrew and Shukri Kazbour, *TARDEC*
- Russ Ristau and George Bilek, *Coritech Services*
- John Bothof, *Burns and McDonnell*
- Joe Redfield, *Southwest Research Institute*