



*An Energy-Efficiency Workshop and Exposition*  
*Orlando, Florida*

# Microgrid Testing at Sandia National Laboratories\*

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(DETL)

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000



# Contents

- Definitions
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- Microgrid Considerations
- Operational Data
- Conclusion



# Definitions

## Microgrid

collection of loads and energy sources capable of operating either grid tied or independently

## Uninterruptible Power Supply (ups)

provides critical load power on loss of prime ac power (10 - 30 minutes energy storage typical)

## Distributed Energy Resources (DER)

power generation < 10 MW sited close to load



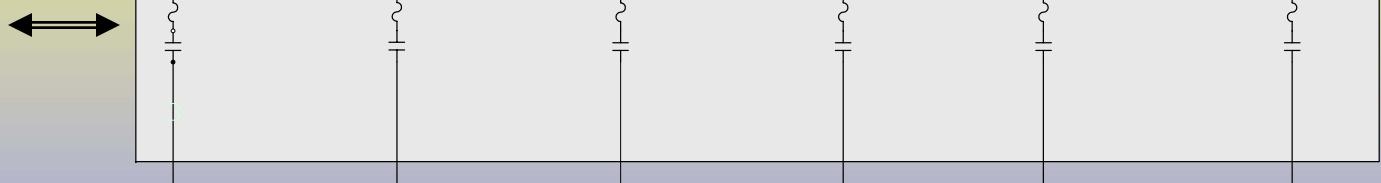
# DETL Microgrid



Secure  
SCADA Lab



480V Microgrid



Distributed  
Energy  
Resources



Loads  
(Various)



# DETL Activities

- Performance of evolving sources
  - Microturbines
  - Fuel cells
- Source interactions
- System controls
  - Grid-tied dispatch/communications
  - Standalone capability



# Hands-on DER Training for Federal Energy Managers



- FEMP FUNDED (no cost)
- Albuquerque Sept. 17-18
- More info at Sandia booth





# Potential Microgrid Advantages

- Economic
  - Aggregation
  - Peak shaving
  - Combined heat & power
- Energy security/reliability ← **Standalone**
  - Diversity: fuel, resources
  - Reduce single-point vulnerabilities
  - Physical security/controls



# Operating Modes and Issues

## Grid-connected

- *Grid follows load, regulates V & f*
- Issue: Utility **interconnection** requirements

## Standalone

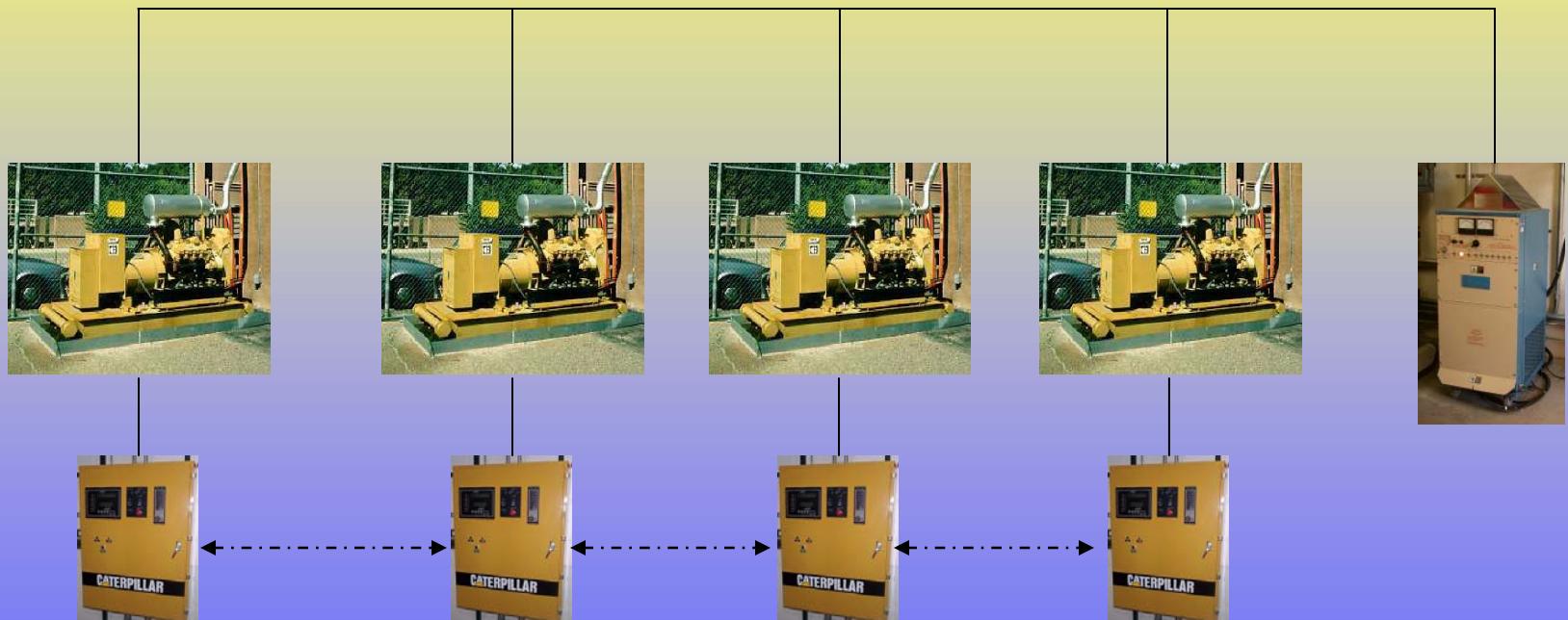
- *DR follows load, regulates V & f*
- Issue: **Load-following**



# Load Following

Gens can share W and var

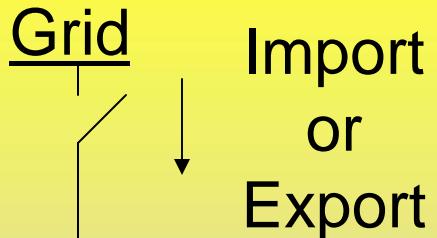
- Droop (P vs. f, Q vs. V)



- Communications



# Microgrid Operation



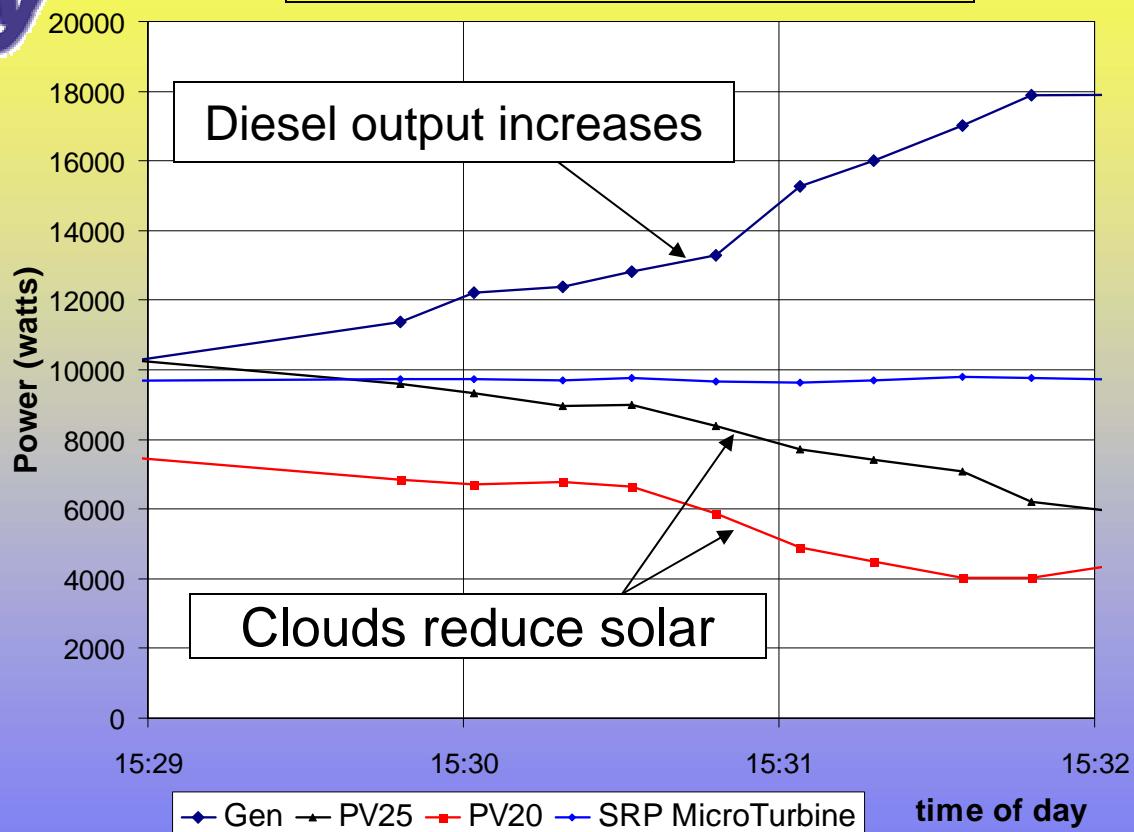
Follows load  
when off grid  
(others fixed)

Critical  
loads



# Diesel Output Adjusts

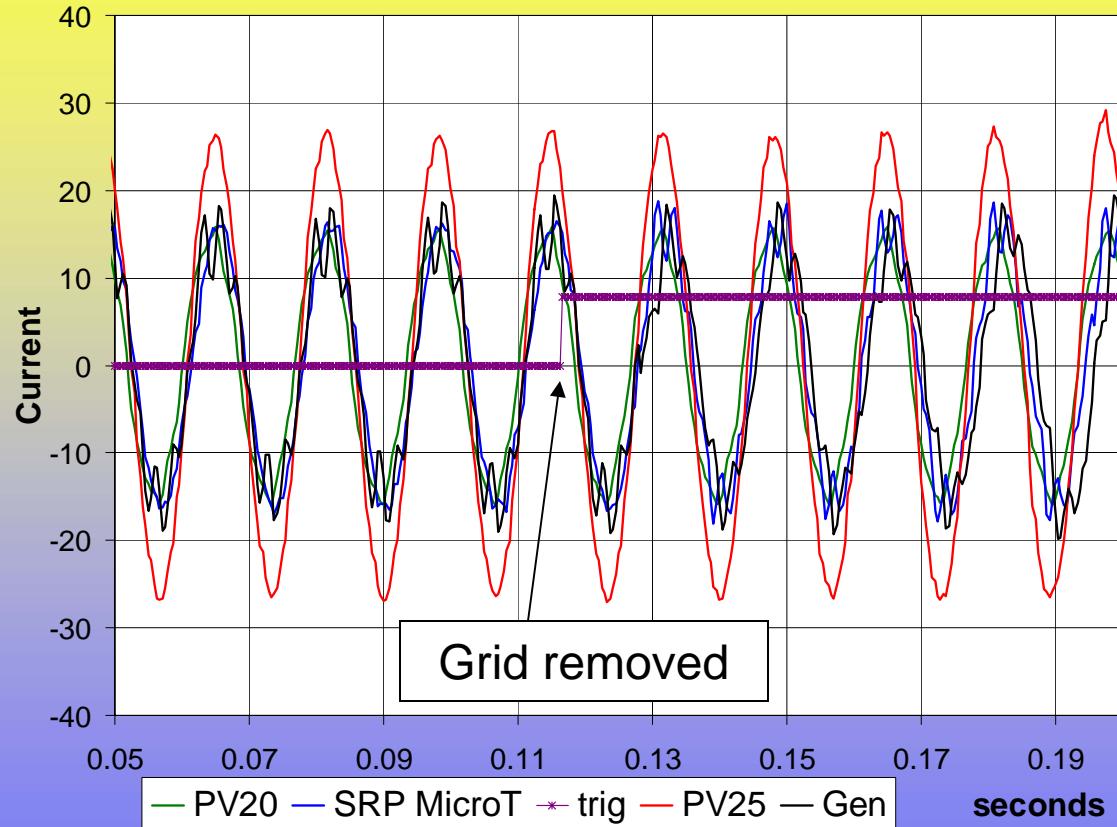
Constant Load





# Loss of Grid

## Loads = Generation

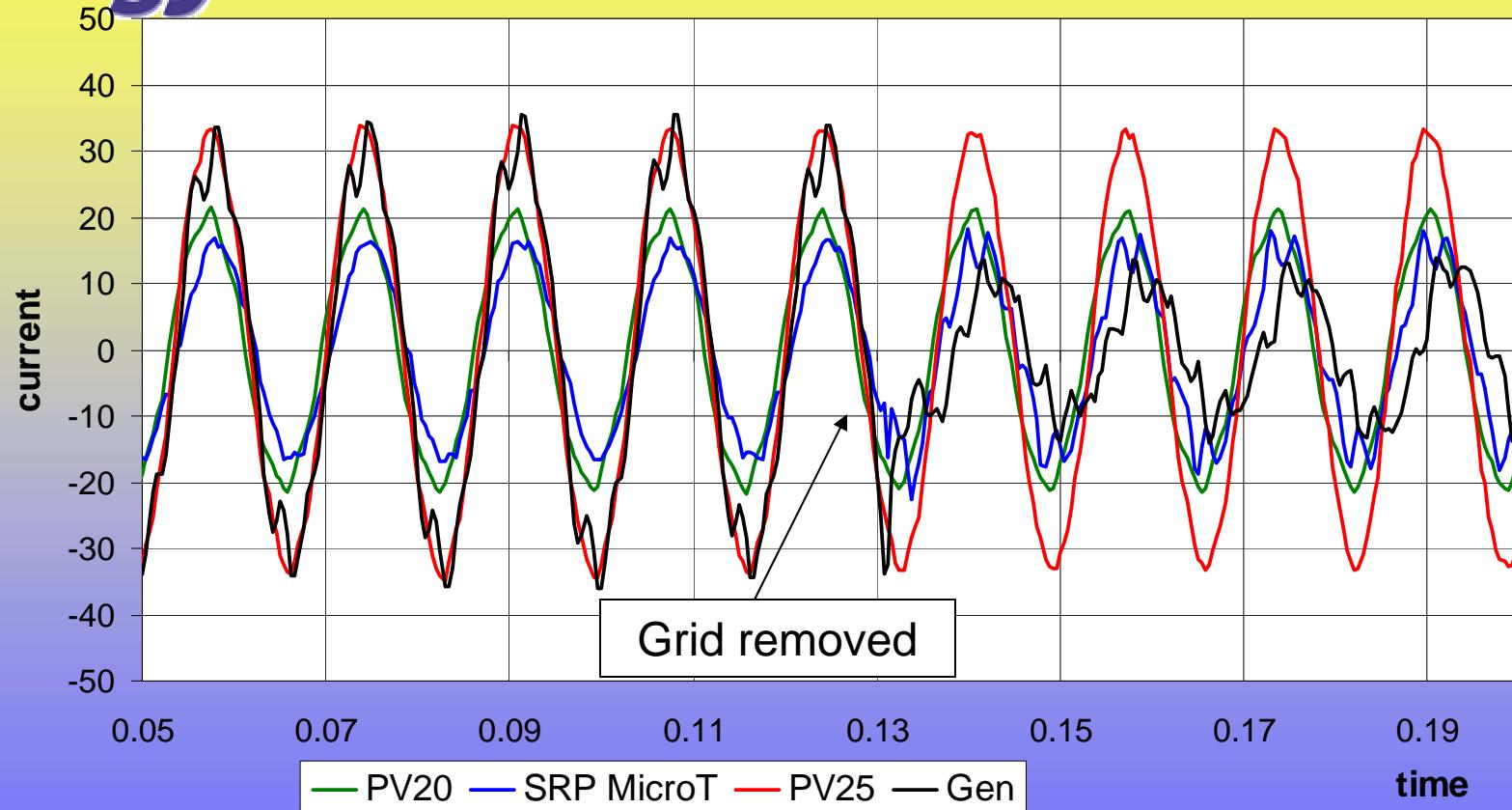


No import or export

No sources trip



# Loss of Grid Loads < Generation

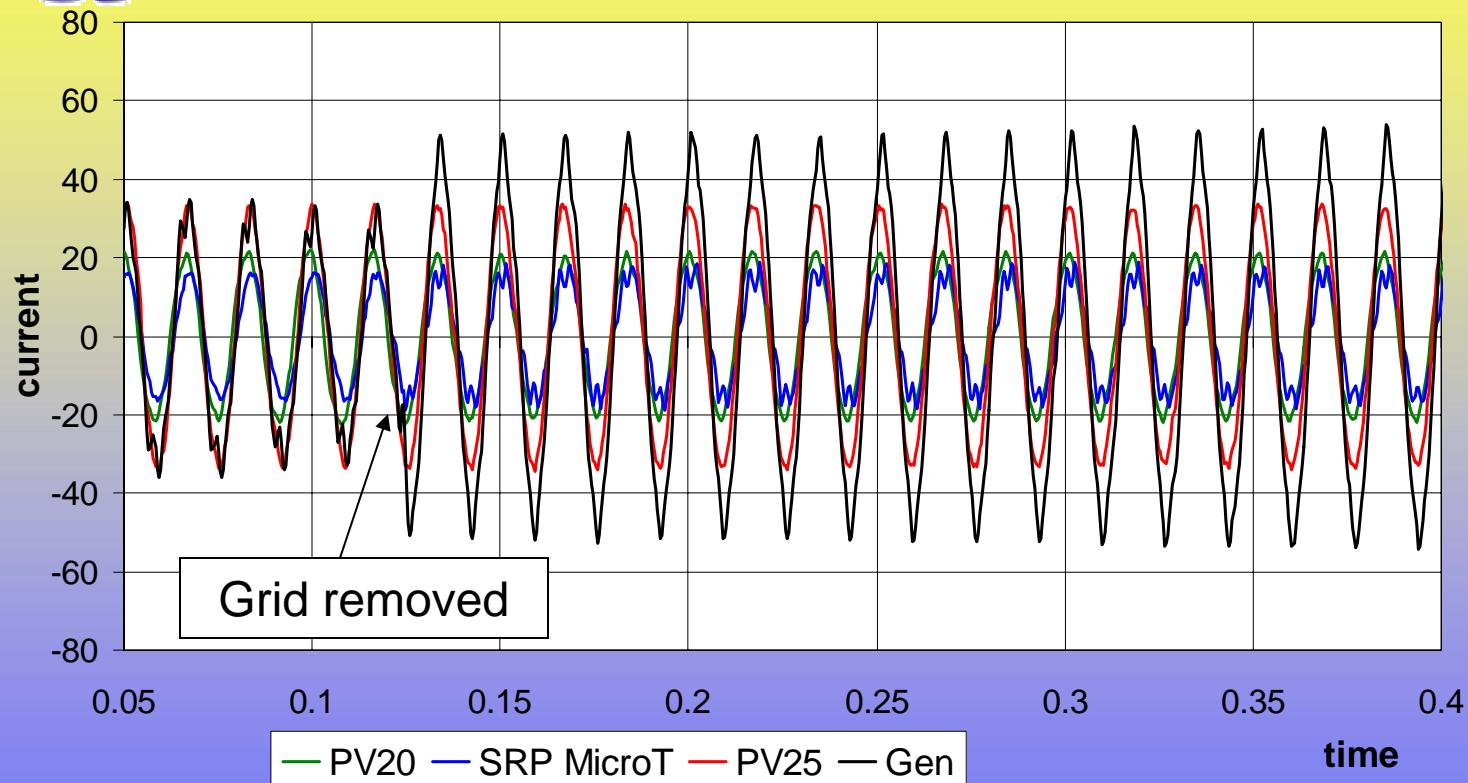


Exporting 13 kW

Microturbine & 1 PV Trip



# Loss of Grid Loads > Generation

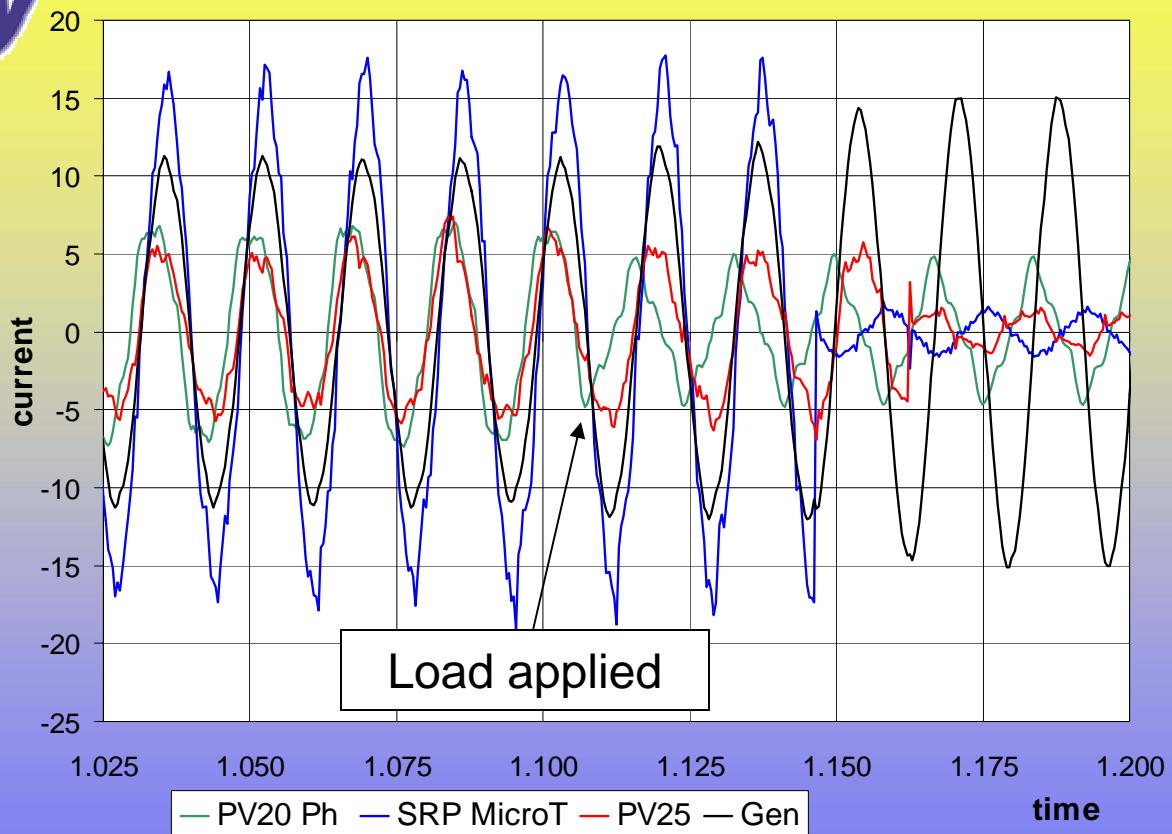


Importing 11kW

No Trips



# Standalone Block Load



17 kW block load

All but generator trip



# Microgrid Conclusion

- Security implies standalone capability
- Standalone operation challenging
  - Rotating machines can load share
  - Inverter-based may not (microturbines, fuel cells)
- Nuisance trips an issue
  - Load-follower dynamic response critical
  - Energy storage (UPS) needed