

Alternative Configurations to Optimize Lead-Acid Batteries for Renewable Generation and Storage (RGS) DOE Program Review, 11/19/2002

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the US DOE as part of the ESS Program**

**The project is managed by Sandia National Labs with Stan Atcitty
as Project Manager. Paul Butler and Garth Corey of SNL also
collaborate on the project.**

Alternative Configurations to Optimize Lead-Acid Batteries for RGS

Project Goal

To conceive, develop, and promote implementation of alternative configurations for renewable generation and storage systems that will improve reliability, enhance component performance, and lower life-cycle-costs

Secondary Goal

To facilitate communication between battery manufacturers and RGS users, using the alternative configurations developed, so that batteries might be used to their best advantage without compromising system performance

Project History/Approach

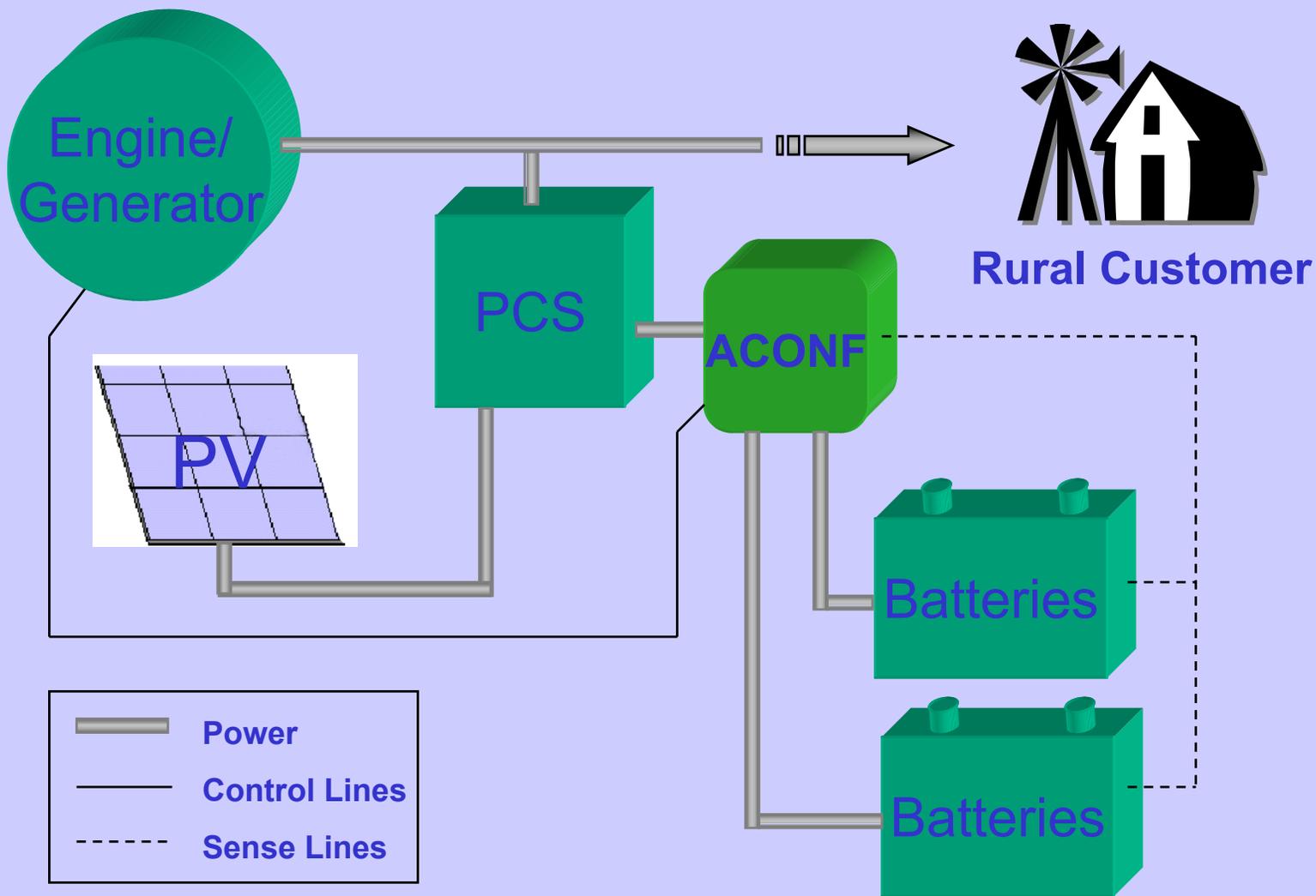
- **FY98: Conceptualized solutions to RGS problems**
 - Batteries do not perform or live as expected
 - Batteries require maintenance charges using generator
- **FY99-00: Developed alternative configurations (ACONF) as solution, with first modeling, then lab testing to confirm validity**
- **FY00-01: Identified user field test site; refined hardware and software; fabricated breadboard and tested in lab and then at field test site**
- **FY02: Identified implementer, performed joint engineering development; built several prototypes and operated at field test site**

What are RGS Battery Alternative Configurations?

- **Added circuitry between each string of the battery and the DC terminals of the AC-DC-AC converter**
- **Hardware and software to control the currents to and from the strings through the additional circuitry**

The string currents are controlled on the basis of measured parameters and the characteristics the battery modules used in each specific installation

ACONF With RGS Hybrid System



Benefits of Alternative Configurations For RGS Solar Hybrid Systems

- **Overcharge and over-discharge avoided**
- **Battery finishing charge & generator “de-coupled”**
- **Can utilize PV for and while finish charging**
- **Easily made smart relative to expected load & solar**
- **In advanced ACONF units now under development, module voltage and temperature used to control charge, finish charge, discharge, and generator starts for weakest modules**
- **Opportunity to maximize battery and system life, performance, and to minimize life-cycle-cost**

FY02 Progress on Alternative Configurations

- **10/01-2/02: Testing of Type I breadboard continued; software modified to reduce data file size and to allow data downloads via serial port**
- **2/02: Type 1 Pre-Prototype built, installed at STAR; operated satisfactorily, needed improvements identified**
- **5/02: Type 1 Prototype development and assembly completed; put under test in RSES shed at STAR with PC104 stack from breadboard**
- **8/02: Development of Type 2, 100kW ACONF units initiated**
- **10-11/02: 2nd and 3rd Type 1 Prototypes completed acceptance tests, Prototype #2 put into field test**

RSES Test Shed at STAR

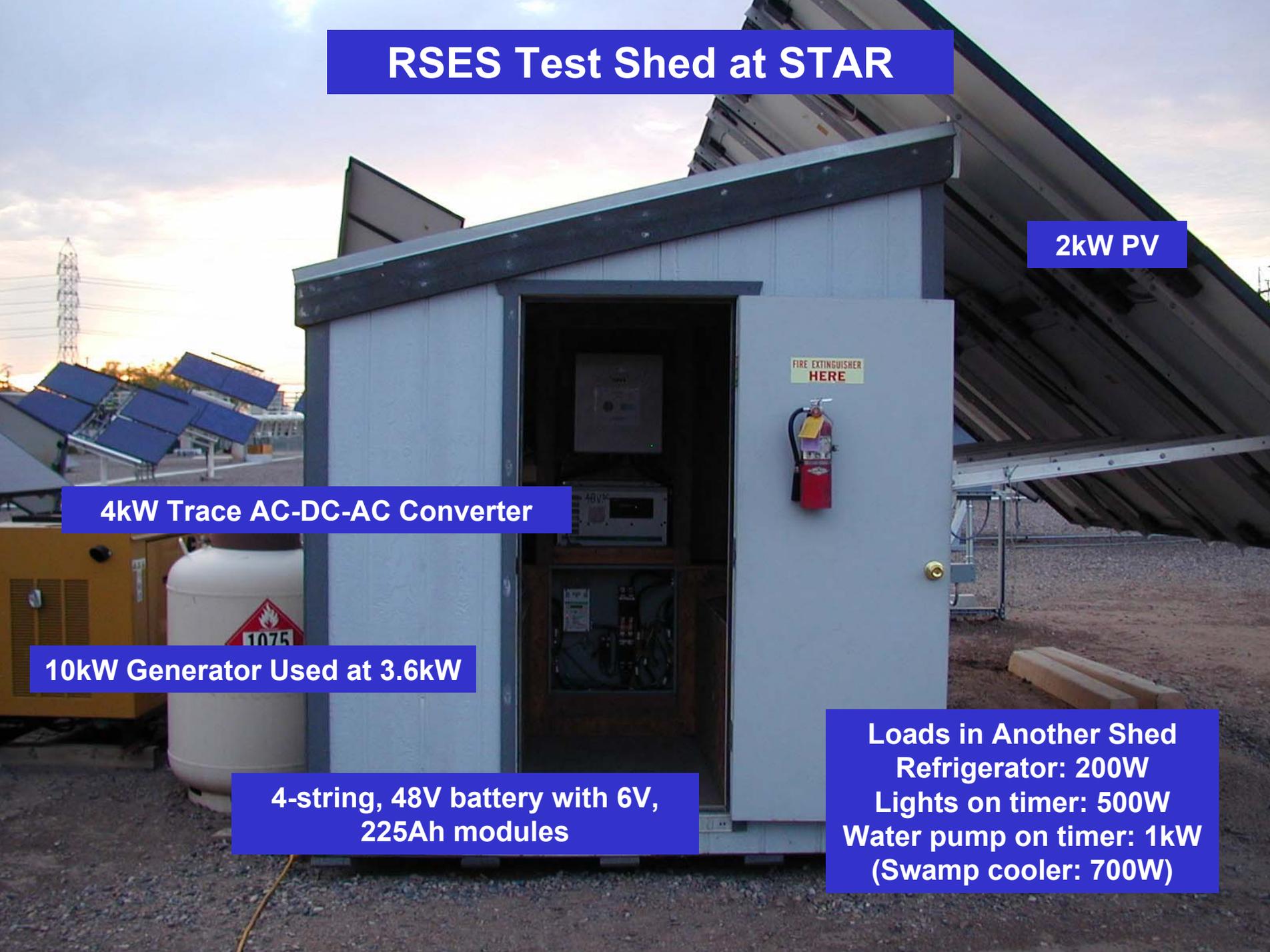
2kW PV

4kW Trace AC-DC-AC Converter

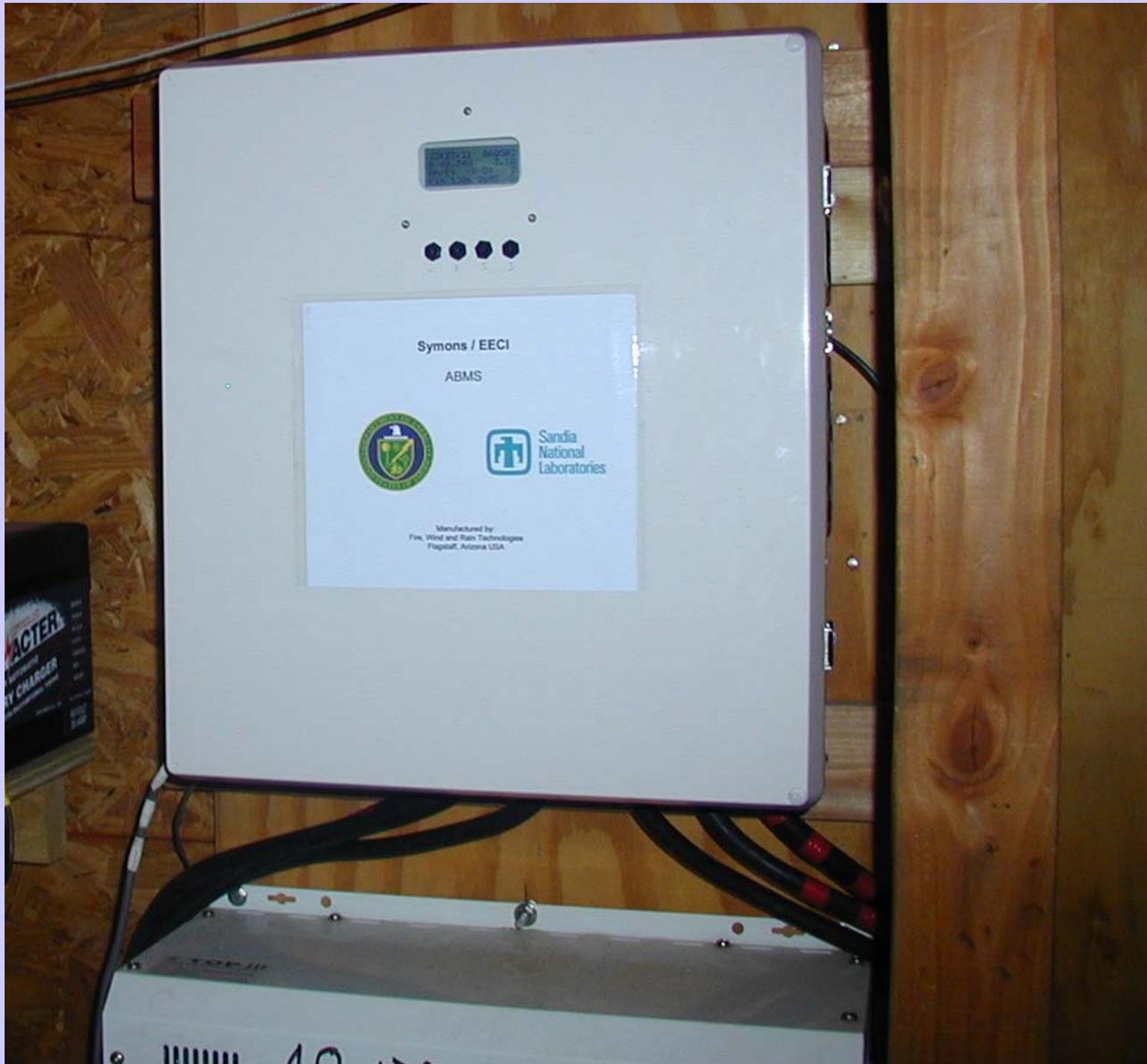
10kW Generator Used at 3.6kW

4-string, 48V battery with 6V,
225Ah modules

Loads in Another Shed
Refrigerator: 200W
Lights on timer: 500W
Water pump on timer: 1kW
(Swamp cooler: 700W)

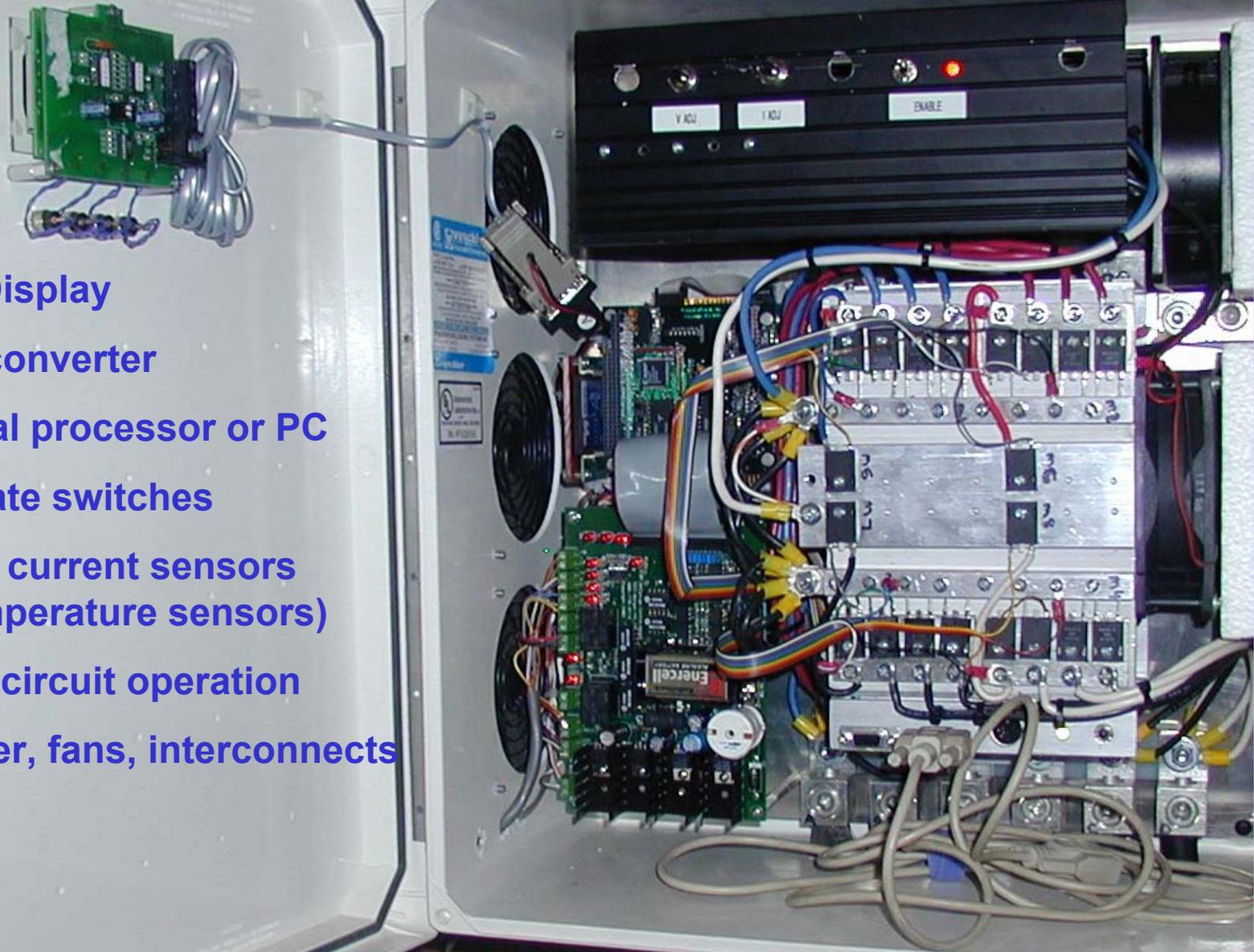


ACONF Prototype #1 at STAR

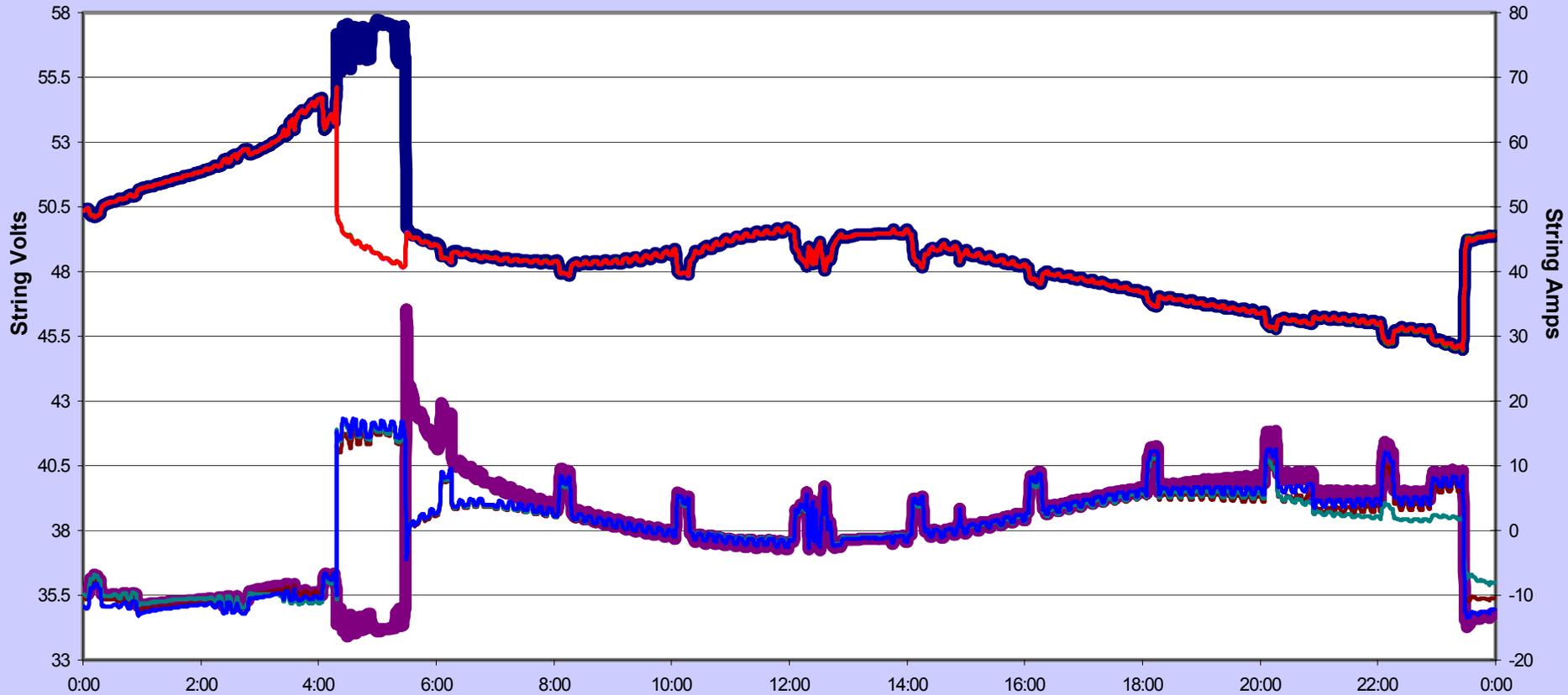


Inside View of ACONF Prototype #1

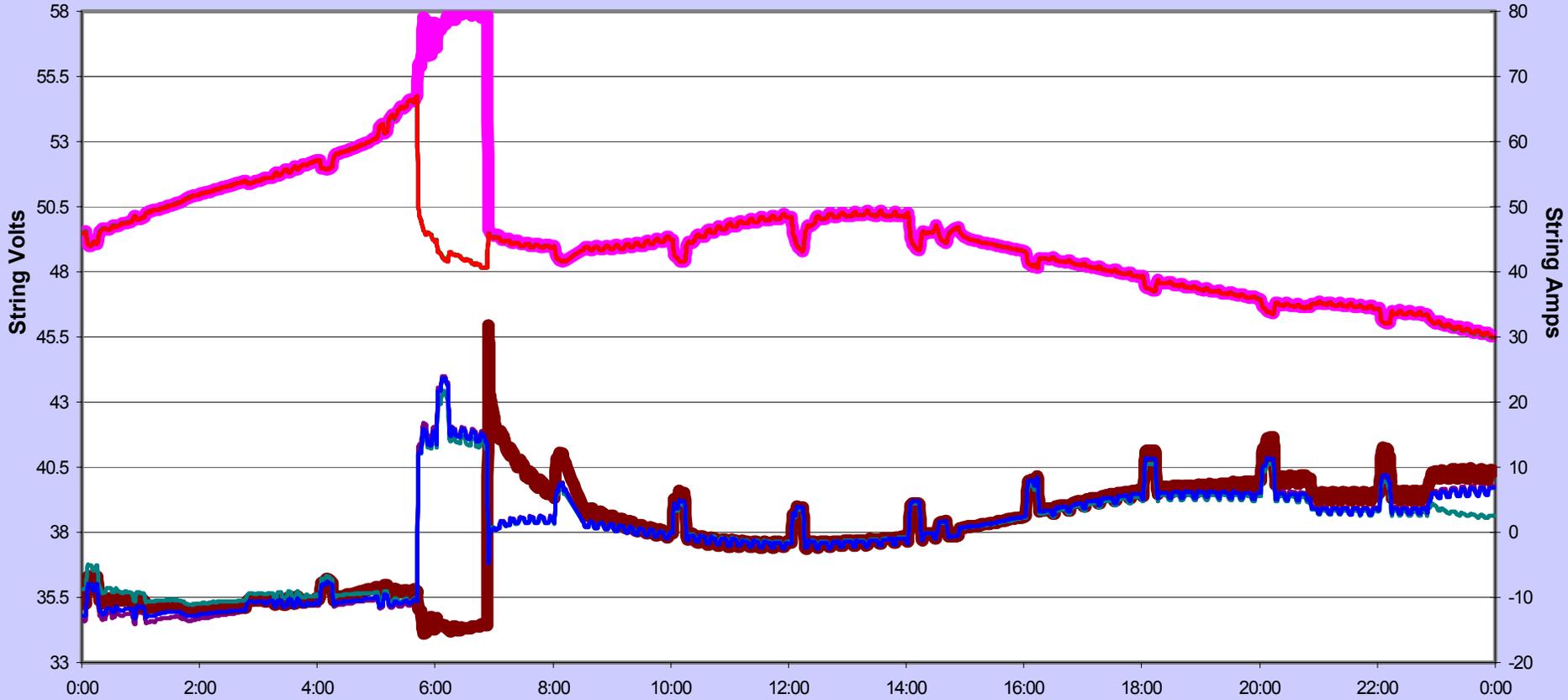
- Status Display
- DC-DC converter
- Industrial processor or PC
- Solid state switches
- Voltage, current sensors
(temperature sensors)
- PCB for circuit operation
- Container, fans, interconnects



ACF Data 5/2/02- Charge, Finish Charge String A & Discharge



ACF Data 5/3/02- Charge, Finish Charge String B & Discharge



Experience with ACONF Units at STAR

- Breadboard, pre-prototype, Prototype #1 each operated for several months at STAR
- Early ACONF units were occasionally unreliable, but these events have become rare as corrections made to hardware and software
- Prototype #2 was installed successfully by STAR personnel, although some undetected assembly problems (now corrected) caused difficulties in early testing

Next Steps

- **Continue/initiate ACONF prototypes testing at field test sites and then in remote field tests**
- **Continue development of other alternative configurations (lab testing, advanced modeling)**
- **With Implementer, complete Engineering Development of Type I ACONF in preparation for commercialization hand-off; fabricate more prototypes as necessary for field demos**
- **Fabricate Type 2, 100kW class ACONF prototype units; test with VRLA battery at Sandia and with flooded battery at STAR**

Summary

- **Alternative configurations to optimize utilization of batteries in RGS and other applications have been conceived; patent on concept issued early 2002**
- **Prototype Type I ACONF unit, with developmental hardware from implementer and software from EECl, has been developed**
- **Breadboard, pre-prototype and prototype ACONF units successfully tested at an RGS site, with further improvements being made as a result of these field tests**
- **Long term testing at RGS site continuing; testing of two more prototypes getting underway**
- **Advantages expected for approach have been qualitatively realized; further benefits identified by potential customers**
- **Engineering Development of products underway in collaboration with implementer, showing a progression towards commercialization**