NREL/ORNL/DOE Distributed Power System Integration R&D

"Fast Response, Load-Matching Hybrid Fuel Cell"

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EPRI PEAC

Quarterly Review Meeting

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The Power of Reliability℠

Project Overview

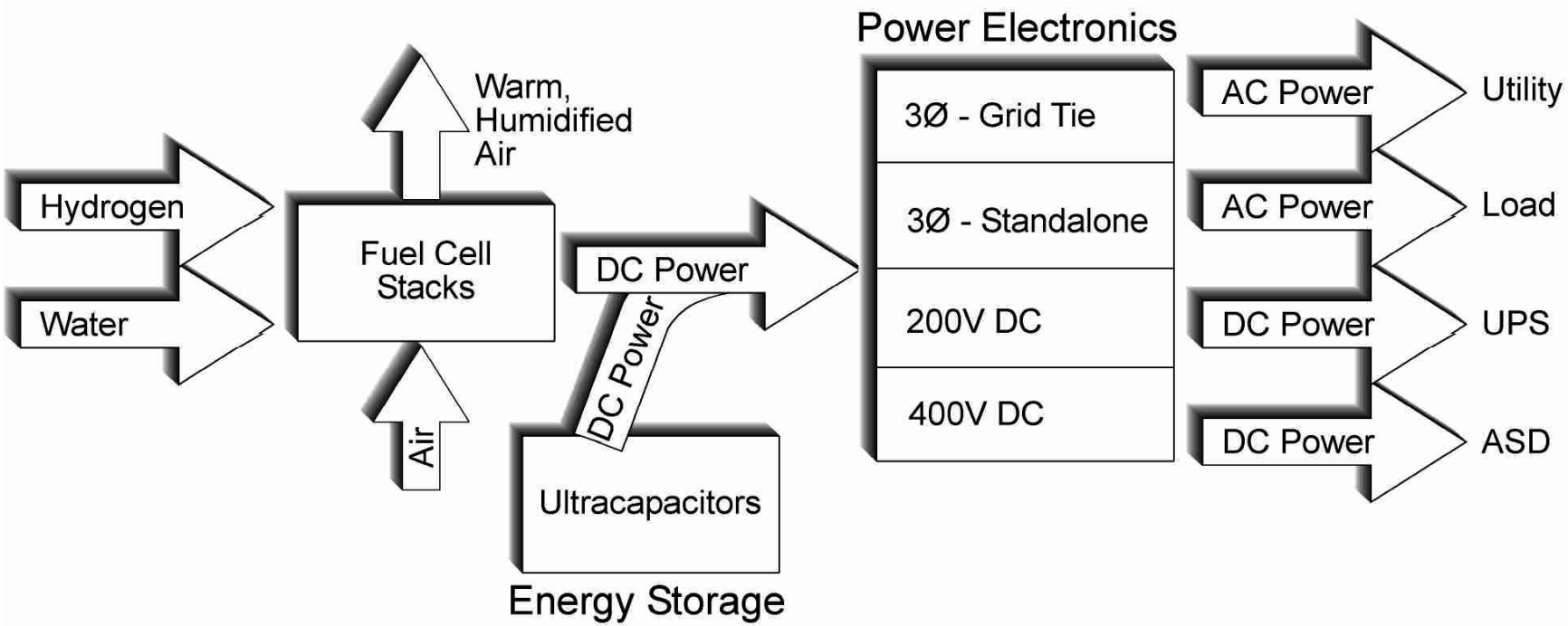
- Integration of ultra-capacitor and PEM fuel cell technologies to create a “fast response, load-matching, hybrid fuel cell”
- NREL Project Manager Tom Basso, PEAC Team T. Key, T. Geist, D. Nastasi, ESMA Ultra Capacitors and DCH-Enable Fuel Cell
- System size is 3kW, configured for four different applications or modes of operation.
- Objective is to establish performance potential as grid-tied hybrid resource…without and with reformer.

Plans for Base Year

- Completed testing of ultra-caps and topical report by July 2001 (draft sent to NREL)
- Complete testing of PEM fuel cell. Topical report by to be provided with October monthly report
- Report system performance results due in 2/02, plan delivery 12/15
  - Design, specifications and evaluation
  - Ragone plots results with and without storage
  - Demonstrate operations from standby mode and as battery replacement in a UPS (EPRI funded tasks)

3 kW PEM Fuel Cell System

Schematic of Hybrid

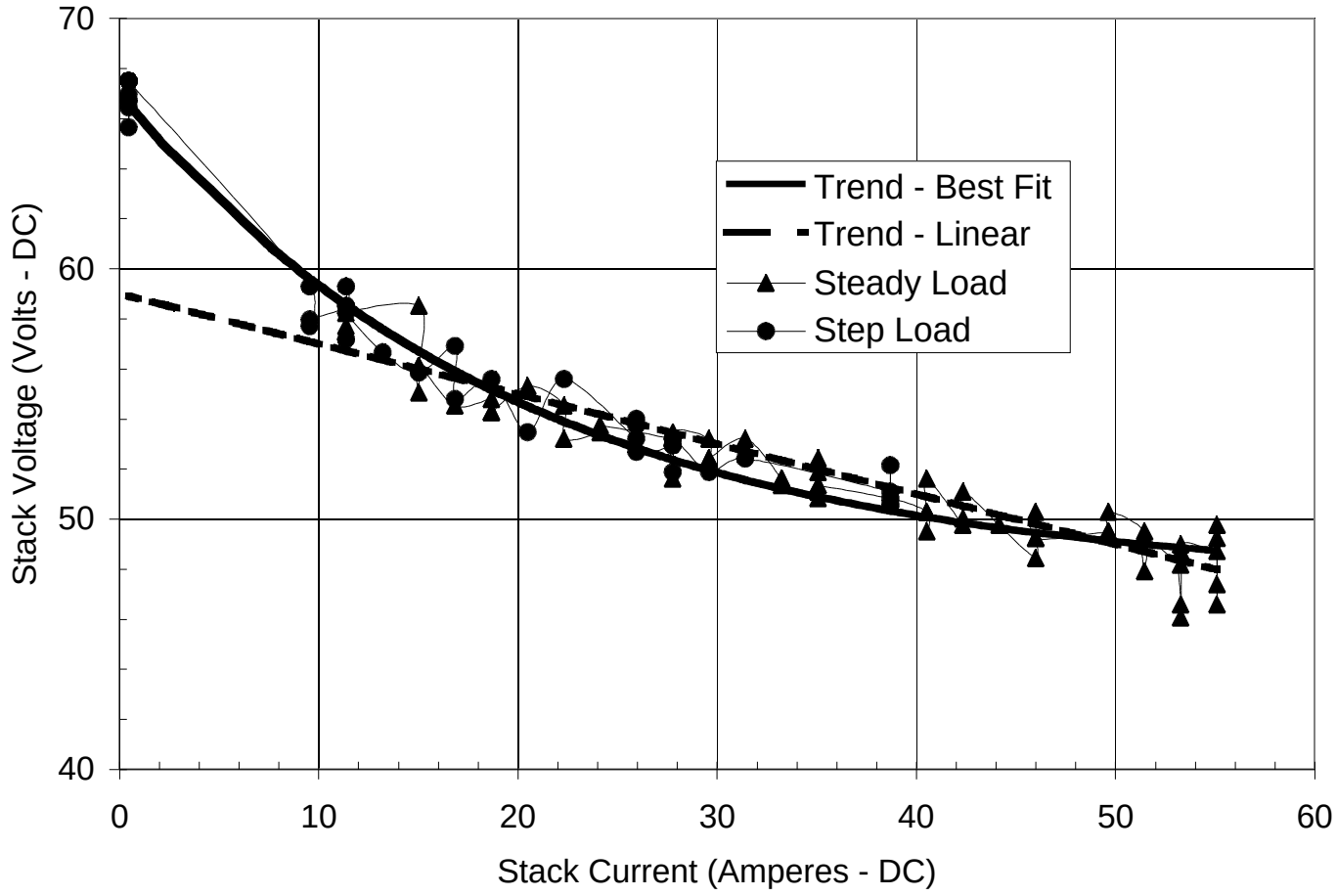


- 3-kW fuel cell system designed for robust grid connection and response with potential grid support via ultra capacitors

PEM Fuel Cell Performance Report

- Performance of PEM operating from H_2 and potential for local grid support
  - Efficiency
  - Stack capacity
  - Response as function of loading
- Relative cost of system component for PEM designs.
- Overview of fuel cell technologies with cost/ performance comparison

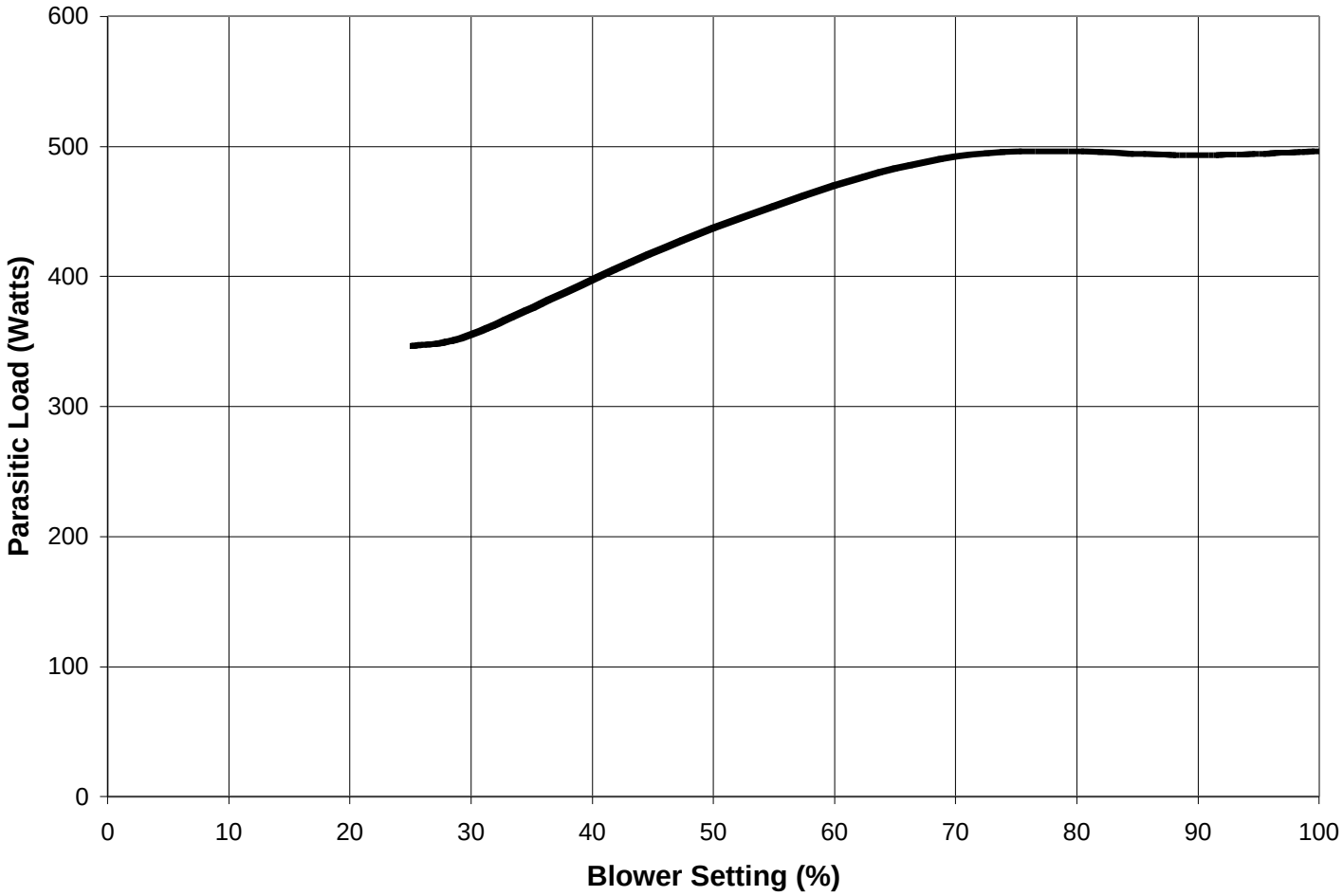
Basic Characterization



PEM Stack Model

- The results from the performance measurements show that electrically the fuel cell can be modeled as a current-controlled voltage source in parallel with a capacitance of significant value.
- Best Fit $V = 47.5 + 19.5 * e^{-I/20}$
- Linear $V = 47.5 - (I * 0.2)$
- Capacitance levels indicate that the stack, by itself, provides some inrush current support for small appliances such as fractional Hp motor, electronic equipment, and thus local grid support.

Standby Operation (zero H_2)



-During the standby testing, the losses were reduced by varying the voltage to the air blower via digital control.

- Stack failure occurred at 25%

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Key results of PEM fuel cell performance tests

- operates at a low-current density minimizing complexity and cost of support systems
- fuel cell in idle mode quickly responded to a request for power:
  - No load to full load in 250 microseconds
  - Potential for no break applications, bridging momentary grid interruptions
- Issues:
  - High cost, need for complex reformer (hydrogen storage)
  - Overload capacity requires energy storage element
  - Built-in inverter needs to be sized for overload

Plan for next quarter

- Complete topical report on fuel cell performance, without reformer
- Complete system configuration tests with ultra capacitors, 3-kW PEM fuel cell and various output converters and loading
- Prepare topical report on grid-tied system design and specification, without reformer
- Begin work on installation report