

Stationary -
Fuel Cells



SIEMENS
Westinghouse

SECA Project at Siemens Westinghouse

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Who Are We?

- **We are a Business Unit of 200 employees within Siemens Westinghouse Power Corporation.**
- **Our charter is to commercialize factory built SOFC Power Systems (3 kWe to 10 MWe) for the distribution generation market.**
- **Our focus is the seal-less, tubular SOFC concept.**
- **We have expertise in the following fields:**
 - ◆ High Temperature Materials
 - ◆ Ceramic Processing
 - ◆ R&D and High Temperature Testing
 - ◆ Hydrocarbon Reforming
 - ◆ SOFC Module and Systems Engineering/Design
 - ◆ Ceramic Powder, Cell and Module Manufacturing
 - ◆ BOP Assembly
 - ◆ Systems Testing

What Have We Accomplished?

- **Developed the state-of-the-art, 150 cm active length, cathode supported, tubular SOFC.**
- **Demonstrated lifetimes of >60,000 operating hours with voltage degradation rates of less than 0.1% per 1000 hours, and thermal cycle capability of >100 cycles.**
- **Manufactured over 15,000 state-of-the-art SOFC's.**
- **Developed our proprietary internal reforming technology.**
- **Designed, manufactured and tested complete power systems.**
- **Began construction of our 15 MWe per year Commercial Manufacturing Facility in Pittsburgh, PA.**

SOFC Power System Demonstrations with State-of-the-Art SOFC's

100 kWe Combined Heat & Power (CHP) System

- 20,500 operating hours (16,500 hours in The Netherlands and 4000 hours in Germany).
- 46% electrical efficiency, 75% CHP efficiency on PNG.
- No measurable voltage degradation.

200 kWe Pressurized Hybrid (PH) System

- Combines a pressurized SOFC with an MTG.
- 1700 operating hours to date (University of California, Irvine)
- 52% electrical efficiency on PNG.
- Stable voltage.

Future SOFC Power System Demonstrations

- **250 kWe CHP System in Ontario, Canada (2002).**
- **300 kWe PH System in Essen, Germany (2002).**
- **300 kWe PH System in Milan, Italy (2002).**
- **250 kWe CHP System in Alaska (2003).**
- **250 kWe CHP System in Hannover, Germany (2003).**
- **250 kWe CHP-Zero Emission System in Norway (2004).**
- **Other projects under negotiations.**

What are our Top Three Commercial Issues?

1. **Product Cost**
2. **Product Cost**
3. **Product Cost**

Commercial Prototype Fuel Cell Power Systems (e.g., PAFC) have historically been in the \$4000 to \$5000/kWe cost/price range.

SECA Program Objectives

- **Develop SOFC system prototypes for the remote, residential, military and APU markets with a net power output of 3-10 kW.**
- **Ultimate cost goal - \$400/kW in 2012.**

SOFC Power System Demonstrations with State-of-the-Art SOFC's

Technology Team

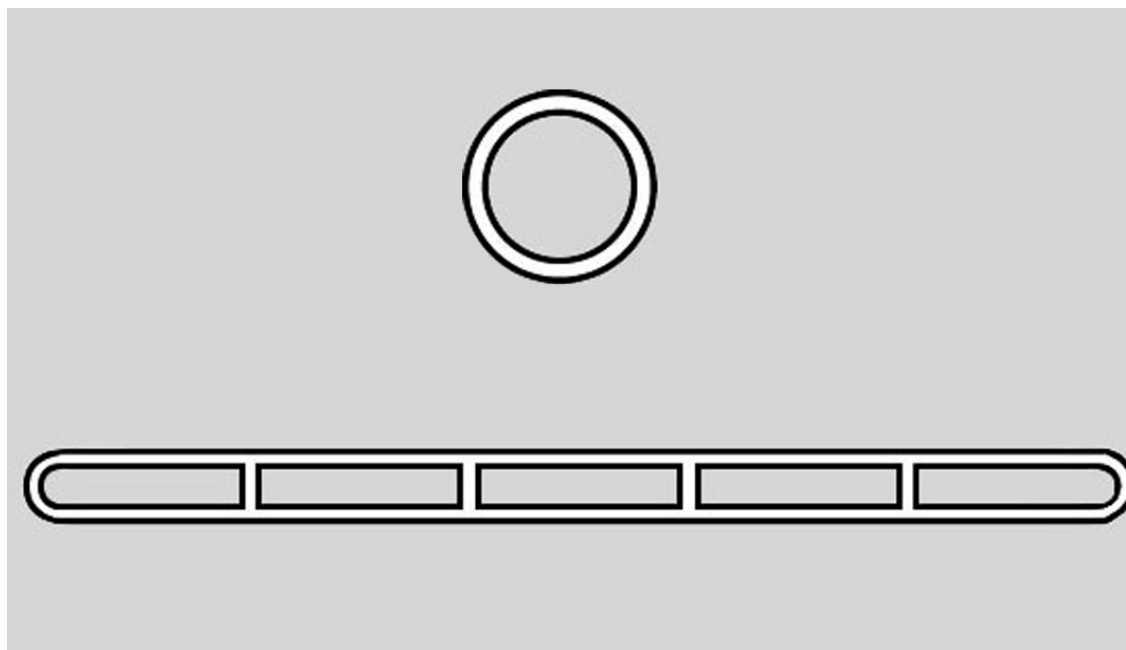
- **SWPC**
- **Fuel Cell Technologies**
- **Blasch Ceramics**
- **ZIRCAR Refractory Composites**
- **Universities**

Customer/Market Teams

- **Stationary**
 - ◆ **Fuel Cell Technologies**
 - ◆ **Lennox Industries**
 - ◆ **Trane**
 - ◆ **Dominion Resources**
- **Transportation**
 - ◆ **Ford Motor Company**
 - ◆ **Eaton Corporation**
- **Military**
 - ◆ **Newport News Shipbuilding**
 - ◆ **Eaton**

- **Improve cell performance thru seal-less planar SOFC concept.**
- **Low temperature (~800°C) SOFC development to allow for lower cost module materials.**
- **Ultra-low cost SOFC materials and manufacturing process development.**
- **On-cell reformation.**
- **Sulfur tolerant anode.**
- **Cost-effective fuel processing including liquid fuels.**
- **High efficiency power conditioning.**
- **High degree of design integration and simplification.**

SWPC SECA Cell Technology

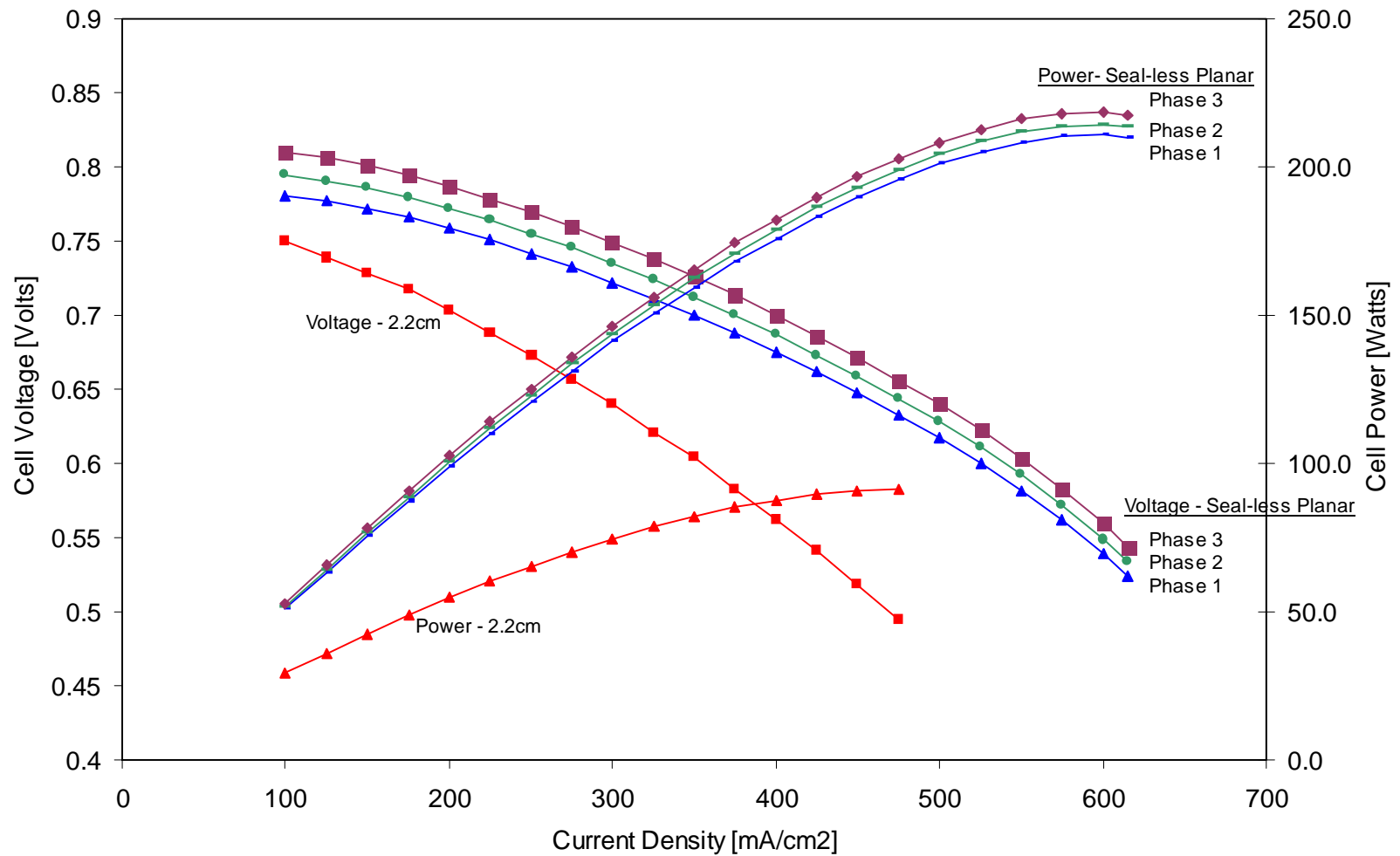


2.2 cm Cylindrical
(Present)

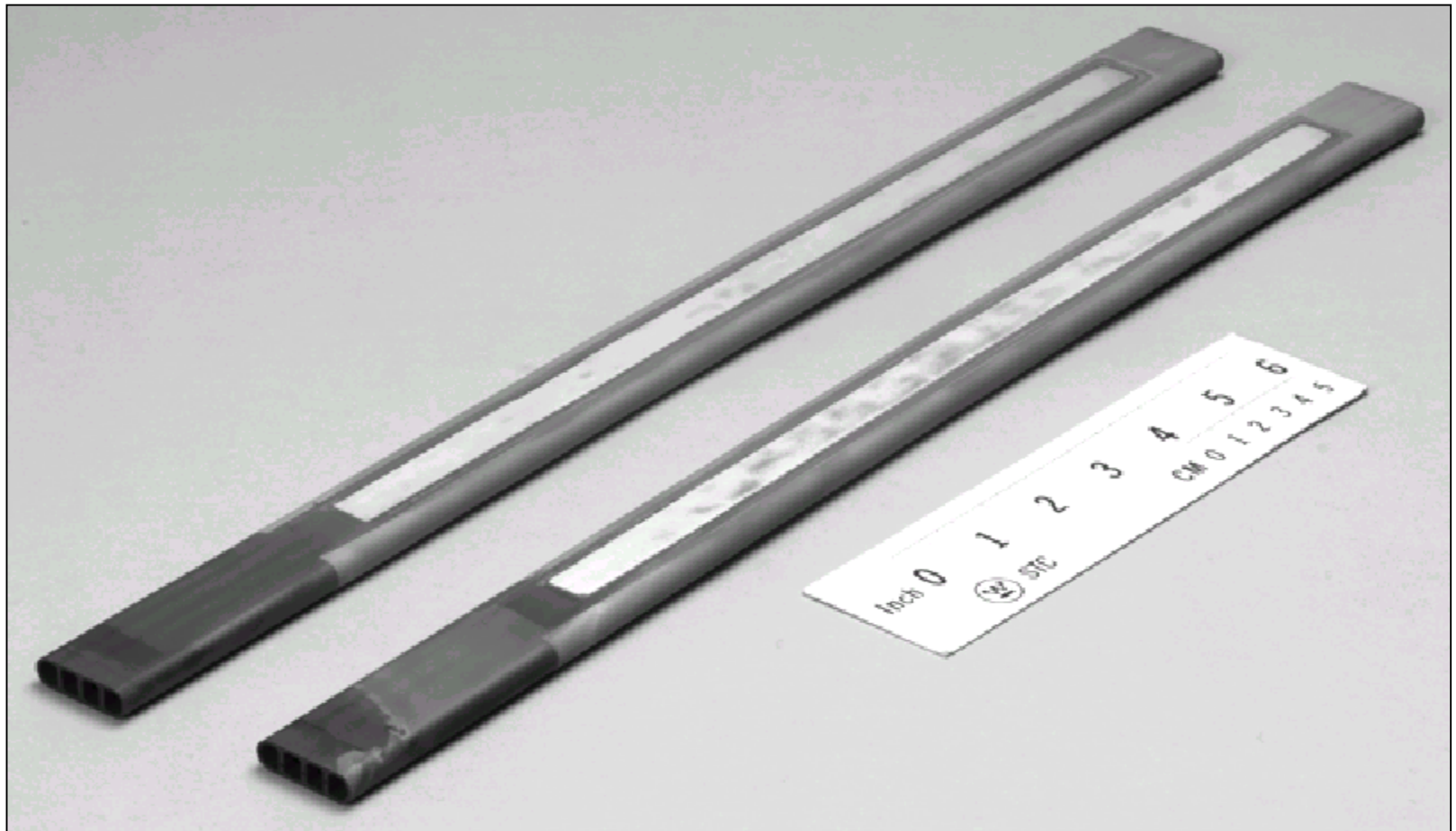
Seal-less Planar

- **Maintains Seal-less planar design**
- **Reduction in resistance and cell cost**
- **Increase in cell power (power density and surface area)**
- **More compact stack**

Cell Performance Comparison



HPD4 Seal-less Planar Cell

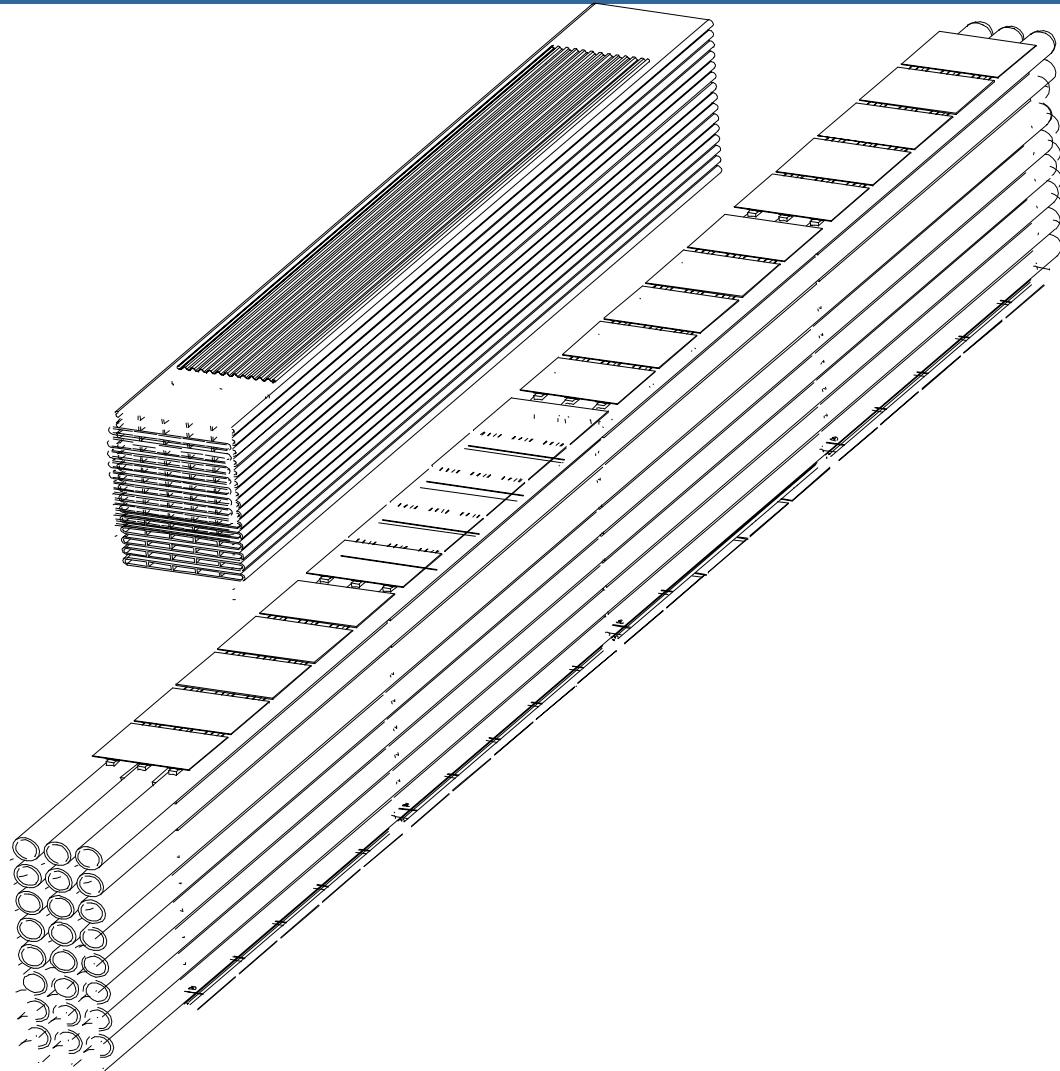


HPD5 Seal-less Planar Cell Versus Seal-less Cylindrical Cells

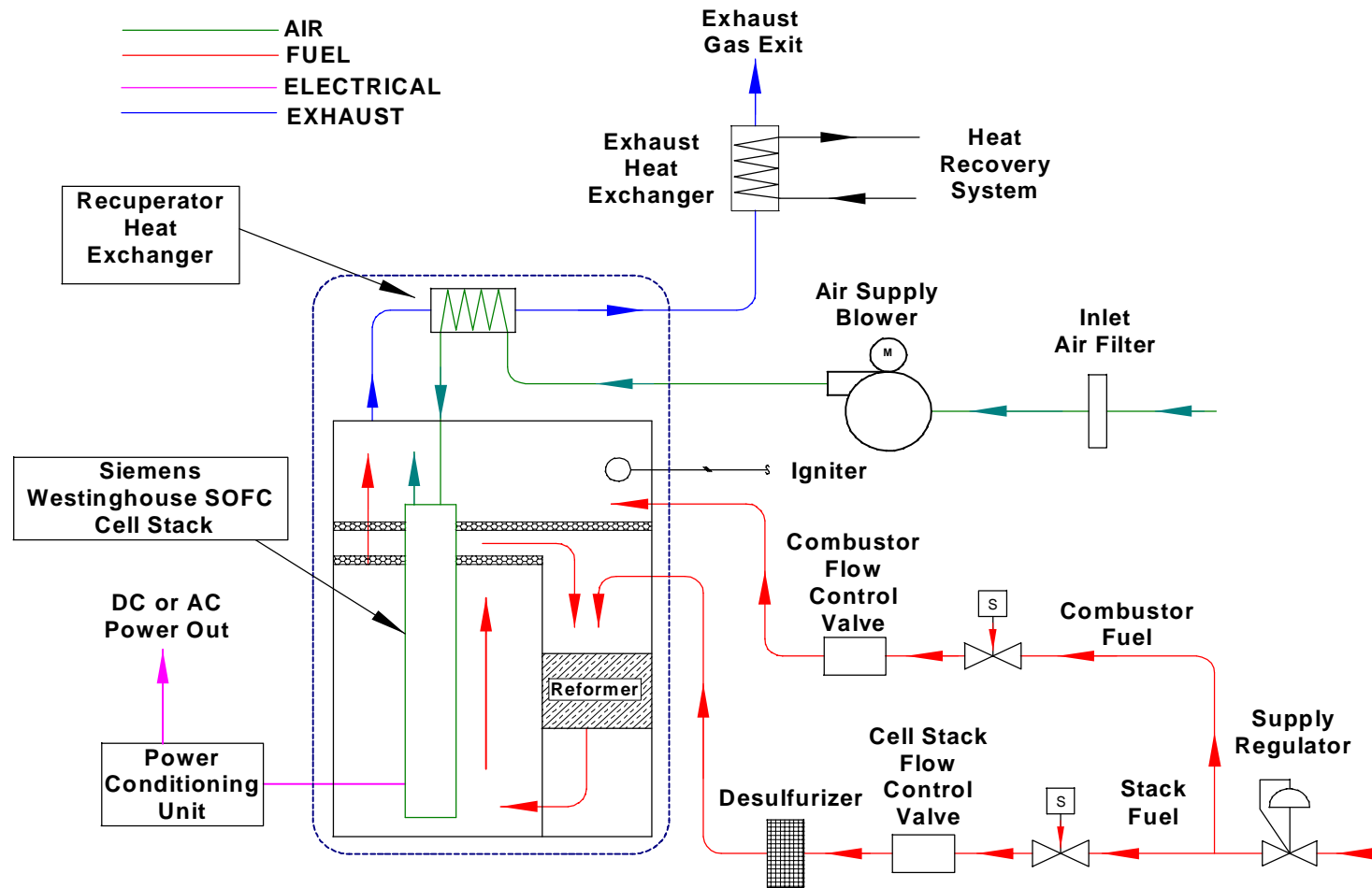
At half the length, the seal-less planar cell will produce 50% more power.



Bundle Comparison



5 kWe Power System - Simplified Flow Schematic



5 kWe Power System Model - SECA Vision



24"L x 31" W x 67"H



- Data Display
- 10kW DC/AC Inverter
- Inlet Air Filter
- Control Computer and Electronics
- Pb/Acid Battery Pack
- Exhaust Heat Exchanger
- Siemens-Westinghouse 5kW Cell Stack
- Gas Control Valve For Start-up Heater
- Gas Shut-off Valve For Start-up Heater
- Desulfurizer
- Cell Stack Gas Control Valve
- Cell Stack Gas Shut-off Valve
- Primary and Backup Air Blowers

Summary and Conclusions

First Commercial CHP250 Units by End 2003

- **Expensive.**
- **Limited market entry penetration in early years.**

SECA Program

- **Revolutionary technology advancements to reduce cost.**
- **Catalyst for broad market penetration and new market creation.**
- **New opportunities for small or emerging U.S. suppliers.**
- **Knowledge and capabilities creation in our Universities.**