

**Solid State Energy Conversion Alliance (SECA)
Solid Oxide Fuel Cell Program**

Nguyen Minh

SECA Core Technology Program Meeting
November 16, 2001
Pittsburgh, PA

Program Objective

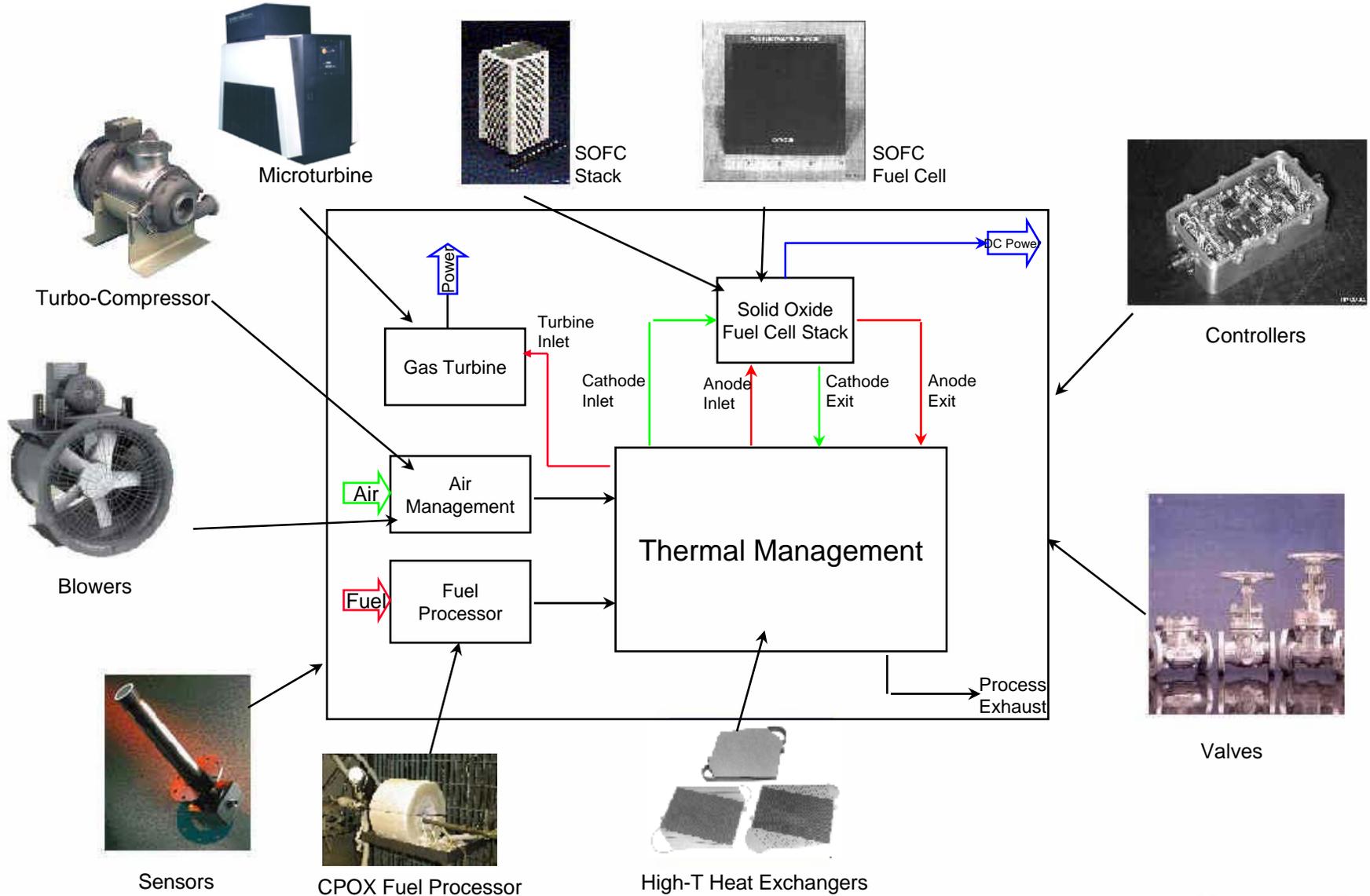
- **Overall objective**

- Demonstrate a fuel-flexible, modular 3-to-10-kW solid oxide fuel cell (SOFC) system that can be configured to create highly efficient, cost-competitive, and reliable power plants tailored to specific markets

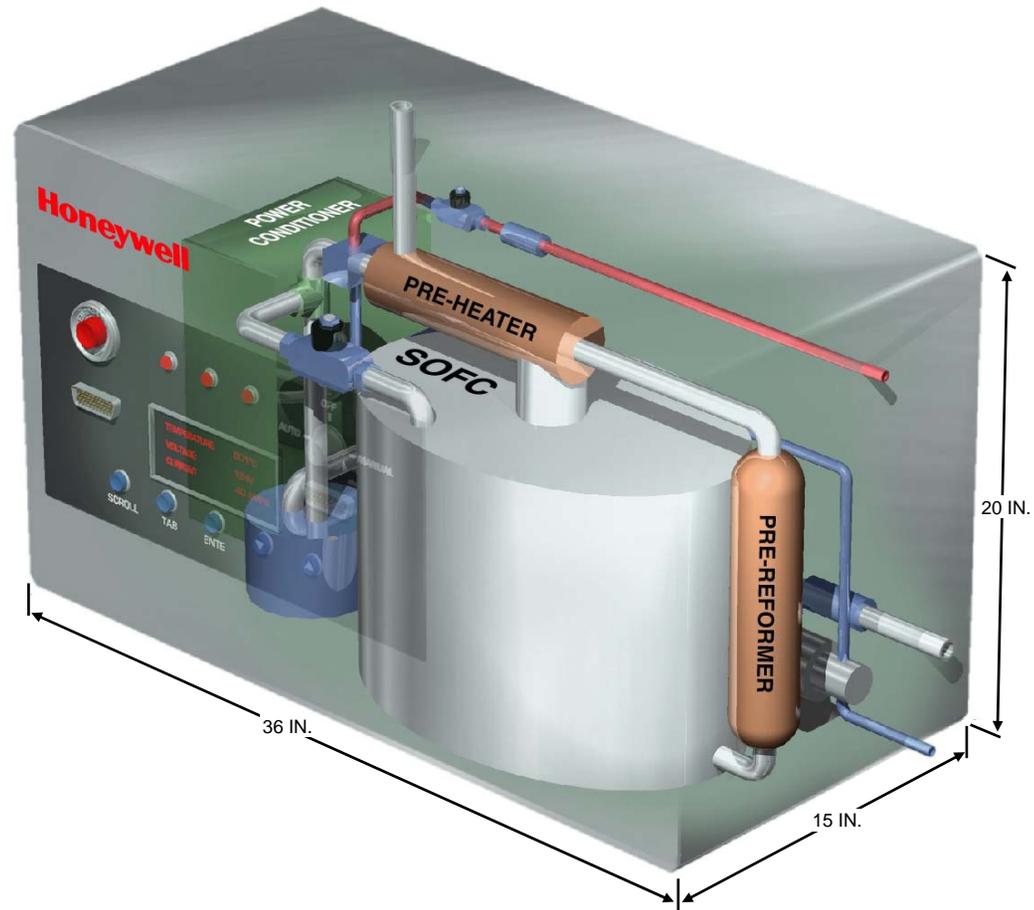
- **Approach**

- System approach
- Development focus
 - ◆ High performance
 - ◆ Low cost
 - ◆ Reliability
 - ◆ Modularity
 - ◆ Fuel flexibility

Simplified SOFC System & Components



SOFC System Concept



FM05584B.ps

Key System Features

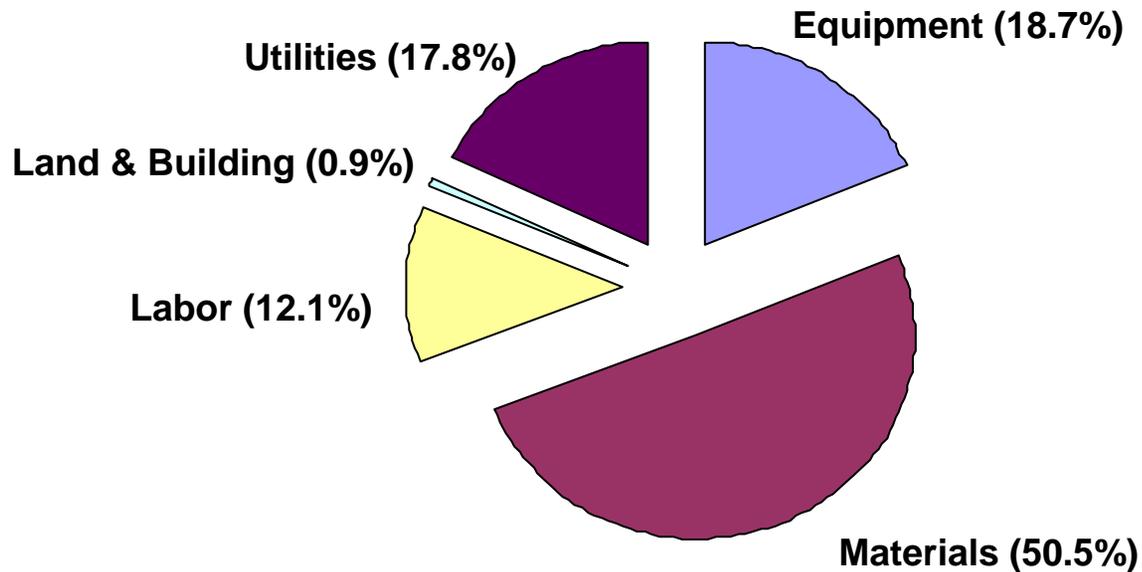
- **SOFC**
 - High-performance reduced-temperature cells
 - Operation on light hydrocarbons
 - Tape calendaring manufacturing process
- **Fuel processor**
 - Low-cost, fuel-flexible fuel processor design
 - Catalytic process
 - Pre-reforming function
- **Other subsystems**
 - Integrated thermal management
 - Flexible control subsystem

System Performance Estimates

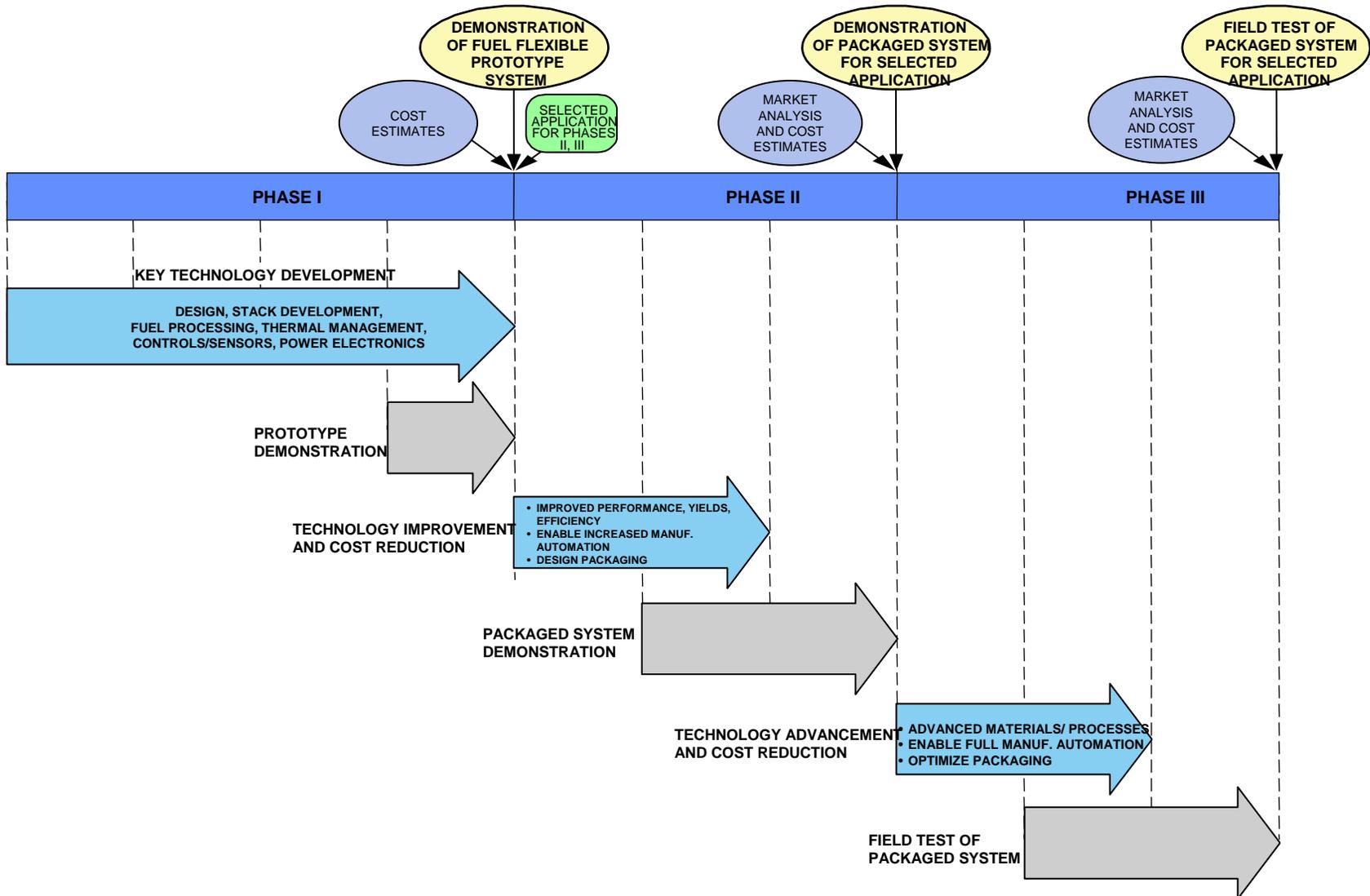
	Stationary	Mobile	Military
Fuel	Natural Gas	Gasoline	Diesel
Net System Power	5 kW	5 kW	5 kW
Net System Efficiency	40%	33%	30%

Cost Estimates

- Projected system cost when fully developed:
\$388/kW
- Stack Costs



Program Features



FM05594.ps

Phase I Work Elements

- **System analysis**
- **Cost estimate**
- **Stack technology development**
- **Fuel processing**
- **Thermal management**
- **Control and sensor development**
- **Power electronics**
- **System prototype demonstration**

SOFC System - R&D Needs

- **Materials and manufacturing**
- **Fuel processing**
- **Modeling and simulation**
- **Thermal systems**
- **Controls and sensors**
- **Power electronics**

Materials and Manufacturing R&D Needs

- **Electrode performance**
 - Anode mechanism
 - Cathode mechanism
- **Electrolyte film**
 - Stability under various conditions
- **Co-firing**
 - Co-firing fundamentals
- **Non-destructive evaluation (NDE)**
 - NDE techniques
- **Contaminant evaluation**
 - Contaminant effects
 - tolerance limits

Fuel Processing R&D Needs

- **Catalytic partial oxidation (CPOX) reaction kinetics**
 - Reaction mechanisms and kinetics
- **Electrochemical CPOX**
 - Electrochemical CPOX processes
- **Advanced catalysts**
 - High-performance catalyst materials

Modeling and Simulation R&D Needs

- **Steady-state system models**
 - Component models for common steady-state platform model
- **Dynamic system models**
 - Component models to predict transient performances
- **SOFC design and performance models**
 - Thermal mapping
 - Stress analysis
 - Current profile

Thermal System R&D Needs

- **High-temperature materials**
 - Low-cost alloys/composites for high-temperature heat exchangers
- **Oxidation resistant coating**
 - Oxidation -resistant coating for low grade metals
- **High-temperature insulation material**
 - Low-cost insulation material for temperatures as high as 1100C

Controls and Sensors R&D Needs

- **Control vs process vs equipment trades**
 - Trade studies to identify critical areas where control, process, and equipment impact each other and affect cost and performance
- **Sensing and measurement**
 - Inferential sensing of gas composition
- **Valves/actuators**
 - High-temperature, low-cost valves

Power Electronics R&D Needs

- **Fuel cell/power inverter interface**
 - Interface impedance calculation method for maximizing system efficiency
- **Power conversion subsystem architecture**
 - Modeling and analysis of various architectures
 - Optimization of architectures

- **Honeywell SECA Solid Oxide Fuel Cell program**
 - Program overview
 - Technical approaches
- **System core technology R&D needs**