Public Benefits

- Negligible emissions of SO$_2$, NO$_x$, particulates, VOC using fossil fuels
- Double the efficiency of producing power from fossil fuels
  - Reduced CO$_2$ emissions
  - Reduced dependence on imported fuels
- Reliability of power supply
- Multiple fuel capability
The Vision: *Fuel Cells in 2010*

- **Cost**
- **Volume**

Low Cost/High Volume
$400/kW/ > 50,000 units/yr
Key to Cost Reduction:  

*Mass Customization of Common Modules*
SECA Development: Progressive Applications

2005
- $800/kW
- Prototype ($-Unit)
  3 - 10 kW

2010
- $400/kW
- Commercial

2015
- Vision 21 Power Plants
  70-80% efficient plants
- Propulsion <$200?/kW

Strategic Center for Natural Gas
Program Structure

Strategic Center for Natural Gas

Industry Input

Program Management

Industry Integration Teams

Research Topics

Needs

Project Management

Technology Transfer

Core Technology Program

Industry

University

National Lab

Small Business

Fuel Processing

Electronics

Modeling & Simulation

Materials

Controls & Diagnostics

Power Electronics

Manufacturing

Fuel Processing

Fuel Processing

Manufacturing

Modeling & Simulation

Power Electronics

Controls & Diagnostics

Materials

Core Technology Program

Strategic Center for Natural Gas
Industry Integration Teams
The Manufacturing Base

Multiple Integration Teams

Mass Customization of Common Modules
Industry Integration Teams

- Three to six competitively selected DOE/DOD teams
- Prototype within four years of award.
- 20% cost share in Phase I
  50% in Phase II and III.
Industrial Team Solicitation Components

Technical Approach

Statement of Work, Milestones, and Test Plan

Cost Estimate

Capabilities, Facilities, Team Structure and Personnel

Market Evaluation and Applicants Existing Experience
Industrial Team Minimum Requirements

PHASE III

Power Rating Net: 3-10 kW

Cost: $400 / kW

Efficiency:
- APU: 30 - 50%
- Stationary: 40 - 60%

Testing (Steady State):
- >1500 hours
- 95% availability
- Power < 0.1% degradation/500 hours at a constant stack voltage

(Transient):
- >100 cycles defined by application
- Power ≤ 1% degradation after 100 cycles at a constant stack voltage

Strategic Center for Natural Gas
Industrial Team Minimum Requirements

**PHASE III**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Lifetime</td>
<td>5,000 Hours [APU]</td>
</tr>
<tr>
<td></td>
<td>40,000 Hours [Stationary]</td>
</tr>
<tr>
<td>Maintenance Interval</td>
<td>&gt; 1,000 Hours</td>
</tr>
<tr>
<td>Fuels (Current infrastructure)</td>
<td>Natural Gas</td>
</tr>
<tr>
<td></td>
<td>Gasoline</td>
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<tr>
<td></td>
<td>Diesel</td>
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</tbody>
</table>
### Core Technology Program

**The Technology Base**

<table>
<thead>
<tr>
<th>University</th>
<th>National Lab</th>
<th>Industry</th>
<th>Small Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Processing</td>
<td></td>
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<tr>
<td>Manufacturing</td>
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<tr>
<td>Materials</td>
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</table>

#### Fuel Cell Core Technology
Core Technology Program (CTP)  
*Raising the Technology Baseline.*

- CTP developments can benefit all SECA Industrial Teams
- A mix of short (1-2 year) projects that address the needs of multiple Industrial Teams and a few longer term projects that add significant value to all projects.
- Biannual meeting of CTP participants, Industrial Teams, Project Management Team
- Limited Lab Call in FY01
- Solicitation in FY01 for universities and small businesses
Intellectual Property
Cornerstone of the Alliance

• Non-Exclusive License
  - Ready market of potential licensees
  - Best designs vs. highest bidder

• Promotes Collaboration - Limits Redundancy
Exceptional Circumstance Provisions

• Each Industrial Team will be offered a non-exclusive license for the IP generated by the Core Technology Program in the SOFC field of use

• Offers must be open for 1 year after issue of a U.S. patent

• Pilot program; reevaluate after 2 years
SECA Players/Efforts

Universities, National Labs, Industry

- Universities
- National Labs
- Industry

- McDermott
- NexTech
- Honeywell
- Argonne National Laboratory
- Pacific Northwest National Laboratory
- The University of Utah
- NETL
- Siemens Westinghouse
- Arthur D. Little
- Oak Ridge National Laboratory
- University of Florida
- Berkeley Lab
- MTI Systems
- Northwestern University
- Delphi

Automotive Systems
Active SECA Projects

- Multi-layered, co-fired, planar, SOFC stack
- Manufacturing technology utilizes high-volume production methods currently employed in the manufacture of multi-layer ceramic packages

Honeywell

- Manufacturing process based on tape calendaring for multi-layer planar SOFC using a new Honeywell design concept
- Demonstrate cell performance
Active SECA Projects

**Pacific Northwest National Laboratory**

- SOFC component development
- SOFC modeling & experimental support
- Prototype small stack testing of developed components and concepts
- Supporting Delphi through CRDA

**Argonne National Laboratory**

- Development of low-temperature cathode materials
- Sulfur-tolerant anode materials
- Metallic bi-polar plates and stack
- Systems modeling

Strategic Center for Natural Gas
Active SECA Projects

- Theoretical studies and materials work on cathode microstructures while maintaining high-power density performance with standard solid oxide fuel cell materials at reduced temperatures

- Revisit the segmented-in-series SOFC design using modern multi-layer manufacturing techniques
Active SECA Projects

- Anode supported thin film fuel cell development
- Tape casting, screen printing

- Fuel cell reformer R&D
- Fuel cell modeling and simulation
- Testing of all fuel cell types
- Dynamic hybrid system studies
- Sensors
Active SECA Projects

- Identify, characterize, test new electrolyte materials that have ionic conductivity suitable for use in the 550 - 800°C range, and are chemically stable at SOFC operating conditions

- Develop a stable bi-layer electrolyte for low-T SOFC’s
- Develop a detailed kinetic/thermodynamic/transport model for use in evaluating bi-layer electrolytes and for SOFC cell evaluation
Active SECA Projects

- Evaluate and test the suitability of electrolyte materials for low temperature SOFC operation in combination with cathode materials

- Research co-sintered electrode supported planar fuel cells, spin coated ultra-thin electrolytes, and co-extrusion of monolithic shapes
Active SECA Projects

- Implement a screen-print manufacturing technique for production of complete cells at lower cost

DELPHI

Automotive Systems

- New project selected in FY 2000 (In negotiation)
- PNNL providing technology support through CRDA
<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>1st Annual SECA Workshop</td>
<td>June 1-2, 2000</td>
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<tr>
<td>Industry Team Solicitation Issued</td>
<td>November 3, 2000</td>
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<tr>
<td>Proposals Due</td>
<td>January 24, 2001</td>
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<td>January 4, 2002</td>
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<td>January 3, 2003</td>
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<tr>
<td>SECA Core Technology Program Workshop</td>
<td>February 14 &amp; 15, 2000</td>
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<tr>
<td>2nd Annual SECA Workshop</td>
<td>March 29-30, 2001</td>
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<tr>
<td>2001 Industrial Teams Selected</td>
<td>May 2001</td>
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<tr>
<td>Core Technology Program Solicitation Issued</td>
<td>May 2001</td>
</tr>
<tr>
<td>Core Technology Program Review Meeting</td>
<td>November 2001</td>
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</tbody>
</table>
SECA FY01 Funding (millions)

- **FY 2001 Funding - $18.9**
  - Industrial Funding - $11.8
    - FY 2001 Industrial Team Funding - $7.4
    - Multi-Layer Ceramic - $3.7
    - Systems - $0.5
    - Materials - $0.24
  - Core Technology Program - $6.7
    - National Laboratories - $5.4
    - Universities - $0.57
    - FY 2001 - $0.68
- Studies, Workshops, and Support - $0.43
DOD Interests/Activities

- Core Technology
  - Accelerate development
  - Logistic fuels
- Militarization
  - Survivability, shock & vibration, etc.
- Integration
  - Balance of plant packaging
- Testing
  - Laboratory to field environment
Some SECA-Related Solicitations

- California Energy Commission PIER Solicitation
- DOE Office of Transportation Technology CARAT Solicitation
- NIST Advanced Technology Program
- EC FRAMEWORK V and VI
- DOD DARPA Palm Power
EU - US Cooperation

- Transatlantic network supporting research and stimulating co-operation on fuel cells for transportation and stationary applications, including several SECA-related areas:
  - Auxiliary power units
  - Codes and standards,
  - SOFC and high temperature fuel cell hybrid systems
  - Assessment of availability of critical materials for high temperature fuel cells
President Bush and I are deeply committed to developing an energy policy that includes . . . developing new technologies that conserve fossil fuels and reduce energy-related pollution.

Spencer Abraham, Secretary of Energy