B. KEYNOTE ADDRESS: THE SOLID STATE ENERGY CONVERSION ALLIANCE (SECA): ITS STRUCTURE, TARGET APPLICATIONS, AND ROLE IN DOE'S STRATEGIC PLAN

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Slide 1
The Solid State Energy Conversion Alliance:
A Paradigm Shift in Technology Development

Good morning. I'm pleased to be here. It is my privilege to present an overview of the Solid State Energy Conversion Alliance, or SECA. I will discuss:

- A vision for the future of fuel cells.
- What the SECA alliance is.
- The concept behind the alliance.
- The proposed structure of the alliance.
- Next steps to initiate the SECA program.

Slide 2
The Vision: Fuel Cells in 2010

Let me start by sharing a vision of the future, a vision of solid-state fuel cell systems in 2010.

- These systems will be low cost: $400 per kilowatt in the multi-kilowatt size range, a remarkable accomplishment in this small size range. The price trajectory will be downward, such that a $50 per kilowatt system for transportation applications is on the horizon.

- Fuel-to-end-use efficiencies will be high: nearly twice as high as today's conventional technologies, again a remarkable accomplishment in the multi-kilowatt size range. These high efficiencies translate to reduced greenhouse gas emissions.

- Given a fuel, there will be a fuel-cell system that can operate on it. Fuel cells will be able to operate on natural gas, gasoline, diesel fuel, landfill gas, hydrogen, and defense logistics fuels.

Early movers in the fuel-cell industry will have commercialized them as auxiliary power units for the nation's cars and trucks, distributed generation units for homes, and field power units for military operations.

Slide 3
The Vision: A Core Module for Multiple Applications

The core of this vision is a 5-kilowatt, low-cost, high power-density, solid-state fuel-cell stack. The core module measures approximately 4 by 4 by 12 inches. It can be mass produced because it can be used in multiple end-use markets. Because it is a standard core module, the cost to customize it for multiple markets is cheap.

This concept of "mass customization of common modules" eliminates the Catch-22 of commercialization:

- High-volume production is needed to reduce costs,
- but low costs are needed to create a large market.

The 5-kilowatt core modules can be combined (like batteries) for applications with larger power needs. This "building block" approach enables low-cost customization. This is the Gateway or Dell computer concept applied to fuel cells. Gateway and Dell keep personal computer costs low and meet the exact needs of their customers by applying using the concept of mass customization.

Ultimately, the SECA concept could lead to megawatt-size fuel-cell systems for commercial and industrial applications and Vision 21 energy plants.

This vision is achievable, but it will take a new approach to technology development.

Slide 4
SECA — Realizing the Vision

That approach is SECA – the Solid State Energy Conversion Alliance.

SECA is an alliance of

- industrial teams, who individually plan to commercialize solid-state fuel-cell systems;
- R&D organizations involved in solid-state activities; and
- government organizations, who provide funding.

SECA is a national program that provides a forum to bring these entities together. All are interested in low-cost, high power-density, solid-state fuel-cell systems for some application. All are committed to the concept of "mass customization" as the route to reducing costs.

The high power-density requirement of the SECA program is a critical driver for transportation applications. This sector presents some of the most challenging requirements for the use of fuel cells. For example, a 5-kilowatt unit for auxiliary power must fit into a volume of 50 liters. (The "unit" includes the stack, reformer, and all other balance-of-plant components.) The 5-kilowatt unit must also weigh less than 50 kilograms, and have a surface temperature less than 45 EC.

High power-density is not as critical for stationary applications. However, by addressing these challenging requirements for the transportation sector, stationary developers may be able to substantially reduce their costs. Over the course of this workshop, I invite your thoughts on these draft requirements for the transportation sector.

The SECA program develops an integrated strategy to address the technical barriers of solid-state fuel-cell systems. SECA also focuses research performers on the breakthrough technologies needed to achieve the program goals.

Two national labs coordinate the SECA program: the National Energy Technology Laboratory (NETL) and the Pacific Northwest National Laboratory (PNNL). They provide the leadership, focus, and integration needed to achieve the goals of the SECA program.

Slide 5
SECA Structure

SECA represents a new model for joint government and private-industry technology development. Through annual workshops such as this, interested stakeholders help develop program goals. This information flows — through the program managers at NETL and PNNL — to the project management at NETL. The project managers coordinate the activities of the Industry Integration Teams and the Core Technology Program.

Each of the vertical bars in the viewgraph represents one Industry Integration Team. Each team is developing a fuel-cell system that they intend to commercialize.

The Core Technology Program (lower left in the viewgraph) consists of a "patchwork quilt" of R&D performers. Their projects address crosscutting technical issues in solid-state fuel-cell systems.

The blue arrows show a "circular" relationship. The Industry Integration Teams communicate their technology development needs to the project managers. The project managers translate these needs into research topics for the Core Technology Program. Participants in the Core Technology Program develop solutions that are transferred back to the Industry Integration Teams.

Slide 6
SECA Industry Integration Teams

Each Industry Integration Team is developing the capability to commercialize a solid-state fuel-cell system. It can be for stationary and/or transportation and/or military applications.
The teams are independent. They compete with each other. However, all are committed to the concept of mass customization as a route to reducing the cost of fuel-cell systems.

These "vertical teams" are competitively selected and will receive funding from interested government organizations, such as DOE's Office of Fossil Energy (FE). Our hope is that DOE's Office of Energy Efficiency and Renewable Energy (EE), and various organizations in the Department of Defense (DOD) will also decide to fund a suite of Industry Integration Teams. We are discussing the possibility of shared

funding with EE and DOD, and are delighted that they are participating in this workshop.

FE is currently developing its first solicitation for Industry Integration Teams. Wayne Surdoval from NETL will discuss this solicitation later this morning. We anticipate that FE will fund two or three Industry Integration Teams as a result of this solicitation. Our hope is other funding organizations will join in this solicitation or issue their own solicitation(s). The number of Industry Integration Teams ultimately selected will depend on the number of government agencies sponsoring the SECA program and their level of commitment.

DOD's Tank Armament and Automotive Command (TACOM) may choose to issue a solicitation for a solid-state fuel-cell module for tanks or other military vehicles.

The SECA program has momentum! "Pre-SECA" R&D work is already underway. Three industry projects in our present program are on a "SECA pathway." They are the Delphi, Honeywell, and McDermott projects. You will hear presentations from these companies later this morning. These organizations are either under contract with us, have a CRADA with us, or have been competitively selected for an award under a previous solicitation. The three projects are likely to be absorbed into the SECA program as Industry Integration Teams.
These three plus an additional two or three give a total of five or six possible Industry Integration Teams funded by FE.

Slide 7
SECA Core Technology Program

R&D performers in the Core Technology Program address the crosscutting technology development needs of the Industry Integration Teams. R&D performers may be:

- universities,
- national labs,
- industry, and
- small businesses.

They will conduct basic and applied R&D. The list of technology development categories we think the R&D performers will need to address includes:

- fuel processing,
- manufacturing,
- controls and diagnostics,
- power electronics,
- modeling and simulation, and
- materials.

This list is draft. I invite workshop participants to tell us if we have the right list of R&D needs.

The projects in the Core Technology Program are competitively selected, and are supported by the same

government agencies that fund the Industry Integration Teams. The target funding split is 40 percent for the Core Technology Program and 60 percent for the Industry Integration Teams.

FE has pre-existing contracts and awards that are relevant to the Core Technology Program. For example, we have projects with the University of Utah and the University of Missouri, and materials work with Honeywell. Our intent is to absorb these projects into SECA.

As a side note, we are successfully using the research model outlined here in our gas turbine program. The Advanced Gas Turbine Research Program is establishing the scientific foundation for 21th century gas turbines. The program is industry driven and involves 95 universities in 37 states. Both FE and EE fund the program. Pre-competitive research areas are defined by an Industry Review Board — the gas turbine manufactures. The South Carolina Institute for Energy Studies coordinates the program for DOE.

Slide 8
Intellectual Property — Cornerstone of the Alliance

SECA's treatment of intellectual property is the cornerstone of the alliance. It is a pilot program. DOE hopes this pilot will become the model for other technology development programs.

In the SECA program, DOE anticipates that all members of the alliance will be granted rights to own any inventions they make under the program. The intellectual property (IP) rights of the Industry Integration Teams are complete. However, those of the Core Technology Program are slightly limited. Participants in the Core Technology Program must be willing to license their patented technologies to any of the Industry Integration Teams, within reasonable time limits and other constraints.

Why this approach to IP? The SECA concept is based on the development of a common fuel-cell core module. This common module is essential to reducing the cost. The core module will be expedited if the technologies developed in the Core Technology Program are available for licensing to the Industry Integration Teams. We believe the Industry Integration Teams will be more likely to identify research needs if they are assured that all solutions will be within reach. This intellectual property approach will open the doors to collaboration!

There are other advantages:

- Technologies developed in the Core Technology Program can be incorporated into any designs that will benefit from them — not just into the designs of the highest bidder.

- Research performers in the Core Technology Program will have a ready market for their inventions. They will reap royalties if an Industry Integration Team commercializes a fuel-cell system with their invention.

- This intellectual property arrangement increases the value of a technology. If a technology is important, all of the Industrial Integration Teams will need it to remain competitive.

Slide 9
Solid-State — The Choice for the New Millennium

- I want to examine some underlying questions about the SECA concept. First: Why solid-state? Solid-state fuel cells have several potential advantages:

- Solid-state fuel cells have inherently high efficiencies — up to 60 to 70 percent hydrocarbon-to-electric efficiency. Hybrid or staged systems can have efficiencies up to 80 percent.

- Their high temperature simplifies high-temperature reforming of hydrocarbon fuels. The reformer and the fuel cell can be coupled.

- Solid-state fuel cells have easier head management and simpler control systems.

They lend themselves to low-cost manufacturing.

Slide 10
SECA — Now is the Time

Why is now the time for SECA? Recent technology breakthroughs have set the stage for low-cost solid-state fuel cells. These breakthroughs include:

- Advances in thin-film manufacturing of solid-state materials; for example, tape casting and multi-layer ceramic processing.
- Innovations in planar designs, such as anode-supported electrolytes.
- Compact fuel-processing technology, such as micro-channel reforming.
- Low-cost invertors.
- Advances from related industries; for example, semiconductor manufacturing.

Market forces make it the right time for SECA. Deregulation is opening the door for distributed generation technologies like fuel cells — domestically and internationally. There is a growing demand for more electric power in the transportation sector.

The environmental spotlight is extending small-scale applications. The superb environmental performance of fuel cells makes them a leading contender for market share of small-size systems.

Slide 11
Status of the Market — Stationary

I would like to touch on the status of markets for solid-state fuel cells. Other speakers will discuss markets in more detail.

In the stationary market, there is a movement from central station to distributed power. This is the mainframe-to-personal-computer analogy. Customers want individual control and reliability. Penetrating the distributed generation market beyond niche markets applications will require costs at or below $400 per

kilowatt. We need breakthrough technologies to reduce costs to this level. Environmental concerns are driving distributed generations toward very clean systems such as fuel cells.

Slide 12
Status of the Market — Transportation

In the transportation market, solid-state fuel cells offer the potential of low cost systems that can operate using the existing fuel infrastructure. These fuel cells offer both very high efficiencies and low emissions. Auxiliary power units for long-distance trucks may be an early market applications for solid-state fuel cells.

Slide 13
Status of the Market — Military

In the military market, fuel logistics are critical. Fuels represents 70 percent of the weight of materials moved in a military logistical deployment. DOD needs high-efficiency power sources compatible with defense logistic fuels. Systems need to be quiet, rugged, and have low thermal signatures. Field power units may be one of the early market applications for fuel cells in the military. The navy's decisions to use electric drive on new ships increases the potential size of the market.

Slide 14
A Paradigm Shift

Predicting the future is an inexact art. There is a Chinese proverb that says: "He who lives by the crystal ball will die from eating broken glass." With that said, a book was published recently that gives a view of the future. It is called *The Long Boom, A Vision For the Coming Age of Prosperity*. The authors are Schwartz, Leyden, and Hyatt.

The book describes several scenarios that might take place in the first two decades of this century. One scenario is named after the title of the book — the Long Boom. It depicts an unprecedented period of continued economic growth and world peace. But it is very clean, high-tech economic growth. Three to four billion people in developing countries move to the middle class. They want very clean energy: clean cars, clean electricity. Distributed power generation takes off. It is the beginning of the hydrogen infrastructure. And fuel cells can play a major role in this scenario.

This is a scenario that many of us would love to see play out. But even in the less optimistic scenarios, fuel cells can begin to play a major role. I believe fuel cells represent a major shift in how we produce electricity and power and power. Using the buzz words, fuel cells represent a paradigm shift, or a disruptive technology that will change the market dramatically. SECA accelerates this paradigm shift. It starts with the end in mind. It capitalizes on industry's willingness to cooperate across traditional lines.

Slide 15
Public Benefits

As a result, the public benefits. When advanced, ultra-clean, fuel cells move from niche markets to widespread use:

- Their high efficiency will result in significantly reduced emissions.
- Grid stability and reliability will be enhanced.
- We will have the option of continuing to use our low-cost domestic energy resources in an environmentally friendly way. We will be "greener sooner" using fossil fuels.

Slide 16
Responding to the Needs of the Nation

Assistant Secretary for Fossil Energy Bob Gee noted that "mass customization of fuel-cell components for stationary, mobile, and military applications can lead to mass manufacturing and in turn, to much lower unit costs."

This approach, the SECA approach, helps the Department of Energy fulfill its mission "to foster a secure and reliable energy system that is environmentally and economically sustainable."

As a new business model, SECA provides "the break with traditional ways of thinking" that author Stephen Covey said is necessary to make significant technological breakthroughs. SECA responds to the needs of the nation by providing the means to commercialize clean, low-cost, solid-oxide fuel-cell technology.

Thank you.

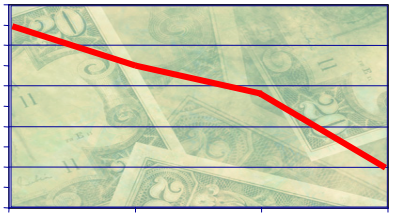
The Solid State Energy Conversion Alliance: A Paradigm Shift in Technology Development

Solid State Energy Conversion Alliance Workshop

June 1-2, 2000

Rita A. Bajura, Director
National Energy Technology Laboratory

The Vision: *Fuel Cells in 2010*



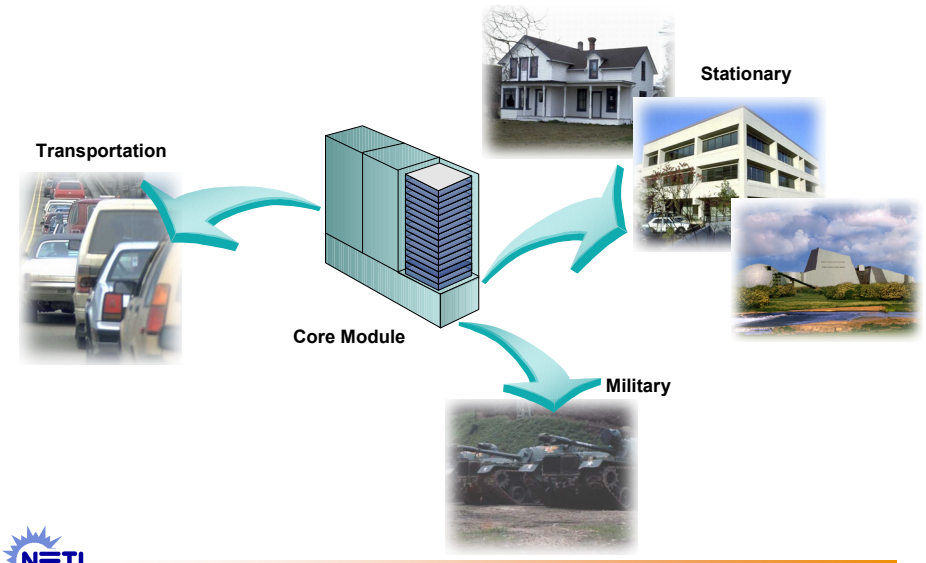
Low Cost
$400/kW

Multiple Fuels

Reduced CO_2 Emissions

2K- 5/00

The Vision: *A Core Module for Multiple Applications*



NETL

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SECA - Realizing the Vision

SECA:

- An alliance of industry teams, R&D performers, and government funding organizations
- Develops an integrated strategy
- Focuses research

NETL

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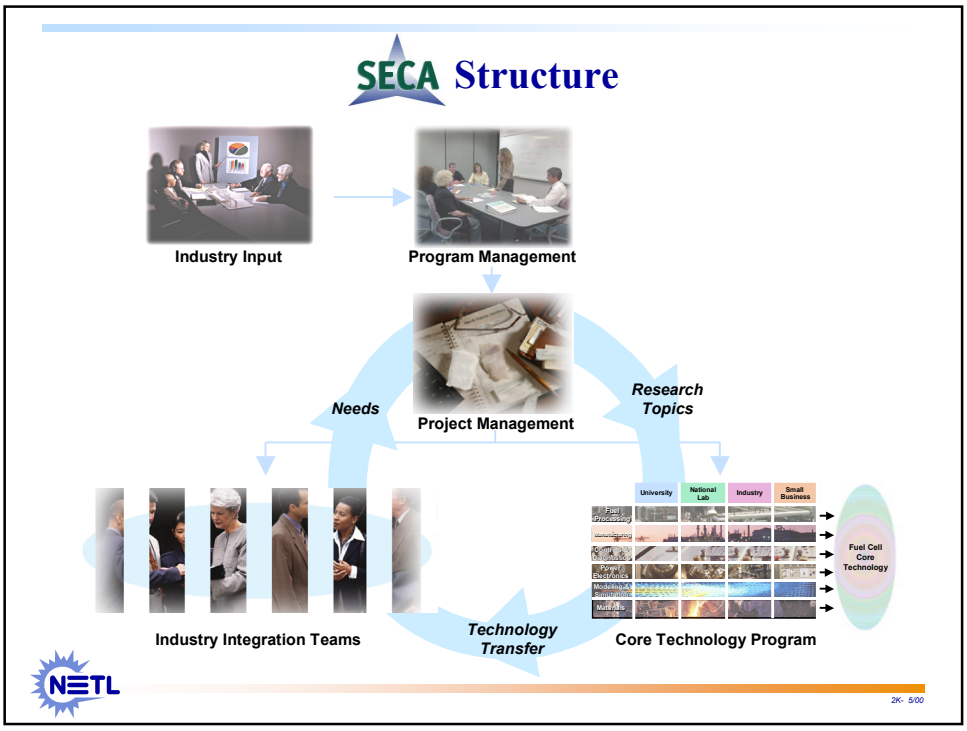
SECA Structure
Industry Input
Program Management
Project Management
Needs
Research Topics
Industry Integration Teams
Technology Transfer
University
National Lab
Industry
Small Business
Fuel Cell Core Technology
Core Technology Program
NETL
2K- 5/00


SECA Industry Integration Teams
The Manufacturing Base
Multiple Integration Teams
Mass Customization of Common Modules
NETL
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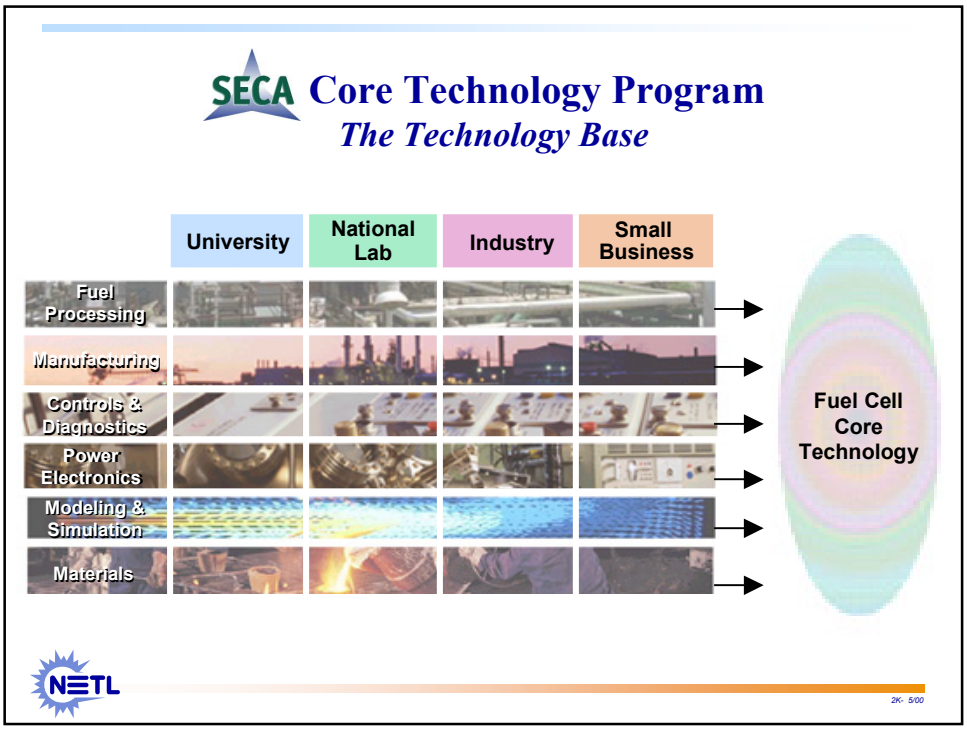
SECA Core Technology Program
The Technology Base
University
National Lab
Industry
Small Business
Fuel Processing
Manufacturing
Controls & Diagnostics
Power Electronics
Modeling & Simulation
Materials
Fuel Cell Core Technology
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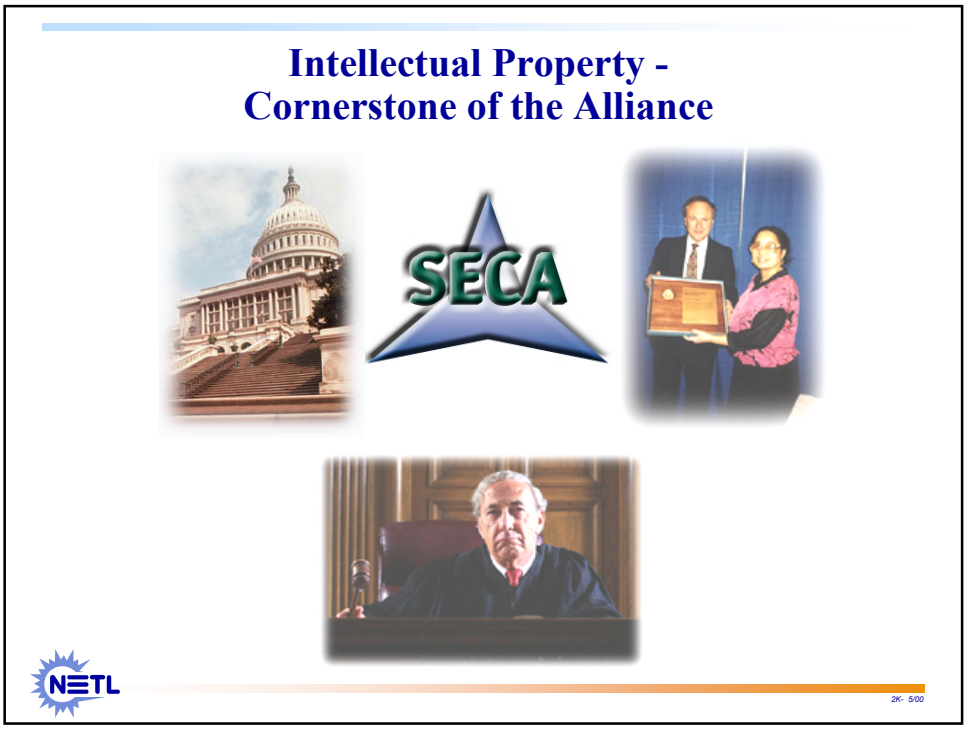
Intellectual Property -
Cornerstone of the Alliance
SECA
NETL
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Solid State - The Choice for the New Millennium

- Inherently high efficiency
- Couples with high-temperature reforming
- Simple and efficient heat removal designs
- Low-cost manufacturing

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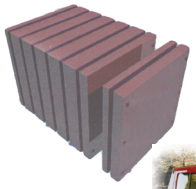
SECA - Now is the Time



- Breakthrough in materials, designs, and manufacturing
- Market forces
- Environmental concerns

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Status of the Market
Stationary

- Major market penetration requires cost ≤ $400/kW
- Breakthrough technologies needed to reduce costs
- Environmental concerns driving DG to very clean systems

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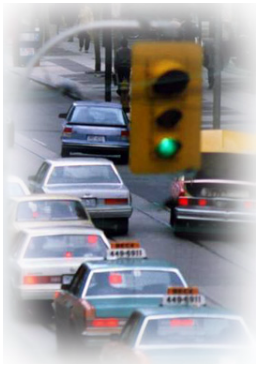
Status of the Market
Transportation



- Potentially low system costs operating on available fuels
- Adaptable to standard transportation fuels
- High efficiencies
- Low emissions

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Status of the Market
Military

- Requires high efficiency, low signature power systems
- Fuel logistics are critical
- Electric drives/field power increasingly important

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A Paradigm Shift
Overcoming the Pull of The Past

Cleaner, more efficient way to use fossil fuels

Start with the end in mind

Industry cooperating across traditional lines

Adopt principles of contemporary system design

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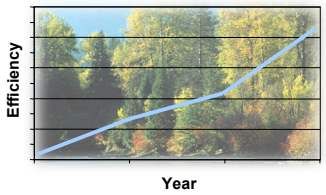
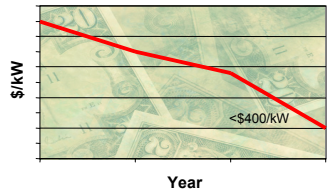
Public Benefits

High Efficiency



Grid Stability

Cost Reduction



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Responding to the Needs of the Nation

"Mass customization of fuel cell components for stationary, mobile, and military applications can lead to mass manufacturing and in turn, to much lower unit costs."

Bob Gee, Assistant Secretary for Fossil Energy

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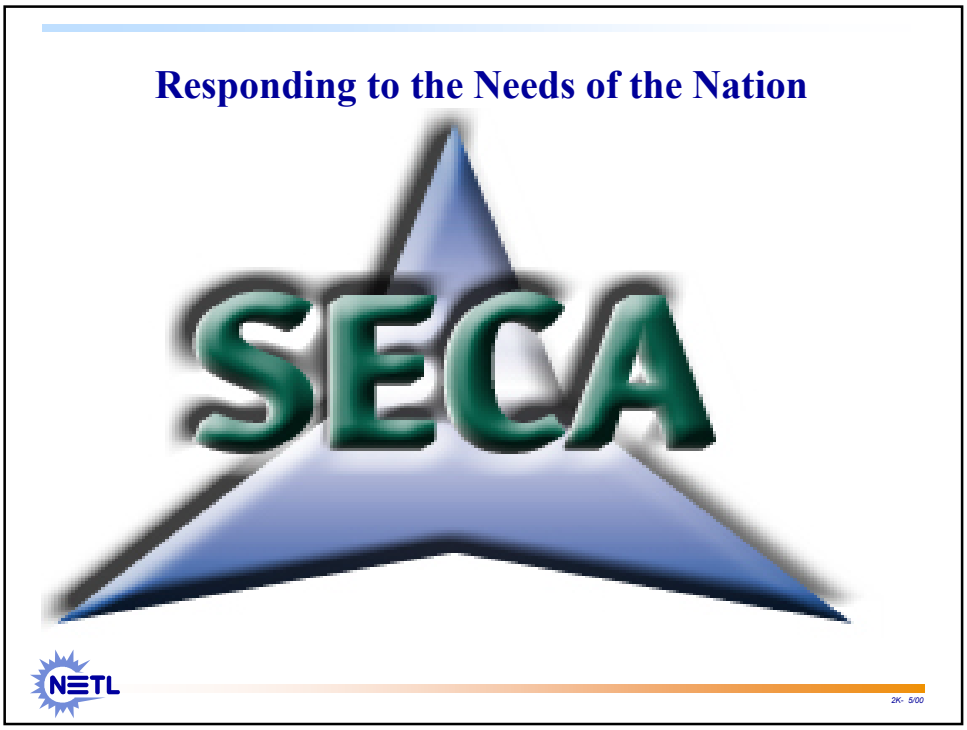
Responding to the Needs of the Nation
SECA
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