

Fossil Energy Fuel Cell Program



***Solid State Energy Conversion
Alliance***

***Wayne Surdoval, SECA Coordinator
July 8, 2003***

**National Energy Technology Laboratory
Office of Fossil Energy**



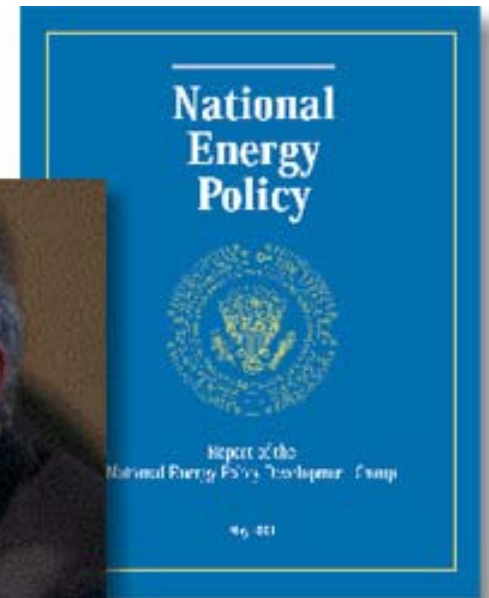
Presidential Priorities

National Energy Policy

- Increasing America's domestic energy supplies
- Protecting America's environment
- Ensuring a comprehensive delivery system
- Enhancing National energy security

Initiatives

- **Hydrogen Fuel Cell**
- Clean Coal Power
- Clear Skies
- Climate Change
- Energy Security

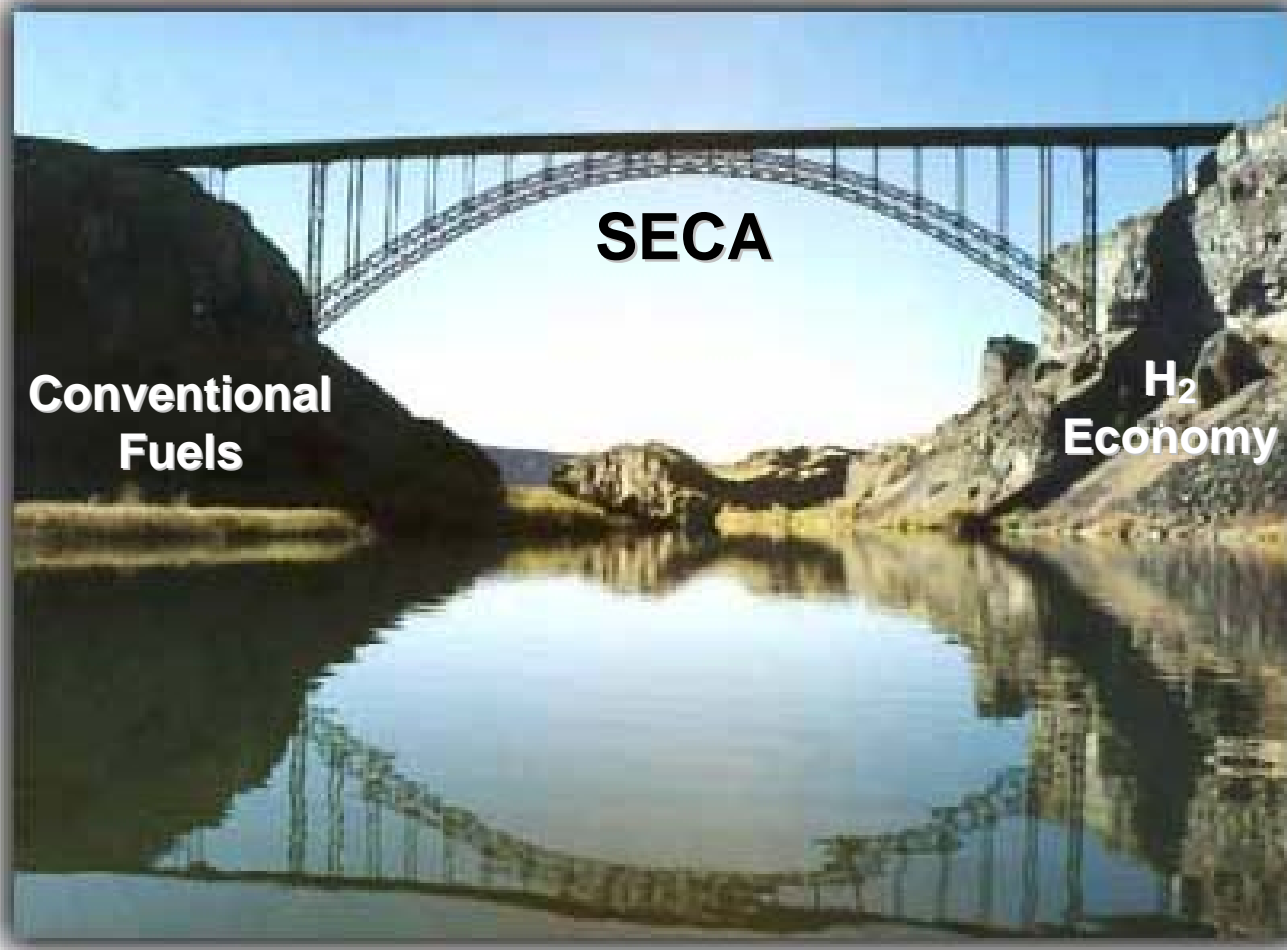


White House photo: Paul Morse

SECA Fits Presidential Initiatives



SECA is an Interim Solution from Conventional Fuels to Hydrogen Economy



Fuel Cell Program Areas (FY03 Funding)



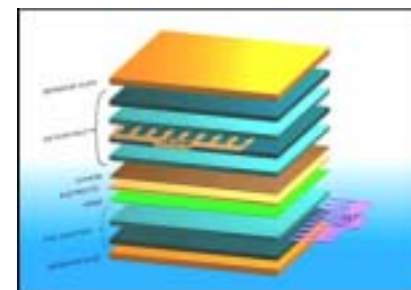
SECA - \$34.5M



Molten Carbonate - \$10.0M



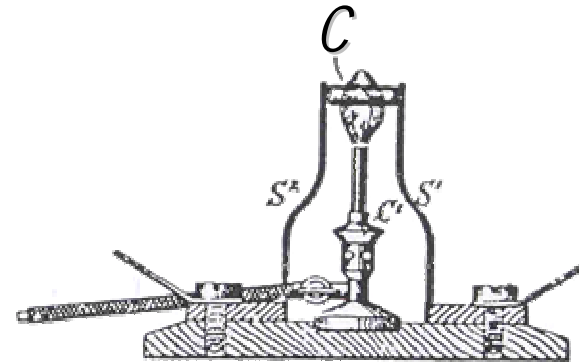
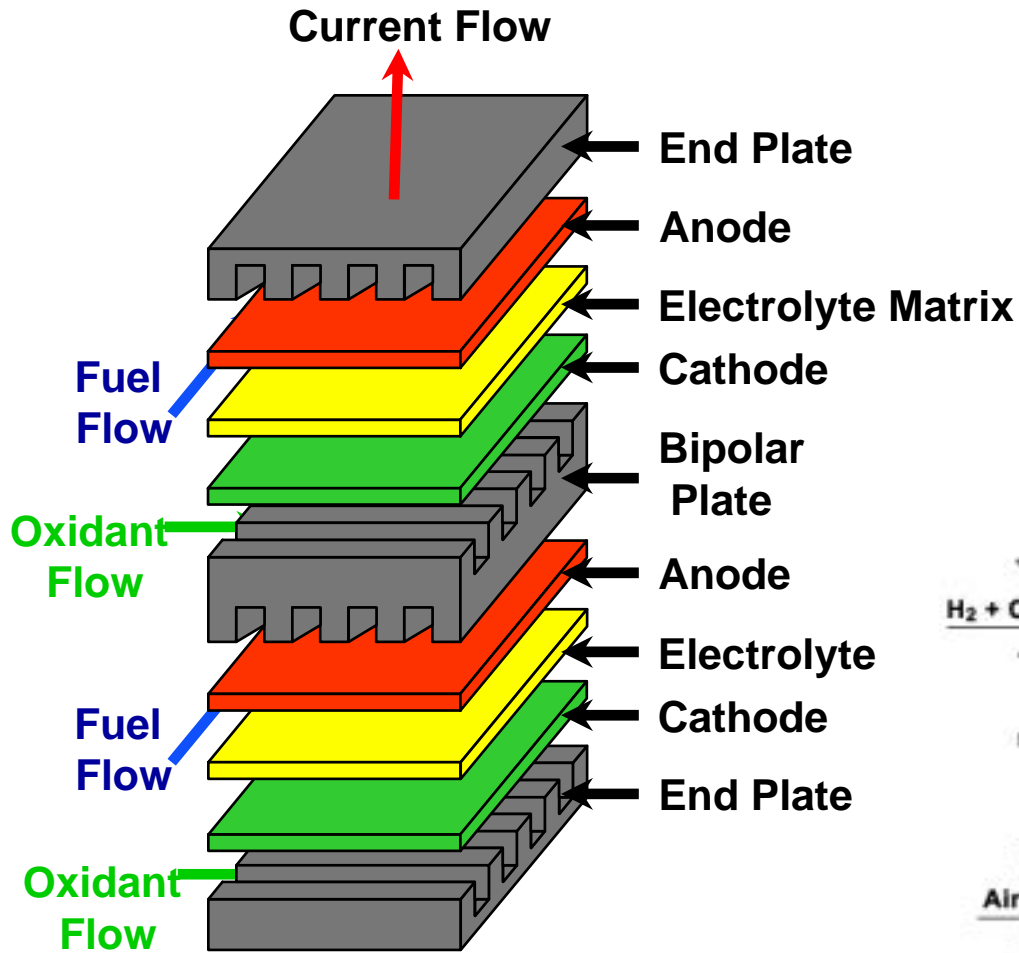
Vision 21 Hybrids - \$13.0M



**Advanced Research
(Electrochemical Engineering)
\$4.0M**

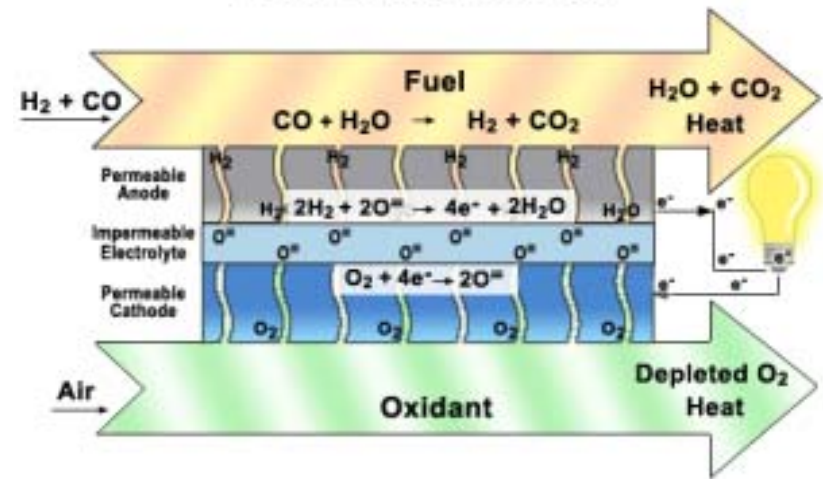


Solid Oxide Fuel Cell

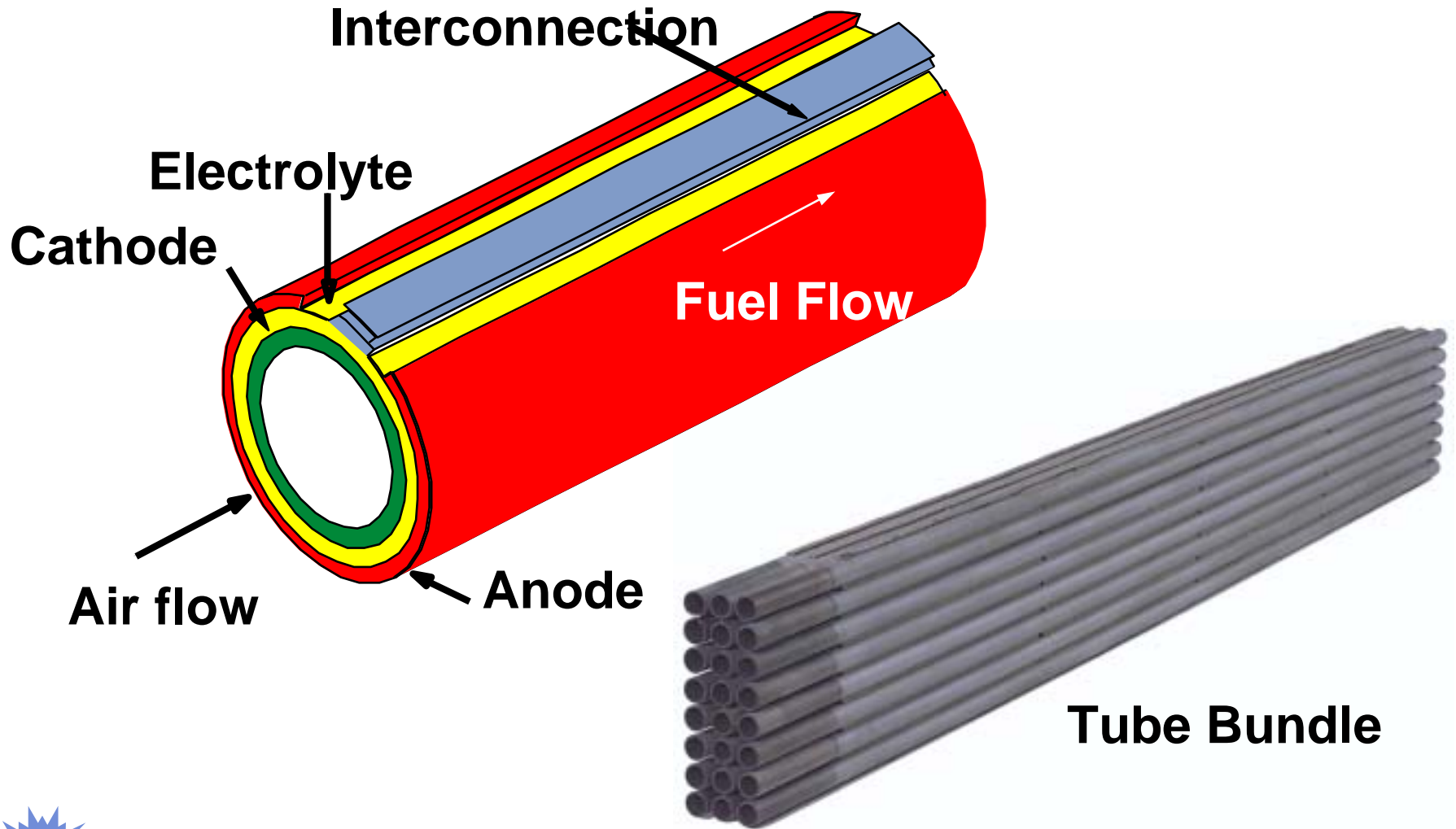


W. Nernst
 "Electrical Glow-Light"
 U.S. Patent 623,811 April 25, 1899

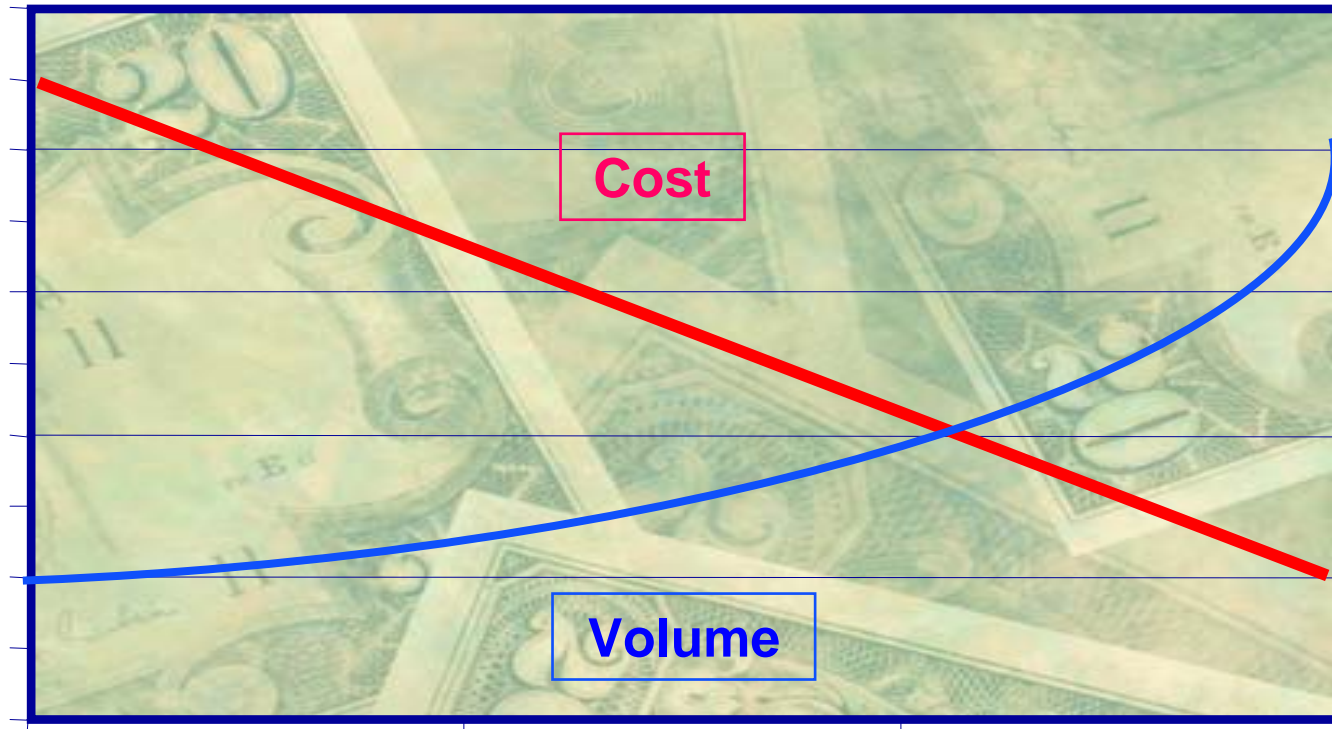
Solid Oxide Fuel Cell



Tubular SOFC



The Vision: *Fuel Cells in 2010*



Low Cost/High Volume
\$400/kW > 50,000 units/yr



SECA: A Path to Making Fuels Cells a Reality



2005

- **1st Generation products**

- Truck APU's
- RV's
- Military

2010

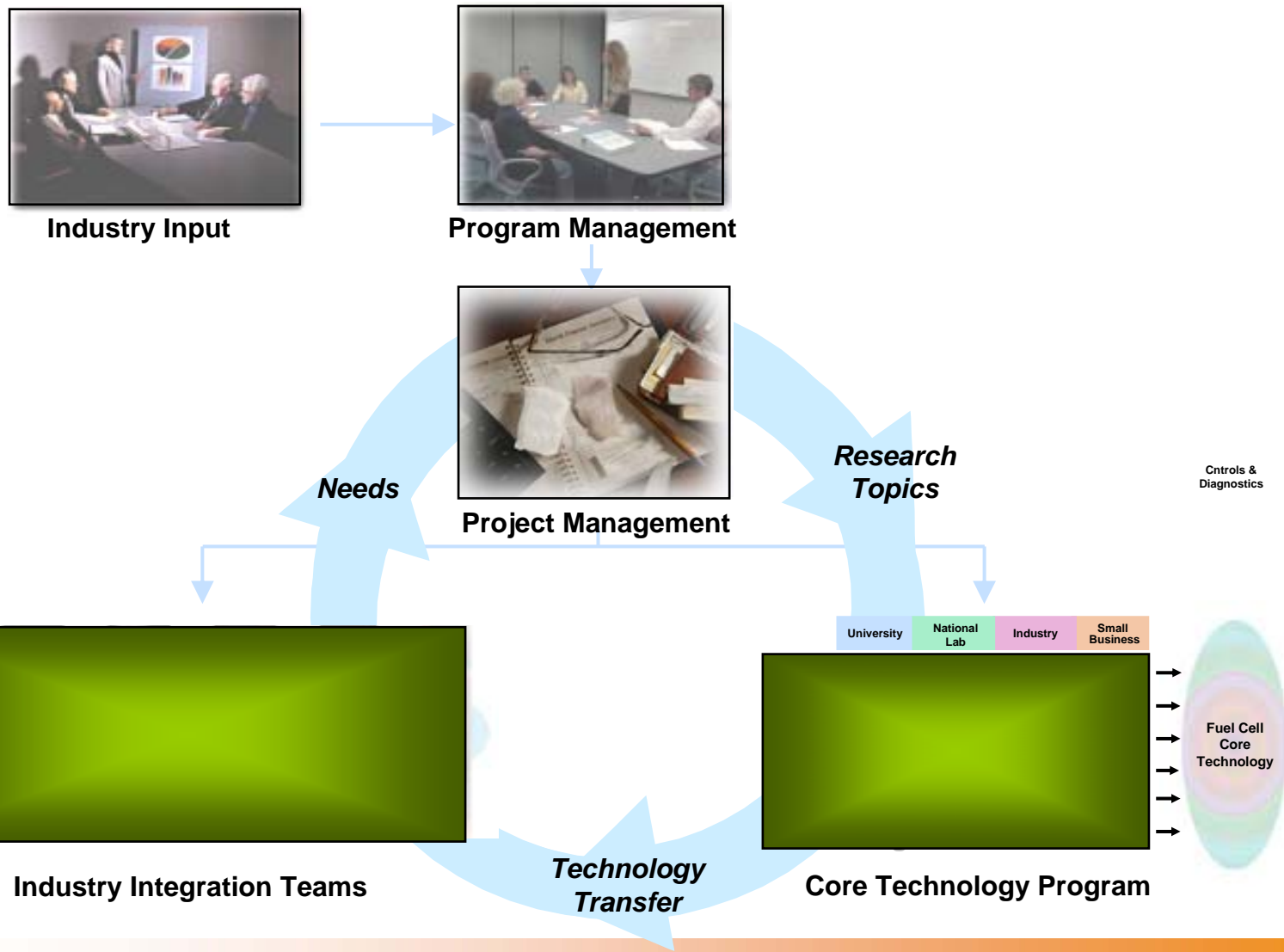
- **\$400/kW**
- **Commercial products**
 - Residential, commercial, industrial CHP
 - Transportation APUs

2015

- **\$400/kW**
- **Hybrid systems**
 - 60-70% efficient
- **Coal power plants**
- **FutureGen**



Program Structure

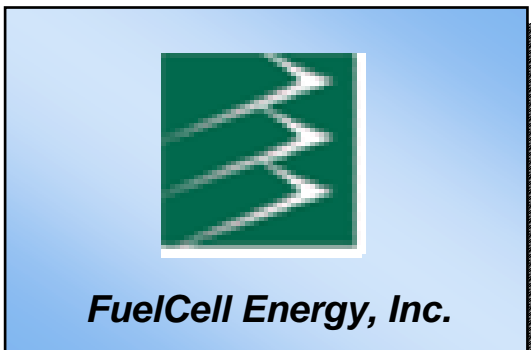
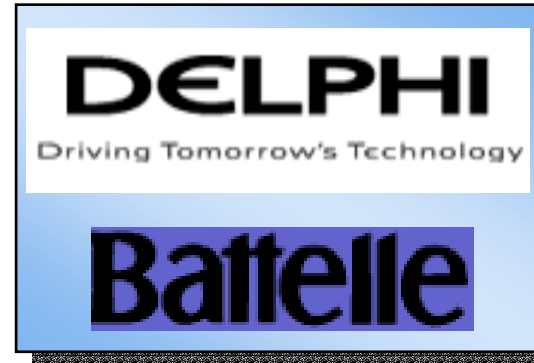


SECA Minimum Technical Requirements

Cost	\$400/ kW
Power Rating Net	3-10 kW
Efficiency (AC or DC/LHV)	30 - 50% [APU] 40 - 60% [Stationary]
Fuels (Current infrastructure)	Natural Gas Gasoline Diesel
Design Lifetime	5,000 Hours 1,000 Cycles [APU] 40,000 Hours 100 Cycles [Stationary]
Maintenance Interval	> 1,000 Hours



Six SECA Industry Teams



Different Approaches!

<i>Team</i>	<i>Design</i>	<i>Manufacturing</i>
Cummins-SOFCo	<ul style="list-style-type: none"> • Electrolyte supported • 850 C • Thermally matched materials • Seal-less stack 	<ul style="list-style-type: none"> • Tape casting • Screen printing • Co-sintering
Delphi-Battelle	<ul style="list-style-type: none"> • Anode supported • 750 C • Ultra compact • Rapid transient capability 	<ul style="list-style-type: none"> • Tape casting • Screen printing • 2-stage sintering
General Electric Company	<ul style="list-style-type: none"> • Anode supported • 750 C • Hybrid compatible • Internal reforming 	<ul style="list-style-type: none"> • Tape calendering • 2-stage sintering
Siemens Westinghouse	<ul style="list-style-type: none"> • Cathode supported • 800 C • Redesigned tubular • Seal-less stack 	<ul style="list-style-type: none"> • Stack extrusion • Plasma spray



Two New Different Approaches!

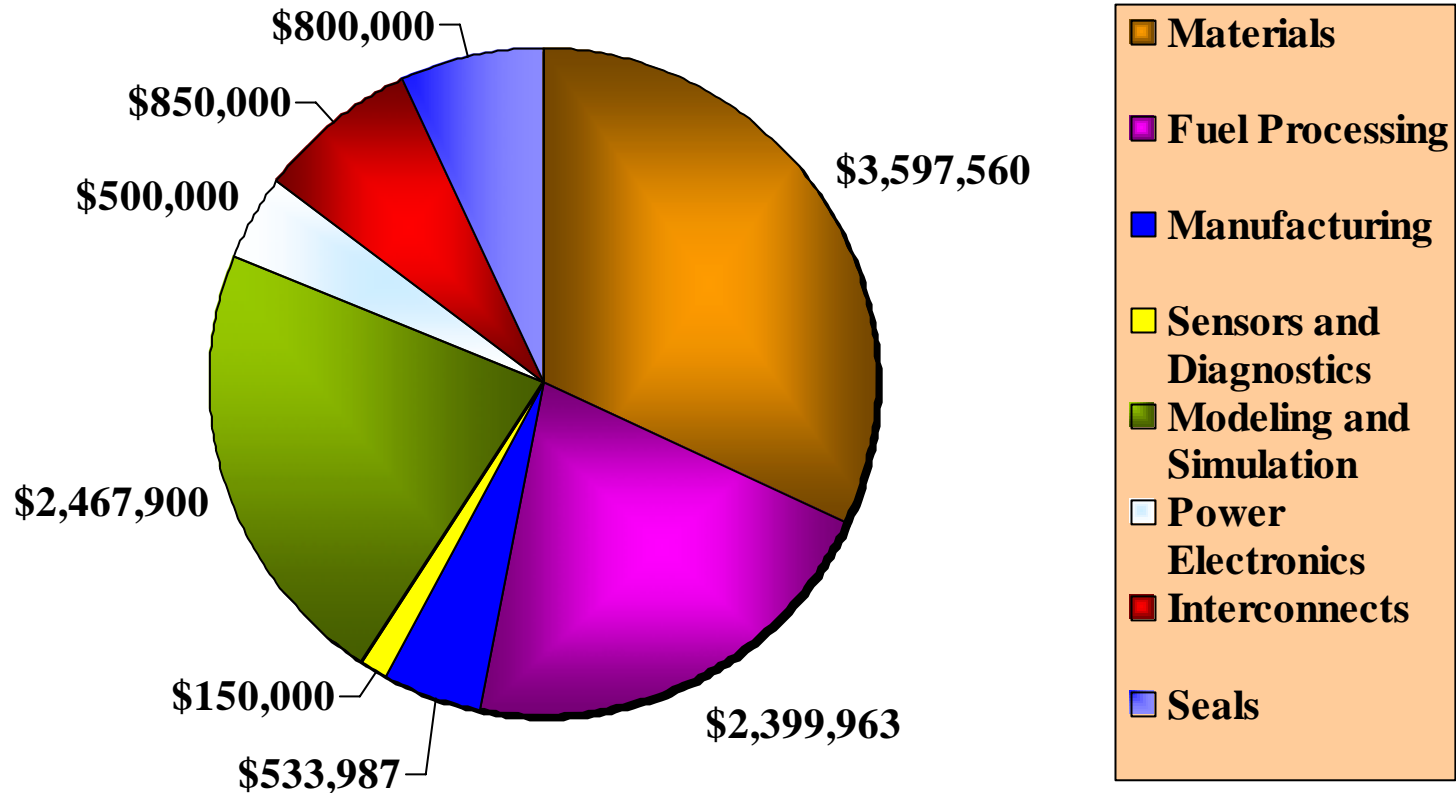
<i>Team</i>	<i>Design</i>	<i>Manufacturing</i>
Acumentrics Corporation	<ul style="list-style-type: none">• Anode supported microtube• 750 C• Thermally matched materials• Robust & rapid start-up	<ul style="list-style-type: none">• Extrusion• Dip processing• Spray deposition
FuelCell Energy, Inc.	<ul style="list-style-type: none">• Anode supported• < 700 C• Low cost metals	<ul style="list-style-type: none">• Tape casting• Screen printing• Co-sintering• Electrostatic deposition

Current Priorities: *Core Technology Program*

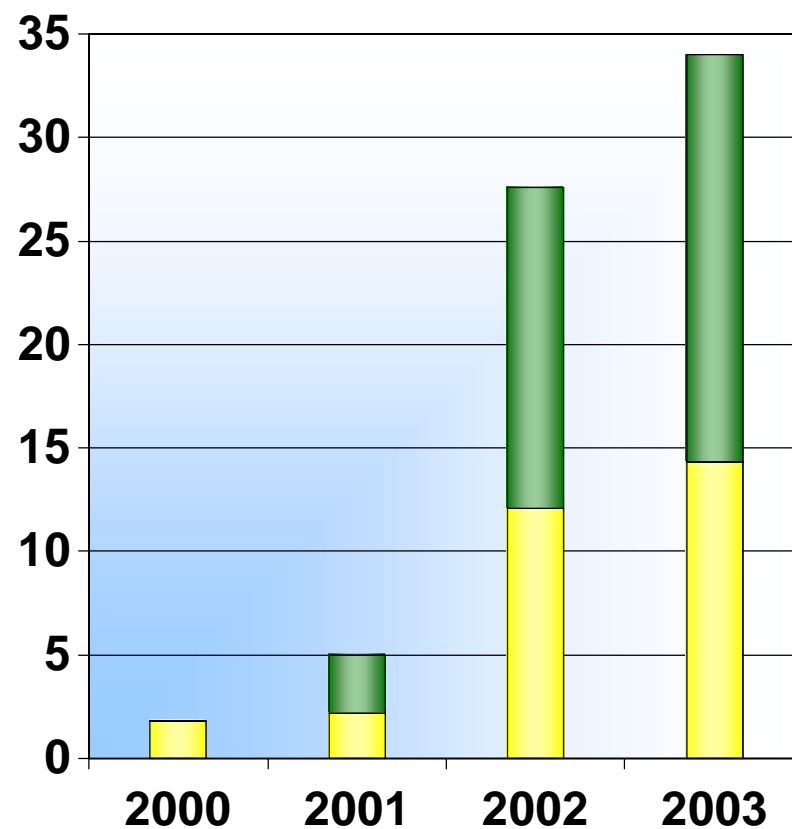
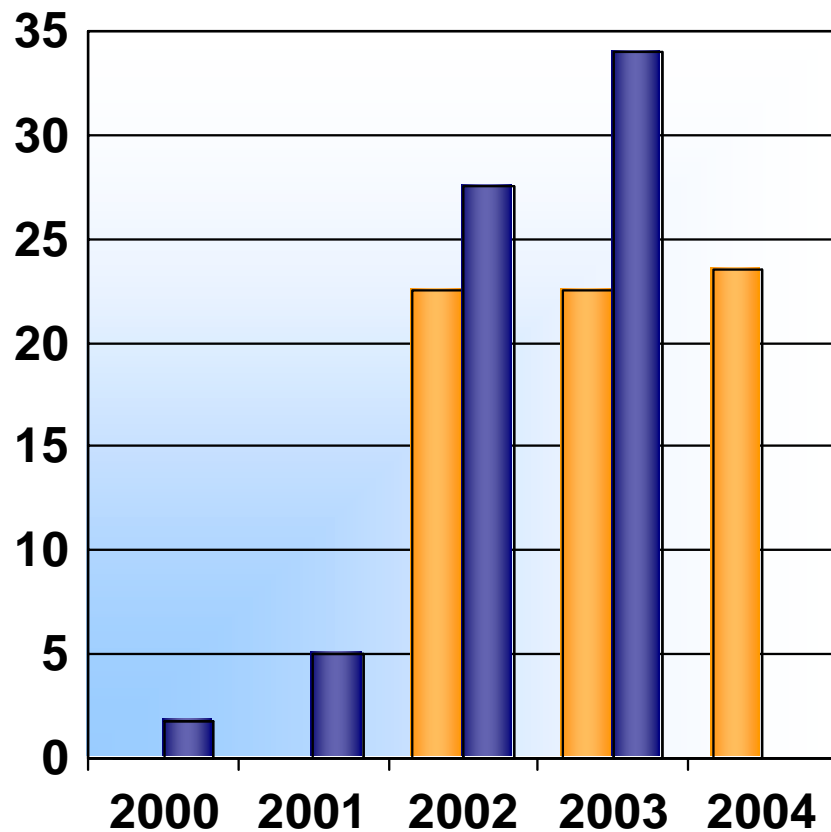
1	Gas seals	<ul style="list-style-type: none">• Glass and compressive seals
1	Interconnect	<ul style="list-style-type: none">• Modifying components in alloys• Coatings
2	Modeling	<ul style="list-style-type: none">• Models with electrochemistry• Structural characterization
2	Cathode performance	<ul style="list-style-type: none">• Micro structure optimization• Mixed conduction• Interface modification
2	Anode/ fuel processing	<ul style="list-style-type: none">• Metal oxides with interface modification• Catalyst surface modification• Characterize thermodynamics/kinetics
3	Power electronics	<ul style="list-style-type: none">• Direct DC to AC conversion• DC to DC design for fuel cells
4	Material cost	<ul style="list-style-type: none">• Lower cost precursor processing• Cost model methodology



Core Technology Program FY 2003



SECA Budget (\$M)

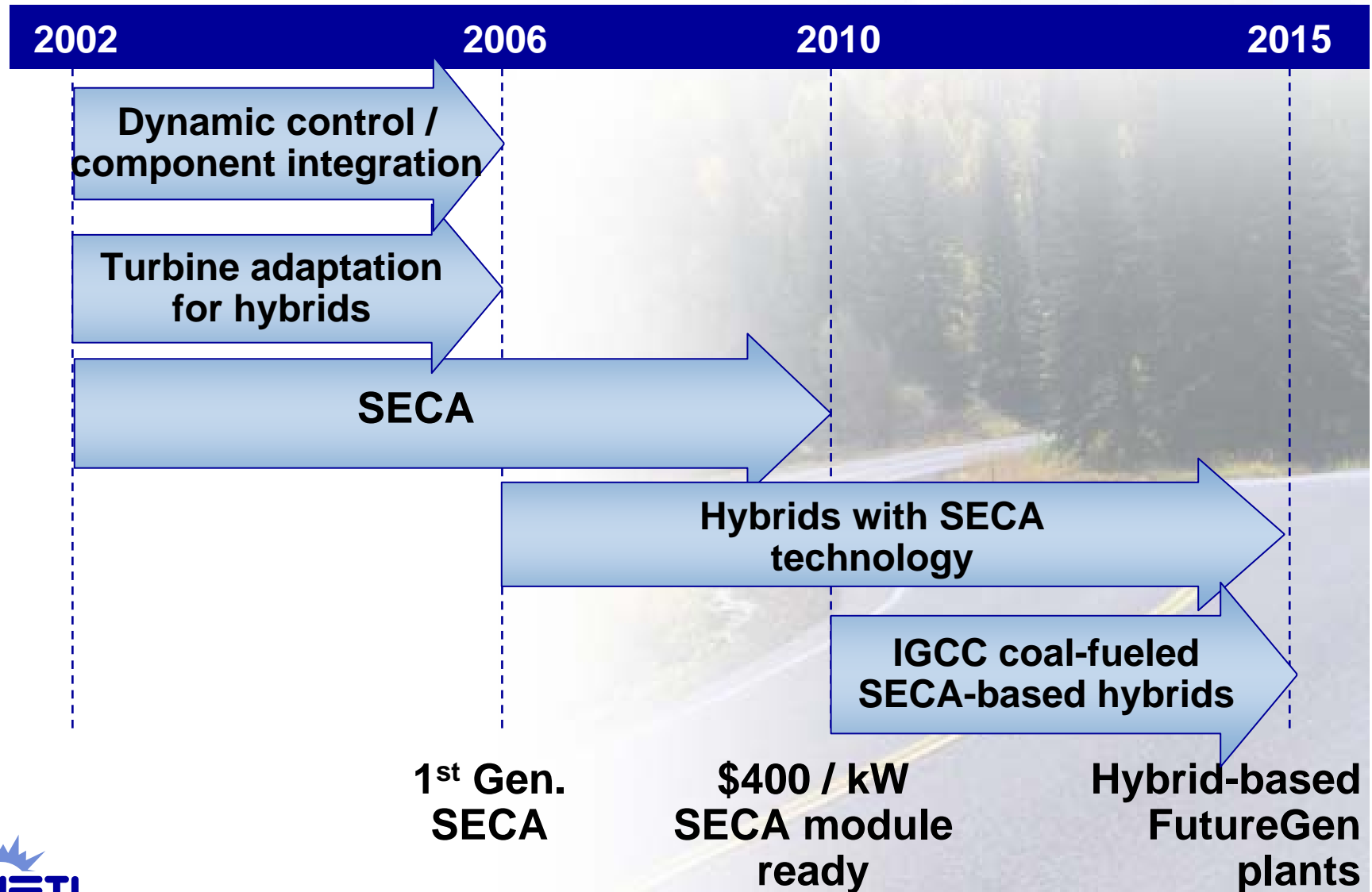


Request
Funding

Industry Teams
Core Technology Program



SECA: Key Part of Larger Fossil Energy Program

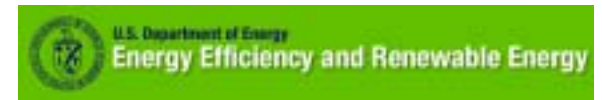


Other Pathways to High Volume

With Help from our Friends

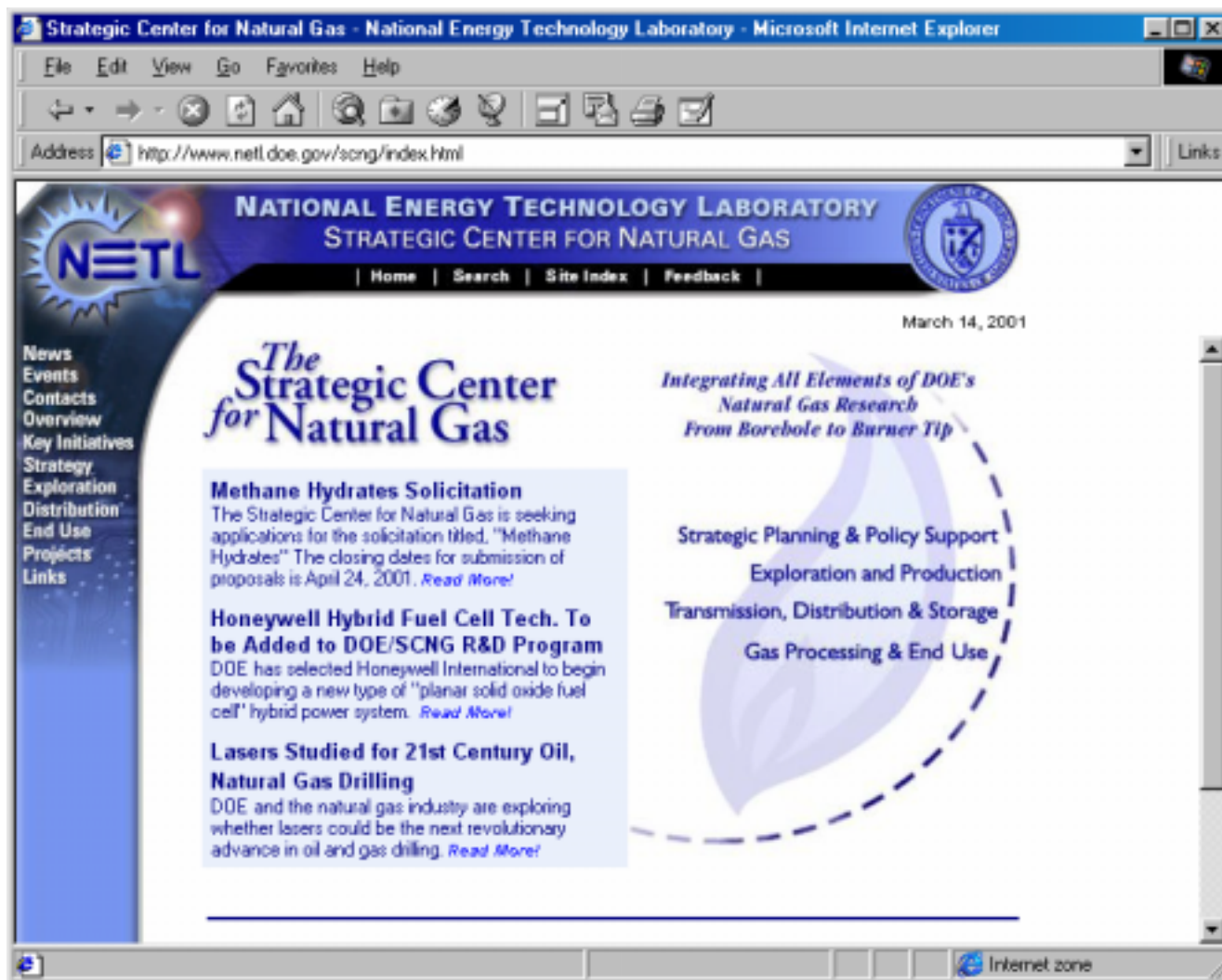


NYSERDA



TACOM





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