NATIONAL ENERGY TECHNOLOGY LABORATORY

Overview of DOE SECA Program

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SECA Program Structure

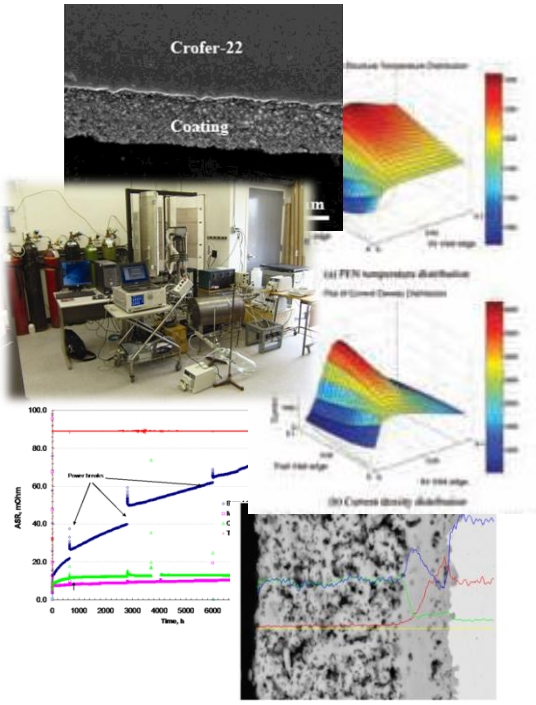
Industry Input

Program Management

Project Management

Needs

Research Topics

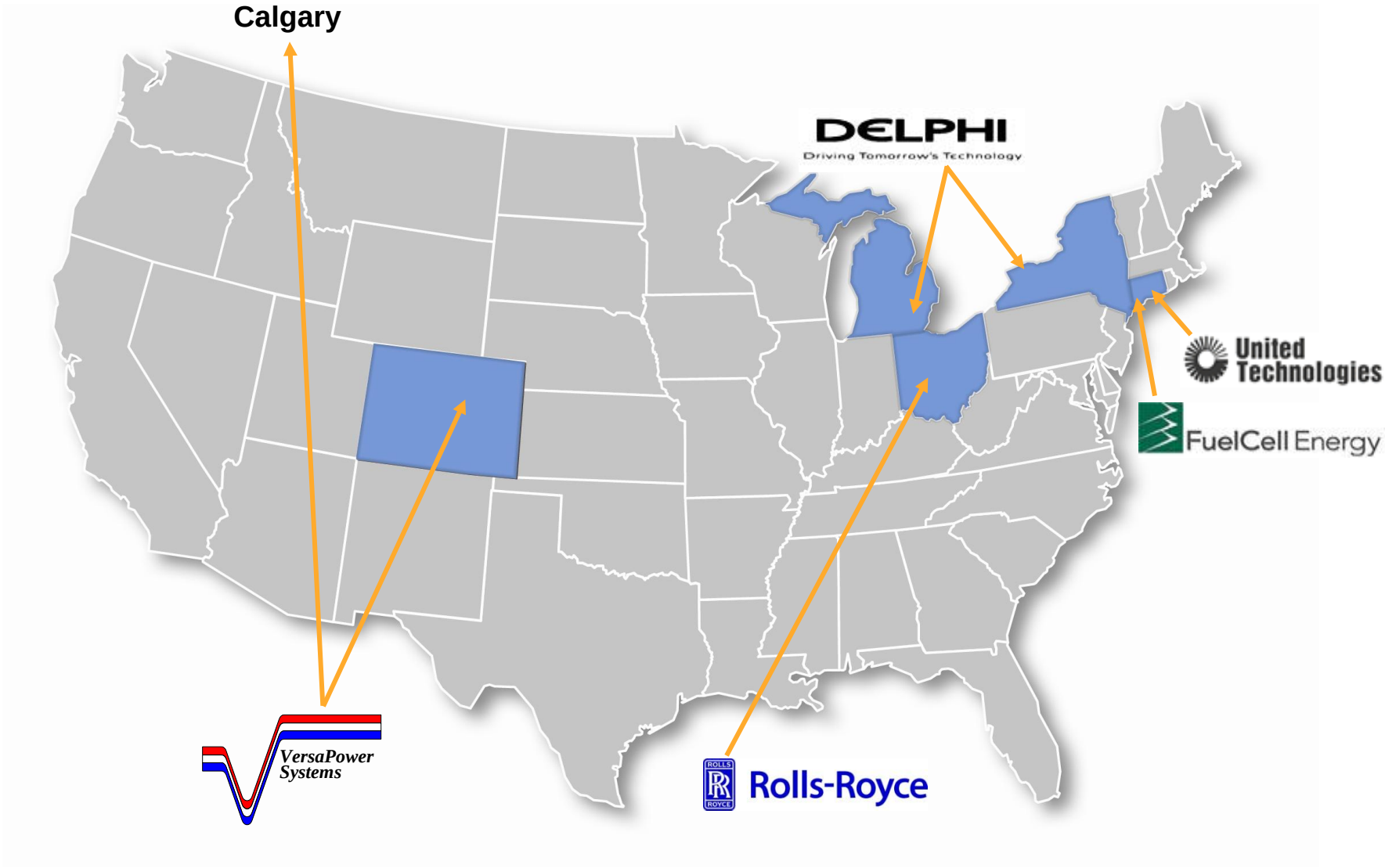


Industry Teams

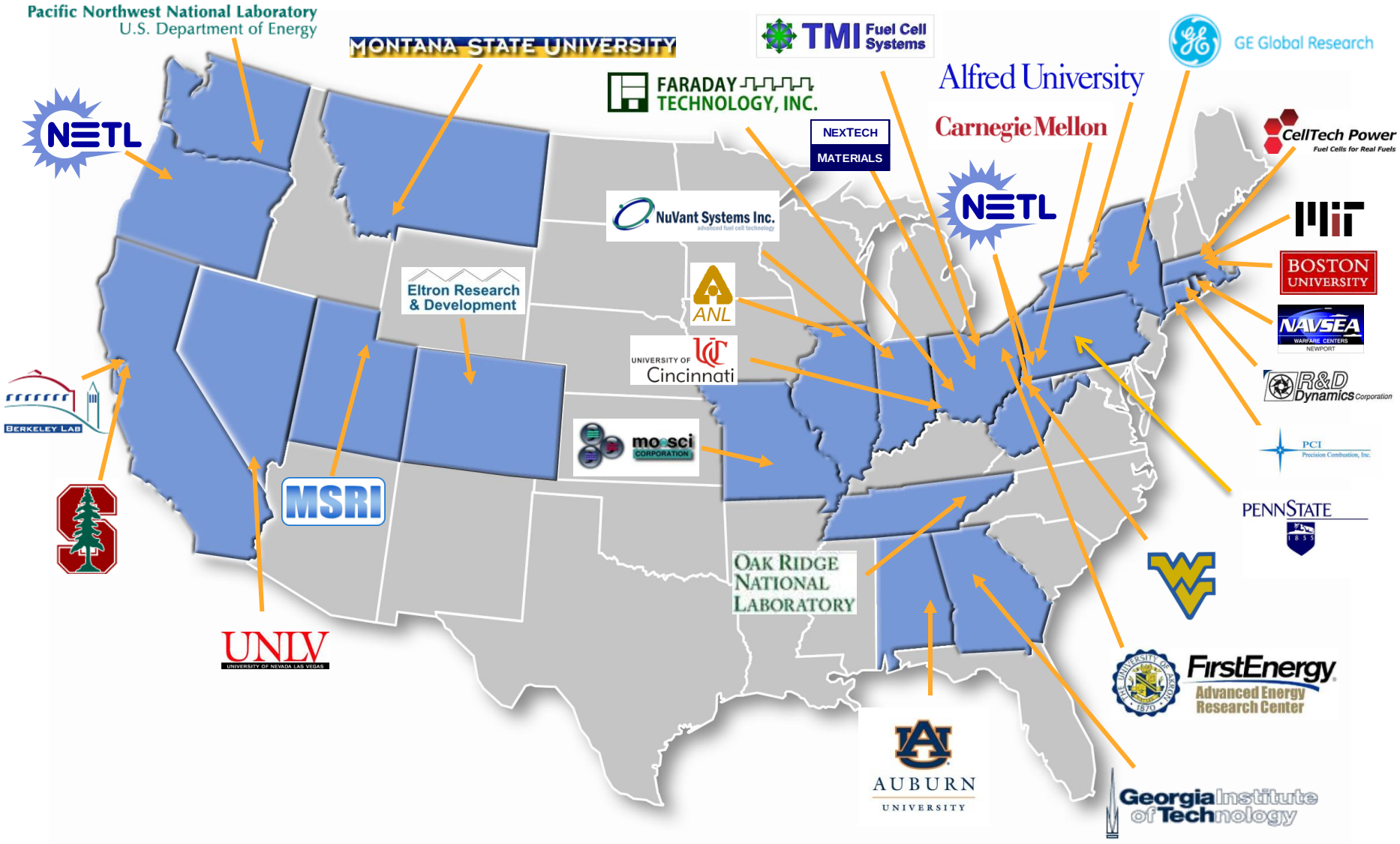
Core Technology Program

Technology Transfer

Industry Teams



Core Technology & Partners (July 2011)



Projects (July 2011)

Industry Teams

FCE & VPS
UTC Power & Delphi
Rolls-Royce

Core Technology Program

Cathodes

ANL
BU
CMU
Georgia Tech
MIT & UNLV
Montana State
Stanford
NETL
PNNL

Interconnects & Contact Materials

Auburn
LBNL

Anodes & Coal Contaminants

NETL
WVU

Modeling & Simulation

PNNL
Rolls-Royce

Materials, Testing & Manufacturing

NUWC
ORNL

Seals

Alfred
Cincinnati
ORNL

Fuel Processing

NETL
Penn State

Innovative Concepts

CellTech
GE
NexTech
NuVant
TMI
Akron

SBIRs

Cathodes

MSRI

Interconnects & Contact Materials

Faraday

Balance of Plant

FCE
R&D Dynamics

Materials, Testing & Manufacturing

NexTech

Seals

MSRI
Mo-Sci

Fuel Processing

Precision Combustion

Innovative Concepts

CellTech

SECA Mission

- ***Enable the generation of efficient, cost-effective electricity from domestic coal with near-zero atmospheric emissions of CO_2 and air pollutants (99% CO_2 capture) and minimal use of water in central power generation applications.***

- ***Provide the technology base to permit grid-independent distributed generation applications.***

60% Efficiency (Coal HHV)	*≥ 99% CO_2 Capture*	*Environmental: <0.5ppm NOx, low H_2O use*	*Low Cost, similar footprint to IGCC*	*Modular Technology*	*Fuel-Flexible: Syngas, NG, H_2, Diesel, etc.*

SECA Program Highlights – FY 2011

FY 11 Performance Measure

Testing of ~25 kWe stack that meets cost and reliability targets.

Performance Measure	Target	Actual
Operating Hours	**1500**	**1500+**
Degradation (%/1000 hours)	**2**	**< 1 %**
Cost (2007 $)	**$700/KW**	**$685/KW**

Industry Teams
FuelCell Energy, Inc. & Versa Power Systems

- Improved cell materials have reduced performance degradation rate.
- Thin anode substrate cells with increased mechanical strength have been developed for cost reduction. This accomplishment will result in more than 25% cell material cost reduction.
- Recognized performance improvements based on advanced cell and materials technology. The improvements encompass a wide range of temperature from 650 C to 800 C, with an 18% gain in voltage observed at the low temperature of 650 C.
- Tested two >25kWe stacks for over 2000 hours with ~1%/1000 hrs steady-state degradation.
- Achieved FY10 cost metrics - $700/kW power block and $175/kW stack (2007 $, mass production estimate).

96-Cell SOFC Stack Block

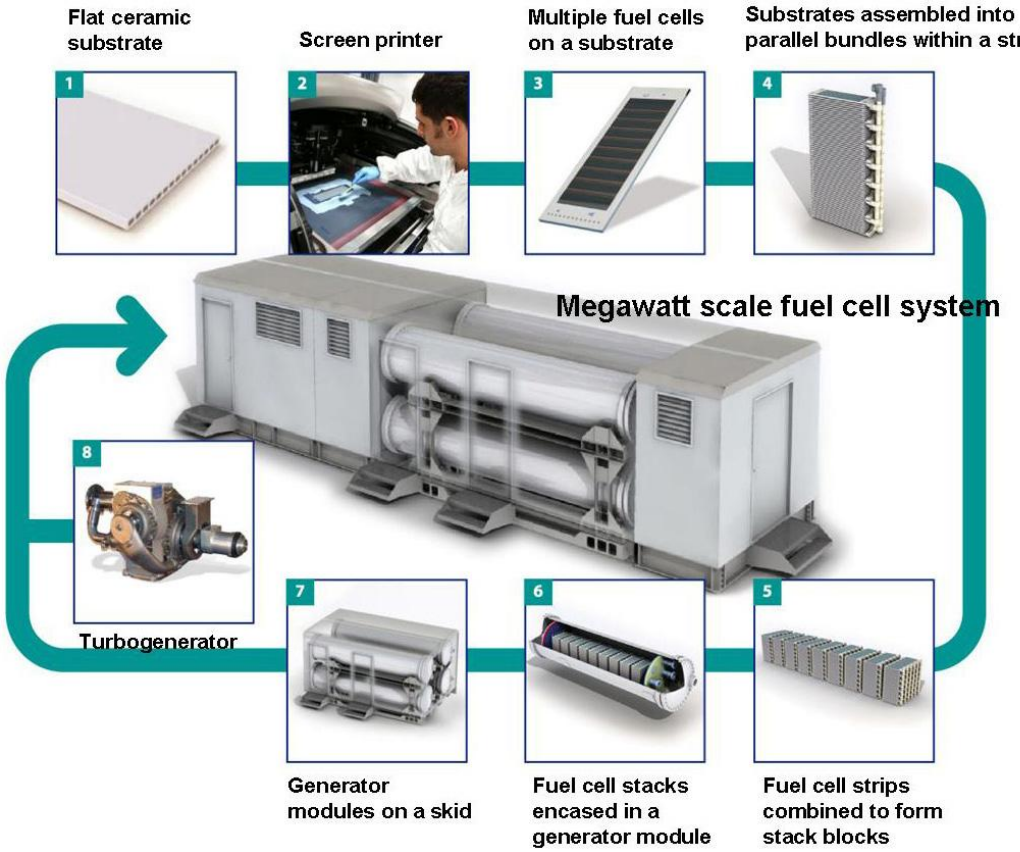
Industry Teams
UTC Power & Delphi

- Expanded cell and stack fabrication, and test capability for Gen 4 stacks.
- Fabricated and tested multiple Gen 4 stacks.
- 40-cell Gen 4 stack produced 6.4 kW on SECA coal gas blend.
- UTC has completed the design, construction, and shakedown of a 25kW test article for the SECA peak power and steady-state tests.
- Developed low cost, high volume manufacturable processes for Gen 4 stack components.
- Developed the conceptual design of an atmospheric IGFC system with an SOFC/gas turbine/steam turbine (GT/ST) cycle achieving an efficiency of 57% [HHV]) without CCS.

UTC Power 50 kW test stand

Industry Teams
Rolls-Royce Fuel Cell Systems

- Next generation cell technology having an ASR of 0.28 ohm-cm^2 was selected for block-scale metric tests. Cumulative power density improvement has been ~73% since start of the program.
- Durability testing under system relevant conditions has shown average degradation of <0.5%/1000 hours for test durations up to 8500 hours. Modifications are being screened to further improve durability.
- A new pressurized block rig in Canton, OH has been commissioned and a rig in the UK modified for metric stack testing. These thermally self-sustaining block rigs accurately match product cycles and boundary conditions.
- Cost models project IGFC SOFC system costs at <$700/kW (2007 $)

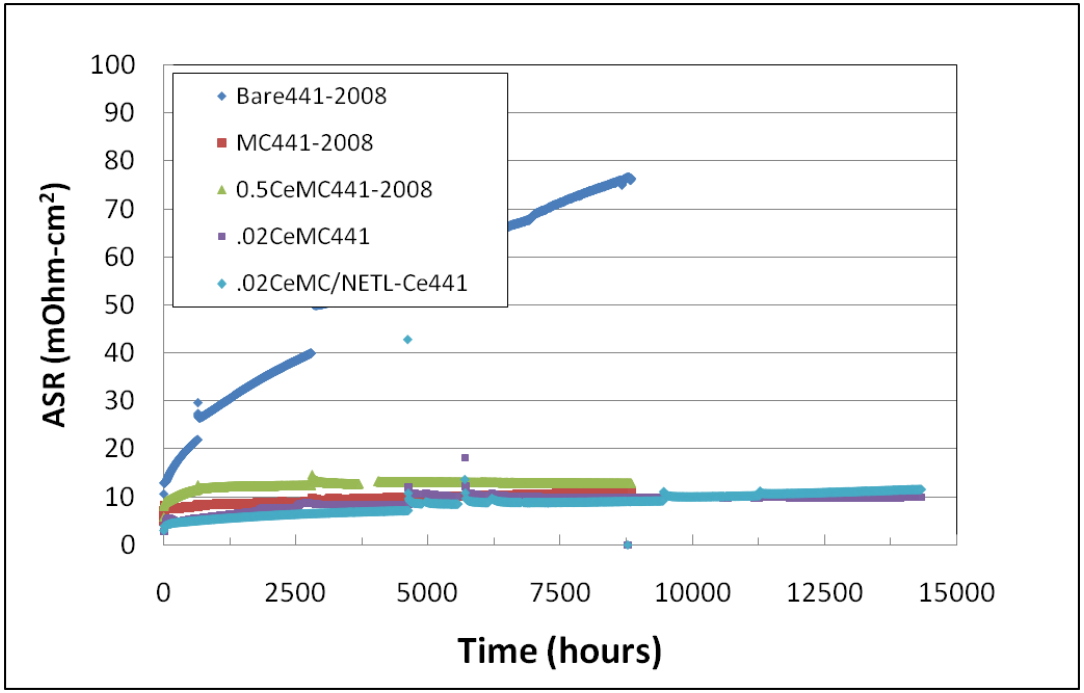


Schematic of the Planned RRFCS 1 MW Distributed Power Generation System

Core Teams
Pacific Northwest National Laboratory

Cost-effective Interconnect Materials

- **Planar SOFC Interconnect Challenges**
  - Cr volatility, scale growth, increased electrical resistance over time
- **Technical Approach**
  - Protective spinel coatings mitigate Cr volatility and improve oxidation resistance and scale adhesion, allowing use of conventional stainless steels, such as AISI 441



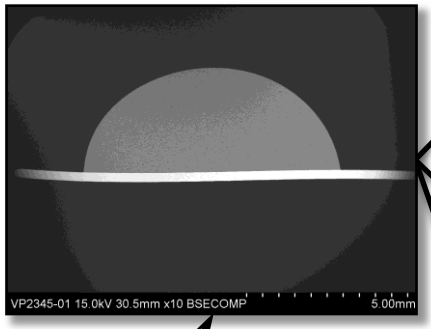
Other activities

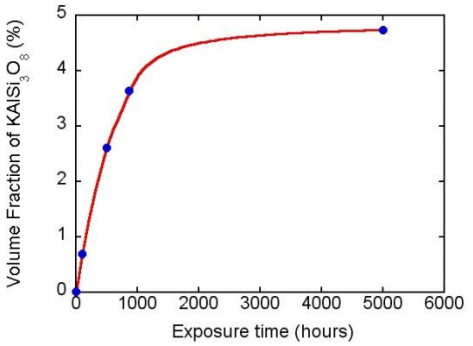
- *Compliant Glass Seals,*
- *Electrode Stability Studies,*
- *Electrical Contact Materials,*
- *Ceramic Interconnects*

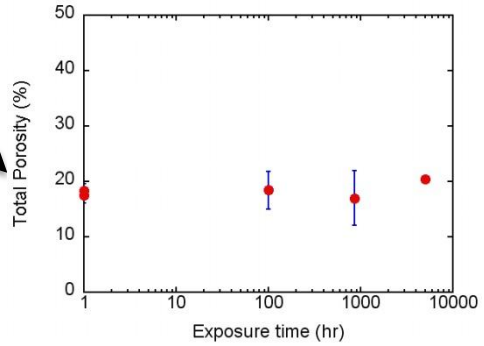
Core Teams
Oak Ridge National Laboratory

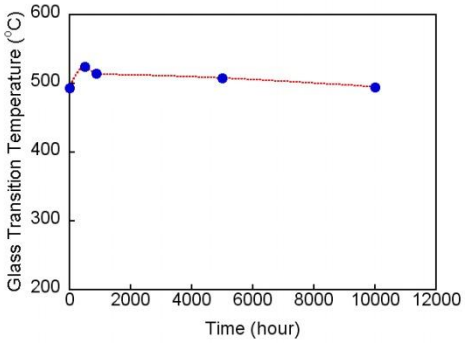
FCE-Versa Power Systems

Effect of very-long term exposure in SOFC-relevant environments on microstructure, chemical composition and properties of glass seals

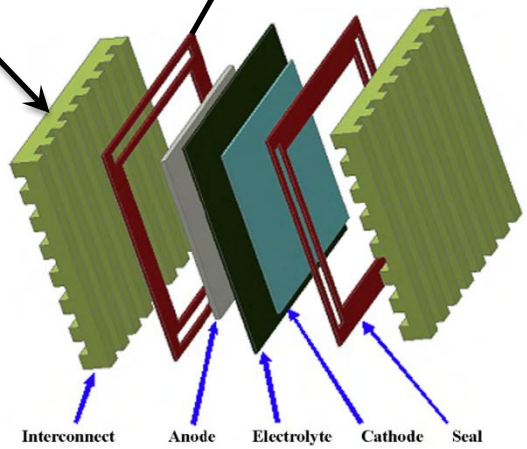








Effect of time on adhesion strength of oxides on metallic interconnects



* Lu and Mahapatra, 2010

Other Activities

- *Databases for mechanical and physical properties of SOFC materials and components*
- *Prediction of durability and reliability*

Project Peer Reviews

17 projects were reviewed by an independent panel in Feb 11

Reviews…

- **Are rigorous, formal, and documented evaluations using objective criteria with qualified and independent reviewers to make judgments on the project's:**
  - Technical/Scientific/Business merit,
  - Actual or Anticipated results, and
  - Productivity and Management effectiveness of the project.

- **Are not merit reviews to select winners.**

Review Criteria

PROJECT OVERVIEW

1. Scientific and Technical Merit
2. Existence of Clear, Measurable Milestones
3. Utilization of Government Resources

TECHNICAL DISCUSSION

4. Technical Approach
5. Rate of Progress
6. Potential Technology Risks Considered
7. Performance and Economic Factors

TECHNOLOGY BENEFITS

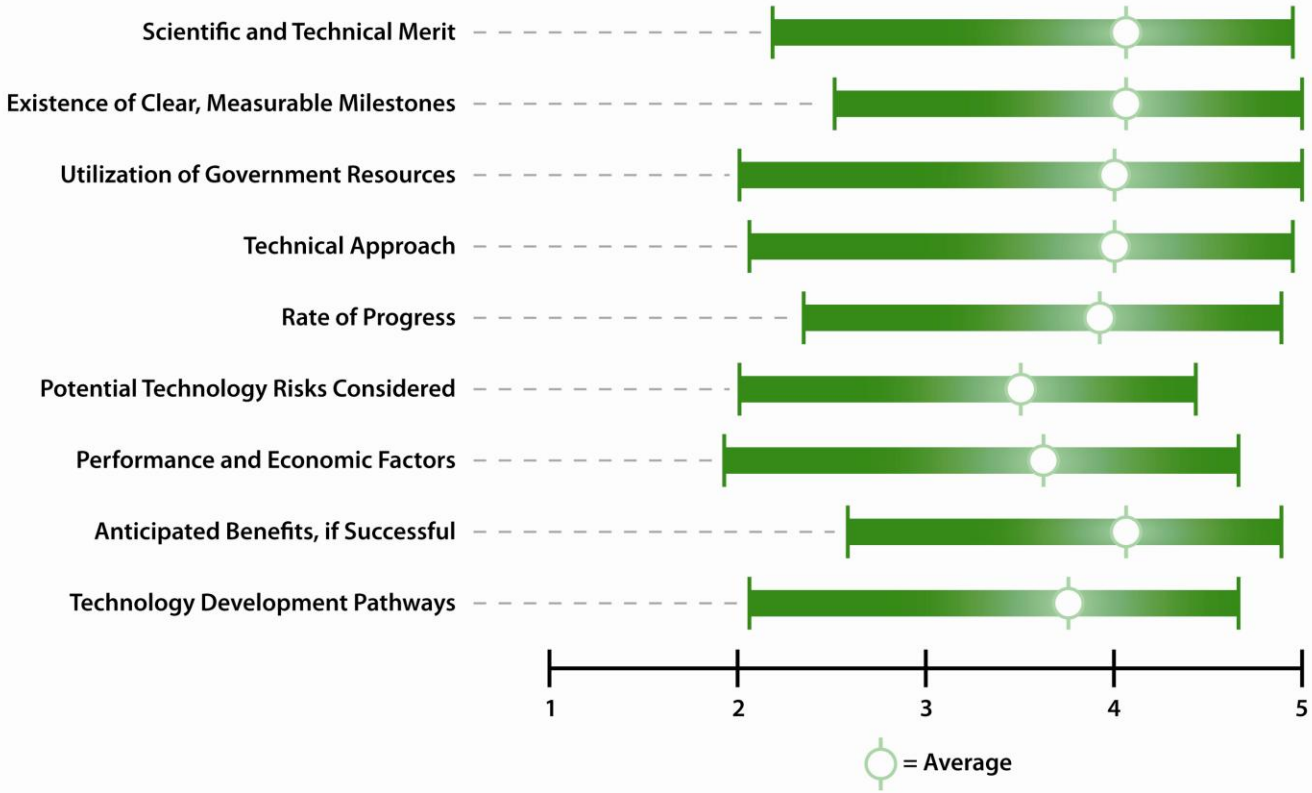
8. Anticipated Benefits, if Successful
9. Technology Development Pathways

Strengths, Weaknesses, Recommendations, and Action Items

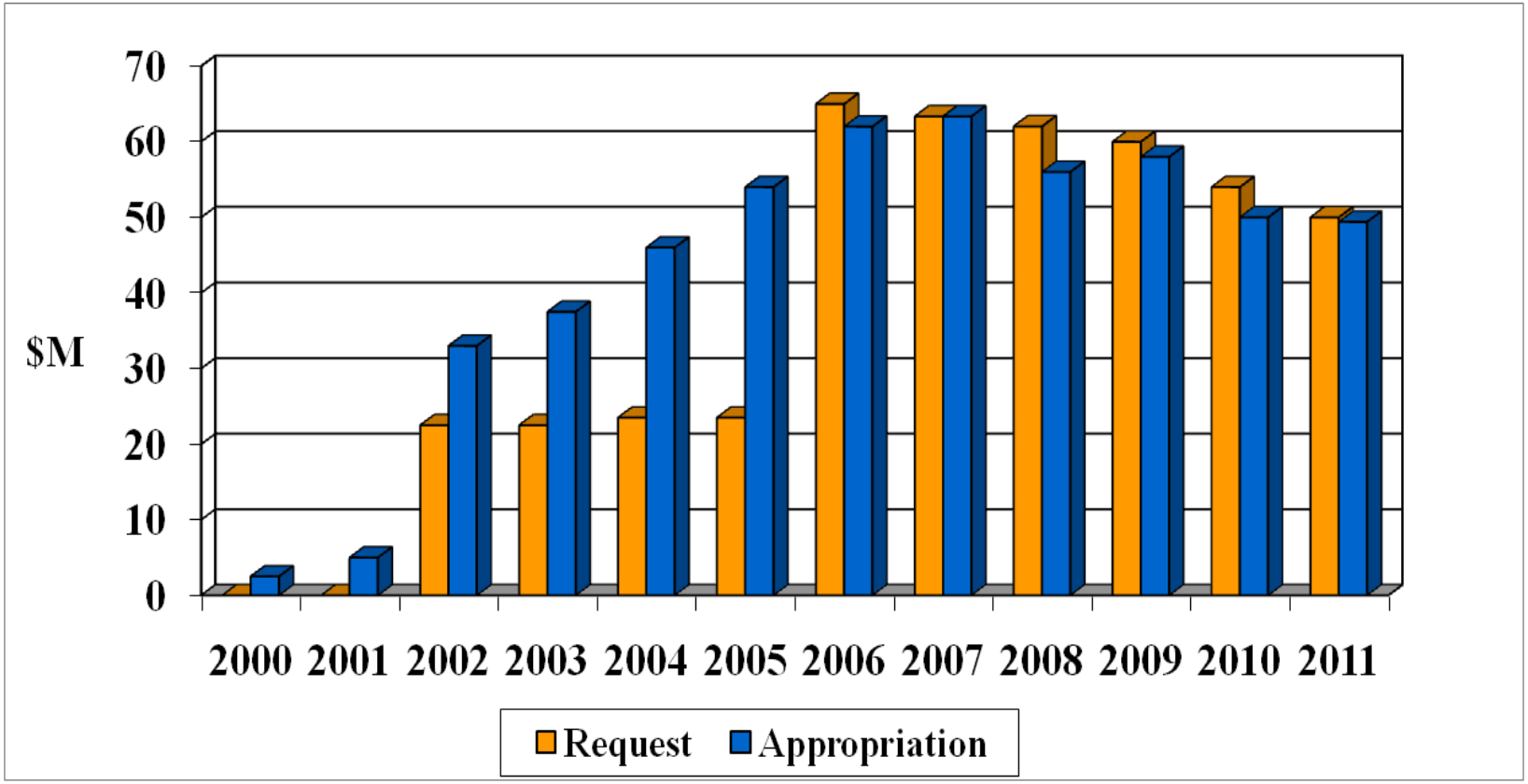
The Review Criteria are used as the basis for the development of:

- **Strengths:** Identified relative to the evaluation criteria.
- **Weaknesses:** Identified as a project item or issue, which might hinder a project's success, relative to the evaluation criteria.
- **Recommendations:** Identified as an action or direction that could add value to a particular project related task and/or attainment of a program goal. It is not essential for the project to meet its intended project objectives.
- **Action Items:** A deficiency has been identified by the Peer Review Panel and the proposed mitigation should be done to preclude the project from not meeting its stated project objectives or program goals.

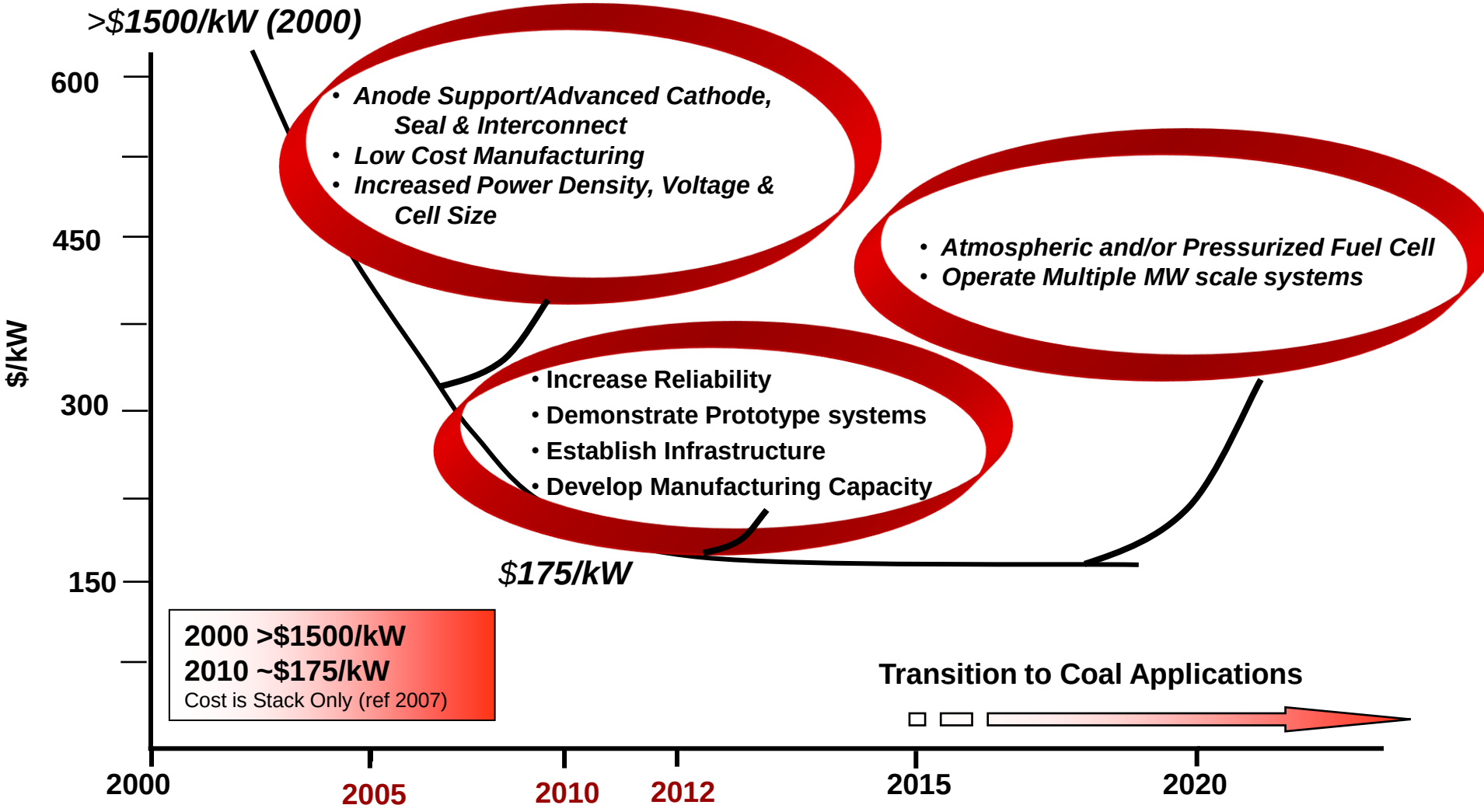
SCORING BY REVIEW CRITERION



SECA Program Annual Budgets



Driving Down Costs For Fuels Cells



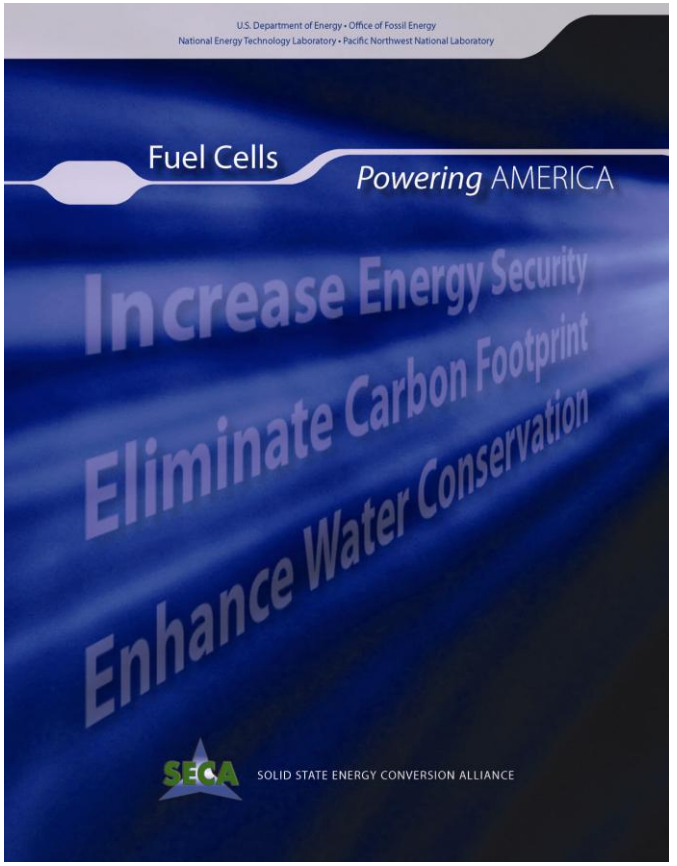
For More Information on SECA…

Websites:

www.netl.doe.gov
www.fe.doe.gov
www.grants.gov

CDs available from the website

- **Annual SECA Workshop Proceedings**
- **Fuel Cell Handbook (7th ed.)**



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