



U.S. DEPARTMENT OF  
**ENERGY**

# **Fuel Cell R&D**

Nancy Garland

## **2006 DOE Hydrogen Program Annual Program Review**

**May 16, 2006**

# Fuel Cell Team

## ● DOE Team

- ➔ Valri Lightner, Fuel Cell Team Leader
- ➔ Jesse Adams (Golden Office)
- ➔ Kathi Epping
- ➔ John Garbak
- ➔ Nancy Garland
- ➔ Jill Gruber (Golden Office)
- ➔ Donna Ho
- ➔ Jason Marcinkoski
- ➔ Amy Manheim
- ➔ Reginald Tyler (Golden Office)
- ➔ David Peterson (Golden Office)

## ● ANL Technical Team

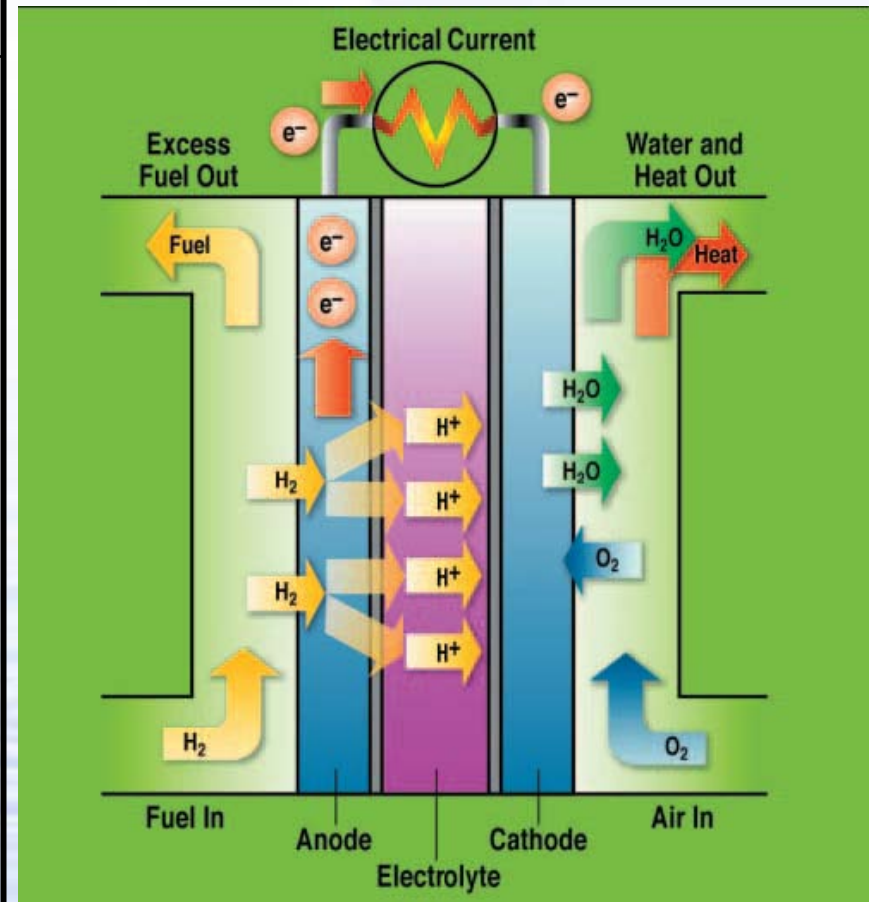
- ➔ Walt Podolski, Team Leader
- ➔ Tom Benjamin
- ➔ John Kopasz

# Fuel Cell Barriers

Cost and durability are two of the more significant barriers to the achievement of clean, reliable, cost-effective systems.

## BARRIERS

- A. Durability
- B. Cost
- C. Electrode Performance
- D. Thermal, Air, Water Management
- E. Compressors/Expanders
- F. Fuel Cell Power System Integration
- G. Power Electronics
- H. Sensors
- I. Hydrogen Purification/CO Cleanup
- J. Startup Time/Transient Operation



# Key Targets



## Transportation (PEMFC)

- \$45/kW by 2010
- \$30/kW by 2015
- 5,000 hours durability

## Distributed Energy (PEMFC)

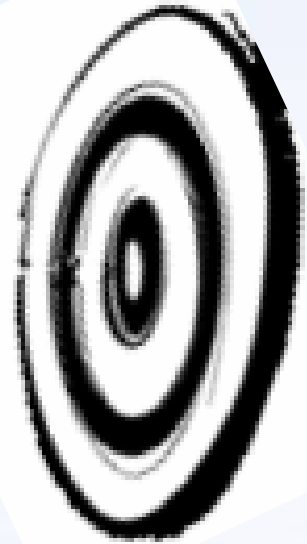
- \$750/kW by 2010
- 40,000 hours durability

## Auxiliary Power Units (SOFC)

- specific power of 100 W/kg by 2010
- power density of 100 W/L by 2010

## Consumer Electronics (DMFC)

- energy density of 1000 W-h/L by 2010



# Technical Tasks

Technical Task	Description
Develop membranes that meet all targets	<ul style="list-style-type: none"><li>• Identify ionomers &amp; fabricate membranes</li><li>• Test and characterize membranes</li></ul>
Develop electrodes that meet all targets	<ul style="list-style-type: none"><li>• Improve catalysts &amp; catalyst supports</li><li>• Optimize electrode design &amp; assembly</li></ul>
Develop MEAs that meet all targets	<ul style="list-style-type: none"><li>• Integrate components &amp; expand operating range</li><li>• Test, analyze &amp; characterize MEAs</li></ul>
Develop gas diffusion layers	<ul style="list-style-type: none"><li>• Improve GDL performance &amp; durability</li><li>• Develop testing and characterization protocols &amp; techniques</li></ul>
Develop bipolar plates	<ul style="list-style-type: none"><li>• Improve performance &amp; durability; decrease cost</li></ul>
Develop seals	<ul style="list-style-type: none"><li>• Improve durability &amp; performance</li></ul>
Develop balance-of-plant components	<ul style="list-style-type: none"><li>• Develop sensors &amp; air management technologies</li><li>• Develop water &amp; thermal management technologies</li></ul>
Develop stationary and other early market fuel cells	<ul style="list-style-type: none"><li>• Develop stationary FC systems, APUs, and fuel cells for portable power and off-road applications</li></ul>
Conduct analysis	<ul style="list-style-type: none"><li>• Conduct cost &amp; tradeoff analyses</li><li>• Improve technical understanding of durability and freeze issues</li></ul>
Characterize and benchmark fuel cells	<ul style="list-style-type: none"><li>• Benchmark fuel cell technology to establish technology; develop protocols for testing</li><li>• Investigate impact of impurities on fuel cell performance</li></ul>
Develop innovative concepts	<ul style="list-style-type: none"><li>• Improve BOP designs and FC performance</li></ul>

# Research Partners

## BOP Components

*(delayed) Honeywell (2),  
Advanced Fluids Tech.  
(SBIR)*

## Characterization and analysis

*NIST, ORNL, LANL,  
LBNL, ANL, TIAX, DTI,  
Battelle (revised)*

## Membranes

*3M, Arkema, DuPont, Plug Power,  
LANL, ANL, NREL, SNL, Colorado  
School of Mines, Penn State,  
Virginia Tech, Giner, U of Tenn,  
Case Western Reserve U (2),  
FuelCell Energy, Clemson U, GE  
Global Research, Arizona State U,  
U of Central Florida*

## MEAs

*UTC Fuel Cells, 3M, DeNora*

## Catalysts

*Ballard, U. of South Carolina, 3M,  
Cabot-Superior Micropowders,  
NRL, NASA/JPL, ANL, LBNL, BNL,  
Farasis Energy (SBIR), NuVant  
Systems (SBIR), Englehard, Ion  
Power*

## Bipolar Plates

*Porvair, ORNL, PNNL, NREL,  
Nanosonic (SBIR)*

## Stationary and other early market Fuel Cells

*(delayed) IdaTech (2),  
UTC Fuel Cells, Plug  
Power, Nuvera,  
ChevronTexaco, Delphi,  
Cummins, PolyFuel,  
MTI Micro*

## FY 2005 & FY 2006 Congressionally Directed Projects

*OSRAM Sylvania, Del  
Co. Electric Coop, U of  
S. Carolina, U of Akron,  
U of S. Miss., UTCFC,  
Kettering U*



# Key Decisions



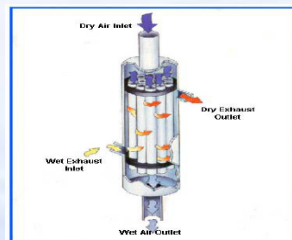
FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
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No-Go Decision for On-Board Fuel Processing

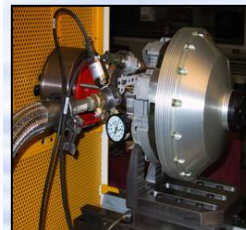


Nuvera - 200 kW<sub>th</sub> fuel processor

Go/No-Go Decision on Air/Water/Thermal Management Technologies



Perma Pure membrane humidifier

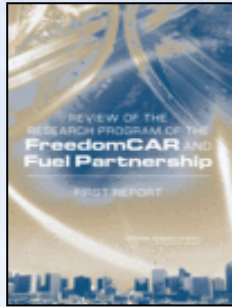


Mechanology-Toroidal intersecting vane machine

Go/No-Go Decision on Distributed Energy Systems



# *Planning and Implementation*



New Membrane  
Projects Selected  
for Award

Annual  
Program  
Review

New Fuel Cell  
Projects  
Selected for  
Award

NRC Review of  
FreedomCAR  
Partnership

High Temp Membrane Working Group  
& New Membrane Project Kick-off

Aug '05

Jan '06

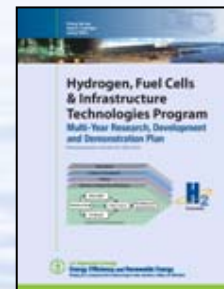
May '06

Jul '06

Oct '06

Jan '07

Funding Opportunity  
Announcement/Lab Call  
for new Fuel Cell Projects  
to Meet 2010 Targets



MYRD&D Plan  
Updated

New  
Projects  
Begin



# For More Information

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