U.S. DEPARTMENT OF ENERGY

Fuel Cell Projects Kickoff Meeting

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Washington, DC

Overview

- ✓ Key Personnel
- ✓ Fuel Cell Program
  - ✓ Key Targets
  - ✓ Barriers
  - ✓ Tasks
  - ✓ Milestones
- ✓ Partners
- ✓ Budget
- ✓ Agenda

Managers, Project Officers, and Advisors

DOE HQ

Nancy Garland, *Acting Team Leader*

Kathi Epping

John Garbak

Amy Manheim

Jason Marcinkoski

DOE GO

Jill Gruber

Dave Peterson

Reg Tyler

Lea Yancey

ANL

Tom Benjamin

John Kopasz

Walt Podolski

DOE Fuel Cell Program - Key Targets

Integrated Transportation Fuel Cell Power System (80 kW_e) Operating on Direct Hydrogen
• **$45/kW by 2010**
• **$30/kW by 2015**
• **5,000 hours durability by 2010 (80°C)**

Other Key Targets

Distributed Energy (PEMFC)

- $750/kW by 2011
- 40,000 hours durability by 2011
- 40% electrical efficiency

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 1,000 W-h/L by 2010

80 kW Direct Hydrogen Fuel Cell System Status & Targets

Characteristic	Units	2003 Status	2005 Status	2010 Target	2015 Target
Cost[a]	$/kW	200	110	45	30
Precious Metal Loading	g/kW (rated)	<2.0	1.1	0.3	0.2
Power Density	W/L	440	525	650	650
Lifetime (durability w/ cycling)	hours	N/A	~2,000	5000	5,000
Start-up Time to 50% of Rated Power at:					
- 20°C	s	120	20	30	30
+ 20°C	s	60	<10	5	5
Start-up and Shut Down Energy at:					
- 20°C	MJ	n/a	7.5	5	5
+ 20°C	MJ	n/a	n/a	1	1

[a] estimate assuming high volume production of 500,000 units/year

Fuel Cell Barriers

A. Durability

B. Cost

C. Performance

D. Water Transport within the Stack

E. System Thermal and Water Management

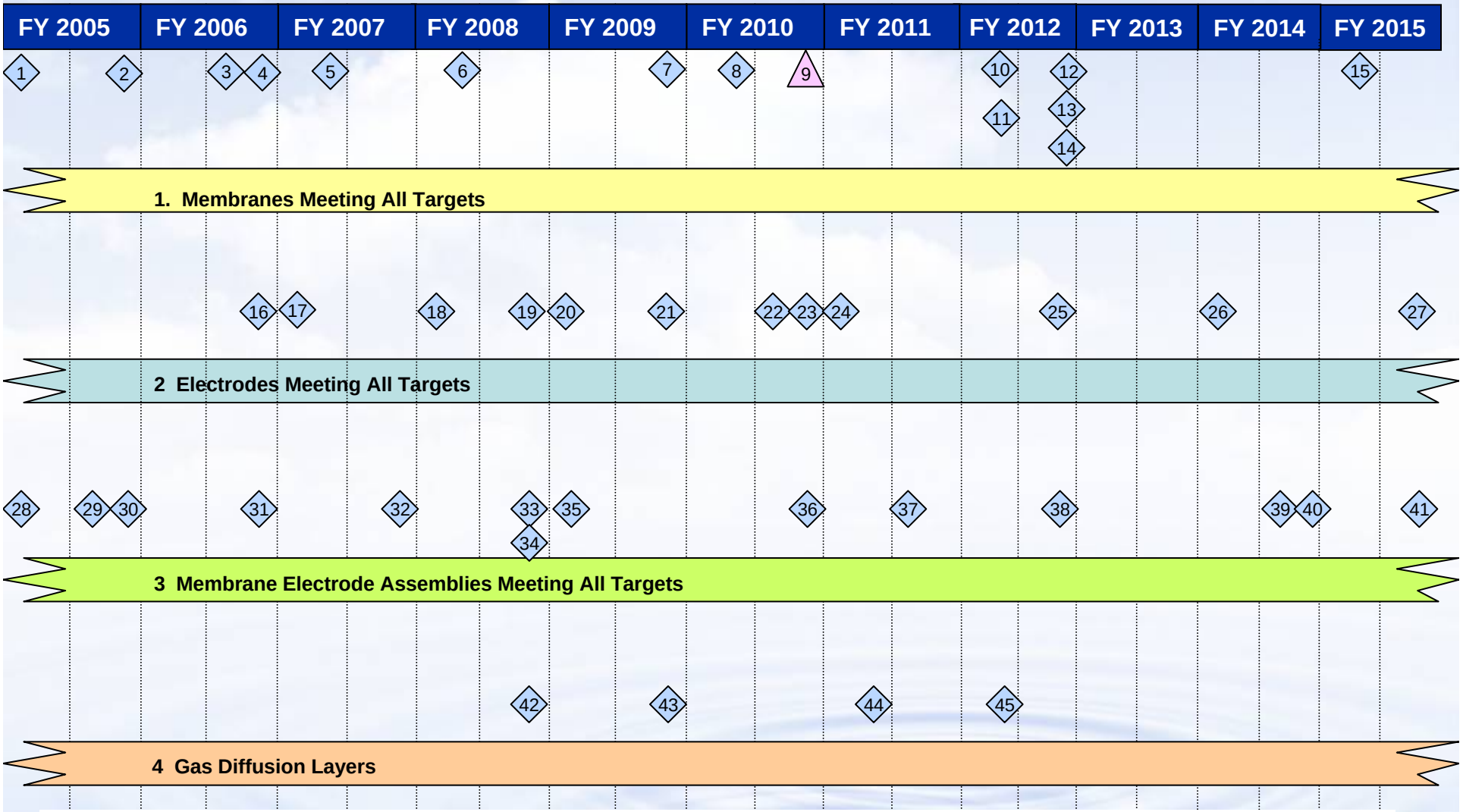
F. Air Management

G. Start-up and Shut-down Time and Energy/Transient Operation

Technical Tasks

Technical Task	Description
Develop membranes that meet all targets	• Identify ionomers & fabricate membranes • Test and characterize membranes
Develop electrodes that meet all targets	• Improve catalysts & catalyst supports • Optimize electrode design & assembly
Develop MEAs that meet all targets	• Integrate components & expand operating range • Test, analyze & characterize MEAs
Develop gas diffusion layers	• Improve GDL performance & durability • Develop testing protocols and characterization methods
Develop bipolar plates	• Improve performance & durability; decrease cost
Develop seals	• Improve durability & performance
Develop balance-of-plant components	• Develop sensors & air management technologies • Develop water & thermal management technologies
Develop stationary and other early market fuel cells	• Develop stationary FC systems, APUs, and fuel cells for portable power and off-road applications
Conduct analysis	• Conduct cost & tradeoff analyses; increase understanding of durability and freeze issues
Characterize and benchmark fuel cells	• Benchmark fuel cell technology; develop testing protocols • Investigate impact of impurities on fuel cell performance
Develop innovative concepts	• Improve BOP designs and FC performance

Fuel Cell R&D Milestone Chart



Milestone 1 (1Q05) - Evaluate >80°C membrane in MEA/single cell and compare to MEA targets

Milestone 2 (4Q05) - Develop procedures for accelerated testing of membrane mechanical stability

Milestone 3 (3Q06) - Evaluate ionomer conductivity at >80°C and < 25% RH and compare to membrane targets

Milestone 4 (4Q06) - Identify major chemical and mechanical degradation mechanism for PFSA type membranes operating at 80°C

Milestone 5 (2Q07) - Evaluate first generation >120°C membrane in MEA/single cell and compare to MEA targets

Research Partners

Membranes
Arkema, LBNL, 3M, Plug Power, 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

Catalysts
U. of South Carolina, 3M, ANL, LANL, PNNL, Engelhard, Ion Power, UTCFC

Impurities
Clemson, U Conn., LANL

Cell Hardware
Graftech, UTCFC, ORNL

Innovative FC Concepts
ANL, Plug Power, CWRU, PNNL

Water Transport
RIT, CFD, Nuvera, LANL

Stationary Fuel Cell System Demonstrations
Intelligent Energy, Plug Power (2)

Portable/APU/Off road
Cummins, Delphi, IdaTech, MTI, PolyFuel

Characterization/Analysis
ANL, Battelle, DTI, LANL, NIST, ORNL, TIAX

Distributed Energy Systems
IdaTech, Plug Power, UTC

Fuel Cell Budget

Budget Activity	Funding ($ in thousands)		
	FY 2006 Appropriation	FY 2007 Request	FY 2008 Request
Fuel Cell Stack Component R&D	30,710	38,082	44,000
Technology Validation	33,301	39,566	30,000
Transportation fuel cell Systems	1,050	7,518	8,000
Distributed Energy Fuel Cell Systems	939	7,419	7,700
Fuel Processor R&D	637	4,056	3,000

The Fiscal Year 2008 budget request for Hydrogen Technology is $213.0 million, a $17.2 million increase over the FY 2007 request.

Fuel Cell Projects Kickoff Meeting

Agenda

Tuesday, February 13, 2007		
9:00	Welcome and Program Overview	Pat Davis Nancy Garland
Membranes		
9:20	Membranes and MEA's for Dry, Hot Operating Conditions	S. Hamrock, 3M
9:40	New Polyelectrolyte Materials for High Temperature Fuel Cells	J. Kerr, LBNL
10:00	The Design of Novel Materials Consisting of a Semi-Interpenetrating Network of PVDF and a Sulfonated Polyelectrolyte	M. Foure, Arkema
10:20	Break	
Water Transport Studies		
10:50	Visualization of Fuel Cell Water Transport and Performance Characterization under Freezing Conditions	S. Kandlikar, RIT
11:10	Water Transport in PEM Fuel Cells: Advanced Modeling, Material Selection, testing, and Design Characterization	V. Cole, CFD Research
11:30	Subfreezing Start/Stop Protocol for an Advanced Metallic Open-Flow field Fuel Cell Stack	J. Cross, Nuvera
11:50	Water Transport Within the Stack: Water Transport Exploratory Studies	R. Borup, LANL
12:10	Lunch	

Program Agenda – Day 1 Afternoon

Catalysts & Supports		
1:30	Advanced Cathode Catalysts and Supports for PEM Fuel Cells	M. Debe, 3M
1:50	Highly Dispersed Alloy Cathode Catalyst for Durability	T. Jarvi, UTCFC
2:10	Advanced Cathode Catalysts	P. Zelenay, LANL
2:30	Non-Platinum Cathode Electrocatalyst based on Bimetallic Base Metal-Noble Metal Systems	D. Myers, ANL
2:50	Development of Alternative and Durable High Performance Cathode Supports for PEM Fuel Cells	Y. Wang, PNNL
3:10	Break	
Innovative Fuel Cell Concepts		
3:40	Aligned Carbon Nanotube-Based MEA and PEMFC	D-J Liu, ANL
4:00	Light Weight Low Cost PEM Fuel Cell Stacks	J. Wainright, CWRU
4:20	Adaptive Stack with Subdivided Cells for Improved Stability, Reliability, and Durability Under Automotive Load Cycle	B. Du, Plug Power
4:40	Low-Cost Manufacturable Microchannel Systems for Passive PEM Water Management	S. Stenkamp, PNNL

Program Agenda – Day 2

Wednesday, February 14, 2007		
Cell Hardware		
8:30	Next Generation Bipolar Plates for Automotive PEM Fuel Cells	O. Adrianowycz, GrafTech
8:50	Nitrided Metallic Bipolar Plates	P. Tortorelli, ORNL
9:10	Low Cost Durable Seals	G. Roberts, UTC Power
Reporting Requirements		
9:30	Reporting Requirements	Golden Field Office Project Officers
9:40	Break	
Impurity Studies		
10:00	Effects of Impurities on Fuel Cell Performance and Durability	T. Molter, U. Conn.
10:20	Effects of Impurities on Fuel Cell Performance and Durability	J. Goodwin, Clemson
10:40	Effects of Impurities on Fuel Cell Performance and Durability	F. Garzon, LANL
Demonstrations		
11:00	International Stationary Fuel Cell Demonstration	J. Vogel, Plug Power
11:20	Development and Demonstration of a New Generation High Efficiency 2 kW Combined Heat and Power Unit	K. Durai-Swamy, Intelligent Energy
11:40	Intergovernmental Stationary Fuel Cell System Demonstration	M. Parsons, Plug Power