U.S. DEPARTMENT OF ENERGY

DOE Fuel Cell Subprogram

Nancy Garland

Acting Fuel Cell Team Leader

Pre-Solicitation Meeting

Golden, CO

January 23-24, 2008

Purpose and Outcome

Purpose

- To identify the most relevant fuel cell research, development, and demonstration (RD&D) topics *appropriate for government funding* in automotive, stationary, portable power, and early market applications

Outcome

- Input from workshop participants will be used to assist DOE in developing topics and scope for the planned Fuel Cell Funding Opportunity Announcement (FOA), tentatively scheduled for release in 2008 and subject to Appropriations

Non-purpose and Workshop Product

Non-purpose

- No sales pitches
- Not to present “mini-proposals” on your particular RD&D ideas
- Not to think only “inside your box”

Product

- A report of the ***workshop proceedings*** including plenary presentations and a summary of participant input (to be made available at www.hydrogen.energy.gov)

Workshop Agenda -- Today

1:00 pm	Plenary Presentations ***- DOE Hydrogen Program and Perspectives*** ***- RD&D Needs: Industry Perspectives***
4:45 pm	Break
5:00 pm	Breakout Group Topics and Process Overview
5:30 pm	Adjourn

Workshop Agenda -- Tomorrow

9:00 am	Facilitated Breakout Groups
NOON	Lunch *(on your own)*
1:30 pm	Plenary: Breakout Group Reports
3:00 pm	Plenary: Facilitated Open Discussion
3:30 pm	Wrap-Up and Action Items
4:00 pm	Adjourn

Breakout Groups:
Suggestions for General Areas

Group 1: Catalysts and Supports

Group 2: MEAs

Group 3: Water Management

Group 4: Early market applications, and demonstrations

Group 5: Solid oxide fuel cells

Please SIGN UP today for a group!!!!!

Fuel Cell Subprogram

Goal

Develop and demonstrate fuel cell power system technologies for transportation, stationary, and portable power applications.

Objectives

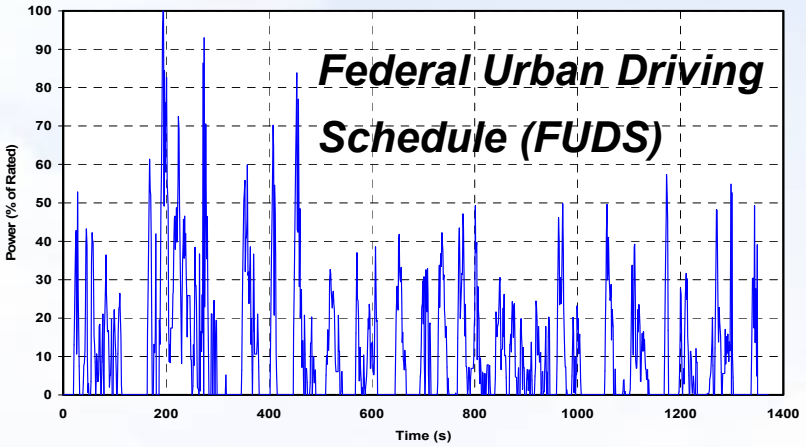
For transportation applications:

- By 2010, develop a 60% peak-efficient, direct hydrogen fuel cell power system at a cost of $45/kW with 5000 hours of durability (80°C); by 2015, a cost of $30/kW.

For stationary power and other early market fuel cell applications:

- By 2011, develop a distributed generation PEM fuel cell system operating on natural gas or LPG that achieves 40% electrical efficiency and 40,000 hours durability at $750/kW.
- By 2010, develop a fuel cell system for consumer electronics (<50 W) with an energy density of 1,000 Wh/L.
- By 2010, develop a fuel cell system for auxiliary power units (3-30 kW) with a specific power of 100 W/kg and a power density of 100 W/L.

Fuel Cell System Challenges



A. Durability

B. Cost

C. Performance

D. Air Management

E. System Thermal and Water Management

F. Water Transport within the Stack

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

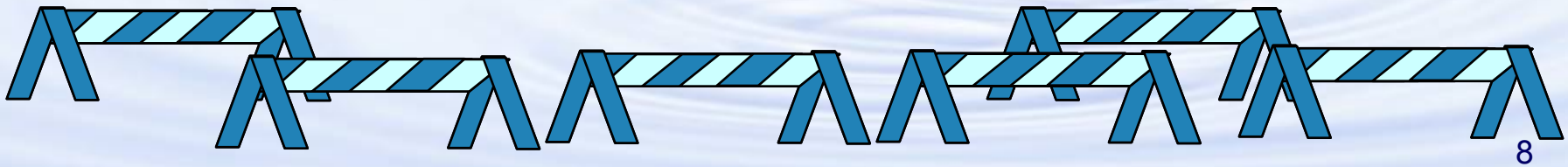


Table 3.4.2 Technical Targets for Automotive Applications: 80-kW_e (net) Integrated Transportation Fuel Cell Power Systems Operating on Direct Hydrogen [a]

Characteristic	Units	2003 Status	2005 Status	2010	2015
Energy efficiency [b] @ 25% of rated power	%	59	59	60	60
Energy efficiency @ rated power	%	50	50	50	50
Power density	W / L	440	500	650	650
Specific power	W / kg	420	470 [c]	650	650
Cost [d]	$ / kW_e	200	110 [e]	45	30
Transient response (time from 10% to 90% of rated power)	s	3	1.5	1	1
Cold start-up time to 50% of rated power					
@–20°C ambient temp	s	120	20	30	30
@+20°C ambient temp	s	60	<10	5	5
Start up and shut down energy [f]					
from -20°C ambient temp	MJ	N/A	7.5	5	5
from +20°C ambient temp	MJ	N/A	N/A	1	1
Durability with cycling	hr	N/A	~1,000 [g]	5,000 [h]	5,000 [h]
Unassisted start from low temperatures [i]	°C	N/A	-20	-40	-40

[a] Targets exclude hydrogen storage, power electronics and electric drive.
[b] Ratio of DC output energy to the lower heating value of the input fuel (hydrogen). Peak efficiency occurs at about 25% rated power.
[c] Based on corresponding data in Table 3.4.3 divided by 3 to account for ancillaries.
[d] Based on 2002 dollars and cost projected to high-volume production (500,000 systems per year).
[e] Status is from 2005 TIAX study and will be periodically updated.
[f] Includes electrical energy and the hydrogen used during the start-up and shut-down procedures.
[g] Durability with cycling is being evaluated through the Technology Validation activity. Steady-state stack durability is 20,000 hours (See Table 3.4.4).
[h] Based on test protocol to be issued by DOE in 2007.
[i] 8-hour soak at stated temperature must not impact subsequent achievement of targets.

Table 3.4.4 Technical Targets [a]: Integrated Stationary PEM Fuel Cell Power Systems (5-250kW) Operating on Reformate

Characteristic	Units	2003 Status	2005 Status	2011
Electrical energy efficiency [b] @ rated power	%	30	32	40
Combined Heat and Power (CHP) energy efficiency [c] @ rated power	%	70	75 [d]	80
Cost [e]	$ / kW_e	2,500	2,500	750
Transient response time (from 10% to 90% power)	s	<3	< 3	< 3
Cold start-up time (to rated power @ -20ºC ambient) Continuous use application	minutes	<20	<90	<30
Survivability (min and max ambient temperature)	ºC ºC	-25 +40	-25 +40	-35 +40
Durability @ <10% rated power degradation	h	15,000	20,000	40,000
Noise	dB(A)	<65 @ 10 m	<60 @ 10 m	<55 @ 10 m
Emissions (combined NO_X, CO, SO_X, hydrocarbon, particulates)	g / 1000 kWh	<8	<8	<1.5

[a] Includes fuel processor, stack and all ancillaries.
[b] Ratio of DC output energy to the LHV of the input fuel (natural gas or LPG) average value at rated power over life of power plant.
[c] Ratio of DC output energy plus recovered thermal energy to the LHV of the input fuel (natural gas or LPG) average value at rated power over life of power plant
[d] For LPG, efficiencies are 1.5 percentage points lower than natural gas because the reforming process is more complex.
[e] Includes projected cost advantage of high-volume production (2,000 units / year). Current cost does not include integrated auxiliaries, battery and power regulator necessary for unassisted start.

Table 3.4.8 Technical Targets: Auxiliary Power Units and Truck Refrigeration Units

Characteristic	Units	2003 Status (Stack)	2005 Status (System) [a]	2006	2010	2015
Specific power	W / kg	50 [b]	25 [b]	70	100	100
Power density	W / L	50 [b]	25 [b]	70	100	100
Efficiency @ rated power[c]	%LHV	20	15	25	35	40
Cost [d]	$ / kW_e	>2,000	>2,000	<800	400	400
Cycle capability (from cold start) over operating lifetime	number of cycles	10	5	40	150	250
Durability	hours	100	100	2,000	20,000	35,000
Start-up time	min	2-3 hours	60-90	30-45	15-30	15-30

[a] Estimate of capability based on cell and small stack laboratory developments.
[b] Without power conditioning. Source: Proceedings of the Sixth Annual SECA Workshop, Pacific, Grove, CA, April 2005.
[c] Electrical efficiency only—does not include any efficiency aspects of the heating or cooling likely being provided.
[d] Cost based on high-volume manufacturing quantities (100,000 units / year)

Table 3.4.7 Technical Targets: Consumer Electronics (sub-Watt to 50-Watt)

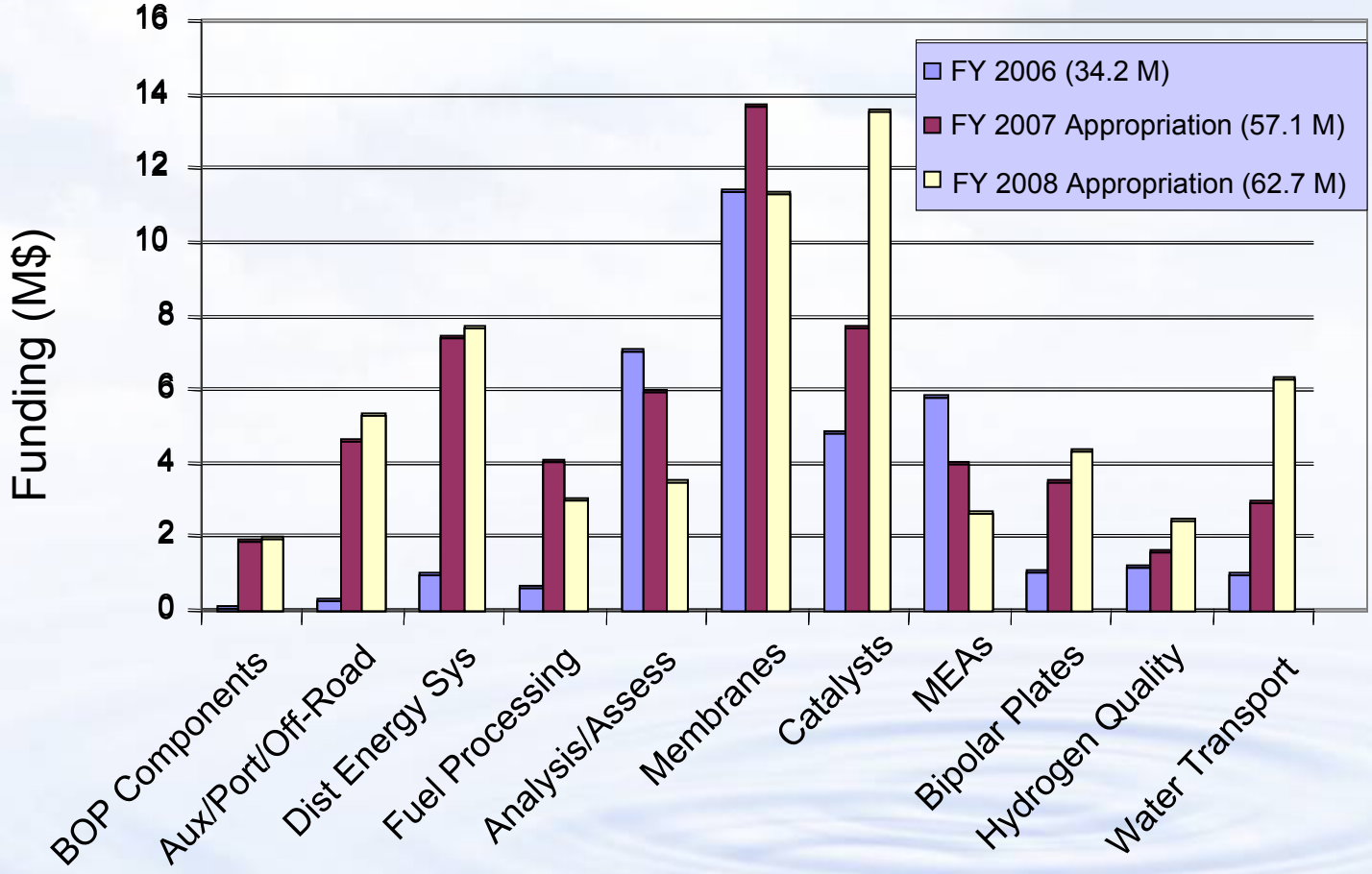
Characteristic	Units	2005 Status [a, b]	2006	2010
Specific power	W / kg	20	30	100
Power density	W / L	20	30	100
Energy density	Wh / L	300	500	1,000
Cost	$ / W	40 [c]	5	3
Lifetime	hours	>500	1,000	5,000

[a] First year for which status was available.
[b] Unless otherwise noted, status is based on average of available data.
[c] Fuel Cell Seminar Abstracts, 2004, p. 290.

Fuel Cell Budget

Budget Activity	Funding ($ in thousands)	
	FY 2007 Appropriation	FY 2008 Appropriation
Fuel Cell Stack Component R&D	38,082	44,000
Transportation Fuel Cell Systems	7,518	8,000
Distributed Energy Fuel Cell Systems	7,419	7,700
Fuel Processor R&D	4,056	3,000
Total	**57,075**	**62,700**

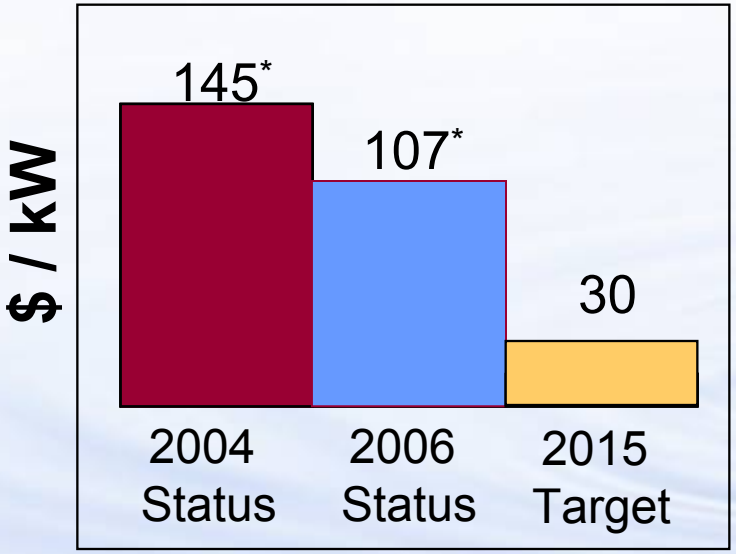
Fuel Cell Budget by Topic



Fuel Cell Progress

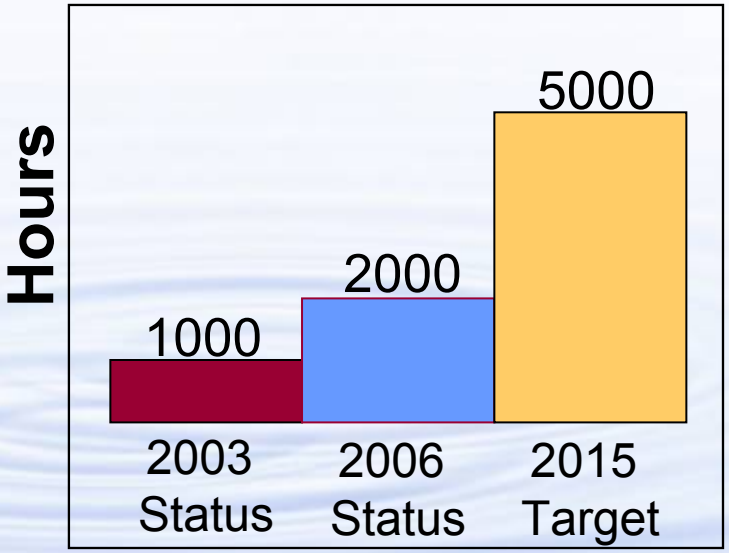
Program has made technical advances that led to reduced cost and improved durability.

80 kW Direct H_2 Fuel Cell System Cost Status vs. Targets

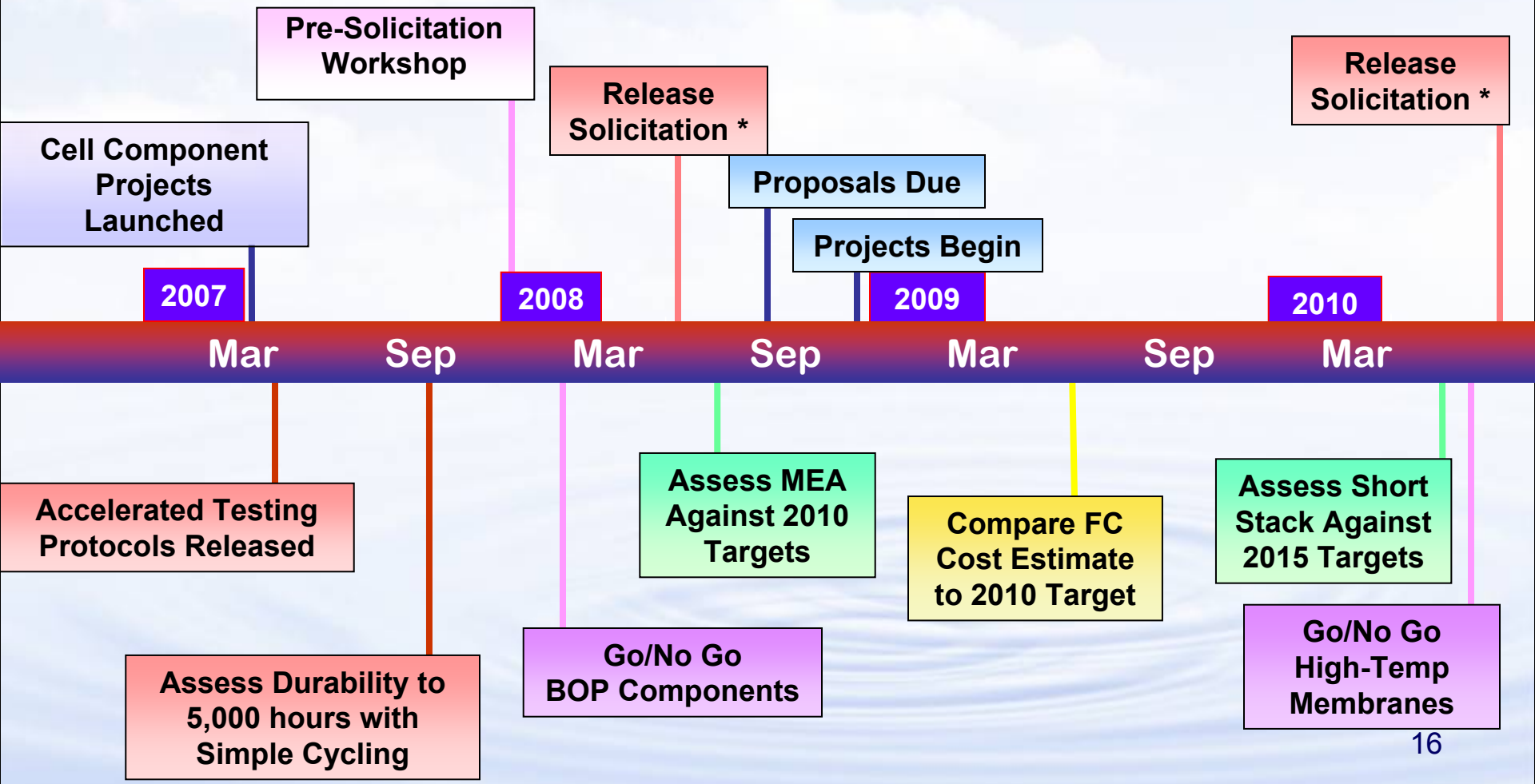


*projected to high volume production of 500,000 units/year

Fuel Cell Stack Durability Status vs. Targets



Fuel Cells – Future Plans



*Subject to appropriations

For More Information - Contact the Fuel Cell Team

HQ

Nancy Garland
(202) 586-5673
nancy.garland@ee.doe.gov

Kathi Epping
(202) 586-7425
kathi.epping@ee.doe.gov

Amy Manheim
(202) 586-1507
amy.manheim@ee.doe.gov

Jason Marcinkoski
(202) 586-7466
jason.marcinkoski@ee.doe.gov

Kevin McMurphy
(202) 586-8058
kevin.mcmurphy@ee.doe.gov

Ingrid Milton
(202) 586-9583
ingrid.milton@ee.doe.gov

Terry Payne
(202) 586-9585
terry.payne@ee.doe.gov

GFO

Dave Peterson
(303) 275-4956
david.peterson@go.doe.gov

Reg Tyler
(303) 275-4929
reginald.tyler@go.doe.gov

Jesse Adams
(303) 275-4954
jesse.adams@go.doe.gov

Jill Gruber
(303) 275-4961
jill.gruber@go.doe.gov

www.hydrogen.energy.gov

Thank you!!!