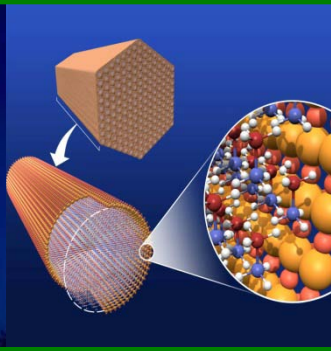
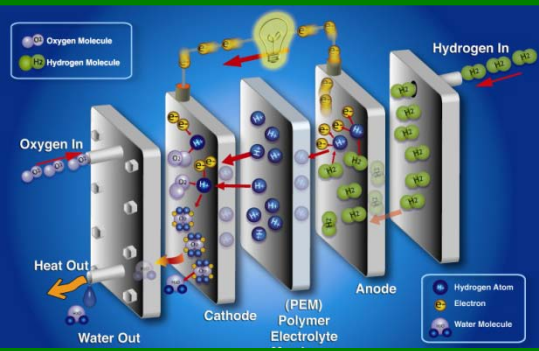




U.S. DEPARTMENT OF
ENERGY



Fuel Cells

Dimitrios Papageorgopoulos

*2010 Annual Merit Review and Peer Evaluation Meeting
08 June 2010*

Goal and Objectives

Goal: Develop and demonstrate fuel cell power system technologies for stationary, portable and transportation application.

Distributed Power*:

- \$750/kW by 2011
- 40,000-hour durability by 2011
- 40% efficiency by 2011

Transportation:

- \$45/kW by 2010; \$30/kW by 2015*
- 5,000-hour durability by 2015
- 60% efficiency

APUs:

- Specific power of 40 W/kg by 2015
- Power density of 35 W/L by 2015

Portable Power*:

- Energy density of 1,000 W-h/L by 2010

Performance metrics being tracked will help form materials handling and backup power targets

*Targets are currently under review



Budget

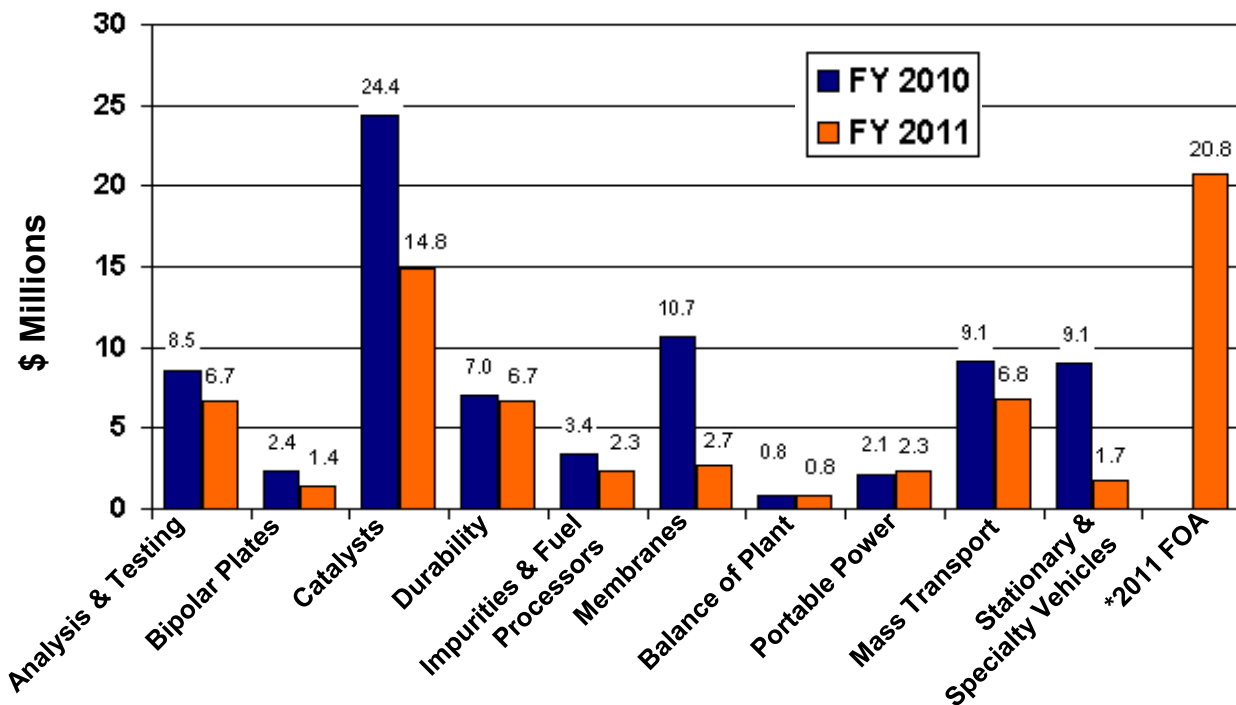
FY 2010 Emphasis

R&D of materials, stack components, balance-of-plant subsystems, and integrated fuel cell systems targeting lower cost and enhanced durability

- Develop improved fuel cell catalysts and membrane electrolytes
- Characterize and optimize transport phenomena improving MEA and stack performance
- Optimize fuel cells and systems for early market applications
- Develop innovative concepts leading to a new generation of fuel cell technologies

Applications include: transportation, combined heat and power (CHP), auxiliary power units (APUs), direct methanol fuel cells for portable power, and backup power for critical infrastructure.

FY 2010 Budget Plan Industry - \$31.5M, National Labs - \$40.2M, University - \$5.7M



*FOA subject to approval / appropriations

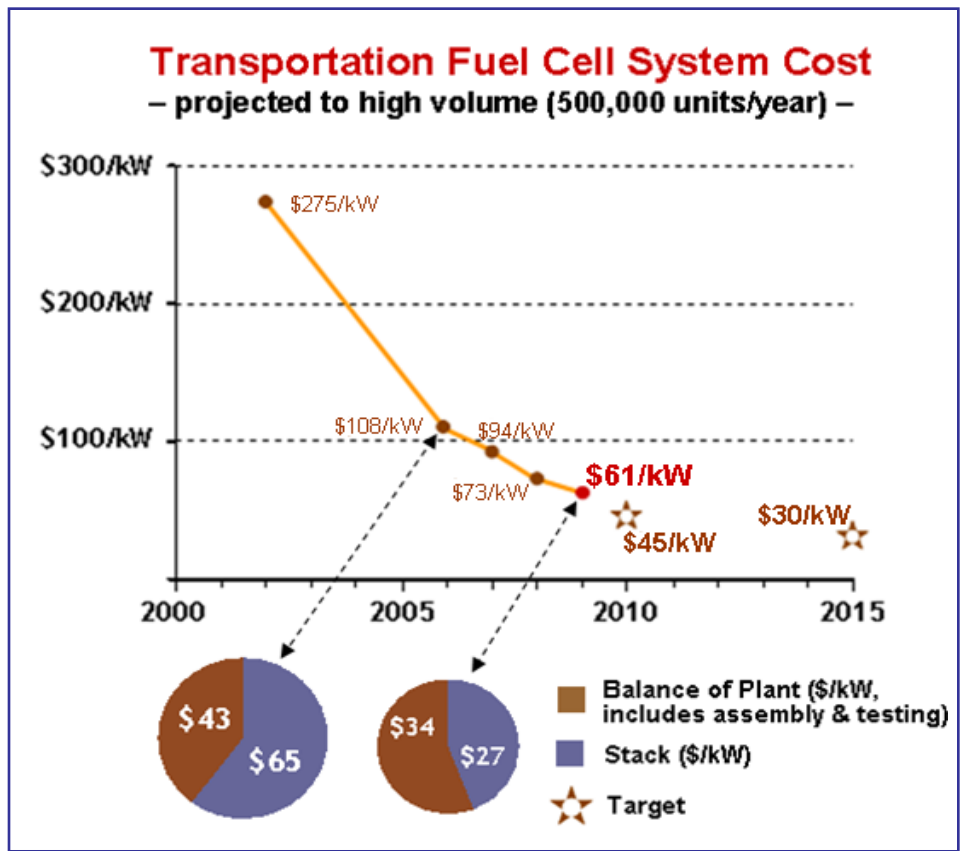
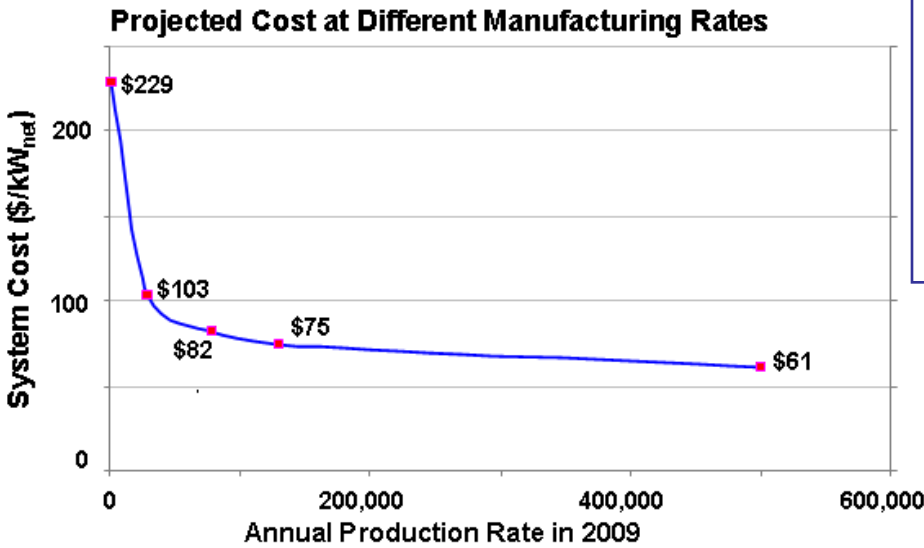
**FY 2010
APPROPRIATION = \$77.4M**

**FY 2011
REQUEST = \$67M**

Fuel Cell R&D - Progress

The projected high-volume cost of transportation fuel cells for 2009 has been reduced to \$61/kW*

- More than 35% reduction in the last two years
- 2008 cost projection was validated by independent panel**

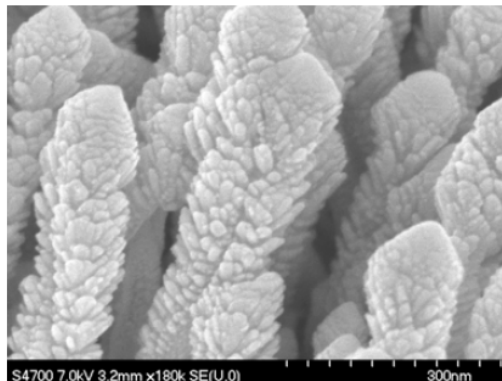
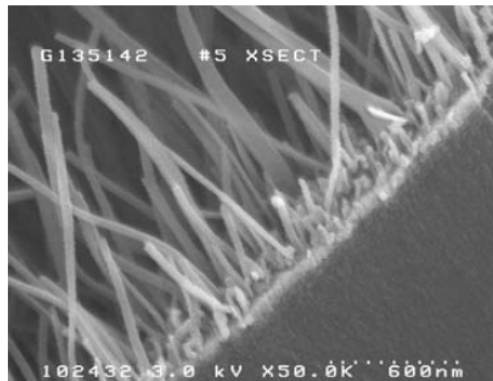


*Based on projection to high-volume manufacturing (500,000 units/year).

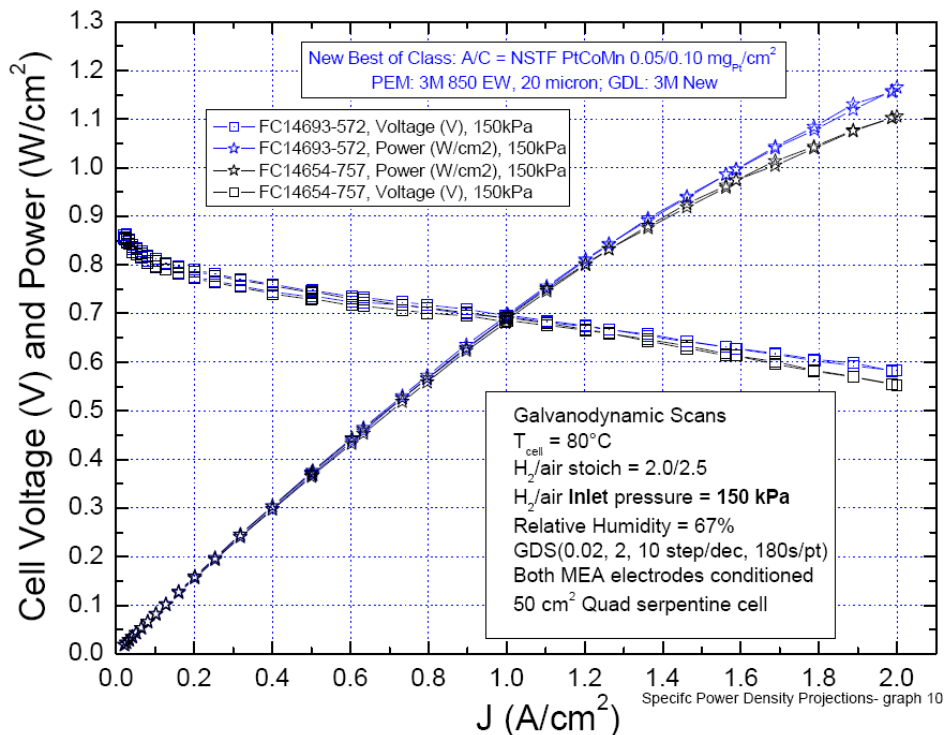
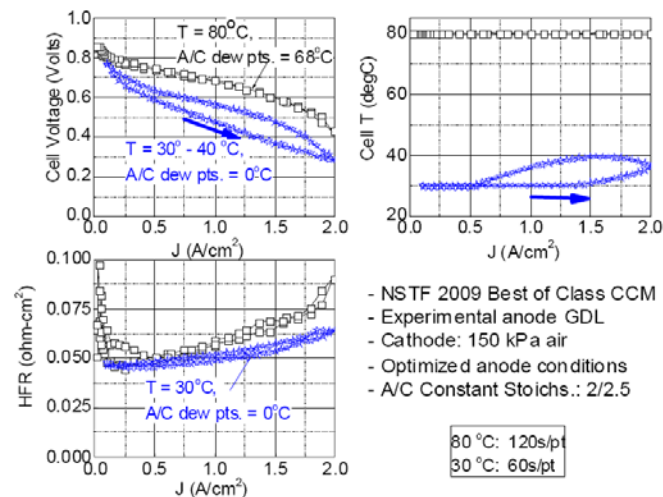
**Panel found \$60 – \$80/kW to be a “valid estimate”:
http://hydrogenodev.nrel.gov/peer_reviews.html

MEAs demonstrate high performance under non-ideal (cool, wet) conditions

3M Nanostructured Thin Film (NSTF) catalyst



First time standard NSTF CCM has ever hit 1.5 to 2 A/cm² at 30 to 35°C

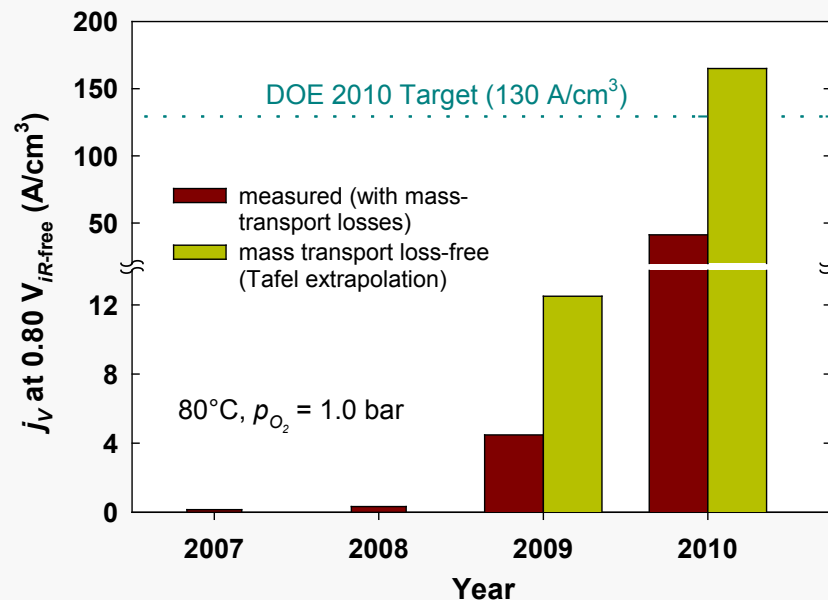
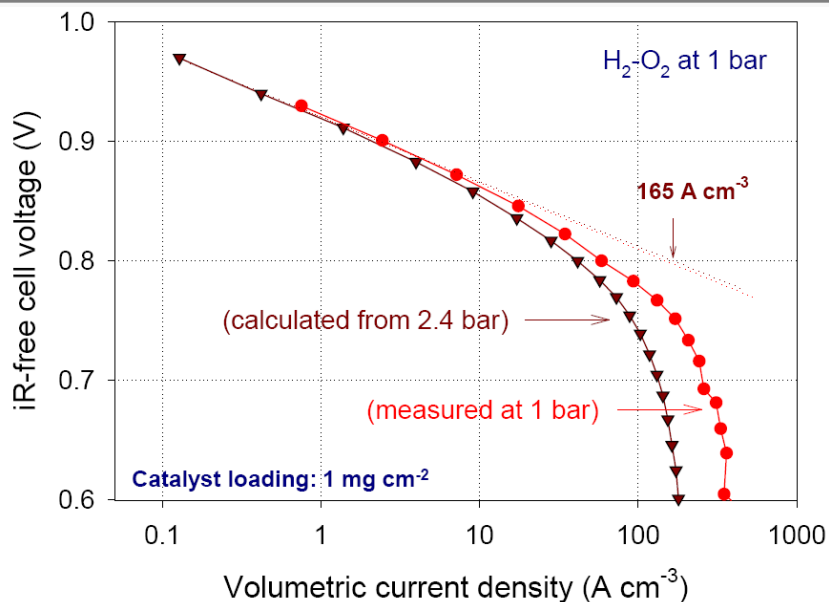


3M's use of specific anode operating conditions and modification of anode diffusion media allows high performance operation under challenging conditions – temperature as low as 30 °C

NSTF meets major performance and durability targets

- High power at low PGM loading – 0.18 g_{PGM}/kW (single cell), 0.19 g_{PGM}/kW (stack) – DOE 2010 target: 0.3 g_{PGM}/kW
- Membrane Durability Test - 5000 hours with cycling (single cell) – DOE 2010/2015 target: 5000 hours

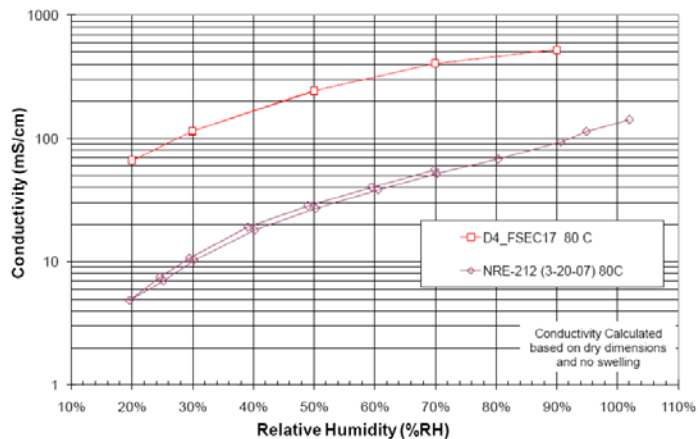
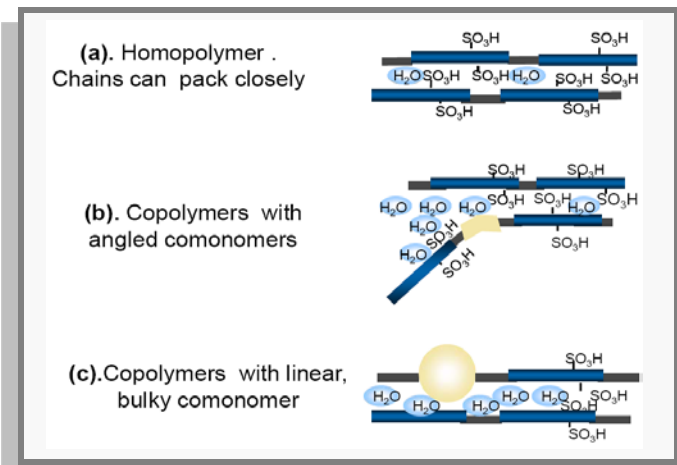
Non-PGM catalyst activity increased



- High ORR activity reached with several non-PGM catalysts by LANL, including cyanamide-Fe-C catalyst (shown)
- Fuel cell performance improved by more than 100x since 2008
- Catalyst activity exceeds DOE 2010 activity target of $130\ A/cm^3$ at $0.80\ V$

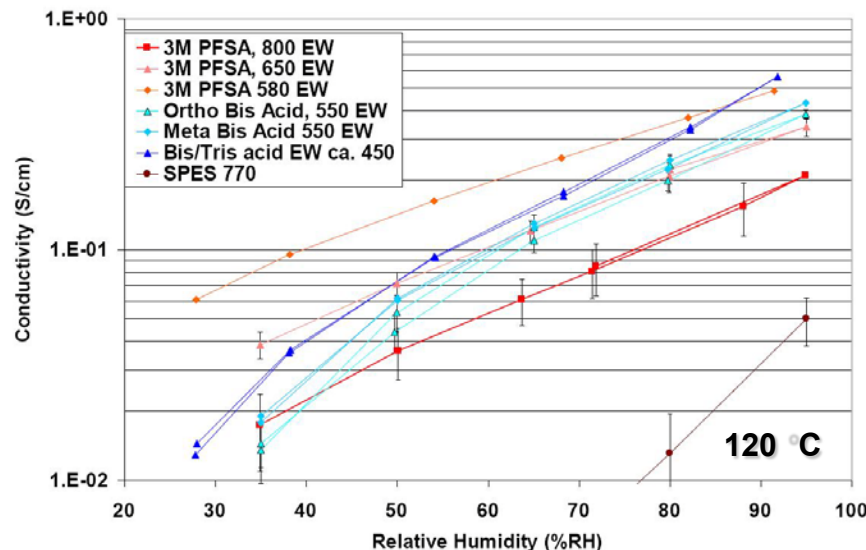
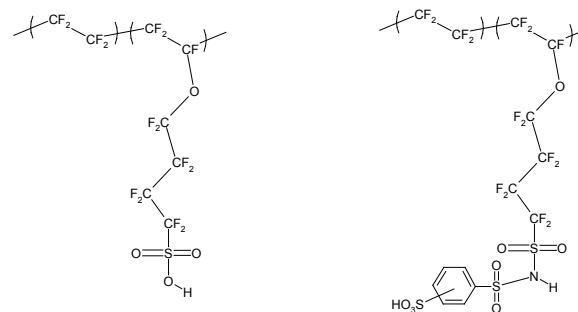
Membranes achieve high conductivity for high temperature applications

CWRU: Frozen-in Free Volume



- Latest rigid-rod polyelectrolytes show outstanding conductivity at 80 C
- 120 C testing in progress

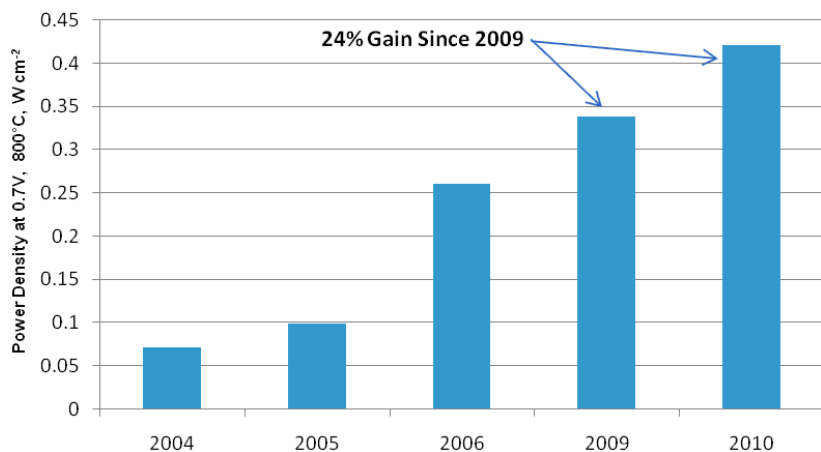
3M: Low-EW PFSA and Multi-Acid Side Chains



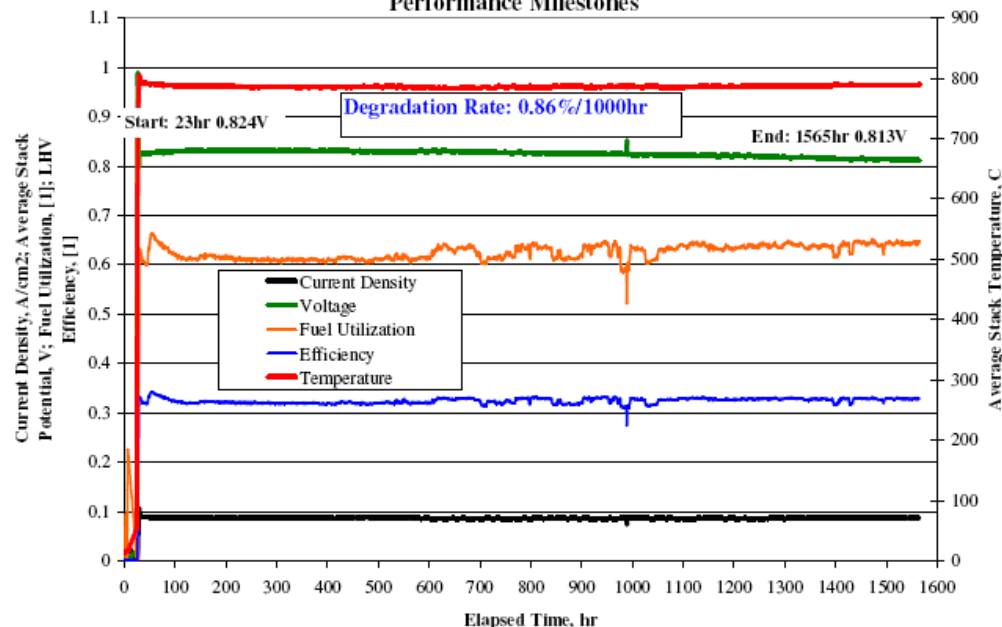
- Low-EW PFSA has highest conductivity, but poor mechanical properties
- Multi-acid side chain ionomer achieves high conductivity while retaining better mechanical properties

Improvements in SOFC power density and durability for micro-CHP applications

Cell Performance Progress



Steady State Operation of an Acumentrics Stack Meeting Phase II Performance Milestones



- Acumentrics demonstrated 24% increase in power density, enabling 33% reduction in stack volume and 15% reduction in stack weight
- Low degradation rate of 0.86%/1000 hours during 1500 hours of testing

Several workshops were held in 2010 with stakeholder participation

November 16 - Joint DOE Fuel Cell Technologies/Fossil Energy MCFC & PAFC Workshop

- ***Purpose:*** Provide an overview of the state-of-the-art, identify critical areas, key barriers and gaps in the current technologies

March 16 & 17 - Pre-Solicitation Workshop

- ***Purpose:*** Gather feedback from the research community and relevant stakeholders regarding pre-competitive development needs and technical barriers related to fuel cells and fuel cell systems designed for stationary and transportation applications, as well as cross-cutting stack and BOP component technology
- A complementary RFI was issued prior to the workshop

June 7 - Workshop on Bus Targets and Gaps

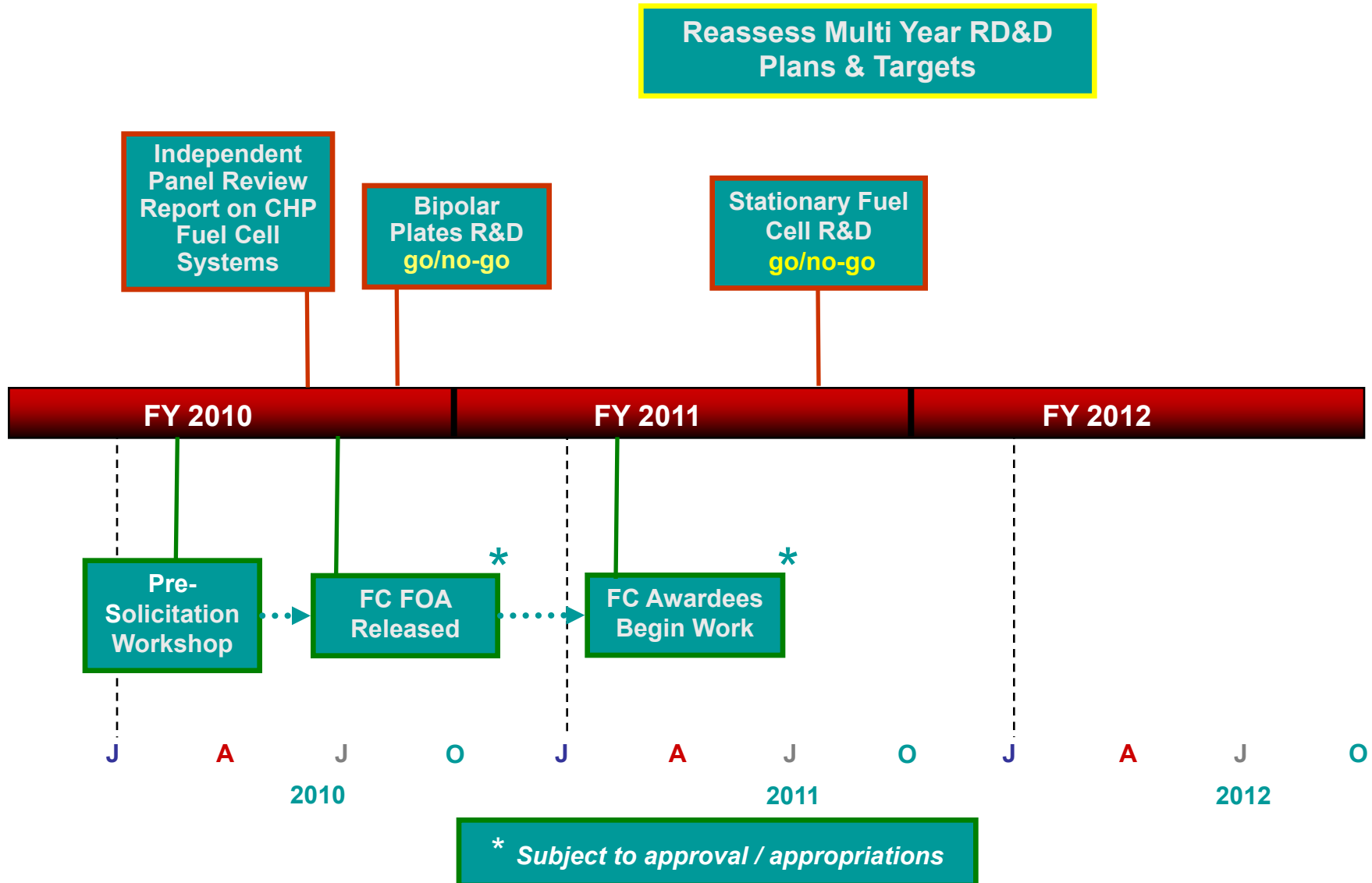
- ***Purpose:*** Provide an overview and discuss relevant R&D needs

RFIs were issued to facilitate target revision for micro-CHP, APU and Portable Power fuel cell applications*

The Portable Power RFI can be found at: www.fedconnect.net - responses are due June 30

Future Plans

Major Milestones & Future Solicitation



- This is a review, not a conference.
- Presentations will begin precisely at the scheduled times.
- Talks will be **20 minutes** and **Q&A 10 minutes**.
- Reviewers have priority for questions over the general audience.
- Reviewers should be seated in front of the room for convenient access by the microphone attendants during the Q&A.
- Please mute all cell phones, BlackBerries, etc.

- Deadline for final review form submittal is **June 18th**.
- ORISE personnel are available on-site for assistance. A reviewer lab is set-up in room 8216 and will be open Tuesday –Thursday from 7:30 AM to 6:00 PM and Friday 7:30 AM to 3:00 PM.
- Reviewer feedback session – **Wednesday, at 6:15 pm (after last Fuel Cell session), in the room of this session.**

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