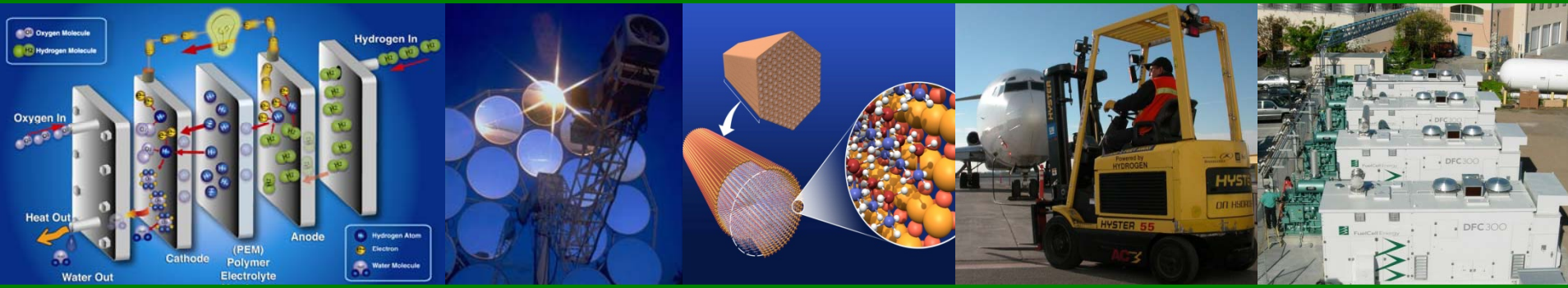




U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Overview of DOE Hydrogen and Fuel Cell Activities

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Program Manager

U.S. Department of Energy

Fuel Cell Technologies Program

*International Hydrogen Fuel-Cell Technology and Vehicle Development Forum:
Shanghai, China
September 21, 2010*

- ✓ Double Renewable Energy Capacity by 2012
- ✓ Invest \$150 billion over ten years in energy R&D to transition to a clean energy economy
- ✓ Reduce GHG emissions 83% by 2050



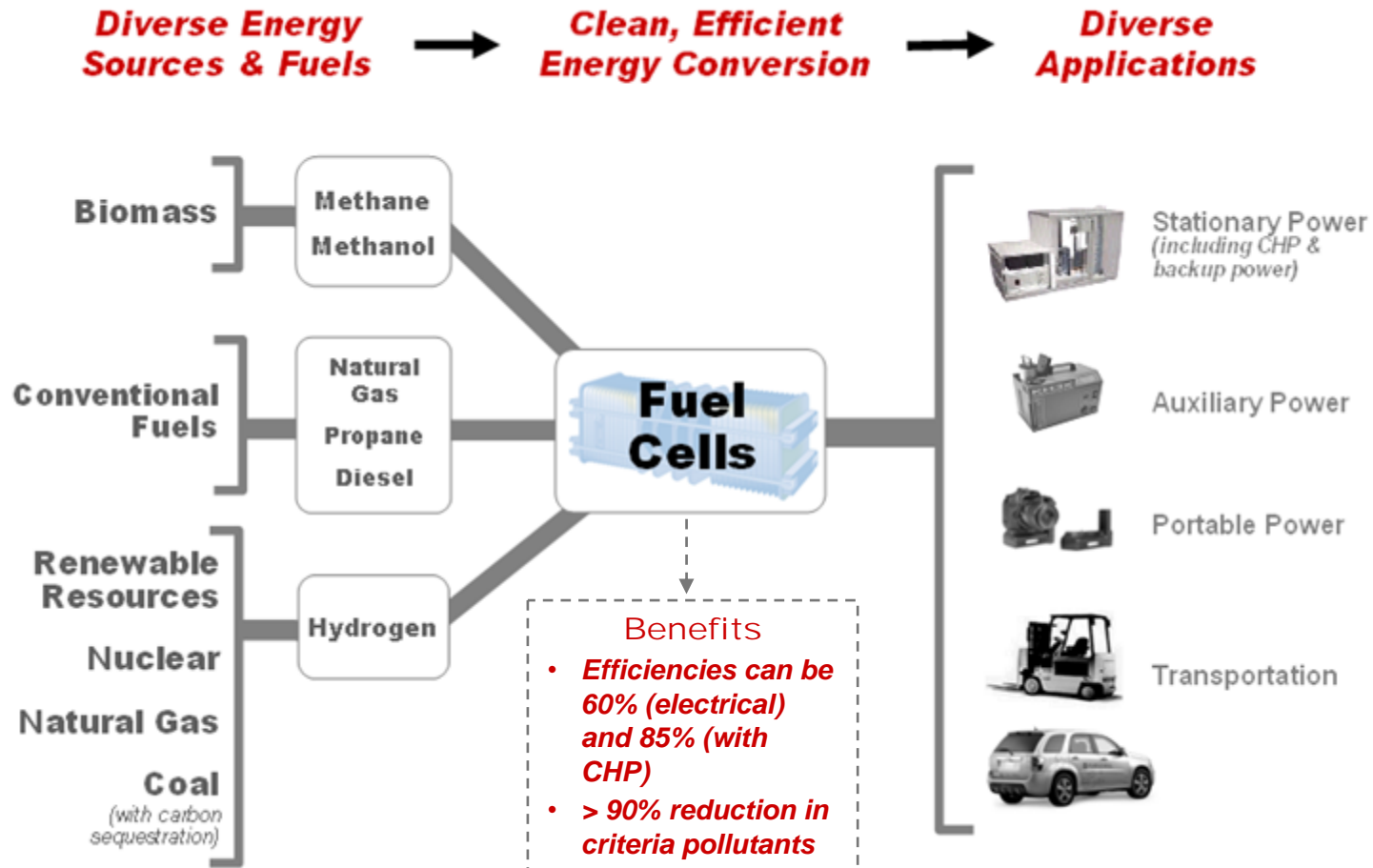
Fuel Cells: Addressing Energy Challenges

Energy Efficiency and Resource Diversity

→ *Fuel cells offer a highly efficient way to use diverse fuels and energy sources.*

Greenhouse Gas Emissions and Air Pollution:

→ *Fuel cells can be powered by emissions-free fuels that are produced from clean, domestic resources.*



Fuel Cells for Stationary Power, Auxiliary Power, and Specialty Vehicles



The largest markets for fuel cells today are in stationary power, portable power, auxiliary power units, and forklifts.

~75,000 fuel cells have been shipped worldwide.
 ~24,000 fuel cells were shipped in 2009 (> 40% increase over 2008).

Fuel cells can be a cost-competitive option for critical-load facilities, backup power, and forklifts.



Fuel Cells for Transportation

In the U.S., there are currently:

- > 200 fuel cell vehicles
- > 20 fuel cell buses
- ~ 60 fueling stations

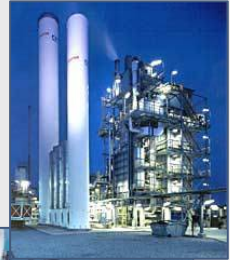
Several manufacturers—including Toyota, Honda, Hyundai, Daimler, GM, and Proterra (buses) — have announced plans to commercialize vehicles by 2015.



Production & Delivery of Hydrogen

In the U.S., there are currently:

- ~9 million metric tons of H₂ produced annually
- > 1,200 miles of H₂ pipelines

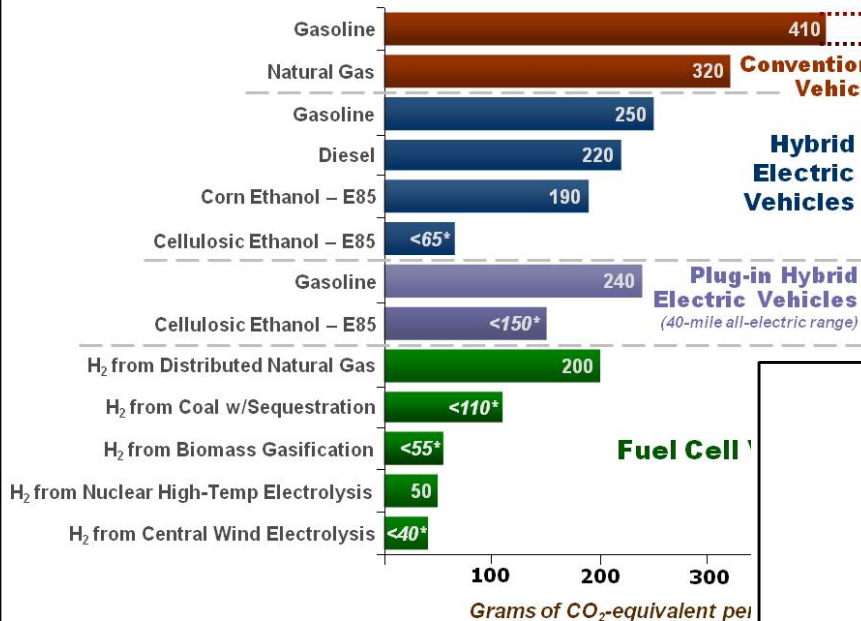


The Role of Fuel Cells in Transportation



Well-to-Wheels Greenhouse Gas Emissions

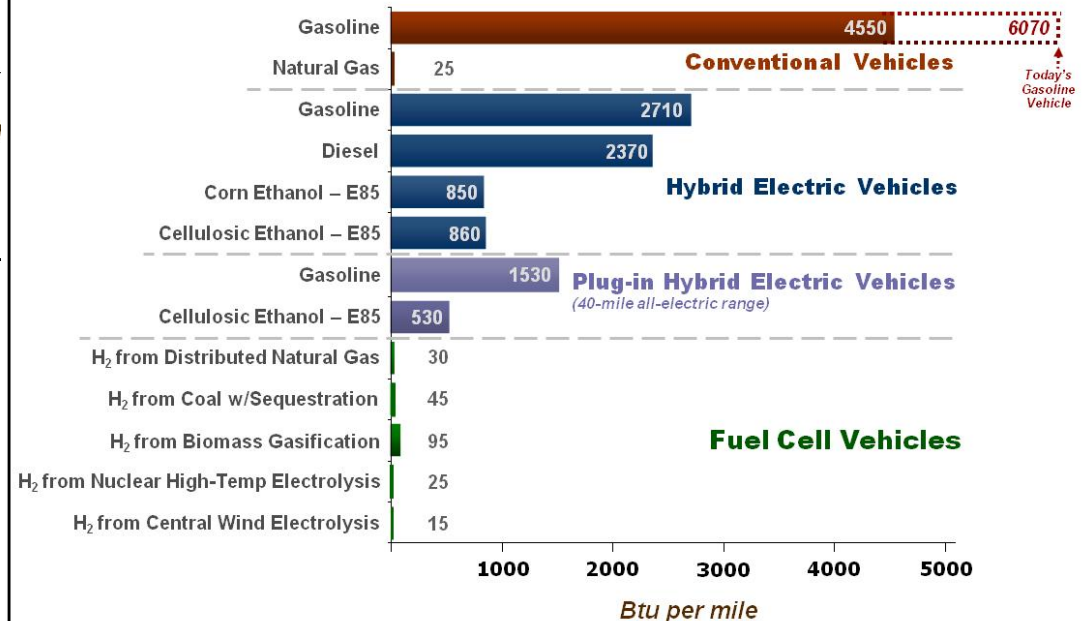
(life-cycle emissions, based on a projected state of the technologies in 2020)



Analysis shows portfolio of transportation technologies will reduce emissions of greenhouse gases and oil consumption.

Well-to-Wheels Petroleum Energy Use

(based on a projected state of the technologies in 2020)



Key Challenges

The Program has been addressing the key challenges facing the widespread commercialization of fuel cells.

Technology
 Barriers*

Fuel Cell Cost & Durability

Targets*:

Stationary Systems: \$750 per kW,
 40,000-hr durability

Vehicles: \$30 per kW, 5,000-hr durability

Hydrogen Cost

Target*: \$2 – 3 /gge, (dispensed and untaxed)

Hydrogen Storage Capacity

Target: > 300-mile range for vehicles—without compromising interior space or performance

Technology Validation:

Technologies must be demonstrated under real-world conditions.

Market Transformation

Assisting the growth of early markets will help to overcome many barriers, including achieving significant cost reductions through economies of scale.

Economic &
 Institutional
 Barriers

Safety, Codes & Standards Development

Domestic Manufacturing & Supplier Base

Public Awareness & Acceptance

Hydrogen Supply & Delivery Infrastructure

* Targets and Metrics are being updated in 2010 .

Some tax credits affecting fuel cells were expanded. Through new financing mechanisms, these credits can help facilitate federal deployments.

Hydrogen Fueling Facility Credit	Increases the hydrogen fueling credit from 30% or \$30,000 to 30% or \$200,000.
Grants for Energy Property in Lieu of Tax Credits	Allows facilities with insufficient tax liability to apply for a grant instead of claiming the Investment Tax Credit (ITC) or Production Tax Credit (PTC). Only entities that pay taxes are eligible.
Manufacturing Credit	Creates 30% credit for investment in property used for manufacturing fuel cells and other technologies
Residential Energy Efficiency Credit	Raises ITC dollar cap for residential fuel cells in joint occupancy dwellings to \$3,334/kW.



**On October 5, 2009
President Obama signed
Executive Order 13514 –
Federal Leadership in
Environmental, Energy, and
Economic Performance**

- Requires Agencies to:
 - Set GHG reduction Targets
 - Develop Strategic Sustainability Plans and provide in concert with budget submissions
 - Conduct bottom up Scope 1, 2 and 3 baselines
 - Track performance

Examples:

- Achieve 30% reduction in vehicle fleet petroleum use by 2020
- Requires 15% of buildings meet the *Guiding Principles for High Performance and Sustainable Buildings* by 2015
- Design all new Federal buildings which begin the planning process by 2020 to achieve zero-net energy by 2030

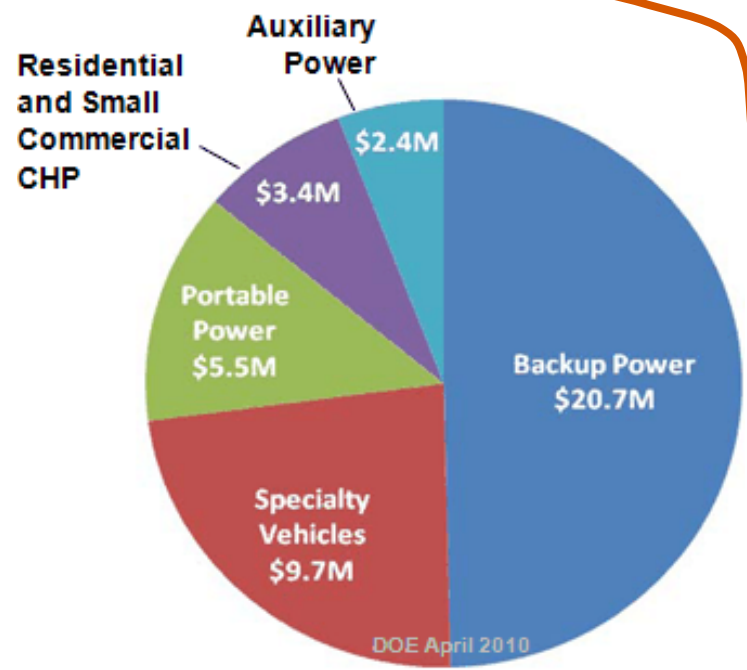
Potential opportunities for fuel cells and other clean energy technologies....

Recovery Act Funding for Fuel Cells

DOE announced more than \$40 million from the American Recovery and Reinvestment Act to fund 12 projects, which will deploy up to 1,000 fuel cells — to help achieve near term impact and create jobs in fuel cell manufacturing, installation, maintenance & support service sectors.

FROM the LABORATORY to DEPLOYMENT:

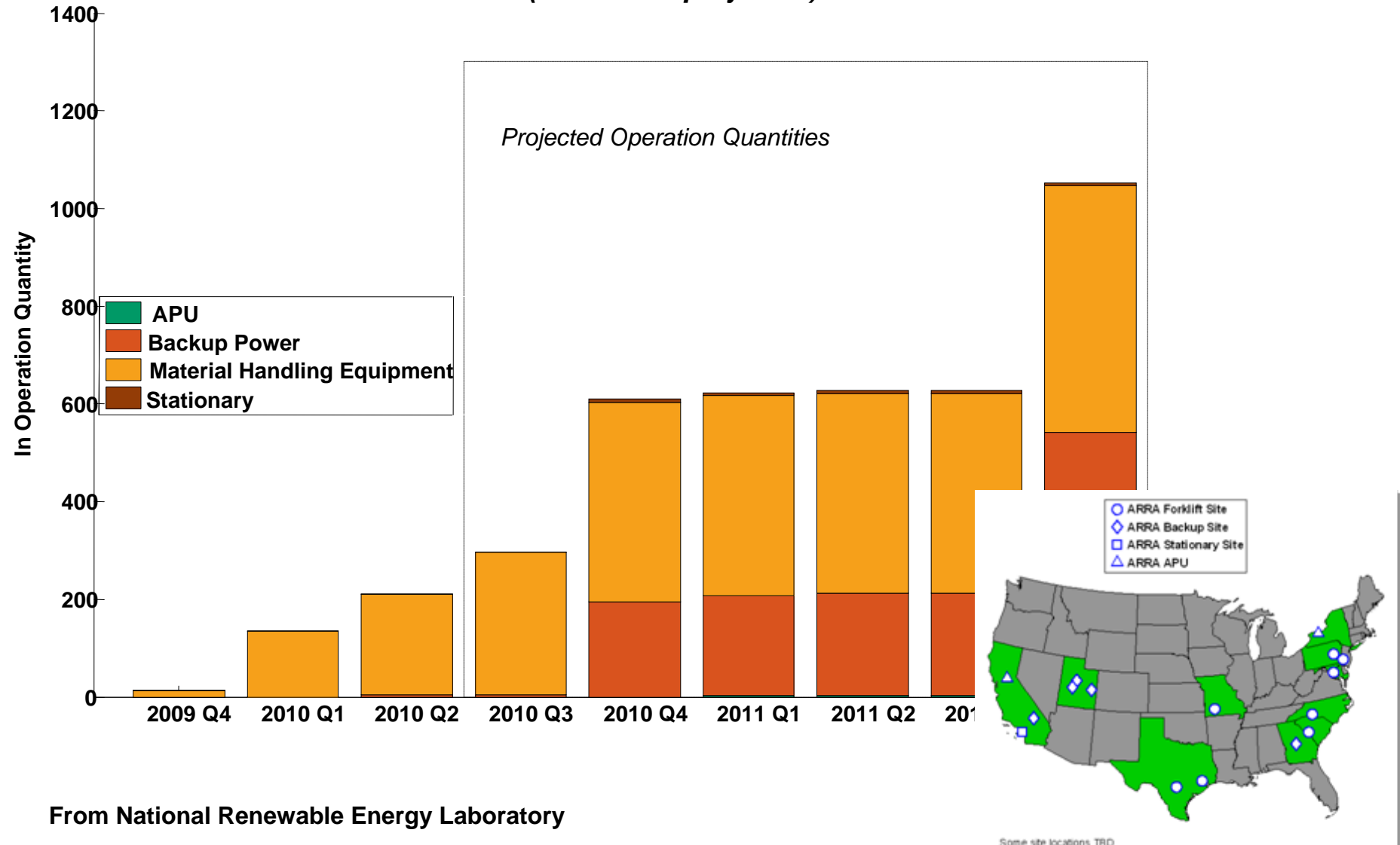
DOE funding has supported R&D by all of the fuel cell suppliers involved in these projects.



COMPANY	AWARD	APPLICATION
Delphi Automotive	\$2.4 M	Auxiliary Power
FedEx Freight East	\$1.3 M	Specialty Vehicle
GENCO	\$6.1 M	Specialty Vehicle
Jadoo Power	\$2.2 M	Backup Power
MTI MicroFuel Cells	\$3.0 M	Portable
Nuvera Fuel Cells	\$1.1 M	Specialty Vehicle
Plug Power, Inc. (1)	\$3.4 M	CHP
Plug Power, Inc. (2)	\$2.7 M	Backup Power
Univ. of N. Florida	\$2.5 M	Portable
ReliOn Inc.	\$8.5 M	Backup Power
Sprint Comm.	\$7.3 M	Backup Power
Sysco of Houston	\$1.2 M	Specialty Vehicle

Approximately \$54 million in cost-share funding from industry participants for a total of about \$96 million.

DOE ARRA-funded Early Market Fuel Cell Installations (actual and projected)



U.S. Fuel Cell Deployments Using Market Transformation and Recovery Act Funding



Example: California

• Hydrogen Fueling Stations

- > 20 stations currently operating
- ~ 10 additional stations planned

• Hydrogen Fuel Cell Vehicle Deployments: CA Fuel Cell Partnership is assessing the potential to deploy over
4,000 vehicles by 2014
50,000 vehicles by 2017

Potential H₂ Communities in Southern California

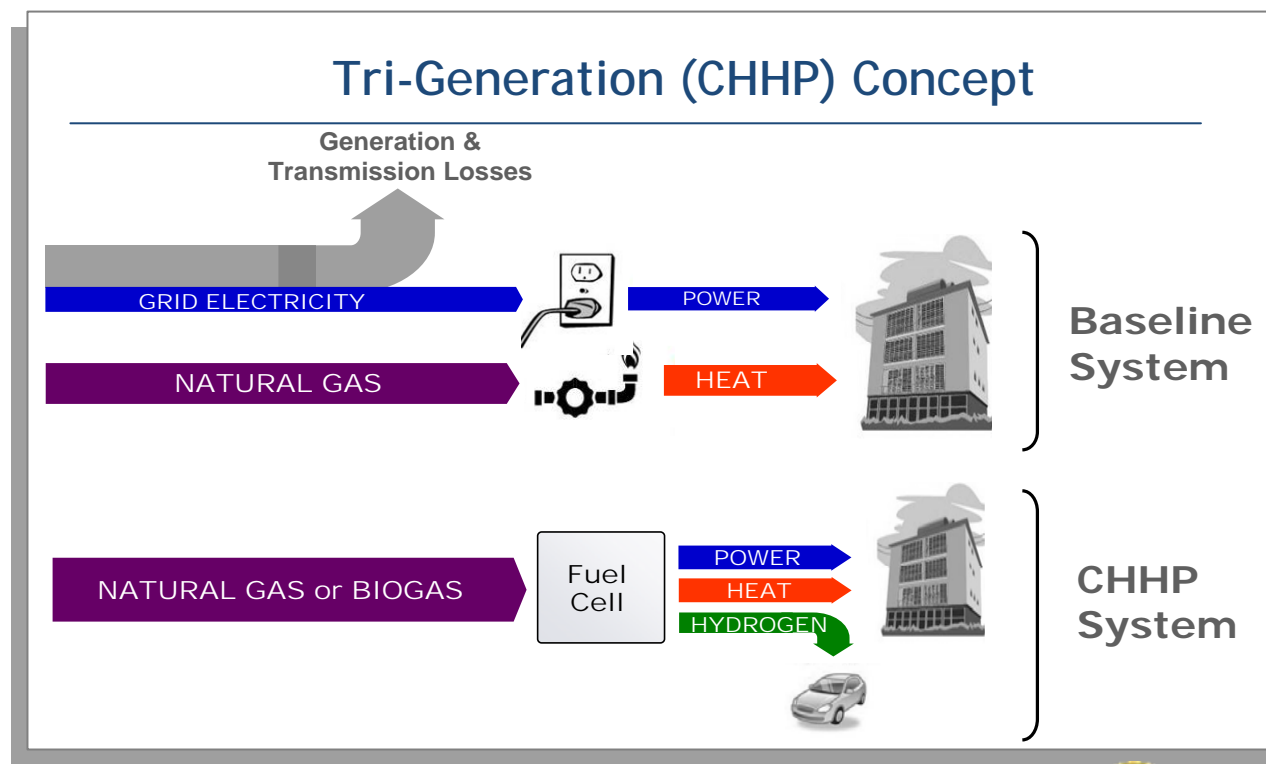


<http://www.fuelcellpartnership.org/>

CHHP: Promising Demonstration

We are participating in a project to demonstrate a combined heat, hydrogen, and power (CHHP) system using biogas.

- System has been designed, fabricated and shop-tested
- Improvements in design have led to higher H₂-recovery (from 75% to >85%)
- On-site operation and data-collection planned for FY10 – FY11



Combined heat, hydrogen, and power systems can:

- Produce clean power and fuel for multiple applications
- Provide a potential approach to establishing an initial fueling infrastructure

Public-Sector Partners:



South Coast Air Quality Management District



California Air Resources Board



Fuel Cell Energy & Air Products

Demonstrations are essential for validating the performance of technologies in integrated systems, under real-world conditions.

RECENT ACCOMPLISHMENTS

Vehicles & Infrastructure

- Fuel cell durability
 - 2,500 hours projected (nearly 75K miles)
- Over 2.8 million miles traveled
- Over 114 thousand total vehicle hours driven
- Fuel cell efficiency 53-59%
- Vehicle Range: ~196 – 254 miles
- Over 134,000 kg- H₂ produced or dispensed*
- 152 fuel cell vehicles and 24 hydrogen fueling stations have reported data to the project

Buses

- DOE is evaluating real-world bus fleet data (DOT collaboration)
 - H₂ fuel cell buses have a range of 39% to 141% better fuel economy when compared to diesel & CNG buses

Forklifts

- Forklifts at Defense Logistics Agency site have completed more than 18,000 refuelings

Recovery Act

- NREL is collecting operating data from deployments for an industry-wide report

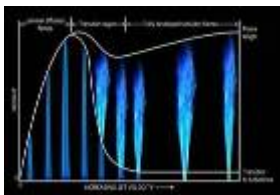


* Not all hydrogen produced is used in vehicles

Safety, Codes & Standards

- *Facilitating the development and adoption of codes & standards for fuel cells*
- *Identifying and promoting safe practices industry-wide*

ACTIVITIES



Develop data needed for key codes & standards (C&S)

Harmonize domestic and international C&S

Simplify permitting process

Promote adoption of current C&S and increase access to safety information



PROGRESS (key examples)

Developed hydrogen release behavior data and incorporated quantitative risk assessment approach for separation distances into the National Fire Protection Association (NFPA) hydrogen code in 2010

Through R&D, enabled the harmonization of domestic and international Fuel Quality Specifications

Developed safety courses for researchers and held permitted workshops that reached >250 code officials

Expanded web-based resources, including: *Hydrogen Safety Best Practices Manual & Hydrogen Permitting Compendium*

Education: *We are working to increase public awareness and understanding of fuel cells.*

ACTIVITIES



Educate key audiences to facilitate demonstration, commercialization, and market acceptance

PROGRESS (key examples)

Educated over 17,000 first responders and code officials through introductory web-based courses and advanced hands-on training.

Conducted seminars and developed fact-sheets and case studies for end-users

Conducted more than 80 workshops to help state officials identify deployment opportunities

Major Workshops Planned

Hydrogen Production & Delivery

- PEC Workshop on EERE/BES Partnerships
- Biological Workshop on EERE/BES Partnerships

Systems Analysis

- Infrastructure workshop on station cost identification and identification of R&D gaps
- Tentatively planned NHA

Hydrogen Storage

- Develop roadmap for lower cost compressed H2 storage
- Identify key R&D issues for cryo-compressed H2 storage
- Hydrogen Sorbents
- Interface issues between infrastructure and on-board storage
- Develop roadmap/strategies for future storage materials R&D

Safety, Codes & Standards

- International Technical Forum: Hydrogen, Natural Gas and Hydrogen-Natural Gas Vehicles and Infrastructure
- Insurability Workshop
- Sensor Assessment of Technology and Targets Workshop
- Certification and Qualification Workshop

Fuel Cell Team

- Alkaline Fuel Cell (AFC) Workshop: Status, prospects, and R&D needs

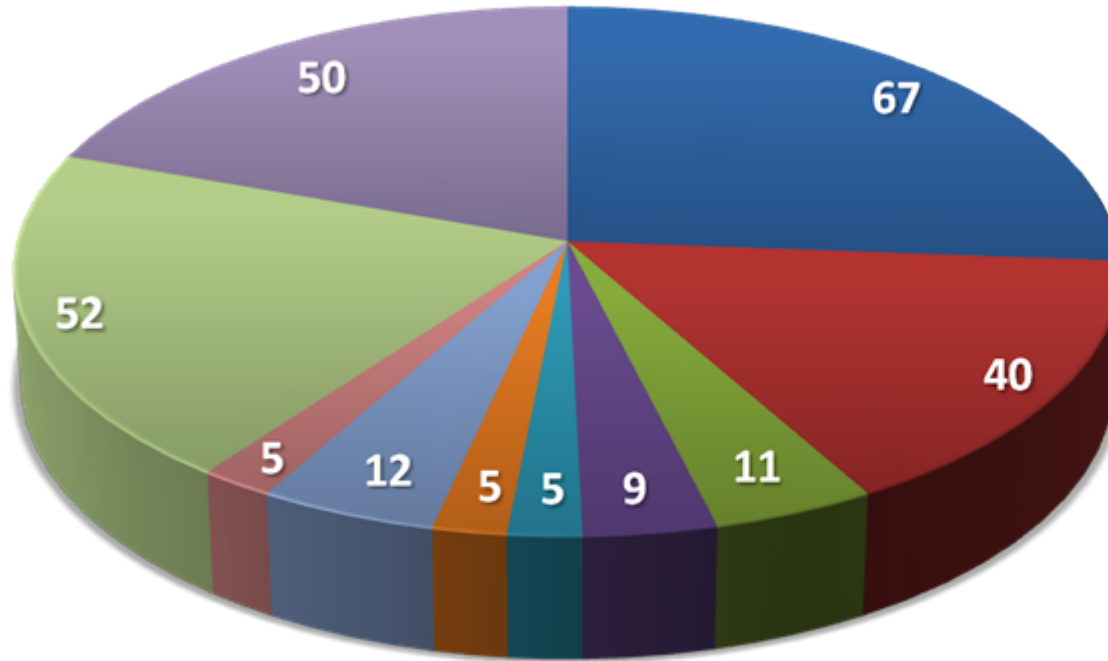
Market Transformation

- DOD Workshop (Sept. 30, 2010)

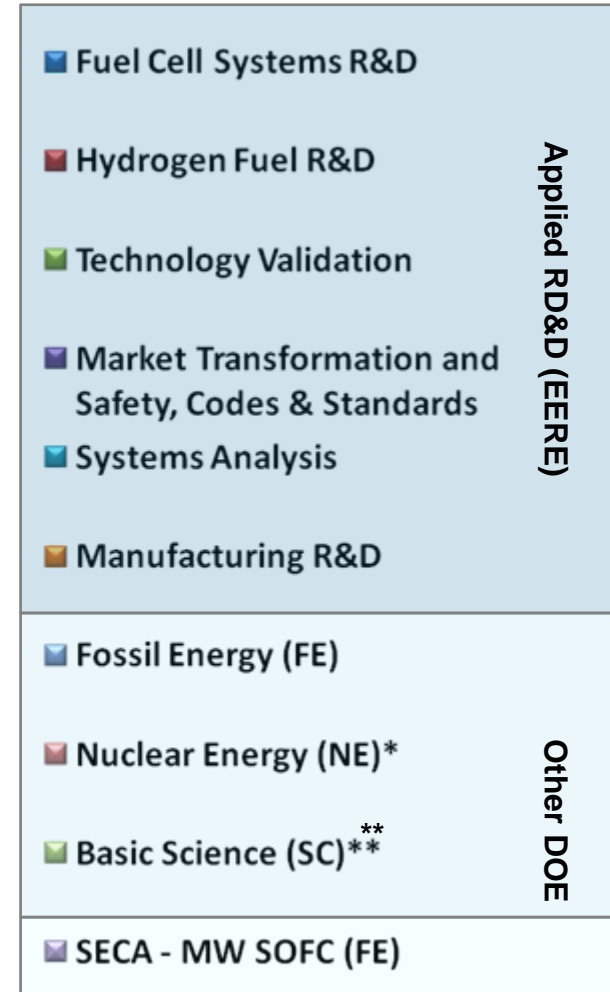
Education

- Stakeholder updated roadmap workshop planned in October

Total DOE Hydrogen and Fuel Cell Technologies FY11 Budget Request (in millions of US\$)

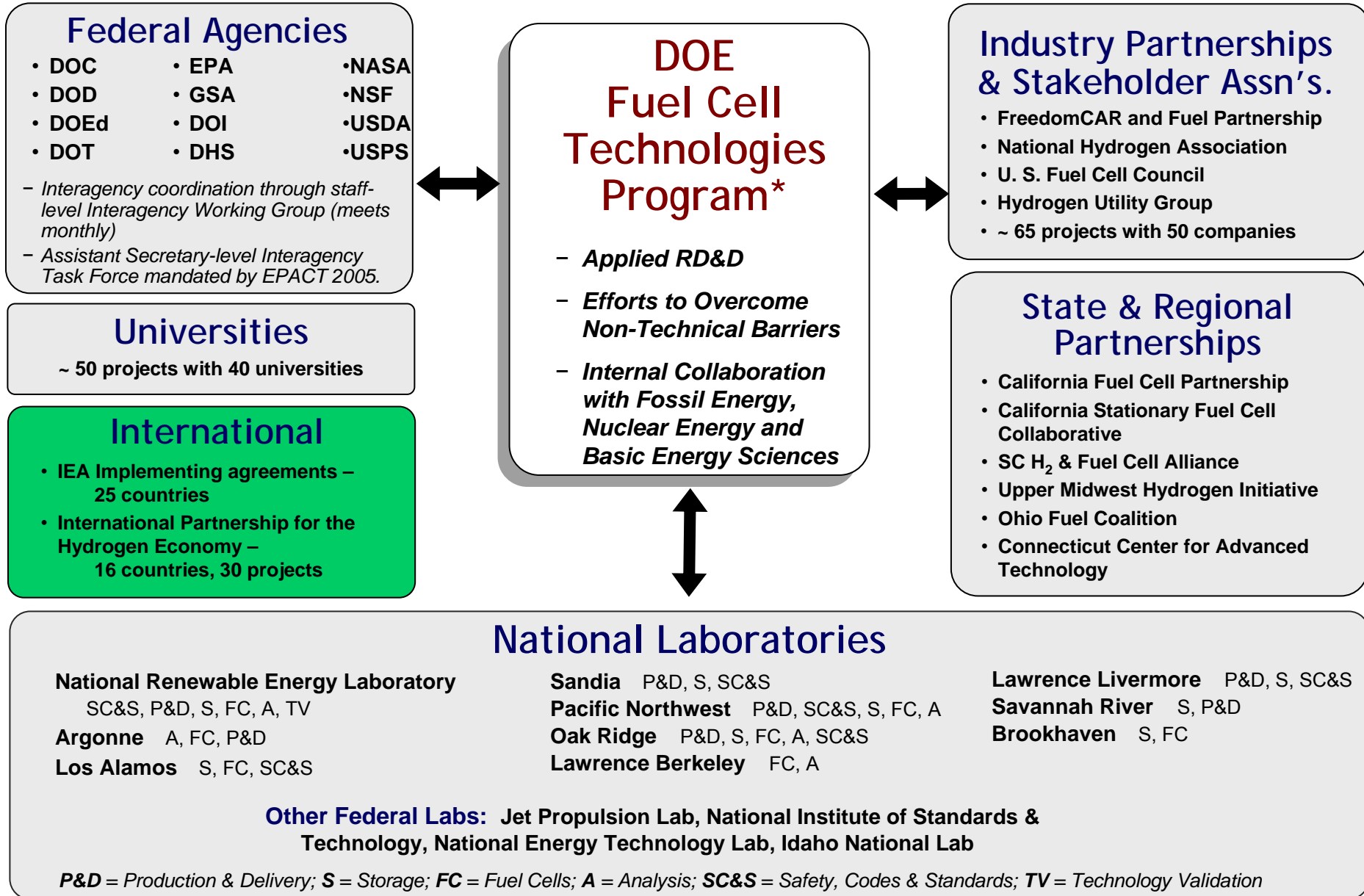


Total FY11 Budget Request \$256 Million



*NE request TBD, \$5M represents FY10 funding

**SC Includes BES and BER





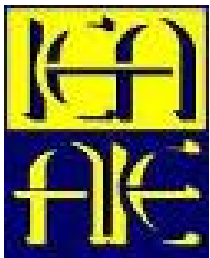
International Partnership for Hydrogen and Fuel Cells in the Economy

- **Representatives from 17 member countries & the European Commission**
- **Facilitates international collaboration on RD&D and education**
- **Provides a forum for advancing policies and common codes and standards**
- **Guided by four priorities:**
 1. Accelerating market penetration and early adoption of hydrogen and fuel cell technologies and their supporting infrastructure
 2. Policy and regulatory actions to support widespread deployment
 3. Raising the profile with policy-makers and public
 4. Monitoring technology developments

Recent Activities:

- IPHE Infrastructure Workshop (Sacramento, 2010)
- Published Demonstration and Deployment Map
- Published Communiqué on the opportunities associated with using hydrogen and fuel cell technologies
- Developing a brochure on the status of research and commercialization of H2 and FCs
- Fuel Cell Cost Analysis Comparison Published

Website: <http://www.iphe.net>



International Energy Agency – Implementing Agreements

Advanced Fuel Cells Implementing Agreement: 19 member countries currently implementing six annexes

Hydrogen Implementing Agreement: 21 member countries, plus the European Commission currently implementing nine tasks

Other Collaborations

Joint Technology Initiative (JTI); MOUs (NEDO-AIST-LANL); Bi-lateral agreements

Hydrogen Posture Plan

An Integrated Research, Development and Demonstration Plan

Fuel Cell Program Plan

Outlines a plan for fuel cell activities in the Department of Energy

- **Replacement for current Hydrogen Posture Plan**
- **To be released in 2010**

Annual Merit Review Proceedings

Includes downloadable versions of all presentations at the Annual Merit Review

→ **Latest edition released June 2010**

www.hydrogen.energy.gov/annual_review10_proceedings.html

Annual Merit Review & Peer Evaluation Report

Summarizes the comments of the Peer Review Panel at the Annual Merit Review and Peer Evaluation Meeting

→ **Latest edition released October 2009**

www.hydrogen.energy.gov/annual_review08_report.html

Annual Progress Report

Summarizes activities and accomplishments within the Program over the preceding year, with reports on individual projects

→ **Latest edition published November 2009**

www.hydrogen.energy.gov/annual_progress.html

Next Annual Review: May 9 – 13, 2011

Washington, D.C.

<http://annualmeritreview.energy.gov/>

The Business Case for Fuel Cells: Why Top Companies are Purchasing Fuel Cells Today

By FuelCells2000
<http://www.fuelcells.org>

38 companies profiled in the report,
cumulatively, have ordered, installed or
deployed:

- more than 1,000 fuel cell forklifts;
- 58 stationary fuel cell systems totaling almost 15MW of power;
- more than 600 fuel cell units at telecom sites.

See report:
<http://www.fuelcells.org/BusinessCaseforFuelCells.pdf>



Thank you

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www.hydrogenandfuelcells.energy.gov