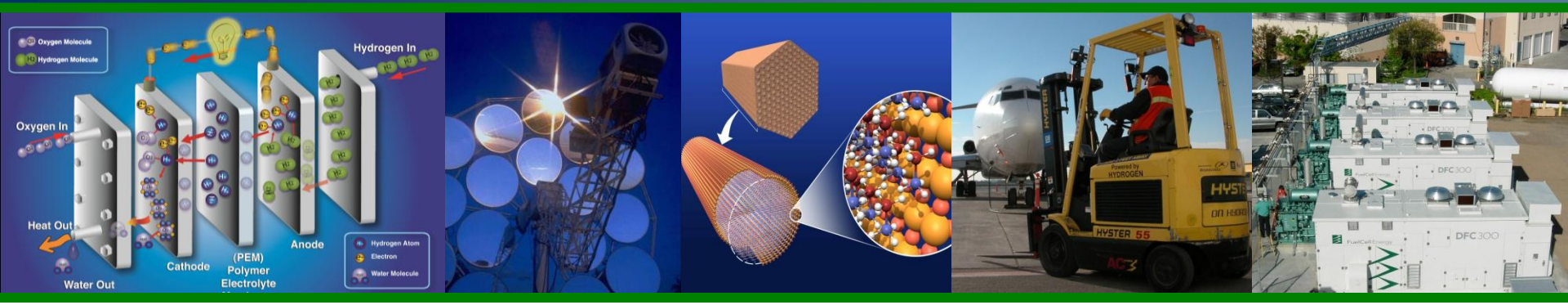
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



U.S. DOE Hydrogen and Fuel Cell Activities

Dr. Sunita Satyapal

Program Manager

Antonio Ruiz

Safety, Codes and Standards Lead

Fuel Cell Technologies Program

International Technical Forum on CNG and Hydrogen Fuels Vehicles

Beijing, People's Republic of China

September 27, 2010

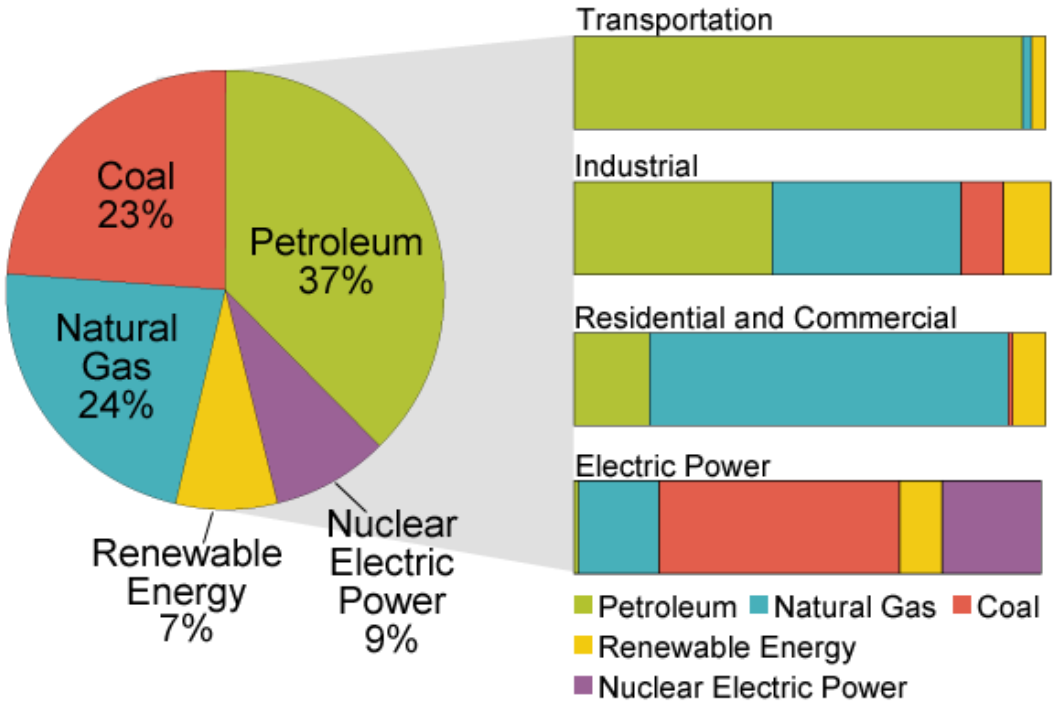
Administration's Clean Energy Goals

- ✓ 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

Source: US DOE 09/2010

U.S. Energy Consumption

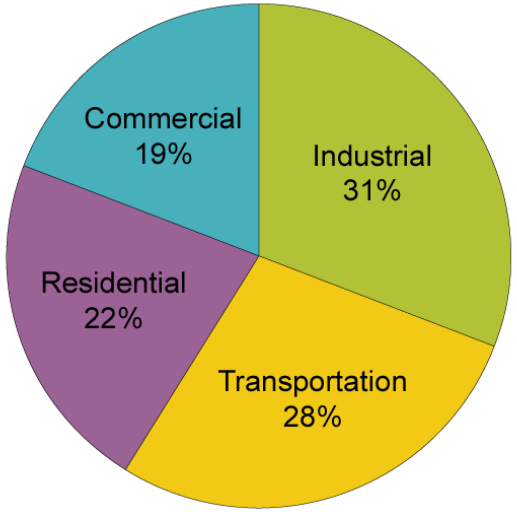
U.S. Primary Energy Consumption by Source and Sector



Total U.S. Energy = 99.3 Quadrillion Btu

Source: Energy Information Administration, *Annual Energy Review 2008*, Tables 1.3, 2.1b-2.1f.

Share of Energy Consumed by Major Sectors of the Economy, 2008



Source: Energy Information Administration, *Annual Energy Review 2008*.

Source: US DOE 09/2010

Fuel Cells: *Addressing Energy Challenges*

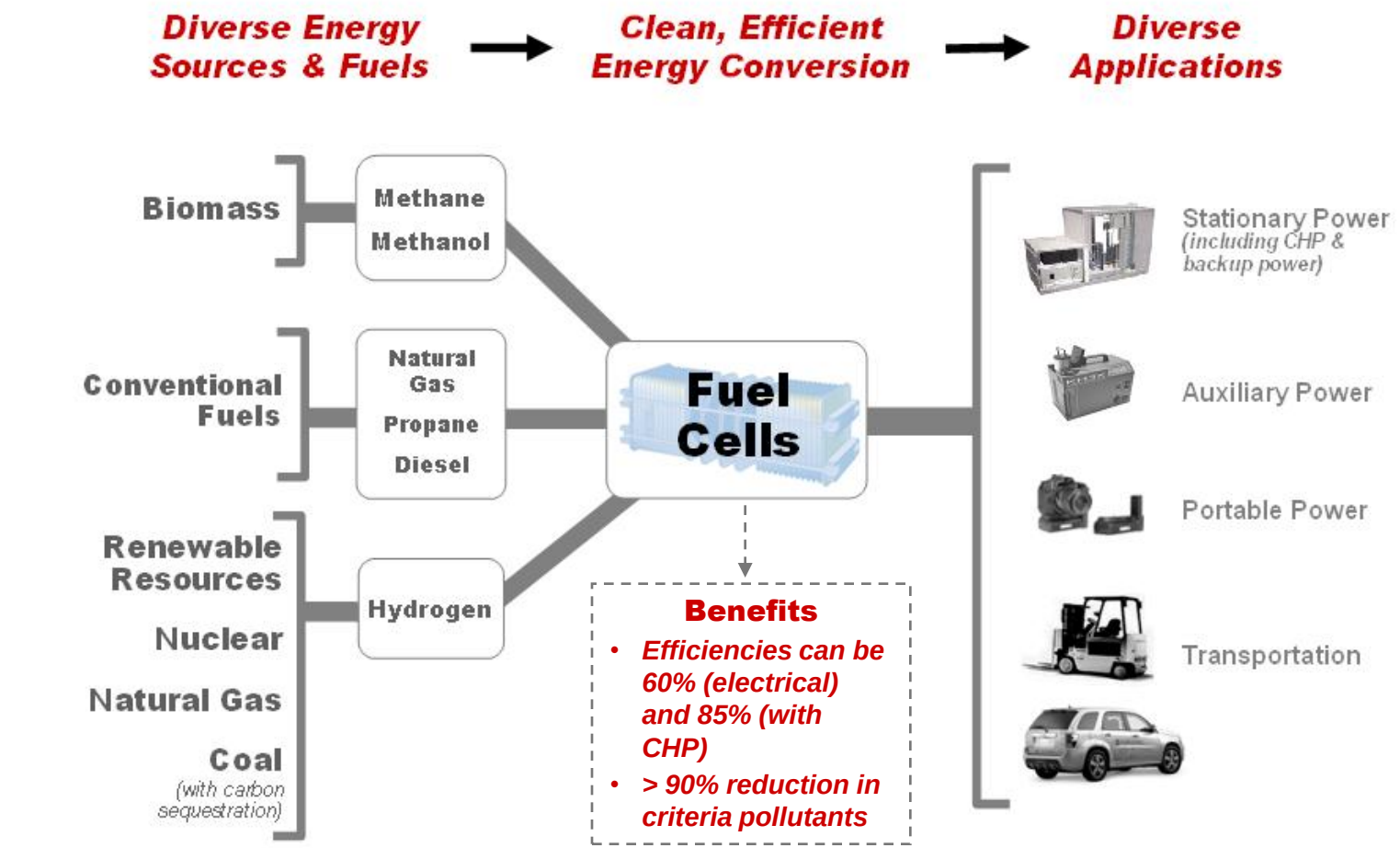
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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*



Source: US DOE 09/2010

Fuel Cells — *Where are we today?*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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 United States:

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

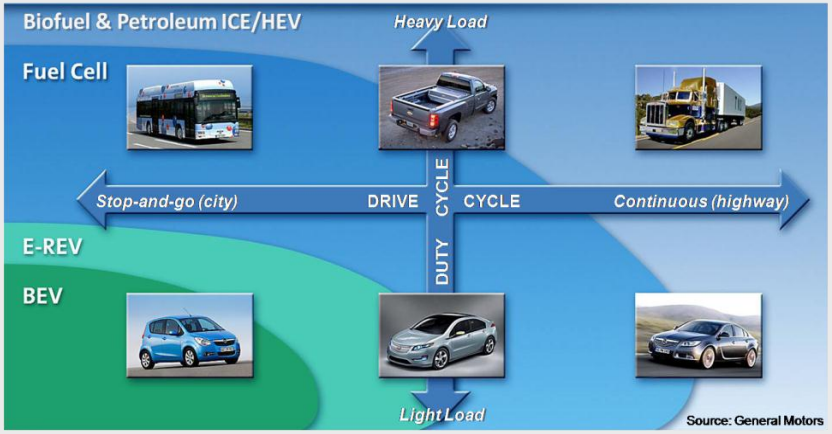
Several manufacturers—including Toyota, Honda, Hyundai, Daimler, GM, and Proterra (buses) — have announced plans to commercialize vehicles by 2015

Production & Delivery of Hydrogen

In the U.S., there are currently:

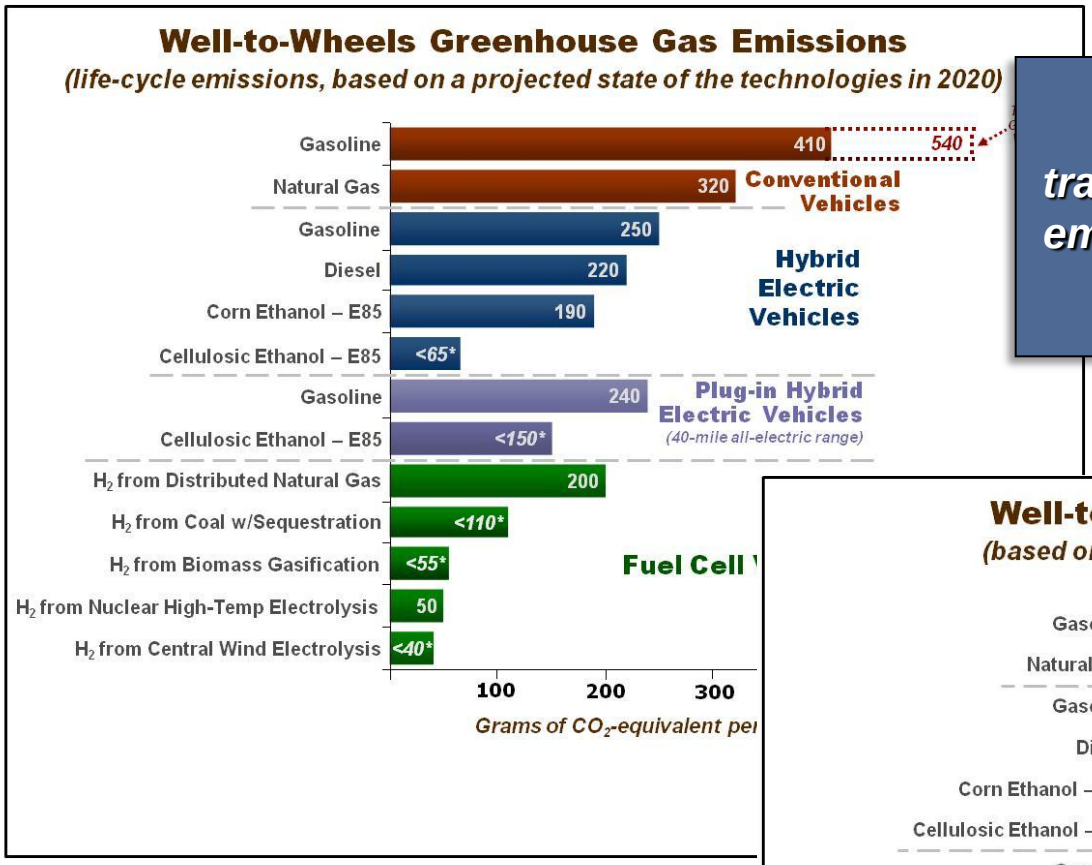
- ***~9 million metric tons** of H_2 produced annually*
- ***> 1,200 miles** of H_2 pipelines*

The Role of Fuel Cells in Transportation

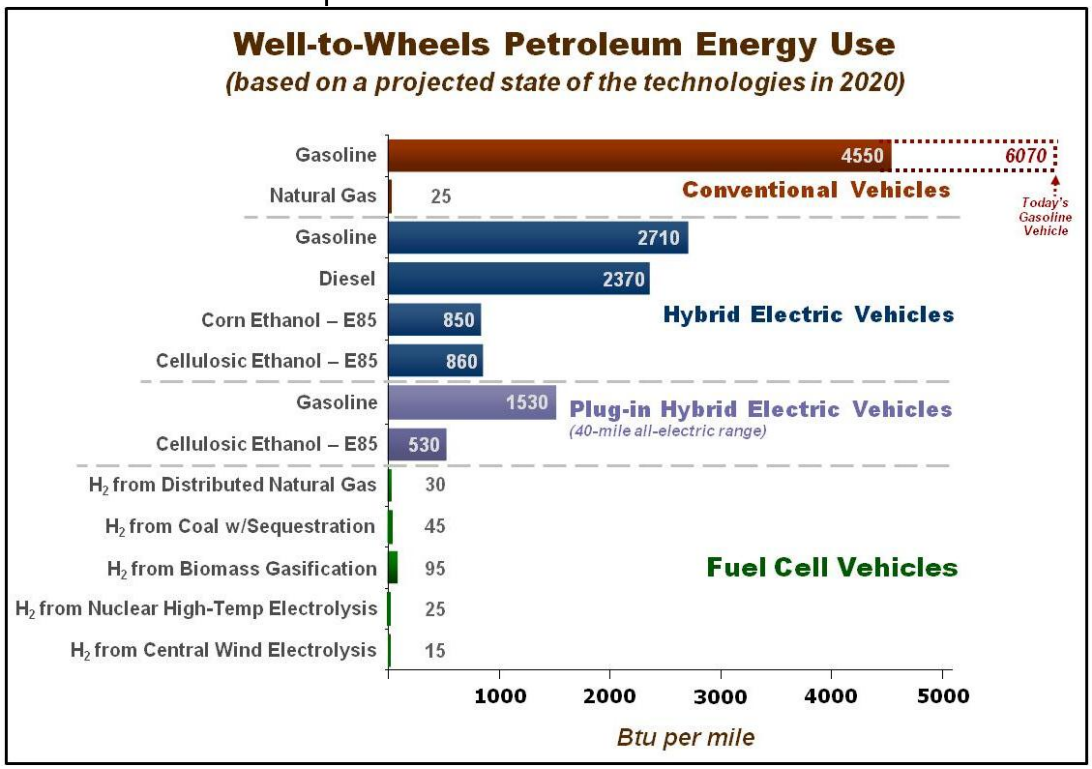


Source: US DOE 09/2010

Systems Analysis — *Examples of Benefits*



Analysis shows DOE's portfolio of transportation technologies will reduce emissions of greenhouse gases and oil consumption



DOE Program Record #9002,
www.hydrogen.energy.gov/program_records.html.

Source: US DOE 09/2010

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

Economic & Institutional Barriers

- Safety, Codes & Standards Development
- Domestic Manufacturing & Supplier Base
- Public Awareness & Acceptance
- Hydrogen Supply & Delivery Infrastructure

Market Transformation

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

* Targets and Metrics are being updated in 2010.

Source: US DOE 09/2010

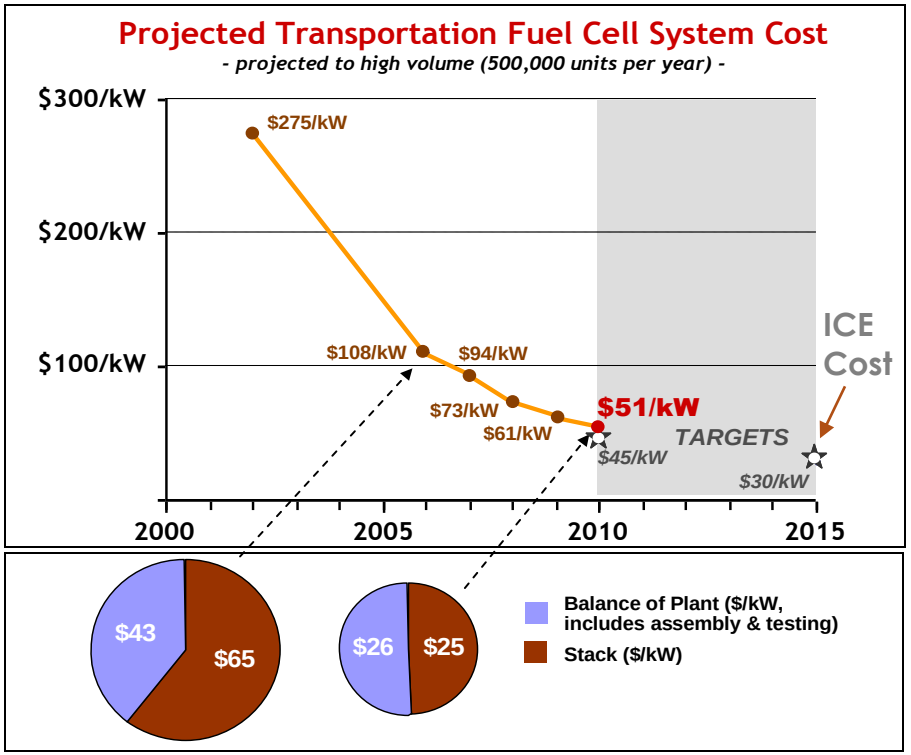
Fuel Cell R&D — *Progress: Cost*

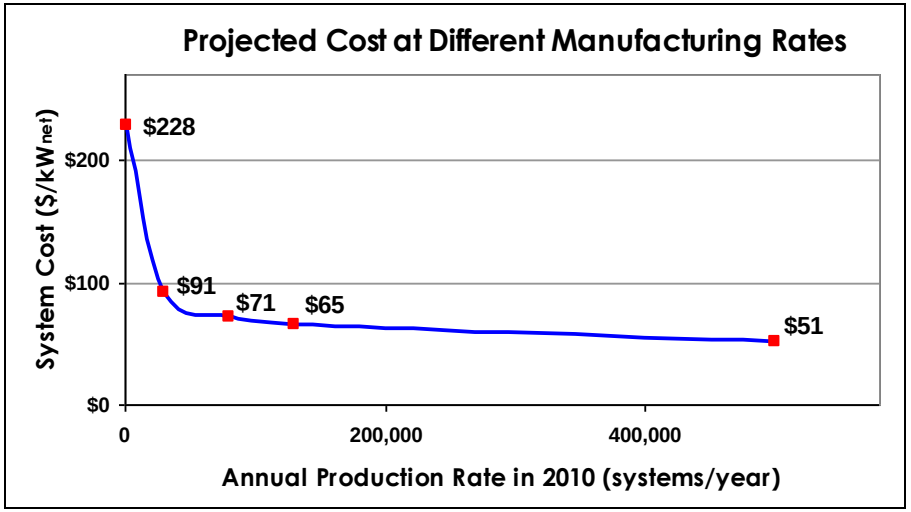
U.S. DEPARTMENT OF ENERGY

Projected high-volume cost of fuel cells has been reduced to $51/kW (2010)*

- *More than 15% reduction since 2009*
- *More than 80% reduction since 2002*
- ***2008 cost projection was validated by independent panel*****

As stack costs are reduced, balance-of-plant components are responsible for a larger % of costs.





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

**Panel found $60 – $80/kW to be a "valid estimate": http://hydrogendoedev.nrel.gov/peer_reviews.html

Source: US DOE 09/2010

Technology Validation
2010 Vehicles Progress & Accomplishments

U.S. DEPARTMENT OF ENERGY

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- H_2 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)
  - H_2 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

Source: US DOE 09/2010

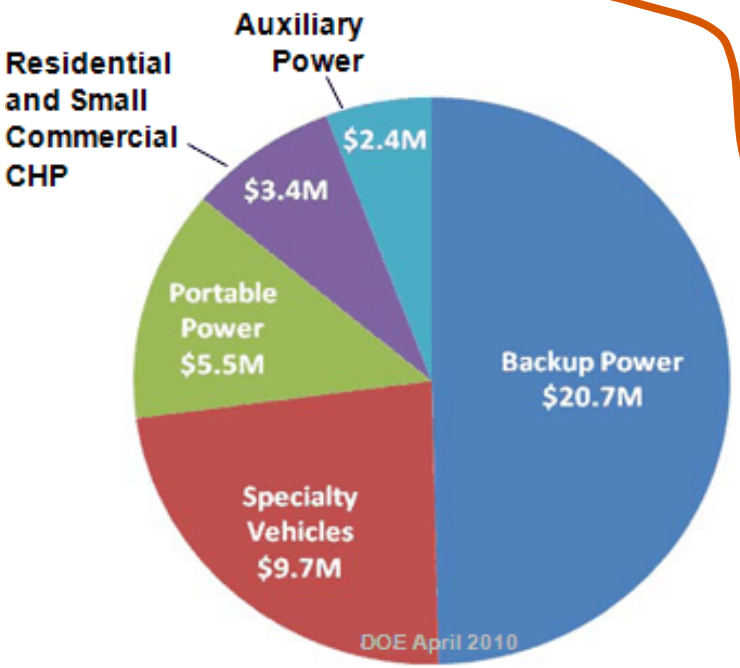
Recovery Act Funding for Fuel Cells

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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



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

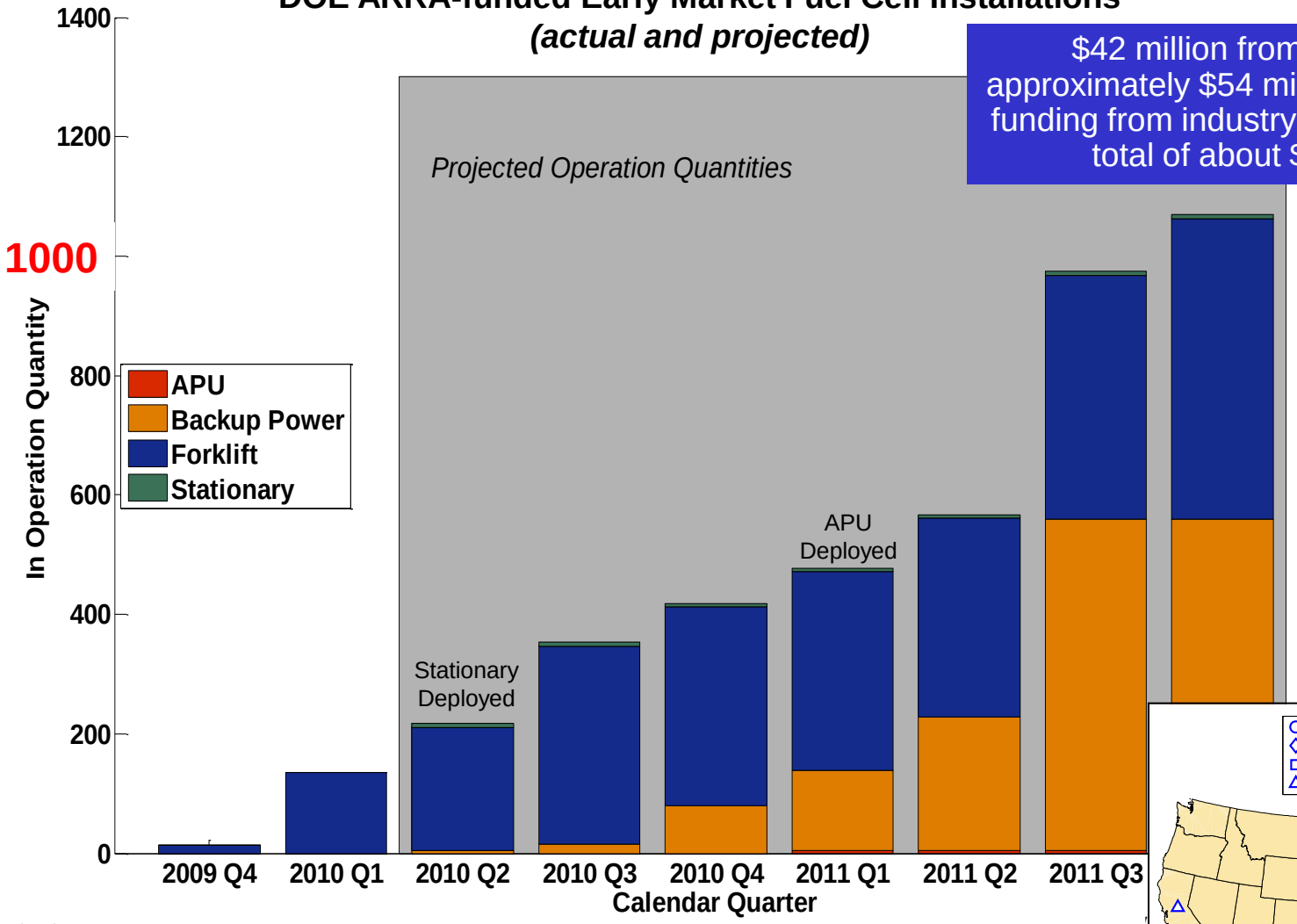
COMPANY	AWARD	APPLICATION
Delphi Automotive	$2.4 M	Auxiliary Power
FedEx Freight East	$1.3 M	Specialty Vehicle
GENCO	$6.1 M	Specialty Vehicle
Jadoo Power	$2.2 M	Backup Power
MTI MicroFuel Cells	$3.0 M	Portable
Nuvera Fuel Cells	$1.1 M	Specialty Vehicle
Plug Power, Inc. (1)	$3.4 M	CHP
Plug Power, Inc. (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

Source: US DOE 09/2010

ARRA Fuel Cell Units in Operation

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

$42 million from ARRA with approximately $54 million in cost-share funding from industry participants for a total of about $96 million



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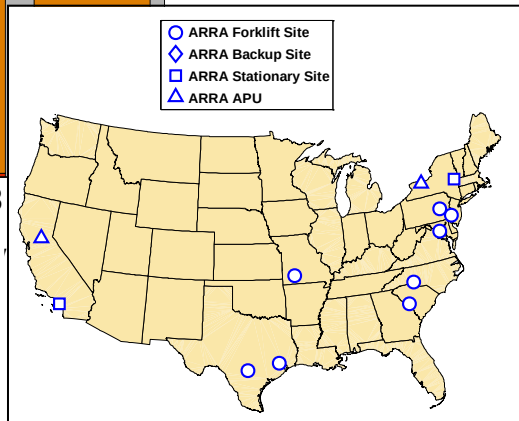


From National Renewable Energy Laboratory

Source: US DOE 09/2010

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

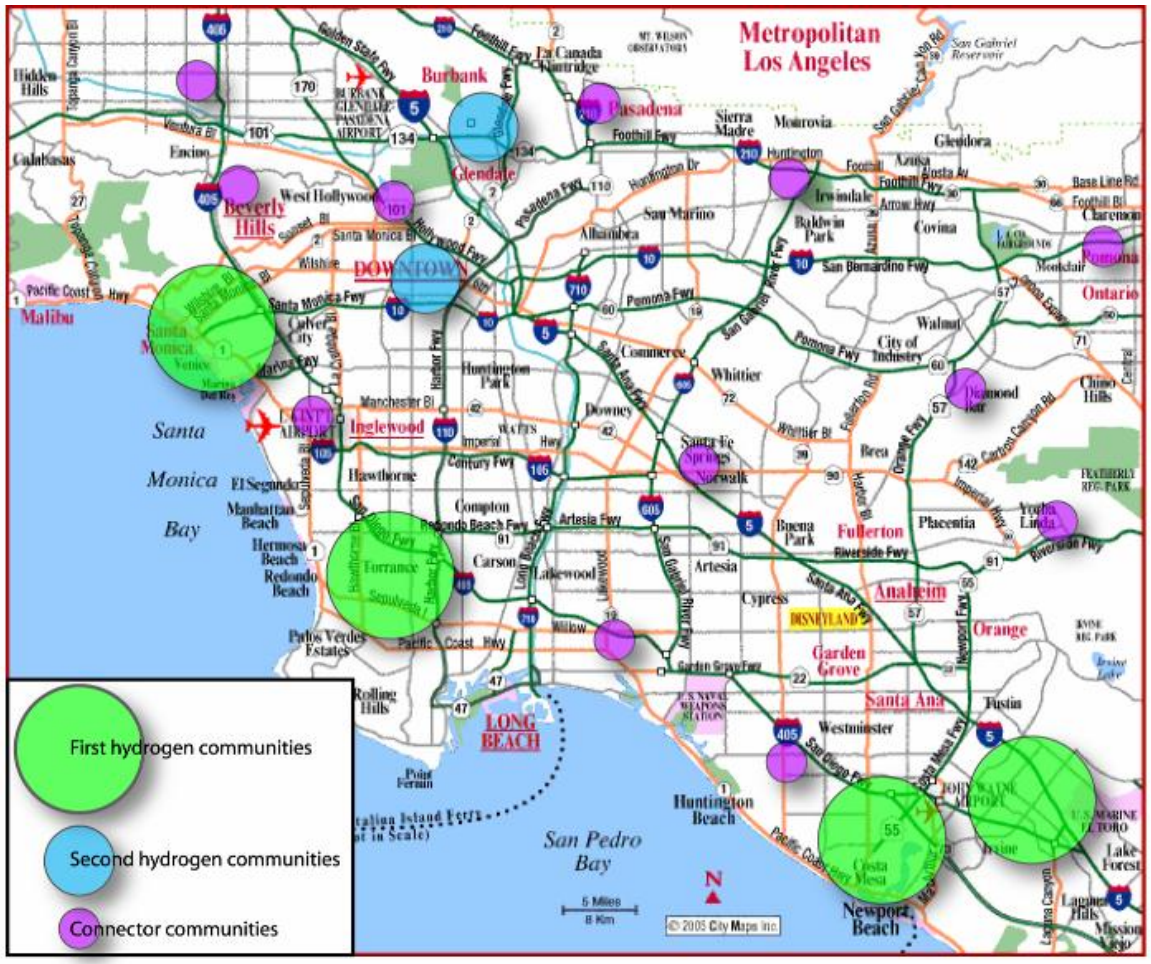
Source: US DOE 09/2010

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 H_2 Communities in Southern California



http://www.fuelcellpartnership.org/

Source: US DOE 09/2010

Education

The DOE Program is working to increase public awareness and understanding of hydrogen and fuel cell technologies.

ACTIVITIES

Educate target audiences to facilitate near-term demonstration, commercialization, and long-term market acceptance

Focus on high-priority audiences:

- *Safety & code officials*
- *Local communities*
- *State & local government officials*
- *End-users/early adopters*
- *Students*

PROGRESS

- **Launched advanced first responder training with hands-on prop (original online course has had > 17,000 users since its launch)**
- **Conducted more than 80 workshops to help state and local leaders identify deployment opportunities**
- **Launched "Introduction to Hydrogen for Code Officials" web course**
- **Trained more than 8,000 middle school and high school teachers**
- **25 courses and modules under development at 5 universities**
- **Conducted educational seminars for lift-truck users**
- **Developed fact sheets and case studies**

Source: US DOE 09/2010

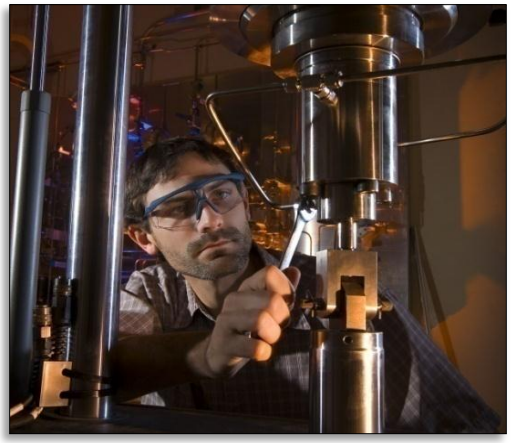
Objectives

- Support critical R&D for the development of scientifically and technically sound codes and standards that enable the safe use of hydrogen and fuel cell technologies and facilitate harmonization of domestic and international regulation, codes and standards (RCS).

- Develop and implement safety practices and procedures to ensure the safe operation, handling and use of hydrogen and fuel cell technologies.

Source: US DOE 09/2010

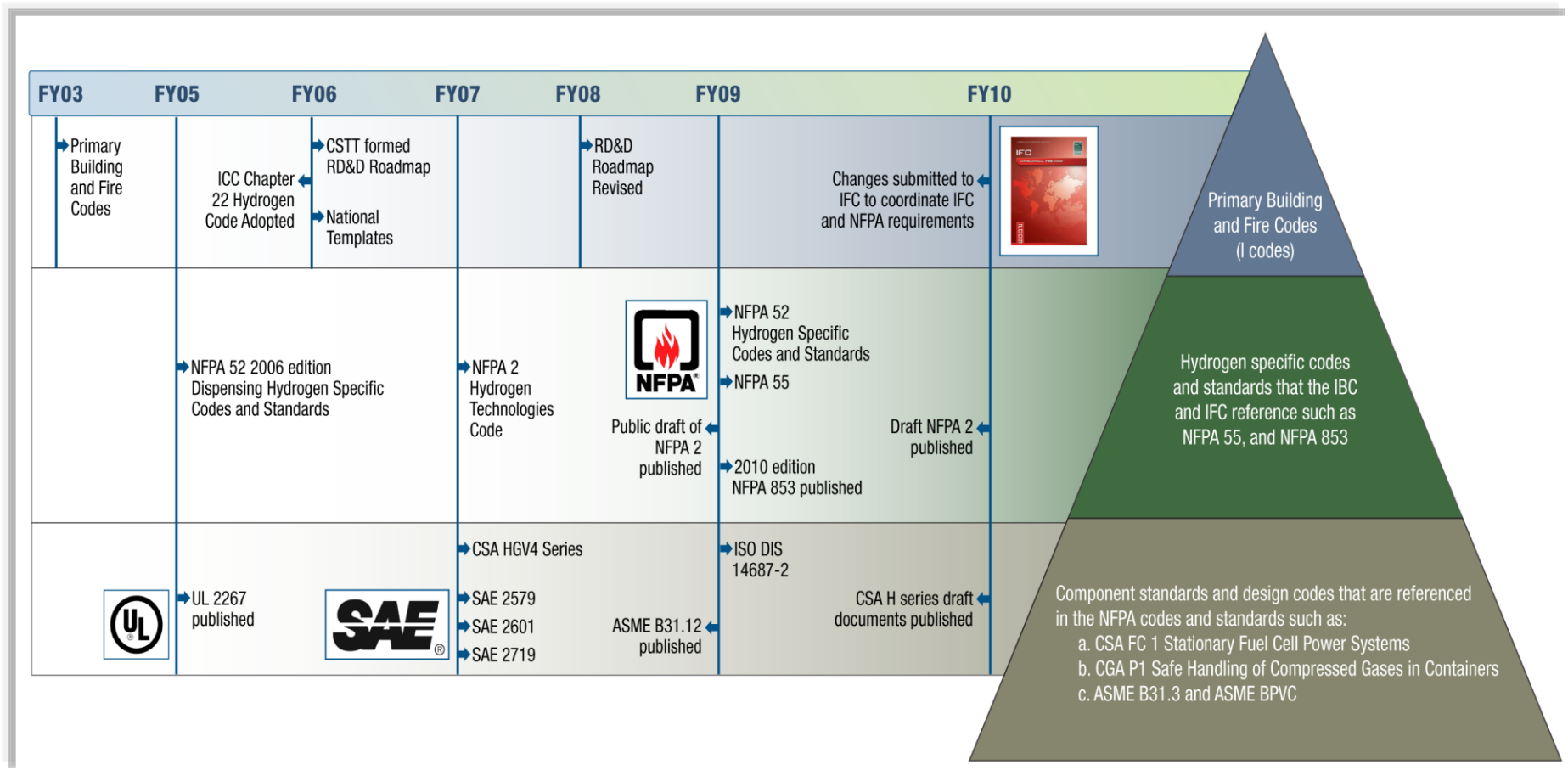
Challenges



- To synchronize codes and standards development and adoption with technology commercialization needs
- To coordinate enabling R&D with the codes and standards development cycle
- To promote domestic and international consistency
- To make approved codes and standards readily available
- To streamline and standardize the permitting process for hydrogen facilities
- To minimize knowledge gaps by disseminating safety information
- To generate hydrogen safety information due to lack of available data

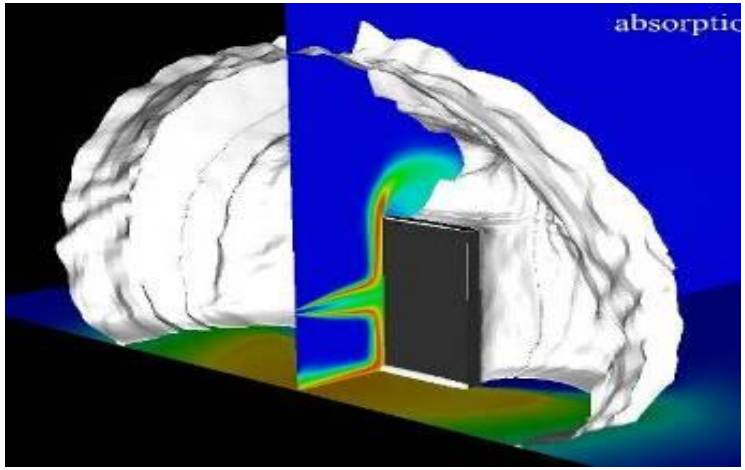
Source: US DOE 09/2010

Timeline of Hydrogen Codes and Standards



Source: US DOE 09/2010

Separation Distances



Barrier walls reduce separation distances – simulated position of allowable heat flux iso-surface for 3-minute employee exposure (2009 IFC).

- Provided technical data and incorporated risk-informed approach that enabled NFPA2 to update bulk gas storage separation distances in the 2010 edition of NFPA55
- Quantified how barrier walls can reduce hazards leading to fifty percent distance reduction credit
- Technical data and methodology are published in archival documents

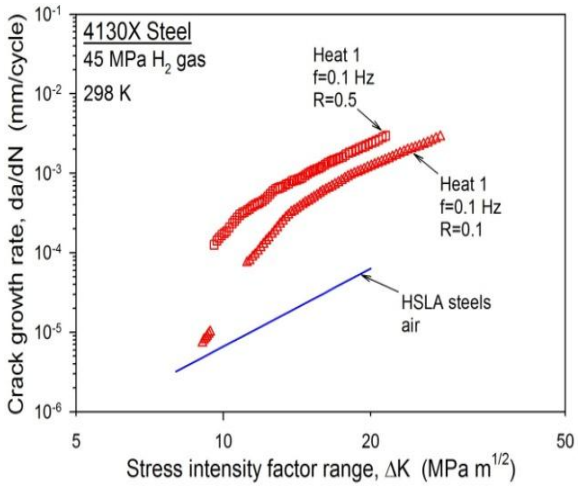
Sample Table

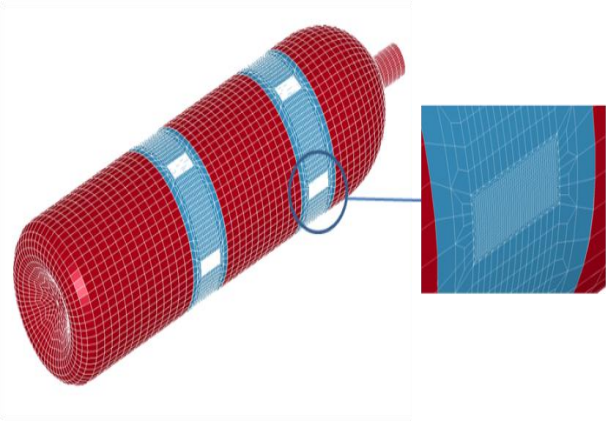
Exposure	NFPA 2005 Separation Distance	NFPA 2010 Separation Distance
Lot Lines	5 ft	10 ft
Air intakes (HVAC, compressors, other)	50 ft	10 ft
Ignition sources such as open flames or welding	25 ft	10 ft
Flammable Gas storage systems - non-bulk - bulk	 10 ft 10 ft or 25 ft	 5 ft 15 ft
Ordinary combustibles	50 ft	5 ft

Source: US DOE 09/2010

U.S. DEPARTMENT OF ENERGY

Materials and Components Compatibility





Online Technical Reference

Table of Contents

Designation	Nominal composition	Code	Revision date
Introduction		INTR	(3/08)
Plain Carbon Ferritic Steels			
C-Mn Alloys	Fe–C–Mn	1100	(5/07)
Low-Alloy Ferritic Steels			
Quenched & Tempered Steels			
Cr-Mo Alloys	Fe–Cr–Mo	1211	(12/05)
Ni-Cr-Mo Alloys	Fe–Ni–Cr–Mo	1212	(12/05)
High-Alloy Ferritic Steels			
High-Strength Steels			
9Ni-4Co	Fe–9Ni–4Co-0.20C	1401	(1/05)
Ferritic Stainless Steels	Fe–15Cr	1500	(10/06)
Duplex Stainless Steels	Fe–22Cr–5Ni+Mo	1600	(9/08)
Semi-Austenitic Stainless Steels	Fe–15Cr–7Ni	1700	(3/08)
Martensitic Stainless Steels			
Precipitation-Strengthened	Fe–Cr–Ni	1810	(3/08)
Heat Treatable	Fe–Cr	1820	(6/08)
Austenitic Steels			
300-Series Stainless Alloys			
Type 304 & 304L	Fe–19Cr–10Ni	2101	(5/05)
Type 316 & 316L	Fe–18Cr–12Ni+Mo	2103	(3/05)
Type 321 & 347	Fe–18Cr–10Ni + Ti/Nb	2104	(12/08)

- Completed report of fracture threshold measurement of tank steels to enable revision of same kd-10
- Completed testing to enable deployment of 100 MPa stationary storage tanks
- Performed testing of forklift tank materials to enable design qualification
- Added two additional Nickel alloy chapters to the Technical Reference
- Forklift tank lifecycle testing program underway to support the development of CSA HPIT1

www.sandia.gov/hydrogen/research/safetyCodesStandards

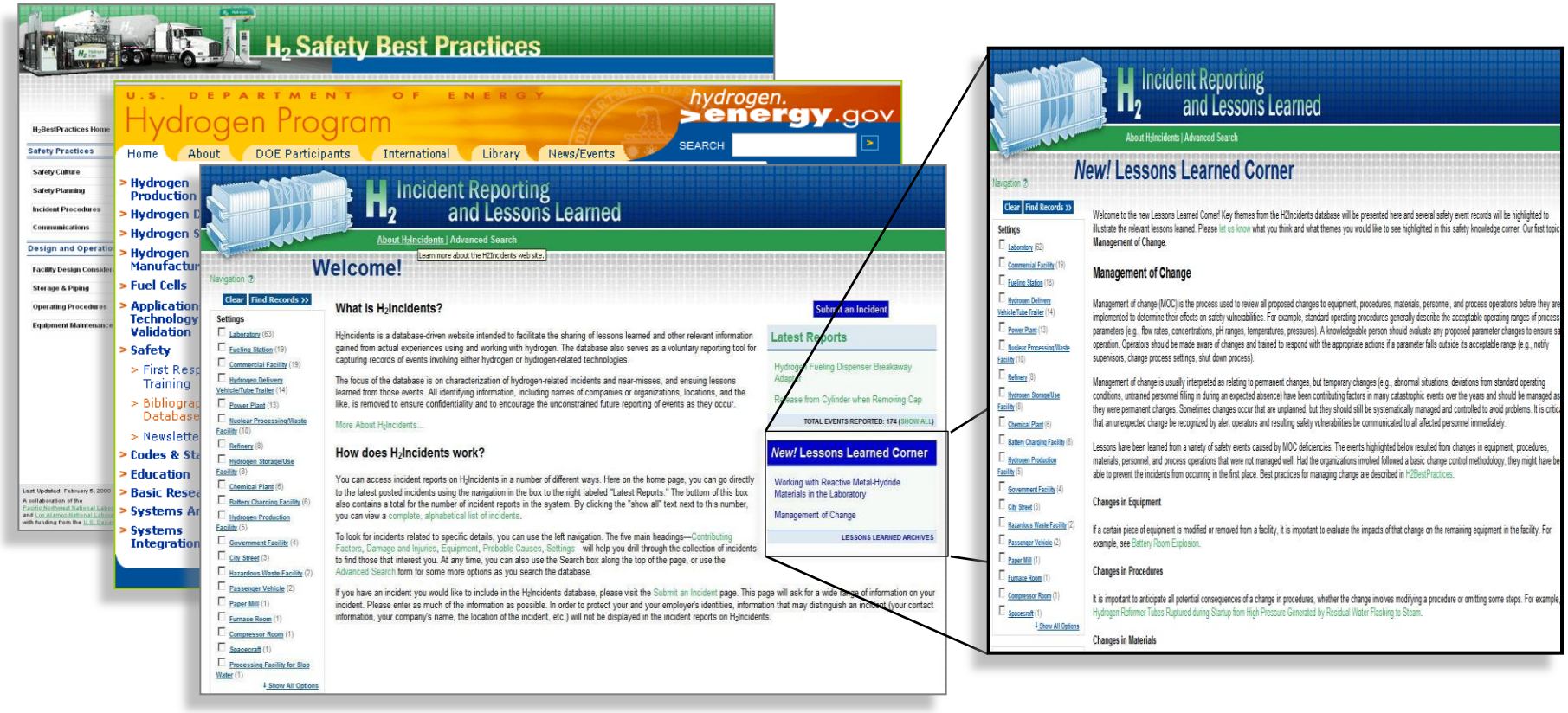
Source: US DOE 09/2010

U.S. DEPARTMENT OF ENERGY

Hydrogen Safety Knowledge Tools

Expanded and Improved Safety Databases

H2 Lessons Learned Corner



Source: US DOE 09/2010

www.hydrogenandfuelcells.energy.gov/codes

U.S. DEPARTMENT OF ENERGY

Hydrogen Safety Training for First Responders

First Responder Education

- Completed upgrade of web-based Introduction to Hydrogen Safety for First Responders – averaging 300-500 unique visits/month for a total of 17,000 visits since January 2007
- Held two pilot courses for the advanced-level, prop-based course at the Hazardous Materials Management and Emergency Response (HAMMER) training center
- Held three official deployments of the advanced-level, prop-based reaching 90 students from 18 states.

www.hydrogen.energy.gov/firstresponders.html

Source: US DOE 09/2010

Workshop

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Compressed Natural Gas (CNG), Hydrogen and Hydrogen Blend Workshop

To promote the exchange of information among experts on CNG, hydrogen and hydrogen blend fuels for vehicles and to share

Washington, D.C. December 10-11, 2009

Workshop Objectives:

1. Share safety requirements and regulatory framework in each country to harmonize domestic and international codes and standards
2. Collect data and information from demonstration activities and real-world applications in Canada, Brazil, China, India and the U.S.
3. Discuss safety and testing of storage tanks and identify research, regulations, codes and standards needed to ensure their safe use
4. Compare properties, behavior and R&D efforts for CNG, hydrogen and hydrogen blend (HCNG) fuels
5. Conduct follow-up workshops, conduct collaborative R&D & testing, share hydrogen roadmaps and education and training plans

Workshop Outcomes: *Brazil, Canada, China, India and the U.S. will identify projects and activities to collaborate in the following areas:*

1. R&D and Testing: Conduct life cycle tests and analysis of high-pressure CNG and hydrogen tanks
2. Codes and Standards: Harmonize regulations, codes and standards for CNG, hydrogen and HCNG vehicles & fueling facilities
3. Education and Training: Conduct programs to train labor force & increase education and outreach
4. Regulations: Encourage participation in international forums and the development of Global Technical Regulations (GTR) for hydrogen fueled vehicle

Source: US DOE 09/2010

www.hydrogenandfuelcells.energy.gov/wkshp_cng_and_h2.html

U.S. DEPARTMENT OF ENERGY

Onboard Storage Tank Workshop

To coordinate R&D, regulations and codes and standards to qualify and enable the deployment of hydrogen storage tanks.

Sandia National Laboratories, Livermore, CA April 29, 2010

Workshop Objectives:

1. Provide initial follow up to the DOE-DOT Workshop on Lessons Learned for Use of CNG, Hydrogen and HCNG Fuels in Vehicles
2. Address specific technical topics from the DOE-DOT Workshop in more detail – including pressure relief device (PRD) testing; tank service life cycle testing, monitoring, and enforcement of inspection requirements
3. Discuss harmonization of key international regulations and codes and standards for on-board hydrogen tanks, including SAE J2579, ISO and Global Technical Regulations (GTR) for hydrogen fueled vehicles

Workshop Outcomes:

1. Potential refinements to tank testing protocols to better address service life and possible failure modes
2. Proposals to monitor, inspect and enforce service life requirements of high-pressure gaseous tanks
3. Identification of priorities for hydrogen component certification
4. Discussion of Non Destructive Evaluation (NDE) methods to monitor safety of tanks during service and for recertification of tanks
5. Confirmation of industry interest in validating 70MPa fast-fill model

NASA CSA STANDARDS Clean Vehicle Education Foundation Sandia National Laboratories

Source: US DOE 09/2010

Other Presenters: California Dept. of Agriculture, Division of Measurement Standards; Smart Chemistry; Powertech; & Sloane Solutions

Acknowledging Partners

U.S. DEPARTMENT OF ENERGY

U.S. PARTNERSHIPS

- **FreedomCAR & Fuel Partnership:** Ford, GM, Chrysler, BP, Chevron, ConocoPhillips, ExxonMobil, Shell, Southern California Edison, DTE Energy
- **Hydrogen Utility Group:** Xcel Energy, Sempra, DTE, Entergy, New York Power Authority, Sacramento Municipal Utility District, Nebraska Public Power Authority, Southern Cal Edison, Arizona Public Service Company, Southern Company, Connexus Energy, etc.
- **State/Local Governments:** California Fuel Cell Partnership, California Stationary Fuel Cell Collaborative, co-coordinators of Bi-Monthly Informational Call Series for State and Regional Initiatives with the National Hydrogen Association and the Clean Energy Alliance
- **Industry Associations:** US Fuel Cell Council, National Hydrogen Association
- **Federal Interagency Partnerships:** Hydrogen and Fuel Cell Interagency Task Force and Working Group, Interagency Working Group on Manufacturing, Community of Interest on Hydrogen and Fuel Cell Manufacturing

INTERNATIONAL PARTNERSHIPS

International Partnership for Hydrogen and Fuel Cells in the Economy—
A partnership among 16 countries and the European Commission

International Energy Agency — Implementing Agreements

- Hydrogen Implementing Agreement — 21 countries and the European Commission
- Advanced Fuel Cells Implementing Agreement — 19 countries

Source: US DOE 09/2010

Collaborations

Federal Agencies

- DOC
- DOD
- DOEd
- DOT
- EPA
- GSA
- DOI
- DHS
- NASA
- NSF
- USDA
- USPS

- *Interagency coordination through staff-level Interagency Working Group (meets monthly)*
- *Assistant Secretary-level Interagency Task Force mandated by EPACT 2005*

Universities

~ 50 projects with 40 universities

International

- **IEA Implementing agreements – 25 countries**
- **International Partnership for the Hydrogen Economy – 16 countries, 30 projects**

DOE Fuel Cell Technologies Program*

- ***Applied RD&D***
- ***Efforts to Overcome Non-Technical Barriers***
- ***Internal Collaboration with Fossil Energy, Nuclear Energy and Basic Energy Sciences***

Industry Partnerships & Stakeholder Assn's.

- **FreedomCAR and Fuel Partnership**
- **National Hydrogen Association**
- **U. S. Fuel Cell Council**
- **Hydrogen Utility Group**
- **~ 65 projects with 50 companies**

State & Regional Partnerships

- **California Fuel Cell Partnership**
- **California Stationary Fuel Cell Collaborative**
- **SC H_2 & Fuel Cell Alliance**
- **Upper Midwest Hydrogen Initiative**
- **Ohio Fuel Coalition**
- **Connecticut Center for Advanced Technology**

National Laboratories

National Renewable Energy Laboratory P&D, S, FC, A, SC&S, TV
Argonne A, FC, P&D
Los Alamos S, FC, SC&S
Sandia P&D, S, SC&S
Pacific Northwest P&D, S, FC, A
Oak Ridge P&D, S, FC, A
Lawrence Berkeley FC, A
Lawrence Livermore P&D, S
Savannah River S, P&D
Brookhaven S, FC

Other Federal Labs: **Jet Propulsion Lab, National Institute of Standards & Technology, National Energy Technology Lab, Idaho National Lab**

P&D *= Production & Delivery;* ***S*** *= Storage;* ***FC*** *= Fuel Cells;* ***A*** *= Analysis;* ***SC&S*** *= Safety, Codes & Standards;* ***TV*** *= Technology Validation*

Source: US DOE 09/2010

* Office of Energy Efficiency and Renewable Energy

For More Information …

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 2009

www.hydrogen.energy.gov/annual_review09_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 & 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/

Source: US DOE 09/2010

Thank you

sunita.satyapal@ee.doe.gov

hydrogenandfuelcells.energy.gov

Additional Slides

Infrastructure Analysis
H_2 Infrastructure Workshop: USA, Feb. 2010

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

An infrastructure workshop was jointly organized by IPHE, CaFCP, NREL and DOE - to explore market implementation needs for H2 infrastructure development in near-term and to develop creative and practical solutions.

Objectives – to determine:

- Business cases
- Number and size of stations needed by 2018-2020
- Factors that will motivate, hinder, or prevent investments
- Possible financing scenarios
- Policies, regulations, etc.
- Opportunities for international programs to leverage their efforts

Fuel Retailers' Business Environment

- Non-traditional fuel retailers ("big box stores," etc.) gaining market dominance
- Fuel retailers make profits from their convenience stores, rather than fuel sales
- Station owners must achieve 3-5 year return on investment to justify investment
- Consumer demand and gasoline price most important factors in determining investment in alternative fuels

KEY OUTCOMES

- Develop low-cost, 100 kg/day ***starter station*** model
- ***Policies:*** including tax incentives, subsidies, gas/carbon tax, low-cost financing, and regulations
- ***Information and education campaigns:*** for legislators and public
- ***Risk Reducing Strategies:*** Public/private partnerships, insurance pool, cost-share, OEM commitments
- ***Innovative ways to boost H_2 demand:*** target fleets and other fuel cell applications, leverage natural gas industry, increase competition
- ***Novel Business Models:*** seek new methods of financing, leverage existing H_2 industry

IPHE International Partnership for the Hydrogen Economy

California Fuel Cell Partnership

NREL National Renewable Energy Laboratory

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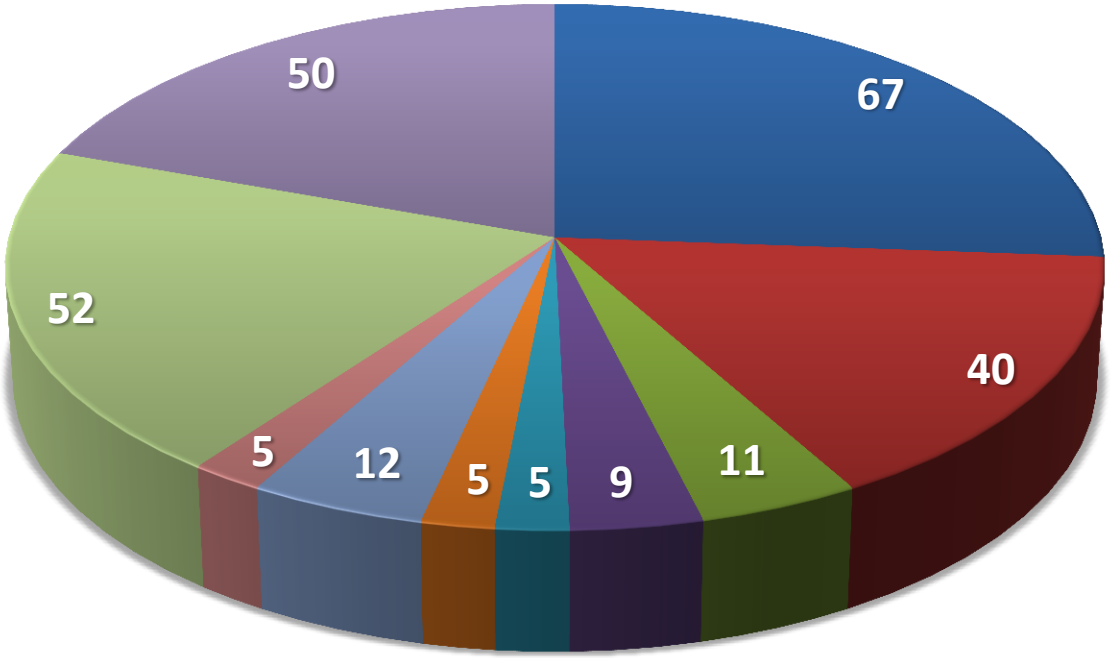
Source: US DOE 09/2010

Total DOE FY11 Budget Request

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



Total FY11 Budget Request $256 Million

Applied RD&D (EERE)
- Fuel Cell Systems R&D
- Hydrogen Fuel R&D
- Technology Validation
- Market Transformation and Safety, Codes & Standards
- Systems Analysis
- Manufacturing R&D

Other DOE
- Fossil Energy (FE)
- Nuclear Energy (NE)*
- Basic Science (SC)**

- SECA - MW SOFC (FE)

*NE request TBD, $5M represents FY10 funding
**SC Includes BES and BER

Source: US DOE 09/2010

Policies Promoting Fuel Cells

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.**

Source: US DOE 09/2010

CHHP: Promising Demonstration

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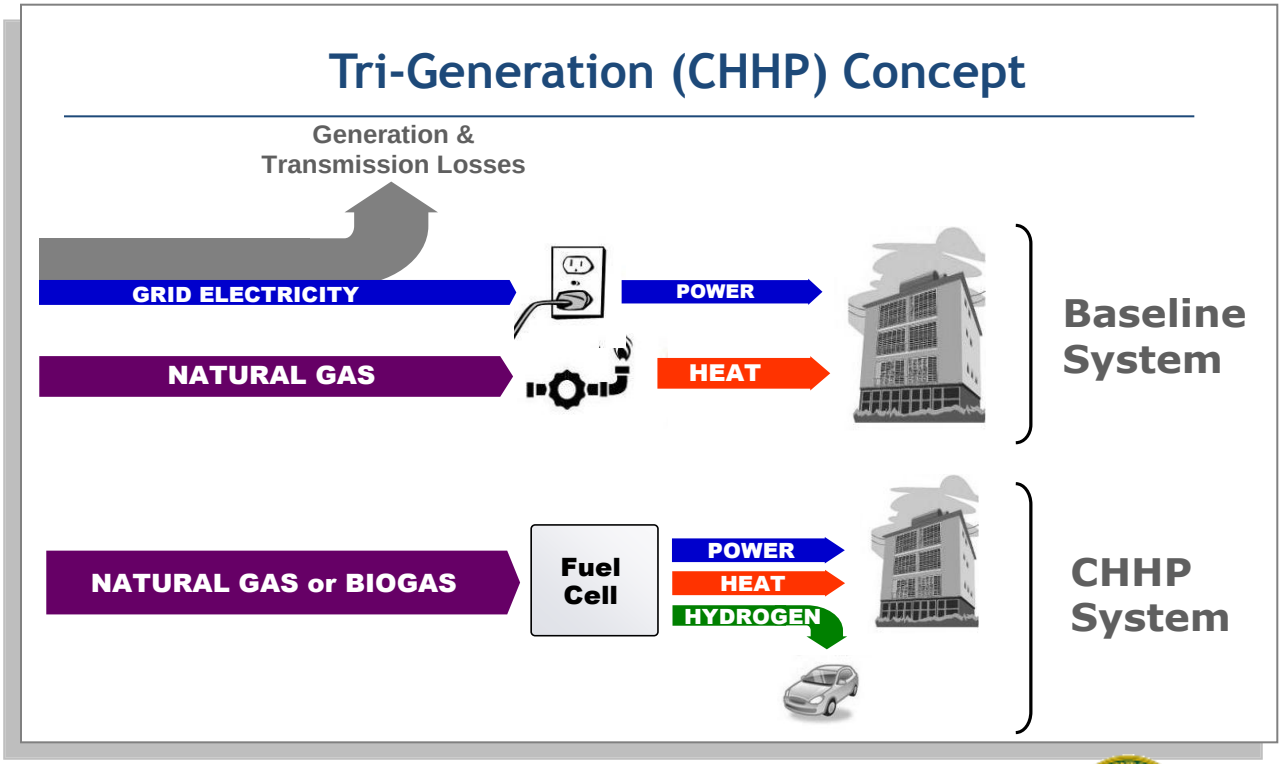
We are participating in a project to demonstrate a combined heat, hydrogen, and power (CHHP) system using biogas.

- **System has been designed, fabricated and shop-tested**
- **Improvements in design have led to higher H_2-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

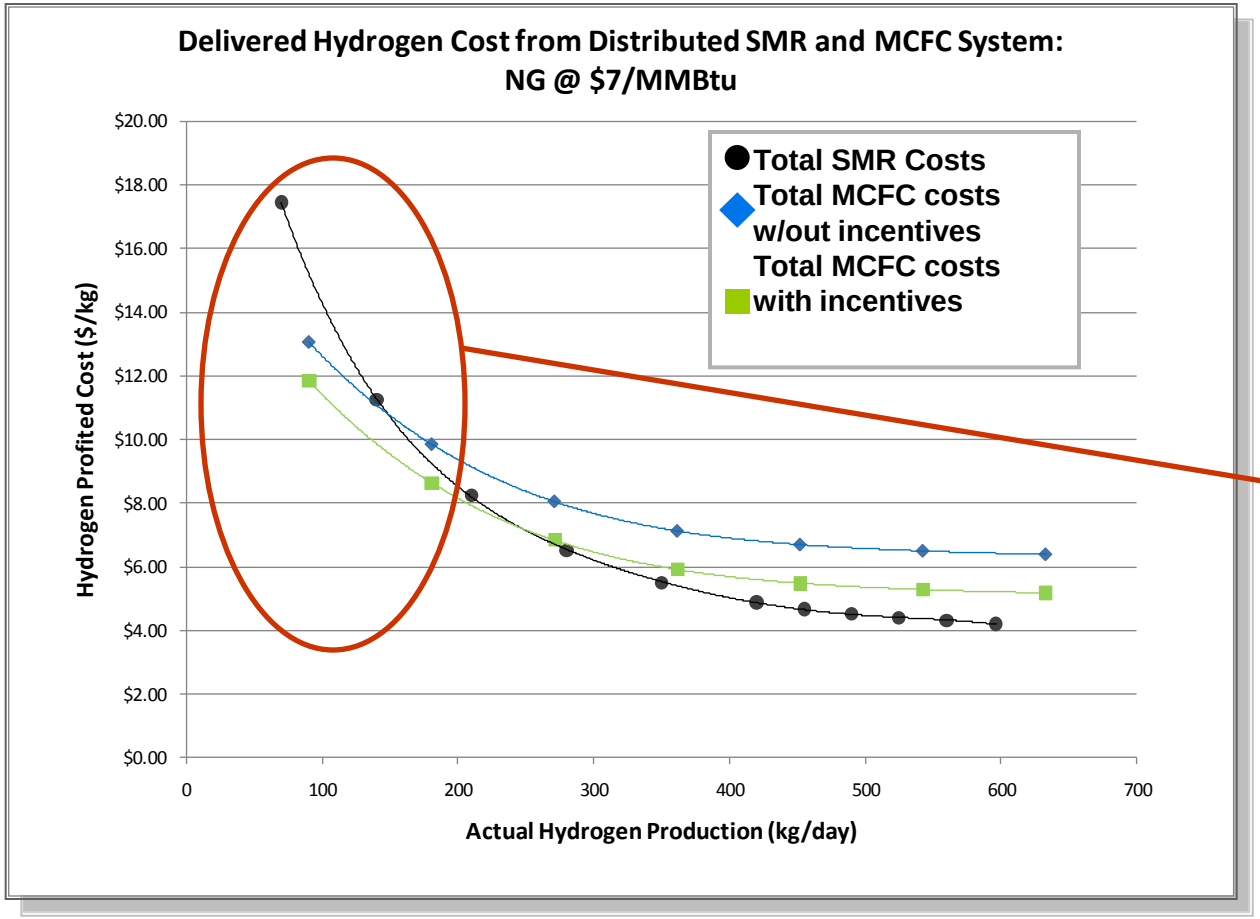
Fuel Cell Energy &

Air Products

Source: US DOE 09/2010

Infrastructure Analysis: CHHP vs. SMR

Hydrogen production costs for a stand-alone steam methane reforming (SMR) station and high-temperature CHHP application were compared. Costs are dependent on natural gas costs. CHHP applications may be more cost-effective at lower production capacities.



In cases where there is a low demand for hydrogen in early years of fuel cell vehicle deployment, CHHP may have cost advantages over on-site SMR production.

Source: Fuel Cell Power Model

Source: US DOE 09/2010

Federal Interagency Coordination

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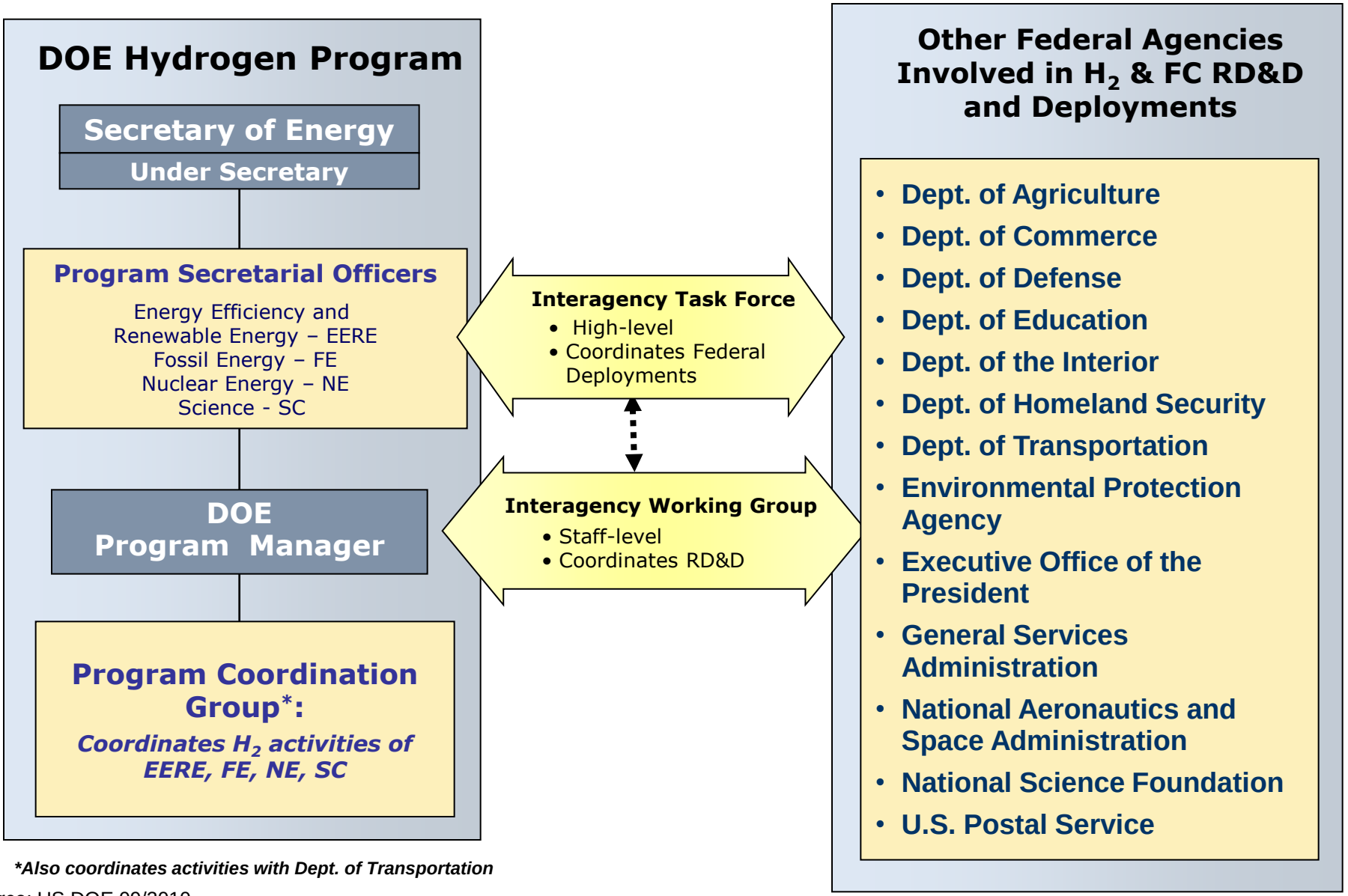
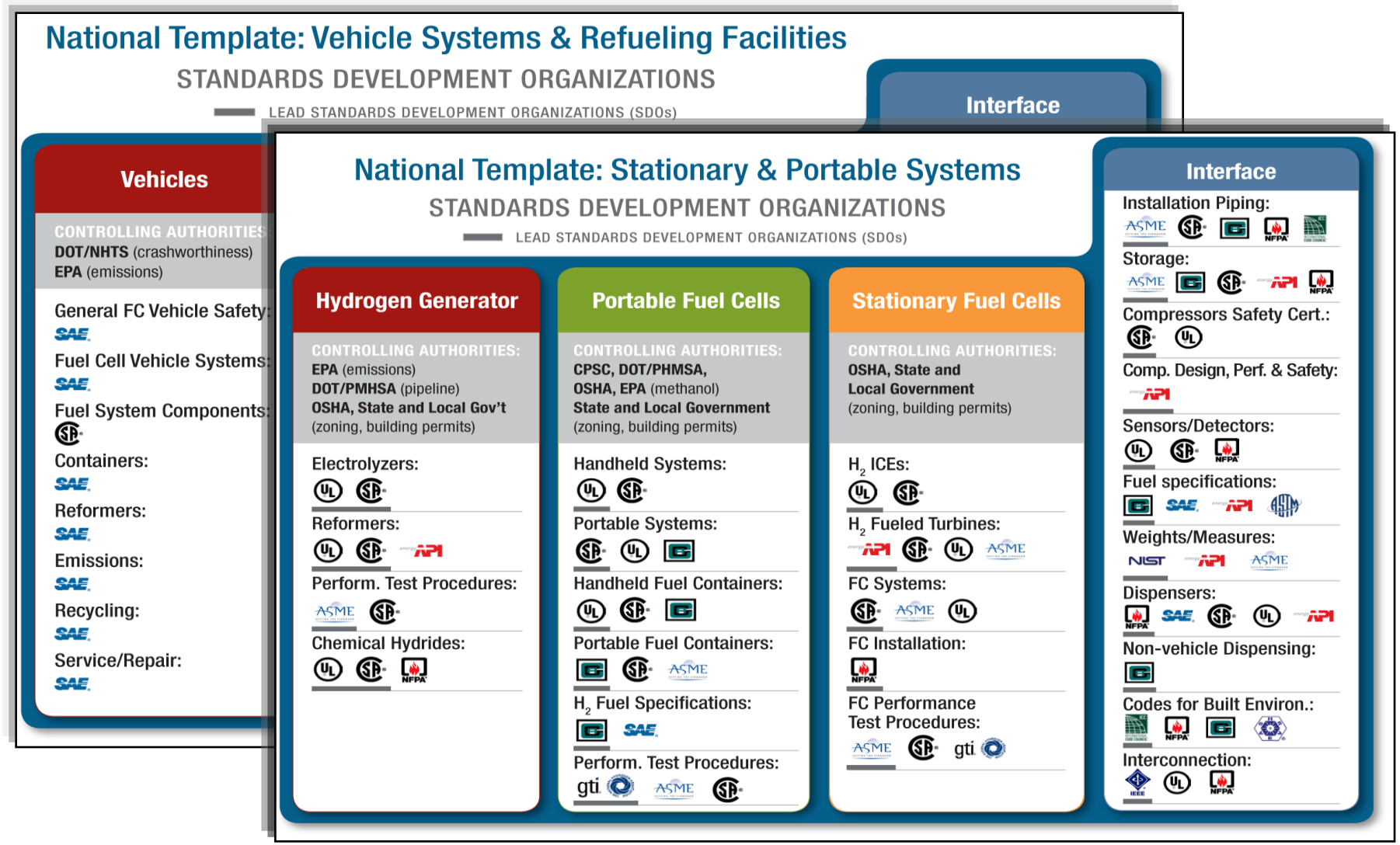


**Also coordinates activities with Dept. of Transportation*

Source: US DOE 09/2010

National Codes and Standards Template



www.hydrogenandfuelcells.energy.gov/codes/pdfs/cs_templates.pdf

Source: US DOE 09/2010

International Collaborations

International Partnership for Hydrogen and Fuel Cells in the Economy

Partnership among 18 member countries & the European Commission

International Energy Agency – Hydrogen Implementing Agreements

21 member countries and the European Commission Advanced Fuel Cells Implementing Agreement – 19 countries

International Association for Hydrogen Safety (HySafe)

Facilitate the international coordination, development and dissemination of hydrogen safety Knowledge by being the focal point for hydrogen safety research, education and training

International Conference on Hydrogen Safety

International safety conference organized by HySafe and the HIA

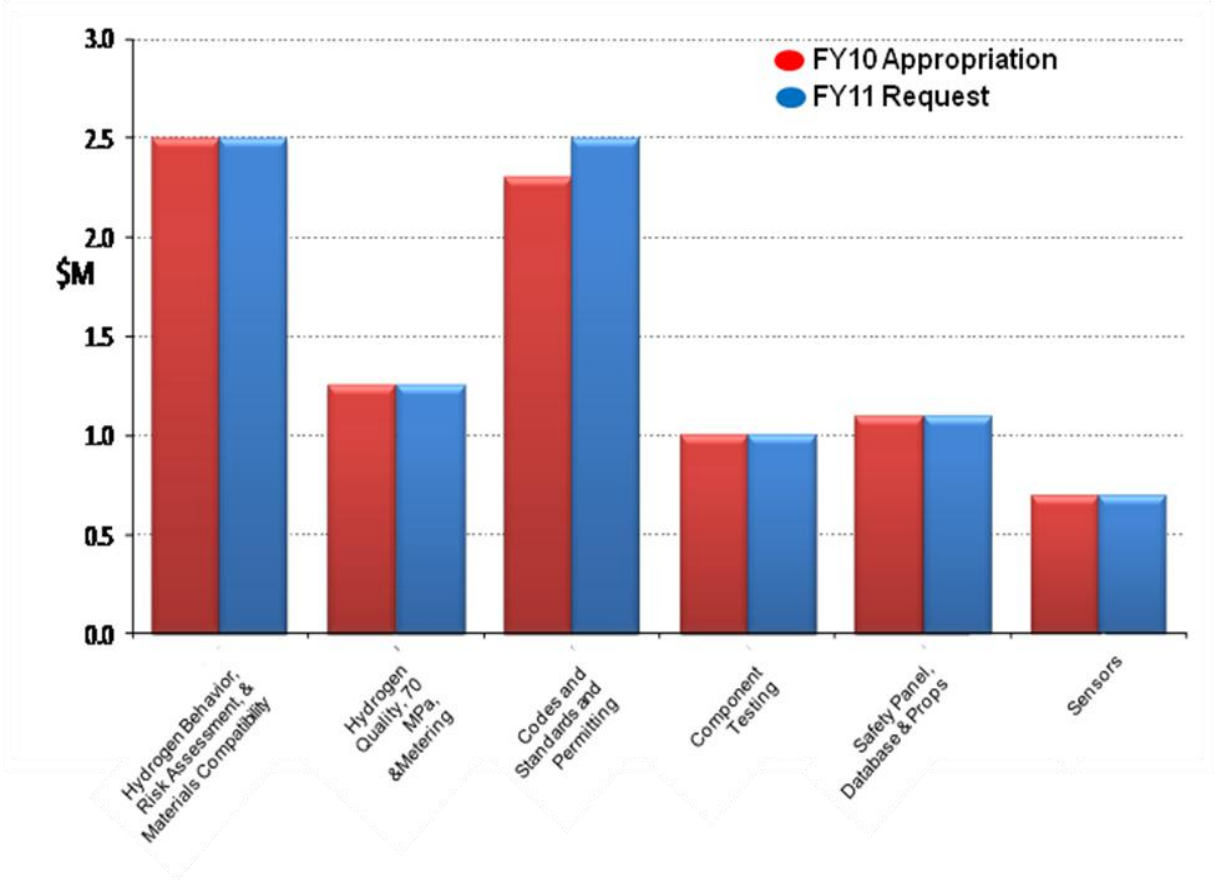
The fourth international conference will be held in San Francisco September 12 – 14, 2011

Source: US DOE 09/2010

Safety, Codes and Standards Budget

FY 2010 Appropriation: **$8.8 M**

FY 2011 Request: **$9.0 M**



FY 2010 EMPHASIS

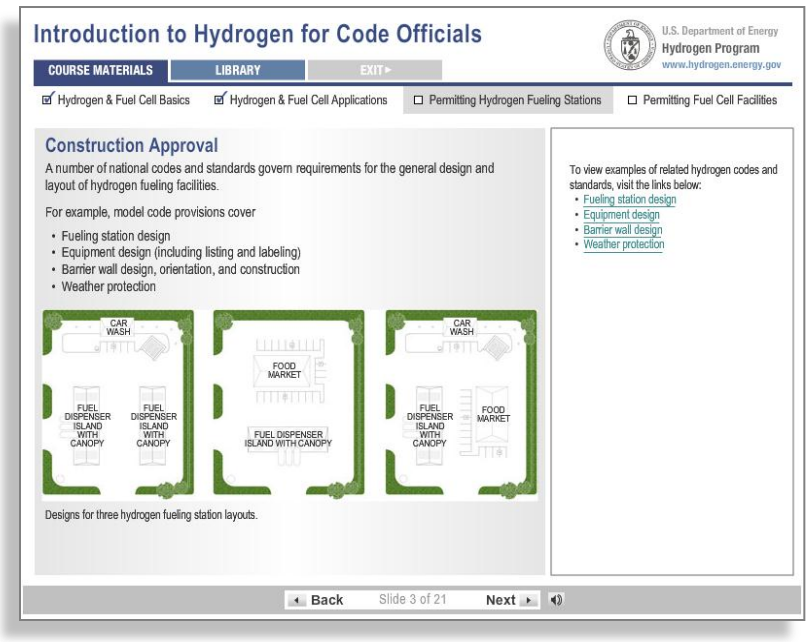
- Creating technical information and performance data to validate codes and standards
- Developing tools to facilitate permitting of hydrogen fueling stations and stationary fuel cell installations
- Testing, measuring, and verifying hydrogen fuel quality
- Assessing risks and establishing protocols to identify and mitigate risks
- Harmonizing hydrogen fuel quality and other key international standards
- Disseminating hydrogen “best practices” and safety information

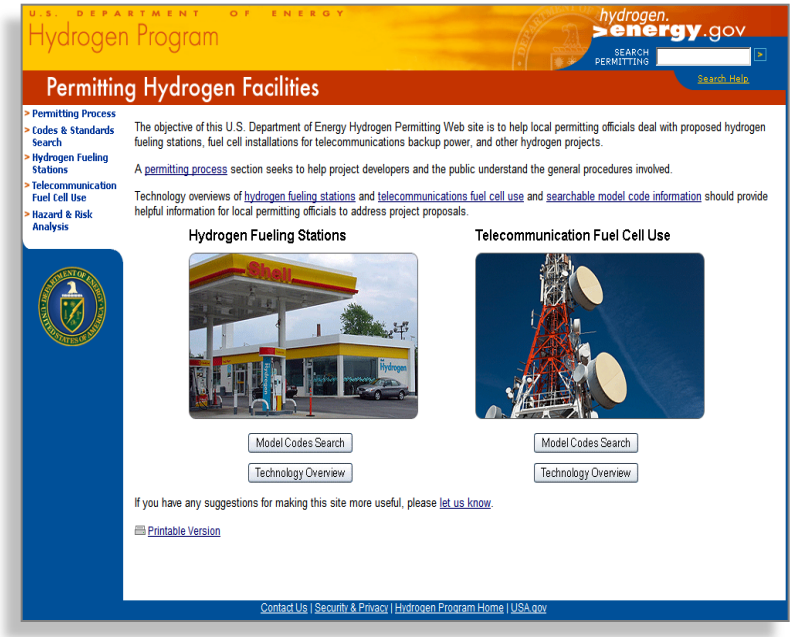
Source: US DOE 09/2010

Codes and Standards Training and Outreach

Permitting Tools for Code Officials

- Added Permitting Compendium – *online information database*
- Introduction to Hydrogen for Code Officials – *online course*
- Permitting Workshops – *classroom training*





www.hydrogenandfuelcells.energy.gov/codes

Source: US DOE 09/2010

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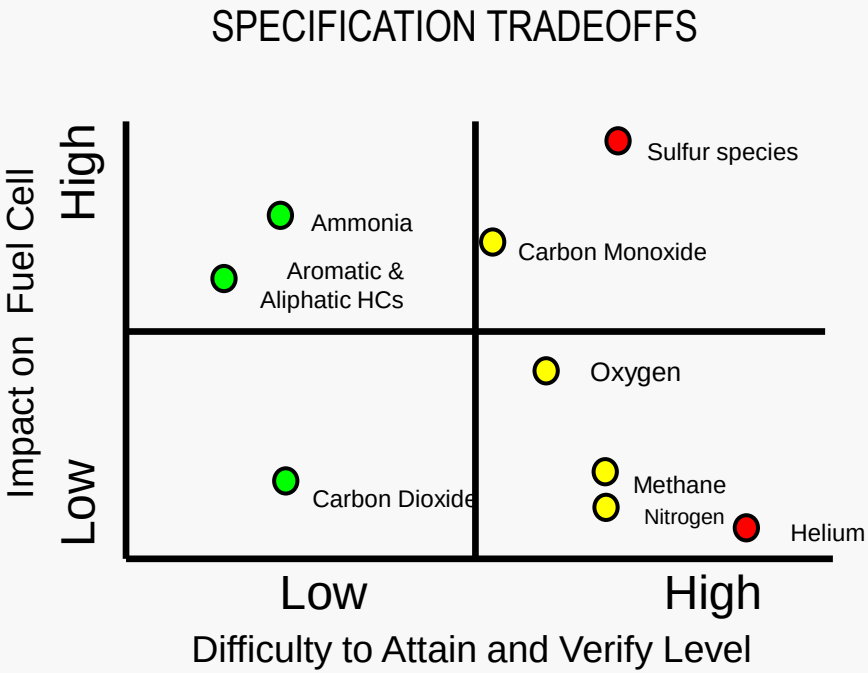
Hydrogen Fuel Quality Specification

- Technical Specification (TS) published and harmonized with SAE J2719, Committee Draft (CD) prepared
- Draft International Standard (DIS) to be submitted to ISO TC197 Dec 2010
- Unified testing underway at LANL, HNEI, USC, Clemson-SRNL, UConn for critical contaminants
- Collaborative testing underway in Japan (JARI) and France (CEA-Liten)
- Developing standardized sampling and analytical methodologies with ASTM
- Applied ANL fuel cell stack and PSA models to support testing and to address fuel quality-fuel cost tradeoffs
- Coordinated overall approach and testing with Fuel Cell, Delivery, and Storage Tech Teams

Fuel Quality - ISO DIS 14687-2 Hydrogen Fuel Product Specification



Source: Shell Hydrogen

Source: US DOE 09/2010

Early Market Fuel Cell Technologies Workshop

Coordinate R&D and code development efforts to enable the rapid deployment of early market fuel cell applications.

Sandia National Laboratories, Livermore, CA April 28, 2010

Workshop Objectives:

1. Early Market Fuel Cells Panel: Industry perspective on barriers to technology deployment
2. Code Development Panel: Coordination of the fire code, the fork lifts and the fuel cell system component
3. Enabling Research Panel: Implementation of R&D in materials, components and risk analysis in the code development process
4. Identification of codes and standards gaps for early market fuel cell technologies

Workshop Outcomes:

1. More than 25 gaps identified in the areas of fire codes, component codes and enabling research
2. Facilitated integration of the DOE Safety, Codes and Standards Program elements with early market fuel cell applications

Source: US DOE 09/2010

Example - *Executive Order 13514*

U.S. DEPARTMENT OF ENERGY

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….

Source: US DOE 09/2010

http://www1.eere.energy.gov/femp/regulations/eo13514.html