Fuel Cell Technologies Program

Market Readiness Workshop

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

DOE Hydrogen & Fuel Cell Overview

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Dr. Sunita Satyapal

Program Manager
U.S. Department of Energy
Fuel Cell Technologies Program

Fuel Cells - *Where are we today?*

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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.*

***> 15,000** fuel cells shipped in 2009 (> 40% increase over 2008).*

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

Production & Delivery of Hydrogen

In the U.S., there are currently:

- ***~9 million metric tons** of H_2 produced annually*
- *> **1200 miles** of H_2 pipelines*

Source: US DOE 09/2010

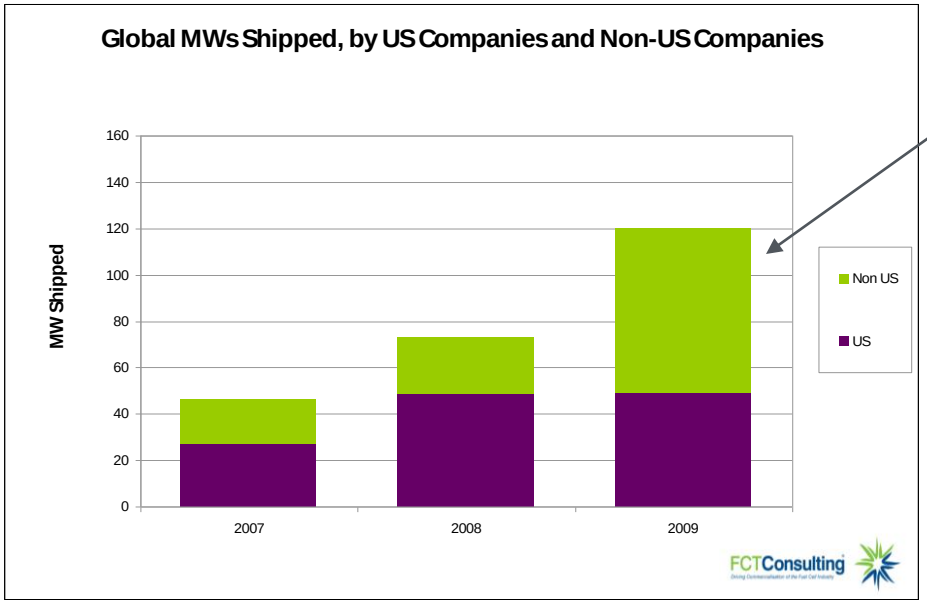
Fuel Cells for Transportation

In the U.S., there are currently:

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

Sept. 2009: Auto manufacturers from around the world signed a letter of understanding supporting fuel cell vehicles in anticipation of widespread commercialization, beginning in 2015.

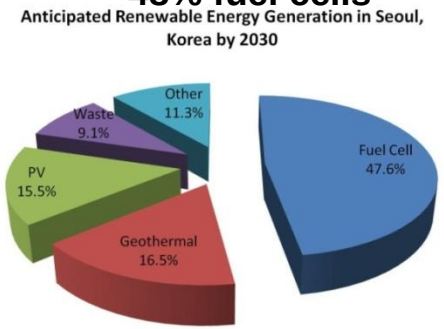
Global competition is increasing



Significant increase in MW shipped by non-US companies in just 1 year

>40% market growth in just one year

Example: Seoul's Renewable energy generation plan includes ~ **48% fuel cells**



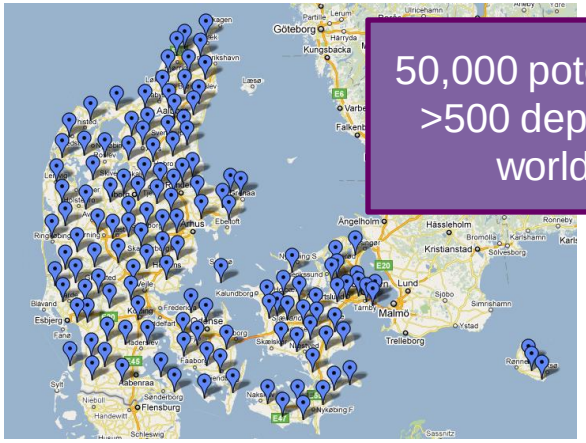
Source: Municipal Government of Seoul

Preliminary market analysis

International Landscape favors H_2 & Fuel Cells

- Germany (>$1.2B; 1,000 H_2 stations)
- European Commission (>$1.2B, 2008-2013)
- Japan (2M vehicles, 1,000 H_2 stations by 2025)
- Korea (plans to produce 20% of world shipments & create 560,000 jobs in Korea)
- China (thousands of small units; 70 FCVs, buses, 100 shuttles at World Expo, Olympics)
- Subsidies for jobs, manufacturing, deployments (e.g. South Africa)

Example: Denmark Backup Power Deployments



50,000 potential sites
>500 deployments worldwide

Specific positions and numbers are not correct

 Source: US DOE 12/2010

Technology Validation

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

RECENT PROGRESS

Vehicles & Infrastructure

- 152 fuel cell vehicles and 24 hydrogen fueling stations
- Over 2.8 million miles traveled
- Over 114 thousand total vehicle hours driven
- 2,500 hours (nearly 75K miles) durability
- Fuel cell efficiency 53-59%
- Vehicle Range: ~196 – 254 miles (independently also validated 430 mile range)

Buses

- DOE is evaluating real-world bus fleet data (DOT collaboration)
- H_2 fuel cell buses have a 41% to 132% better fuel economy when compared to diesel & CNG buses

Forklifts

- Over 18,000 refuelings at Defense Logistics Agency site

Recovery Act

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

 Source: US DOE 09/2010

Recovery Act Funding for Fuel Cells

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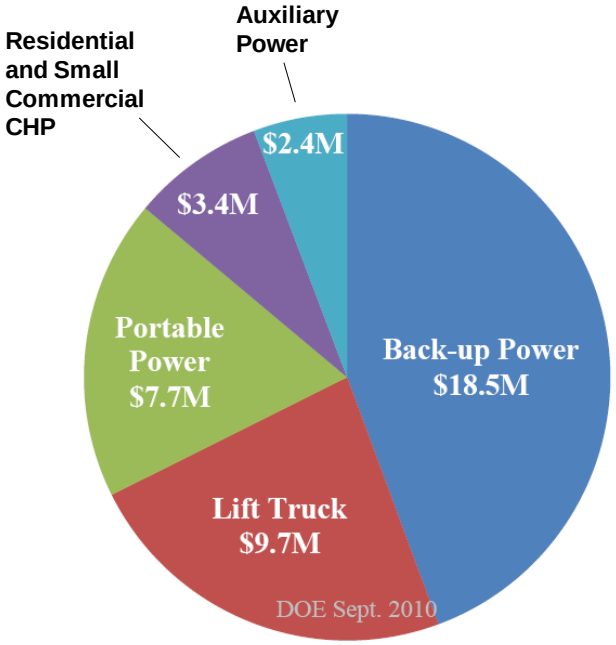
More than $40 million from the 2009 American Recovery and Reinvestment Act to fund 12 projects to deploy up to 1,000 fuel cells

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	Lift Truck
GENCO	$6.1 M	Lift Truck
Jadoo Power	$2.2 M	Portable
MTI MicroFuel Cells	$3.0 M	Portable
Nuvera Fuel Cells	$1.1 M	Lift Truck
Plug Power, Inc. (1)	$3.4 M	CHP
Plug Power, Inc. (2)	$2.7 M	Back-up Power
Univ. of N. Florida	$2.5 M	Portable
ReliOn, Inc.	$8.5 M	Back-up Power
Sprint Nextel	$7.3 M	Back-up Power
Sysco of Houston	$1.2 M	Lift Truck

 Source: US DOE 10/2010

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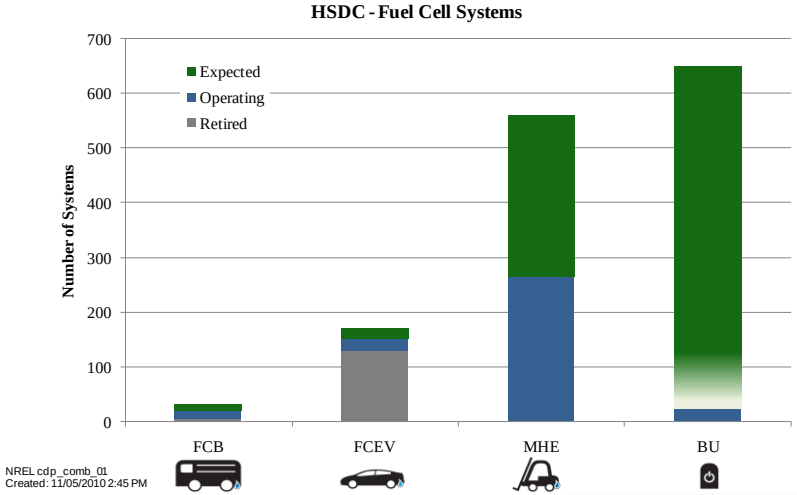

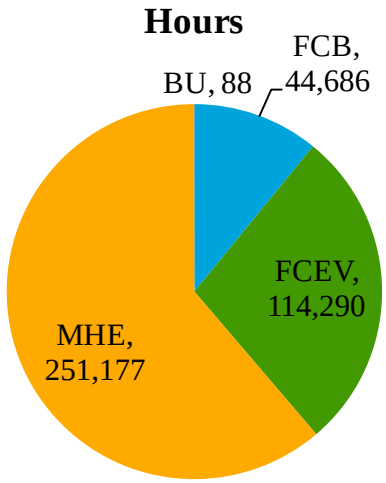

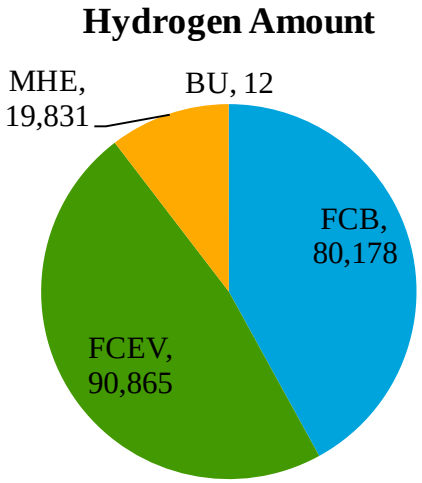

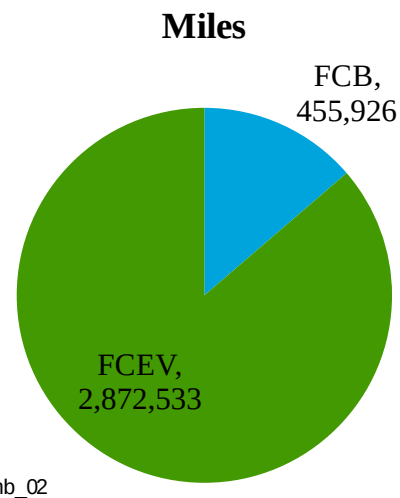

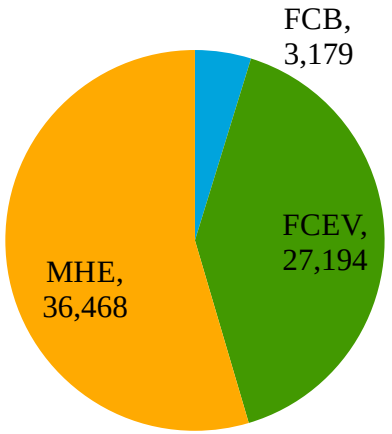

NREL cdp_comb_02
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 Source: US DOE 12/2010

Sample Projects

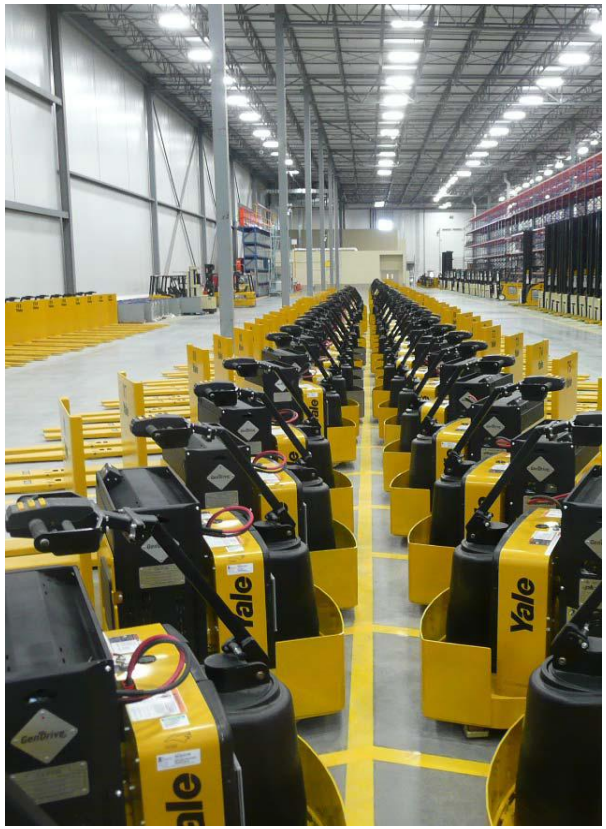
Federal incentives, including §1603 grant-in-lieu of tax credit and §48, have helped facilitate commercial transition to fuel cell forklifts.

Examples[1]:

- $660K: Central Grocers (Joliet, IL)
- $420K: United Natural Foods (Sarasota, FL)
- $600K: Sysco Foods (Houston, TX)
- $620K: Wegmans (Pottsville, PA)
- $320K: Kimberly Clark (Graniteville, SC)
- $400K: Coca-Cola Bottling (Charlotte, NC)
- $390K: Whole Foods (Landover, MD)

Other examples: H-E-B, Walmart, and more

[1] Source: Plug Power



Super Store Industries - First Grocery Warehouse and Distributor to Deploy Methanol Fuel Cells for Material Handling Equipment

Source: US DOE 12/2010

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

 Source: US DOE 10/2010

Analysis of Policies for FCEVs & Hydrogen Infrastructure

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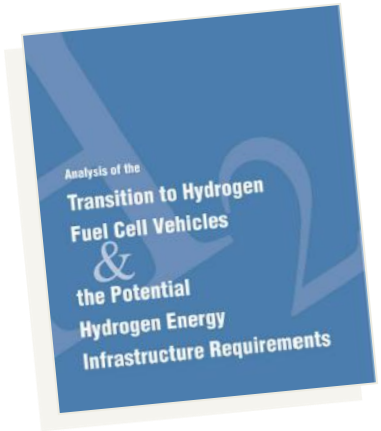
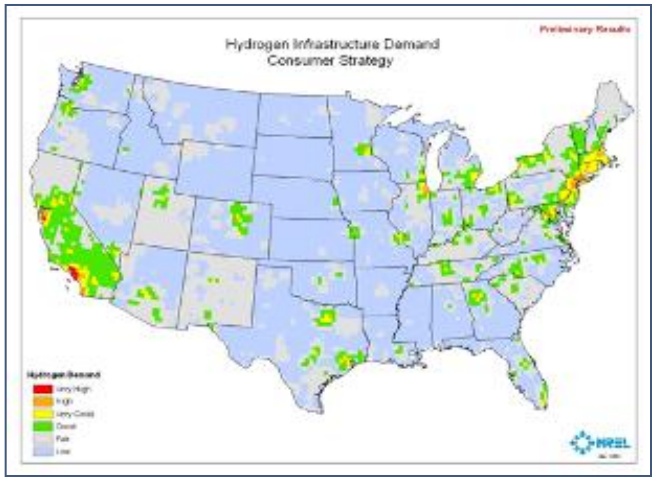
Analysis by Oak Ridge National Laboratory explores the impacts and infrastructure and policy requirements of potential market penetration scenarios for fuel cell vehicles.

Key Findings:

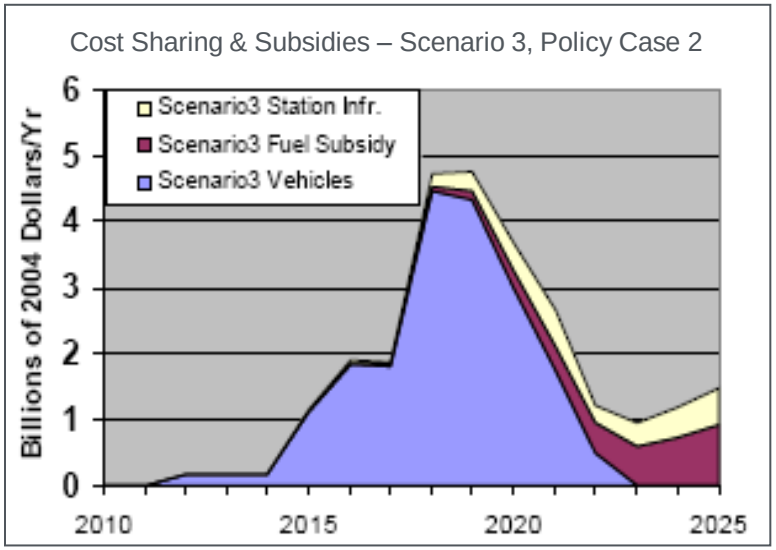
- Transition policies will be essential to overcome initial economic barriers.
- Cost-sharing & tax credits (2015 – 2025) would enable industry to be competitive in the marketplace by 2025.
- With targeted deployment policies from 2012 to 2025, FCV market share could grow to 50% by 2030, and 90% by 2050.
- Cost of these policies is not out of line with other policies that support national goals.
  - The annual cost would not exceed $6 billion—*federal incentives for ethanol are expected to cost more than $5 billion/year by 2010.*
  - Cumulative costs would range from $10 billion to $45 billion, from 2010 to 2025—*federal incentives for ethanol have already cost more than $28 billion, and these cumulative costs are projected to exceed $40 billion by 2010.*



http://cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008_30.pdf



Areas of projected fuel cell vehicle use—and fuel demand



Projected cost of policies to sustain a transition to fuel cell vehicles and H_2 infrastructure, based on the most aggressive scenario

 Source: US DOE 12/2010

Analysis of Policies for FCEVs & Hydrogen Infrastructure

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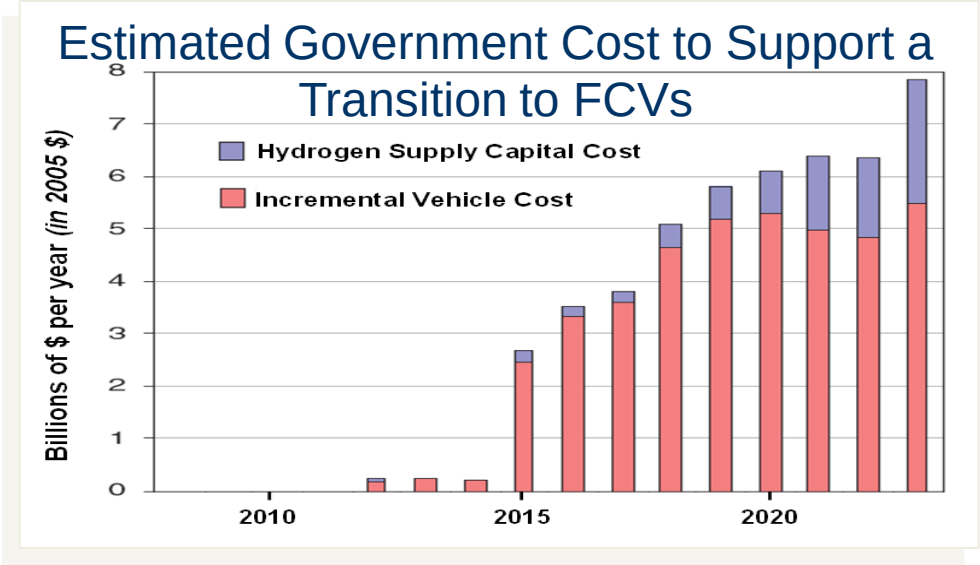
NAS study, "Transitions to Alternative Transportation Technologies: A Focus on Hydrogen," shows positive outlook for fuel cell technologies—results are similar to ORNL's "Transition Scenario Analysis."

The study was required by EPACT section 1825 and the report was released in 2008, by the Committee on Assessment of Resource Needs for Fuel Cell and Hydrogen Technologies.

www.nap.edu/catalog.php?record_id=12222



Key Findings Include:

- By 2020, there could be 2 million FCVs on the road. This number could grow rapidly to about 60 million by 2035 and 200 million by 2050.
- Government cost to support a transition to FCVs (for 2008 – 2023) estimated to be $55 billion—about $3.5 billion/year.
- The introduction of FCVs into the light-duty vehicle fleet is much closer to reality than when the NRC last examined the technology in 2004—due to concentrated efforts by private companies, together with the U.S. FreedomCAR & Fuel Partnership and other government-supported programs around the world.
- A portfolio of technologies has the potential to eliminate petroleum use in the light-duty vehicle sector and to reduce greenhouse gas emissions from light-duty vehicles to 20 percent of current levels—by 2050.

 Source: US DOE 12/2010

Workshop Objective

The objective of the workshop is to identify and collect stakeholder feedback on the following:

- Cost reduction opportunities from economies of scale (e.g., station standardization, number and size of installations) and learning-by-doing resulting from growth in material handling equipment (MHE), backup power, light duty vehicles and transit bus markets.
- Cost reduction opportunities from focused R&D areas and priorities.
- Specific examples through which early markets, such as MHE, backup power, and transit buses, can provide increased demand and reduce hydrogen infrastructure costs.

Workshop Outcomes

- Identify key cost drivers for hydrogen supply infrastructure supporting light duty vehicles, buses, MHE, etc.
- Identify and quantify major cost reduction opportunities
  - Impact of economies of scale, learning by doing, redundancy of installation
- Identify actions required to achieve cost reductions

Thank you

For more information, please contact

Sunita.Satyapal@ee.doe.gov

Fred.Joseck@ee.doe.gov

hydrogenandfuelcells.energy.gov