

Energy Overview & A Perspective on Fuel Cell Technologies

Dr. Sunita Satyapal

Chief Engineer and Deputy Program Manager

United States Department of Energy

Fuel Cell Technologies Program

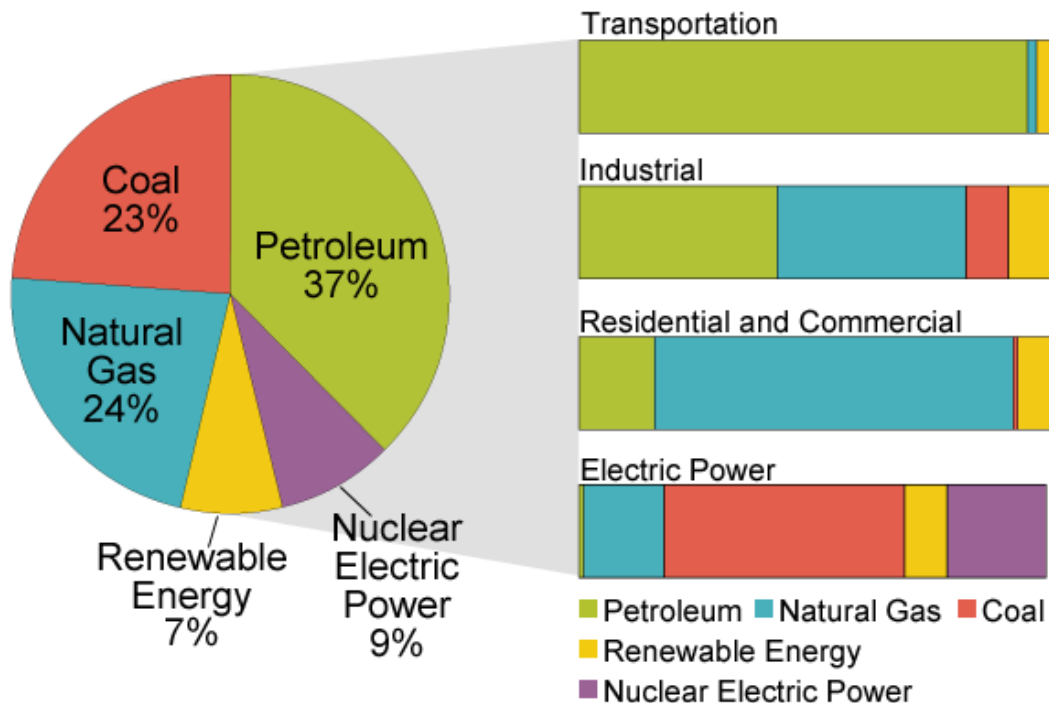
2010 Worldwide Energy Conference

Defense Energy Support Center

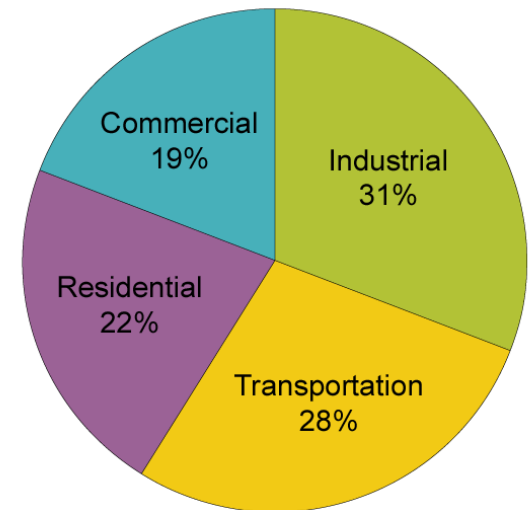
May 11, 2010

Washington National Harbor

U.S. Primary Energy Consumption by Source and Sector



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



Total U.S. Energy = 99.3 Quadrillion Btu

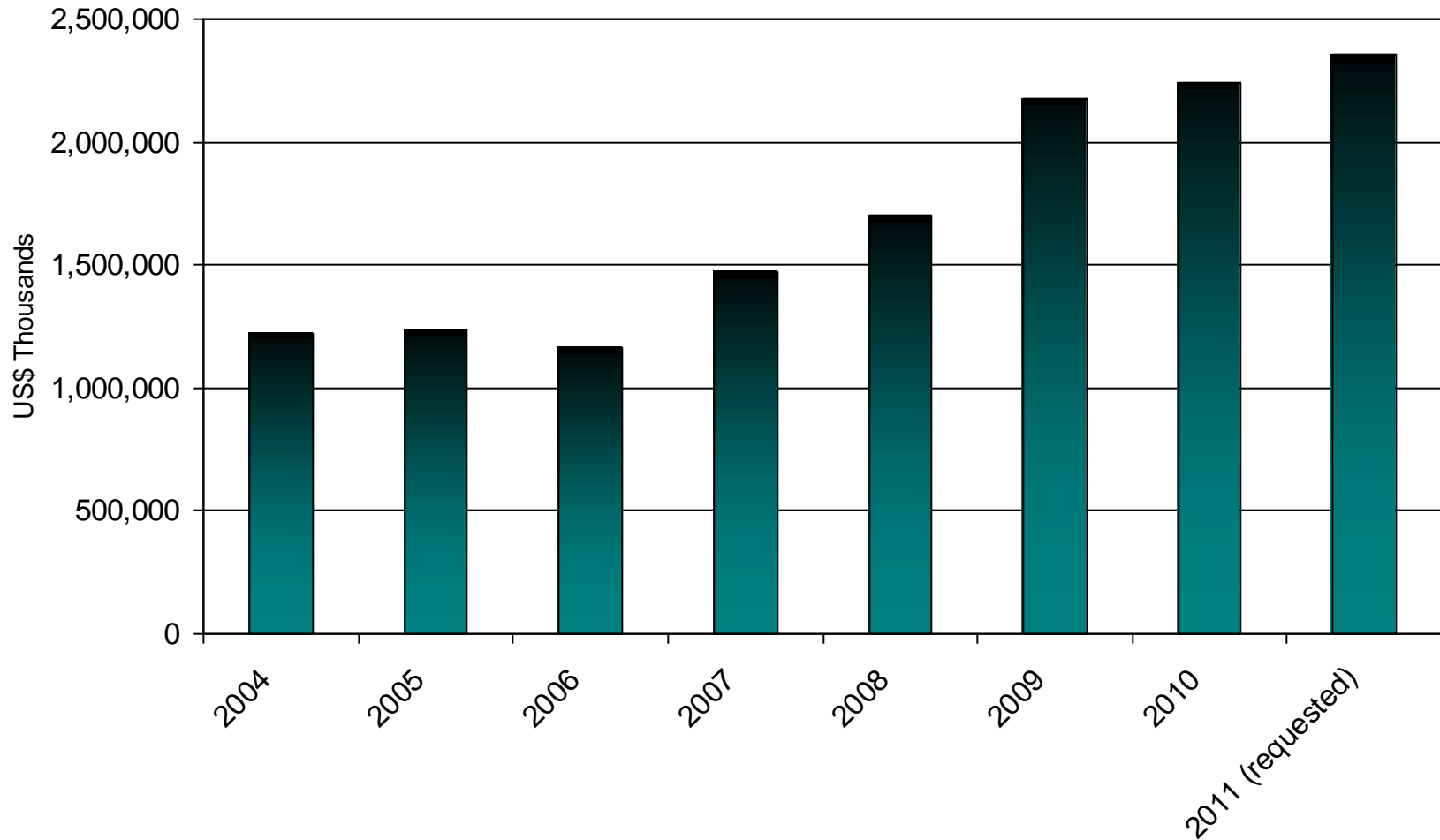
Source: Energy Information Administration, *Annual Energy Review 2008*, Tables 1.3, 2.1b-2.1f.

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

- ✓ 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



Energy Efficiency and Renewable Energy (EERE) Budget History FY2004-FY2011 (requested)



Renewable Energy

- Solar
- Biomass/Biofuels
- Hydrogen/Fuel Cells
- Wind/ Water Power
- Geothermal

Energy Efficiency

- Vehicle Technologies
- Weatherization
- Building Technologies
- Industrial Technologies
- Federal Energy Management



Mission:

Strengthen America's energy security, environmental quality, and economic vitality through R&D and public-private partnerships that –

- diversify the Nation's sources of energy;
- increase efficiency and productivity of the existing energy infrastructure;
- bring clean, reliable and affordable energy technologies to the marketplace; and,
- make a difference in the everyday lives of Americans by productively enhancing their energy choices and quality of life.

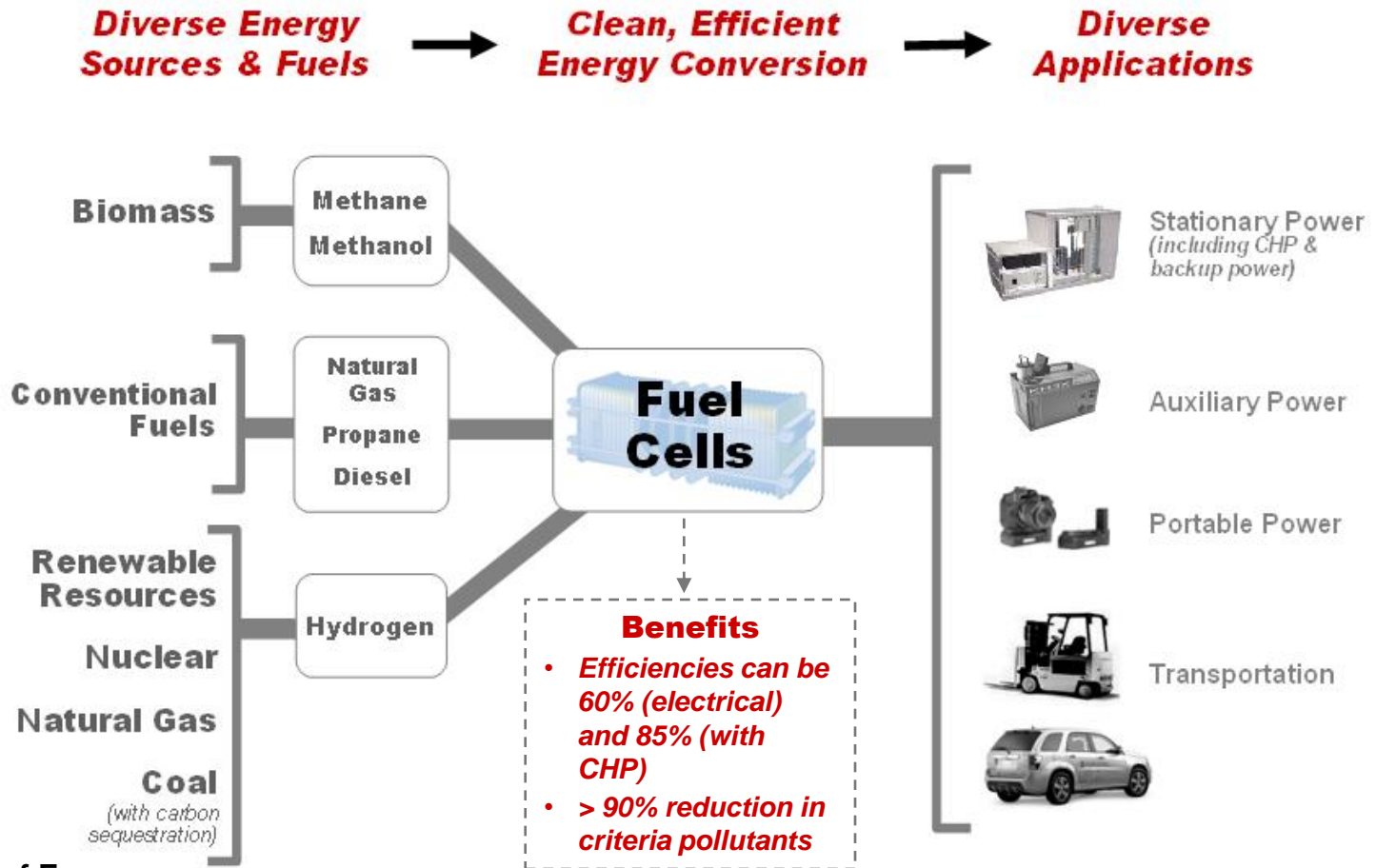
Fuel Cells Example

Energy Efficiency and Resource Diversity

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

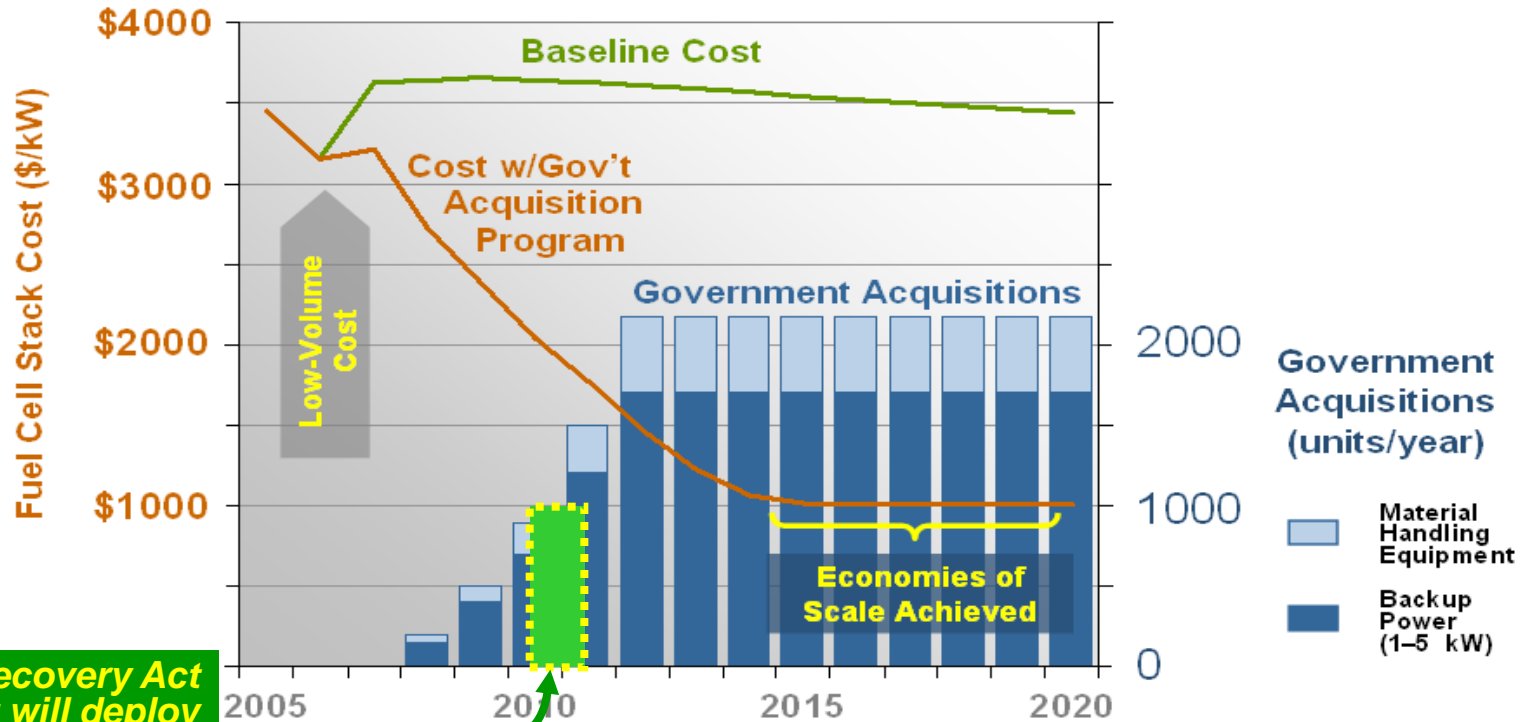
Greenhouse Gas Emissions and Air Pollution:

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



Government acquisitions could significantly reduce the cost of fuel cells through economies of scale, and help to support a growing supplier base.

Impact of Government Acquisitions on Fuel Cell Stack Costs (for non-automotive fuel cells)



Recovery Act funding will deploy up to 1000 fuel cells, in the private sector, by 2012.

Source: ORNL

We are facilitating the adoption of fuel cells across government and industry:

- 100 fuel cells are being deployed, through interagency agreements.
- More interagency agreements under development.

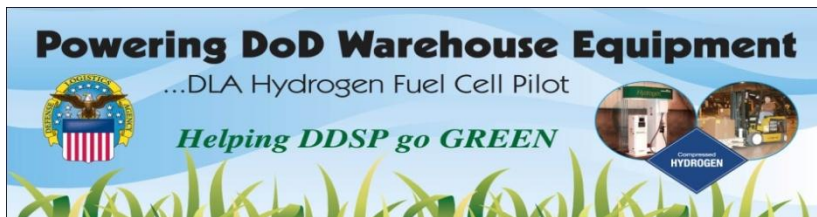
Army : Backup Power, Waste to Energy, H2ICE shuttle buses, high pressure steam using wood chips, Geothermal heat, Solar and Hydroelectric power generation

Navy: Wind/Solar/Geothermal Power Generation

Air Force: Wind/Solar/Geothermal Power Generation

DLA: Fuel Cell Material Handling Equipment, Solar Power, and H2ICE shuttle buses

Fuel Cell Deployments Example





***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....

Thank you

For more information:

hydrogenandfuelcells.energy.gov

Sunita.Satyapal@ee.doe.gov

Additional Information

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

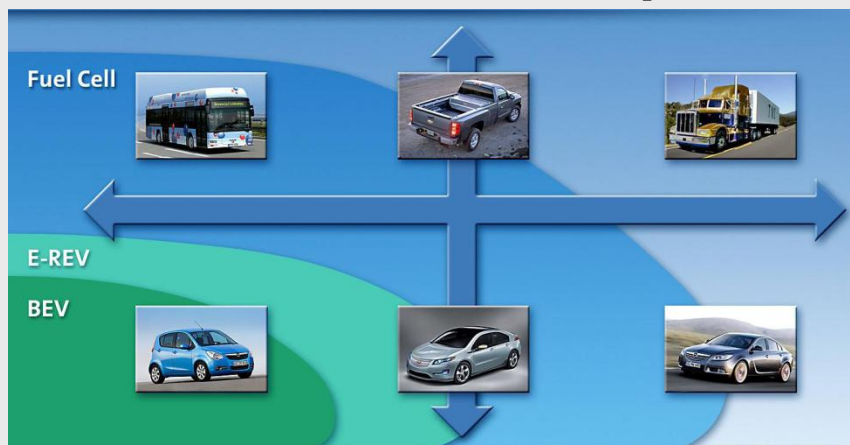
In the U.S., there are currently:

~9 million metric tons of H₂ produced annually

> 1200 miles of H₂ pipelines

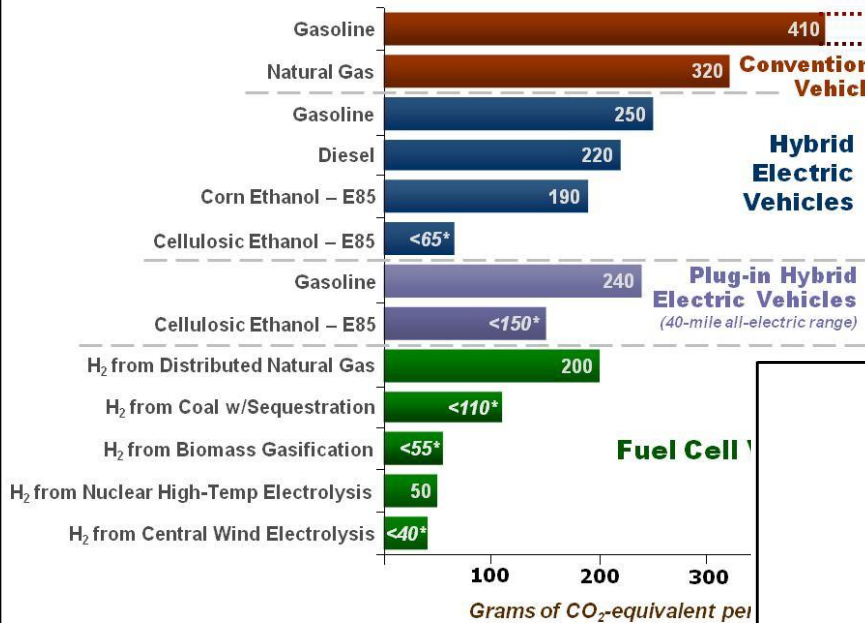


The Role of Fuel Cells in Transportation



Well-to-Wheels Greenhouse Gas Emissions

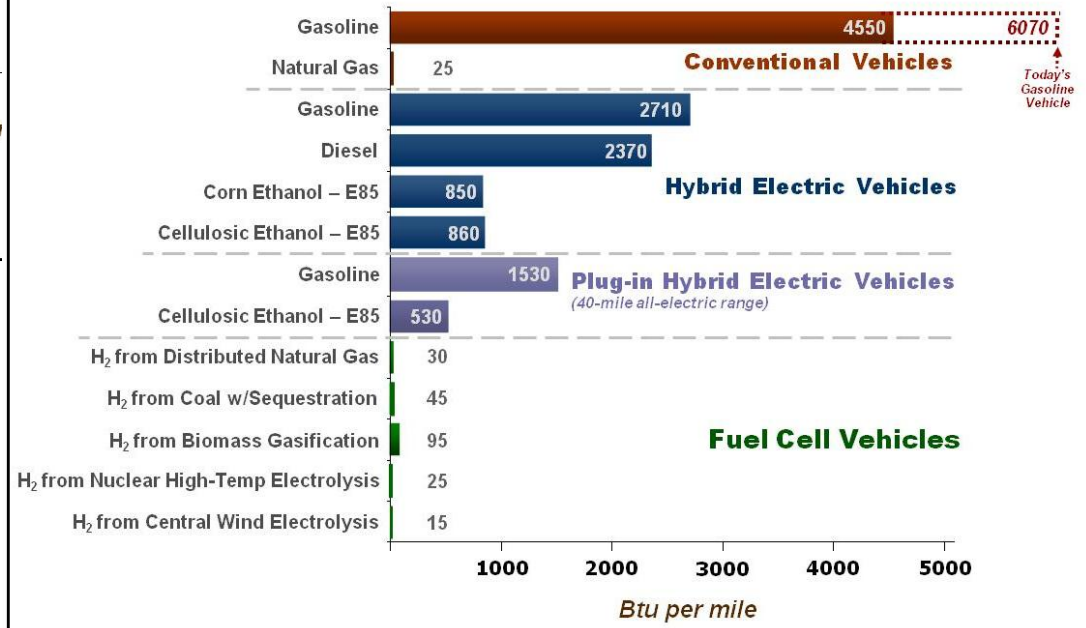
(life-cycle emissions, based on a projected state of the technologies in 2020)



Analysis shows DOE's 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)



DOE Program Record #9002,

www.hydrogen.energy.gov/program_records.html

Today's Gasoline Vehicle

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

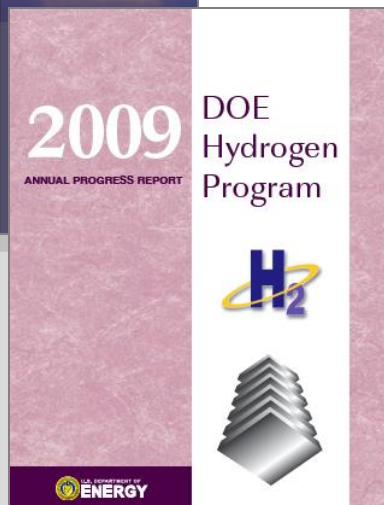
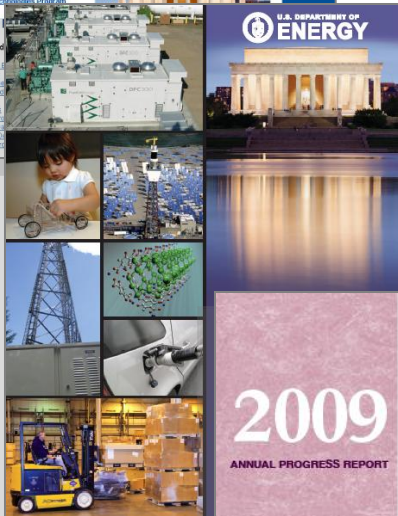
→ **Latest edition published November 2009**

www.hydrogen.energy.gov/annual_progress.html

Next Annual Review: June 7 – 11, 2010

Washington, D.C.

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



Examples of Early Market Applications

Fuel Cells for Backup Power ...

- Provide longer continuous run-time, greater durability than batteries
- Require less maintenance than batteries or generators
- *May provide substantial cost-savings over batteries and generators*



A 1-kW fuel cell system has been providing power for this FAA radio tower near Chicago for more than three years.

(Photo courtesy of ReliOn)

Fuel Cells for Material Handling Equipment ...

- Allow for rapid refueling — much faster than changing-out or recharging batteries
- Provide constant power without voltage drop
- Eliminate need for space for battery storage and chargers
- *May provide substantial cost-savings over battery-powered forklifts*



Photo courtesy of Hydrogenics

Fuel Cells for Data Centers ...

- Provide high-quality, reliable, grid-independent on-site critical load power
- Improve the effectiveness of data center power use by 40%, with combined heat-and-power (for cooling and heating)
- Produce no emissions
- Have low O&M requirements
- Can be remotely monitored

