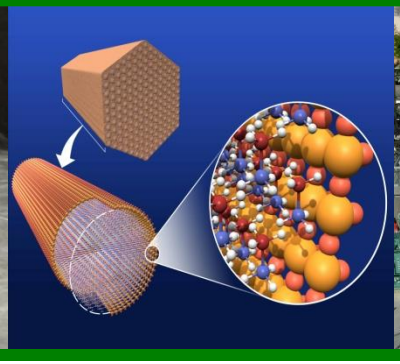
U.S. DEPARTMENT OF ENERGY



Hydrogen & Fuel Cells
- Program Overview -

Sunita Satyapal

Program Manager

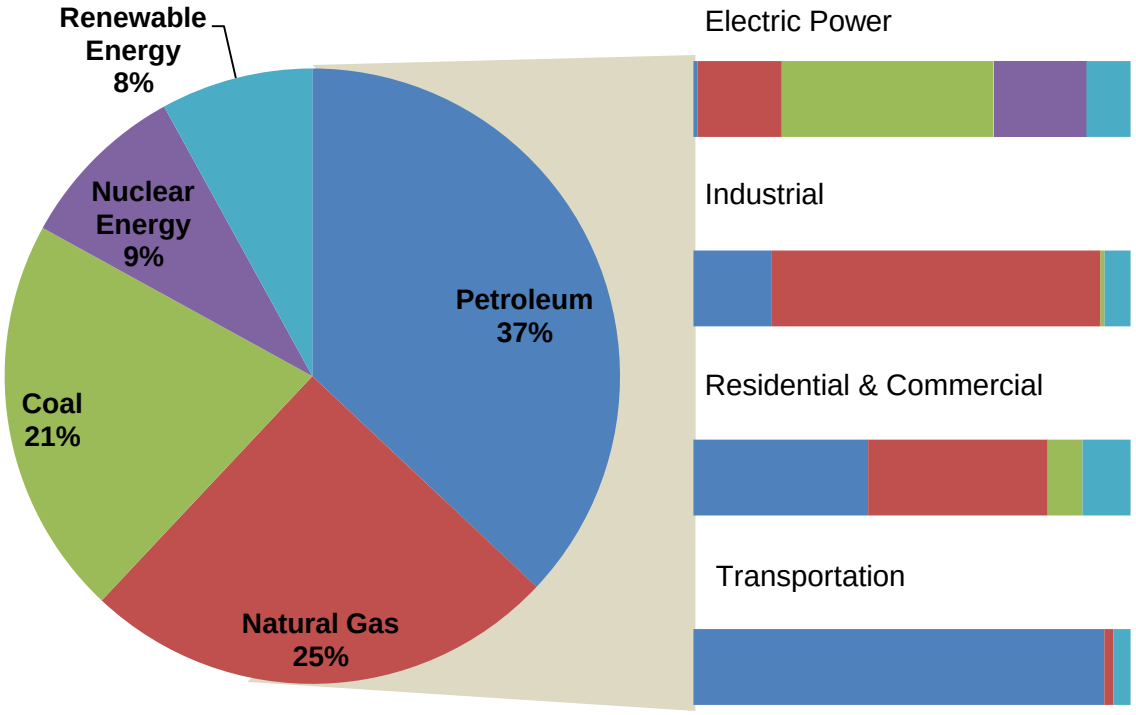
2012 Annual Merit Review and Peer Evaluation Meeting

May 14, 2012

U.S. Energy Consumption

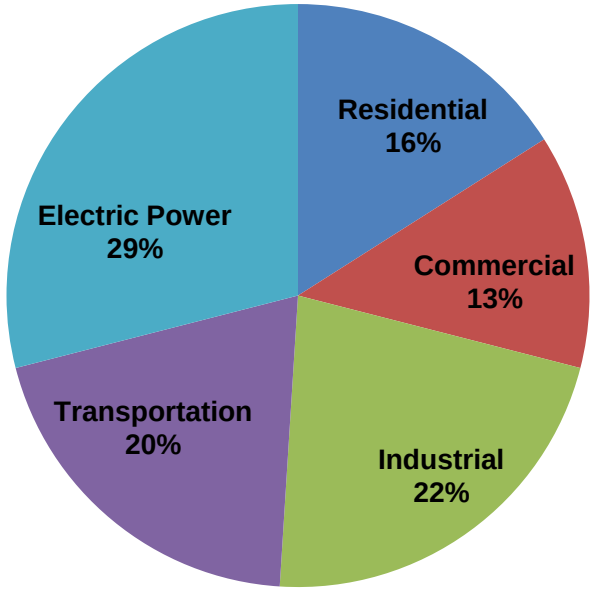
U.S. DEPARTMENT OF ENERGY

U.S. Primary Energy Consumption by Source and Sector



Fuel Cells can apply to diverse sectors

Share of Energy Consumed by Major Sectors of the Economy, 2010

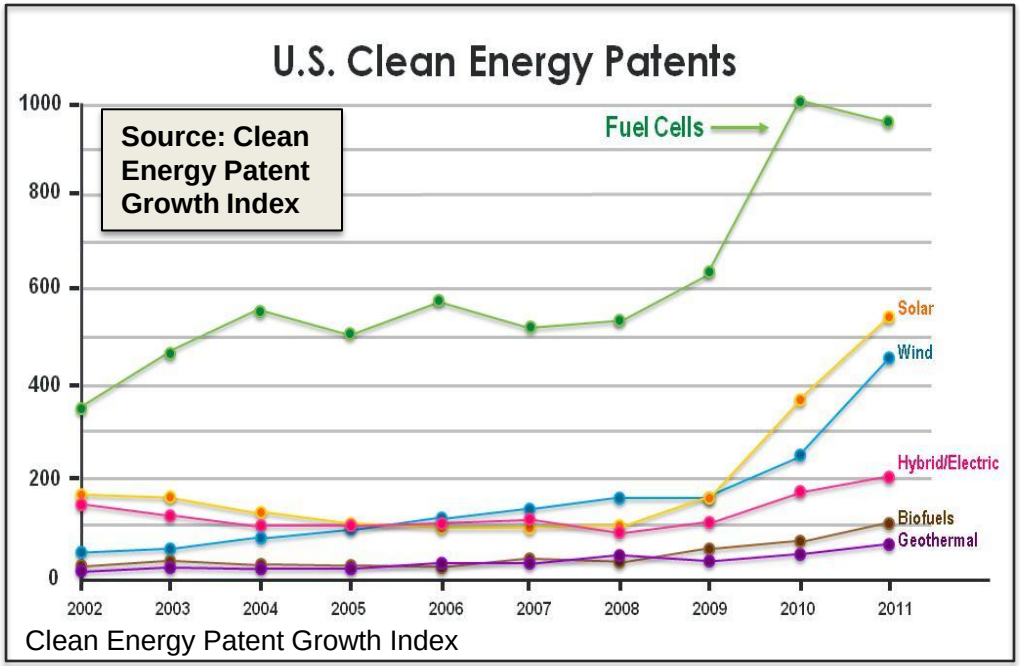


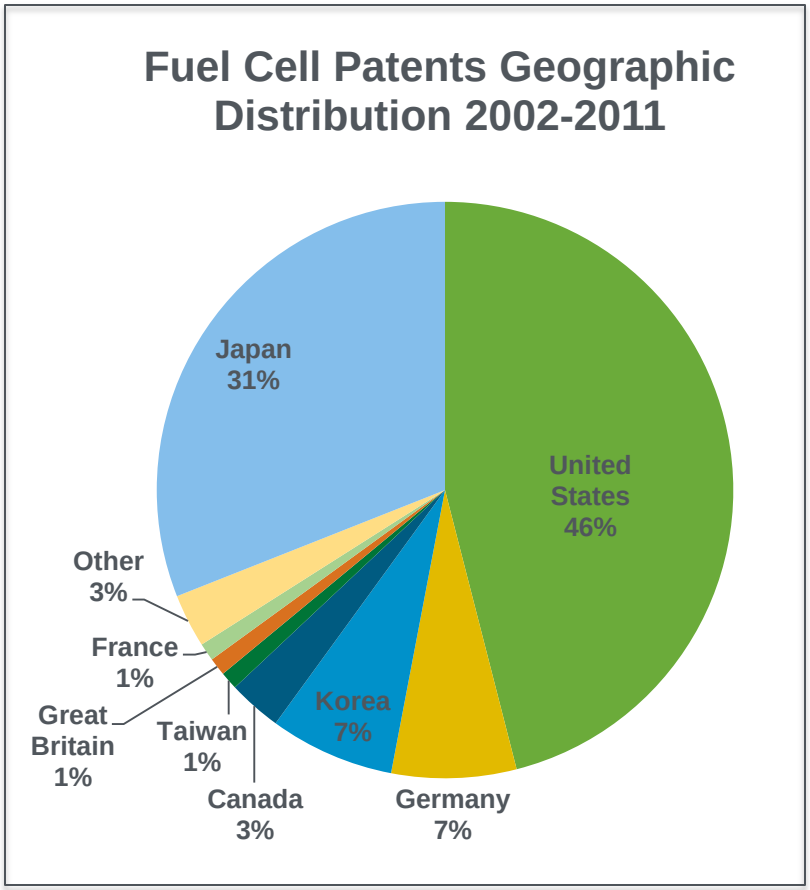
Total U.S. Energy = 98 Quadrillion Btu/yr

Source: Energy Information Administration, *Annual Energy Review 2010,* Table 1.3

Fuel Cells – An Emerging Global Industry

U.S. DEPARTMENT OF ENERGY





Top 10 companies: GM, Honda, Samsung, Toyota, UTC Power, Nissan, Ballard, Plug Power, Panasonic, Delphi Technologies

Clean Energy Patent Growth Index[1] shows that fuel cell patents lead in the clean energy field with over 950 fuel cell patents issued in 2011.

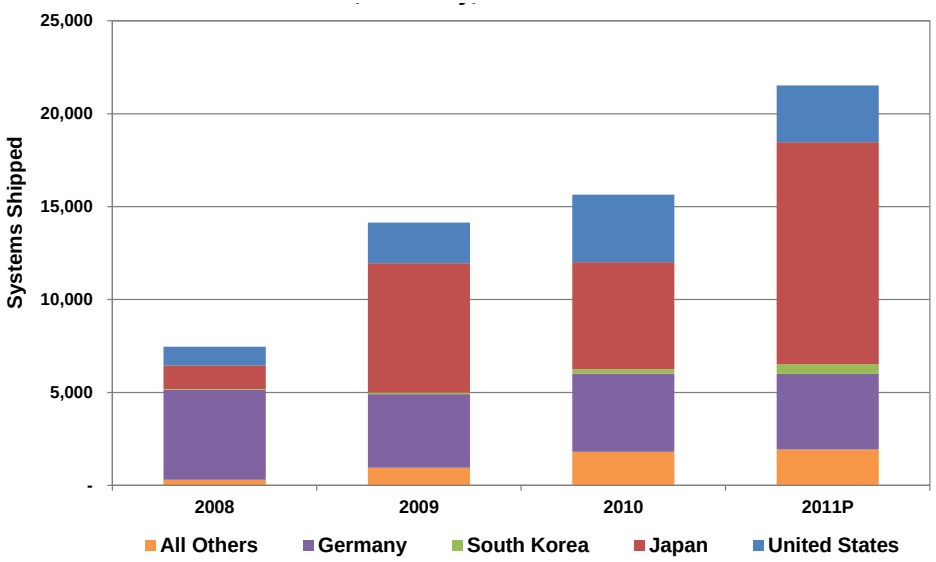
- Nearly double the second place holder, solar, which has ~540 patents.

[1] http://cepgi.typepad.com/files/cepgi-4th-quarter-2011-1.pdf

Fuel Cell Market Overview

U.S. DEPARTMENT OF ENERGY

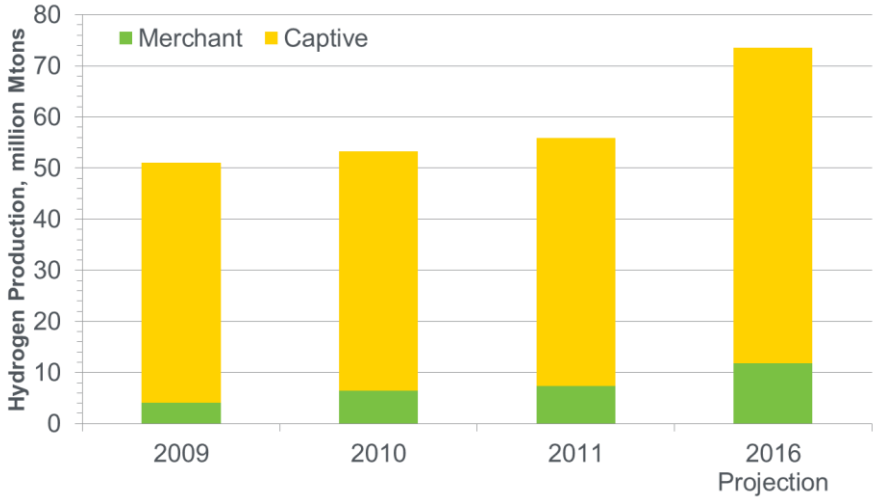
System Shipments by Key Countries: 2008-2011



The fuel cell market remains strong with over 20,000 systems shipped in 2011, a > 35% increase over 2010[1]

~3X increase in VC/private equity fuel cell funding in just one year ($113M).*

Global Hydrogen Production Market 2009 – 2016 (million metric tons)



The global hydrogen market is also robust with over 55 Mtons produced in 2011 and over 70 Mtons projected in 2016, a > 30% increase.

Sources: FuelCells2000, Pike Research, Markets & Markets

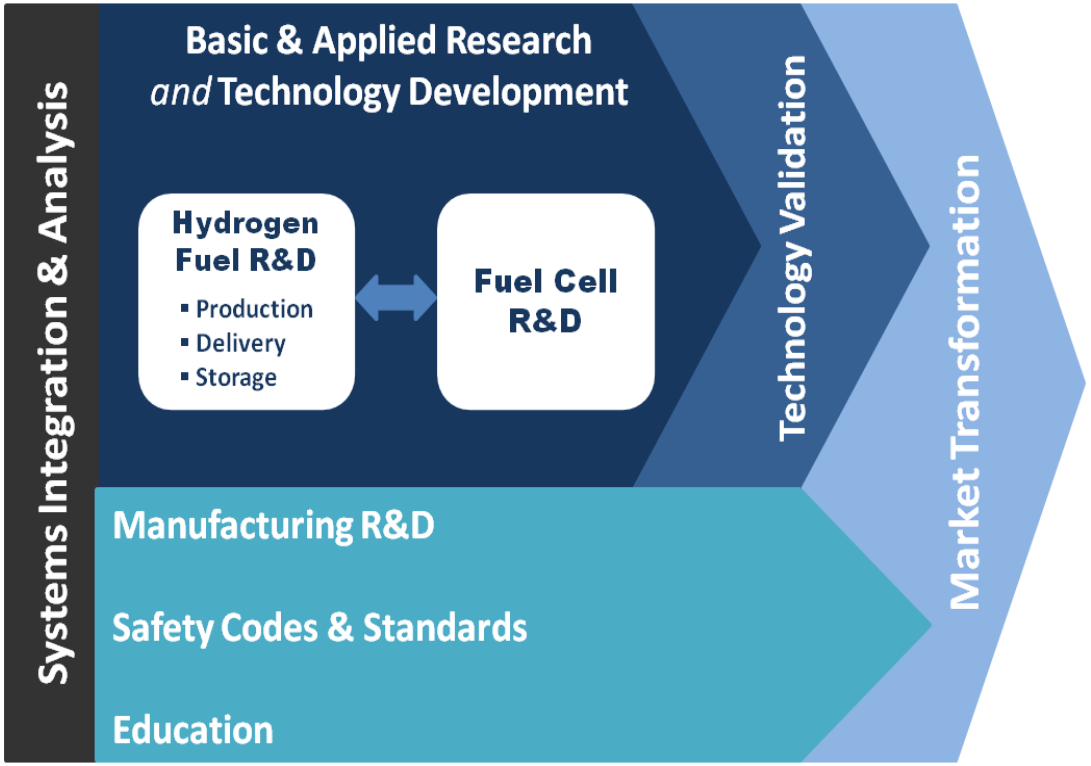
[1]FCT Market Report to be published in June 2012.

*by Top 10 Investors

DOE Program Structure

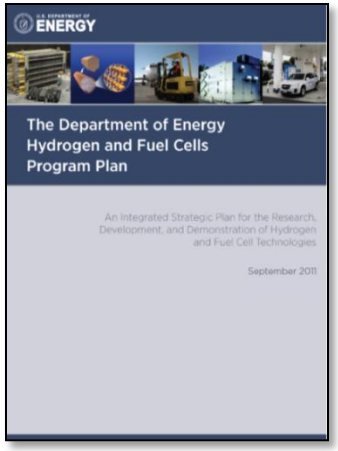
U.S. DEPARTMENT OF ENERGY

The Program is an integrated effort, structured to address all the key challenges and obstacles facing widespread commercialization.



WIDESPREAD COMMERCIALIZATION ACROSS ALL SECTORS

- Transportation
- Stationary Power
- Auxiliary Power
- Backup Power
- Portable Power



Released September 2011
Update to the Hydrogen Posture Plan (2006)
Includes Four DOE Offices
EERE, FE, NE and Science

Nearly 300 projects currently funded
at companies, national labs, and universities/institutes
More than $1B DOE funds spent from FY 2007 to FY 2011

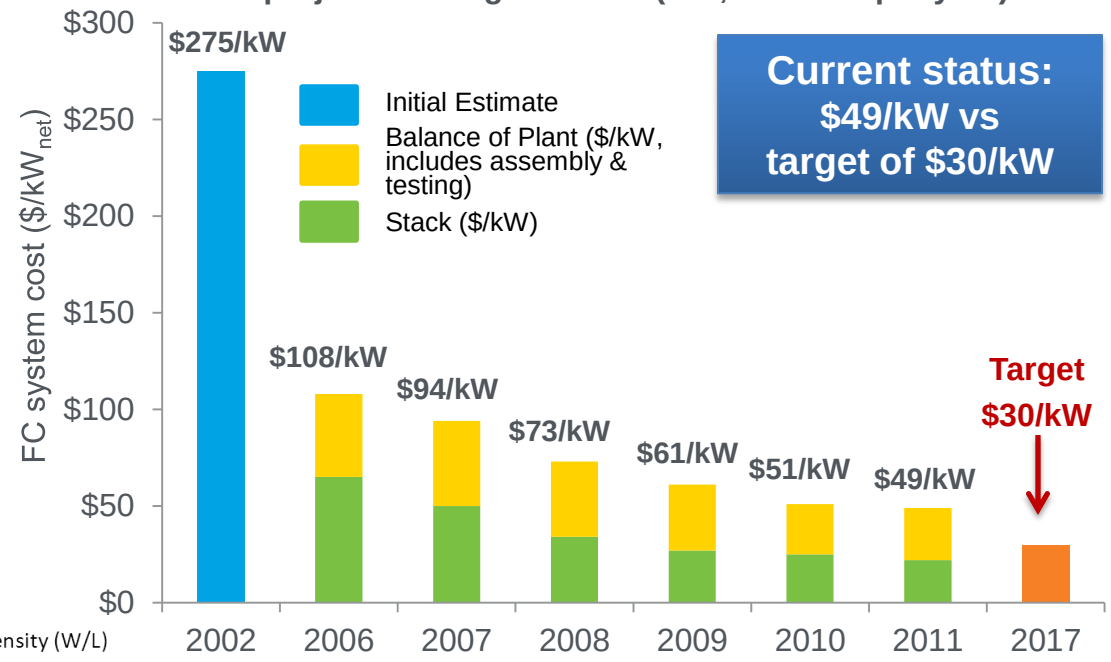
Fuel Cell R&D

U.S. DEPARTMENT OF ENERGY

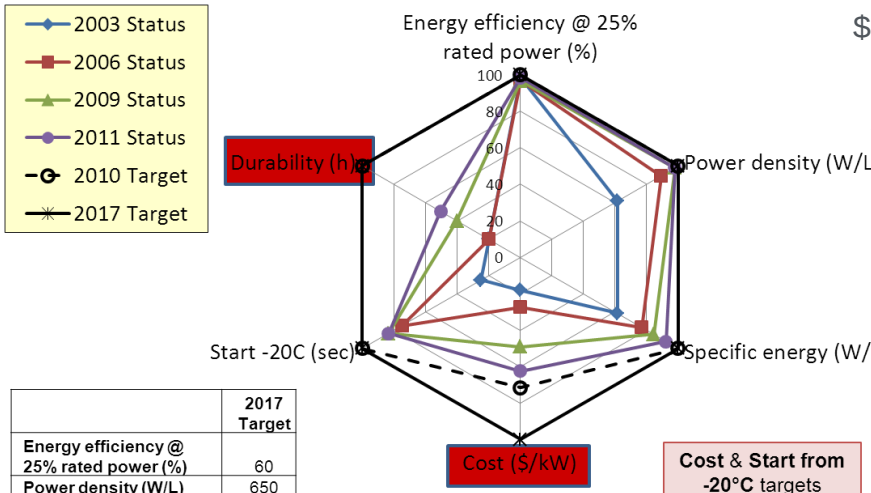
Reduced projected high-volume cost of fuel cells to $49/kW (2011)*

- ***Reduced Pt by a factor of 5 since 2005***
- ***More than 30% reduction since 2008. More than 80% reduction since 2002***

Projected Transportation Fuel Cell System Cost
-projected to high-volume (500,000 units per year)-



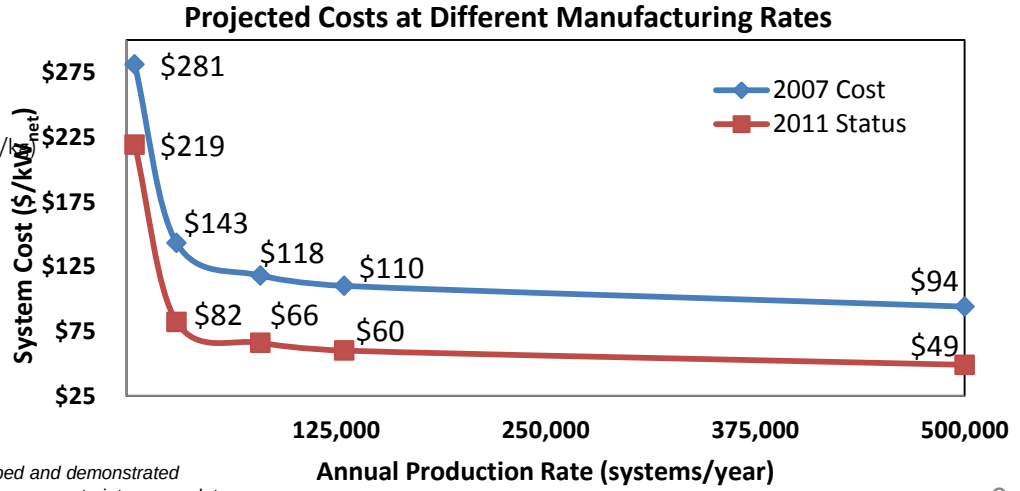
Current status: $49/kW vs target of $30/kW



	2017 Target
Energy efficiency @ 25% rated power (%)	60
Power density (W/L)	650
Specific energy (W/kg)	650
Cost ($/kW)	30
Start from -20°C (sec)	15
Durability (h)	5000

Cost & Start from -20°C targets plotted as 1/target

Projected Costs at Different Manufacturing Rates

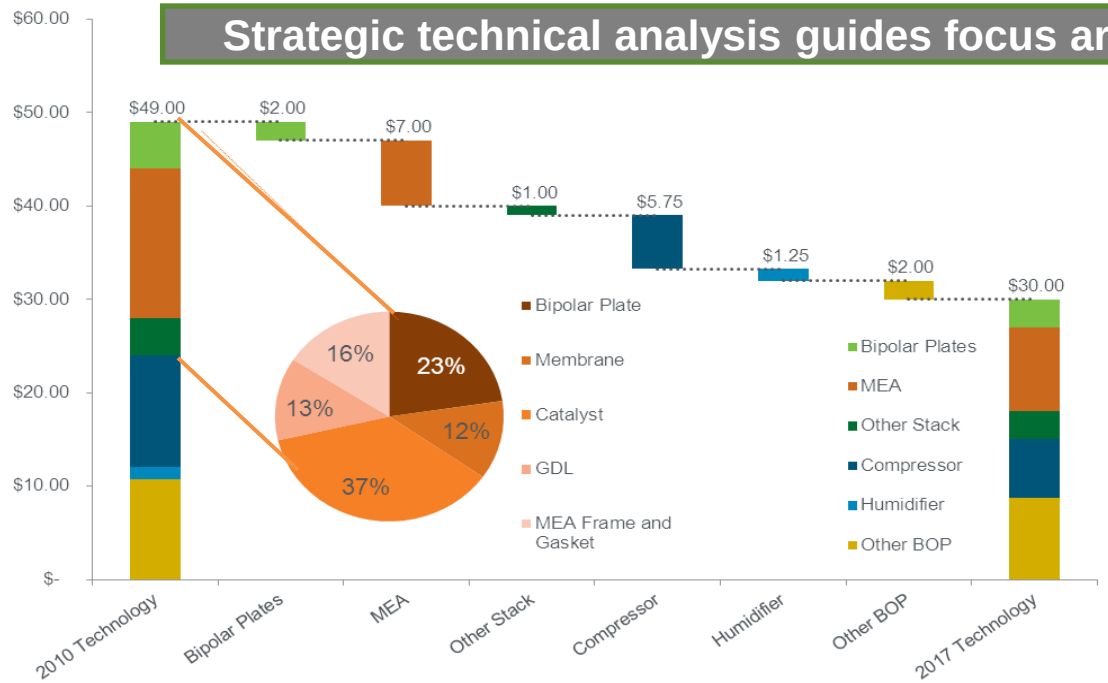


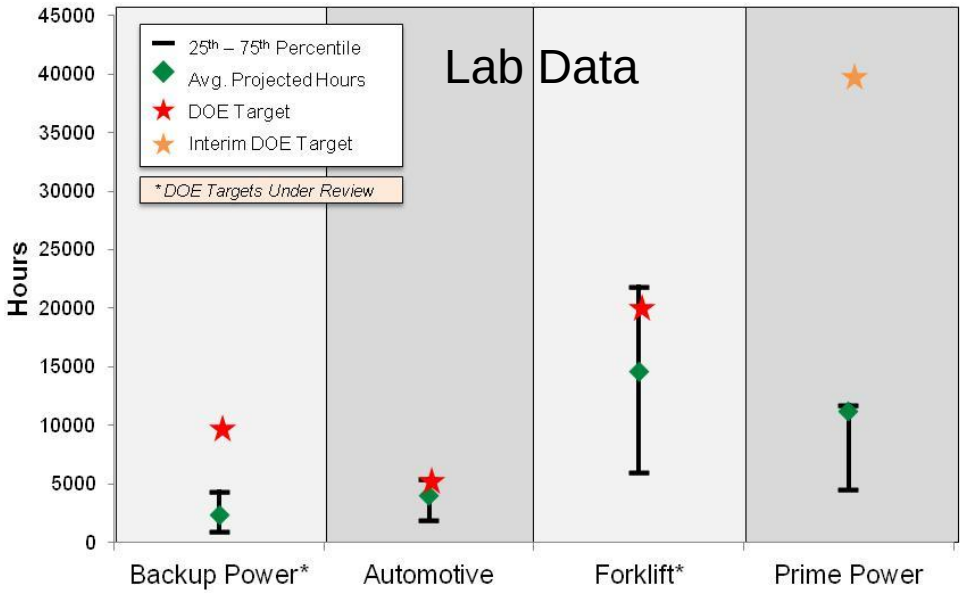
Based on projection to high-volume manufacturing (500,000 units/year).
The projected cost status is based on an analysis of state-of-the-art components that have been developed and demonstrated through the DOE Program at the laboratory scale. Additional efforts would be needed for integration of components into a complete automotive system that meets durability requirements in real-world conditions.

Portfolio Focuses on High Impact Areas

U.S. DEPARTMENT OF ENERGY

Strategic technical analysis guides focus areas





Source: DOE/NREL

Strategies to Address Challenges Catalyst Examples

- Lower PGM Content
- Pt Alloys
- Novel Support Structures
- Non-PGM catalysts

Accomplishment Highlights:

- **Catalysts meet durability milestones of 5,000 start up/shut down cycles and 200 cell reversals with total PGM loading < 0.135 mg/cm² (3M)**
- **Successfully completed 8,000 hrs desulfurizer testing and 1,000 hrs CPOX reformer testing as part of 1 MW SOFC powerplant concept running on pipeline natural gas (Rolls Royce Fuel Cell Systems)**
- **Launched cost studies for non-automotive applications, developed new fuel cell targets**

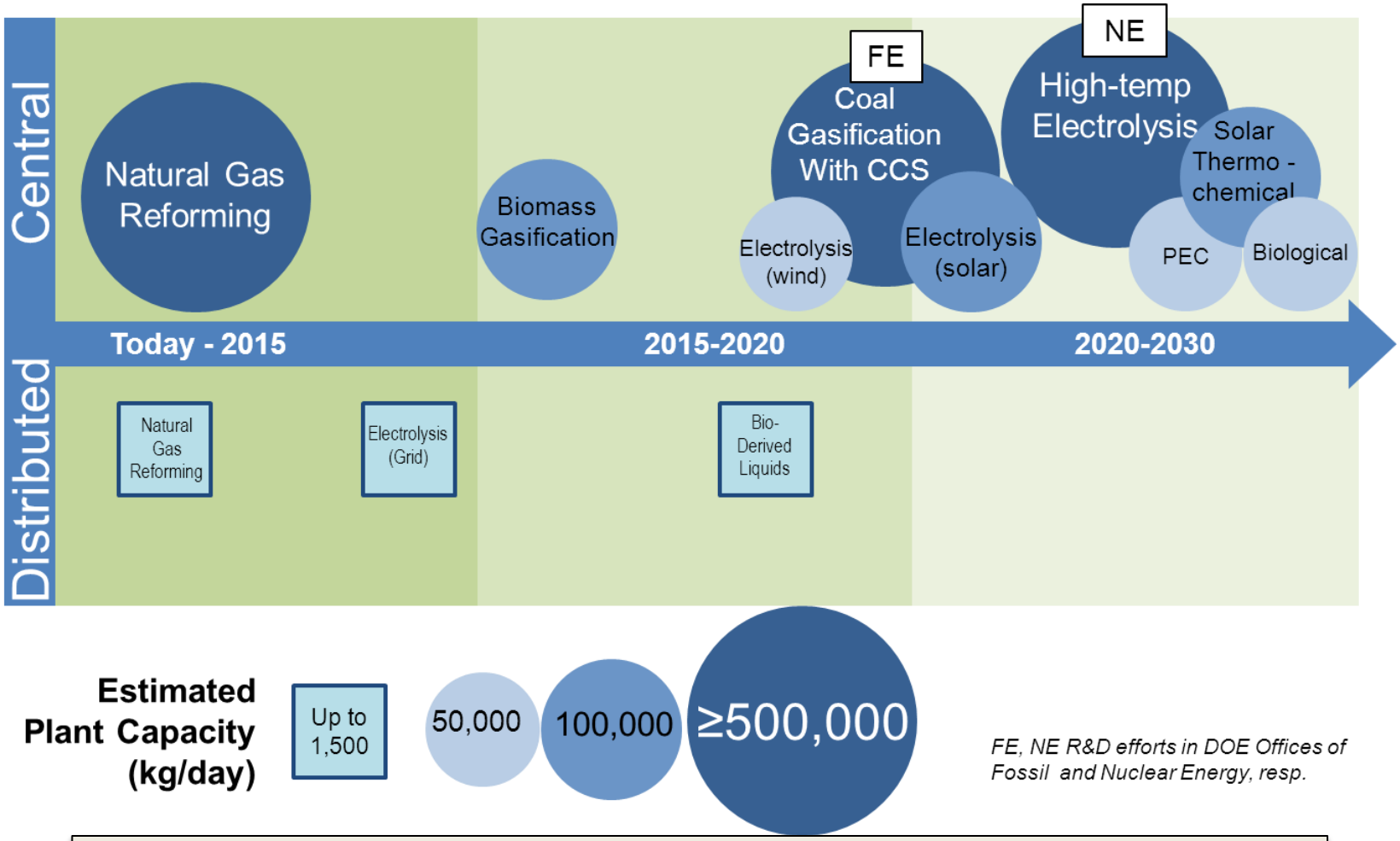
Aggregated results provide a benchmark in time of state-of-the-art fuel cell durability (time to 10% voltage degradation). Results include > 80 data sets from 10 fuel cell developers.

Please email Fuelcelldatacenter@ee.doe.gov

Hydrogen Production - Strategies

U.S. DEPARTMENT OF ENERGY

Develop technologies to produce hydrogen from clean, domestic resources at a delivered and dispensed cost of $2-$4/gge H_2 by 2020



FE, NE R&D efforts in DOE Offices of Fossil and Nuclear Energy, resp.

HTAC Subcommittee: H_2 Production Expert Panel Review underway to provide recommendations to DOE

H_2 Production & Delivery

U.S. DEPARTMENT OF ENERGY

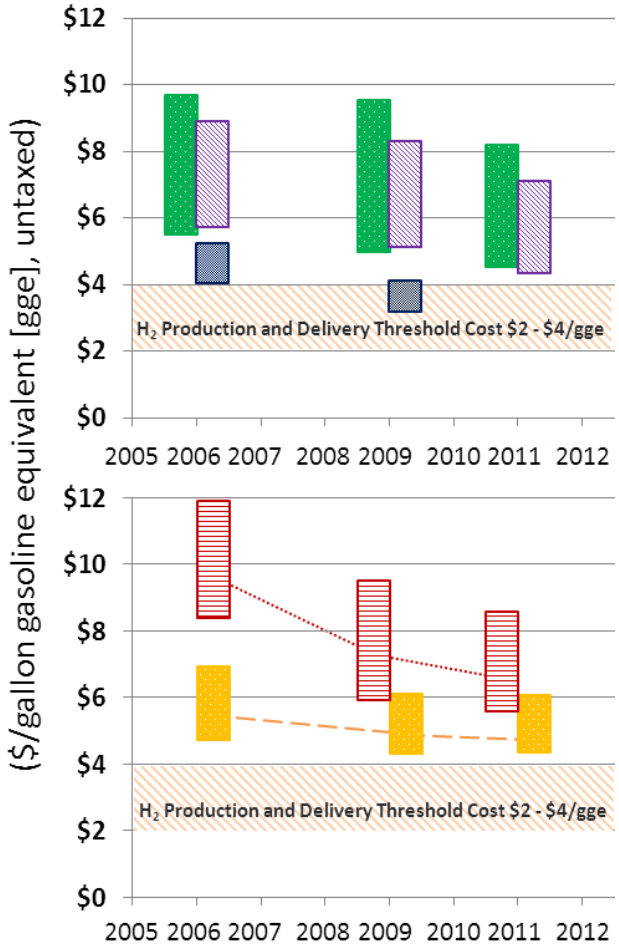
Projected High-Volume Cost of Hydrogen Production[1] (Delivered[2])—Status

Distributed Production (near term)

- Electrolysis
  Feedstock variability: $0.03 - $0.08 per kWh
- Bio-Derived Liquids
  Feedstock variability: $1.00 - $3.00 per gallon ethanol
- Natural Gas Reforming
  Feedstock variability: $4.00 - $10.00 per MMBtu

Central Production (longer term)

- Electrolysis
  Feedstock variability: $0.03 - $0.08 per kWh
- Biomass Gasification
  Feedstock variability: $40-$120 per dry short ton



Notes:
[1] 2007$ based on high-volume projections from H2A analyses, reflecting variability in major feedstock pricing and a bounded range for capital cost estimates.
[2] Costs include total cost of production and delivery (dispensed, untaxed). Forecourt compression, storage and dispensing added an additional $1.82 for distributed technologies, $2.61 was added as the price of delivery to central technologies. All delivery costs were based on the Hydrogen Pathways Technical Report (NREL, 2009).

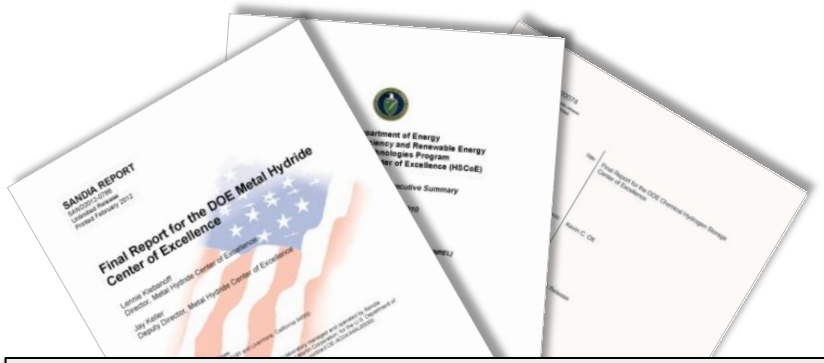
Accomplishment Highlights:

- **Updated H2A cost analysis tool. (NREL)**
- **Demonstrated high pressure electrolysis (>2,000 psig). (Proton OnSite, Giner)**
- **2-fold increase for fermentative H_2 production. (NREL)**
- **18% increase in H2 payload capacity compared to FY11, exceeding 2015 DOE target (700 kg of H_2). (Lincoln Composites)**
- **> 40% reduction in the projected tube trailer transport cost relative to the incumbent steel vessels. (Lincoln Composites)**

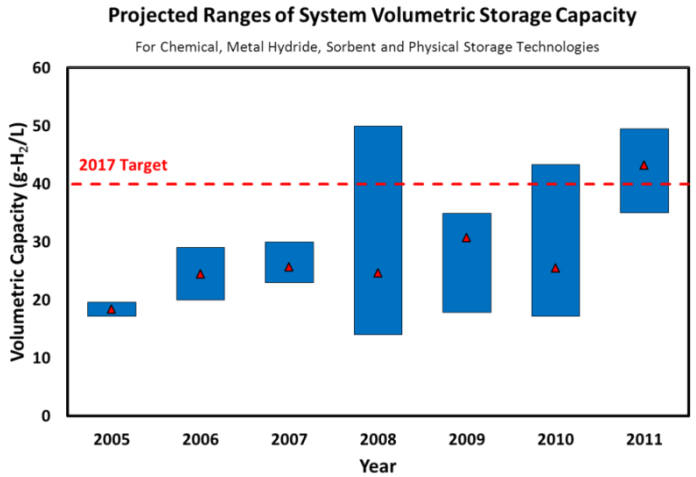
Delivery Element	2011 Status*	Goal (2015 Targets)**
Tube trailers	• Capital cost: $930/kg of H_2 transported • Capacity: 616 kg H_2 at 250 bar	• Capital cost: < $730/kg of H_2 transported • Capacity: 700kg
Forecourt storage***	• Storage tank cost: $1000 - $1450/kg H_2 for low to high pressure storage.	• Storage tank cost: $850 - $1200/kg H_2 for low to high pressure storage respectively.

* High volume projections based on the latest data employed in HDSAM (v. 2.3)
** Based on the new DOE-FCTP MYRD&D technical targets for Delivery.
***1,000 kg/day station

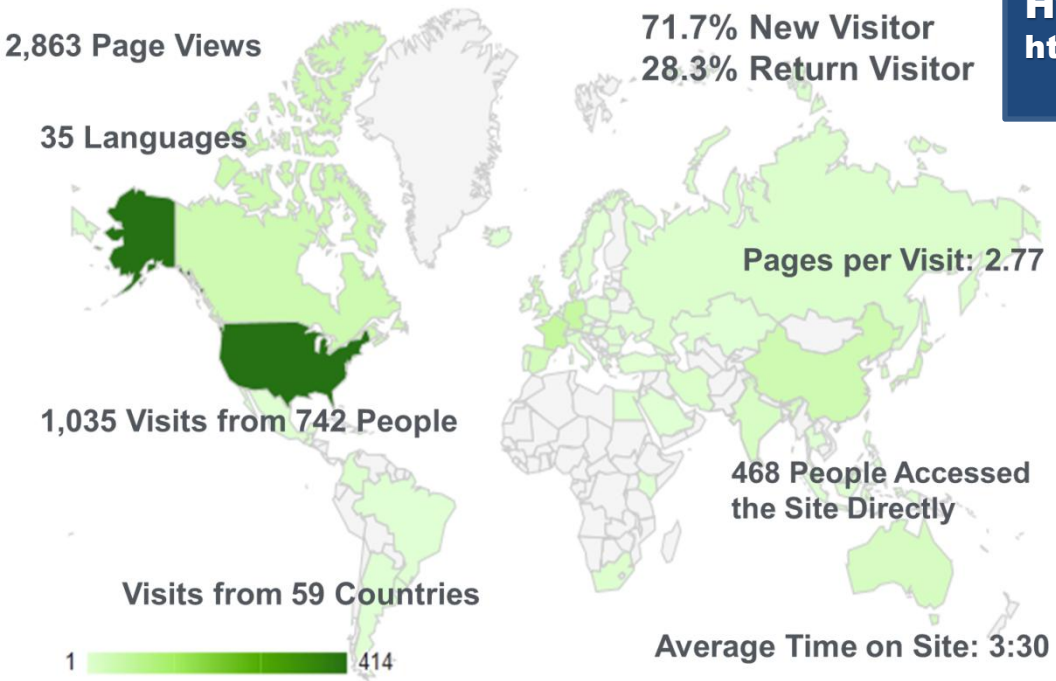
Hydrogen Storage



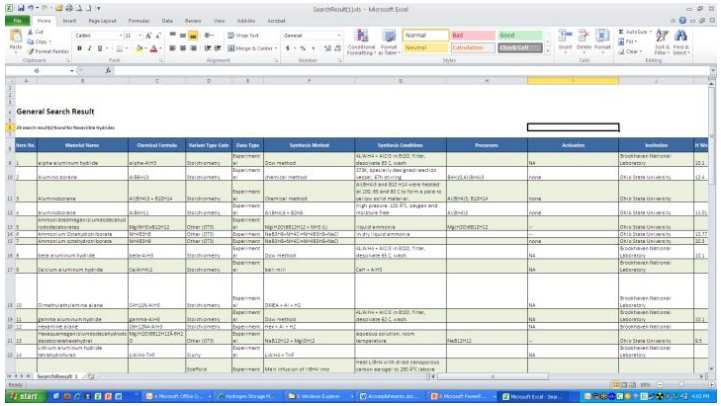
Final Reports and Executive Summaries from the 3 Hydrogen Storage Materials Centers of Excellence available online.
http://www1.eere.energy.gov/hydrogenandfuelcells/hydrogen_publications.html#h2_storage



Launched open source database* on Hydrogen Storage Materials Properties:
http://hydrogenmaterialssearch.govtools.us/



Still looking to populate it with more data!



* Presented to President's Materials Genome Initiative Interagency Working Group

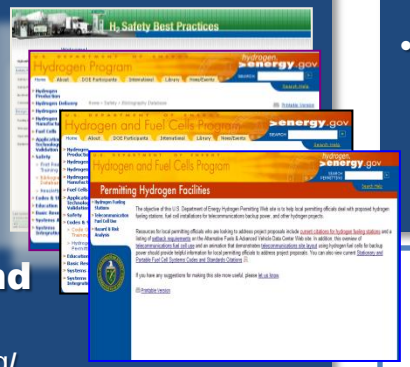
Safety, Codes & Standards & Manufacturing R&D

U.S. DEPARTMENT OF ENERGY

Safety, Codes & Standards R&D

Accomplishment Highlights:

- **Submitted Global Technical Regulation to the U.N. for Dec 2012 approval**
- **Demonstrated up to 50,000 refuelings of metal tanks for forklift applications**
- **Launched international round robin to harmonize test measurement protocols for high pressure vessels**
- **Published Online Permitting Compendium and Safety Information Tools**
  http://www.hydrogen.energy.gov/permitting/



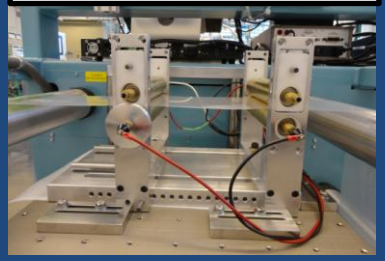
Hydrogen Safety Bibliographic Database
Permitting Hydrogen Facilities
Introduction to Hydrogen for Code Officials
Hydrogen Safety Best Practices Manual
Incidents Database and Lessons Learned

- **Trained > 23,000 first-responders and code officials on hydrogen safety and permitting through on-line and in-classroom courses**

Manufacturing R&D

- **Scaled up in-line diagnostics for MEA component quality control to 10 - 30 ft/min (NREL)**

IR/Direct Current



- **Used ultrasonic sealing of MEAs to provide rapid bonding and the potential for cost savings of >90% compared to thermal sealing (RPI)**

NREL Hydrogen & Fuel Cells Manufacturing R&D Workshop

Reps from industry, academia, lab, and government identified and prioritized needs and barriers to manufacturing. Output from the workshop was used to update the MYRD&D plan and will inform a future funding opportunity in FY13.*

Element One, Inc. named Runner-up in DOE's America's Next Top Energy Innovator Challenge

Element One has created revolutionary "smart" coatings for the detection of hydrogen that change color (reversible or non-reversible) to provide information about hydrogen leaks.

*Subject to appropriations

Completed world's largest single FCEV & H_2 Demonstration to date (50-50 DOE-Industry cost share)

- >180 fuel cell vehicles and 25 hydrogen stations
- 3.6 million miles traveled; 500,000 trips
  - ~152,000 kg of hydrogen produced or dispensed; >33,000 refuelings

	Status	Project Target
Durability	~2,500	2,000
Range	196 – 254*	250*
Efficiency	53 – 59%	60%
Refueling Rate	0.77 kg/min	1 kg/min

	Status (NG Reforming)	Status (Electroylsis)	Ultimate Target
H_2 Cost at Station	$7.70 - $10.30/kg	$10.00 - $12.90/kg	$2.00 - $4.00/kg

Demonstrated world's first Tri-generation station

Anaerobic digestion of municipal wastewater (Orange County Sanitation District)

- Produces 100 kg/day H_2; generates ~ 250 kW; 54% efficiency co-producing H_2 and electricity
- Nearly 1 million kWh of operation
- >4,000 kg H_2 produced

(Air Products, FuelCell Energy)

Demonstrated H_2 for Energy Storage (NREL)

- Showed PEM and alkaline electrolyzers provide grid frequency regulation, 4X faster than 'control' with no electrolyzers
- Achieved 5,500 hrs of variable electrolyzer stack operation to determine effects of wind AC power on stack degradation

*Independently validated a vehicle that can achieve a 430 mile range.

Market Transformation and ARRA – Catalyst for Deployments

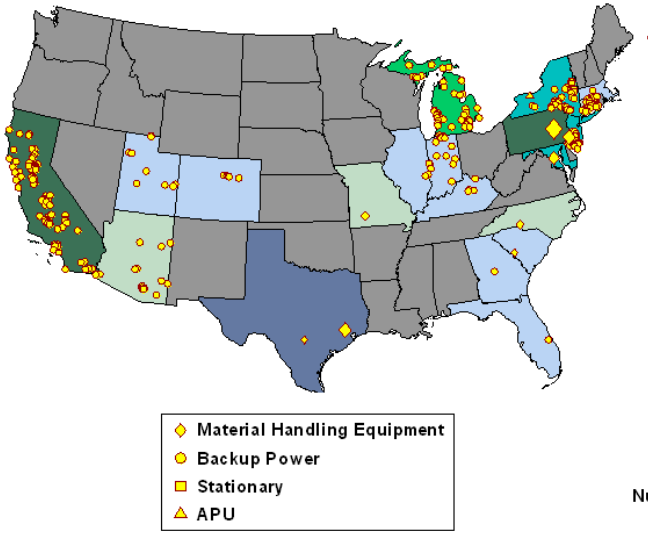
U.S. DEPARTMENT OF ENERGY

ARRA and MT deployments of fuel cells for lift trucks led to industry purchases* of an estimated 3,000 additional fuel cell lift trucks with NO DOE funding

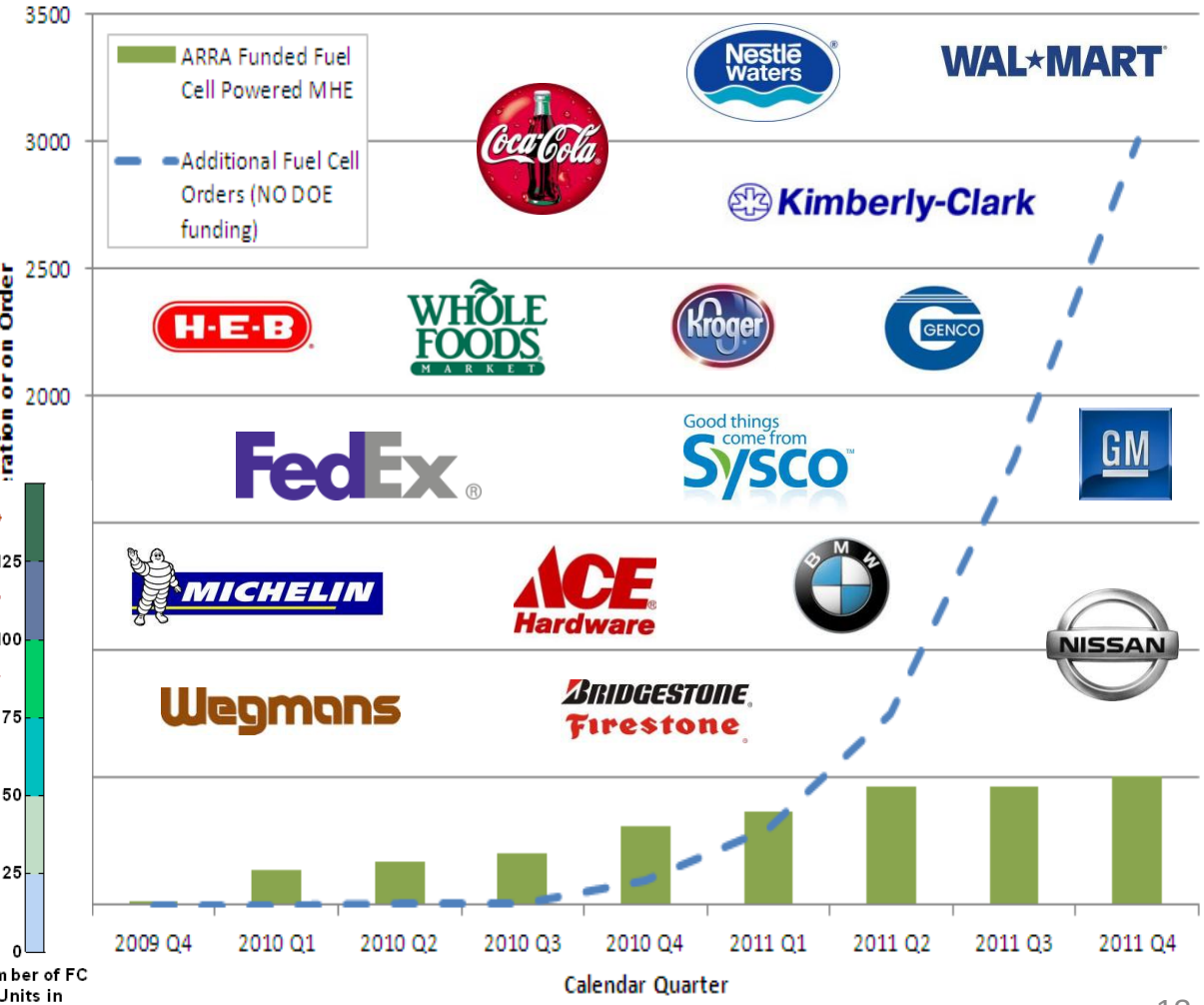
Fuel Cell Deployments

Application	Currently Operational (#)
Backup Power	668
Material Handling	504
Total	**1,172**

- **Exceeded ARRA target of up to 1,000 fuel cell deployments**
- **Demonstrated 1 million hours of operation to date**

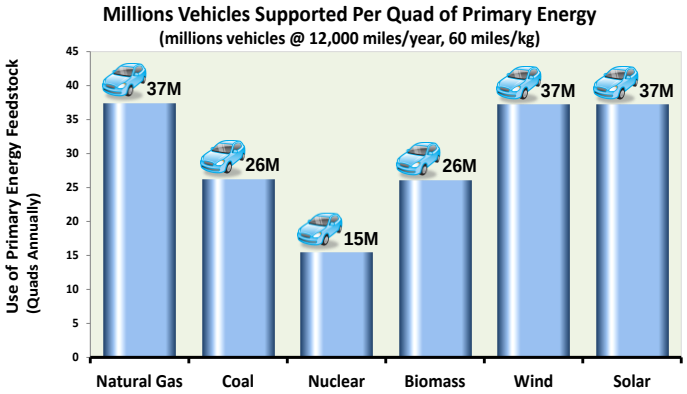


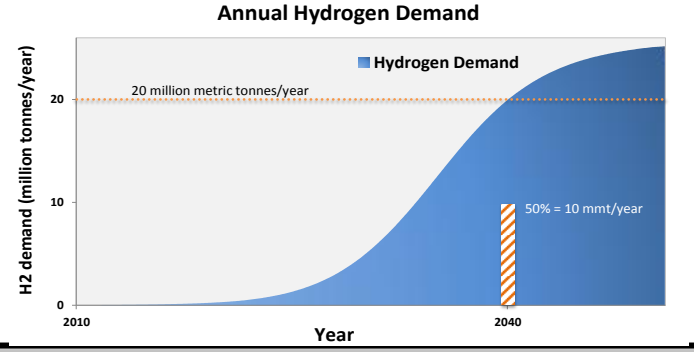
Fuel Cell Lift Truck Purchases



Systems Analysis

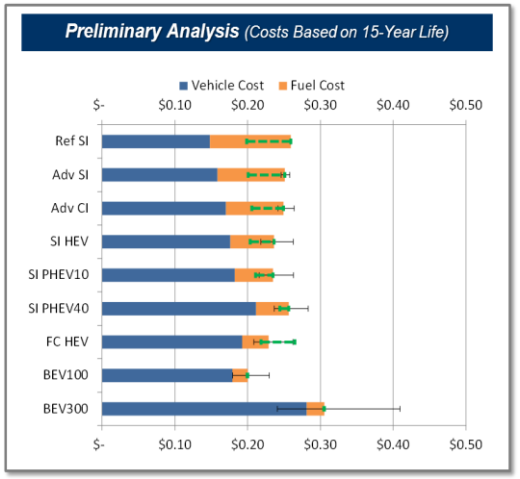
International Resource Flow





Accomplishments:

- Conducted life cycle cost and emissions analysis
- Developed station cost tool (NREL)
- Launched global study on H2 resource availability (IEA HIA, SNL, NREL)
- Workshop identified opportunities for natural gas-H_2 synergies (ANL)
- Completed H_2 in natural gas pipelines study (NREL)



Developed online jobs tool to determine employment potential (ANL)
http://jobsfc.es.anl.gov

CA STREET model – Optimizing station locations (UC Irvine, CaFCP

Renewable Hydrogen Production by Electrolysis

U.S. DEPARTMENT OF ENERGY

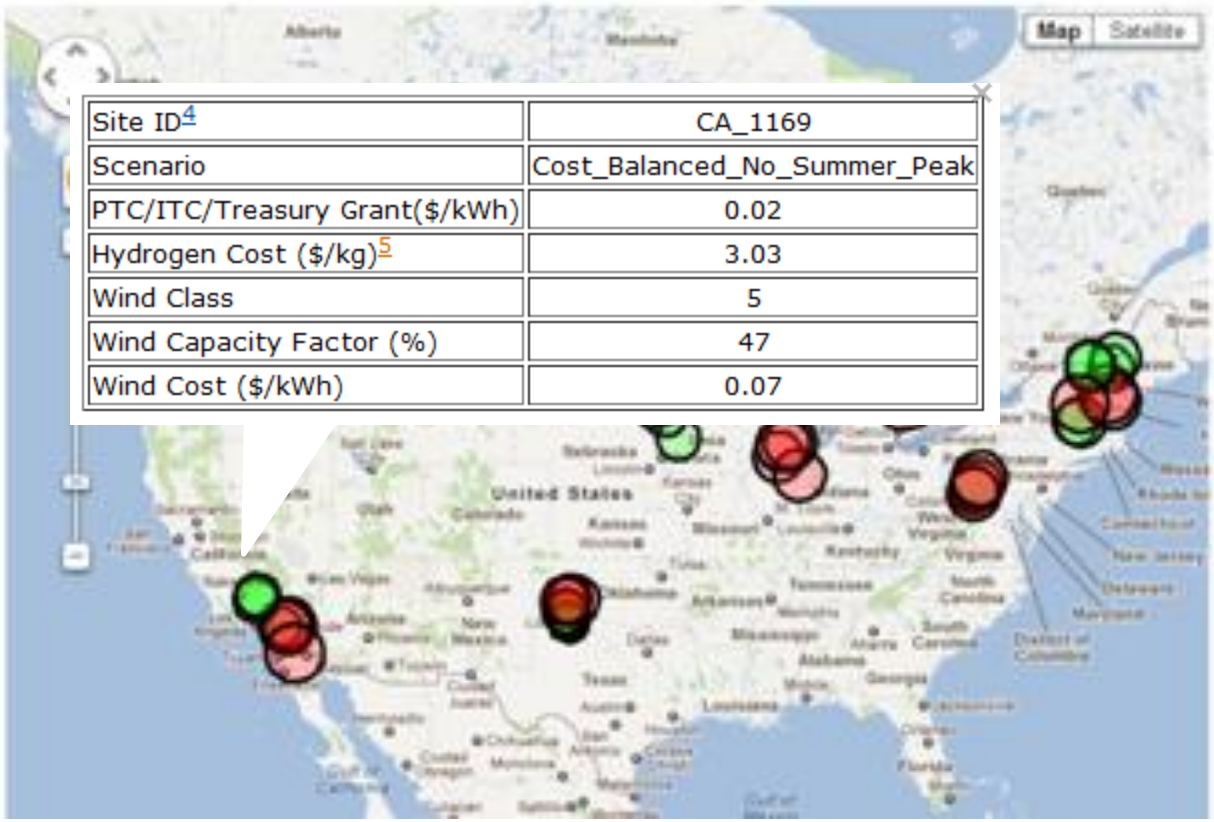
NREL has analyzed the viability of wind-based electrolysis at 42 sites in 11 states and five electricity markets in the continental US.

Summer Peak Purchase

	Yes	No
Power Balanced	◉	○
Cost Balanced	○	○

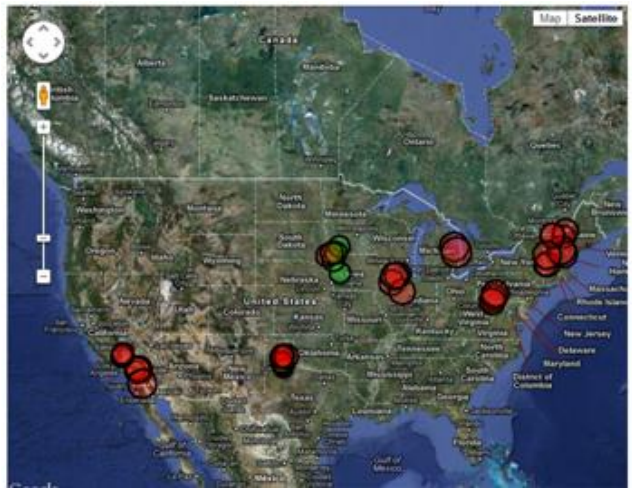
Other Variables

Enable PTC/ITC/Treasury Grant [1]	☑ Reduces wind power cost $0.02/kWh	
Target Cost [2]	○ Central $3.10/kg	◉ Distributed $3.70/kg
Compression, Storage, and Dispensing Costs [3]	☐ $2.00/kg H_2	$ [ ] /kg H_2



Site ID [4]	CA_1169
Scenario	Cost_Balanced_No_Summer_Peak
PTC/ITC/Treasury Grant($/kWh)	0.02
Hydrogen Cost ($/kg) [5]	3.03
Wind Class	5
Wind Capacity Factor (%)	47
Wind Cost ($/kWh)	0.07

Satellite View



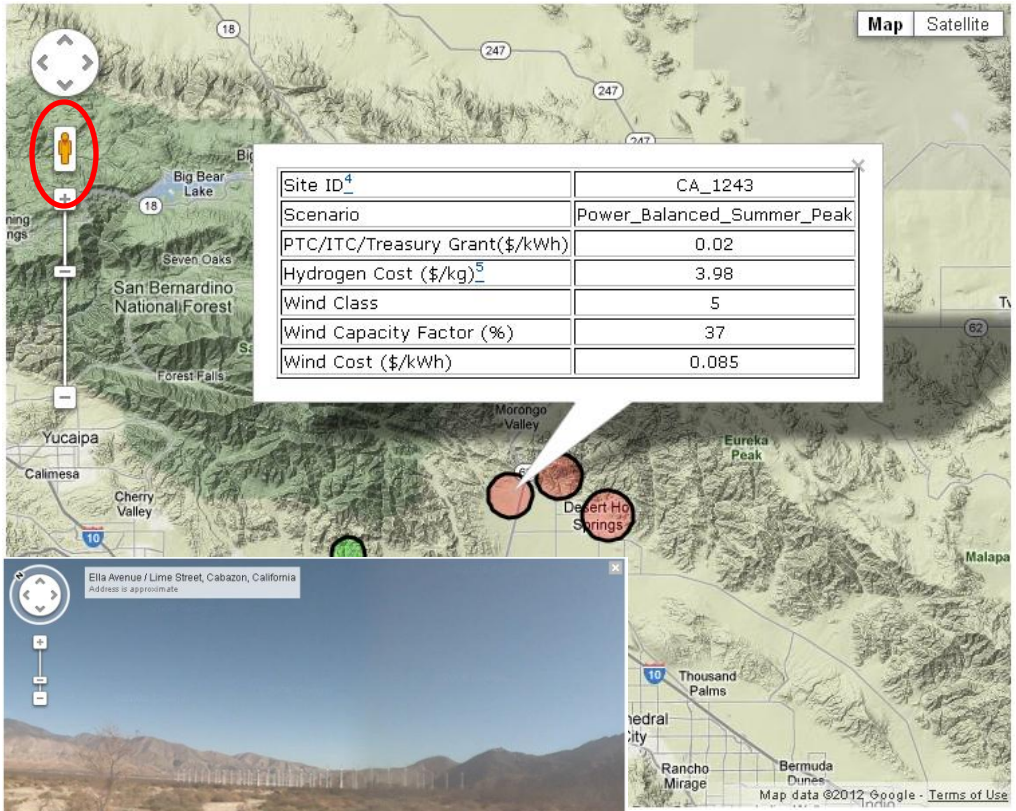
http://www.nrel.gov/hydrogen/production_cost_analysis.html

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Renewable Hydrogen Production by Electrolysis

U.S. DEPARTMENT OF ENERGY

NREL has analyzed the viability of wind-based electrolysis at 42 sites in 11 states and five electricity markets in the continental US.



Site ID[4]	CA_1243
Scenario	Power_Balanced_Summer_Peak
PTC/ITC/Treasury Grant($/kWh)	0.02
Hydrogen Cost ($/kg)[5]	3.98
Wind Class	5
Wind Capacity Factor (%)	37
Wind Cost ($/kWh)	0.085

Significance of Results

- Wind incentives amounting to \$0.02/kWh result in a \$~1/kg H_2 cost reduction.
- These incentives allow some sites to meet DOE targets.
- Interactive tool allows users to provide input to the analysis and see updated results immediately.

Users can:

- Explore the effects of the four different balance scenarios; cost or power with & without the purchase of peak summer electricity.
- Compare H_2 costs with DOE targets.
- See the effects of wind power incentives on H_2 costs.
- Add compression, storage, and dispensing costs.
- See the effects of local topography.
- See what's at the site with Google Street View. ™

http://www.nrel.gov/hydrogen/production_cost_analysis.html

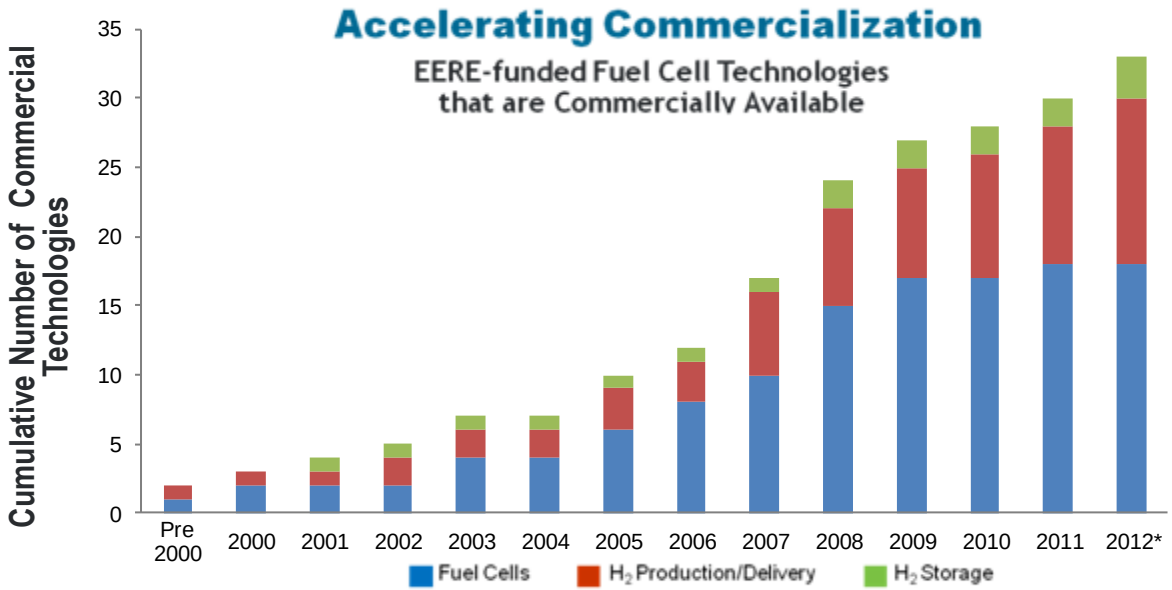
NREL NATIONAL RENEWABLE ENERGY LABORATORY

16

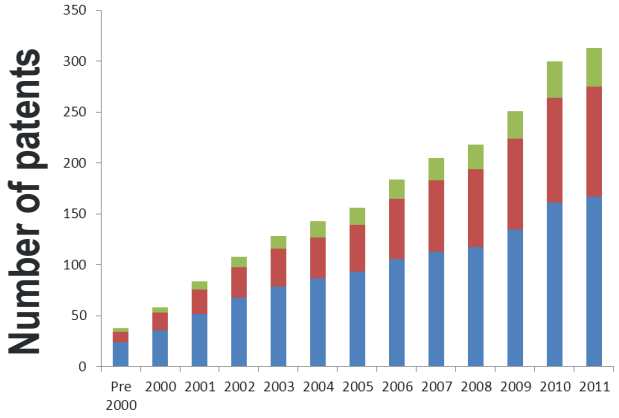
Assessing the Impact of DOE Funding

U.S. DEPARTMENT OF ENERGY

DOE funding has led to 313 patents, ~33 commercial technologies and >60 emerging technologies.
DOE's Impact: ~$70M in funding for specific projects was tracked – and found to have led to nearly $200M in industry investment and revenues.



Source: Pacific Northwest National Laboratory
http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/pathways_success_hfcit.pdf



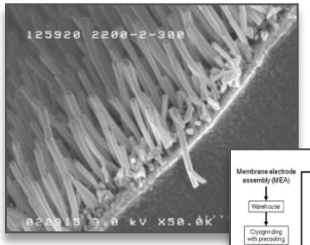
>310 PATENTS resulting from EERE-funded R&D:

- *Includes technologies for hydrogen production and delivery, hydrogen storage, and fuel cells*

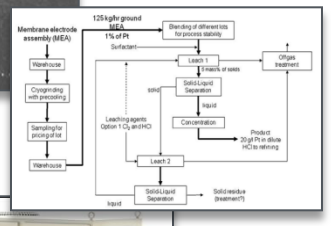
http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/pathways_2011.pdf

Examples

3M



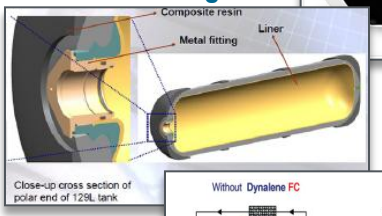
BASF Catalysts LLC



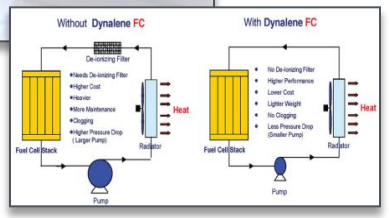
Proton OnSite

DuPont

Quantum Technologies



Dynalene, Inc.



Methodology – Includes competitive review processes, peer reviews & go/no go decisions

U.S. DEPARTMENT OF ENERGY

Topic Selection

- **Stakeholders**
  - e.g.: RFIs, industry, HTAC, etc.
- **U.S. DRIVE**
- **Peer Reviews**
  - NAS
  - GAO
  - Others

→ **Targets**
- **"Critical Path" needs**
- **Technology Gaps**

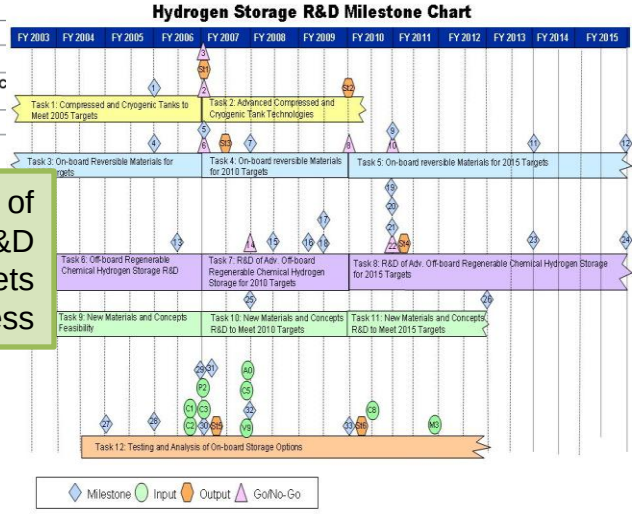
→ **RD&D Plan and Solicitation Topics**

- **Risk Analysis**
- **Technology Reviews**

Example Fuel Cell Membrane Targets

Characteristic	Units	2011 status	2017 target	Nafion® NRE211
Maximum oxygen crossover	mA/cm²	<1	2	2.7
Maximum hydrogen crossover	mA/cm²	<1.8	2	2.2
Area specific resistance at:				
Max operating temp and 40 – 80 kPa water partial pressure	ohm cm²	0.023 (40 kPa) 0.012 (80 kPa)	0.02	0.186
80°C and water partial pressures from 25 - 45 kPa	ohm cm²	0.017 (25 kPa) 0.006 (44 kPa)	0.02	0.03-0.12
30°C and water partial pressures up to 4 kPa	ohm cm²	0.02 (3.8 kPa)	0.03	0.049
-20°C	ohm cm²	0.1	0.2	0.179
Operating temperature				
Minimum electrical resistance				
Cost				
Durability				
Mechanical	C			
Chemical				

Technical targets help guide go/no-go decisions.



Update of Multiyear RD&D Plan and Targets in process

Project & Program Review Processes

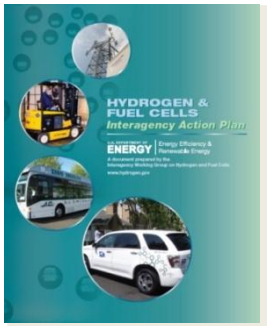
- **Annual Merit Review & Peer Evaluation meetings**
- **Tech Team reviews (monthly)**
- **Other peer reviews- National Academies, GAO, etc.**
- **DOE quarterly reviews and progress reports**

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
123	New Polymer/ Inorganic Proton Conductive Composite Membranes for PEMFC	2.1		X		The project was unable to meet conductivity targets or significantly improve upon Nafion®, and the membranes developed have poor chemical stability. The project will not be continued.

Over $19M saved in the last 3 years through go/no-go decisions

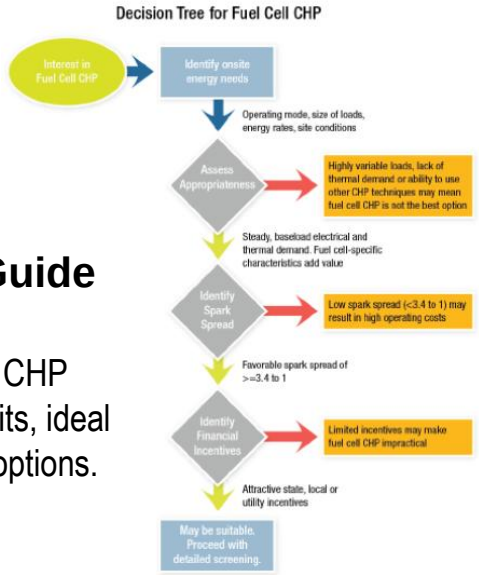
Reviewer comments for projects posted online annually. Projects discontinued/ work scope altered based on performance & likelihood of meeting goals.

Collaborations – Federal Agencies and States



December 2011

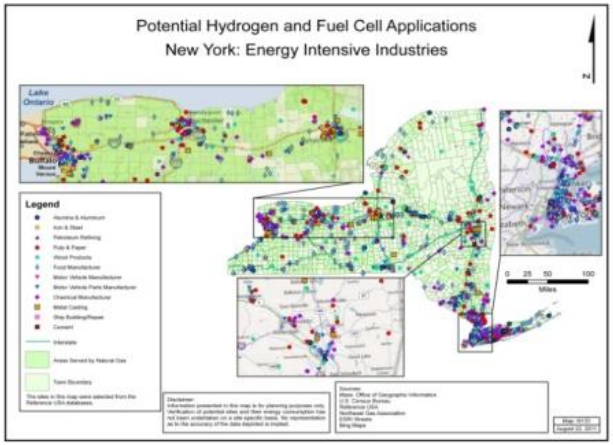
Developed Interagency Action Plan with 10 Federal Agencies (Interagency Working Group)



Developed Procurement Guide (ORNL)

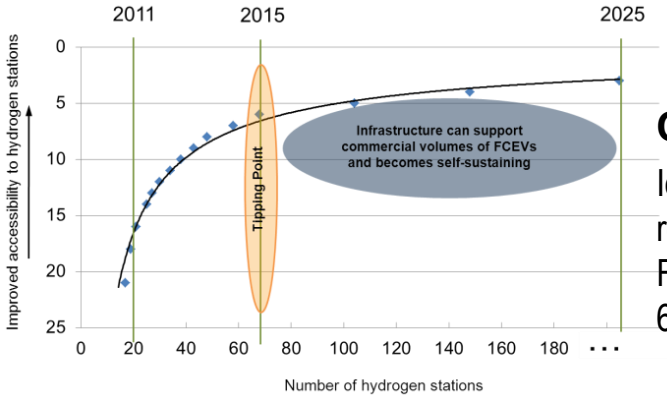
Provides guidance on CHP technology – its benefits, ideal usage, and financing options.

Published States Report (Joel M. Rinebold, et al, Connecticut Center for Advanced Technology (CCAT))



Identified numerous opportunities for fuel cells for different applications. **>1.8 GW opportunity identified.**

Developed Roadmaps for Northeastern States (CCAT)



California (CaFCP)

Identified infrastructure requirements for commercial FCEV launch ("tipping point" is 68 stations)

Communication & Outreach

U.S. DEPARTMENT OF ENERGY

Published more than 70 news articles in FY 2011 (including blogs, progress alerts, DOE news alerts)

- ***Webinar Series***
  - May 22: Jobs Tool
  - June: Recent fuel cell licenses
  - July: Portable power
  - August: Mobile lighting
  - Register at - http://www1.eere.energy.gov/hydrogenandfuelcells/webinars.html

We are requesting topics for future webinars and value your input!

- ***News Items***
- Energy Department Announces up to $2.5 Million to Deploy Fuel Cell Powered Baggage Vehicles at Commercial Airports (April 25, 2012)
- Energy Department Awards More than $5 Million to Reduce Cost of Advanced Fuel Cells (March 27)

- ***Monthly Newsletter***
- Visit the web site to register or to see archives (http://www1.eere.energy.gov/hydrogenandfuelcells/newsletter.html)

"These technologies are part of a broad portfolio that will create new American jobs, reduce carbon pollution, and increase our competitiveness in today's global clean energy economy."

Hydrogen fuel cell power lights at the 2011 Golden Globes

Developed education materials and educated more than 9,600 teachers on H_2 and fuel cells to date.

Hydrogen fuel cell powered light tower at Space Shuttle launch

EERE H_2 & Fuel Cells Budgets

U.S. DEPARTMENT OF ENERGY

FY12 Appropriations: **" The Committee recognizes the progress and achievements of the Fuel Cell Technologies program. The program has met or exceeded all benchmarks, and has made significant progress in decreasing costs and increasing efficiency and durability of fuel cell and hydrogen energy systems."**

EERE FCT Funding *($ in thousands)*			
Key Activity	FY 2011 Allocation	FY 2012 Appropriation	FY 2013 Request
Fuel Cell Systems R&D	41,916	44,812	38,000
Hydrogen Fuel R&D	32,122	34,812	27,000
Technology Validation	8,988	9,000	5,000
Market Transformation	0	3,000	0*
Safety, Codes & Standards	6,901	7,000	5,000
Education	0	0	0
Systems Analysis	3,000	3,000	3,000
Manufacturing R&D	2,920	2,000	2,000
Total	$95,847	$103,624	$80,000*

FY 2013 House Mark: $82M Senate Mark: $104 M

Future Directions

Continue critical R&D

Hydrogen, fuel cells, safety, codes and standards, etc.

Conduct strategic, selective demonstrations of innovative technologies

Continue to conduct key analysis to guide RD&D and path forward, determine infrastructure needs

Leverage activities to maximize impact

In FY 2013, the Program plans to leverage activities in other EERE Programs (e.g., Advanced Manufacturing and Vehicle Technologies in key areas), *subject to appropriations.

Funding Opportunity Announcements & Requests for Information

U.S. DEPARTMENT OF ENERGY

FY 2012 FOAs	FY 2012 Funding
Collect Performance Data on Fuel Cell Electric Vehicles (deadline extended 6/18)	$6.0 million
Hydrogen Fueling Stations and Innovations in Hydrogen Infrastructure Technologies (closed 5/11)	$2.0 million
Fuel Cell Powered Baggage Vehicles at Commercial Airports	$2.5 million
Zero-Emission Cargo Transport Vehicles (Vehicle Technologies, closes 5/15)	$10.0 million

Requests for Information

- Fuel Cell RFIs on Targets for Lift Trucks and Backup Power
- Potential Topics for H-Prize—*extended to May 31, 2012*
  (www.hydrogenandfuelcells.energy.gov/m/news_detail.html?news_id=18182)
- Storage RFI on Early Market Targets
  (Posted on eXCHANGE at https://eere-exchange.energy.gov/Default.aspx#6d785cb1-552e-44bd-98e3-e27a7e3fea0b)

Acknowledgements

U.S. DEPARTMENT OF ENERGY

Federal Agencies

- DOC
- DOD
- DOE
- 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.*

External Input

- Annual Merit Review & Peer Evaluation
- H2 & Fuel Cell Technical Advisory Committee
- National Academies, GAO, etc.

Industry Partnerships & Stakeholder Assn's.

- Tech Teams (U.S. DRIVE)
- Fuel Cell and Hydrogen Energy Association (FCHEA)
- Hydrogen Utility Group
- ~ 65 projects with 50 companies

Universities

~ 50 projects with 40 universities

DOE Hydrogen & Fuel Cells Program

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

International

- IEA Implementing agreements – 25 countries
- International Partnership for Hydrogen & Fuel Cells in the Economy – 17 countries & EC

National Laboratories

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

Other Federal Labs: Jet Propulsion Lab, National Institute of Standards & Technology, National Energy Technology Lab (NETL)

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

World Class Researchers - Examples

U.S. DEPARTMENT OF ENERGY

Adam Weber (LBNL) honored as Energy Technology Division Supramaniam Srinivasan Young Investigator Award from The Electrochemical Society in Seattle.

Scott Samuelsen (UC Irvine) named a White House Champion of Change for his work as Director of the Advanced Power and Energy Program and the National Fuel Cell Research Center.

Dr. Fernando Garzon (LANL) was elected President of the National Electrochemical Society (ECS).

Radoslav Adzic (BNL) honored as 2012 Inventor of the Year by the NY Intellectual Property Law Association.

3 Presidential Awardees:

- **Professor Susan Kauzlarich** – UC Davis, a 2009 recipient of the ***Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring***—and a partner of the Chemical Hydrogen Storage Center of Excellence

- **Dr. Jason Graetz** – Brookhaven National Laboratory, a 2009 recipient of the ***Presidential Early Career Award for Scientists and Engineers***—and a partner of the Metal Hydride Center of Excellence

- **Dr. Craig Brown** – NIST, a 2009 recipient of the ***Presidential Early Career Award for Scientists and Engineers***—and a Partner of the Hydrogen Sorption Center of Excellence

Thank you

Sunita Satyapal
Program Manager
Hydrogen and Fuel Cells Program
Sunita.Satyapal@ee.doe.gov
(202) 586-2336

Additional Information

www.hydrogen.energy.gov

Key Reports

Pathways to Commercial Success: Technologies and Products Supported by the Fuel Cell Technologies Program

By PNNL, http://www.pnl.gov/

See report: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/pathways_2011.pdf

The Business Case for Fuel Cells 2011: Energizing America's Top Companies

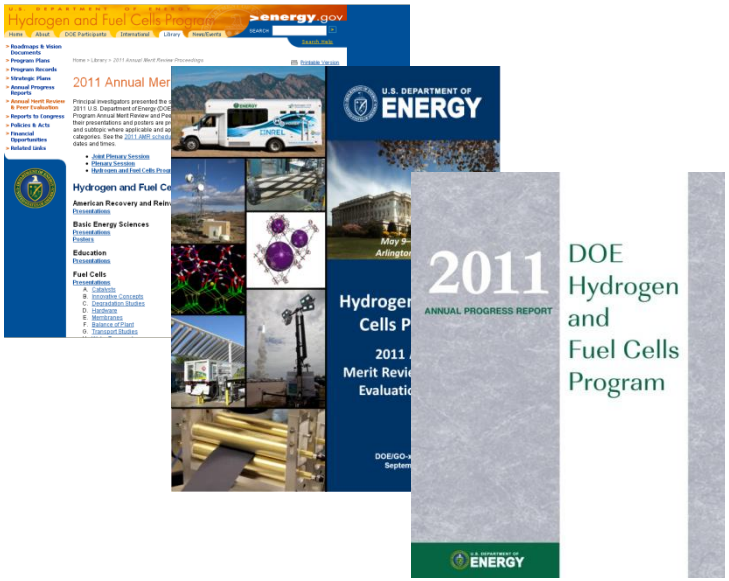
By FuelCells2000, http://www.fuelcells.org

See report: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/business_case_fuel_cells_2011.pdf

State of the States 2011: Fuel Cells in America

By FuelCells2000, http://www.fuelcells.org

See report: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/stateofthestates2011.pdf



Annual Merit Review & Peer Evaluation Proceedings

Includes downloadable versions of all presentations at the Annual Merit Review

http://www.hydrogen.energy.gov/annual_review11_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

http://hydrogen.energy.gov/annual_review11_report.html

Annual Progress Report

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

www.hydrogen.energy.gov/annual_progress.html

Next Annual Review: May 13– 17, 2013 Arlington, VA

http://annualmeritreview.energy.gov/

Examples of DOE-funded Partners and Locations – Fuel Cell Technologies Program

U.S. DEPARTMENT OF ENERGY

Participation Organizations/Collaborators

U.S. DEPARTMENT OF ENERGY

- **Industry**
  - 3M
  - Acumentrics
  - Air Products & Chemicals, Inc.
  - Altergy
  - Arkema, Inc.
  - AT&T
  - Avalence
  - Ballard
  - BASF
  - BMW
  - Boeing
  - BP
  - Carolina Tractor
  - Chevron
  - Clear Edge
  - Coca Cola
  - Concepts ETI
  - Concepts NREC
  - ConocoPhillips
  - Delphi Automotive
  - Dupont
  - Eaton
  - EnergyWorks
  - ExxonMobil
  - FedEx Freight East
  - Ford Motor Company
  - FuelCell Energy
  - Gas Technology Institute
  - GENCO
  - General Motors
  - Giner
  - H2 Technology Consulting LLC
  - Hawaii Hydrogen Carriers, LLC.
  - H-E-B
  - HRL Laboratories
  - Hydrogen Frontier, Inc.
  - Hydrogenics Corporation
  - Hyundai-Kia
  - Ion Power
  - Innovatek
  - Jadoo Power
  - Kimberly Clark
  - Linde
  - Lincoln Composites
  - Lockheed Martin
  - Media and Process Technologies
  - Mercedes Benz R&D, North America
  - Midwest Optoelectronics
  - MITI
  - Mohawk Innovative
  - MTI Micro Fuel Cells
  - MV Systems
  - Nuvera Fuel Cells
  - Oorja Protonics
  - ORISE
  - PG&E
  - Plug Power
  - Praxair
  - Proton OnSite
  - Quantum Technologies
  - Regulatory Logic
  - ReliOn, Inc.
  - Rolls Royce
  - SAIC
  - Sempra Energy
  - Shell
  - Sprint Nextel
  - Strategic Analysis
  - SunLine
  - Sysco Houston
  - Sysco Philadelphia
  - TDA (SBIR Phase III)
  - TIAX
  - UTC Power
  - UTRC
  - Versa Power
  - Wegmans
  - Whole Foods Market
  - W. L. Gore & Associates

Participation Organizations/Collaborators

U.S. DEPARTMENT OF ENERGY

- **National Labs**
  - Argonne National Laboratory
  - Brookhaven National Laboratory
  - Jet Propulsion Laboratory
  - Lawrence Berkeley National Laboratory
  - Lawrence Livermore National Laboratory
  - Los Alamos National Laboratory
  - National Renewable Energy Laboratory
  - Oak Ridge National Laboratory
  - Pacific Northwest National Laboratory
  - Sandia National Laboratories
  - Savannah River National Laboratory

- **Government/Non-Profits**
  - AC Transit
  - Army CERL
  - CA Fuel Cell Partnership
  - Clean Energy State Alliance
  - City of Burbank, CA
  - City of Folsom, CA
  - Connecticut Center for Advanced Technology, Inc.
  - CT Transit
  - FAA
  - Fort Irwin
  - Hydrogen Education Foundation
  - NASA
  - National Energy Education Development Project
  - NIST
  - NPS
  - ONR
  - Ohio Fuel Cell Coalition
  - SCRA
  - South Carolina Hydrogen and Fuel Cell Alliance
  - Technology Transition Corporation
  - U.S. DOT
  - U.S. DOC
  - Virginia Clean Cities
  - Warner Robins Air Force Base

- **Universities & Institutes**
  - Battelle
  - California Institute of Technology
  - Cal State – LA
  - Case Western University
  - Colorado School of Mines
  - Farmingdale State College
  - Hawaii Natural Energy Institute
  - Humboldt State University
  - I2CNER
  - Illinois Institute of Technology
  - J. Craig Venture Institute
  - Kettering University
  - Miami University
  - Michigan Technical University
  - National Fuel Cell Research Center, U.C. Irvine
  - Northeastern University
  - Northwestern University
  - Oregon State University
  - Pennsylvania State University
  - Rochester Polytechnic Institute
  - Southwest Research Institute
  - Stanford University
  - Stark State College
  - State University of New York
  - Texas A&M University
  - Univ. of Akron
  - Univ. of California – Berkeley Lawrence Hall of Science
  - Univ. of California – Davis
  - Univ. of California – Irvine
  - Univ. of California – LA
  - Univ. of Central Florida
  - Univ. of Colorado – Boulder
  - Univ. of Hawaii
  - Univ. of Michigan
  - Univ. of Missouri – Columbia
  - Univ. of Nevada – Las Vegas
  - Univ. of NC – Charlotte
  - Univ. of North Dakota
  - Univ. of North Florida
  - Univ. of Oregon
  - Univ. of South Carolina
  - Vanderbilt University
  - Virginia Tech University