U.S. Department of Energy
Energy Efficiency and Renewable Energy

**Hydrogen, Fuel Cells & Infrastructure Technologies Program**

# Program Overview

# Steve Chalk, Program Manager

**Annual Program Review**
May 19th – 22nd, 2003
Berkeley, California

# President Bush Launches the Hydrogen Fuel Initiative

"Tonight I am proposing $1.2 billion in research funding so that America can lead the world in developing clean, hydrogen-powered automobiles."

"A simple chemical reaction between hydrogen and oxygen generates energy, which can be used to power a car producing only water, not exhaust fumes. With a new national commitment, our scientists and engineers will overcome obstacles to taking these cars from laboratory to showroom so that the first car driven by a child born today could be powered by hydrogen, and pollution-free."

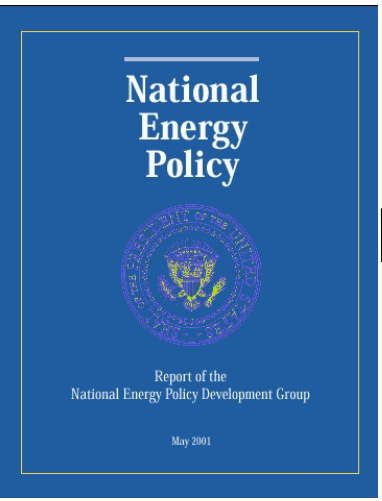
"Join me in this important innovation to make our air significantly cleaner, and our country much less dependent on foreign sources of energy."

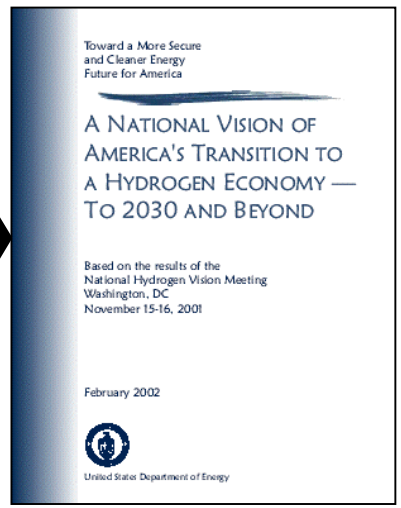
President George W. Bush
2003 State of the Union Address
January 28, 2003

# Vision For The Hydrogen Economy

President Bush "Hydrogen fuel cells represent one of the most encouraging, innovative technologies of our era. …And so that's why I'm going to work with the Congress to move this nation forward on hydrogen fuel cell technologies."

***-President Bush, February 6, 2003, Remarks on Energy Independence***



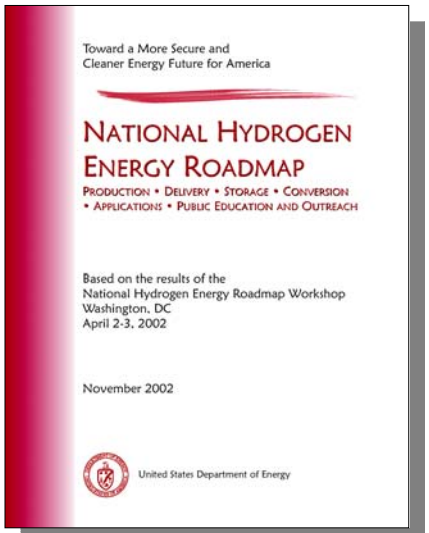




**Vision for the Hydrogen Economy**

Hydrogen is America's clean energy choice.

Hydrogen is flexible, affordable, safe, domestically produced, used in all sectors of the economy, and in all regions of the country.

# President's Hydrogen Fuel Initiative Complements FreedomCAR




***Secretary Abraham Calls for "International Partnership for the Hydrogen Economy"***
***April 28, 2003***

*Secretary of Energy Spencer Abraham called for the development of international collaboration in advanced research and development that will support the deployment of hydrogen energy technologies. Secretary Abraham announced the initiative during a presentation to the International Energy Agency Ministerial meeting.*

***On January 9, 2002, Energy Secretary Abraham announced the FreedomCAR Partnership***

**Four "Freedom" Principles:**

- Freedom from foreign petroleum dependence
- Freedom from pollutant and carbon dioxide emissions
- Freedom for Americans to drive where they want, when they want, in the vehicle of their choice
- Freedom to obtain fuel affordably and conveniently

# Hydrogen Infrastructure and Fuel Cell Technologies put on an Accelerated Schedule

- President Bush commits a total $1.7 billion over first 5 years:
  - $1.2 billion for hydrogen and fuel cells RD&D ($720 million in new money)
  - $0.5 billion for hybrid and vehicle technologies RD&D
- Accelerated, parallel track enables industry commercialization decision by 2015.

***Fuel Cell Vehicles in the Showroom and Hydrogen at Fueling Stations by 2020***

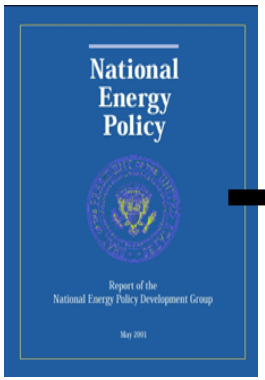
# The President's FY04 Budget Request for FreedomCAR and Hydrogen Fuel Initiatives

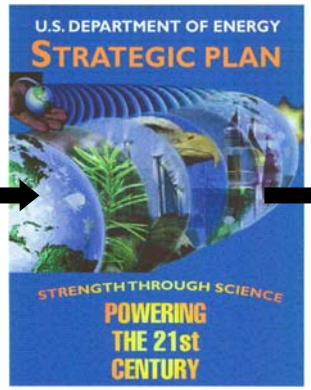
| Organization | Million $ |
|---|---|
| Hydrogen, Fuel Cells & Infrastructure Technologies Program (EERE) | 165.5 |
| FreedomCAR and Vehicle Technologies Program (EERE) | 91.1 |
| Office of Fossil Energy (FE) | 11.5 |
| Office of Nuclear Energy, Science and Technology (NE) | 4.0 |
| Department of Transportation (RSPA) | 0.7 |
| *Total* | *272.8* |

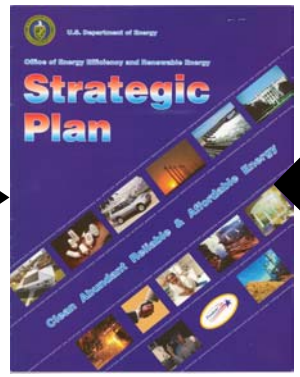
***President's Office of Science and Technology Policy has formed an Interagency Hydrogen Research and Development Task Force***

# Planning

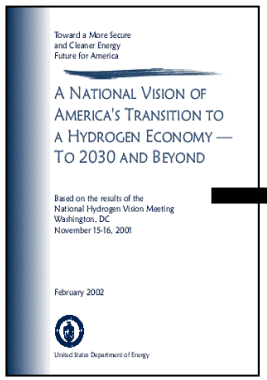
**Policy**

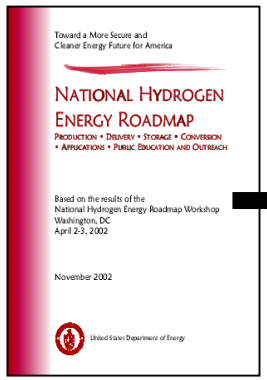


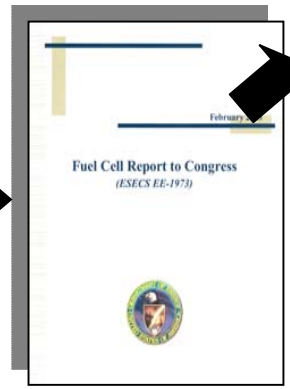



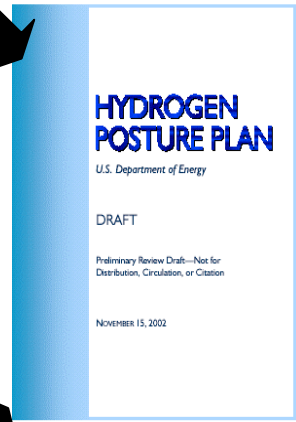




**Stake-holder Input**

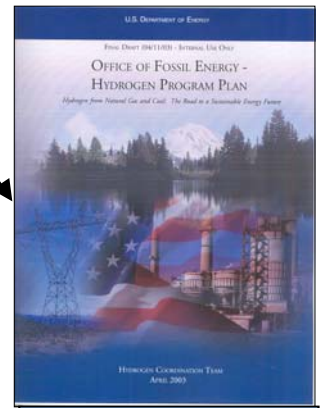







Nuclear Hydrogen Initiative Program Plan

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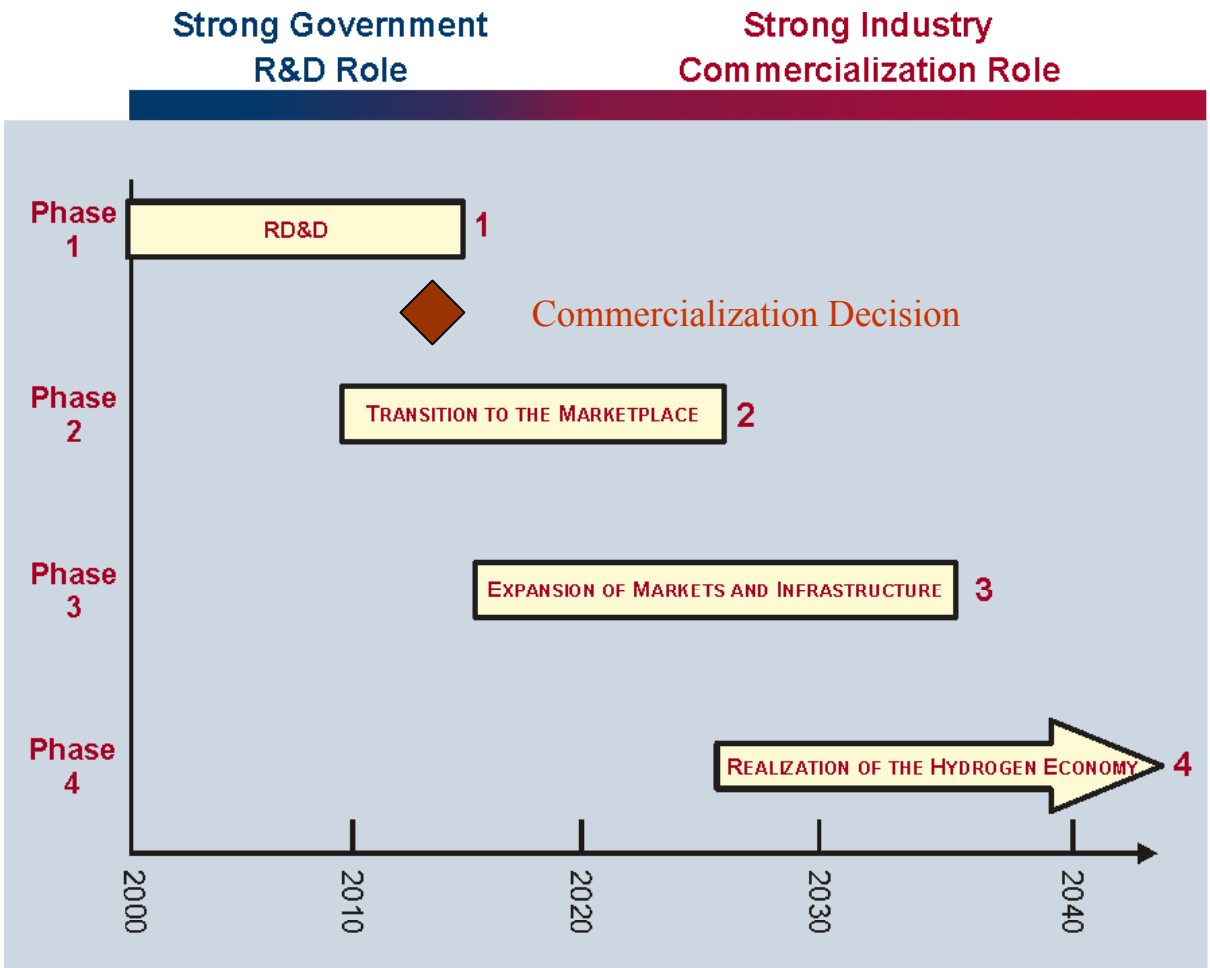
www.eere.energy.gov/hydrogenandfuelcells

# Timeline for Hydrogen Economy




## Transitional Phases

1. **Technology Development Phase**
   $H_2$ power and transport systems available in select locations; limited infrastructure
2. **Initial Market Penetration Phase**
   $H_2$ power and transport systems begin commercialization; infrastructure investment begins with governmental policies
3. **Infrastructure Investment Phase**
   $H_2$ power and transport systems commercially available; infrastructure business case realized
4. **Fully Developed Market and Infrastrucure Phase**
   $H_2$ power and transport systems commercially available in all regions; national infrastructure

# Benefits of a Hydrogen Economy

"*If we develop hydrogen power to its full potential, we can reduce our demand for oil by over **11 million barrels** per day by the year 2040.*" - President G.W. Bush

- **Energy Security**

Can be produced from a variety of domestic sources

- **Environmental**

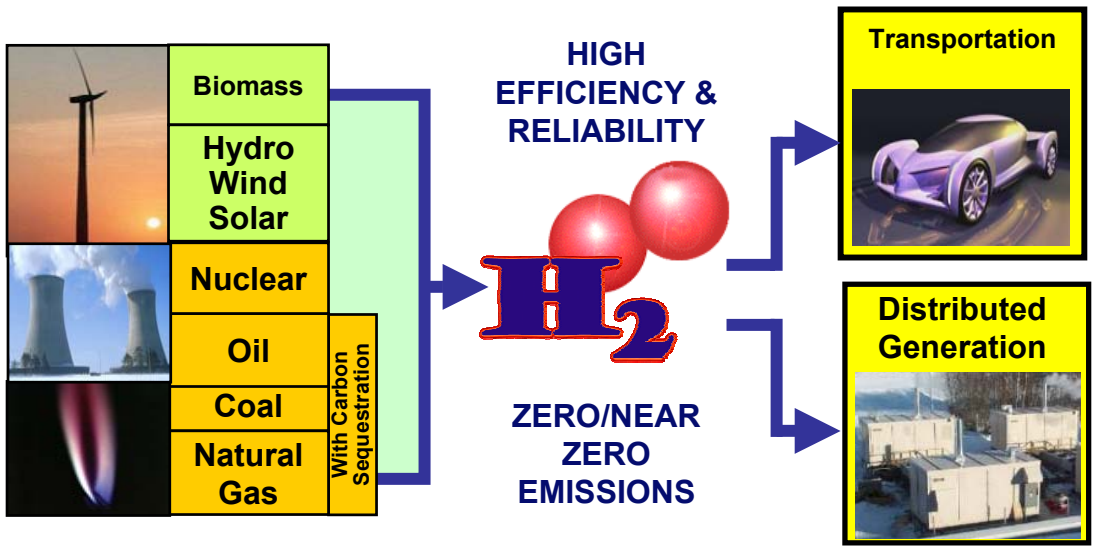
Criteria pollutants from mobile sources eliminated

Emissions from stationary $H_2$ production sites easier to control

Greenhouse gas emissions significantly reduced

- **International Competitiveness**

Government – sponsored R&D can help industry compete in global economy

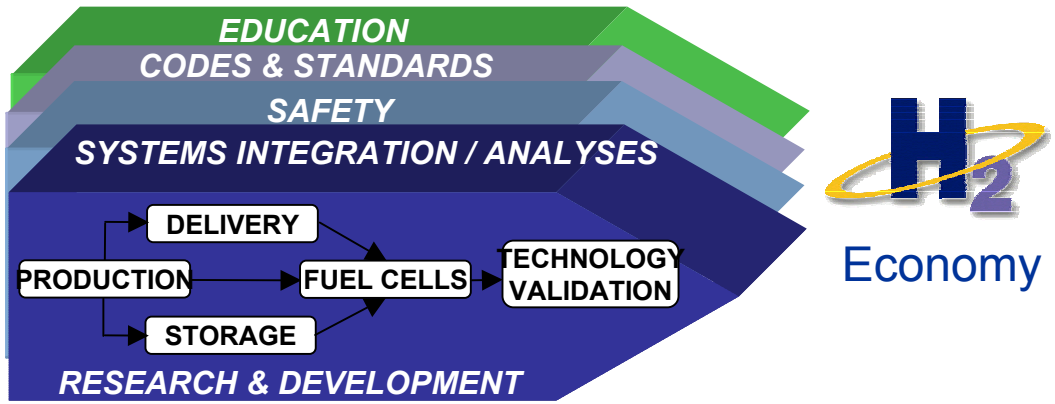


## Mission Statement

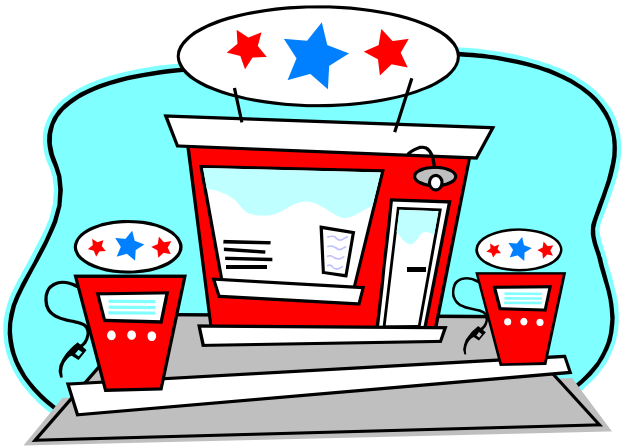
The mission of the Hydrogen, Fuel Cells & Infrastructure Technologies Program is to research, develop, and validate fuel cells and hydrogen production, delivery, and storage technologies for transportation and stationary applications.

The Program supports EERE Strategic Goals:

- Dramatically reduce dependence on foreign oil
- Promote the use of diverse, domestic, and sustainable energy resources
- Reduce carbon emissions from energy production and consumption
- Increase the reliability and efficiency of electricity generation



# 2002-03 Activity Highlights



## Technology Validation:

Completed a 5-year project resulting in the demonstration of a multi-purpose refueling station with

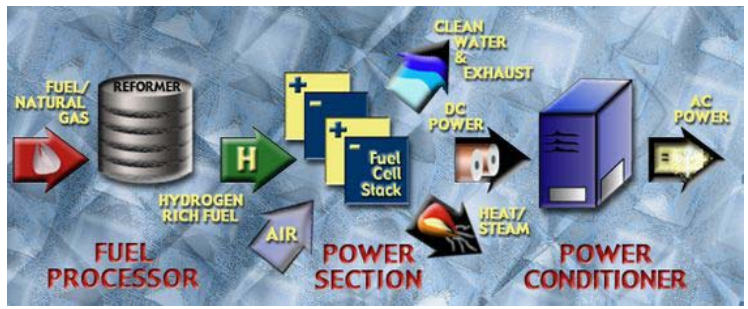
1) on-site $H_2$ production by reforming natural gas;
2) operating a 50 kW PEM Fuel Cell to generate electricity; and
3) dispensing compressed hydrogen for vehicles and buses.

## Education:

Developed a comprehensive, long-term plan to educate multiple audiences.

## Fuel Cell:

3M Corporation developed a set of high-performance, matched PEM fuel cell components and pilot manufacturing processes demonstrating high volume, high yield MEA production.



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# Hydrogen Vehicle/Infrastructure "Learning" Demonstration

**Objectives:** To conduct "learning" demonstrations that emphasize and integrate hydrogen infrastructure and hydrogen powered vehicles to validate technology status and focus future R&D directions.

Performance, durability and safety data to be collected. Vehicle-refueling interface issues will be evaluated and codes/standards will be developed.

**Participants:** Energy and automobile companies plus fuel cell suppliers, hydrogen technology suppliers, fleet operators, small businesses, universities, and state, local and federal governments.

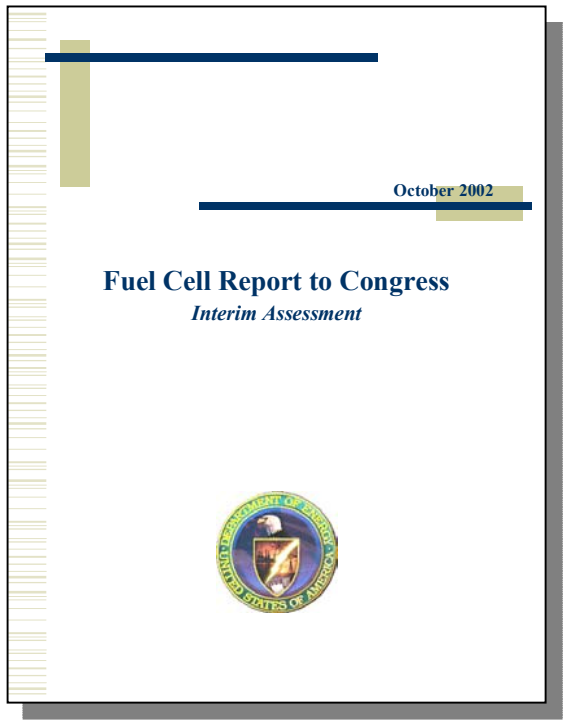
**Schedule:** Issue date, May

Closes, August

Awards, early 2004

Project period 2004-2008

50/50 cost shared co-operative agreements




Golden Field Office
United States Department of Energy

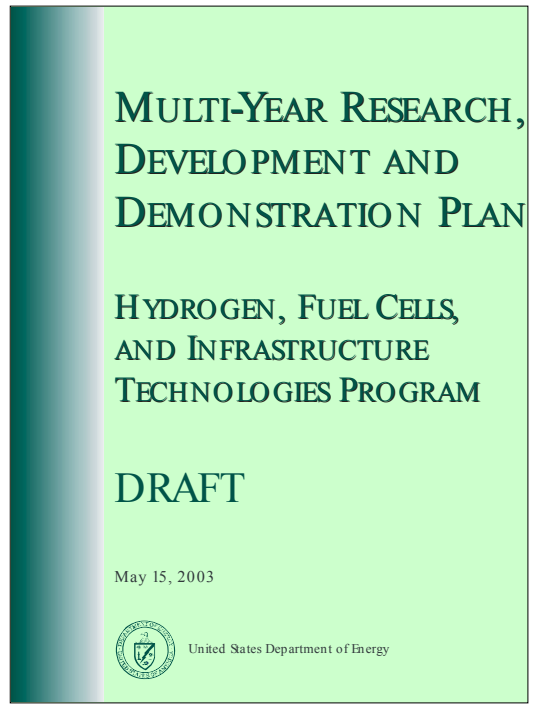
http://www.go.doe.gov

# Planning Workshops and Other Stakeholder Input

| | |
|---|---|
| Fuel Cell Report to Congress Workshops | December 2001, January-February 2002 |
| National Hydrogen Energy Roadmap Workshop | April 2-3 2002 |
| Hydrogen Storage Materials Workshop | August 2002, Argonne IL |
| DOE HFCIT Codes and Standards Meeting | August 19-20, 2002, Washington DC |
| International Code Council (ICC) Final Code Change Hearings held in Fort Worth, TX | In late September and early October 2002 |
| Compressed/Liquid Hydrogen Workshop | October 2002, Detroit, MI |
| HFCIT Education Workshop | December 4-5, 2002, Arlington, VA |
| Hydrogen Infrastructure: State of Technology and Standards | January 13, 2003, Washington DC |
| Hydrogen Storage "Think Tank" Meeting | March 2003, Washington, DC |
| Harmonization of Domestic Hydrogen Standards, Codes, and Regulations | March 7, 2003, Washington DC |
| Technology Validation Pre-Solicitation Event | March 19, 2003, Detroit |
| Hydrogen Delivery Workshop | May 7-8, 2003, Washington, DC |
| 9th Annual National Clean Cities Conference | May 20, 2003, Palm Springs |
| Storage Pre- Solicitation Conference | June 2003, Location TBD |

# Draft Multi-year Research, Development and Demonstration Plan

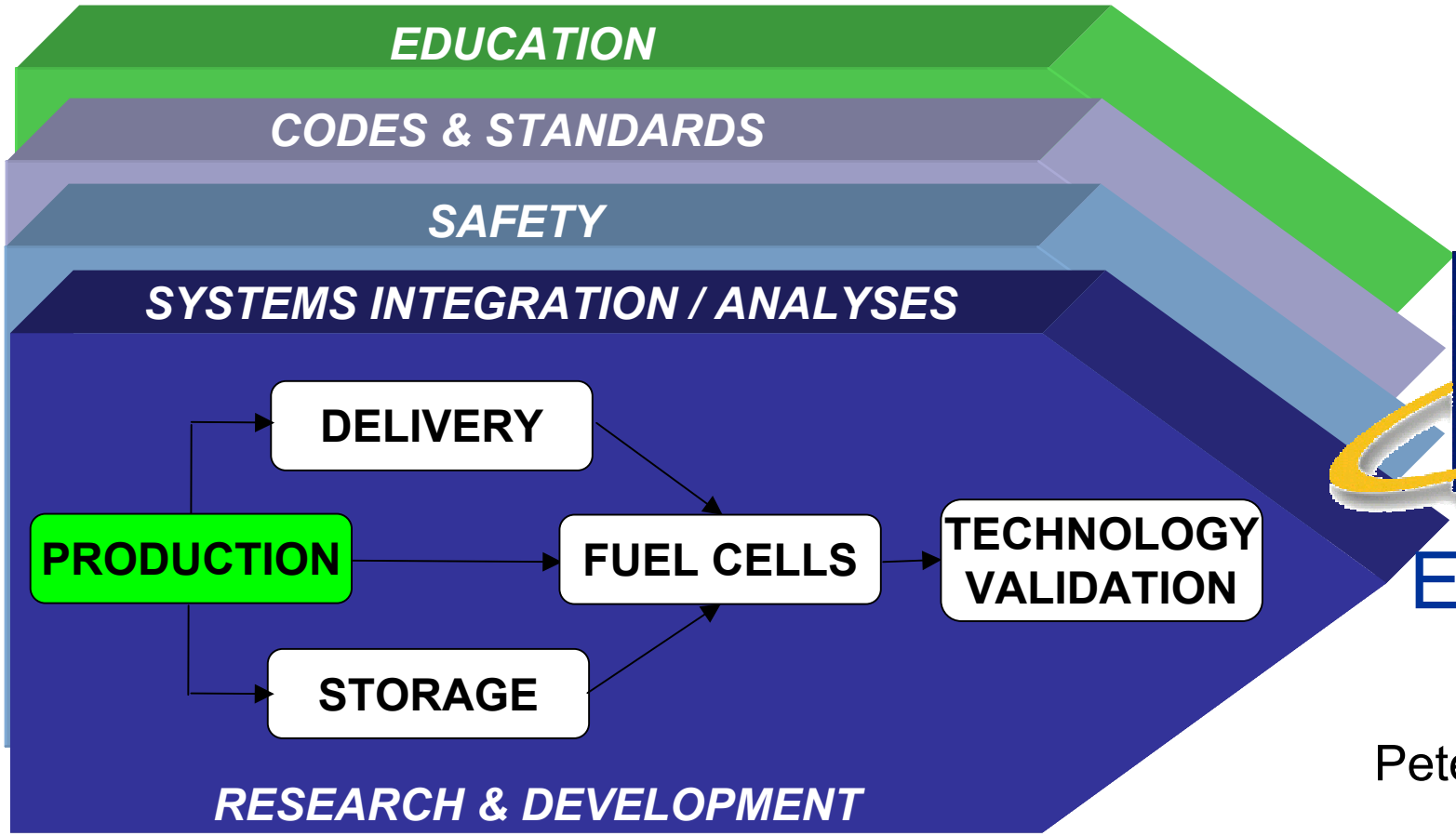
- Introduction
- Program Benefits
- Technology Development and Management Approach
- Technical Plan
  - Hydrogen Production
  - Hydrogen Delivery
  - Hydrogen Storage
  - Fuel Cells
  - Technology Validation
  - Codes & Standards
  - Safety
  - Education
- Systems Integration & Analyses




www.eere.doe.gov/hydrogenandfuelcells

# Overview of R,D& D Plans by Elements

# Hydrogen Production




H2 Economy

Pete Devlin

# Hydrogen Production Goals and Objectives

**Goal** : Research and develop low cost, highly efficient hydrogen production technologies from diverse, domestic sources, including fossil, nuclear, and renewable sources.

## Objectives for 2010

- Reduce the cost of distributed production of hydrogen from natural gas and/or liquid fuels to $1.50/gallon gasoline equivalent ($1.50/kg delivered, untaxed) at the pump [without carbon sequestration];
- Develop and demonstrate technology to supply purified hydrogen from biomass at $2.60/kg at the plant gate;
- Generate hydrogen with water electrolysis at a capital cost of $250/kWe with 73% system efficiency at 5,000 psi.

# Hydrogen Production

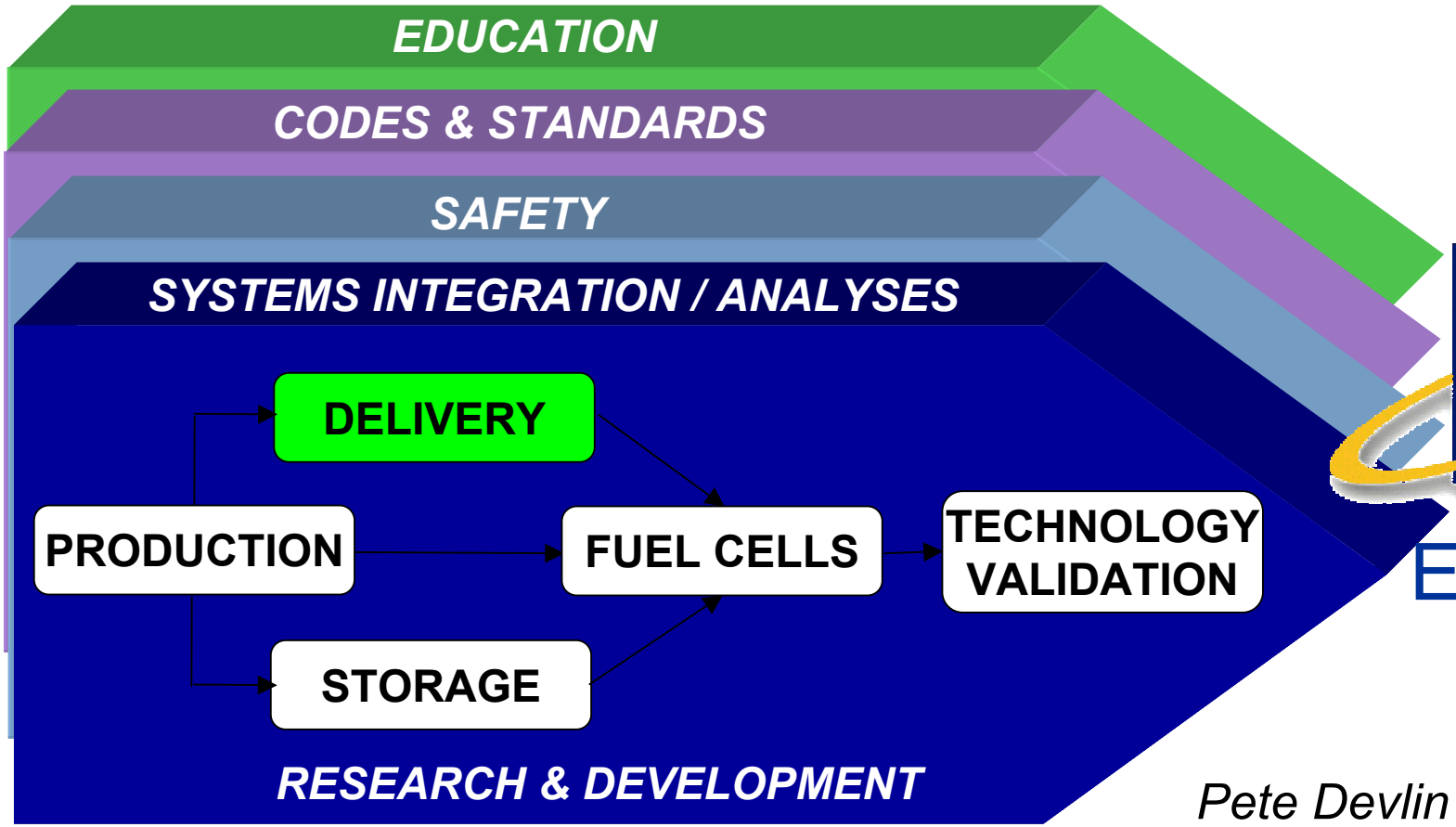
## Objectives (cont'd)

- Develop advanced photolytic hydrogen generation technologies.
  - By 2015, demonstrate direct photoelectrochemical water splitting with a plant-gate hydrogen production cost of $5/kg
  - By 2015, demonstrate an engineering-scale photobiological system which produces hydrogen at a plant-gate cost of $10/kg.
- By 2015, research and develop high and ultra-high temperature thermochemical processes to convert hydrogen from high temperature heat sources (nuclear or solar).
- Evaluate other technologies that have the potential for cost effective sustainable production of hydrogen and fund appropriate research.

# Hydrogen Production Key Milestones

- Develop hydrogen production technologies for distributed systems using natural gas with projected cost of $3.00/kg hydrogen at the pump, by 3rd quarter, 2004.
- Select and develop biomass gasification technologies to reduce hydrogen cost to $3.30/kg by 4th quarter, 2005.
- Develop electrolyzer technologies that reduce costs to $3.75/kg at 5,000 psi with 65% energy efficiency by 4th quarter, 2005.
- Identify or develop photoelectrochemical material that has solar-to-hydrogen efficiency of 7.5% and 1,000 durability by 4th quarter, 2005.

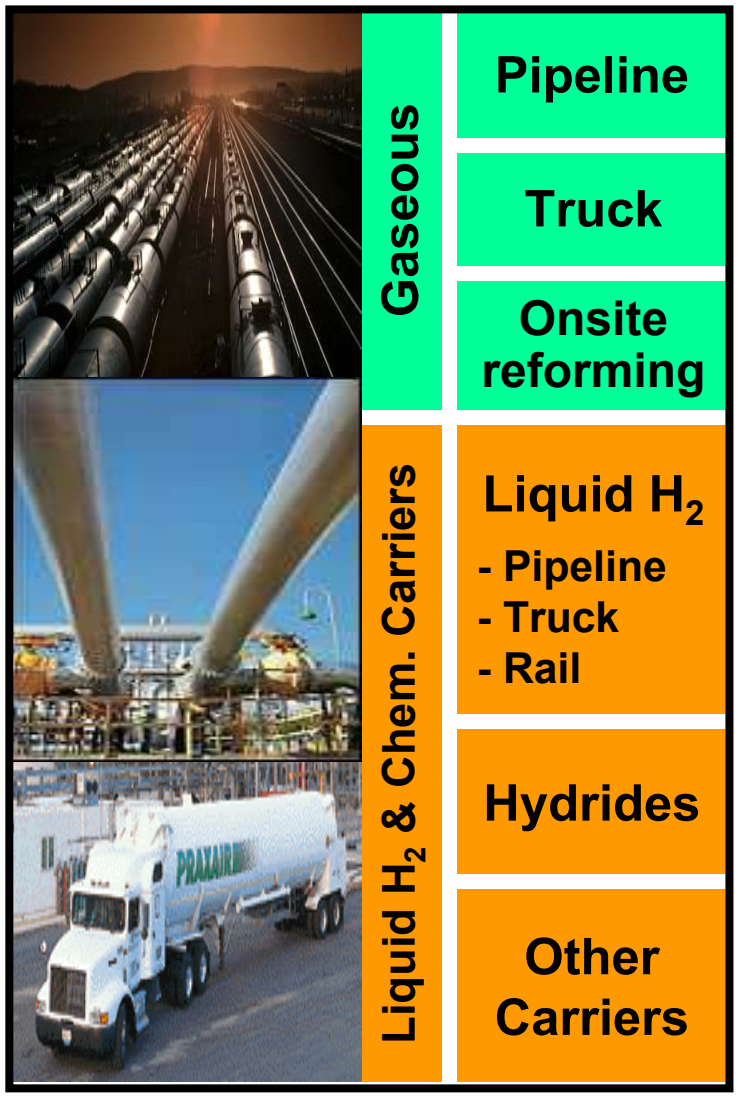
# Hydrogen Delivery




$H_2$ Economy

*Pete Devlin*
*on behalf of Mark Paster*

# Hydrogen Delivery: Goal




**Develop *hydrogen fuel delivery* technologies that enable the introduction and long-term viability of hydrogen as an energy carrier for transportation and stationary power.**

# Delivery Objectives

- **By 2006, define a cost effective and energy efficient fuel delivery infrastructure for the introduction and long-term use of hydrogen for transportation and stationary power.**

- **By 2010, develop enabling technologies to reduce the cost of hydrogen fuel delivery from central/semi-central production facilities to the gate of refueling stations and other end users to <$0.70/kg.**

- **By 2010, develop enabling technologies to reduce the cost of hydrogen movement and handling within refueling stations and stationary power facilities to a vehicle or stationary power unit to <$0.60/kg.**

- **By 2015, develop enabling technologies to reduce the cost of hydrogen fuel delivery from the point of production to the point of use in vehicles or stationary power units to <$1.00/kg in total.**

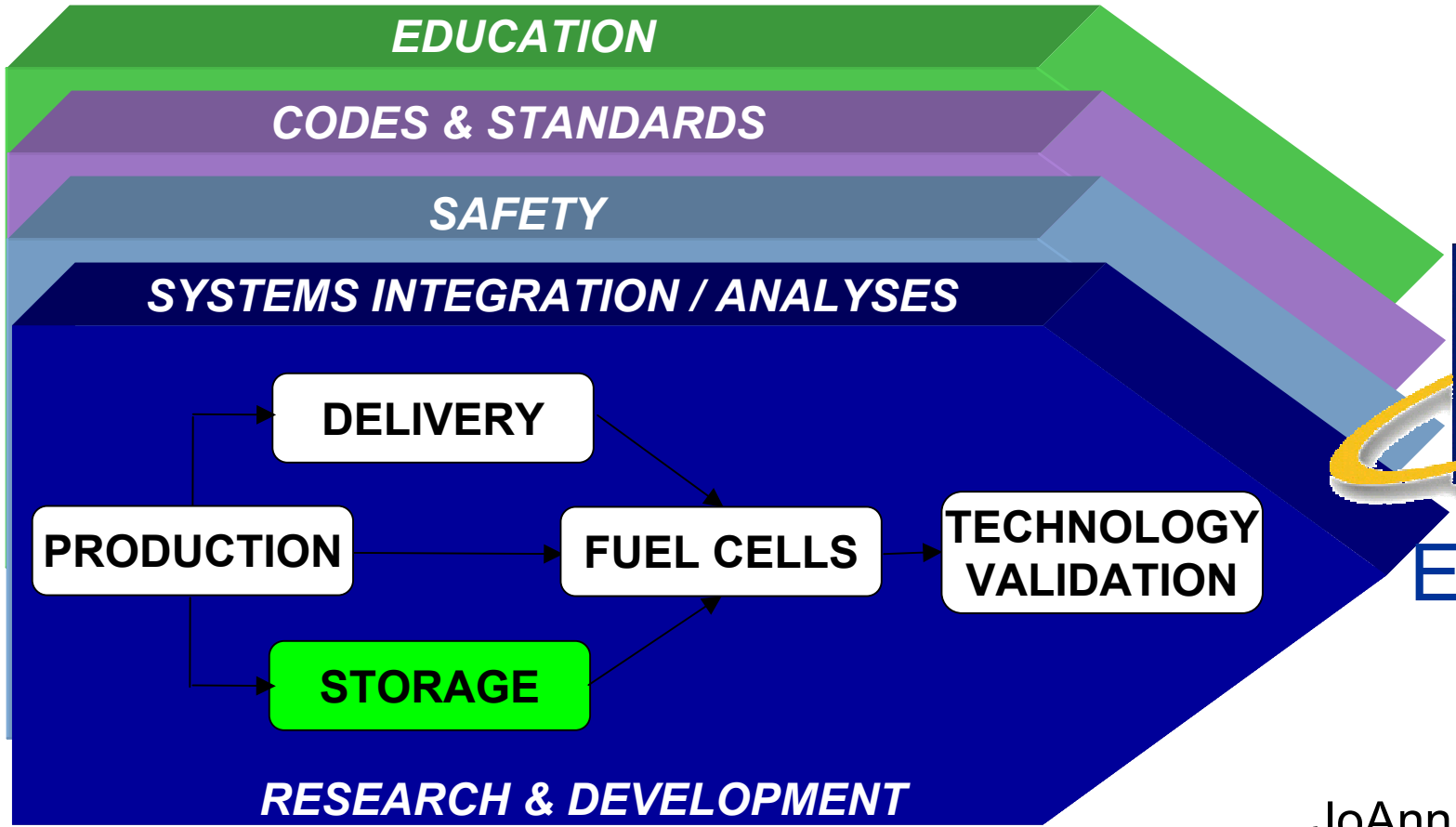
# Key Delivery Milestones

| Milestone | Description | Quarter (Calendar Year) |
|---|---|---|
| -- | Complete definition of a cost effective hydrogen fuel delivery infrastructure for the introduction and long term use of hydrogen for transportation and stationary power | 2Q 2005 |
| -- | Verify 20% cost reduction for hydrogen compression | 4Q 2008 |
| -- | Verify 50% cost reduction for hydrogen liquefaction | 4Q 2010 |
| -- | Verify 50% reduction in capital cost for hydrogen pipelines | 4Q 2010 |

# Delivery Targets/Milestones

| Characteristics | Units | 2003 status | 2005 | 2010 |
|---|---|---|---|---|
| **Gaseous Hydrogen Compression** | | | | |
| Cost | $/kg $H_2$ | 0.18 | 0.17 | 0.14 |
| Energy efficiency | % | 90 | 92 | 95 |
| **Hydrogen Liquefaction** | | | | |
| Cost | $/kg $H_2$ | 1.11 | 1.01 | 0.53 |
| Energy efficiency | % | 65 | 70 | 87 |
| **Hydrogen Gas Pipelines** | | | | |
| Trunk lines | $/mile | 1.4M | 1.2M | 600k |
| Distribution lines | $/mile | 600k | 500k | 350k |
| **Hydrogen Carrier Technology** | | | | |
| Hydrogen Content | % by wt | 3 | 6.5 | 10 |
| Energy efficiency | % | 80 | 82 | 85 |

# Hydrogen Storage




H2 Economy

JoAnn Milliken

# Hydrogen Storage Technical Goal & Objectives

**Goal** : Develop and demonstrate viable hydrogen storage technologies for transportation and stationary applications.

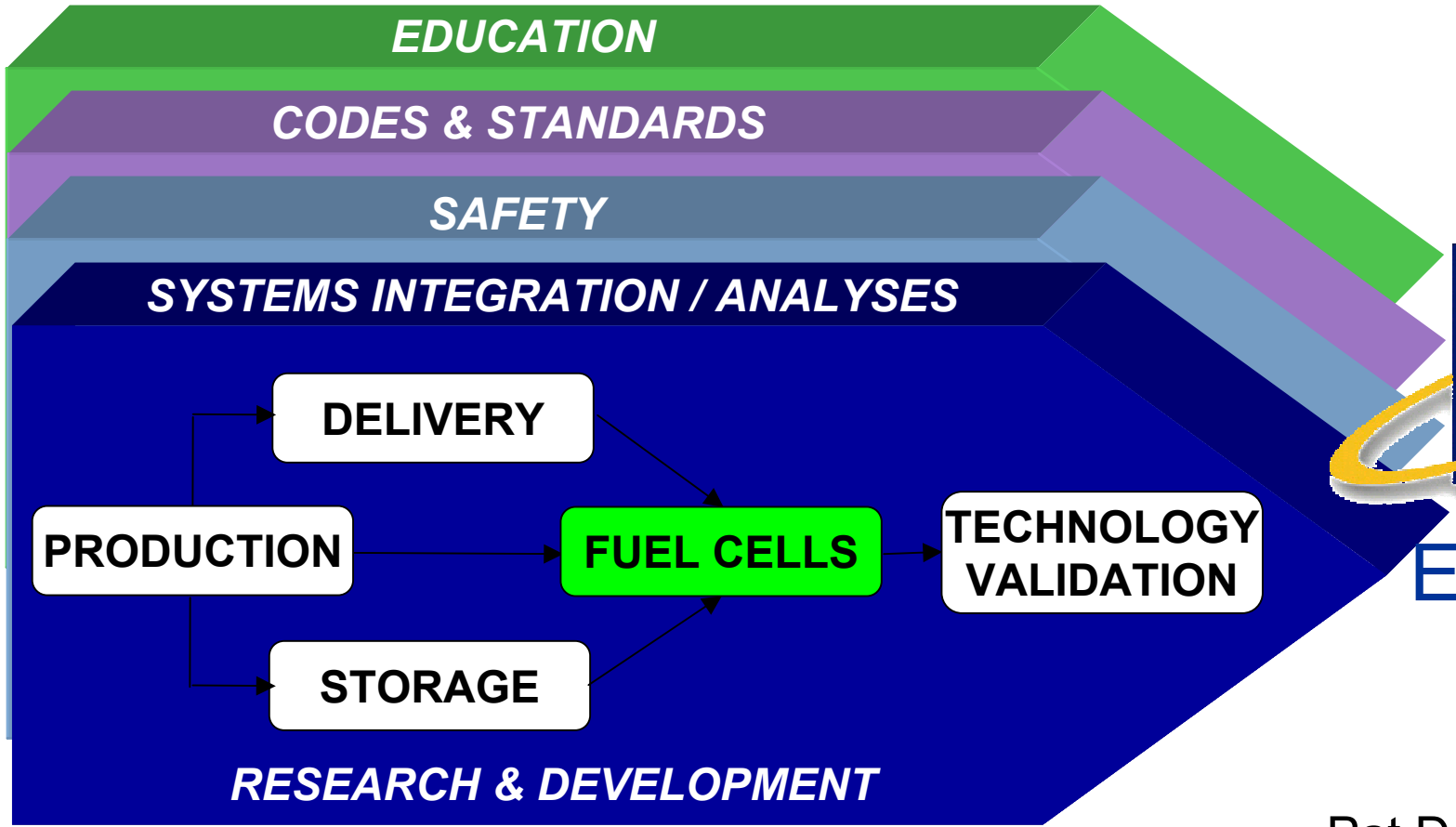
## Objectives – Develop and verify:

- On-board hydrogen storage systems achieving:
  - 1.5 kWh/kg (4.5 wt%), 1.2 kWh/L, and $6/kWh by 2005
  - 2 kWh/kg (6 wt%), 1.5 kWh/L, and $4/kWh by 2010
  - 3 kWh/kg (9 wt%), 2.7 kWh/L, and $2/kWh by 2015
- Low cost, off-board hydrogen storage systems, as required for hydrogen infrastructure needs to support transportation, stationary and portable power markets by 2015.
- Vehicle interface technologies for fueling on-board hydrogen storage systems by 2015.

# Hydrogen Storage Key Milestones

| Milestone | Description | Quarter (Calendar Year) |
|---|---|---|
| 6 | Complete construction of reversible solid-state materials test facility | 4Q, 2004 |
| 8 | Go/No-Go decision on carbon nanotubes | 4Q, 2005 |
| 4 | Go/No-Go decision on R&D of liquid and compressed tanks | 4Q, 2006 |

# Fuel Cells




$H_2$ Economy

Pat Davis

# Fuel Cells Technical Goals & Objectives

**Goal** : Develop and demonstrate fuel cell power system technologies for transportation, stationary, and portable applications.

## Objectives

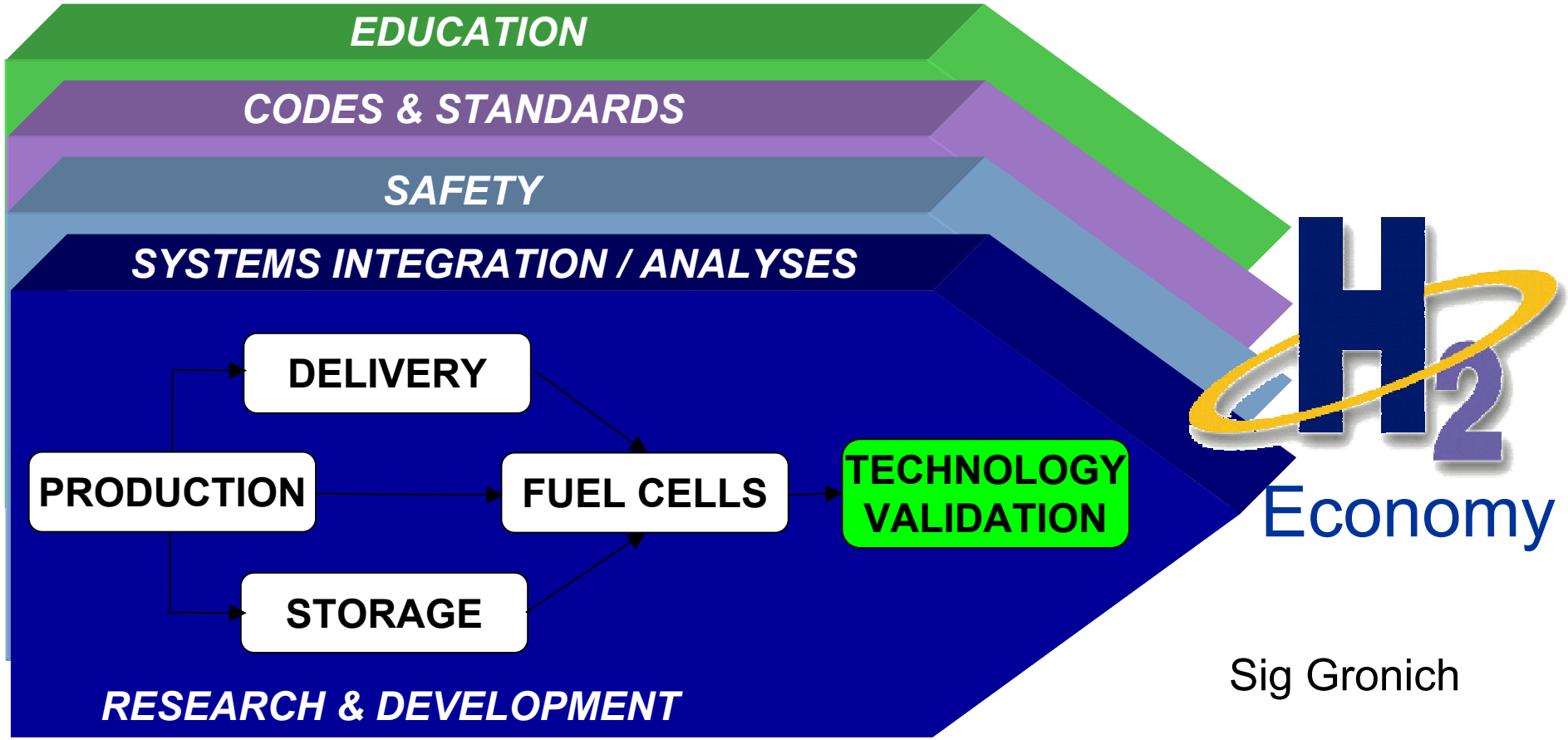
- Develop a 60% efficient, durable, direct hydrogen fuel cell power system for transportation at a cost of $45/kW (including hydrogen storage) by 2010.
- Develop a 45% efficient reformer-based fuel cell power system for transportation operating on clean hydrocarbon or alcohol based fuel that meets emissions standards, a start-up time of 30 seconds, and a projected manufactured cost of $45/kW by 2010.
- Develop a distributed generation PEM fuel cell system operating on natural gas or propane that achieves 40% electrical efficiency and 40,000 hours durability at $750/kW by 2010.
- Develop a fuel cell system for consumer electronics with an energy density of 1,000 W-h/L by 2010.
- Develop a fuel cell system for auxiliary power units (1-3kW) with a specific power of 150 W/kg and a power density of 150 W/L by 2010.

# Fuel Cells Key Milestones

| Milestone | Description | Quarter (Calendar Year) |
|---|---|---|
| 9 | Go/No Go. Determine whether to continue funding of DMFC R&D for transportation applications. | 3Q, 2003 |
| 11 | Benchmarking of UTC Fuel Cells atmospheric 50kW system | 4Q, 2003 |
| 14 | Verify reproducibility of full-size bipolar plates in high-rate manufacturing processes | 4Q, 2003 |
| 16 | Fuel Processing Go/No Go Decision | 2Q, 2004 |

# Cross-cutting Functions

**Technology Validation**




Sig Gronich

# Technology Validation
# Technical Goal & Objectives

**Goal** : Demonstrate and validate integrated hydrogen and fuel cell technologies in a systems context under real operating conditions.

## Objectives

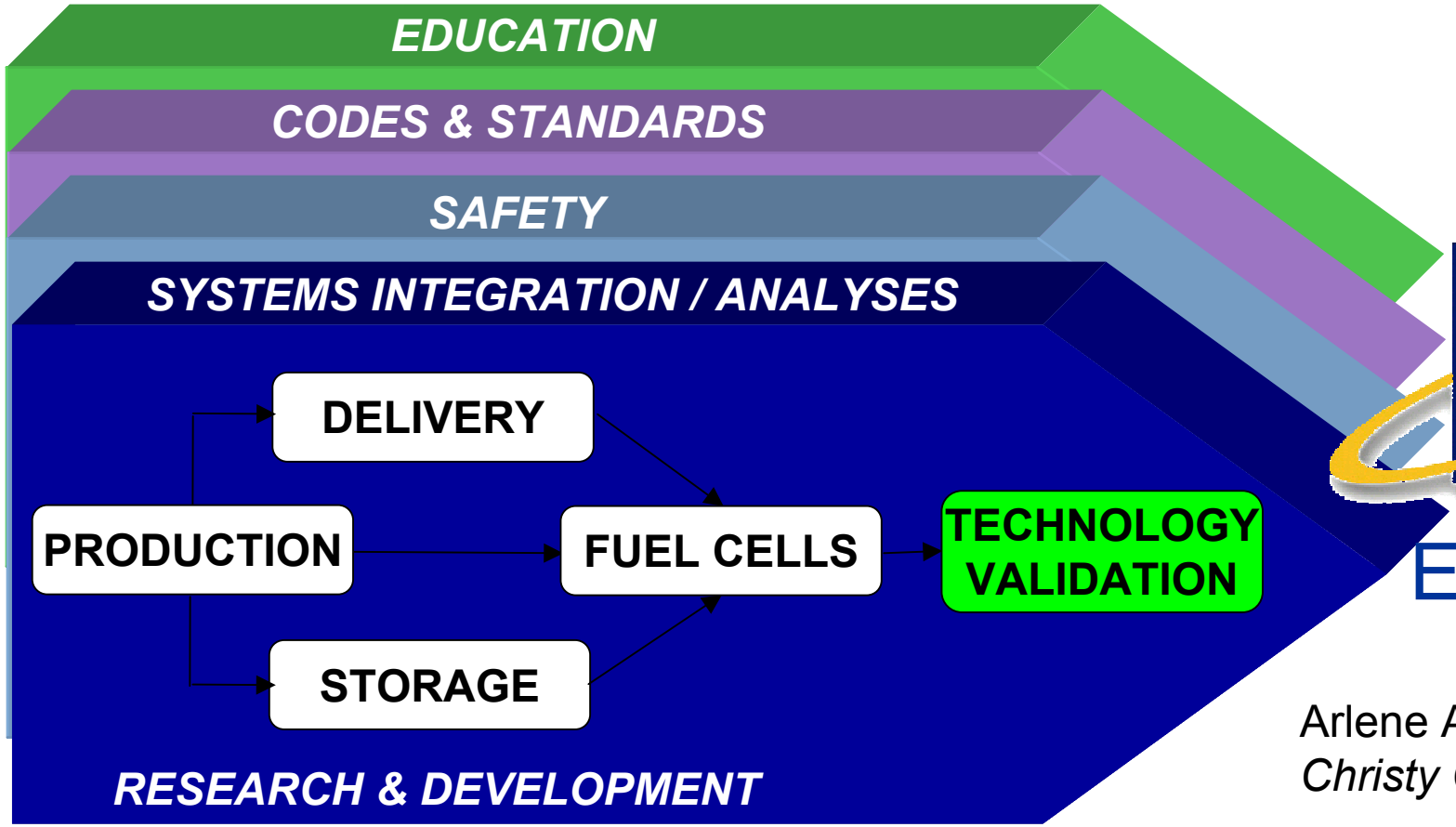
- By 2007, validate an electrolyzer at a capital cost of $300/kWe when built in quantity that is powered by a wind turbine.
- By 2008, validate hydrogen vehicles with greater than 300 miles range, 2,000 hour fuel cell durability, and $3.00/gallon (gasoline equivalent) hydrogen production cost (untaxed) and vehicles that can be safely and conveniently refueled by trained drivers.
- By 2008, validate stationary fuel cell and hydrogen ICE systems that co-produce hydrogen and electricity from non-renewable and renewable resources, and demonstrate 20,000 hour durability, greater than 40% efficiency and a price of $1,500/kW or less (for volume production).
- By 2015, validate (in collaboration with the Office of Nuclear Energy) a high-temperature electrolyzer that produces hydrogen with 40% efficiency at a price of $300/kW when in high-volume production.
- By 2008, validate a biomass to hydrogen system to produce hydrogen for $2.60/kg at the plant gate (unpressurized).

# Technology Validation: Key Milestones

| Milestone | Description | Date (FY) |
|---|---|---|
| 1 | Awards made to start fuel cell vehicle/infrastructure demonstration activity and for hydrogen co-production infrastructure facilities. | 2Q, 2004 |
| 6 | Validate fuel cell demonstration vehicle range of ~200 miles and durability of ~1,000 hours. | 3Q, 2006 |
| 17 | Four stations and maintenance facilities constructed with advanced sensor systems and operation procedures. | 3Q, 2006 |

# Cross-cutting Functions

**Education**




$H_2$ Economy

Arlene Anderson *for*
*Christy Cooper*

# Education

# Education Sub-Program Technical Goal & Objectives

**Goal** : Educate key audiences about hydrogen and fuel cell systems to facilitate commercialization and market acceptance of these technologies.

## Objectives

By 2010 –

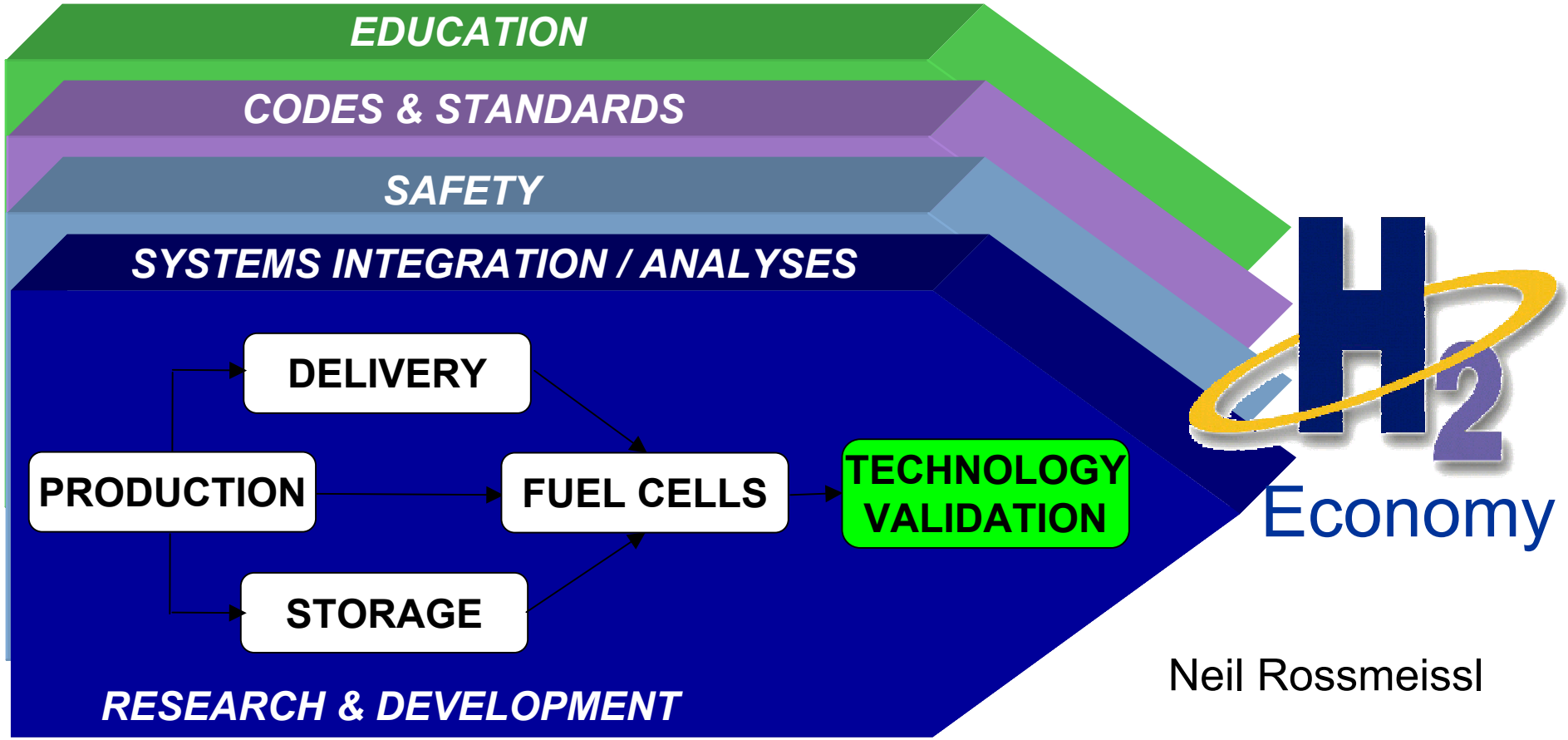
- Achieve a four-fold increase in the number of students and teachers who understand the concept of a hydrogen economy and how it may affect them
- Achieve a four-fold increase in the number of state and local government representatives who understand the concept of a hydrogen economy and how it may affect them
- Achieve a two-fold increase in the number of large-scale end-users who understand the concept of a hydrogen economy and how it may affect them
- Launch a comprehensive and coordinated public education campaign about the hydrogen economy and fuel cell technology

# Education Key Milestones

| Milestone | Description | Date (FY) |
|---|---|---|
| 4 | Establish educational materials library and information clearinghouse/distribution system to serve the immediate needs of multiple audiences | 4Q, 2004 |
| 21 | Conduct public perception analysis and publish report | 4Q, 2004 |
| 5 | Publish codes and standards database (in conjunction with Safety, Codes and Standards program) | 3Q, 2005 |
| 6 | Publish safety training materials (in conjunction with Safety, Codes and Standards program) | 3Q, 2005 |
| 12 | Launch coordinated materials development and teacher training/professional development program for secondary school teachers | 3Q, 2005 |
| 31 | Create Education Advisory Panel | 4Q, 2005 |

# Cross-cutting Functions

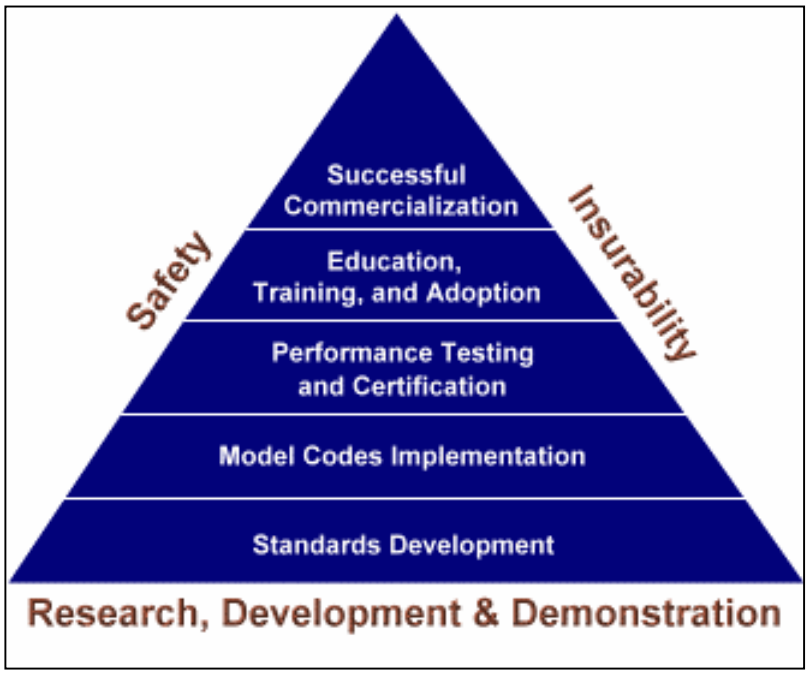
**Codes and Standards**




H2 Economy

Neil Rossmeissl

# Hydrogen Codes & Standards




# Hydrogen Codes & Standards: Goal & Objectives

**Goal** : Facilitate the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications. Provide technical resources to harmonize the development of international standards among IEC, ISO, and GRPE.

## Objectives

- Complete the drafting of hydrogen building codes for NFPA's hearing cycle. Facilitate in the adoption of the ICC codes in three key regions: North East, Mid-Atlantic, and Midwest, by 2005;
- Complete the adoption of the ISO standards for hydrogen refueling and storage, by 2006;
- Complete and adopt the revised NFPA 55 standard for hydrogen storage with data from Technology Validation projects and the experimental project for underground bulk storage of hydrogen, by 2008;
- Complete U.S. adoption of a Global Technical Regulation (GTR) for hydrogen fuel cell vehicles under the Global Regulation on Pollution and Efficiency Program, by 2010.

# Hydrogen Codes & Standards: Key Milestones

| Milestone | Description | Date (FY) |
|---|---|---|
| 3 | Collaborate with ICC and NFPA to develop first-order continuing education for code officials. | 3Q, 2004 |
| 4 | Establish a coordination plan with education sub-program activity to run workshops for state and local officials. | 3Q, 2004 |
| 11 | Initiate negotiations with critical SDOs and develop draft generic licensing agreement and estimate of costs. | 4Q, 2003 |
| 24 | With industry and code officials, develop templates of commercially viable footprints for fueling stations that incorporate underground and above ground storage of liquid and gaseous hydrogen. | 1Q, 2004 |
| 30 | Implement analytical and experimental program to support the submittal of a comprehensive vehicular safety standard as a regulation. | 4Q, 2005 |
| 32 | Implement research program to support five new technical committees for the key critical standards including fueling interface, power block, and fuel storage. | 4Q, 2006 |

# Hydrogen Safety


Neil Rossmeissl

# Hydrogen Safety: Goal & Objectives

**Goal** : Develop and implement the practices and procedures that will ensure safety in the operation, handling and use of hydrogen and hydrogen systems for all DOE funded projects.

## Objectives

- Draft a comprehensive safety plan to be completed in collaboration with industry. The plan will initiate the research necessary to fill safety information gaps and enable the formation of a Safety Review Panel, by 2004;
- Integrate safety procedures into all DOE project funding procurements. This will ensure that all projects that involve the production, handling, storage, and use of hydrogen incorporate project safety requirements into the procurements, by 2005;
- Publish a handbook of Best Management Practices for Safety. The Handbook will be a “living” document that will provide guidance for ensuring safety in future hydrogen endeavors, by 2010.

# Hydrogen Safety: Key Milestones

| Milestone | Description | Date (FY) |
|---|---|---|
| 2 | Develop in collaboration with NASA, DOT, Commerce, a search protocol on component and system safety. | 1Q, 2004 |
| 12 | Assemble panel of experts in hydrogen safety to provide expert technical guidance to funded projects. | 4Q, 2003 |
| 17 | Identify areas of additional study and research for failure modes scenarios. | 3Q, 2004 |
| 21 | Gather and review data to support the inclusion of hydrogen safety in procurements. | 4Q, 2003 |
| 31 | Establish annual review criteria for safety. | 4Q, 2004 |

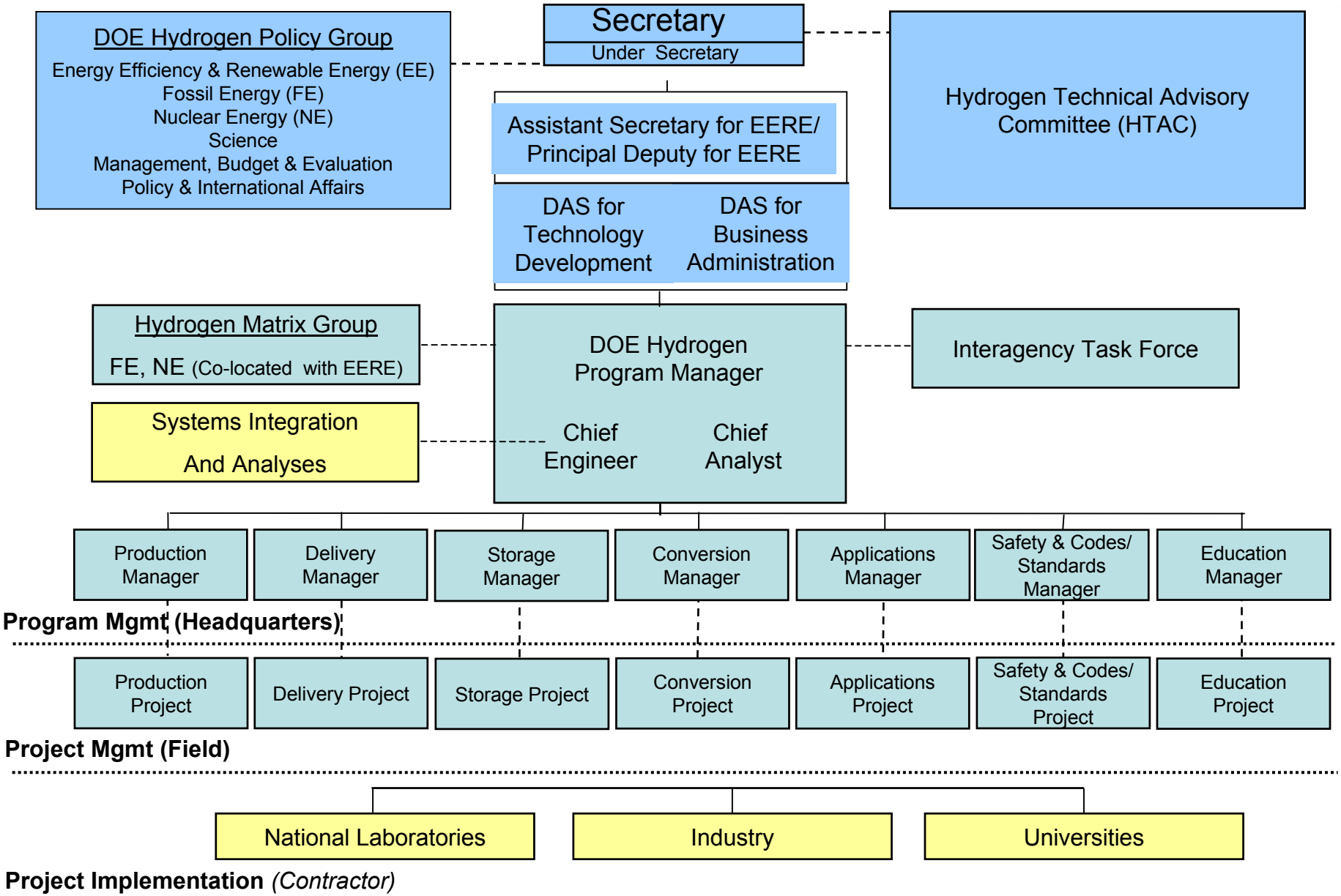
# National Academy of Sciences Interim Report

- **Safety**
  The Committee recommended that DOE make significant efforts to address safety issues.
- **Systems Integration and Analyses**
  The academy recommends that R&D successes & failures be analyzed and modeled both as individual technologies, and as components parts of a greater system.
- **Exploratory Research**
  The Committee encouraged DOE to continue funding fundamental, exploratory research for promising, high-risk new technologies.
- **Organization**
  The Committee supports the DOE in its efforts to integrate various hydrogen-related RD&D programs, the Office of Science, and the private sector.

THE NATIONAL ACADEMIES
*Advisers to the Nation on Science, Engineering, and Medicine*

Find more information at www.nas.edu under BEES-J-02-04-A.

# Proposed Management Structure



# Future Directions

- **Technology Validation Projects**
  Validation and Demonstration projects will be implemented.
- **Virtual Centers for Hydrogen Storage**
  Will bring together experts from multiple fields under the direction of one lab. EERE will collaborate with the Office of Science.
- **Fuel Cell Processor Go/No-Go**
  Review in late 2004 to determine the future course of on-board vehicle fuel processing activities.
- **International Partnerships**
  Secretary announced International partnerships at IEA; US-EU co-operating on codes and standards. Working with China and India to develop Roadmaps on H2 Future.
- **Hydrogen Production from Renewables**

*EERE Wind and Hydrogen Programs collaborating on study for wind-based hydrogen and electricity.*

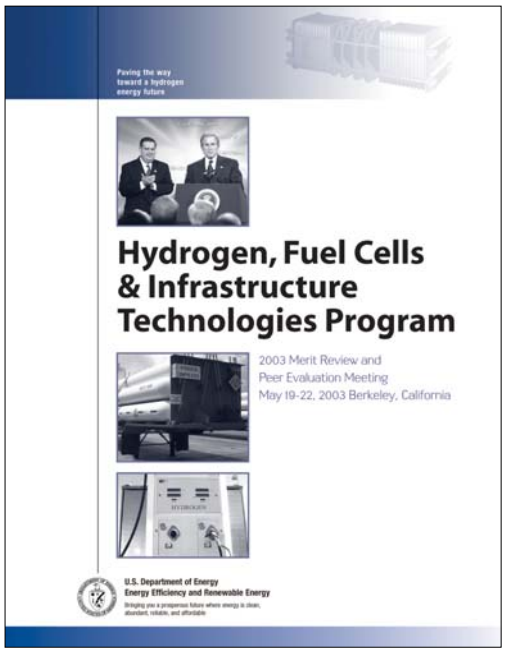
# Future Opportunities

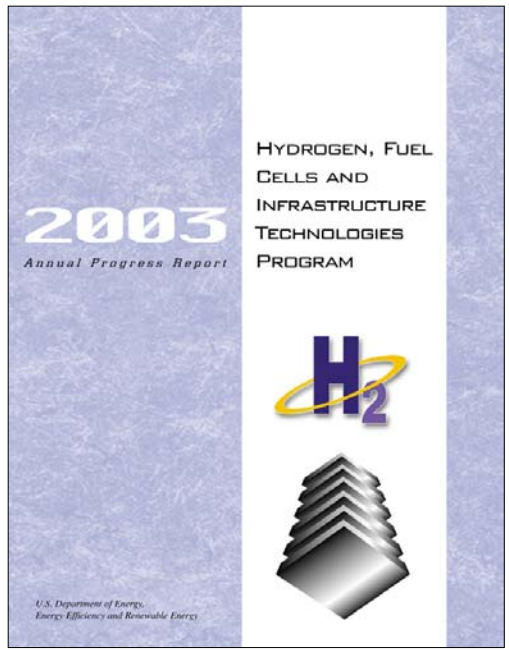
| | |
|---|---|
| "Grand Storage Challenge" | Solicitation to be announced in June 2003.<br>Contact: JoAnn Milliken |
| Hydrogen Production | Solicitation: May 2003<br>Contact: Pete Devlin |
| Fuel Cells (Portable, Auxiliary, Off-Road) | Solicitation: April 9, 2003- June 5, 2003<br>Contact: Pat Davis/John Garbak |
| Codes/Standards | Solicitation: No immediate releases<br>Contact: Neil Rossmeissl |
| Technology Validation and Demonstration | Solicitation: May 2003<br>Contact: Sig Gronich, John Garbak |
| Education | Solicitation: Late Summer 2003<br>Contact: Christy Cooper |
| FutureGen | Contact: Fossil Energy and the National Energy Technology Lab (NETL)<br>Contact: Lowell Miller |

# Information Resources


http://www.eere.energy.gov/hydrogenandfuelcells

# Information Resources



# Acknowledgements


- FreedomCAR Partners
- Reviewers
- Technical Support
- Lawrence Livermore National Lab (LLNL)


# Appendix X

- Budget Information
- Responsibility Matrix

| *Key Activity* | FY 02 | FY 03 | FY 04 Req. | '04 Comments |
|---|---|---|---|---|
| *Interior Appropriations in $ Millions* | | | | |
| **Transportation Systems** | **$7.5** | **$6.2** | **$7.6** | More emphasis on balance of plant systems components such as air compressors, blowers, heat exchangers, sensors, and APU's |
| **Distributed Generation Sys.** | **$5.5** | **$7.5** | **$7.5** | System durability issues, fuel processor integration and balance of plant component development |
| **Stack Component R&D** | **$12.6** | **$14.9** | **$28.0** | Emphasize basic membrane materials work, advanced catalysts/non-precious metal catalystsmaterials/manufacturing. |
| **Fuel Processor R&D** | **$20.9** | **$24.7** | **$19.0** | Decrease reflects reduced mortgages, approaching FY04 go/no go decision. Supports natural gas/propane fuel processing for distributed generation. |
| **Technology Validation** | **$0** | **$1.8** | **$15.0** | Significant increase represents first year of vehicle test and evaluation program |
| **Technical Support** | **$0.2** | **$0.4** | **$0.4** | |
| **TOTAL** | **$46.7** | **$55.5** | **$77.5** | |

| *Key Activity* | FY 02 | FY 03 | FY 04 Req. | '04 Comments |
|---|---|---|---|---|
| *Energy & Water Appropriations in $ Millions* | | | | |
| **Hydrogen Production & Delivery*** | **$11.2** | **$11.8** | **$23.0** | Distributed natural gas reformers, and separation technologies, more emphasis on renewable production ($6M to $17M) |
| **Hydrogen Storage** | **$6.1** | **$11.3** | **$30.0** | Critical path technology! Expands current R&D and initiates research on advanced concepts such as conducting polymers and nanostructured materials. |
| **Infrastructure Validation** | **$5.7** | **$10.1** | **$13.2** | Increase for hydrogen refueling stations in support of controlled fleet demonstration project |
| **Safety, Codes & Standards, Utilization** | **$4.5** | **$4.8** | **$16.0** | Expands R&D efforts to develop critical engineering data for C&S and hydrogen safety |
| **Education and Cross-Cutting Analyses** | **$1.4** | **$2.0** | **$5.8** | Initiates national campaign to communicate hydrogen benefits and barriers. Includes only cross-cutting life cycle analysis |
| **TOTAL** | **$28.9** | **$40.0** | **$88.0** | |

* EERE program activities (excludes FE ($11.5M) and NE ($4M) for FY 2004)

# Responsibility Matrix

## $H_2$ Production Team

| | |
|---|---|
| Pete Devlin<br>202 586-4905<br>Peter.Devlin@ee.doe.gov | • Team Leader, Hydrogen Production<br>• Overall Hydrogen Production R&D<br>• FreedomCAR Energy Industry Expansion |
| Roxanne Danz<br>202 586-7260<br>Roxanne.Danz@ee.doe.gov | • Biological, Biomass, and other H2 Renewables<br>• NAS and Roadmap coordination |
| Chris Bordeaux<br>202 586-3070<br>Christopher.Bordeaux@ee.doe.gov | • Integrated Power Parks/Uninterruptible Power Systems<br>• California Fuel Cell Partnership<br>• International Outreach (non-IEA) |
| Matt Kauffman<br>202 586-5824<br>Matthew.Kauffman@ee.doe.. | • Cross-cutting Analyses<br>• Electrolyzers |
| Arlene Anderson<br>202 586-3818<br>Arlene.Anderson@ee.doe... | • Fossil Energy Coordination on Coal-Based Production<br>• Natural Gas, Petroleum Feedstocks/Platinum Mining<br>• 5-Year R,D&D Plan Development |
| Mark Paster<br>202 586-2821<br>Mark.Paster@ee.doe.gov | • Overall Feedstock Strategy for $H_2$ production<br>• High Temperature Thermochemical and Electrolysis<br>• Hydrogen Delivery |

# Hydrogen Storage

| | |
|---|---|
| JoAnn Milliken<br>**202 586-2480**<br>**JoAnn.Milliken@ee.doe.gov** | • **Tech Team Storage Chair**<br>• **Overall Hydrogen Storage**<br>• **Team Leader, Hydrogen Storage**<br>• **Fuel Cell International Activities**<br>• **FreedomCAR Storage & Vehicle Interface Tech Team** |
| Lucito Cataquiz<br>**202 586-0729**<br>**Lucito.Cataquiz@ee.doe.gov** | • **Support Service Contractor COTR**<br>• **Cost/Financial Status**<br>• **Pressurized Tanks & Hydrogen Compressors**<br>• **Compressed/Liquid Tank Projects** |
| New Hire | • **New $H_2$ Storage Materials Virtual Centers/Projects**<br>• **BES Liaison** |
| Carole Read<br>**202 586-xxxx**<br>**Carole.Read@ee.doe.gov** | • **New $H_2$ Storage Materials Virtual Centers/Projects**<br>• **IHIG** |

# Fuel Cell Team

| | |
|---|---|
| Pat Davis<br>202 586-8061<br>Patrick.Davis@ee.doe.gov | • Overall Fuel Cell Systems<br>• FreedomCAR Fuel Cell Tech Team<br>• Compressors/Expanders |
| Donna Ho<br>202 586-8000<br>Donna.Ho@ee.doe.gov | • Transportation Fuel Cells<br>• CARAT Program |
| Valri Lightner<br>202 586-0937<br>Valri.Lightner@ee.doe.gov | • Fuel Processing<br>• MEA R&D |
| John Garbak<br>202 586-1723<br>John.Garbak@ee.doe.gov | • Fuel Cell Vehicle Demonstration<br>• Liaison with 21st Century Truck<br>• Fuel Cells for APUs |
| Kathi Epping<br>202 586-7425<br>Kathi.Epping@ee.doe.gov | • Stationary Fuel Cells |
| Nancy Garland<br>202 586-5673<br>Nancy.Garland@ ee.doe.gov | • National Lab Fuel Cell R&D<br>• Sensors<br>• GATE Program |

# Cross-Cutting Functions

| | |
|---|---|
| Sig Gronich<br>**202 586-1623**<br>**Sigmund.Gronich@ee.doe.gov** | • Overall Technology Validations for Transportation and Stationary Applications<br>• Manager, Technology Validation |
| Christy Cooper<br>**202 586-1885**<br>**Christy.Cooper@ee.doe.gov** | • Education on Hydrogen and Fuel Cells |
| Neil Rossmeissl<br>**202 586-8668**<br>**Neil.Rossmeissl@ee.doe.gov** | • $H_2$ Codes and Standards<br>• $H_2$ Safety<br>• Hydrogen Technical Advisory Panel<br>• IEA $H_2$ Agreement |
| Tia Alexander<br>**202 586-9118**<br>**Tia.Johnson@ee.doe.gov** | • Administrative Reporting and Support<br>• Controlled Correspondence<br>• Travel Planning and Approval<br>• Meeting Facilitation<br>• Foreign Visitors |

# *Additional On-site Resources*


| | | |
|---|---|---|
| Reeshemiah Schuler | Reeshemiah.Schuler@ee.doe.gov | 202 586-8012 |
| Bill Cleary | Bill.Cleary@ee.doe.gov | 202 586-1570 |
| Dr. John Petrovic | John.Petrovic@ee.doe.gov | 202 586-8058 |
| Lauren Inouye | Lauren.Inouye@ee.doe.gov | 202 586-0894 |
| Kristen Rannels | Kristen.Rannels@ee.doe.gov | |

# *Additional DOE Contacts*

Fossil Energy (FE)

| | | |
|---|---|---|
| **Lowell Miller** | **301 903-9451** | **Lowell.Miller@hq.doe.gov** |
| **Ed Schmetz** | **301 903-3931** | **Edward.Schmetz@hq.doe.gov** |
| **Art Hartstein** | **301 903-2760** | **Arthur.Hartstein@hq.doe.gov** |

Nuclear Energy (NE)

| | | |
|---|---|---|
| **David Henderson** | **301 903-3097** | **David.Henderson@hq.doe.gov** |

Office of Science (SC)

| | | |
|---|---|---|
| **John Houghton** | **301 903-8288** | **JOHN.HOUGHTON@science.doe.gov** |
| **Pat Dehmer (BES)** | **301 903-3081** | **PATRICIA.DEHMER@science.doe.gov** |