

DOE Hydrogen Program Review

Philadelphia, Pennsylvania



Reviewing the first year of the President's Hydrogen Fuel Initiative

Steve Chalk

DOE Hydrogen Program Manager

May 24, 2004



Tremendous Progress Made Since President Bush's State of the Union Address



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

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

- Program Management of Departmental Hydrogen Activities Integrated
- Public/Private Partnerships Established
- NRC Evaluation of DOE Plans Aiding in Hydrogen Production Strategies
- Major Systems Integration/ Analysis Capability Being Implemented
- Programmatic and Technical Accomplishments



Hydrogen Providing a Clean, Secure Energy Future

All drivers in a hydrogen economy are important:

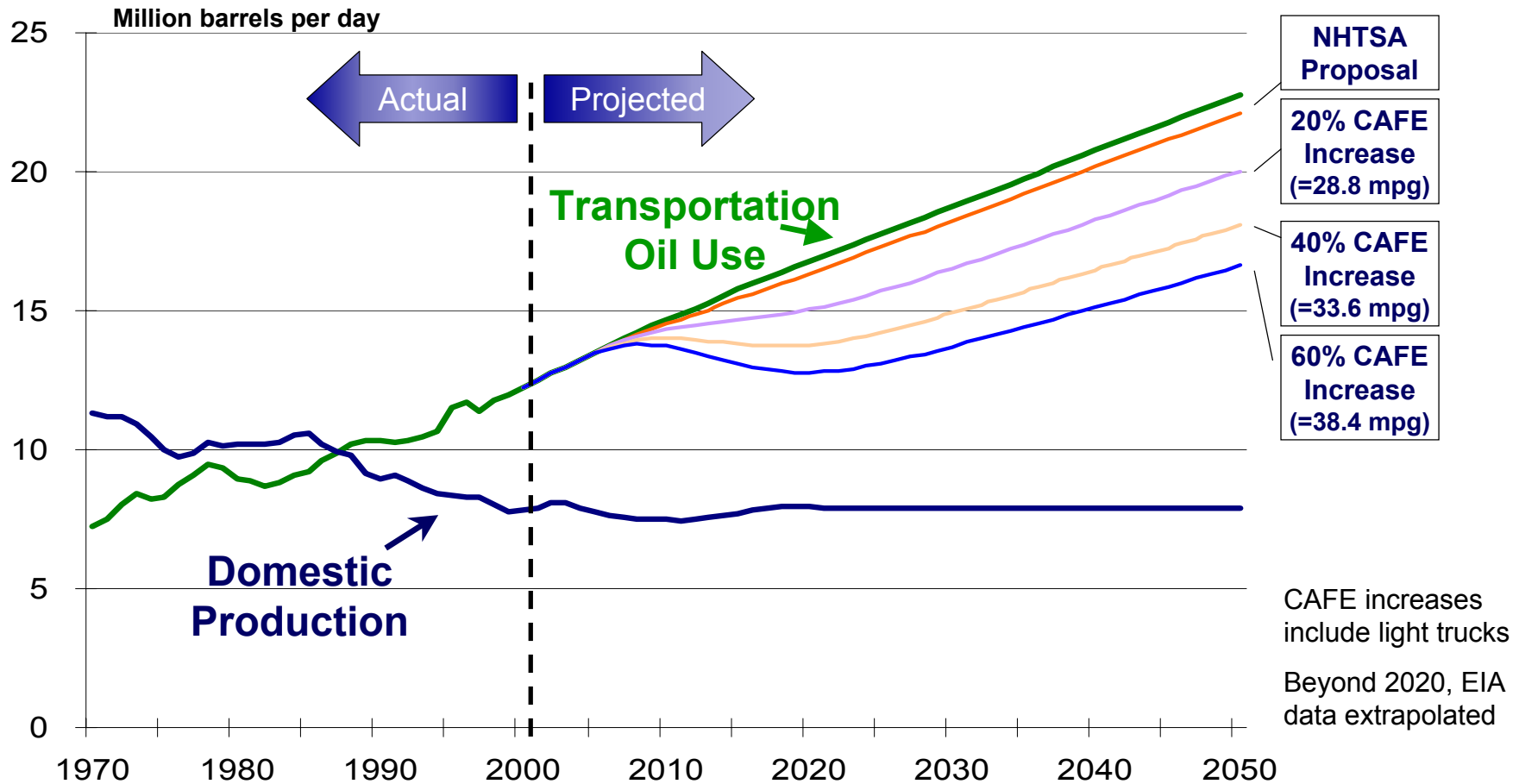
- Energy Security
- CO₂ and Criteria Emissions Reductions
- Economic Competitiveness

DOE has accelerated hydrogen research efforts to realize hydrogen's benefits by the 2030 – 2040 time frame while maintaining a balanced portfolio of RD&D on other energy-saving transportation and renewable technologies.





Increasing Fuel Economy Helps for Next 2 Decades, But is Not Enough to Offset Long-Term Growth

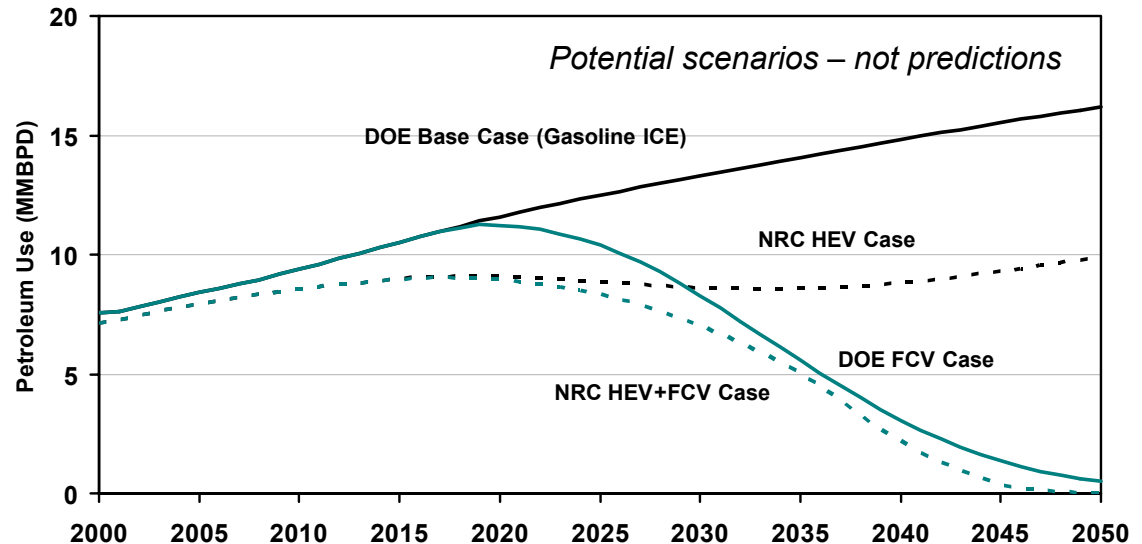
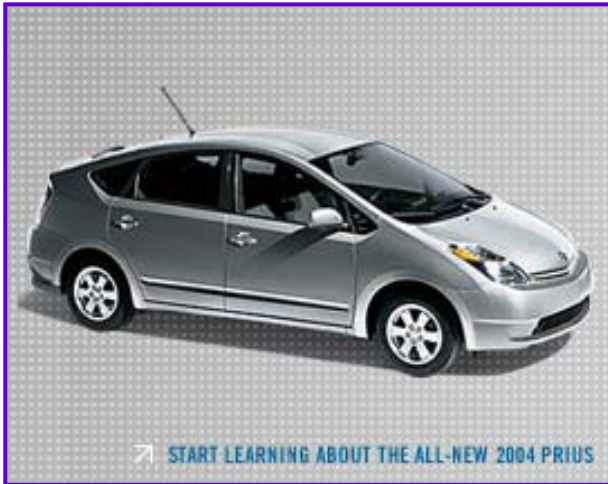


DOE is promoting hybrid vehicles in near-term (\$90M annually for cost reduction of hybrid components) and hydrogen research for long-term.



Hybrids are a Bridge

Hybrid vehicles are a bridge technology that can reduce pollution and our dependence on foreign oil until long-term technologies like hydrogen fuel cells are market-ready.



Hybrid/Hydrogen FCV Strategy

- In 2040, if hydrogen reached its full potential, the use of FCV's could generate a savings of 11 million barrels per day in oil consumption in the light-duty transportation sector.
- Using the same assumptions, in 2040, U.S. carbon reduction could be 19% of our total emissions, equivalent to 500 million metric tons per year

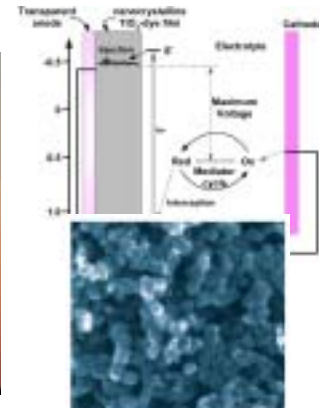


H₂ Production Strategies

Distributed natural gas and electrolysis economics are important for the “transition”

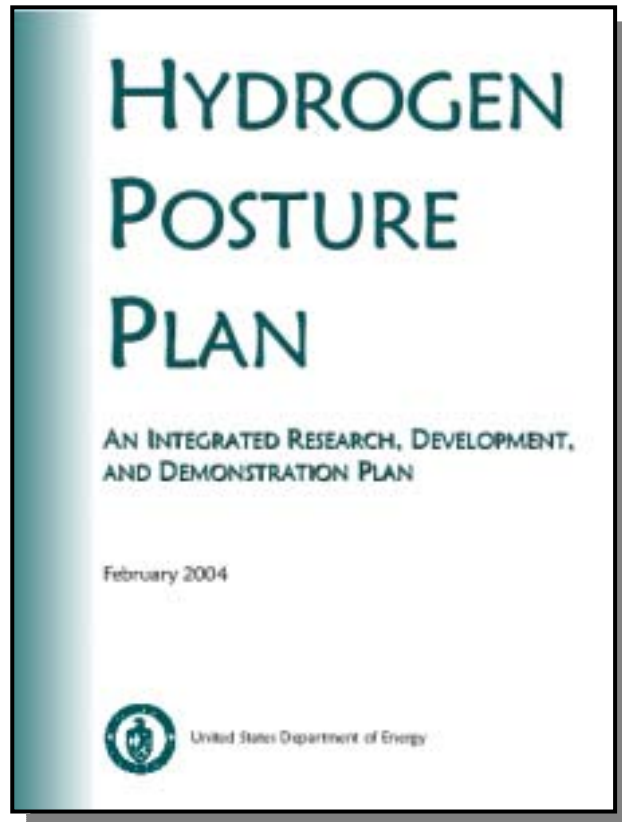


Energy resource diversification is important for the long-term





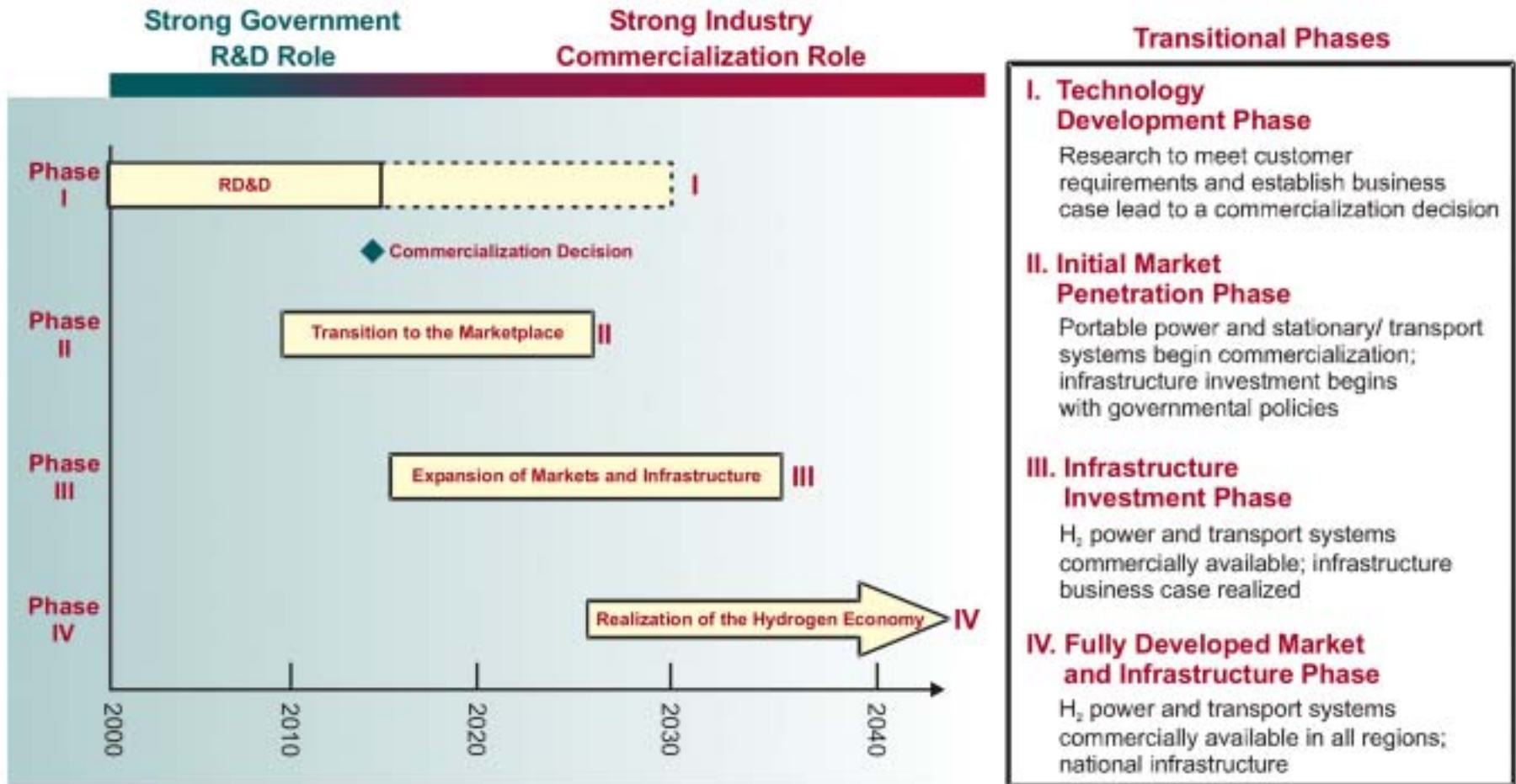
Integrated Plan Developed to Overcome Challenges



- Describes technology development to support commercialization decision by industry in 2015
- Covers basic research through technology validation
 - Office of Science
 - Office of Fossil Energy
 - Office of Nuclear Energy, Science and Technology
 - Office of Energy Efficiency and Renewable Energy
- Identifies performance-based milestones for stakeholders to track progress



Timeline for a Hydrogen Economy



Positive commercialization decision in 2015 leads to beginning of mass-produced hydrogen fuel cell cars by 2020



Resources to Support the President's Hydrogen Fuel Initiative (\$K)

Major Line Items and Key Activities	FY 04 Appropriation	FY 05 Request
<u>Fuel Cell Technologies</u> : system components, stack components, fuel processors, technology validation	\$65,187	\$77,500
<u>Hydrogen Technologies</u> : distributed natural gas and renewable production, delivery, storage, safety and codes/standards, infrastructure technology validation, education/analysis	\$81,991	\$95,325
<u>Coal-based Hydrogen Production</u> : gasification, gas separation	\$4,889	\$16,000
<u>Nuclear-based Hydrogen Production</u> : high temperature reactions	\$6,377	\$9,000
<u>Basic Science</u> : production, storage and use	\$0*	\$29,183
<u>Department of Transportation</u> : safety, codes/standards	\$555	\$832
Total	\$158,999**	\$227,840

* Excludes about \$8 million of baseline activities not counted as part of the Initiative.

** FY 04 Request = \$181.7 M

Note: Some FY 04 numbers vary slightly due to RESCISSIONS AFTER appropriation and other reductions.



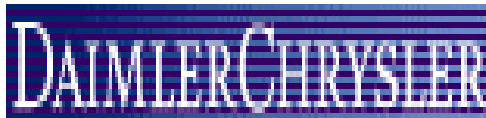
FreedomCAR and Fuel Partnership Established



ChevronTexaco



ExxonMobil



New Energy Company/DOE Technical Teams

- Production
- Delivery
- Fuel Pathway Integration

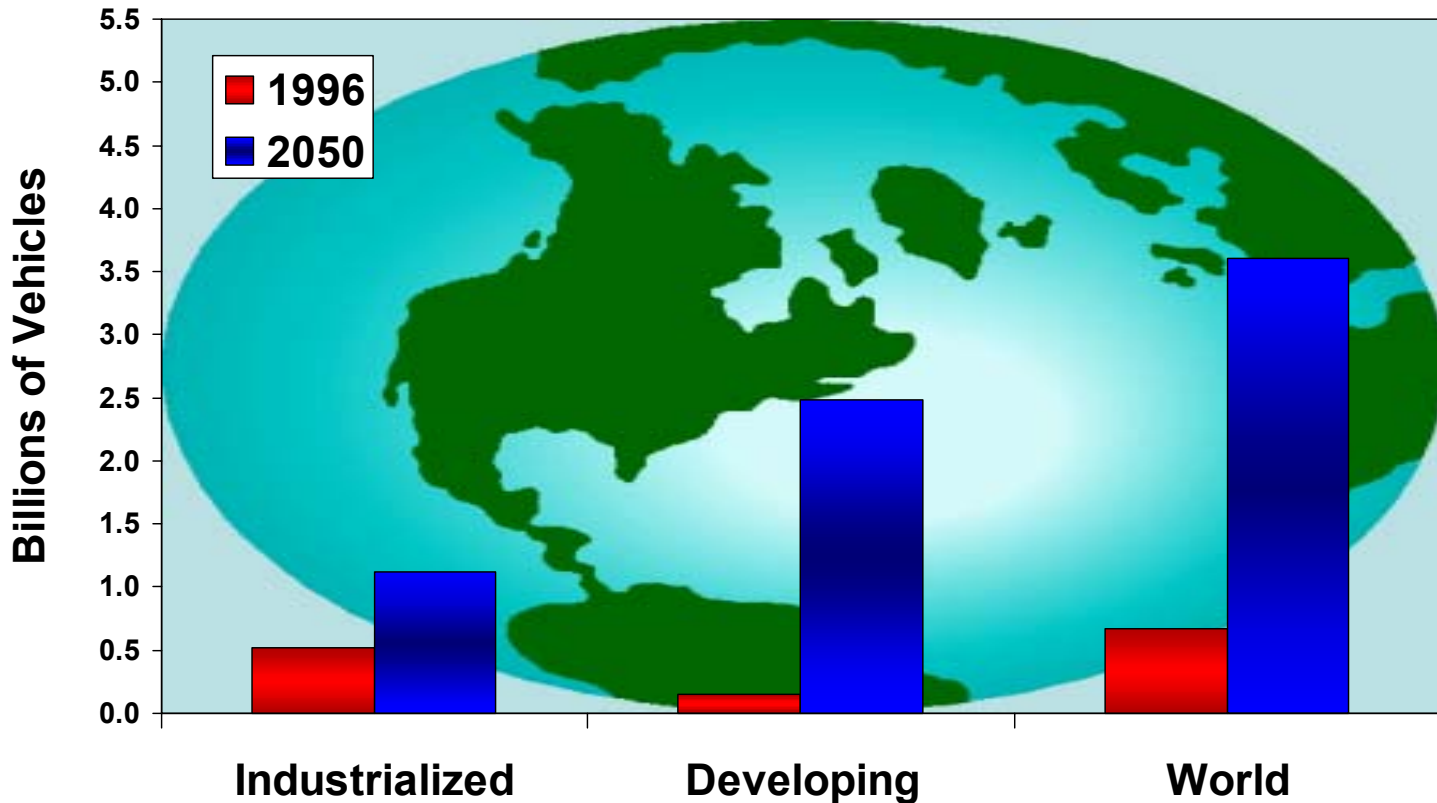
New Joint Auto/Energy/DOE Technical Teams

- Codes and Standards
- Storage



Global Perspective

... the Number of Vehicles in the World Is Growing



Source: EE Analytic Team

Many countries have concerns about energy and environmental security related to transportation/mobility



International Partnership for the Hydrogen Economy



Russian Federation



USA



Canada



Iceland



IPHE Partners' Economy:

- Over \$35 Trillion in GDP, 85% of world GDP
- Nearly 3.5 billion people
- Over 75% of electricity used worldwide
- > 2/3 of CO₂ emissions & energy consumption

IPHE Vision:

“... consumers will have the practical option of purchasing a competitively priced hydrogen power vehicle, and be able to refuel it near their homes and places of work, by 2020.”

- Secretary Abraham, April 2003



Japan



South Korea



China



India



United Kingdom



France



Germany



Italy



Australia



Brazil



Norway



European Commission





DOE Requested the National Academies to Evaluate its Hydrogen Planning

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine



“A transition to hydrogen as a major fuel in the next 50 years could fundamentally transform the U.S. energy system, creating opportunities to increase energy security through the use of a variety of domestic energy sources for hydrogen production while reducing environmental impacts ...”

“This committee believes that investigating and conducting RD&D activities to determine whether a hydrogen economy might be realized are **important to the nation.**”



DOE is Evolving its H₂ Program to Respond to NRC Recommendations

- Focus on the “transition” to a hydrogen economy, critical issues needed for 2015 decision
 - Exploratory research on hydrogen storage and fuel cell cost & durability
 - “Laser-like” focus on distributed hydrogen infrastructure. Lower capital costs & increase efficiency of natural gas reformers and electrolyzers
- Let the long-term hydrogen economy “evolve”
 - Fundamental and exploratory research on coal/carbon capture sequestration, photoelectrochemical, photobiological, thermochemical, etc.

*The National Academies’ conclusions support the President’s vision.
DOE concurs fully with 35 of 43 recommendations.
Currently evaluating other 8 for implementation.*

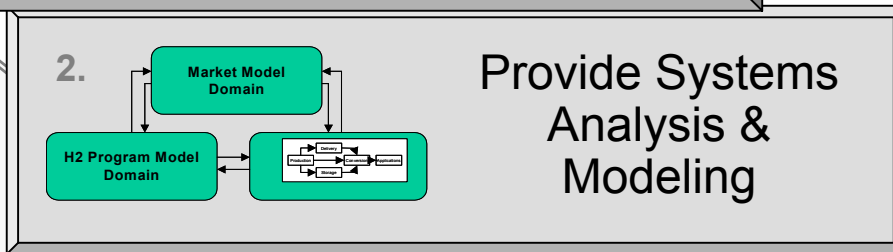
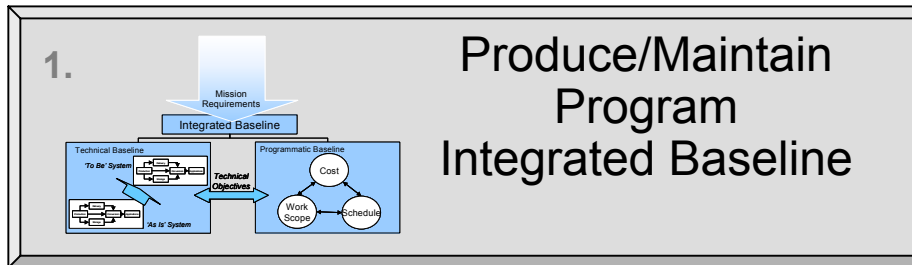


Path Forward to Implement the NRC Recommendations

- Use hydrogen storage model to shift emphasis in fuel cells to exploratory research for cost & durability
- Increase investments in natural gas reforming and electrolyzers (treat these as critical path)
- Employ systems analysis to map out options and a transition plan consistent with developing infrastructure
- Strengthen infrastructure program (storage, purity, pipeline materials, compressors, leak detection, permitting, and codes/standards)
- Increase underlying safety research and analysis
- Establish fundamental science efforts in longer term hydrogen production concepts, storage, fuel cells, etc.
- Integrate with carbon capture/sequestration and across all department programs

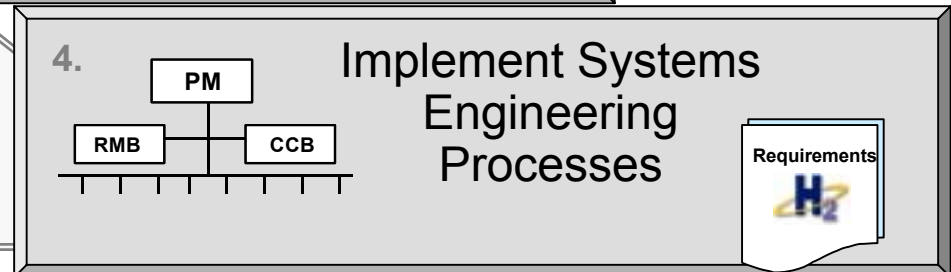
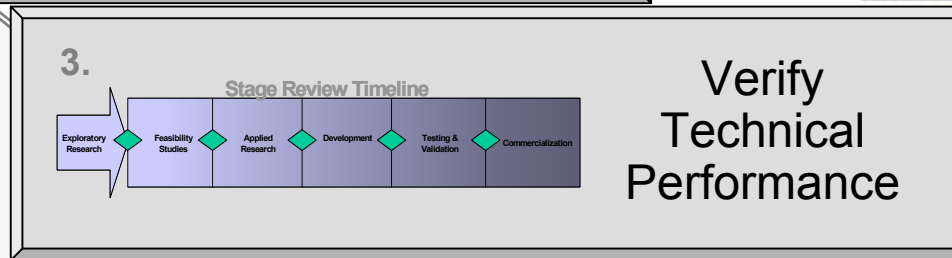


Systems Integration Functions



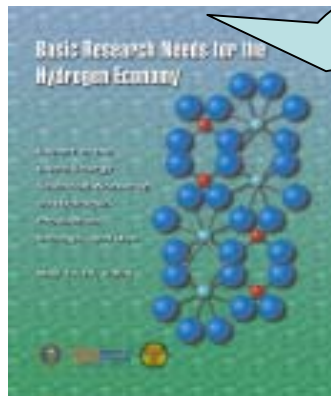
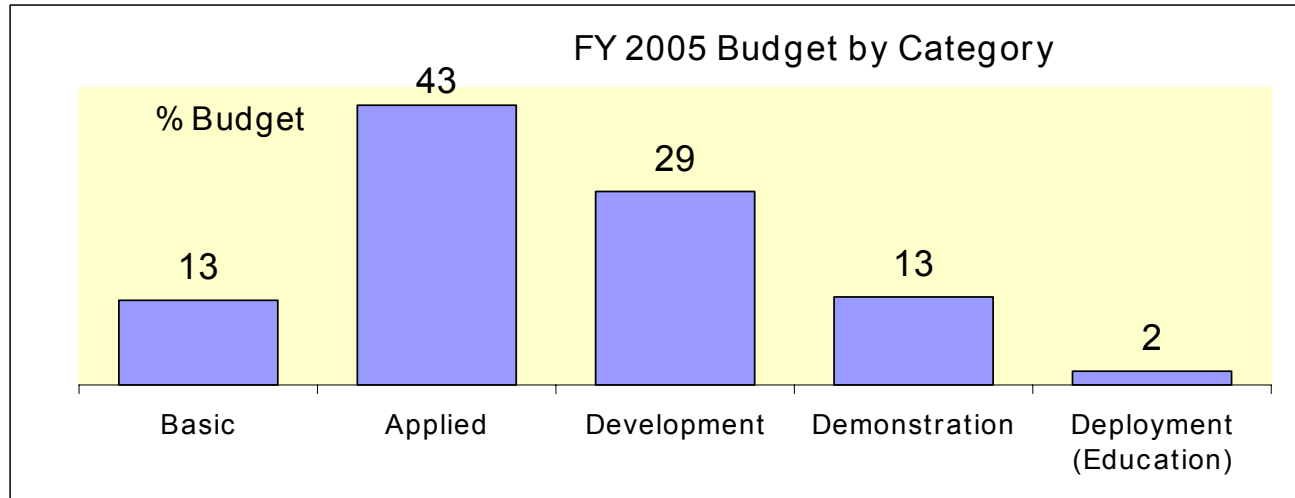
Supporting Tasks:

- Assemble team
- Produce Systems Integration Plan
- Develop Systems Integration schedule
- Establish FE/NE/SC, Lab, & Industry relationships
- Provide FreedomCAR & Fuels Technical Team support
- Develop Systems Integ briefing/roadshow
- Prepare for Internal & External assessments

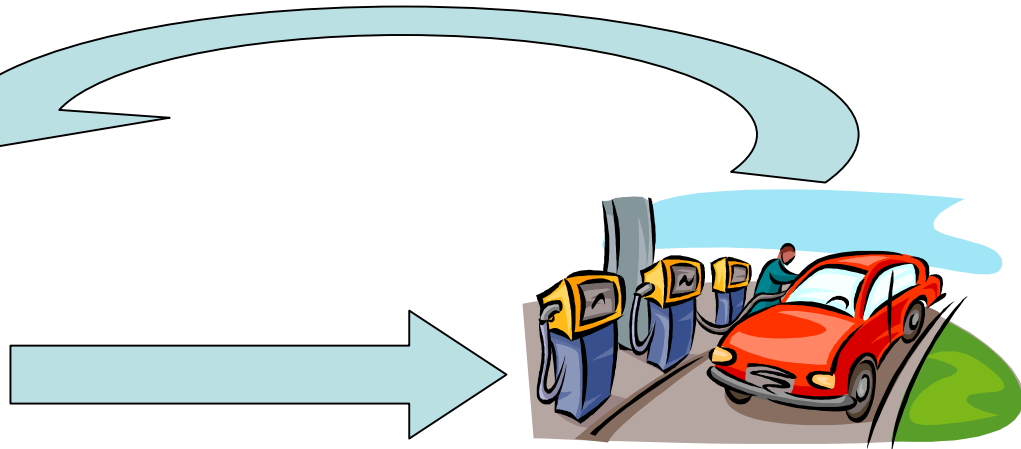




Balanced Program Being Implemented



Basic Research



Technology Validation



Selection of New Hydrogen Projects

Hydrogen Storage - \$150M over 5 years

- Three Centers of Excellence for exploratory research; individual projects to explore new materials for hydrogen storage (\$25M in cost share)

Vehicle and Infrastructure “Learning”

Demonstration - \$190M over 5 years

- Automobile/energy company teams will demonstrate integrated and complete system solutions in real world environments (\$190M in cost share)

Fuel Cell Research - \$13M over 2 years

**in addition to \$75M awarded in FY2003*

- Consumer electronics, fuel cells for auxiliary power generation, and off-road fuel cell R&D (\$9.5M in cost share)

Hydrogen Education - \$4.5M over 5 years

- Curricula and teacher professional development, education materials, co-sponsorship of events (\$800K in cost share)

Active Solicitations

- Production and Delivery – July 2004 Selections
- Coal-based Production – Opens this Fall
- Nuclear-based Production – Open, September Selections
- Codes and Standards – October 2004 Selections
- Basic Research – 2005 Selections



“Today, the Department of Energy has selected recipients for \$350 million of research grants...the administration is now acting upon the Congress' appropriation. ... We want to be the country that leads the world in innovation and technological change.”

- President George W. Bush
April 26, 2004

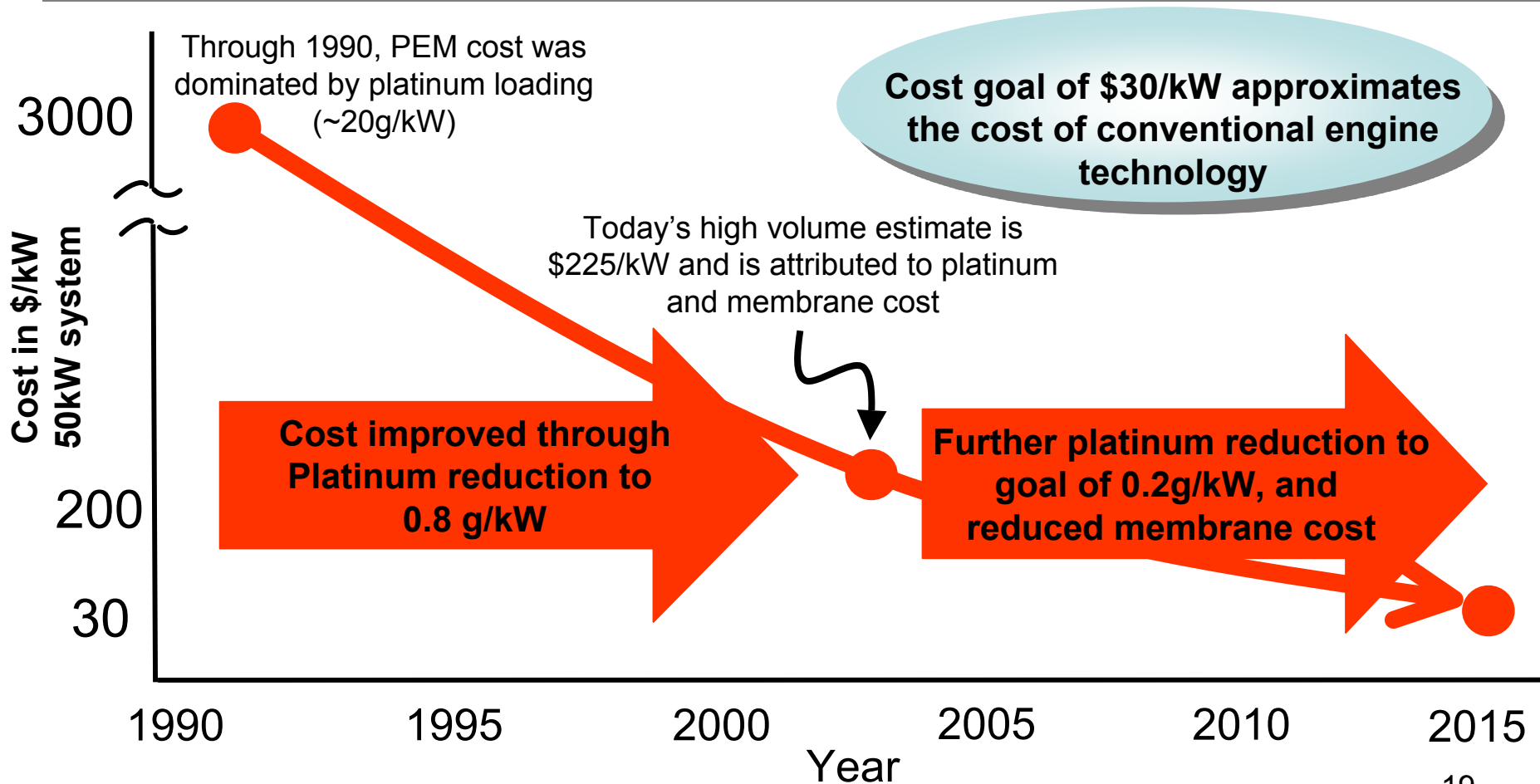
Note: Cost share amounts are in addition to government award amounts



PEM Fuel Cell Cost

7X gap between today's high volume cost & our target

Cost of a fuel cell prototype remains high (~\$3,000/kW), but the high volume¹ production cost of today's technology has been reduced to \$225/kW



1. High volume production defined as 500,000 units per year
2. Cost estimated by Tiax with enhanced hydrogen storage.



Distributed Hydrogen Production From Natural Gas On Target

- APCI validated \$3.60/gge hydrogen – delivered, untaxed, co-producing electricity at 8¢ per kWh.
- \$3.00/gge target in 2005 within reach
- Reformer research
 - Optimized desulfurization, reformer, and shift catalysts
 - Improved heat recovery system
- PSA research
 - 99.999% pure H₂
 - 3x cost reduction compared to commercial units
 - Decreased size
 - 82% efficiency (64% in 2003)



Las Vegas station

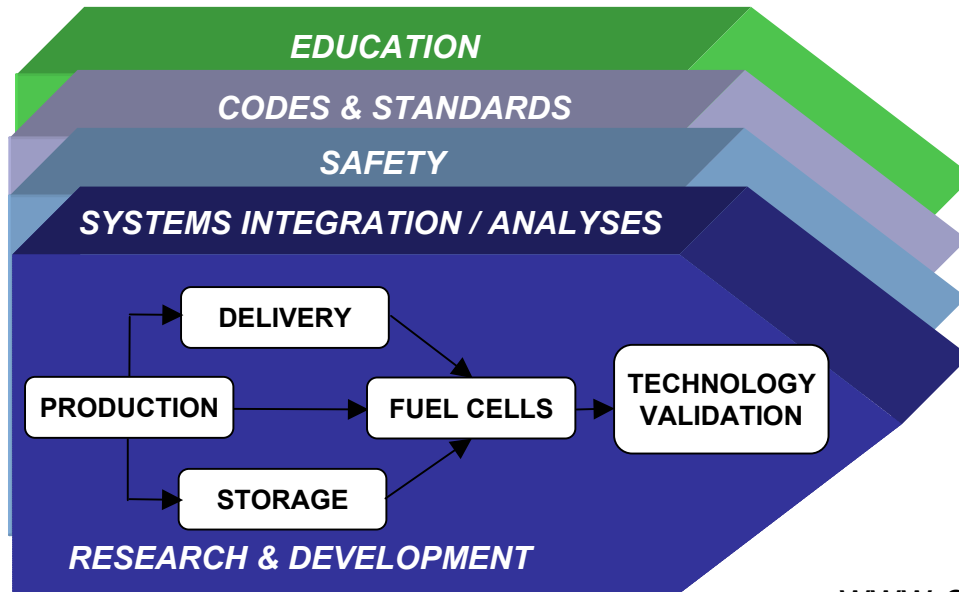


PSA Unit

In 2025, assuming FCVs represent 12% of LDV inventory, EIA estimates only 2.8% increase in natural gas demand compared to reference case



The DOE Hydrogen Program



- www.eere.energy.gov/hydrogenandfuelcells
- www.fe.doe.gov
- www.nuclear.gov
- www.sc.doe.gov/bes/hydrogen.html

Coming Soon!

Integrated DOE Hydrogen Program web site
with links to each office