Fuel Cells Summit VI

Hydrogen Fuels

Hydrogen Coordinating Committee

May 29, 2002

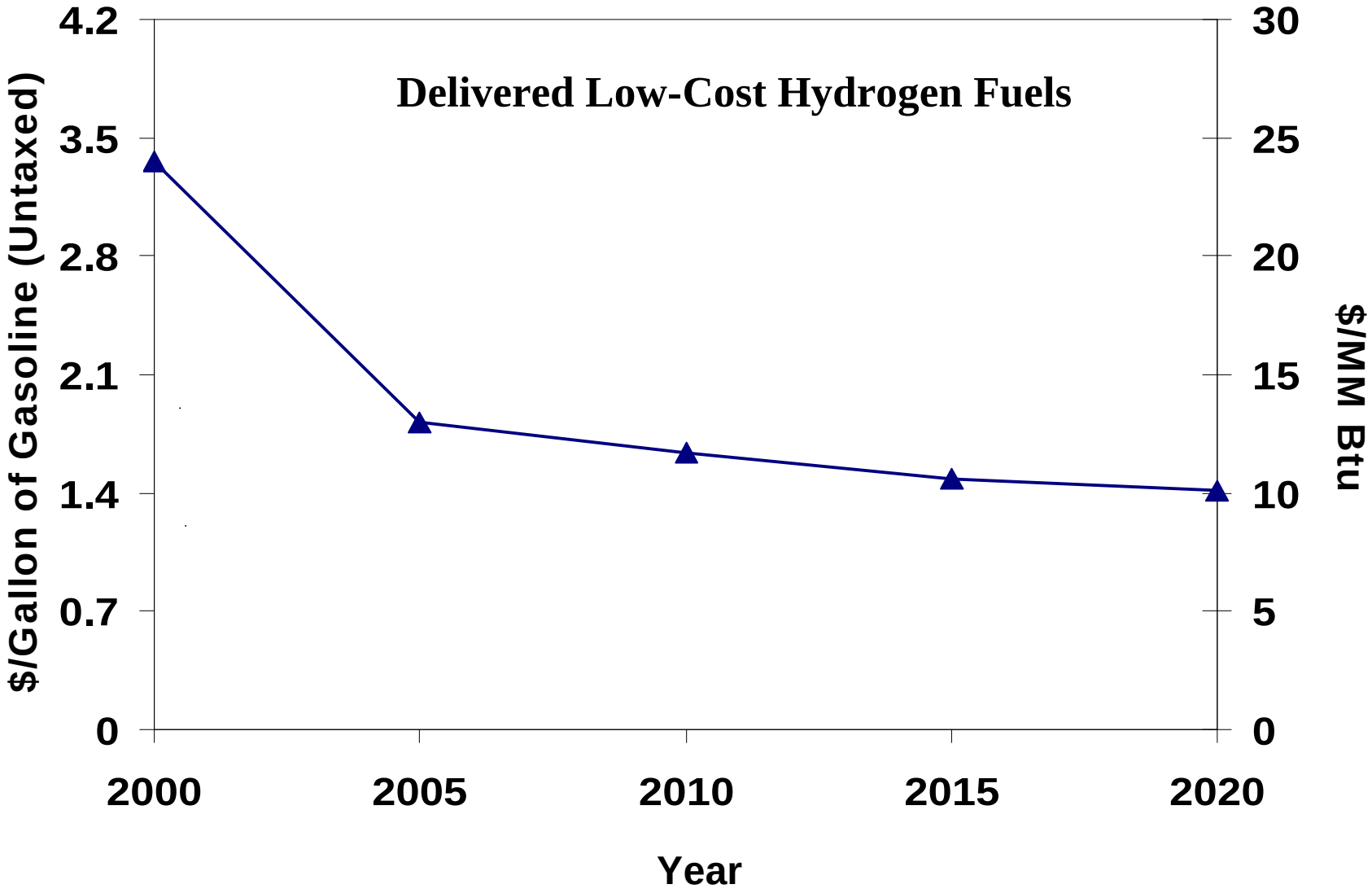
Congressional Language

Conference Committee:

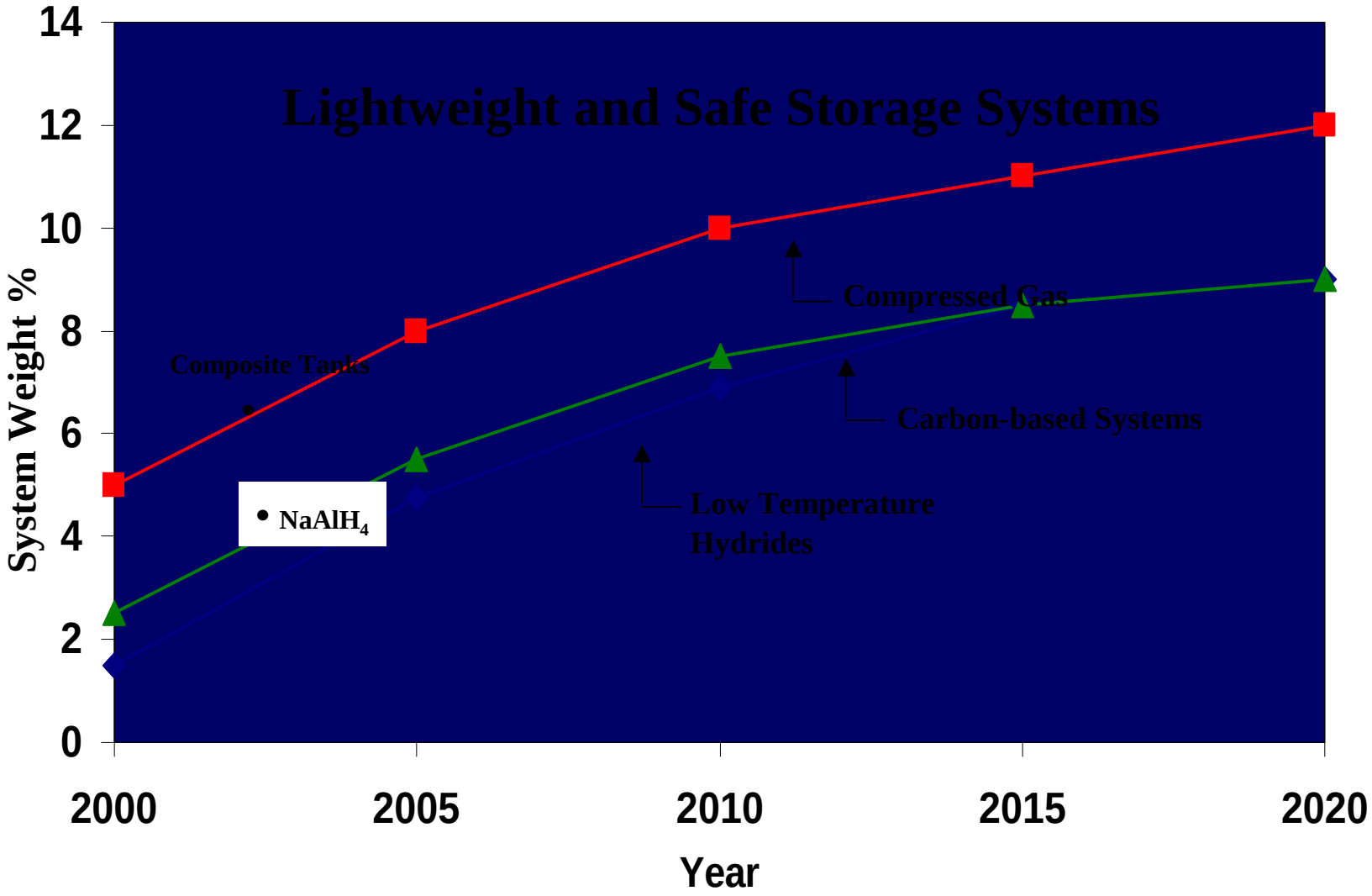
Hydrogen. --The Committee recommendation is $31,000,000 for hydrogen activities. The Conference Agreement includes:

- **$1,000,000 for the Fuel Cell Technology Assessment and Demonstration at the University of Alabama at Birmingham**
- **$350,000 for the Big Sky Economic Development Authority Demonstration Fuel Cell Technologies, Montana**
- **$500,000 for the gasification of Iowa switch grass and its use in fuel cells, Iowa State**
- **$1,500,000 for the ITM Syngas project, Air Products Pennsylvania**
- **$1,500,000 for the fuel cell installation project at Gallatin County, Montana**
- **$1,000,000 for continued demonstration of the hydrogen locomotive and front-end loader projects, Nevada.**

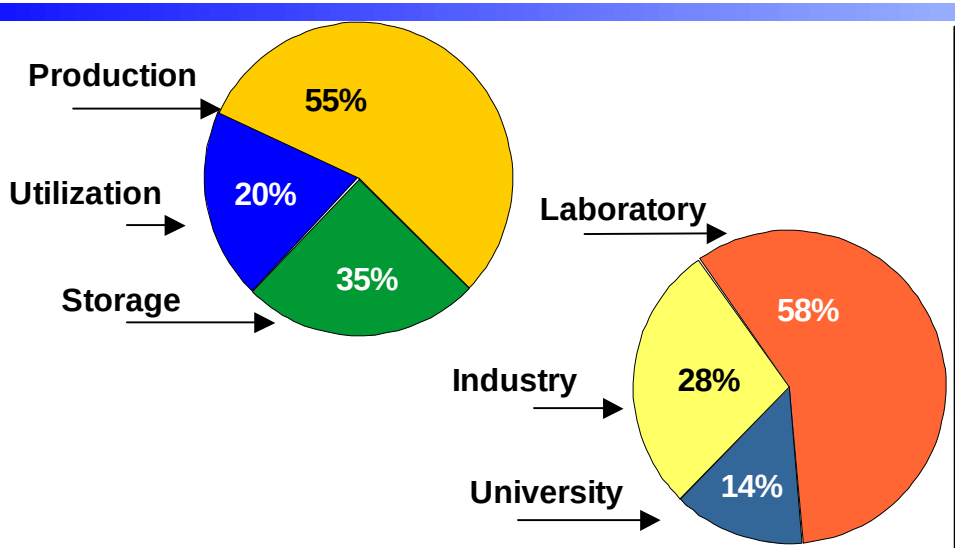
Hydrogen Program Performance Measures



Hydrogen Program Performance Measures



Core R&D Thrust FY02



Storage: $ 7.84 M

FY 01 Milestones

Developed new method to synthesize catalyzed alanate.

Demonstrated thermal compressor at 6000 psig.

FY 02 Milestones

Validate 5.2% by weight storage on catalyzed alanate wit over 1000 cycles.

Scale up thermal compressor to 15 liters/min

Production : $ 7.76 M

FY 01 Milestones

Completed construction of ITM PDU

Operated a 5 liter bioshift reactor on a slipstream of syngas.

FY02 Milestones

Operate PDU continuously at 24,000 SCFD of syngas to verify performance.

Operate the 5 liter bioshift reactor at 10 psi on a slipstream of syngas

Utilization : $ 3.74 M

FY 01 Milestones

Supported CaFCP by modeling maintenance building ventilation.

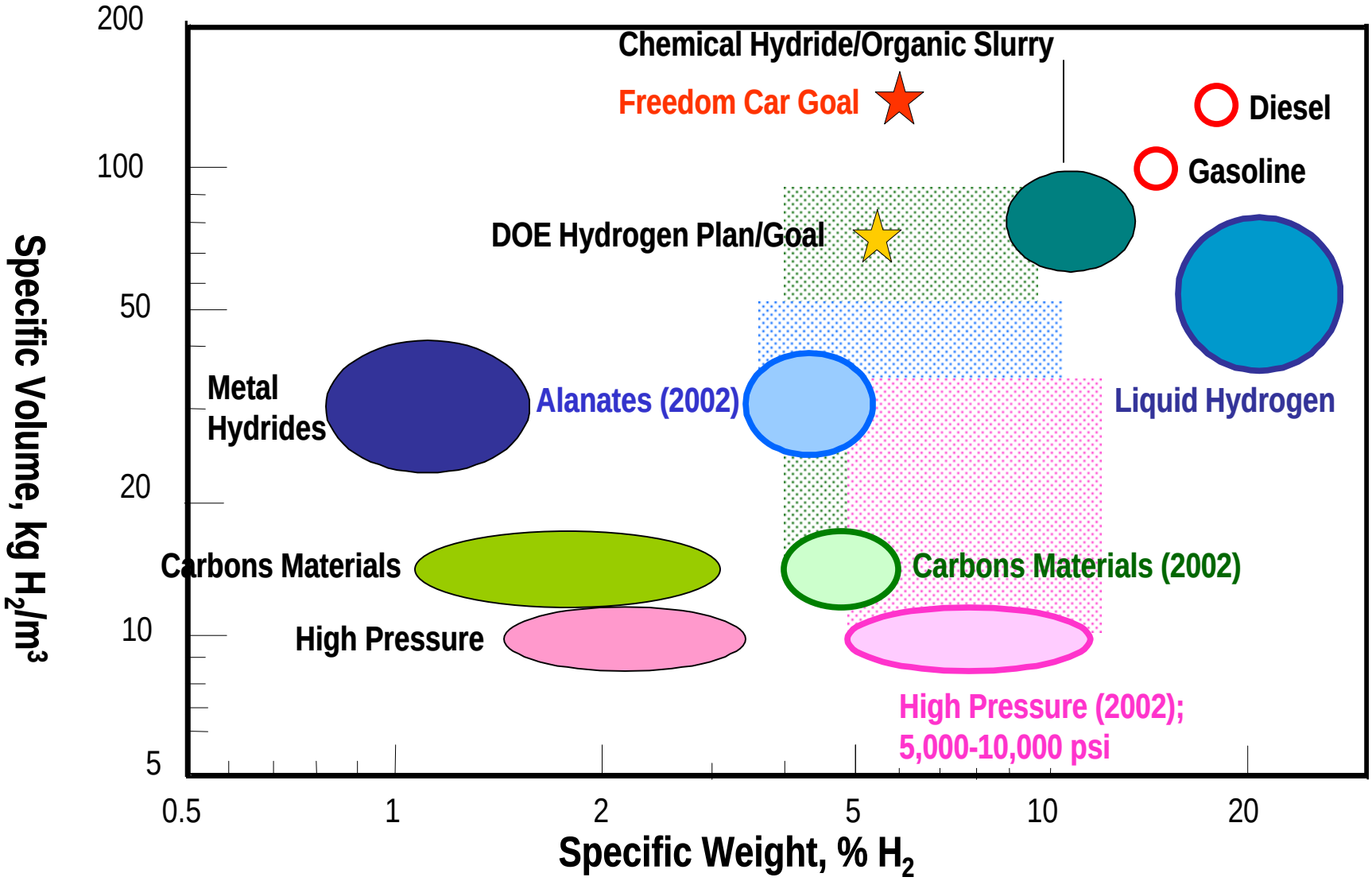
Hydrogen additions to natural gas extended the lean flammability limits cutting NO_x by 25%.

FY 02 Milestones

Demonstrate 200 W advanced PEM fuel cell for personal mobility devices.

Quantify the effect of adding up to 100% hydrogen to combustion turbine emissions.

Hydrogen Storage Developments
Reference Data From the R&D Roadmap 1998



Programmatic Activities

Hydrogen Storage	5000psi Composite Wall Tanks	up to 10,000 psi Composite Wall Tanks
	Cryogas Tank	80°K, 3600 psi Composite Wall Tanks
	Alanate Hydride Storage	Metal Hydrides Chemical Hydrides Carbon Nanotubes
Hydrogen Fuel Costs	Integrated refueling stations (3)	advanced reformers
	Las Vegas co-production	implement
	Reformer systems	fossil with sequestrated
	Biomass systems	nuclear heat
	Electrolyses	
Codes and Standards	work with code organizations;	implementation
	NFPA, ICC, ISO, SAE	

Major Accomplishments

- Steam and autothermal reformers being incorporated into refueling stations
    - Las Vegas
    - SunLine Transit Agency
    - Three Integrated Systems
- Biomass to hydrogen systems being developed
- Collaboration with fossil and nuclear energy
- Certification of class IV 5,000 psi and 10,000 psi pressurized tanks
- Certification of cryo-gas tank
- Cyclic performance of alanate hydride storage tanks
- Formed ICC and NFPA panels for codes and standards development, and supported ISO committees
- Pioneered development of high efficiency hydrogen ICE and hythane ice
- Achieved a 50% cost-reduction of electrolysers and proceeding with next 50% cost reduction
- Pioneered hydrogen Power Park Concepts and co-production systems

Hydrogen Program- Timeline

	1990-1995	1996	1997	1998
Changes of Direction	Program moved from an earmarked activity to projects funded through competitive solicitations. Created HTAP charter and appointed members	Created and industry outreach project to inform industry about the program, its goals and longer-term objectives.	Created Technology Validation project Initiated cluster concept for refueling stations	Published strategic plan to replace five-year management plan. Decision made to develop natural gas to hydrogen reformers for refueling stations
Key Accomplishments	Published five year management plan Created Hydrogen Interagency Panel Created Peer Review Process	Produced industry roadmap on hydrogen. Initiated codes and standards activities	Demonstrated first PEM fuel cell vehicle at Palm Desert. Published report that hydrogen fueled internal combustion engines could achieve significant efficiency and emissions improvements.	Published technology roadmap for R&D Two researchers received awards, Christopher Columbus and SAE Top Research Paper Achieved 12.4% solar-to-hydrogen efficiency
Down Selects	Four universities earmarked in prior years were required to compete for awards. Four storage contracts were awarded.	Discontinued all activated carbon storage work, and high temperature metal hydrides. Moved glass microsphere storage work to industry	Eliminated R&D on carbon foam and other engineered carbon forms for hydrogen adsorbents.	Discontinued coal gasification Discontinued all conventional hydride development Refocused carbon nanotube research

Hydrogen Program- Timeline

	1999	2000	2001	2002
Changes of Direction	Initiated joint program with State Energy Program to validate technology. Established collaboration with DOT on fuel cell buses	Signed an MOU with FE to co-fund and co-manage coal to hydrogen projects. Instituted powerpark program	Initiated joint program with OTT to co-fund and co-mange research on hydrogen storage and validate refueling technology.	Expanded joint program with OTT to co-fund and co-mange research on hydrogen storage, production and validate refueling technology. Co-fund separation technology development with FE
Key Accomplishments	First electrolyzer delivered to BC Transit to fill three fuel cell buses. Operated reversible fuel cell at 1000 amps/ft^2 @ 0.6 V Created Dr. Bob show to teach middle and high school students.	Second generation electrolyzer delivered to SunLine Transit to fill vehicles. Demonstrated 7.5% by weight hydrogen storage in high pressure tanks.	Third electrolyzer delivered to Nevada to fill buses. Operated lab scale PDU for Ion Transport Membrane Reactor. Created hydrogen curriculum and implemented it in CA.	Demonstrated hydride storage system for mine vehicle Completed milestone for Ion Transport Membrane Reactor. Nevada refueling station Mining Locomotive
Down Selects	Discontinued Sorbent Enhanced Reaction project due to poor performance on scale-up.	Discontinued work on organic catalysts for metal hydride adsorbents. Discontinued work on diesel reforming.	Discontinued project with ECD, commercialization partnerships could not be finalized.	Discontinued projects with FSEC, ORNL, NETC, SNL, UTRC, MER Carbon storage was expanded

Why HYEDI?

- **hydrogen can "decouple transportation from primary energy systems" (Don Huberts, CEO, Shell Hydrogen)**
  - **–hydrogen is "feedstock-flexible"**
  - **–but also need to decouple hydrogen from limited production base of fuel cells**
- **"…two technologies that are crucial to the way in which hydrogen could be introduced into energy markets. One is the fuel cell and the second is hydrogen storage." Mark Moody-Stuart, Chairman, Royal Dutch/Shell Group**
  - **–need to reduce cost of fuel cells**

HYEDI HOW?

- Focal area for Initiative
  - Integrated Production, Storage, Utilization
    - Integrate hydrogen fuel cells into federal buildings through incentive program
    - Locate for most cost-effective use in early markets
- Industry team leaders funded by DOE through competitive solicitation
  - Each team divides funding as specified in contracts
  - 50-50 cost-share required
  - National labs assist teams as requested

Coordination?

- Focus Area
  - Effectively use all gov't funding in a coordinated fashion to achieve goals
    - Integrate hydrogen and fuel cell activities with NES, ICC, NFPA, ISO
    - Provide framework to quickly assess needs and provide critical resources
- Industry leaders
  - Actively involved in all meetings
  - Benefit from the outcome
  - Assist the gov't at critical C&S meetings