Hydrogen Delivery

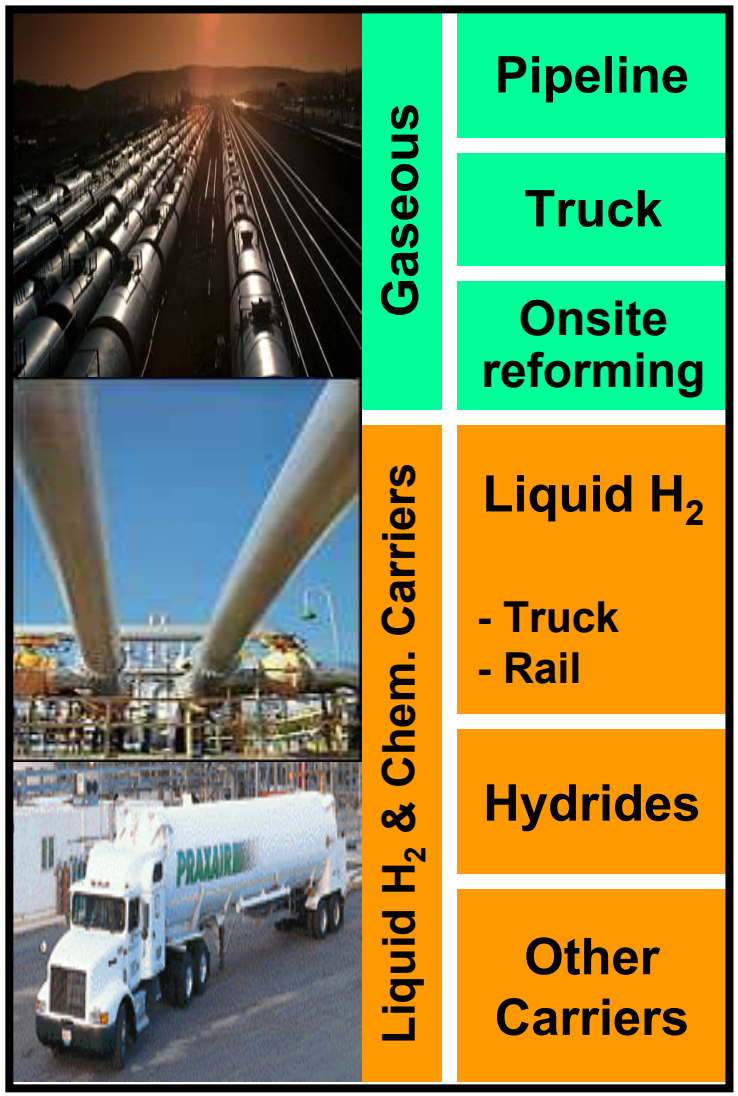
Mark Paster

Energy Efficiency and Renewable Energy

Hydrogen, Fuel Cells and Infrastructure Technology Program

Hydrogen Production and Delivery Team

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 Options

- End Game
  - Pipelines
  - Other as needed
    - Breakthrough Hydrogen Carriers
    - Truck: HP Gas & Liquid Hydrogen
  - Electrolysis and Distributed reforming of NG, Renewable Liquids (e.g. ethanol etc.)
- Transition
  - Electrolysis and Distributed reforming of NG, Renewable Liquids (e.g. ethanol etc.)
  - Truck: HP Gas & Liquid Hydrogen
  - Regional Pipelines
  - Breakthrough Hydrogen Carriers

Barriers

- Lack of Infrastructure Options Analysis
- High Capital Cost of Pipelines
- High Cost of Compression
- High Cost of Liquefaction
- Lack of cost effective Carrier Technology

Delivery

Key Challenges

- Pipelines
  - Retro-fitting existing NG pipeline for hydrogen
  - Utilizing existing NG pipeline for Hythane with cost effective hydrogen separation technology
  - New hydrogen pipeline: lower capital cost
- Lower cost, improved durability/reliability, and more energy efficient compression technology
- Lower cost and more energy efficient liquefaction technology
- Novel low cost solid or liquid carriers

Draft

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.**

Draft

Key Delivery Milestones

- 4Q 2005: Complete definition of a cost effective hydrogen fuel delivery infrastructure for the introduction and long term use of hydrogen for transportation and stationary power
- 4Q 2008: Verify 20% cost reduction for hydrogen compression
- 4Q 2010: Verify 50% cost reduction for hydrogen liquefaction
- 4Q 2010: Verify 50% reduction in capital cost for hydrogen pipelines

Draft

Targets

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[d]	$/mile	600k	500k	350k
Hydrogen Carrier Technology				
Hydrogen Content	% by wt	3	6.5	10
Energy efficiency	%	80	82	85

Funding and Partners

- Funding

  FY03: $0 Effort being Initiated

  FY04: $2-3M

- Partners

  FE, DOT

  Stakeholders: Gas Industry, Energy Companies, etc.

Future Direction

- Joint Workshop with Stakeholders held 5/03
  - Results will help refine the R&D Plan and Targets
- FY04 Solicitation (Issue in June, 2003)
  - Infrastructure Analysis
  - Initial R&D
    - Pipelines
    - Compression
    - Liquefaction