Electrolysis-Utility Integration Workshop
DOE Hydrogen Program Overview
Broomfield, Colorado

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Hydrogen Providing a Clean, Secure Energy Future

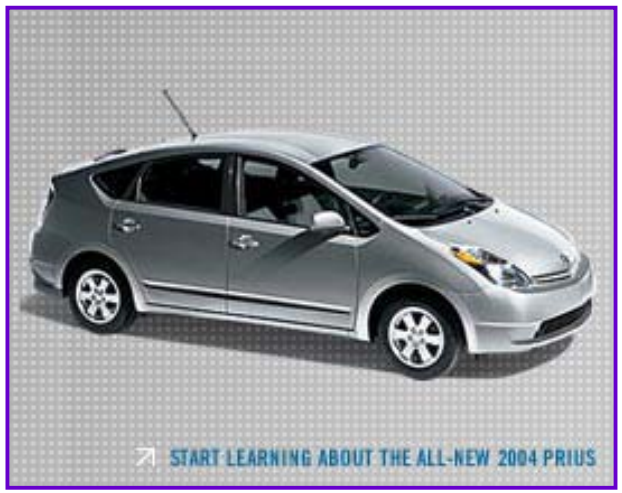
All drivers in a hydrogen economy are important:

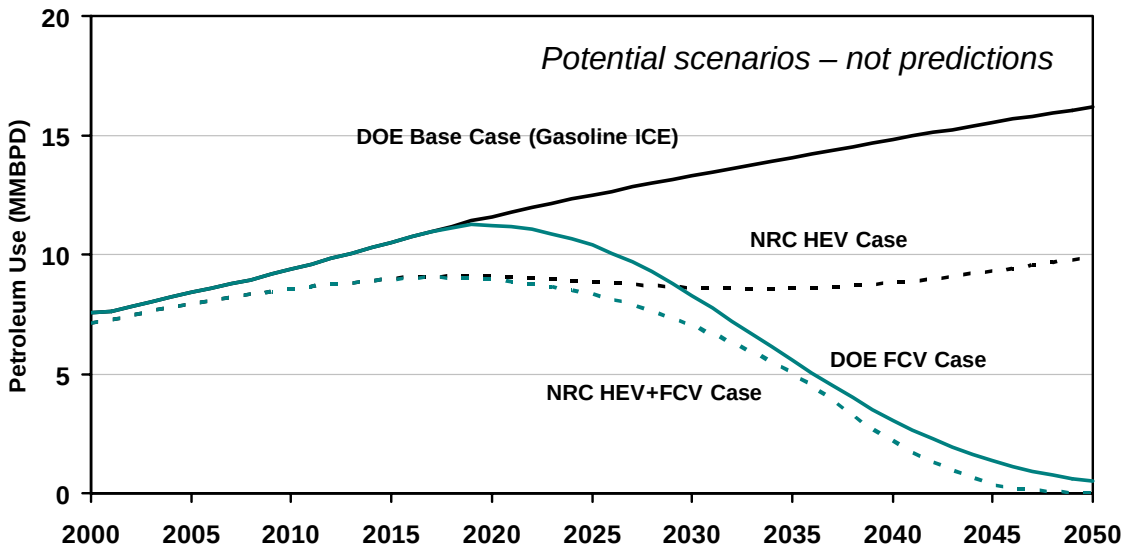
- Energy Security
- CO_2 and Criteria Emissions Reductions
- Economic Competitiveness

DOE hydrogen research aim is 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.

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.*

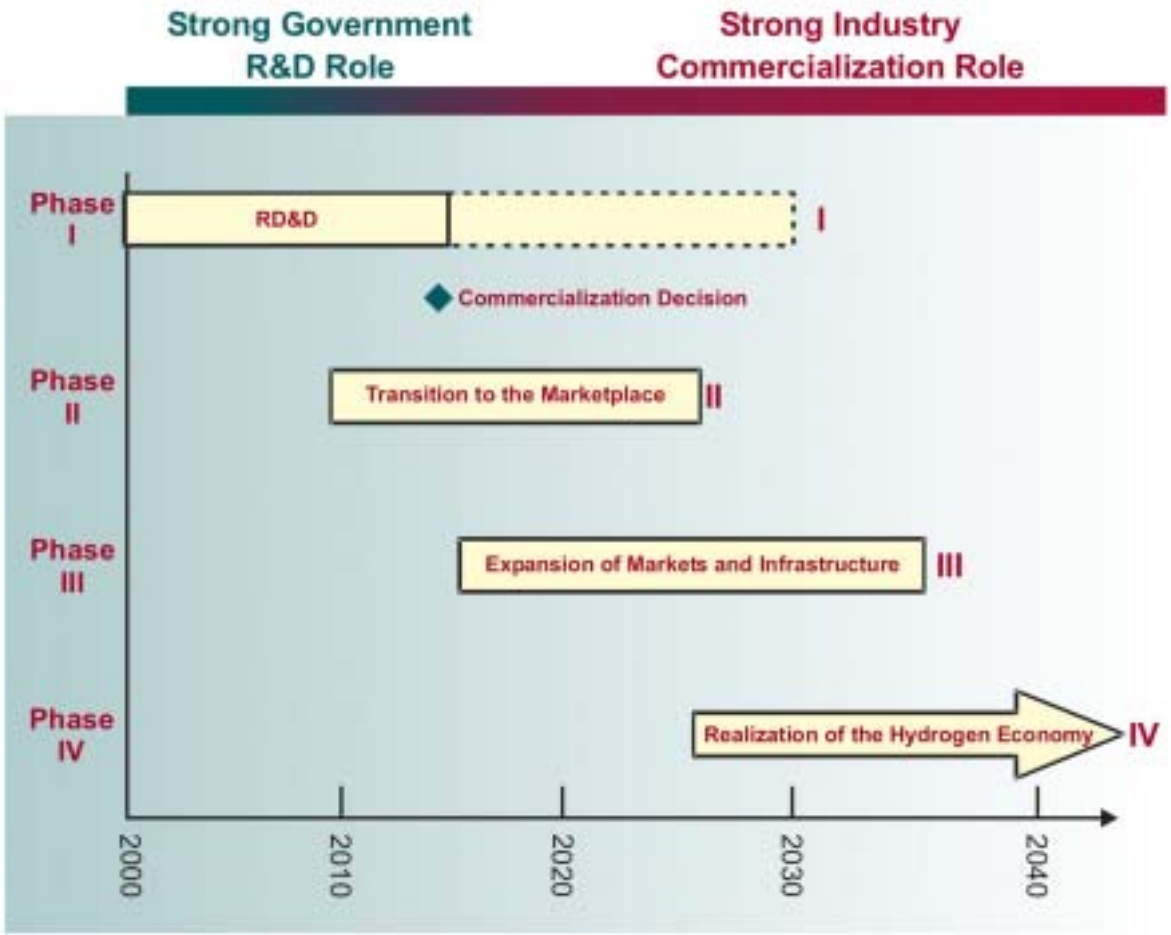




Hybrid/Hydrogen FCV Strategy

- 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

Timeline for a Hydrogen Economy



Transitional Phases

I. Technology Development Phase

Research to meet customer requirements and establish business case lead to a commercialization decision

II. Initial Market Penetration Phase

Portable power and stationary/ transport systems begin commercialization; infrastructure investment begins with governmental policies

III. Infrastructure Investment Phase

H_2 power and transport systems commercially available; infrastructure business case realized

IV. Fully Developed Market and Infrastructure Phase

H_2 power and transport systems commercially available in all regions; national infrastructure

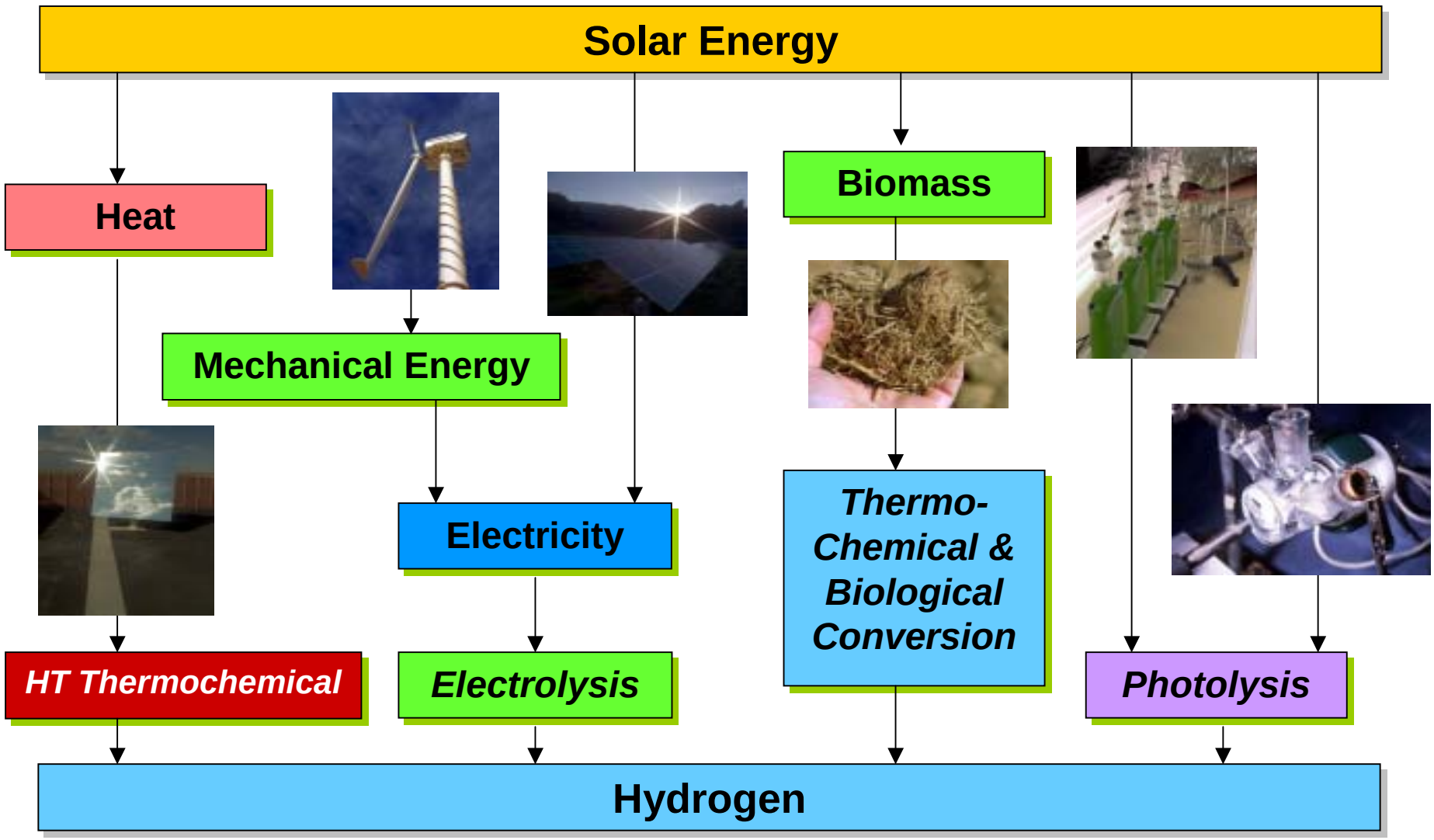
Positive commercialization decision in 2015 leads to beginning of mass-produced hydrogen fuel cell cars by 2020

H2 Production Strategies

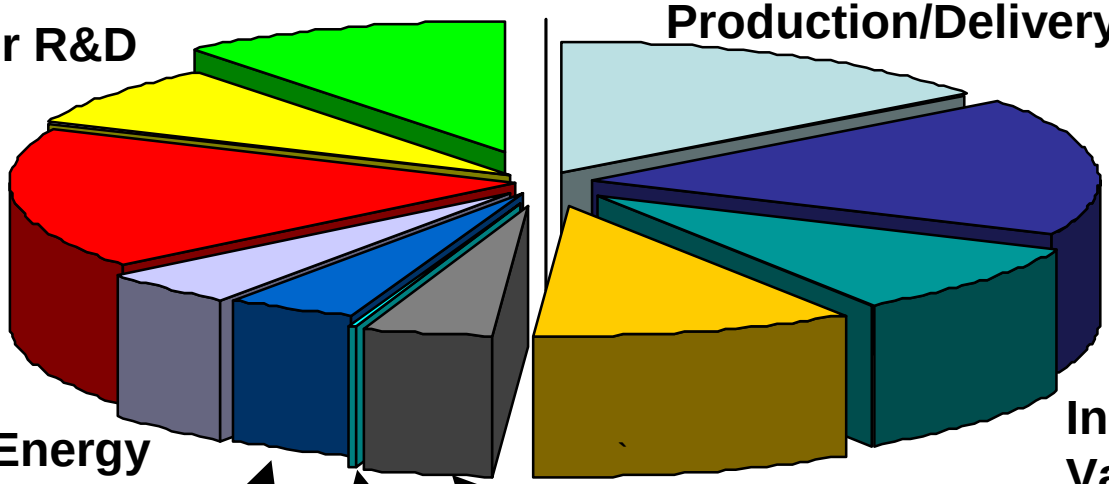
Distributed natural gas and electrolysis economics are important for the "transition"

Energy resource diversification is important for the long-term

Sustainable Paths to Hydrogen



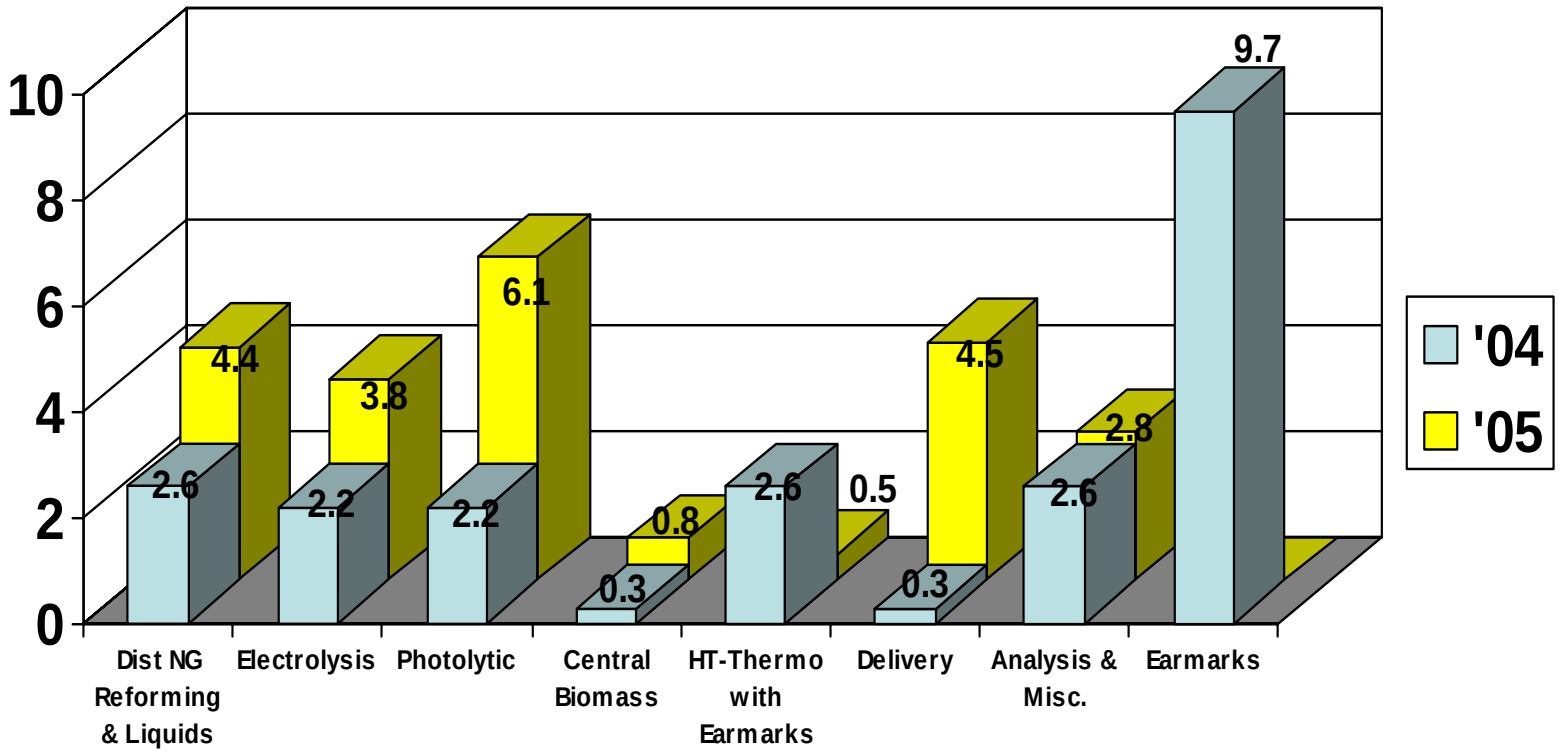
Hydrogen and Fuel Cell FY2005 Budget Request



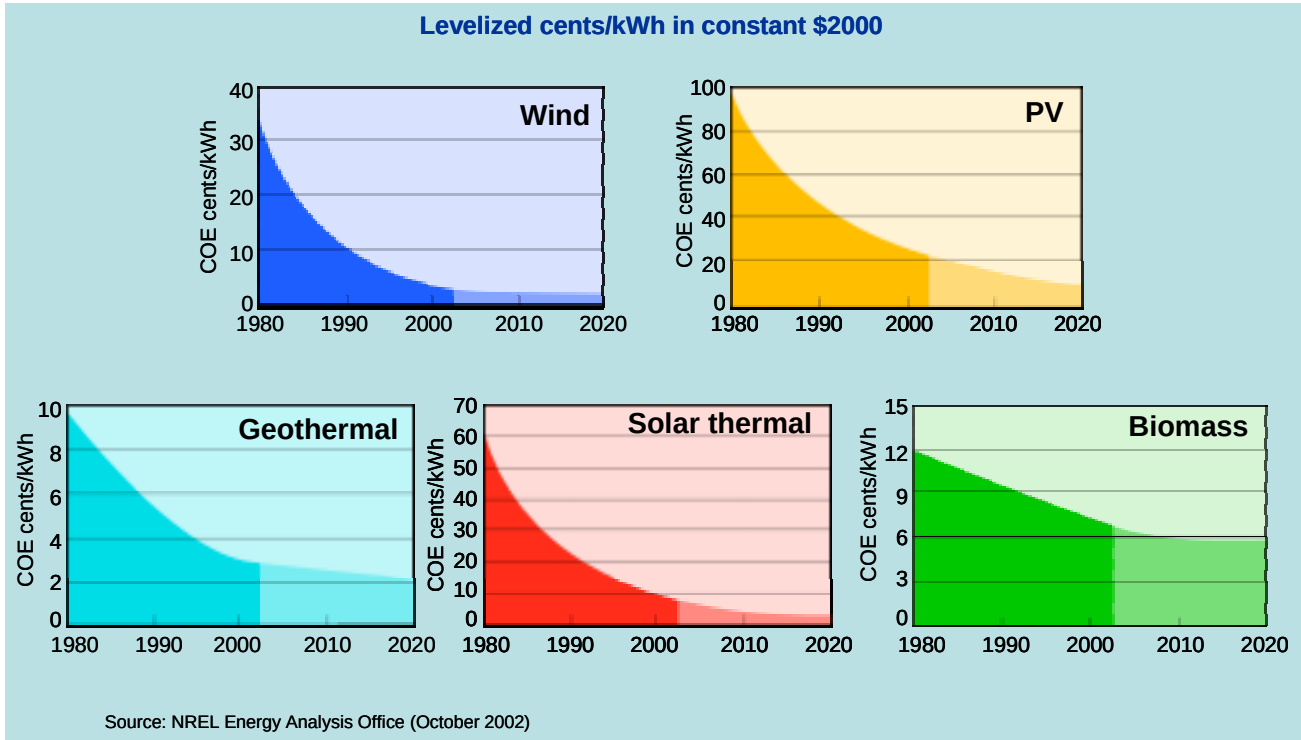
Total FY-05 Request: $172.8M

Hydrogen Production & Delivery Budget

FY 2005 Budget Request = $25.3M
FY 2004 Appropriation = $22.6M



Cost of Renewable Electricity



- Over the past two decades technology advances have steadily reduced the cost of renewable energy.
- Continued reductions in the cost of renewables are key to realizing a future hydrogen electric economy.
- With electricity costs at 3-7¢/kWh, *wind-electrolysis* is likely to be the first economical renewable hydrogen production system.

Key Barriers – Distributed Hydrogen Production

Reforming of Natural Gas and/or Liquid Fuels

- Capital costs
- Operation and maintenance

Water Electrolysis

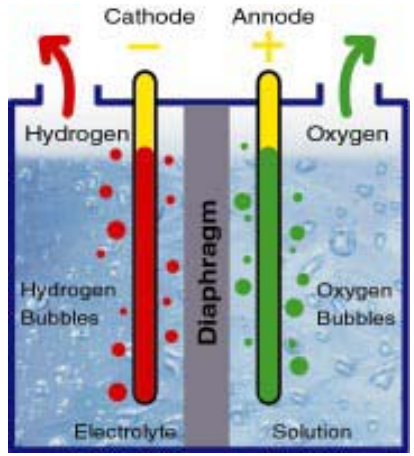
- Electrolyzer capital costs and efficiency
- Grid electricity emissions

Renewable Electrolysis

- Electrolyzers use electricity to separate water into hydrogen and oxygen:

  $2H_2O$ + electricity ➲ $2H_2$ + O_2

- Renewable technologies, like photovoltaics (PV), wind, and hydroelectric, can provide the power to drive electrolysis.
- Technical Challenges
  - Cost
  - System Efficiency
  - Renewable Integration
  - Electricity Costs



Future Directions

- Address outcomes of the Utility Electrolysis Workshop
- Revise draft RD&D to reflect new developments and analyses results
- Implement NRC recommendations with emphasis on:
  - Electrolyzer development to lower capital costs
  - Distributed reforming
- Select new projects from solicitation that achieve cost and efficiency targets

The Goal: Integrated Renewable Hydrogen-Electricity Production