II.1 Hydrogen Production Overview

Introduction

The Hydrogen Production activity is focused on developing hydrogen fuel production technologies that enable the introduction and long-term viability of hydrogen as an energy carrier for transportation and stationary power. A variety of feedstocks, processes, and pathways are being pursued to meet the objective of producing hydrogen that is pure enough for use in fuel cells and cost-competitive with gasoline.

Four DOE offices are engaged in R&D relevant to hydrogen production. The Office of Energy Efficiency and Renewable Energy (EERE) is developing technologies for producing hydrogen in a distributed manner from natural gas, liquid renewable fuels, and by electrolysis of water, and is developing centralized renewable production options that include water electrolysis using renewable power (e.g., wind, solar, hydroelectric, geothermal), biomass gasification, photoelectrochemical and biological processes, and high-temperature solar thermochemical cycles. The Office of Fossil Energy (FE) is focused on advancing the technologies needed to produce hydrogen from coal-derived synthesis gas, including co-production of hydrogen and electricity as well as carbon sequestration. FE is also conducting R&D to reduce the cost of producing hydrogen via centralized steam methane reforming of natural gas. The Office of Nuclear Energy, Science and Technology (NE) is developing commercial-scale production of hydrogen using heat from a nuclear energy source. The Office of Science's basic research program is emphasizing fundamental understandings of bio-inspired materials and processes, photo-induced water splitting, catalysis, membranes, and gas separation.

In 2006, EERE completed a significant revision of the Production section of the Program Multi-Year Research, Development and Demonstration Plan. The revision included significant changes to both Program Objectives and individual Technical Targets (see Objectives, below).

Goal

Research and develop low-cost, highly efficient hydrogen production technologies from diverse, domestic sources, including natural gas and renewable sources.

Objectives

Reduce the cost of hydrogen to $2.00-$3.00/gge (delivered) at the pump. This goal is independent of the technology pathway. Technologies are being researched to achieve this goal in timeframes relative to their current states of development.

- By 2010, reduce the cost of distributed production of hydrogen from natural gas to $2.50/gge (delivered,) at the pump. By 2015, reduce the cost of distributed hydrogen production from natural gas to $2.00/gge (delivered,) at the pump.
- By 2012 reduce the cost of distributed production of hydrogen from biomass-derived renewable liquids to $3.80/gge (delivered) at the pump. By 2017, reduce the cost of distributed production of hydrogen from biomass-derived renewable liquids to <$3.00/gge (delivered) at the pump.
- By 2012, reduce the cost of distributed production of hydrogen from distributed electrolysis to $3.70/gge (delivered) at the pump. By 2017, reduce the cost of distributed production of hydrogen from distributed electrolysis to <$3.00/gge (delivered) at the pump. By 2012, reduce the cost of central production of hydrogen from wind electrolysis to $3.10/gge at plant gate ($4.80/gge delivered). By 2017, reduce the cost of central production of hydrogen from wind electrolysis to <$2.00/gge at plant gate (<$3.00/gge delivered).
- By 2012, reduce the cost of hydrogen produced from biomass gasification to $1.60/gge at the plant gate (<$3.30/gge delivered). By 2017, reduce the cost of hydrogen produced from biomass gasification to $1.10/gge at the plant gate ($2.10/gge delivered).

- By 2017, develop high-temperature thermochemical cycles driven by concentrated solar energy to produce hydrogen with a projected cost of $3.00/gge at the plant gate ($4.00/gge delivered) and verify the potential for this technology to be competitive in the long term.
- Develop advanced renewable photoelectrochemical and biological hydrogen generation technologies. By 2018, verify the feasibility of these technologies to be competitive in the long term.
- By 2015, have ready to operate a zero-emissions, high-efficiency co-production power plant that will produce hydrogen from coal along with electricity.
- Demonstrate the commercial-scale, economically feasible production of hydrogen using nuclear energy by 2017.

FY 2006 Technology Status

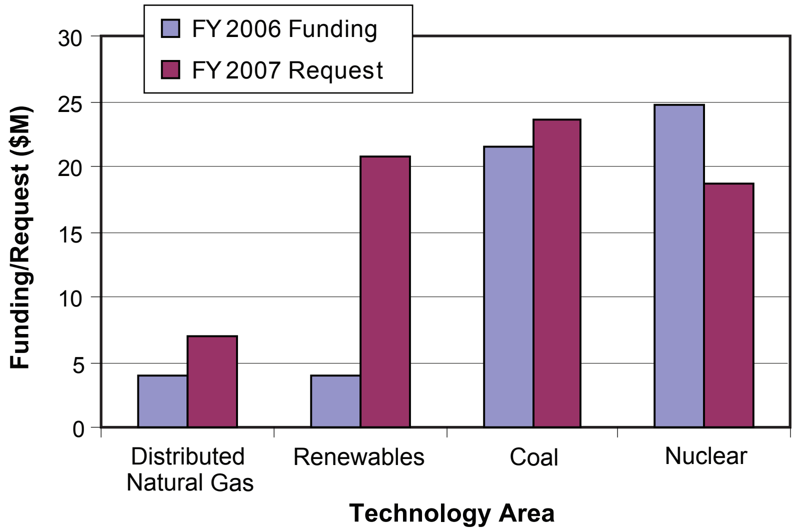
In the summer of 2006, an independent panel confirmed that the 2005 hydrogen cost goal of $3.00 per gallon of gasoline equivalent (gge) for distributed hydrogen production from natural gas had been met. The panel utilized the H2A cost model to analyze information submitted from DOE industry partners and National Laboratories and determined that the calculated hydrogen cost ranged from $2.75 to $3.50 for units capable of delivering 1,500 kilograms per day when manufactured in quantities of about 500 units per year.

FY 2006 Accomplishments

- A new reactor system was identified that allows Aqueous Phase Reforming (APR) of bio-sugars. Improvements in APR hydrogen generation with appropriate catalyst, reactor configuration, and reaction conditions are underway.
- An independent panel confirmed that the $3.00/gge cost target for distributed hydrogen production from natural gas had been met. Integrated energy efficient components into a refueling system that produces, dispenses and stores high purity hydrogen at a low cost. Gains were achieved through improvements to the purification system, reactor design (materials and catalysts) and systems integration.
- An economic analysis of wind electrolysis was completed and utilized to refine technical targets for distributed and central applications. These targets have been integrated into an updated Multi-Year Program Plan.
- A cooperative research agreement between NREL and XCEL was established to characterize integration issues between wind and hydrogen production systems, with a test system to be assembled at NREL.
- 353 High temperature solar cycles were evaluated and down selected. Seven cycles are now under active R&D development. Systems were designed and costs estimated for two example cycles and H2A results indicate this technology is capable of achieving a competitive cost if required technology improvements are achieved.

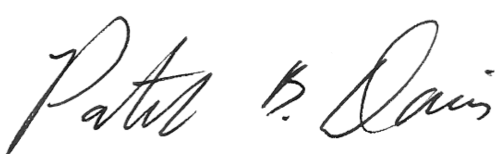
Budget

The President's FY 2007 budget request (subject to Congressional appropriation) includes increased funding for R&D on hydrogen production from coal, distributed natural gas and renewables (including distributed and central electrolysis, biological and photoelectrochemical processes, central biomass reforming, and solar high-temperature thermochemical cycles). A small reduction in nuclear-based hydrogen production technologies is indicated.



2007 Plans

- Since the interim target for natural gas distributed reforming has been met, the R&D emphasis for distributed reforming will be shifted from natural gas to bio-derived liquids.
- Continue to work with the newly established Hydrogen Utility Working group to increase collaboration with electric utilities on electrolysis technology development.
- Continue development of high-efficiency, low-cost electrolysis systems and increase focus on the integration of electrolysis technologies with renewable electricity sources. Establish new projects that address the need for innovative, low-cost electrolyzer technologies.
- After several years of low funding in longer-term renewable technologies such as photobiological and photoelectrochemical, establish a more robust R&D effort in longer-term technologies.



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