OAK RIDGE NATIONAL LABORATORY FACT SHEET
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Integrated Analysis of Link-Networks of Technologies Supporting a Hydrogen Infrastructure

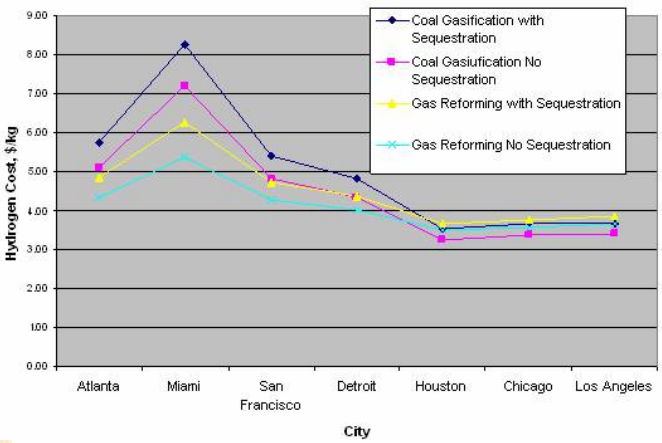
Modeling Capital and Operating Costs of Hydrogen Producing Technologies

Background

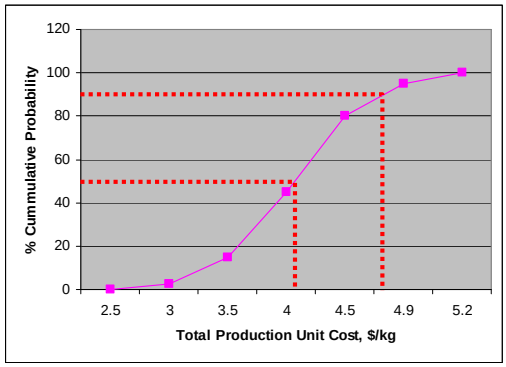
The understanding of the relationships between the nation's current infrastructure, future infrastructure needs, and the costs of the transition to a hydrogen infrastructure is critical to the DOE Hydrogen Program. To better understand the factors important to this transition, a model has been developed that integrates multiple hydrogen economy development and implementation scenarios. This model compares paths in a network of likely hydrogen economy development scenarios utilizing the existing H2A computerized models to determine capital and operating cost of various hydrogen producing technologies. To support the integration of these models, the project will analyze the current hydrogen infrastructure (including natural gas production, electrical transmission cables, and water availability), determine projections of gas prices and subsequent impacts on the hydrogen economy, suggest modifications to the current infrastructure, and advise on the funding strategy of the Hydrogen Program to support the best transition process.

Infrastructure Analysis

Baseline data for the infrastructure analysis for the transition process was performed by compiling all available information on H_2 production from industry, government, and other sources. In addition, all existing and potential H_2 delivery systems in the country were analyzed, as well as existing and planned future H_2 storage. Cost estimates for the infrastructure required for the transition process were performed using DOE H2A models and the ORNL FLOW model that uses production and economic models to simulate scenarios. Differing scenarios considered realistic integrated resources, production processes, delivery mechanism and dispensing alternatives . Baseline assumptions of geographic location of the dispensing stations, the corresponding requirements for delivery of hydrogen and consequently, the production of hydrogen are made appropriate for the scenario.



Summary of hydrogen production cost for four production technologies in seven cities.



Uncertainty analysis for the cost of hydrogen production using natural gas reforming indicates that the cost of hydrogen will not be very sensitive to the variation in natural gas prices in the range of $2-14/MMBtu.

The analysis includes two general scenarios that exclude and include nuclear hydrogen. For the non-nuclear options, the lowest total capital costs were (a) $5.15 billion for the centralized production of hydrogen using natural gas reforming without sequestration, (b) $4.3 billion for distributed H_2 with production at the dispensing unit of up to 1,500 kg/d at each station using natural gas, (c) $4.9 billion for trucking liquefied H_2 from existing plants to dispensing units when hydrogen was transported from natural reforming plants, and (d) $9.1 billion for centralized H_2 distribution produced by wind energy and including dispensation.

Nuclear-based hydrogen production technologies have inherent advantages over other potential production pathways including low greenhouse gas (GHG) emissions, flexibility in facility size to meet both small- and large-scale H_2 production needs, and long-term sustainability. Analysis for nuclear use in the production of H_2 assumed California as localization, electrolysis as the source of production, piping as distribution, and final dispensation. The total capital ranged between $2.9-4.4 billion depending on the electrolysis process. The production cost ranged from $3.5-4.6/kg H_2.

Completion of infrastructure analysis

Approximately 505,000 metric tons per year of hydrogen will be required to fuel 2,500,000 cars to jump start the hydrogen economy using the following elements:

Coal Used	**855,039**	**MT/yr**
Electric Energy Used	**2.92 e7**	**kWh/yr**
Water Used	**1.23 e6**	**MT/yr**

Coal Gasification with Carbon Sequestration in Chicago

Natural Gas	**1,750,000**	**MT/yr**
Electric Energy Used	**21,595,236**	**kWh/yr**
Total Water Used	**228,654**	**MT/yr**

Natural Gas Reforming with Carbon Sequestration in Miami

Analysis of availability of these elements indicate for example that there will be enough natural gas to sustain the transition process to a hydrogen economy.

Benefits

- This analysis will determine gaps to be filled in the current infrastructure to enable the transition to the hydrogen infrastructure.
- The analysis will determine the optimal path to achieve this transition and help guide allocation of program resources.

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