May 2005

2005 Hydrogen, Fuel Cells & Infrastructure Technologies Program Review:

Broad-Based Solicitation—Hydrogen Education

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Project ID: EDP4

This presentation does not contain any proprietary or confidential information

Overview

Timeline

- 3 years: October 2003 till September 2006

Budget

- Total project funding:
  - $358,548 (DOE)
  - $88,295 (Cost-Share)
- Funding received in FY04: $96,910 (100%)
- Funding received for FY05: $57,000 (35%)

Barriers

- Barriers addressed
  - Lack of Hydrogen Awareness
  - Lack of Demonstrations or Examples of Real World Use
  - Institutional Barriers and Access to Audiences

Partners

- OURCO, Inc., Sentech, Inc.

Objectives

- Develop education and outreach materials for the transit industry, code officials, and the public that can facilitate timely information exchange between stakeholders for buses and fleet vehicles. (Task 1)
- Develop standardized fact sheets to provide a knowledge base on hydrogen energy projects and systems so that both the general public and technical communities are aware of the advancements in hydrogen energy systems. (Task 2)
- Develop an Education Plan that outlines program direction and established program metrics to educate stakeholders regarding the programmatic leadership being provided by DOE. (Task 3)

Approach

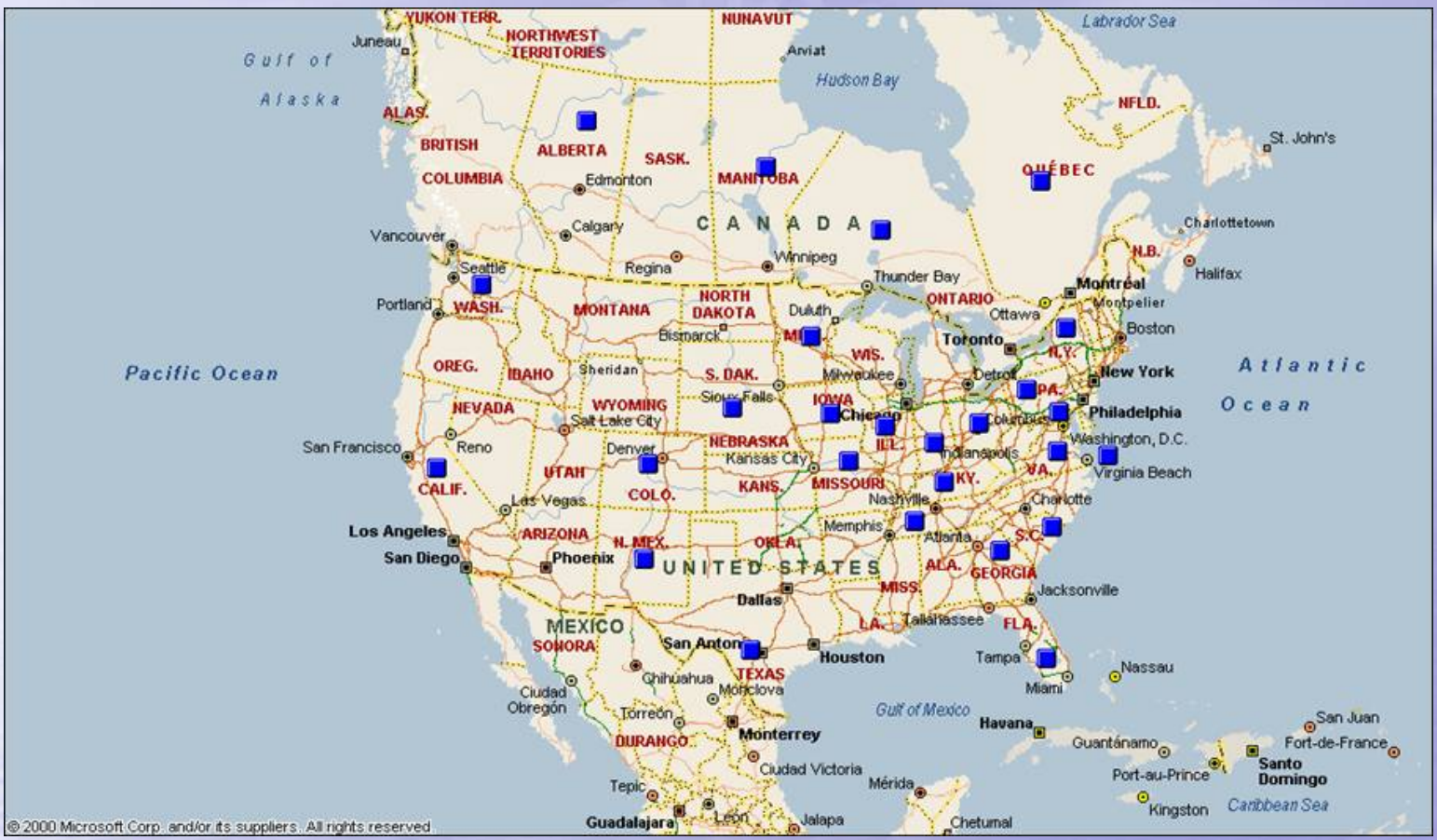
- Assess the level of hydrogen knowledge and awareness among fleet vehicle users.
- Assess the most desired medium and hydrogen subjects that can contribute to increased knowledge and awareness.
- Develop a standardized series of fact sheets on various hydrogen subjects for fleet and prioritized target audiences.
- Collect other education collateral that can be used to reach fleet and prioritized target audiences.
- Disseminate fact sheets and other education collateral using the mediums most requested by respondents.

Progress and Results (Task 1)

- **Assessment of Hydrogen Information Needs for Operators and Managers of Fleet Vehicles**
  - **Over the June to December 2004 time period, OURCO staff contacted and requested responses from approximately 2000 fleet operators in the U.S. and Canada. These operators represented a wide variety of fleet operations, including:**
    - **Transit operations;**
    - **State agencies (e.g., public works, transportation, etc.);**
    - **Local government agencies (e.g., public works, law enforcement, etc.); and**
    - **Various private sector organizations.**

Progress and Results (Task 1 cont'd)

- **Responses received in 22 States and 4 Canadian Provinces**



Progress and Results (Task 1 cont'd)

- **Some highlights:**
  - ***Nearly 90% of the respondents have read at least one article about hydrogen or know how a fuel cell works*.** **This suggests that there is a good initial base of knowledge about hydrogen.**
  - ***Fleet operators want information on technical features and the costs of hydrogen-fueled internal combustion engines, vehicles, fuel, equipment and related operational aspects*.**
  - ***Respondents want information in the form of workshops/ seminars/classes, websites, and videos/DVDs*; then demonstration hardware and printed materials.**
  - ***Fleet operators believe that the three most significant hurdles to be overcome are cost, fuel storage limitations, and vehicle durability*.**

Progress and Results (Task 1 cont'd)

- **Recommendations:**
  - **Collect and make available information on:**
    - The costs of hydrogen (at the dispenser), fleet related equipment, vehicles, operation and maintenance, installation and training;
    - Hydrogen vehicles and their attributes (e.g., fuel economy, emissions, performance, range, duty cycle limitations, etc.); and
    - How hydrogen-fueled internal combustion engines work.
  - **Provide descriptions and periodic updates of progress describing how the DOE hydrogen R&D program and industry is addressing issues related to;**
    - Cost;
    - Fuel storage limitations; and
    - Vehicle durability.

Progress and Results (Task 1 cont'd)

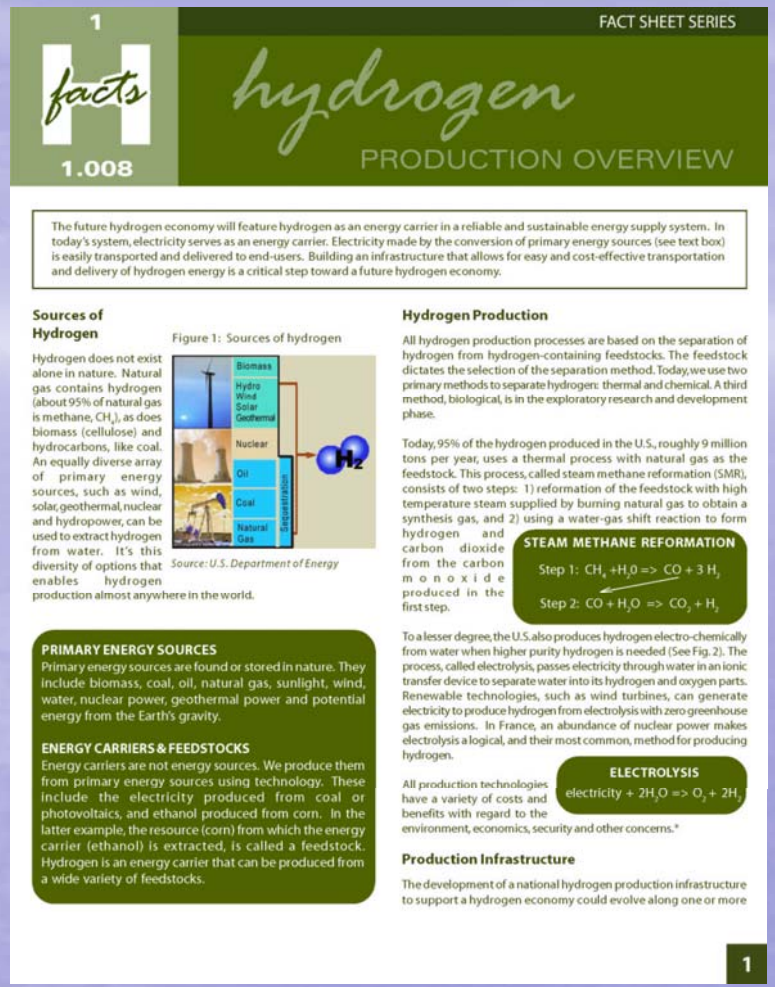
- **Recommendations:**
  - **Create the information for previous recommendations in the following delivery formats:**
    - Posting to website specifically for use by fleet operators;
    - Workshops and seminars geared toward fleet operators; and
    - Videos and/or DVDs on relevant hydrogen information that can be replicated at low cost and distributed to a wide audience of fleet operators.
  - **Make demonstration information (particularly related to previous recommendations) that is relevant to fleet operators available, and invite the participation from fleets that have expressed interest in being a part of such projects.**

Progress and Results (Task 2)

- **Hydrogen Fact Sheet Series (10 completed)**
  - History of Hydrogen
  - The Hydrogen Economy
  - Hydrogen Safety
  - Hydrogen Safety Basics
  - A Global Hydrogen Effort
  - Hydrogen Production Overview
    - Hydrogen Production from Coal
    - Nuclear Hydrogen Production
    - Renewable Hydrogen Production using Electrolysis
    - Hydrogen Production from Natural Gas

Progress and Results (Task 2 cont'd)

- **Fact Sheets available to the public:**
- **NHA Website**
  http://www.hydrogenassociation.org/nha-facts.asp
- **DOE Website**
  http://www.eere.energy.gov/hydrogenandfuelcells/hydrogen_publications.html



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facts

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FACT SHEET SERIES

hydrogen

PRODUCTION OVERVIEW

The future hydrogen economy will feature hydrogen as an energy carrier in a reliable and sustainable energy supply system. In today's system, electricity serves as an energy carrier. Electricity made by the conversion of primary energy sources (see text box) is easily transported and delivered to end-users. Building an infrastructure that allows for easy and cost-effective transportation and delivery of hydrogen energy is a critical step toward a future hydrogen economy.

Sources of Hydrogen

Hydrogen does not exist alone in nature. Natural gas contains hydrogen (about 95% of natural gas is methane, CH_4), as does biomass (cellulose) and hydrocarbons, like coal. An equally diverse array of primary energy sources, such as wind, solar, geothermal, nuclear and hydropower, can be used to extract hydrogen from water. It's this diversity of options that enables hydrogen production almost anywhere in the world.

Figure 1: Sources of hydrogen

Source: U.S. Department of Energy

PRIMARY ENERGY SOURCES

Primary energy sources are found or stored in nature. They include biomass, coal, oil, natural gas, sunlight, wind, water, nuclear power, geothermal power and potential energy from the Earth's gravity.

ENERGY CARRIERS & FEEDSTOCKS

Energy carriers are not energy sources. We produce them from primary energy sources using technology. These include the electricity produced from coal or photovoltaics, and ethanol produced from corn. In the latter example, the resource (corn) from which the energy carrier (ethanol) is extracted, is called a feedstock. Hydrogen is an energy carrier that can be produced from a wide variety of feedstocks.

Hydrogen Production

All hydrogen production processes are based on the separation of hydrogen from hydrogen-containing feedstocks. The feedstock dictates the selection of the separation method. Today, we use two primary methods to separate hydrogen: thermal and chemical. A third method, biological, is in the exploratory research and development phase.

Today, 95% of the hydrogen produced in the U.S., roughly 9 million tons per year, uses a thermal process with natural gas as the feedstock. This process, called steam methane reformation (SMR), consists of two steps: 1) reformation of the feedstock with high temperature steam supplied by burning natural gas to obtain a synthesis gas, and 2) using a water-gas shift reaction to form hydrogen and carbon dioxide from the carbon monoxide produced in the first step.

STEAM METHANE REFORMATION

Step 1: $CH_4 + H_2O \Rightarrow CO + 3\,H_2$

Step 2: $CO + H_2O \Rightarrow CO_2 + H_2$

To a lesser degree, the U.S. also produces hydrogen electro-chemically from water when higher purity hydrogen is needed (See Fig. 2). The process, called electrolysis, passes electricity through water in an ionic transfer device to separate water into its hydrogen and oxygen parts. Renewable technologies, such as wind turbines, can generate electricity to produce hydrogen from electrolysis with zero greenhouse gas emissions. In France, an abundance of nuclear power makes electrolysis a logical, and their most common, method for producing hydrogen.

ELECTROLYSIS

electricity + $2H_2O \Rightarrow O_2 + 2H_2$

All production technologies have a variety of costs and benefits with regard to the environment, economics, security and other concerns.*

Production Infrastructure

The development of a national hydrogen production infrastructure to support a hydrogen economy could evolve along one or more

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Progress and Results (Task 3)

- **An industry education plan (originally, this was to determine industry priorities for input into the MYPP)**
- **Prioritized Target Audiences 2005**
  - Media;
  - Policymakers;
  - Codes, standards and safety officials (including emergency response personnel and insurance companies);
  - Large-scale end-users (fleet operators; facilities and maintenance personnel; military);
  - State and local government representatives;
  - Teachers (and Students through teachers); and
  - General public.

Progress and Results (Task 3 cont'd)

- **Goals:**
  - achieve a level of understanding among target audiences so they can make informed choices about their energy options;
  - heighten knowledge;
  - create a positive attitude;
  - and influence behavior with regard to fuel cell and hydrogen systems in order to facilitate their implementation.
- **If successful, the target audiences should be able to:**
  - Express the value of a hydrogen economy,
  - Recognize the realities of hydrogen and fuel cell technology in the near-term,
  - Understand their part in facilitating the transition to the Hydrogen Age

Future Work

- Hold a series of hydrogen fleet preparation seminars/workshops in conjunction with conferences of major fleet organizations such as the National Association of Fleet Administrators (NAFA), American Public Transportation Association (APTA) and Federal Government fleet managers (FedFleet)
- Identify technical content and develop data for a “Hydrogen Fleet 101” course to be presented at the seminars/workshops
- Develop a hydrogen web site for fleet operators for dissemination of the “Hydrogen Fleet 101” content.
- Implement DOE changes on existing fact sheets
- Develop “Renewable Hydrogen Production using Biomass” fact sheet.

Hydrogen Safety

The most significant hydrogen hazard associated with this project is:

There are no hazards related to this broad-based hydrogen education project.

Where To Find the NHA

On the Web:	www.HydrogenAssociation.org
Conference Information:	www.HydrogenConference.org
Safety, Codes & Standards Info:	www.HydrogenSafety.info

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