

DOE Hydrogen Program  
**Hydrogen Analysis Resource Center  
(HyARC)**

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Project ID # AN8

This presentation does not contain any proprietary or confidential information

# Overview

## Timeline

- ▶ Project start date: 6/05
- ▶ Project end date: ongoing; will be updated every year
- ▶ Percent complete: 95% for FY06

## Barriers

- ▶ Lack of consistent data, assumptions and guidelines
- ▶ Stove-piped analytical capabilities

## Budget

- ▶ Total project funding: \$210K (all DOE) to date
- ▶ Funding received in FY05: \$110K
- ▶ Funding for FY06: \$100K

## Partners

- ▶ Other national laboratories, other Federal agencies, private sector representatives and contractors provided data and website review

# Objectives

- ▶ Long-term objective: Support the development of tools, methods and data for the conduct of sound analysis of hydrogen production/delivery costs, markets, policy options and other key analysis topics.
- ▶ Objectives for FY06: Develop a publicly-accessible, web-based hydrogen analysis resource center to provide ready access to a wide range of consistent and high-quality data and tools for use in hydrogen-related analyses.

# Approach for FY06

- ▶ Update the links in the HyARC prototype (developed in FY05) to include the most recent data
- ▶ Identify new data sets to include in the data book and create data files compatible with the data book/website format
- ▶ Expand the capability of the calculator tools embedded in the HyARC website
- ▶ Expand the list of analytical tools linked to the website
- ▶ Provide demonstrations of HyARC website to DOE and external reviewers, and make changes in response

# Accomplishments/Results

**Start date: 06/05**

**Milestones achieved (all on schedule):**

- ▶ **08/05** First prototype completed (in FY05)
- ▶ **10/05** Website demonstration to HFCIT
- ▶ **12/05** First internal review completed
- ▶ **02/06** External technical review by:
  - ✓ industry (Chevron, Praxair)
  - ✓ other agencies (NIST, DOT)
  - ✓ DOE staff (HFCIT, Freedom Car, NE, FE, EERE/PAE, NETL)
  - ✓ national lab experts (NREL, ANL)
- ▶ **03/06** Launch of publicly-available website

# Accomplishments/Results

[http://www.hydrogen.energy.gov/resource\\_center.html](http://www.hydrogen.energy.gov/resource_center.html)

Hydrogen Analysis Resource Center - Microsoft Internet Explorer

Address: <http://hydrogen.pnl.gov/cocoon/morf/hydrogen>

U.S. DEPARTMENT OF ENERGY  
Hydrogen Analysis Resource Center  
hydrogen.energy.gov

SEARCH: All Media FOR:  SEARCH BROWSE: Select a Topic... GO!

Home

Hydrogen Data Book

Hydrogen Glossary

Related Sites

Guidelines and Assumptions

Calculator Tools

Analysis Tools

Contact Us

Advanced Search

## Welcome to the Hydrogen Analysis Resource Center

The Hydrogen Analysis Resource Center provides well-documented, reliable data to be used for hydrogen-related analytical activities. These data can serve as the basis for calculations, modeling, and other analytical activities. Data can be accessed from databases housed in the site itself as well as through links to important websites such as those maintained by the Energy Information Administration (EIA), U.S. Department of Energy (DOE) Programs, other U.S. Government Agencies, and non-government websites. The search feature of the site allows the user to seamlessly search available data, independent of whether the data are from internal or external sources. The website also provides guidelines and a set of assumptions for use in Hydrogen Program analysis projects (these assumptions will be updated annually). In addition, the website contains several calculator tools that do useful conversions and other simple calculations relevant to hydrogen and fuel cells and links to websites housing more sophisticated analysis tools such as the H2A website, the GREET website, and others analyses.

NEW MATERIALS

- Latest fuel price projections from EIA
- Hydrogen Properties

POPULAR RESOURCES

- Transportation Energy Data Book
- H2A Hydrogen Production Cost Estimates

Descriptions of the main components within the website follow:

- [Hydrogen Data Book](#) - contains a wide range of factual information on hydrogen and fuel cells (e.g., hydrogen properties, hydrogen production and delivery data, and information on fuel cells and fuel cell vehicles), and it also provides other data that might be useful in analyses of hydrogen infrastructure in the United States (e.g., demographic data and data on energy supply and/or infrastructure)
- [Related Sites](#) - provides links to data from EIA, other data books (e.g., the transportation, buildings, and utilities data books developed by DOE's Office of Energy Efficiency and Renewable Energy), and other sites with data relevant to hydrogen and fuel cell analysis (e.g., the National Institute of Standards and Technology's Chemistry WebBook).
- [Guidelines and Assumptions for DOE Hydrogen Program Analysis](#) - contains guidelines for conducting analysis (under development) and assumptions, such as projected feedstock prices, projected utility prices, and financial assumptions, for use in analyses conducted by DOE's Hydrogen Program.
- [Calculator Tools](#) - provides tools to perform conversions of hydrogen from weight to energy, calculate energy equivalency among hydrogen and other transportation fuels based on heating values, perform equation of state calculations, convert units for many parameters from metric to English and other units, make simple financial calculations, and more.
- [Analysis Tools](#) - provides links to models and other tools relevant to hydrogen and fuel cells, such as H2A, GREET, PSAT, VISION, MOVES, and other transportation and energy models.

Note that this website is intended to provide data primarily for analysis of hydrogen and fuel cells in the United States, and it focuses on the use of hydrogen in fuel cells rather than other uses, such as in internal combustion engines or chemical processes.

The Hydrogen Analysis Resource Center was developed with the latest data and materials available. If you have any

Local intranet

# Accomplishments/Results

## Components of HyARC:

1. [Hydrogen Data Book](#) - wide range of factual information on hydrogen and fuel cells (e.g., hydrogen properties, hydrogen production and delivery data, and information on fuel cells and fuel cell vehicles), and other data that might be useful in analyses of hydrogen infrastructure in the United States (e.g., demographic data and data on energy supply and/or infrastructure)
2. [Related Sites](#) - provides links to data from EIA, other data books (e.g., the transportation, buildings, and utilities data books developed by DOE's Office of Energy Efficiency and Renewable Energy), and other sites with data relevant to hydrogen and fuel cell analysis (e.g., the National Institute of Standards and Technology's Chemistry WebBook).
3. [Guidelines and Assumptions for DOE Hydrogen Program Analysis](#) - contains guidelines for conducting analysis (under development) and assumptions, such as projected feedstock prices, projected utility prices, and financial assumptions, for use in analyses conducted by DOE's Hydrogen Program.

# Accomplishments/Results

## Components of HyARC (continued) :

4. [Calculator Tools](#) - provides tools to perform conversions of hydrogen from weight to energy, calculate energy equivalency among hydrogen and other transportation fuels based on heating values, perform equation of state calculations, convert units for many parameters from metric to English and other units, make simple financial calculations, and more.
5. [Analysis Tools](#) - provides links to models and other tools relevant to hydrogen and fuel cells, such as H2A, GREET, PSAT, VISION, MOVES, and other transportation and energy models.

Note that this website is intended to provide data primarily for analysis of hydrogen and fuel cells in the United States, and it focuses on the use of hydrogen in fuel cells rather than other uses, such as in internal combustion engines or chemical processes.



# Accomplishments/Results

## Hydrogen Data Book -- Table of Contents

### Data on Hydrogen

[Hydrogen Properties](#) - contains chemical characteristics of hydrogen, such as density, flammability range, boiling point characteristics, heating values, and more, and compares characteristics of hydrogen to other fuels.

[Hydrogen Production](#) - contains data on hydrogen production trends as well as merchant and refinery capacity for hydrogen production.

[Hydrogen Storage](#) - provides links to information on metal-hydrogen systems, their properties, applications and literature sources, as well as profiles of organizations involved in research.

[Hydrogen Delivery](#) - presents information on hydrogen fueling stations.

[Fuel Cells](#) - contains information on fuel cell types and manufacturers.

[Fuel Cell Vehicles](#) - contains information on fuel cell vehicle types.

# Accomplishments/Results

## Hydrogen Data Book -- Table of Contents (continued)

### Data Pertinent to Hydrogen and Fuel Cell Analysis

[Regional Demographic Information](#) - presents demographic data pertinent to hydrogen and fuel cell analysis, including population and employment.

[Regional Energy Supply Data](#) - contains energy supply and delivery data related to natural gas, petroleum products, coal, nuclear, and renewable energy.

[Conversion Factors and Constants](#) - contains physical constants and metric prefixes and suffixes.

# Accomplishments/Results

## Related Sites

### Data Books

- [Transportation Energy Databook](#)
- [Buildings Energy Databook](#)
- [Power Technologies Energy Data Book](#)
- [NIST Chemistry WebBook](#)

### EIA Data and Projections

- [EIA Annual Energy Outlook 2006: National Forecasts, by Year](#)
- [EIA Annual Energy Outlook 2006: Regional and Sectoral Detail](#)
- [EIA US Federal Region Map](#)
- [EIA Annual Energy Outlook 2006: High/Low Oil Price Cases; High/Low Economic Growth Cases](#)
- [EIA International Energy Outlook 2005](#)
- [EIA Recent Energy Statistics](#)
- [EIA Annual Energy Review: Historical Energy Data Back to 1949](#)

### Websites

- [Hydrogen Program Website](#)
- [NIST Website](#)
- [IPHE Website](#)

# Accomplishments/Results

## Guidelines and Assumptions

- ▶ Standard financial assumptions
- ▶ Feedstock and utility cost assumptions

## Links to Analysis Tools

- ▶ H2A Model
- ▶ ANL GREET Model
- ▶ ANL Vision Model
- ▶ MOVES
- ▶ NEMS
- ▶ ANL PSAT/PSAT-PRO
- ▶ PVWATTS

# Accomplishments/Results

## Calculator Tools

- ▶ [Hydrogen Cost Target Calculator](#) - uses gasoline price and fuel economy ratio to calculate the cost of hydrogen that would be equivalent to a gallon of gasoline, on a per-mile basis.
- ▶ [Energy Equivalency of Fuels](#) - computes the amount of each fuel necessary to provide the same energy as 1 kg of hydrogen, 1 million cubic feet natural gas, 1 barrel of crude oil, or 1 gallon of other fuels, based on lower heating values.
- ▶ [Hydrogen Conversions Calculator](#) - converts between four popular phase points of hydrogen:
  - liquid at boiling point ( $-252.87^{\circ}\text{C}$  at 1 atm).
  - gas at Normal Temperature and Pressure (NTP =  $20^{\circ}\text{C}$  at 1 atm).
  - gas at standard conditions ( $15.6^{\circ}\text{C}$  at 1 atm).
  - gas at standard conditions ( $0^{\circ}\text{C}$  at 1 atm).
- ▶ [Hydrogen Heating Values on Mass Basis](#) - calculates energy content of a certain amount of hydrogen based on the mass in kg or lb.

# Accomplishments/Results

## Calculator Tools (continued)

- ▶ [Lower and Higher Heating Values of Fuels](#) - calculates fuel parameters for hydrogen, natural gas, gasoline, diesel, propane, oil, coal, and wood.
- ▶ [Equation of State Calculator](#) - provides a full equation of state that can be used over the temperature range 13.957 K to 400 K at pressures to 1210 bar; calculates isothermal, isobaric, and isochoric properties for hydrogen in units specified by the user (developed by the National Institute of Standards and Technology).
- ▶ [Unit Conversion Calculator](#) - contains conversion factors to convert units of weight, volume, distance, etc.
- ▶ [Financial Calculator](#) - calculates simple financial and/or economic parameters, such as present value of a future amount, future value of a present amount, present value of an annuity, levelized cost, etc., based on user-supplied assumptions about discount rates and number of years.

# Future Work

- ▶ Over the remainder of FY06, PNNL will continue to make minor improvements, answer questions and make any corrections needed
- ▶ List of potential improvements to the site has been compiled and prioritized, based on external technical review, e.g.,
  - Additional data, e.g., maps of energy resources, vehicle performance data, additional hydrogen production data, global hydrogen fueling stations, trends in energy delivery, etc.
  - Additional guidelines and assumptions to be used in Hydrogen Program analysis
  - More explanation and text for people unfamiliar with hydrogen analysis
- ▶ Plan is to update the site on a continuous basis and to annually update links, guidelines & assumptions and any data that is regularly updated (e.g., EIA data and projections)
- ▶ No additional milestones to be met in FY06; all milestones were met on schedule

# Summary

- ▶ **Relevance:** Meets the need for high-quality, consistent data and assumptions for use in hydrogen analyses
- ▶ **Approach:** Use existing PNNL web-site functions developed for other DOE programs and modify for use by the Hydrogen Program; populate with well-reviewed data and tools
- ▶ **Results:** Website and data book have been reviewed, and are operational and available to the public
- ▶ **Future Expectations:** Continue to improve the functionality, usability and content of the site