Hydrogen Pipelines

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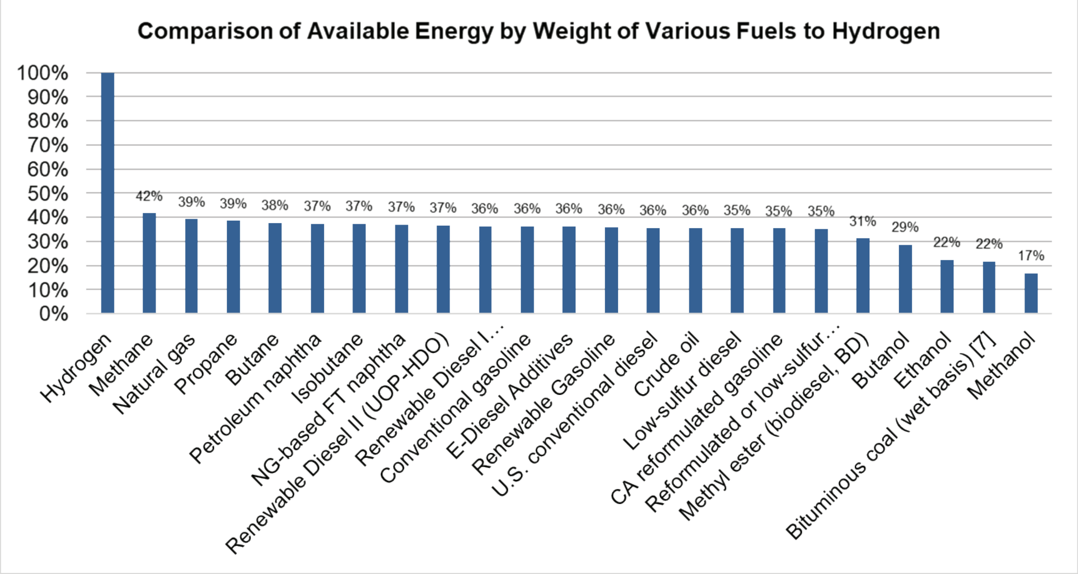
Introduction

Hydrogen is one of the fuels of the future and it is a critical feedstock for the chemical industry. Hydrogen can be used in fuel cells, synthetic fuels, and for heating to name a few applications.

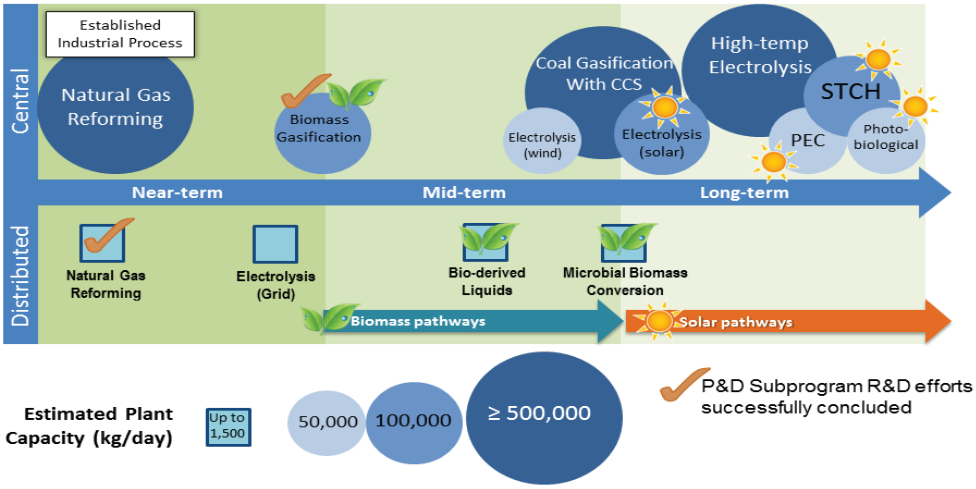
Hydrogen contains the most energy by weight of any chemical fuel. Methane (usually consumed as natural gas) has the second highest energy level by weight but has only 40% of the energy that hydrogen does. The table [I,II] below gives a perspective of the energy available from different fuels as compared to hydrogen.



Where to Find Hydrogen

Hydrogen is available in great quantities on Earth combined with other elements to make water and hydrocarbons.[III] Hydrogen makes up 0.00005% of the atmosphere and 0.14% of the Earth's crust. [IV]

Hydrogen must be produced from the molecules that contain it. The most common methods are steam-methane reforming using natural gas (95% of production) and electrolysis using water. [V,VI] Developing technologies such as bio-derived liquids and microbial biomass conversion may make use of solar energy and biomass for more direct generation of hydrogen as they become cost competitive. The graphic on the next page illustrates the current and potential production processes. [VII]



Categories of Hydrogen

Hydrogen might be categorized by the energy sources for its production. Think of hydrogen produced using renewable energy as renewable hydrogen or green hydrogen, hydrogen produced from coal as brown hydrogen, hydrogen produced from natural gas or petroleum as grey hydrogen. When brown or grey hydrogen production is combined with carbon capture and storage, it is referred to as blue hydrogen. [VIII]

Storage, Transportation, and Blending

Gaseous hydrogen must be stored after being made.

Hydrogen pipelines operate in the gas region. Some design considerations include:

- Consider hydrogen gas embrittlement of the carbon steel pipe – control by having dry, pure gas
- Design for outside corrosion through effective cathodic protection measures
- Select the right metallurgy for line pipe (generally, API 5L X52 PSL2 (fine grained structure, ductile, superior toughness)
- Welding procedures and welder qualifications specifically for hydrogen service
- Pipeline components, including but not limited to, valves, compressors, and instrumentation must be specified for hydrogen service

The benefits of blending hydrogen into natural gas include significant reduction of greenhouse gas emissions (if hydrogen is produced from renewable sources). The potential benefits come from reducing petroleum consumption and improving air quality by reducing sulfur dioxide, oxides of nitrogen, and particulate emissions; greening natural gas: when a hydrogen/natural gas mixture is used in existing appliances for heat and electricity generation. [IX]

One of the challenges to blending hydrogen into natural gas is the impact of hydrogen on performance of end uses and pipeline infrastructure, and the differences between hydrogen and natural gas with regard to price and heating value. [X]

UPI Experience

UPI offers a full complement of solutions including: Conceptual selection, FEED, Project development, including Total Installed Costs for funding, and EPC/EPCM. The EPC/EPCM solutions include Project Management, Engineering and Design Services, Procurement Services, Sub Contractors Management, Survey, Laser Scanning, Construction Management, Inspection, Mobile Inspection Platform, Systems Integration, Automation, and Controls.

UPI has a rich heritage of pipeline and facilities project experience for pipeline planning design and construction management. UPI has engineered over 35,000 miles of pipeline and installed over 5 million Hp of pumps and compressors.

UPI's recent hydrogen projects include:

- Detailed design, survey and construction support of 200 miles of 12-inch pipeline
- Detailed design, survey and construction support of 80 miles of 14-inch pipeline
- Engineering, procurement, and construction of hydrogen pipeline system (11 miles of 8-inch and 10-inch)

Closing

UPI looks forward to talking with you about how we can help you with your project.

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II. GREET Transportation Fuel Cycle Analysis Model, GREET 1.8b, developed by Argonne National Laboratory, Argonne, IL, released May 8, 2008. http://www.transportation.anl.gov/software/GREET/index.html
III. https://energies.airliquide.com/resources/planet-hydrogen-hydrogen
IV. D. R. Lide, ed. CRC Handbook of Chemistry and Physics, 89th ed. Boca Raton, FL: CRC Press, 2008–9, 14–17.
V. https://www.energy.gov/eere/fuelcells/h2scale
VI. https://www.eia.gov/energyexplained/hydrogen/production-of-hydrogen.php
VII. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Hydrogen Production (public domain)
VIII. https://www.eia.gov/energyexplained/hydrogen/production-of-hydrogen.php
IX. Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues, Golden, Colorado, National Renewable Energy Laboratory, March 2013
X. Assessment of Potential Future Demands for Hydrogen in the United States, Oak Ridge, Tennessee, Argonne National Laboratory, October 2020