III.2 Moving Toward Consistent Analysis in the HFC&IT Program: H2A

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Objectives

- Improve the transparency and consistency of analysis of hydrogen systems.
- Improve the understanding of the differences among analyses.
- Seek validation from industry on consistent analysis methodology.
- Develop a tool for the consistent reporting and analysis of the cost of hydrogen technologies.

Technical Barriers

This project addresses the development of consistent analysis methodologies mentioned in Section 4.5 of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan, with the aim of providing direction, focus, and support to the development and introduction of hydrogen production, storage, and end-use technologies. The types of analyses on which the current H2A effort has focused are technology feasibility and cost analysis of hydrogen production systems. This project addresses the following technical barriers from the Systems Analysis section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- B. Lack of Consistent Data, Assumptions, and Guidelines
- D. Stovepiped/Siloed Analytical Capabilities

Approach

- Develop a cash flow analysis tool.
  - Estimates the levelized price of hydrogen for a desired internal rate of return
  - Takes into account capital costs, construction time, taxes, depreciation, operation and maintenance, inflation, and projected feedstock prices
- Estimate production costs for several key hydrogen production technologies.
  - Current, mid-term (~2015), and long-term (~2030) technologies
  - Natural gas, coal, biomass, nuclear, electrolysis
- Refine inputs and results based on peer review and input from key industrial collaborators (KICs).
- Identify key cost drivers using sensitivity analysis.

Accomplishments

- Developed central and forecourt standard reporting spreadsheets.
- Documented assumptions, inputs, and results.
- Completed base case cost analyses with sensitivity analyses for current, mid-term, and long-term technologies.
  - Natural gas reforming: central and forecourt
  - Coal
  - Biomass
  - Nuclear
  - Central wind/electrolysis
  - Distributed (forecourt) electrolysis
- Worked with KICs to establish parameters, process designs, and technology assumptions.
- Demonstrated ability to calculate levelized hydrogen price and document a consistent set of assumptions.
- Completed Version 1.0 of cash flow model.
- Beta testing of v1.0 is in progress.
- Estimated hydrogen selling price for key technologies.
  - Current, mid-term (~2015), and long-term (~2030) technologies
  - Natural gas, coal, biomass, nuclear, electrolysis
- Beginning to apply H2A to other areas (storage, fuel cells, transition modeling, energy forecast modeling).

Future Directions

- Apply H2A principles (consistency and transparency) to other areas of analysis.
- Provide H2A model for other analysis work.
- Use H2A model in technology validation projects.

Introduction

According to the Hydrogen, Fuel Cells & Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan, systems analysis is conducted to support decision-making in the development of the production, delivery, storage, fuel cell and safety technologies. To make the appropriate recommendations to decision-makers, analysis of hydrogen technologies and systems must be carried out using consistent and transparent methodologies.

H2A, which stands for Hydrogen Analysis, was formed in 2003 to better leverage the combined talents and capabilities of analysts working on hydrogen systems, and to establish a consistent set of financial parameters and methodology for cost analyses. The objective of H2A is to improve the transparency and consistency of analysis, improve the understanding of the differences among analyses, and seek better validation of analysis studies by industry.

Approach and Results

The H2A Cost Analysis Tool

In order to address the need for transparent reporting and a consistent cost analysis methodology, H2A developed a modeling tool to assess the cost of producing hydrogen for central and forecourt (filling station) hydrogen production technologies. This tool requests the user to define several characteristics of the process being studied, including process design, capacity, capacity factor, efficiency, and feedstock requirements. While the tool includes agreed-upon H2A reference values for several financial parameters, the user is also given the opportunity to vary parameters such as internal rate of return, plant life, feedstock costs, and tax rate, to examine the technology using their own basis. The calculation part of the tool uses a standard discounted cash flow rate of return analysis methodology to determine the hydrogen selling price for the desired internal rate of return (10% is the H2A reference value). Some of the more significant H2A parameter reference values are:

- Reference year (2005$)
- Debt versus equity financing (100% equity)
- After-tax internal rate of return (10% real)
- Inflation rate (1.9%)
- Effective total tax rate (38.9%)
- Design capacity (varies according to technology and market)
- Capacity factor (90% for central [exc. wind]; 70% for forecourt)
- Length of construction period (0.5 – 3 years for central; 0 for forecourt)
- Depreciation period and Modified Accelerated Cost Recovery Schedule (MACRS) (20 yrs for central; 7 yrs for forecourt)
- Plant life and economic analysis period (40 yrs for central; 20 yrs for forecourt)
- Cost of land ($5,000/acre for central; land is rented in forecourt)
- Burdened labor cost ($50/hour central; $15/hour forecourt)
- General & administrative rate as % of labor (20%)

A schematic of the H2A production cash flow analysis tool is shown in Figure 1.

Review of the H2A Approach

In January 2005, the H2A production modeling tool and two example case studies were sent to a

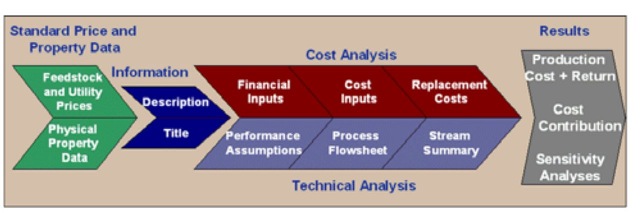

Figure 1. H2A Cash Flow Analysis Tool

DOE-selected group of technology, policy, and industry experts to perform a beta test of the tool and the general approach. Four questions were asked of the reviewers:

- Are the financial guidelines reasonable?
- Are the calculations correct?
- Are there recommendations for enhancements?
- Is the model easy to use?

A total of 175 comments were received from 15 reviewers. Each comment was reviewed by the H2A team and assigned one of three severity scores. A severity score of "1" meant that the comment indicated that the model does not work or identified an issue that contradicted the stated goals of H2A. A score of "2" was assigned to those comments that identified a possible functionality error. A score of "3" was assigned to comments that recommended formatting changes or future enhancements. Of the 175 comments received, zero comments received a severity score of "1". This is probably due to the fact that H2A had undertaken significant reviews of the approach and model throughout the project. Comments receiving scores of "2" or "3" numbered 23 and 138, respectively. All comments have been addressed to-date. Identified functionality errors have been corrected, and many of the suggested formatting changes have been adopted.

Plans for Version 2.0 of the H2A Production Modeling Tool

While the Hydrogen, Fuel Cells & Infrastructure Technologies Program is in the process of reviewing internally-generated cost goals prior to the release of the H2A model and case studies, version 2.0 of the H2A Production Modeling Tool is being developed. The following enhancements are being implemented:

- Add capital recovery factor and fixed-charge rate calculations
- Provide for scaling of equipment
- Identify options for automating Monte Carlo sensitivity analysis
- Automate efficiency calculations via feedstock and utility consumption
- Automate CO_2 emissions calculations via feedstock consumption

- Create an automatic link to the GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model

For all of these changes, the documentation of the tool will be updated and a distinct beta-test evaluation will be conducted.

Conclusions

The H2A effort has been extraordinarily successful in pulling together technology analysis expertise, industry review, and DOE support. Of primary importance for the necessary analysis of hydrogen pathways was the development of a standard methodology and tool for performing consistent analyses of hydrogen production technologies. The beta-test evaluation of version 1.0 of the production cash flow analysis modeling tool confirmed that the calculation methodologies and physical structure are correct and useful to the hydrogen analysis community.

Special Recognitions & Awards/Patents Issued

1. H2A and its members were awarded with a DOE Hydrogen Program R&D award at the Program's 2005 Annual Peer Review Meeting in May.