
IX.9 Expanded Capabilities for the Hydrogen Financial Analysis Scenario Tool

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Project Start Date: September 2014

Project End Date: Project continuation and direction
determined annually by DOE

Technical Barriers

This project addresses the following technical barriers from the Systems Analysis section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan:

- Section 4.2 Technical Approach: Infrastructure Analysis
- Section 4.5 A. Future Market Behavior: Scenarios to understand vehicle-fuel interactions
- Section 4.5 E. Unplanned Studies and Analysis: Response to H2USA public-private partnership and infrastructure deployment goals

Contribution to Achievement of DOE Systems Analysis Milestones

This project will contribute to achievement of the following DOE milestones from the Systems Analysis section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan:

- Milestone 1.12: Complete an analysis of the hydrogen infrastructure and technical target progress for technology readiness. (4Q, 2015)
- Milestone 1.15: Complete analysis of program milestones and technology readiness goals - including risk analysis, independent reviews, financial evaluations, and environmental analysis - to identify technology and risk mitigation strategies. (4Q, 2015)
- Milestone 1.16: Complete analysis of program performance, cost status, and potential use of fuel cells for a portfolio of commercial applications. (4Q, 2018)
- Milestone 1.17: Complete analysis of program technology performance and cost status, and potential to enable use of fuel cells for a portfolio of commercial applications. (4Q, 2018)
- Milestone 1.19: Complete analysis of the potential for hydrogen, stationary fuel cells, fuel cell vehicles, and other fuel cell applications such as material handling equipment including resources, infrastructure and system effects resulting from the growth in hydrogen market shares in various economic sectors. (4Q, 2020)
- Milestone 2.2: Annual model update and validation. (4Q, 2011 through 4Q, 2020)

Overall Objectives

- Provide convenient detailed hydrogen infrastructure financial analysis to facilitate investments in hydrogen refueling stations and improve policy-design decisions to support early hydrogen station and fuel cell electric vehicle market development.
- Inform multiple stakeholders: policy and government decision makers, station operators, equity investors, strategic investors, lenders.
- Enable transparent incentive analysis.
- Provide embedded investment risk analysis.

Fiscal Year (FY) 2016 Objectives

- Complete additional refinements to the Hydrogen Financial Analysis Scenario Tool (H2FAST), such as the following examples of potential revisions or additions:
 - Sensitivity analysis capability (Monte Carlo/risk analysis)
 - Capability to analyze additional stations
 - More supply chain component titles (e.g., pipeline, gasifier) and feedstocks (e.g., woody biomass)
 - Salvage value (or net expense at end of life), including capital gains considerations
 - Cumulative column on pareto chart, profitability index, \$/kg incentives
 - Add custom station types (e.g., half electrolysis, half delivered)

FY 2016 Accomplishments

- Added risk analysis with triangular distribution for any input parameter (lowest, most likely, highest values).
- Added quick visualization for any input or output stochastic distribution.
- Enabled reporting of 5th, 50th, and 95th percentile for each input or output parameter
- Added ability to specify fixed hydrogen price or fixed internal rate of return (IRR)
- Added profitability index, a robust financial performance metric (unlike IRR, which sometimes does not yield a value)
- Added consideration of byproducts such as grid service, waste heat, user-defined co-products (enabling combined heat, hydrogen, and power [CHHP] and other non-conventional system analysis)
- Added per-kilogram (\$/kg) revenue for modeling: Low Carbon Fuel Standard, Renewable Identification Number credits, others
- Incorporated take-or-pay contract specifications
- Added more feedstocks, allowing custom station modeling (e.g., half delivered, half produced hydrogen; H2A case implementation)
- Added linear depreciation, enabling International Financial Reporting Standard analysis
- Added consideration of non-depreciable assets (e.g., land)
- Added salvage value and capital gains considerations (allowing land sale and equipment salvage considerations)
- Expanded case count to 300 for larger portfolio analysis

- Increased maximum project life to 100 yr (allowing pipeline analysis)



INTRODUCTION

In this project, DOE is distilling investor-grade analysis capability for evaluating hydrogen infrastructure. The DOE is sponsoring numerous technology developments which coalesce in hydrogen infrastructure’s ability to enter mainstream markets. A financial modeling framework is necessary to determine the financial performance potential for these emerging technologies. The DOE has a large suite of models which provide similar analysis but none of them is designed with detailed investor-grade financial analysis capability.

APPROACH

Model design follows U.S. financial reporting standards known as Generally Accepted Accounting Principles¹. This analytic framework is applied in an Excel-based model, which can be readily shared and used among stakeholders, as well as through a web-based calculator [1]. To assure model articulation relevance and usefulness, the team has worked closely with H2USA Investment and Finance Working Group members. Direct input into model design and functionality has been provided by financial experts from the banking and venture capital sectors.

RESULTS

Some of the key new functions of the model are described in this section. Multi-product, multi-feedstock analysis capability enables users to analyze complex systems such as CHHP, as shown in Figure 1. In addition, H2FAST

¹ The model has capability to analyze financial performance in line with International Financial Reporting Standards.

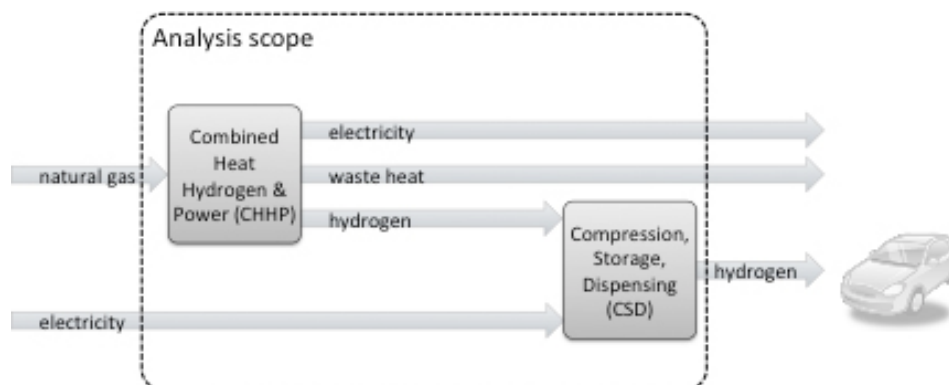


FIGURE 1. Analysis scope capability has been improved to allow analysis of multiple feedstock and products streams as well as breakdown of capital between subsystem components

can be used to analyze sub-system performance and overall system financial performance for scenarios where multiple stakeholders own and operate components. For example, if one entity owns a stationary fuel cell and another owns retail hydrogen equipment. The model can be quickly utilized to determine each stakeholder’s financial position.

Risk analysis has been implemented and allows users to specify uncertainty ranges around most input parameters, as shown in Figure 2. The model performs statistical analysis and yields ranges for possible financial outcomes. Detailed cash flow attribution is expressed in a simple Pareto chart, which allows users to determine financial performance drivers, as shown in Figure 3. Additional incentive analysis capability and take-or-pay contract modelling has been implemented in the model to allow performance estimation on complex financial scenarios.

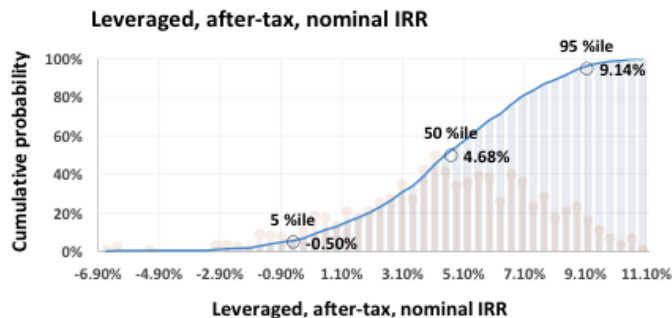


FIGURE 2. Model capability has been expanded to allow uncertainty analysis and articulation of ranges of financial outcomes

CONCLUSIONS AND FUTURE DIRECTIONS

The H2FAST model provides a platform for hydrogen infrastructure financial performance analysis. The model is being actively used for many efforts, and as a new tool in the DOE’s portfolio, developers are receiving constructive feedback from multiple users. Expanded capabilities and model refinements in FY 2016 have been made in response to a wide range of end user suggestions and interactions. As hydrogen infrastructure components become commercialized, and engagement with the

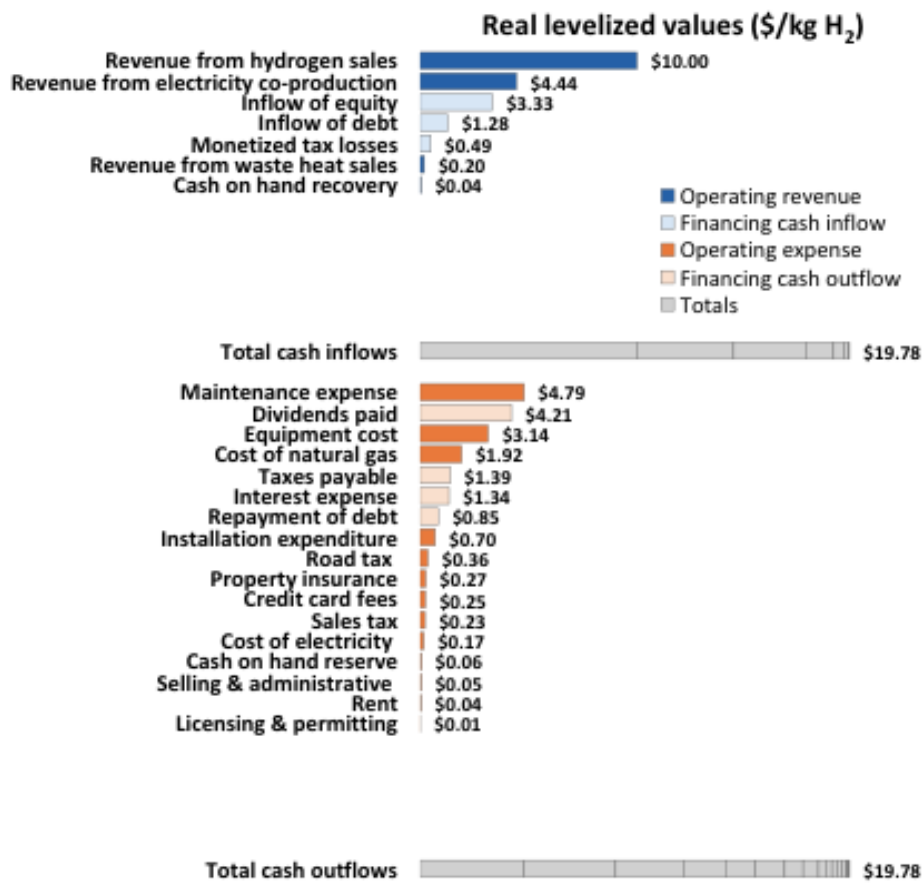


FIGURE 3. Pareto chart is generated for each analysis, which highlights cash flow contributions on a normalized basis to help communicate relative cash flow magnitudes

investment community increases, it is prudent to provide a clear articulation of financial scenarios and metrics, and to respond to and incorporate ongoing improvement requests from users. Future developments will include capability to assess investments for multiple stations or components across different timeframes, linkages between supply chain components, and incorporation of externality costs such as water impacts or the social cost of carbon.

FY 2016 PUBLICATIONS/PRESENTATIONS

1. Michael Penev, Brian Bush, Marc Melaina, “Expanded Capabilities for the Hydrogen Financial Analysis Scenario Tool (H2FAST),” Presented at the DOE Hydrogen and Fuel Cells Program Annual Merit Review and Peer Evaluation Meeting, Washington, D.C., June 6–10, 2016.

REFERENCES

1. H2FAST, Hydrogen Financial Analysis Scenario Tool, 2016, Available online: <http://www.nrel.gov/hydrogen/h2fast/>