IX.12 Infrastructure Investment and Finance Scenario Analysis

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

Overall Objectives

- Provide an independent financial assessment capability that incorporates multiple real-world influences on hydrogen station investments
- Develop a financial analysis tool designed to meet the needs of a range of end users
- Adhere to standard financial analysis methods
- Provide user-friendly and readily accessible tools

Fiscal Year (FY) 2015 Objectives

- Provide analysis capability in the form of an interactive online tool and downloadable spreadsheet
- Develop interface formats that highlight priority results of interest to end users
- Develop a beta version of a visualization tool for full supply chain network financing

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:

(A) Future Market Behavior

(E) Unplanned Studies and Analysis

Technical Targets

This project will help facilitate investments in hydrogen refueling stations and improve policy design decisions to support early hydrogen station and fuel cell electric vehicle (FCEV) market development. Ultimately, as early markets evolve, more informed investment decisions will increase station availability and may result in reduced hydrogen costs to consumers. In this way the project facilitates commercialization of FCEVs and contributes to stakeholder coordination efforts to expand hydrogen station networks.

FY 2015 Accomplishments

- A financial analysis framework for hydrogen stations, called the Hydrogen Financial Analysis Scenario Tool (H2FAST), has been developed as an extension of the Hydrogen Analysis (H2A) suite of cost estimation tools. The framework employs standard financial accounting methods, reporting income statements, cash flows, balance statements, as well as a wide range of financial metrics that are readily comprehensible and meaningful to users with a finance background.
- H2FAST has been implemented in website and spreadsheet (Microsoft Excel) tools as well as in a beta version Business Case Scenario (BCS) visualization tool. Each H2FAST tool has been designed for distinct end-user types and needs and has been carefully validated.
  - The web version of H2FAST is simple to use and provides quick, first-cut analyses of multiple station financing options. The intuitive, user-friendly interface provides instant visual and numerical results.
  - The spreadsheet version of H2FAST allows users more control over a larger set of inputs, and it allows for analysis of multiple stations and financial options. It is intended for more advanced users with more detailed information about one or more station projects. The user interface is highly annotated and easy to navigate, and it allows for both basic and advanced modes of interaction.
  - The BCS version of H2FAST, which is in beta development, is intended for more advanced users interested in full supply chain financing and regional or national scenarios of infrastructure dynamics. The interface is based on a general multivariate visualization framework, allowing users access to large volumes of data from detailed scenarios. Additional knowledge of end user requirements is needed to refine this tool.

- The H2FAST scenario is fully integrated with the scenario development and cost optimization capabilities of the Scenario Evaluation, Regionalization, and Analysis (SERA) model. Therefore, all national station and infrastructure rollout scenarios developed using SERA are easily analyzed across the full range of H2FAST financial metrics, and they can be assessed for a wide range of financial strategies and policy support mechanisms.

INTRODUCTION

Limited availability of hydrogen stations is a significant barrier to the successful commercialization of FCEVs. Investment risk is one of the factors that may inhibit the expansion of hydrogen stations in advance of widespread FCEV adoption. While the U.S. Department of Energy's Fuel Cell Technologies Office has supported extensive cost estimation tools based on engineering principles and vetted by industry experts, these tools have been limited in their ability to explore finance options. This is a barrier to conveying the relevance of hydrogen station investment opportunities to key stakeholders and project partners through existing assessments of station costs and deployment.

Multiple studies have examined hydrogen infrastructure in terms of financial metrics. A 2008 National Academies study conveyed costs in terms of cash flows, highlighting the shortfall period—or "valley of death"—between initial market growth and net positive cash flow [3]. A 2013 Energy Independence Now report incorporated greater detail at the individual station level and examined policy support mechanisms [1]. A 2013 National Academies study examined cash flows in terms of private and social costs and compared a hydrogen scenario with success scenarios for other alternative fuels, with a study goal of examining light-duty vehicle greenhouse gas emission reductions of 80% by 2050 [2]. The development of H2FAST builds on these previous studies, providing a rigorous framework and set of tools that can be used alongside or in conjunction with standard financial tools used in the private sector.

APPROACH

The H2FAST framework is based on the discounted cash flow framework originally implemented in the H2A suite of cost estimation models. This cash flow basis allows future capital costs, such as component replacements or station upgrades, to be treated consistently with upfront capital and annual operating costs. H2FAST extends the financial calculations to develop a much broader range of outputs than is contained in the H2A models. The financial calculations are consistent with Generally Accepted Accounting Principles, and the format and terms used to convey financial results are consistent with standard reports used by private companies. One important difference between H2A and H2FAST is that hydrogen price is a user-defined input in H2FAST, as opposed to a profited-cost result in H2A. (H2FAST does, however, estimate the break-even hydrogen price at which investors would achieve their desired rate of return.) In addition, H2FAST is not a cost estimation tool; users must bring reliable input cost data to the model to obtain meaningful results.

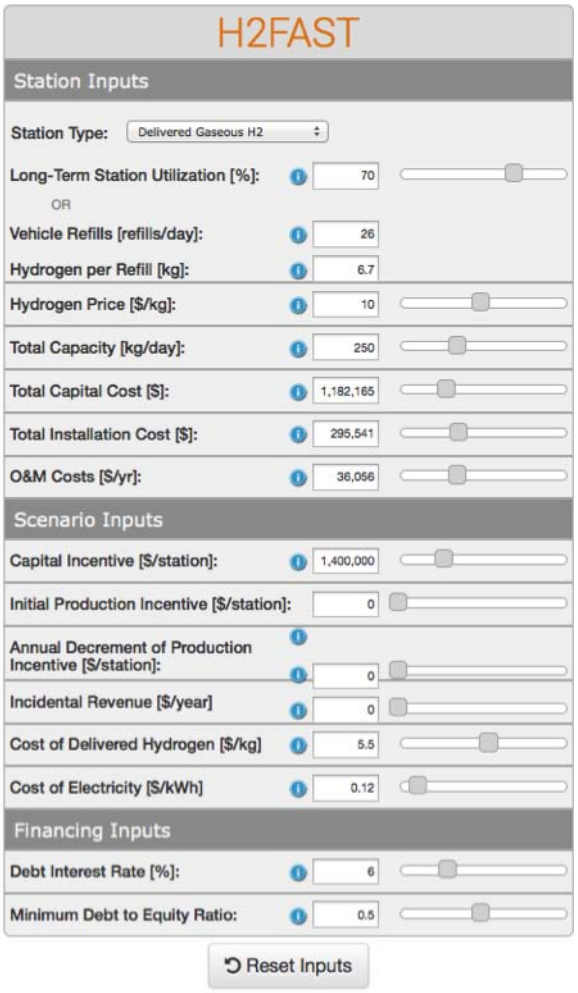
The user interfaces of the web and spreadsheet versions of H2FAST have been designed for financial end users. Reviews of the model interface were completed with members of the H2USA Investment and Finance Working Group, and modifications were made to highlight metrics of greatest interest to target end users. The interfaces enable users to perform many iterations and variations on station financing assumptions and scenarios quickly.

RESULTS

The input panel of the web version of H2FAST is shown in Figure 1. These inputs are a subset of the total range of possible inputs in the analysis framework. A review process identified them as high-priority inputs for the target audience, and their limited number enables use of a simple, easily navigated interface within a web browser. As shown, these inputs are categorized as station inputs, scenario inputs, and financial inputs. Values can be entered directly into input cells or adjusted with sliders. The website opens with default values, taken from Argonne National Laboratory's H2A Refueling Station Analysis Model, which can be restored by clicking on the "reset inputs" button at the bottom of the panel.

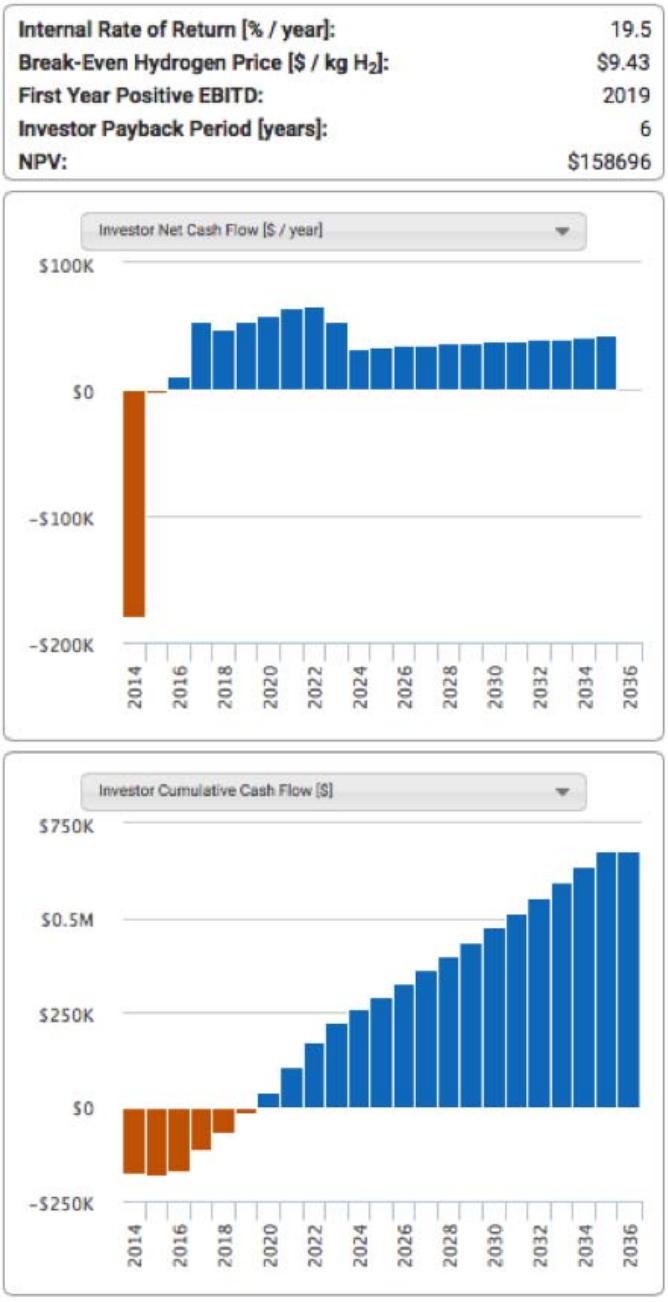
The results panel of the web version of H2FAST is shown in Figure 2. The key numerical results shown at the top of the panel are internal rate of return, breakeven hydrogen price, first year of positive earnings before interest, tax, and depreciation, investor payback period, and net present value. In addition, the results panel provides graphs illustrating trends over time; users can select from among 20 different graphs to visualize a wide variety of results. The values and graphs in the results panel update automatically in response to changes in the input panel. Full financial tables can be downloaded for any station scenario simply by clicking a "download results" button, and a brief user's guide is accessible through the "about" link. H2FAST can easily be embedded into other websites as a widget. The version on the National Renewable Energy Laboratory website is located at http://www.nrel.gov/hydrogen/h2fast/.

For financial analyses beyond the capabilities of the web version, users can turn to the spreadsheet version of



O&M - operating and maintenance

FIGURE 1. Input panel for the website version of H2FAST



NPV - net present value; EBITD - earnings before interest, taxes, and depreciation

FIGURE 2. Results panel for the website version of H2FAST

H2FAST, which can be downloaded directly from the website version. The spreadsheet version contains many hover-over annotations to orient users, and a draft user's manual is available through the website "about" link. Key capabilities unique to the spreadsheet version include the ability to assess multiple stations individually or as a group, a broader range of inputs that enable more customized financial assessments, and the flexibility of working within a spreadsheet environment. The number of input values can be expanded from basic to advanced mode, depending on the needs of the user. The standard financial calculations have been resolved in closed form, allowing use of other spreadsheet functions, such as Excel's "Goal Seek," for determining relationships between input values and results. For example, a particular subsidy level can be determined precisely for a target (goal) internal rate of return.

Although the H2FAST framework has been deployed across all aspects of the SERA model, results from national or regional scenarios of hydrogen infrastructure rollout can be very data intensive and multifaceted. One means of exploring these results is the BCS visualization version of H2FAST. This map- and web-based tool has only been developed as a beta version, but it may be refined in future work as additional end-user requirements are clarified. The general platform and features of this multivariate visualization tool are reviewed in a brief demonstration video: http://youtu.be/J7y51c-dldo.

CONCLUSIONS AND FUTURE DIRECTIONS

The H2FAST financial framework has been implemented consistently across multiple analysis tools. Because these independently developed tools provide financial assessment capabilities consistent with standard practices within the finance sector, they will be useful to stakeholders involved in real-world hydrogen station projects, including individual companies, government agencies, and project partnerships with multiple stakeholders. User comments on the first version of H2FAST will inform the development of updated versions, and future work may involve applying the framework to other components along the hydrogen supply chain.

SPECIAL RECOGNITIONS & AWARDS/ PATENTS ISSUED

1. Annual Merit Review Award 2015, Systems Analysis: Marc Melaina, Brian Bush, and Michael Penev. http://www.hydrogen.energy.gov/annual_review15_awards.html

FY 2015 PUBLICATIONS/PRESENTATIONS

1. Melaina, M., B. Bush, and M. Penev. 2015. "Overview of Station Analysis Tools Developed in Support of H2USA: Overview of the Hydrogen Financial Analysis Scenario Tool (H2FAST)." Presentation as part of EERE Webinar Series, May 12, 2015. http://energy.gov/eere/fuelcells/downloads/overview-station-analysis-tools-developed-support-h2usa

2. Melaina, M. 2015. "Infrastructure Investment and Finance Scenario Analysis." Presentation at 2015 Annual Merit Review Meeting, June 8-12, Washington, DC. http://www.hydrogen.energy.gov/annual_review15_analysis.html

3. Bush, B., M. Penev, M. Melaina, and J. Zuboy. 2015. *Hydrogen Financial Analysis Scenario Tool (H2FAST): Web Tool User's Manual*. NREL/TP-5400-64020. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy15osti/64020.pdf

4. Penev, M., M. Melaina, B. Bush, and J. Zuboy. 2015. *Hydrogen Financial Analysis Scenario Tool (H2FAST): Spreadsheet Tool User's Manual*. Draft Technical Report. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/hydrogen/h2fast/assets/pdfs/h2fast_spreadsheet_user_manual.pdf

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1. Eckerle, T., and R. Garderet. 2013. *Hydrogen Network Investment Plan*. Energy Independence Now. http://www.einow.org/images/stories/factsheets/h2nip_full_paper_final.pdf

2. NRC (National Research Council). 2013. *Transitions to Alternative Vehicles and Fuels*. Washington, D.C.: National Academies Press.

3. NRC (National Research Council). 2008. Transitions to Alternative Transportation Technologies: A Focus on Hydrogen. Washington, D.C.: National Academies Press.