IX.6 Hydrogen Financial Analysis Scenario Tool (H2FAST) Updates with Analysis of 101st Station

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Project Start Date: September 2014
Project End Date: Project continuation and direction determined annually by DOE

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 (FCEV) 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) 2017 Objectives

- Incorporate H2FAST into the Scenario Evaluation, Regionalization, and Analysis (SERA) model.
- Evaluate when hydrogen refueling stations in each state are projected to become profitable on average in national hydrogen deployment scenarios.
- Use H2FAST to evaluate real-world installations and identify key hydrogen cost factors.

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

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 1.19: 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)

FY 2017 Accomplishments

- Incorporated H2FAST into the SERA model.
- Showed that national scenarios have variable transition to un-incentivized financial profitability for different states.
- Used H2FAST to evaluate real-world installations.
- Demonstrated that early station operation demand charges are major cost factors.

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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 when a company receives initial capital investment and when it begins generating profit [1]. A 2013 Energy Independence Now report incorporated greater detail at the individual station level and examined policy support mechanisms [2]. 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 [3]. 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

H2FAST provides a quick and convenient in-depth financial analysis for hydrogen refueling stations. It is meant to facilitate investments in hydrogen stations, improve policy design decisions to support early station and FCEV market development, and examine the market and financial implications of such support strategies. Intended users include policy and government decision makers, station operators, equity investors, strategic investors, and lenders. 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 conform to generally accepted accounting principles and are compatible with analysis for International Financial Reporting Standards [4,5], and the format and terms used to convey financial results are consistent with standard reports used by private companies. H2FAST also can interface with many other models to provide enhanced analysis capabilities. Collaborative model development and use by a variety of public and private stakeholders helps ensure relevance to ongoing analytical needs.

H2FAST accepts user inputs including capital and maintenance costs, incentives, demand profile, feedstock use, retail hydrogen price, and various financial parameters. The model then provides users with detailed annual finance projections in the form of income statements, cash flow statements, and balance sheets; graphical presentation of financial performance parameters for numerous common metrics; life cycle cost breakdown for each analysis scenario; and common ratio analysis results such as debt/equity position, return on equity, and debt service coverage ratio. It also enables risk analysis based on user-defined input value upper- and lower-bounds.

RESULTS

H2FAST was integrated into the SERA model and used to evaluate the financial performance of hydrogen stations deployed to support urban hydrogen demand growth in the United States over the 2015–2050 timeframe. Financial performance drivers included station cost reduction (learning curves), the construction of larger stations over time (driven by higher demand per location), and accelerating utilization growth. H2FAST was used to estimate the crossover point when stations become financially profitable without incentives. Relevant local conditions were modeled, and net present value (NPV) was estimated for every projected station. Figure 1 shows example results for projected stations in Massachusetts. Although poorly performing stations (those with negative NPVs) exist throughout the analysis span, the average NPV rises over time and becomes positive in 2033. Average station NPV indicates when profits from high-performing stations can offset losses from other stations, and it may be a good indicator of the advent of self-sustaining infrastructure.

This approach was applied to analyze when each state achieves a positive average station NPV without incentives. Figure 2 shows the results. California and New York achieve a positive average NPV by 2029, and most other states follow over the next 20 years. However, eight states in the contiguous 48 still have negative average NPVs in 2049.

H2FAST was also used for detailed analysis of real-world hydrogen stations in California, showing the impact of electricity costs and use patterns on station economics. The U.S. Energy Information Administration reports California's average commercial blended electricity rate at 15.73¢/kWh. However, California stations use electricity at peak daily rate times (Figure 3) and incur substantial service and demand charges, resulting in electricity costs around 50¢/kWh. Figure 4 shows the electricity cost breakdown for stations in three California cities in 2016. Total electricity costs for these stations are 2.8–3.5 times higher than the California average, with the largest cost contribution from demand charges. Because maximum demand charges are incurred even at minimal station utilization, demand charges are most relevant for stations with low utilization. For this reason, demand charges should be treated as a fixed operating cost.

CONCLUSIONS AND UPCOMING ACTIVITIES

H2FAST continues to be an effective and flexible tool for analyzing the financial performance of hydrogen refueling stations. Subject to funding received, upcoming activities may include exploring national and regional station deployment scenarios in greater detail as well as integrating H2FAST further with SERA to account for hydrogen production scenarios and transitions to renewable hydrogen.

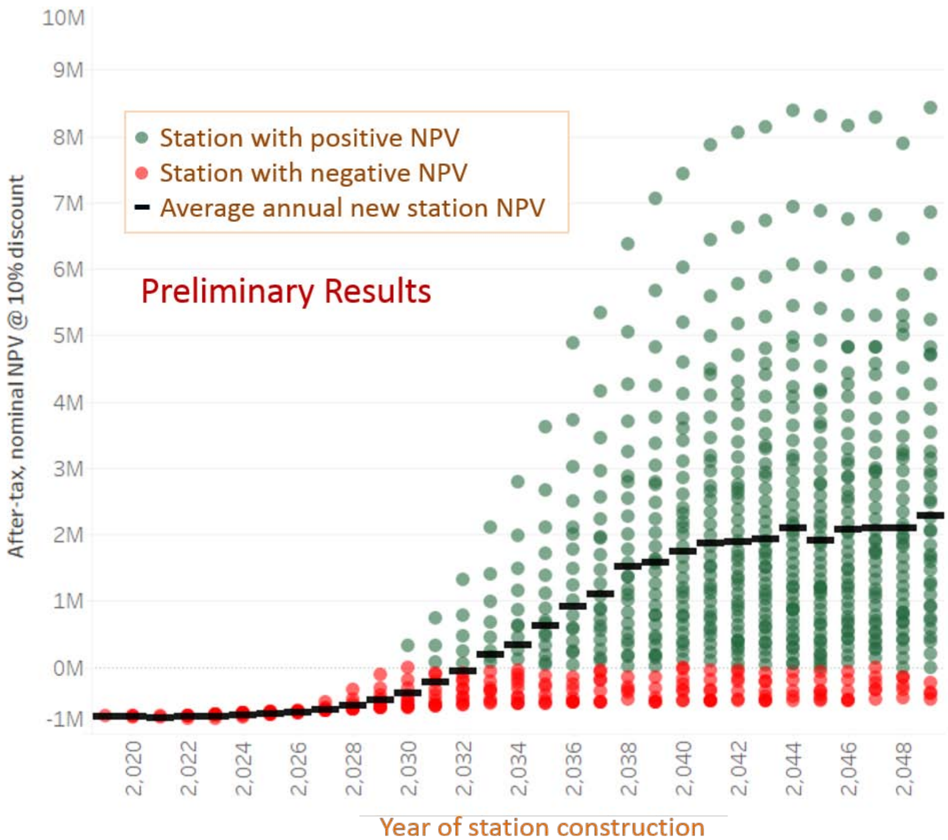


FIGURE 1. After-tax, nominal NPV at a 10% discount rate for simulated hydrogen refueling stations deployed in Massachusetts through 2049

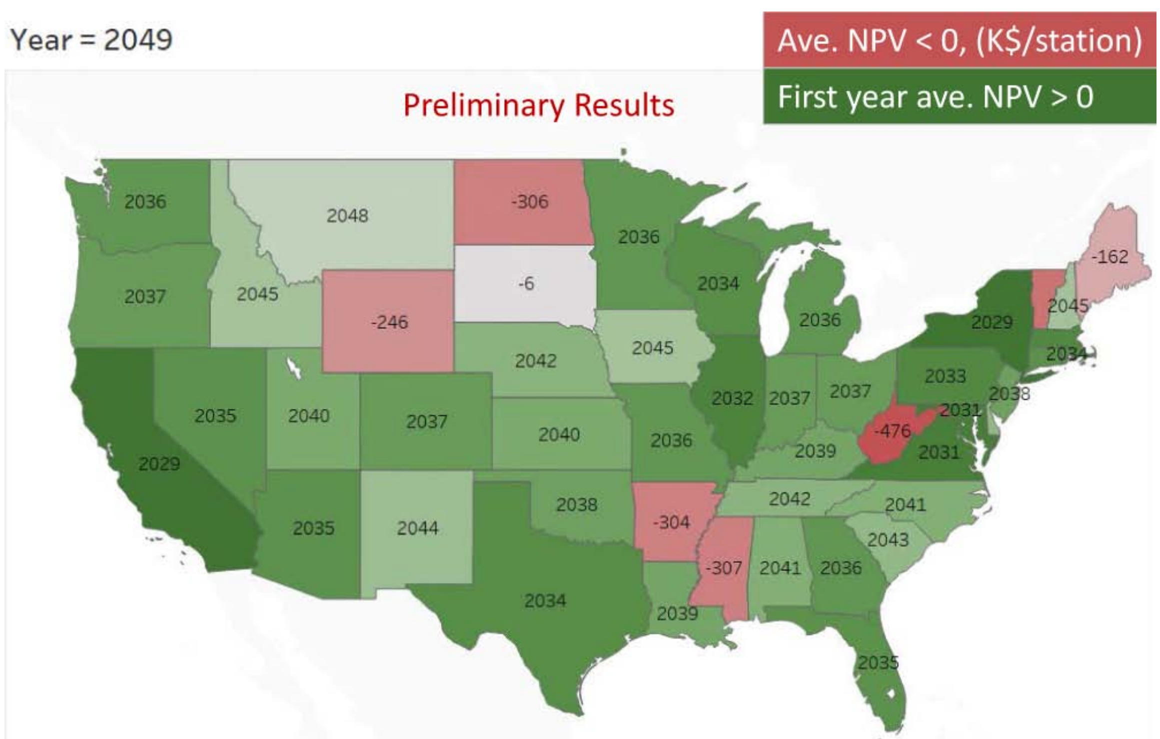


FIGURE 2. Projections of the years at which hydrogen refueling stations in each state achieve a positive NPV on average without incentives

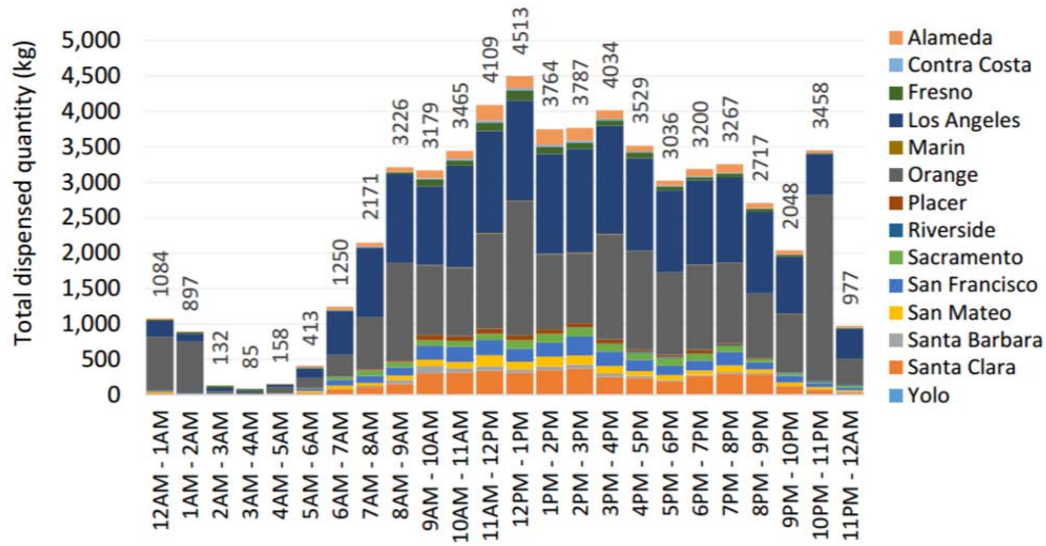
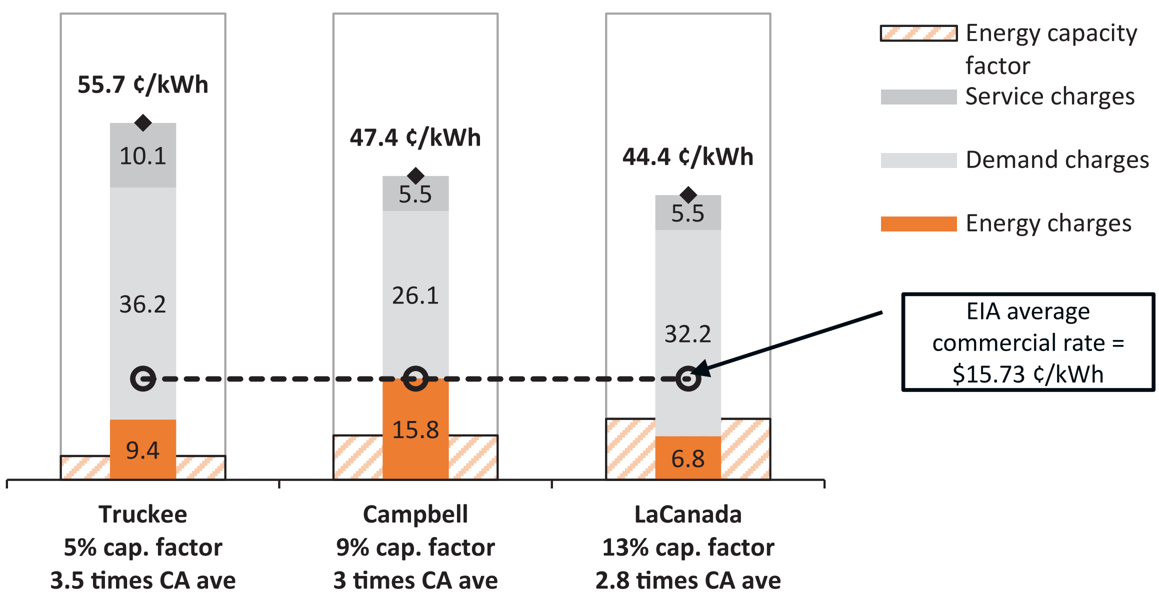


FIGURE 3. Total hydrogen dispensed by hour of day and California county; use profile from Baronas, et al. [6], rate structure from First Element Electricity [7]



EIA – Energy Information Administration

FIGURE 4. Empirical electricity cost for hydrogen refueling stations operating in three California cities in 2016; utility bills from First Element Electricity [7]

The model could also be enhanced via features such as additional fixed operating costs (e.g., demand charges), more detailed demand ramp-up specifications, and the ability to provide custom feedstock and retail price profiles. Finally, ongoing maintenance and support could include supporting custom analysis and user-base requests and producing model updates as needed.

FY 2017 PUBLICATIONS/PRESENTATIONS

1. M. Melaina, and M. Penev, "Hydrogen Financial Analysis Scenario Tool (H2FAST)," presented to the H2USA Location Roadmap Working Group, 2017.

2. M. Penev, "Hydrogen Financial Analysis Scenario Tool (H2FAST) Model Summary and Demonstration," webinar, February 2017, https://energy.gov/eere/fuelcells/downloads/hydrogen-financial-analysis-scenario-tool-h2fast-model-summary-and.

REFERENCES

1. National Research Council, 2008, *Transitions to Alternative Transportation Technologies: A Focus on Hydrogen*, Washington, D.C.: National Academies Press.

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

3. National Research Council, 2013, *Transitions to Alternative Vehicles and Fuels*, Washington, D.C.: National Academies Press.

4. Federal Accounting Standards Advisory Board, 2014, *FASAB Handbook of Federal Accounting Standards and Other Pronouncements, as Amended*, Washington, DC: Federal Accounting Standards Advisory Board.

5. Investopedia, 2014, "Accounting (Fundamental Analysis) Terms," accessed December 2014, http://www.investopedia.com/categories/accounting.asp.

6. J. Baronas, and G. Achtelik, 2017, *Joint Agency Staff Report on Assembly Bill 8: 2016 Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*, California Energy Commission and California Air Resources Board, http://www.energy.ca.gov/2017publications/CEC-600-2017-002/CEC-600-2017-002.pdf.

7. First Element Electricity, 2017, electricity bills, with permission of Tim Brown, COO.