IX.13 The Business Case for Hydrogen-Powered Passenger Cars: Competition and Solving the Infrastructure Puzzle

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Project Start Date: February 2015
Project End Date: Project continuation and direction determined annually be DOE

Overall Objectives

- Cost and business case analyses of various key sub-sectors of the hydrogen fuel-based transport sector

Fiscal Year (FY) 2015 Objectives

- A competitive analysis of a variety of alternative fuel passenger cars, focusing on the total cost of ownership, with a particular emphasis on the current and expected competitive posture of hydrogen-powered passenger cars
- A business case analysis for commercial hydrogen filling stations that serve the prospective hydrogen passenger car market

Technical Barriers

- Uncertain learning curves for hydrogen-based vehicle manufacturing, especially for fuel cells
- Uncertainties regarding marketplace acceptance

Contribution to Achievement of DOE Milestones

- Establishment of the current and prospective competitive posture of hydrogen-powered passenger vehicles vis-à-vis passenger vehicles using other fuel technologies
- Establishment of investment opportunities for commercial hydrogen fueling stations aimed at the passenger car market

FY 2015 Accomplishments

- Completed competitive total cost of ownership analysis for hydrogen-powered vehicles, as compared to cars using other fuel technologies
- Completed cost data collection for a business case analysis for investing in hydrogen fueling stations

INTRODUCTION AND APPROACH

Our analyses entail two distinct procedures. First, we are engaged in a broad effort to collect extant cost data for both vehicles and hydrogen fueling stations, focusing in particular on both bounding costs from above and below (e.g., most and least expensive), as well as obtaining statistical information, when available, for the uncertainties in these cost estimates. Second, we have developed a costing model for establishing the lifetime total cost of vehicle ownership (TCO), used in our competitive vehicle cost analysis. In addition, we are using the National Renewable Energy Laboratory's (NREL's) Hydrogen Financial Analysis Scenario Tool (H2FAST) to compute the investment picture for building and operating hydrogen filling stations, based on the cost parameters we have been establishing. In all cases, we are vetting our analyses with experts versed in the hydrogen-based transport sector at Argonne National Laboratory, as well as with one of the key automobile vendors active in the hydrogen transport sector.

RESULTS

As part of the lifetime competitive cost analysis for hydrogen-powered vehicles, we have expanded beyond our presentation at the DOE Annual Merit Review and Peer Evaluation meeting (AMR) [1] by developing a Monte Carlo-based statistical analysis that now allows us to conduct error analyses of our results. That is, based on our assessment of the uncertainties associated with the various cost components for car ownership, we are now able to provide uncertainties for the TCO. The results of this analysis are presented in Figure 1.

As part of a related sensitivity analysis, we have identified the purchase price of the vehicles as the key contributor to TCO uncertainties in the out years. In the case of hydrogen-powered vehicles, this uncertainty appears to be dominated by uncertainties related to the cost of the hydrogen fuel cell. We are currently investigating what is currently

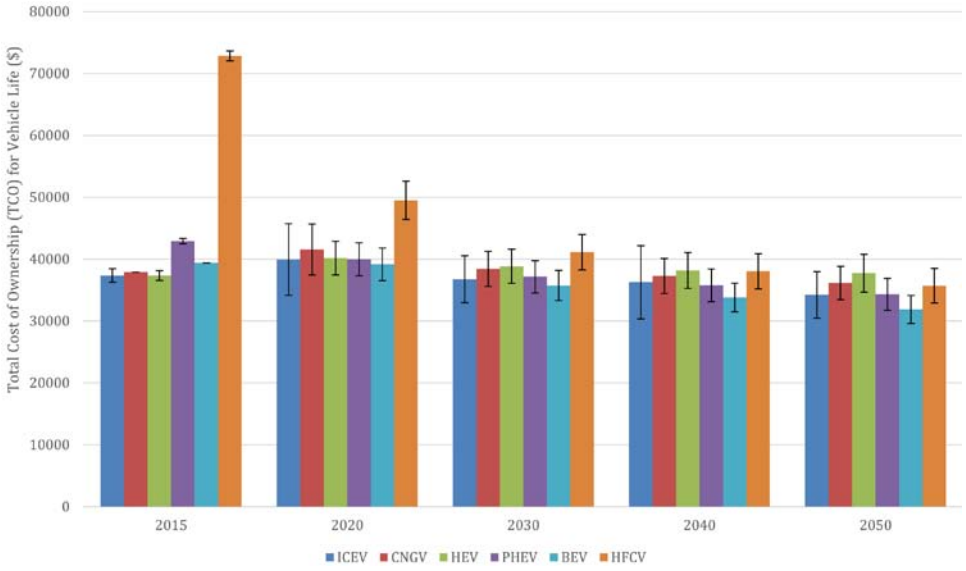

FIGURE 1. Total cost of ownership for vehicle life. This figure shows the results of our new uncertainty analysis for the TCO for vehicles acquired in 2015 through 2050 (internal combustion engine vehicle [ICEV] = Toyota Camry, gasoline-powered; compressed natural gas vehicle [CNGV] = Honda Civic natural gas-powered; hybrid electric vehicle [HEV] = Toyota Camry hybrid; plug-in hybrid electric vehicle [PHEV] = Chevy Volt hybrid plug-in; battery electric vehicle [BEV] = Ford Focus battery-powered; hydrogen fuel cell vehicle [HFCV] = Toyota Mirai hydrogen-powered). Error bars indicate the results of a Monte Carlo statistical analysis, based on uncertainties in our model's input cost data.

understood about potential cost reductions in fuel cells, based both on recourse to alternate membrane technologies as well as the cost reductions associated with 'learning' as production of fuel cells ramps up.

We are using a combination of NREL's H2FAST investment tool and our own analysis of the various cost factors entering into the building and operation of a commercial hydrogen filling station, to build a first analysis of the investment picture for such a facility. Because commercial exploitation of this market is relatively recent, there are insufficient data to develop a statistical uncertainty analysis; instead, we are developing bounds on the various cost factors, based on the most expensive and least expensive cost numbers to be found in the extant literature.

CONCLUSIONS AND FUTURE DIRECTIONS

By the end of FY 2015, we will finish our TCO competitive cost analysis. Two memos will be prepared: one detailing the input data used in our cost analysis, the second providing the detailed results of our TCO analysis.

In the case of the hydrogen filling station business plan, we are completing our investment analysis using H2FAST. This analysis will result in a memo, to be completed by the end of FY 2015, detailing the business case, including our bounding analysis for the various cost factors entering into the construction and operation of hydrogen filling stations.

REFERENCES

1. R. Rosner and R. Topel, *The Business Case for Hydrogen--powered Passenger Cars: Competition and Solving the Infrastructure Puzzle,* Presented at the 2015 DOE Hydrogen and Fuel Cells Program Annual Merit Review, June 2015.