IX.7 Hawaii Hydrogen Initiative (H2I) Financial Scenario Analysis

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Project End Date: December 31, 2012

Overall Objectives

- Support Hawaii Hydrogen Initiative (H2I) [1] team with technology guidance for hydrogen fueling infrastructure
- Evaluate fuel cell vehicle deployment potential in Oahu
- Evaluate hydrogen resource supply options and delivery pathways
- Produce scenario analysis of fueling infrastructure deployment
- Produce financial analysis and incentive requirements for infrastructure deployment

Fiscal Year (FY) 2013 Objectives

- Produce financial projection scenarios:
  - Consider vehicle adoption rates
  - Determine infrastructure support requirements
  - Evaluate full range of expenses
  - Apply competitive revenue ceiling
  - Perform accounting cycle analysis
  - Perform multi-year financing projections
- Provide H2I team with scenario analysis:
  - Communicate risk and sensitivities
  - Facilitate strategic planning
  - Evaluate incentive requirements

Technical Barriers

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

Market Transformation:

(C) Inadequate private sector resources available for infrastructure development

(D) Market uncertainty around the need for hydrogen infrastructure versus timeframe and volume of commercial fuel cell applications

(E) A lack of flexible, simple, and proven financing mechanisms

(N) Policies and incentives (e.g., Investment Tax Credit) are not available to government or other non-profit entities - impeding early market adoption in the public sector

Systems Analysis:

(A) Future Market Behavior

(B) Stove-piped/Siloed Analytical Capability

(D) Insufficient Suite of Models and Tools

(E) Unplanned Studies and Analysis

Contribution to Achievement of DOE Market Transformation and Systems Analysis Milestones

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

Market Transformation:

- Milestone 2.5: Develop third party financing model for Federal users to aggregate and multiply power needs. (2Q, 2012)

Systems Analysis:

- Milestone 1.4: Complete evaluation of fueling station costs for early vehicle penetration to determine the cost of fueling pathways for low and moderate fueling demand rates. (4Q, 2012)

FY 2013 Accomplishments

- Developed an Excel-based infrastructure deployment model that was integrated with Automotive Deployment Options Projection Tool (ADOPT), a vehicle sales model based on economic conditions and calibrated to past market vehicle purchasing behavior
- Produced multiple infrastructure deployment scenarios for internal H2I team support

- Produced two scenarios for external reporting (covered under this report):
  - Baseline scenario (low vehicle sales)
  - Optimistic scenario (high vehicle sales)
- Deployment scenarios were evaluated with new modeling algorithms accounting for annual dispensing infrastructure capital deployment, feedstock usage, financing requirements, and incentives

INTRODUCTION

Early market hydrogen infrastructure deployment requires synchronization of the proverbial chicken and egg. When fuel cell electric vehicles (FCEVs) are not available, fueling infrastructure providers have no business case to provide hydrogen. In our analysis, we model an annual approach to infrastructure deployment in which infrastructure leads vehicle sales.

APPROACH

Analysis for hydrogen infrastructure roll-out assumes that vehicle sales will not occur if fueling infrastructure is not available to the Oahu population. The overall strategy of roll-out thus preempts vehicle sales with infrastructure deployment. Vehicle sales were projected via the ADOPT model, which was calibrated to past vehicle purchasing behavior on Oahu. Such behavior is driven by vehicle characteristics such as size, cost, and fuel efficiency. Additional considerations were included in the model for infrastructure availability and vehicle range. A vehicle stock model was used to track the number of vehicles on the road. Fuel efficiency projections along with vehicle-miles-traveled profiles were used to derive annual aggregate hydrogen demand. The demand was allocated to individual fueling stations through 2050, and each station's financial performance was projected for the same period based on the cost of delivered hydrogen to the station over time and a maximum price the market can bear for hydrogen (based on competitive pricing with gasoline). Initial revenue shortfalls were used as an indicator for required incentives.

RESULTS

Modeling infrastructure roll-out incorporates a minimal station coverage required to initiate vehicle sales. In the presented scenarios, 15 stations were deployed preemptively to demand growth. Demand for hydrogen was distributed among stations in a statistical manner, which then drove station upgrades and new station builds throughout the length of the analysis (see Figure 1).

Each station's performance was tracked on an annual basis. Generally accepted accounting principles framework analysis was used to evaluate each station's financial performance each year. Three projections using generally accepted accounting principles were used for financial analysis:

- Projected income statement: accounts for revenues and expenses to arrive at annual net income
- Projected statement of cash flows: accounts for annual cash flows, including financing activities such as acquisition of additional debt or equity investment
- Projected balance sheet: accounts for business structure according to the following equation:

$$\text{Assets} = \text{Liabilities} + \text{Owners Equity}$$

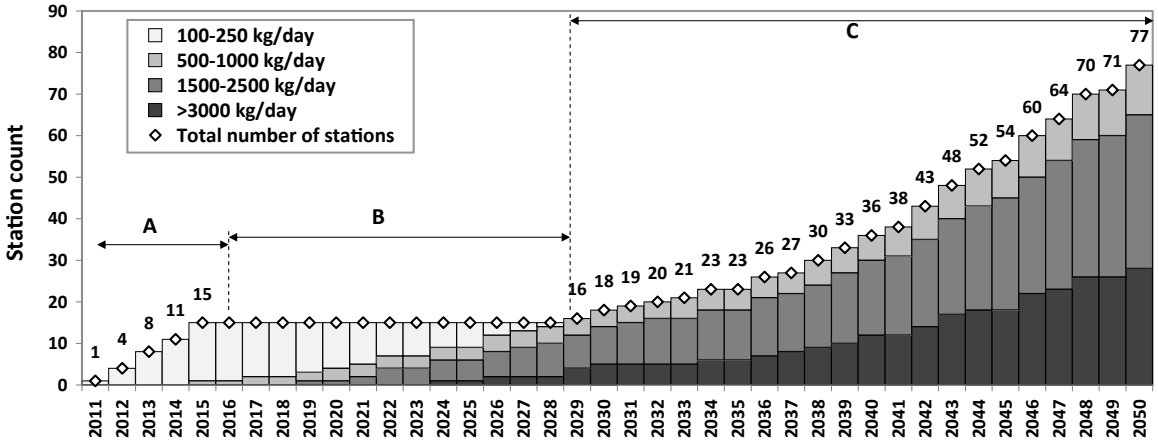

FIGURE 1. Station stock size distribution for the optimistic hydrogen roll-out scenario: (A) coverage stations build-out, (B) coverage stations saturation, (C) upgrading and infrastructure expansion.

The balance sheet arrives at capital structure and maintains financing sourcing to comply with covenant debt-to-equity limit (see Figure 2)

Financial analysis finds that revenue shortfalls will be experienced for an extended period after the initial infrastructure deployment. Such shortfall is expected to impede investment into hydrogen infrastructure. In order to encourage private sector participation in infrastructure roll-out, an after-tax internal rate of return of 10% was solved for by our financial solver by introducing a "production incentive" (see Figure 3). Such an incentive acts as a revenue supplement for station owners and makes return on investment into hydrogen similar to other owner investments.

The financial performance in the scenarios was benchmarked by the relative amount of required incentives. Scenarios requiring more incentives were not as attractive. Figure 4 shows the incentive requirements for the optimistic scenario presented in this report.

CONCLUSIONS AND FUTURE DIRECTIONS

NREL analysts have worked closely with the H2I analysis team to produce a streamlined model for analyzing hydrogen infrastructure deployment and financial scenarios. The modeling effort has outlined timelines for infrastructure deployment requirements, as well as financial incentive projections to support such activities. Our analysis projects potential sales of FCEVs in Oahu and a schedule of station deployments necessary to support the fleet. Detailed financial analysis was performed on a station-by-station basis and was aggregated for an island-wide infrastructure outlook. Infrastructure incentives for this scenario totaled $18.5 million through 2050. NREL's findings quantify

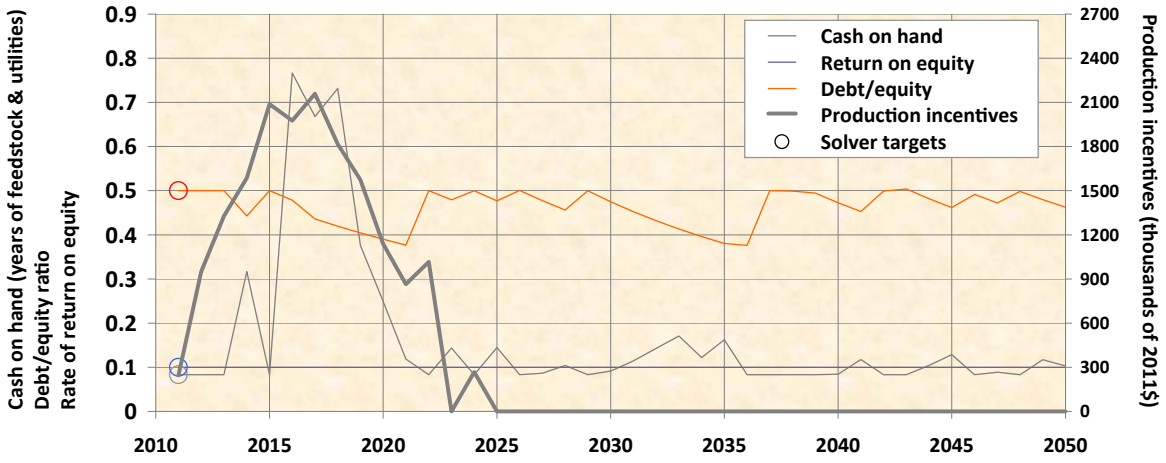

FIGURE 2. Financial performance evaluation performed annually to drive financing activities and to conform to capital structure requirements.

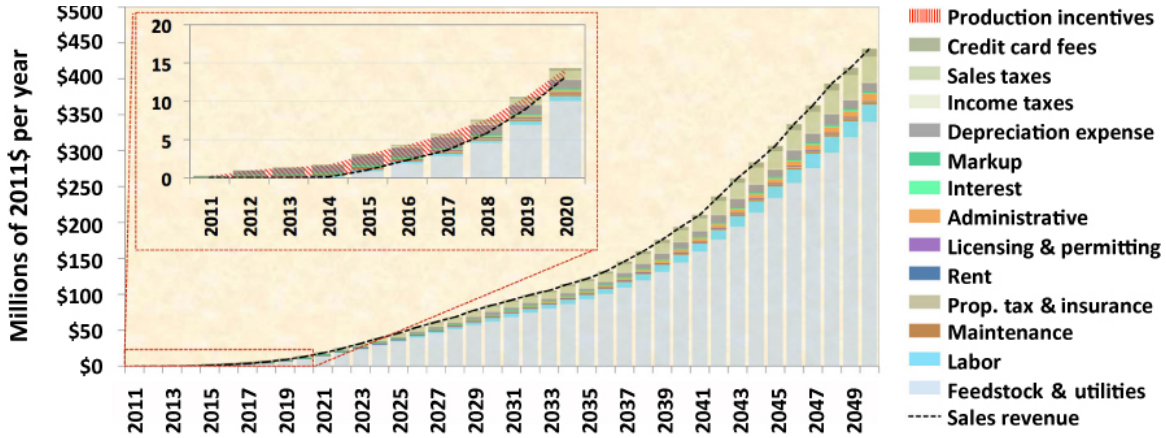

FIGURE 3. Hydrogen fueling station network revenues and expenses through 2050. Early revenue shortfalls constitute the need for incentives (labeled as "production incentives"). Production incentives close the gap between total revenues and total expenses.

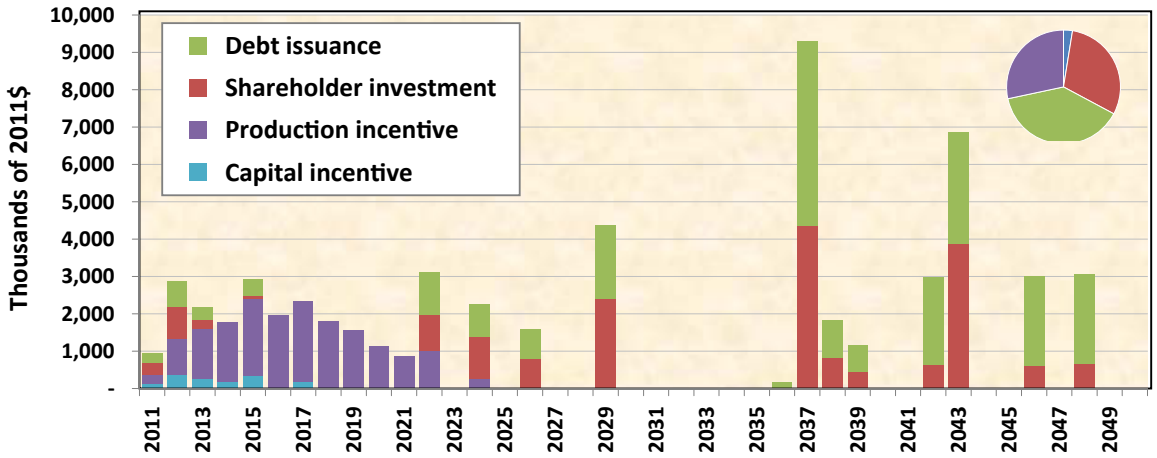

FIGURE 4. Annual incentives and new financing need projections. Pie-chart shows relative amounts of total investment by type.

funding opportunity projections by four sources: equity investment, debt investment, capital incentives, and production incentives. Work on this project concluded in the first quarter of FY 2013. Analytical results were used in decision making by the H2I team, and positive feedback on the usefulness of the methodology has spawned additional activities. The NREL team used this modeling framework to evaluate financial performance of the California Fuel Cell Partnership roadmap [2]. In addition, the model was used to evaluate the potential for hydrogen infrastructure in the northeastern United States, and screening results were presented at a working meeting of stakeholders [3].

Feedback from H2I members has been very positive about the modeling framework. The model algorithms will be further enriched and will be embedded in NREL's Scenario Evaluation, Regionalization and Analysis model [4]. This will allow complete supply chain analysis for hydrogen production using a geospatially and temporally resolved framework. Work with this model will be used on regional and national scales to inform DOE and other stakeholders.

FY 2013 PUBLICATIONS/PRESENTATIONS

1. Penev, M., Melaina, M., Brooker, A., "Hawaii Hydrogen Initiative Financial Scenario Analysis," Fuel Cell Seminar, November 6, 2012.

REFERENCES

1. "H2I, Hawaii Hydrogen Initiative." Accessed [7/10/13]: http://www.hydrogen2hawaii.com/.

2. "A California Road Map." (2012). California Fuel Cell Partnership. Accessed [7/10/13]: http://cafcp.org/carsandbuses/caroadmap.

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4. Brian Bush et. al. "Optimal Regional Layout of Least-Cost Hydrogen Infrastructure," Proceedings of the 2010 NHA Hydrogen Conference & Expo, 2010, volume 28.