VII.2 Stationary Fuel Cell Evaluation

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Project Start Date: October 2011
Project End Date: Project continuation and direction determined annually by DOE

Overall Objectives

Independently assess, validate, and report operation targets and performance under stationary fuel cell system real operating conditions.

Fiscal Year (FY) 2014 Objectives

- Analysis of data quarterly as available.
- Publication of 28 technical stationary fuel cell composite data products (CDPs) biannually.
- Update of a public website for dissemination of CDPs.

Technical Barriers

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

(B) Lack of Data on Stationary Fuel Cells in Real-World Operation - Address gaps in knowledge as stationary fuel cell installations have increased.

(E) Codes & Standards - Provide data and context to codes and standards activities.

Contribution to Achievement of DOE Technology Validation Milestones

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

- Milestone 1.1: Complete validation of residential fuel cell micro CHP (combined heat and power) systems that demonstrate 40% efficiency and 25,000 hour durability. (4Q, 2015)
- Milestone 1.2: Complete validation of commercial fuel cell CHP systems that demonstrate 45% efficiency and 50,000 hour durability. (4Q, 2017)

FY 2014 Accomplishments

- Individual CDPs were disseminated by a website (http://www.nrel.gov/hydrogen/proj_fc_systems_analysis.html) in September 2013 and April 2014.
- The project published an updated and expanded set of CDPs in November 2013 and May 2014, which included three new operational CDPs as well as expanded analysis of differentiated capacities and comparison to other incumbent technologies—28 CDPs in total.
- The project presented stationary CDP results at the Fuel Cell Seminar, October 2013.

INTRODUCTION

This project aims to provide status on stationary fuel cell systems to inform DOE, the public, fuel cell manufacturers, and other stakeholders. This is the only technology validation project working directly on technical barrier (B): Lack of Data on Stationary Fuel Cells in Real-World Operation.

APPROACH

The project's data collection plan builds on other technology validation activities. Data (operation, maintenance, and safety) are collected on site by the project partners for the fuel cell system(s) and infrastructure. NREL receives the data quarterly and stores, processes, and analyzes the data in NREL's National Fuel Cell Technology Evaluation Center (NFCTEC).

The NFCTEC is an off-network room with access for a small set of approved users. An internal analysis of all available data is completed quarterly, and a set of technical CDPs is published every six months. The CDPs present aggregated data across multiple systems, sites, and teams in order to protect proprietary data and summarize the performance of hundreds of fuel cell systems.

A review cycle is completed before the publication of CDPs. The review cycle includes providing detailed data products of individual system and site performance results

to the individual data provider. Detailed data products also identify the individual contribution to CDPs. The NREL Fleet Analysis Toolkit is an internally developed tool for data processing and analysis structured for flexibility, growth, and simple addition of new applications. Analyses are created for general performance studies as well as application- or technology-specific studies.

RESULTS

California's Self-Generation Incentive Program (SGIP) has helped deploy 317 fuel cell systems, for a total of 131 MW, since 2001. These fuel cell deployments have shown that fuel cells may be applied with a wide variety of fuels, including renewable biogas from landfill, biomass, and digester sources. Natural gas is the dominate fuel type, accounting for 74% of projects and 66% of the capacity. Since 2011, electric-only fuel cell projects have been increasing at a rate (number and capacity) greater than other competing technologies, which include gas turbines, internal combustion turbines, microturbines, and pressure reduction turbines (Figure 1). Deployment numbers have increased even in a climate of declining incentive. As such, 23 new fuel cell projects were accepted into the SGIP between the second quarter of 2013 and the fourth quarter of 2013 for a proposed capacity of 10 MW. To date, 75% of the fuel cell projects are completed and 11% of fuel cell projects have qualified for performance-based incentives, which were implemented in 2011.

The average unit costs in the SGIP are significantly higher than the DOE target of $1,500/kW. The overall average unit cost is $10,189/kW without incentives and $6,722/kW with incentives. The average range, when differentiating by capacities (0-50 kW, 51-200 kW, 201-400 kW, 401+ kW), is $9,524-$10,932/kW without incentives and $5,587-$8,299/kW with incentives. Generally, larger projects (those with larger capacities) have lower unit costs and also receive more incentives (Figure 2), but very few SGIP projects meet the DOE target costs.

This year the NFCTEC has also begun collecting operations data from several sites. Submission is voluntary and the data is limited. The mean availability of the systems analyzed was 93%, with almost 65% of systems showing more than 90% availability (Figure 3). This is less than the DOE target for commercial stationary power of 97%, but it is showing high availability of systems with the limited data. The systems had a mean electrical efficiency of 27% based on the higher heating value of hydrogen, with more than 65% having 25%-35% electrical efficiency based on the higher heating value of hydrogen (Figure 4). This converts to a mean of 32% based on lower heating value and about 65% of systems having 30%-41% lower heating value electrical efficiency. This is lower than the 2015 DOE target of 43% lower heating value for electrical efficiency for commercial systems. However, the data is limited and covers multiple fuel cell capacity ranges, across several stationary applications, and is not steady-state data. These factors contribute to the lower electrical efficiencies seen.

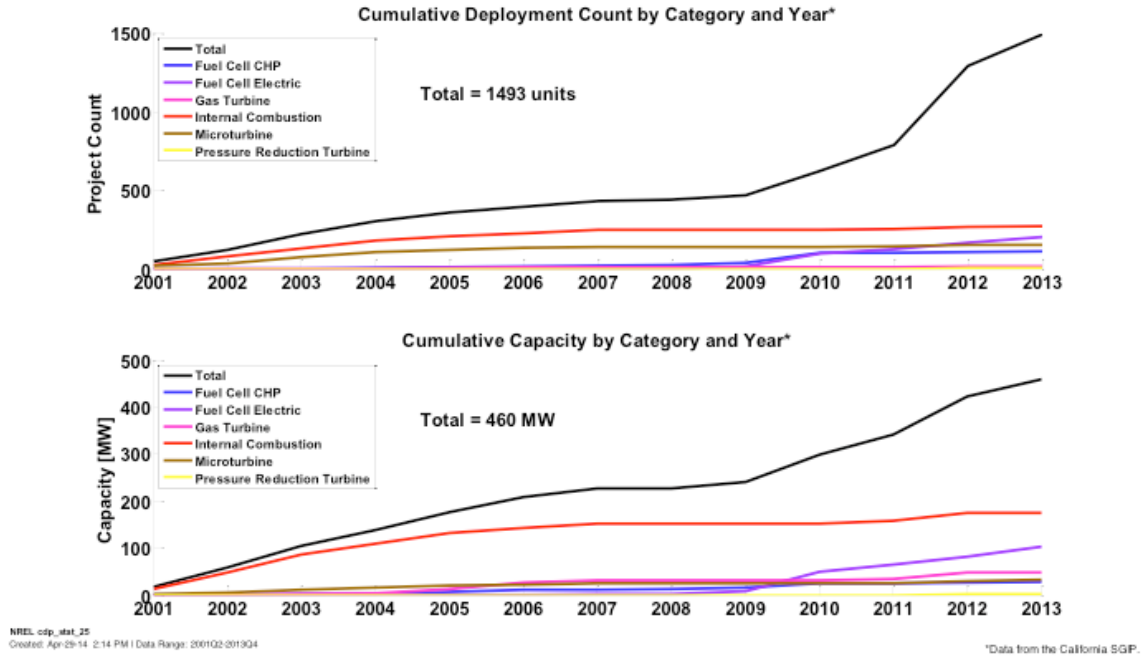

FIGURE 1. Cumulative Deployment of Fuel Cells Versus Competing Technologies

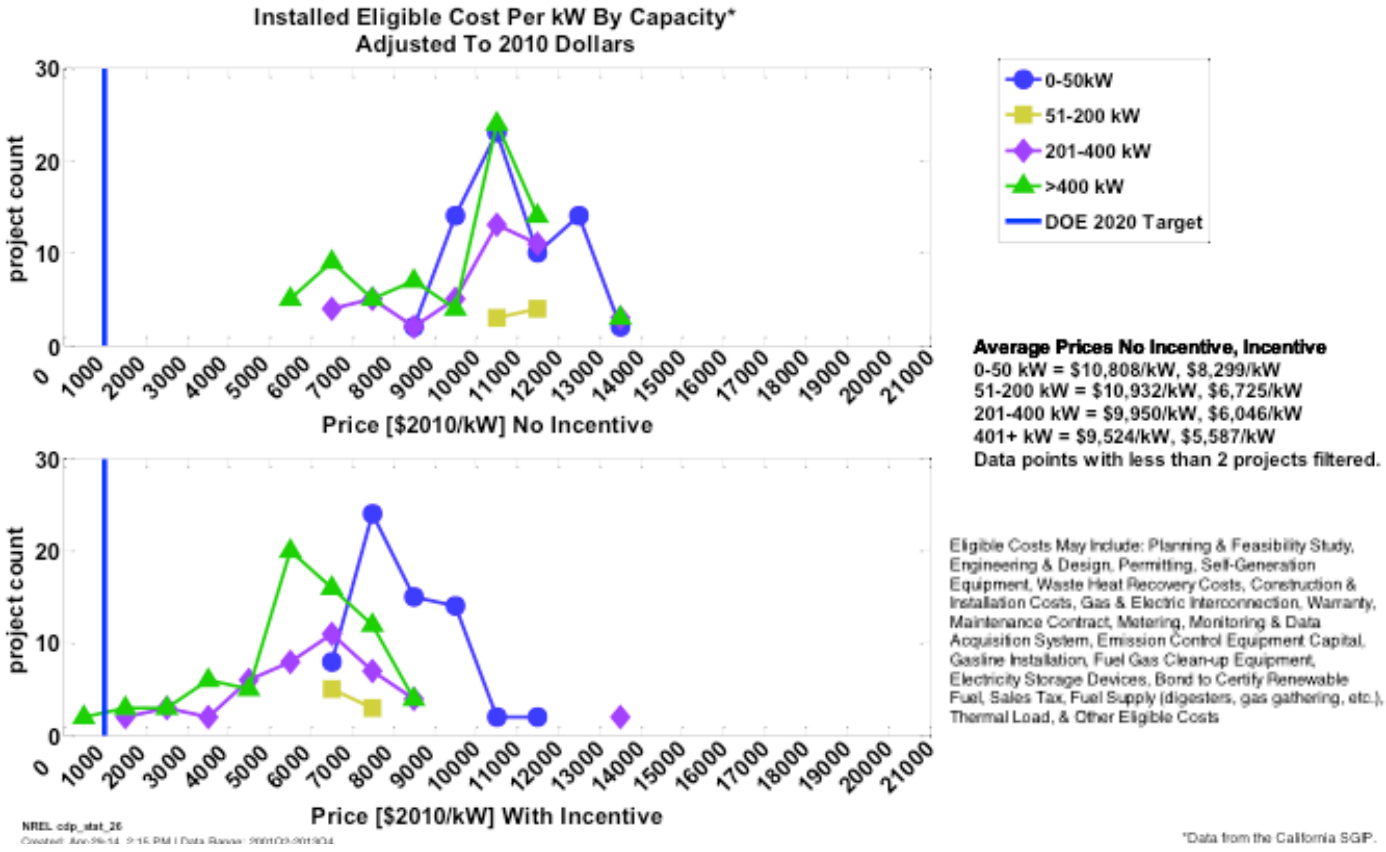

FIGURE 2. Eligible Installed Fuel Cell Unit Costs by Capacity

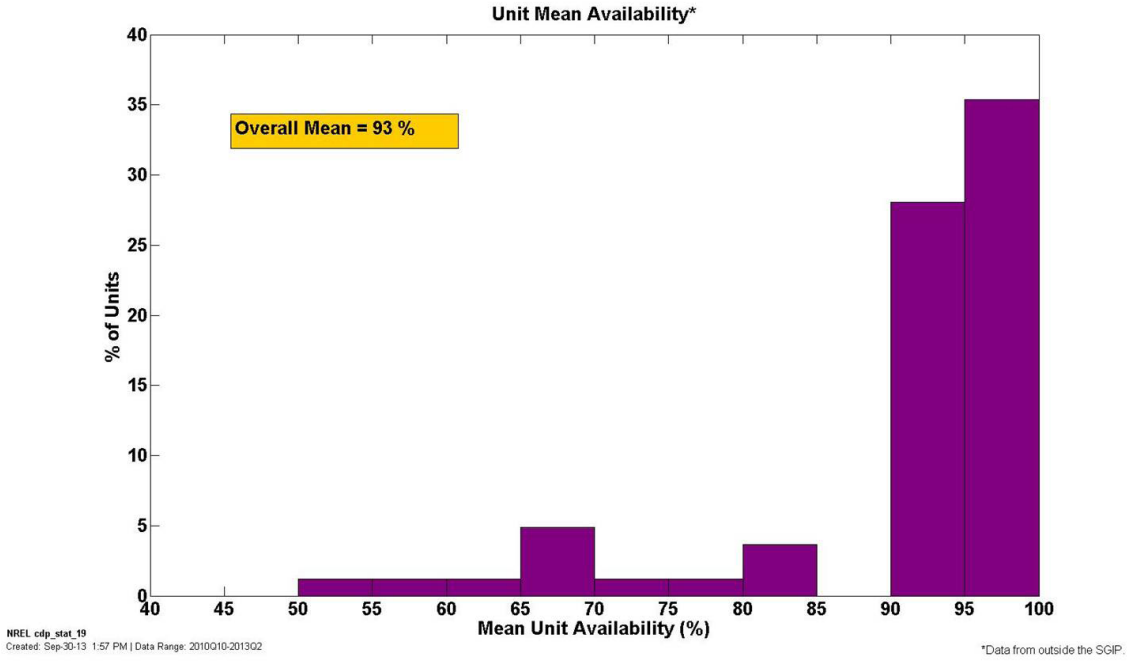

FIGURE 3. Stationary Fuel Cell Availability

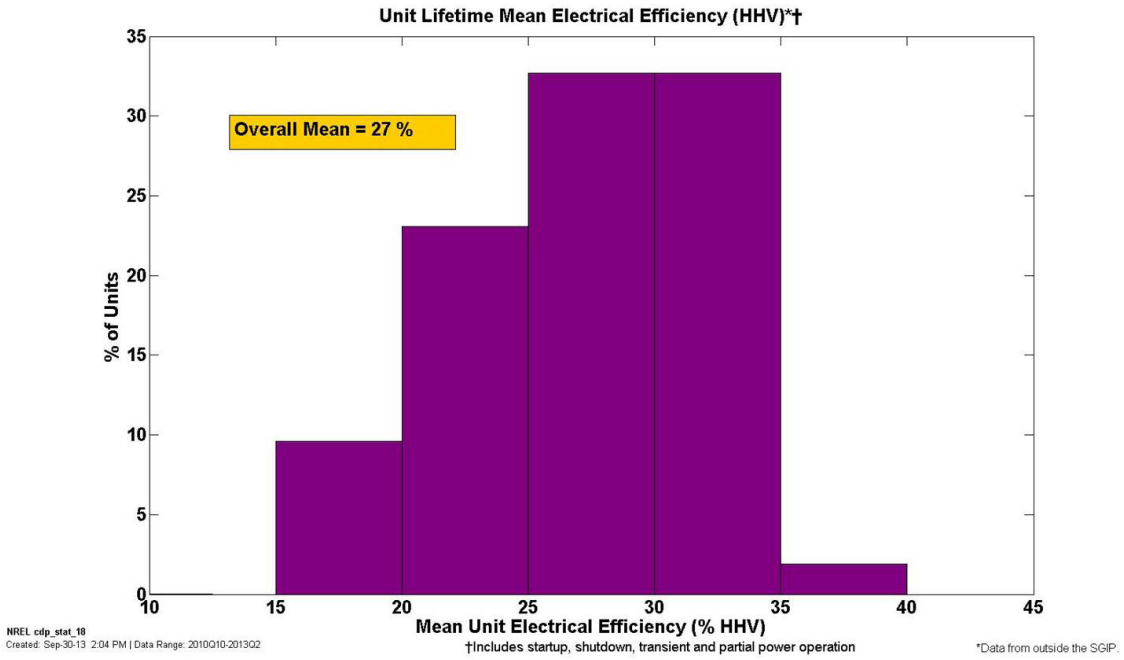

FIGURE 4. Stationary Fuel Cell Electrical Efficiency

Operations data continues to be collected for future iterations of the CDPs.

A total of 25 deployment CDPs have been published using California SGIP data as well as three new operations CDPs covering stoppages, availability, and electrical efficiency. All CDPs are available at http://www.nrel.gov/hydrogen/proj_fc_systems_analysis.html.

CONCLUSIONS AND FUTURE DIRECTIONS

The California SGIP has been very successful in installing fuel cell systems. In recent years, fuel cell projects have been installed in greater numbers than other competing technologies, despite generally higher installed costs and decreasing incentive spending. This early-market rollout is important for the stationary fuel cell industry in terms of real-world experience, especially as the SGIP program is slated to end January 1, 2016.

Operations data has been limited, but the NFCTEC is exploring more avenues to validate DOE performance targets.

Activities for the remainder of FY 2014 will include the following:

- FY 2014 Q4: Update all CDPs with current data from the SGIP and voluntary operations data submissions.
- Expand analysis to include new CDPs that address further segmentation of the data (CHP/non-CHP, competing technologies, fuel sources) and trends over time.
- Look into other data partners (state and federal programs, original equipment manufacturers) for additional data relevant to DOE targets.

FY 2014 PUBLICATIONS/PRESENTATIONS

1. Saur, G., Kurtz, J., Ainscough, C., Peters, M. "TV016: Stationary Fuel Cell Evaluation." Annual Merit Review meeting, Washington, DC, June 2014. (presentation)

2. Saur, G., Kurtz, J., Ainscough, C., Peters, M. "Stationary Fuel Cell System Composite Data Products: Data through Quarter 4 of 2013." Golden, CO: National Renewable Energy Laboratory, published May 2014. (report)

3. Ainscough, C., Saur, G. "VII.2 Stationary Fuel Cell Evaluation." DOE FY13 Annual Merit Review Proceedings, Washington, DC, published December 2013. (report)

4. Ainscough, C., Kurtz, J., Peters, M., Saur, G. "Stationary Fuel Cell System Composite Data Products: Data through Quarter 2 of 2013." Golden, CO: National Renewable Energy Laboratory, published November 2013. (report)

5. Wipke, K. "Evaluation of Stationary Fuel Cell Deployments, Costs, and Fuels." Fuel Cell Seminar, published October 2013. (presentation)