VII.2 Stationary Fuel Cell Evaluation

Chris Ainscough (Primary Contact), Genevieve Saur
National Renewable Energy Laboratory (NREL)
15013 Denver West Pkwy
Golden, CO 80401
Phone: (720) 431-7296
Email: chris.ainscough@nrel.gov

DOE Manager
Jason Marcinkoski
Phone: (202) 586-7466
Email: Jason.Marcinkoski@ee.doe.gov

Project Start Date: October 1, 2011
Project End Date: Project continuation and direction determined annually by DOE

Overall Objectives

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

Fiscal Year (FY) 2013 Objectives

- Quarterly analysis of available data in the NREL Hydrogen Secure Data Center (HSDC)
- Publication of eleven composite data products (CDPs)
- Update of a public website for disseminating the CDPs

Technical Barriers

This project addresses the following technical barrier 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

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 combined heat and power (CHP) 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 2013 Accomplishments

- This project published an initial set of CDPs in October 2012
- This project published an updated, expanded set of CDPs in March 2013
- This project completed the publication of a website to help disseminate the above results in November 2012, http://www.nrel.gov/hydrogen/proj_fc_systems_analysis.html (Figure 1)
- Published a report, "Stationary Fuel Cell Deployments in California: Interim Technology Status, Deployments and Eligible Incentive Costs

✧ ✧ ✧ ✧ ✧

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 project directly working on technical barrier (B): Lack of Data on Stationary Fuel Cells in Real-World Operation.

FIGURE 1. A screenshot of the website where all CDPs for stationary fuel cells can be seen and disseminated to stakeholders.

APPROACH

The project's data collection plan builds on other technology validation activities. Data (operation, maintenance, and safety) are collected onsite 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 HSDC.

The HSDC 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 249 fuel cell systems, for a total of 97 MW, since 2001. These fuel cell deployments have shown that they may be applied to a wide variety of fuels, including renewable biogases from landfill, biomass and digester sources. Deployment numbers have increased even in a climate of declining incentive spending. However, current fuel cell installation costs are significantly higher than the 2020 DOE target; ~$10,000/kW compared to a DOE target of $1,500 (running on natural gas), Figure 2.

Throughout the 12 year history of California's SGIP, nearly 250 fuel cell units have been deployed, accounting for almost 100 MW of installed electrical capacity. The progression of the deployments (count and capacity) can be seen in detail in Figure 3. Deployment activities were relatively slow until the 2010 program year when a sharp increase took place. The number of deployments in 2010 (145) was greater than the number that had been deployed in all the prior years combined (55). This spike was partially fueled by the arrival of a new supplier.

Looking at the deployment trends of fuels over the span of the program's history (Figure 4), we see the greatest diversity of fuels in the 2009 and 2010 program years.

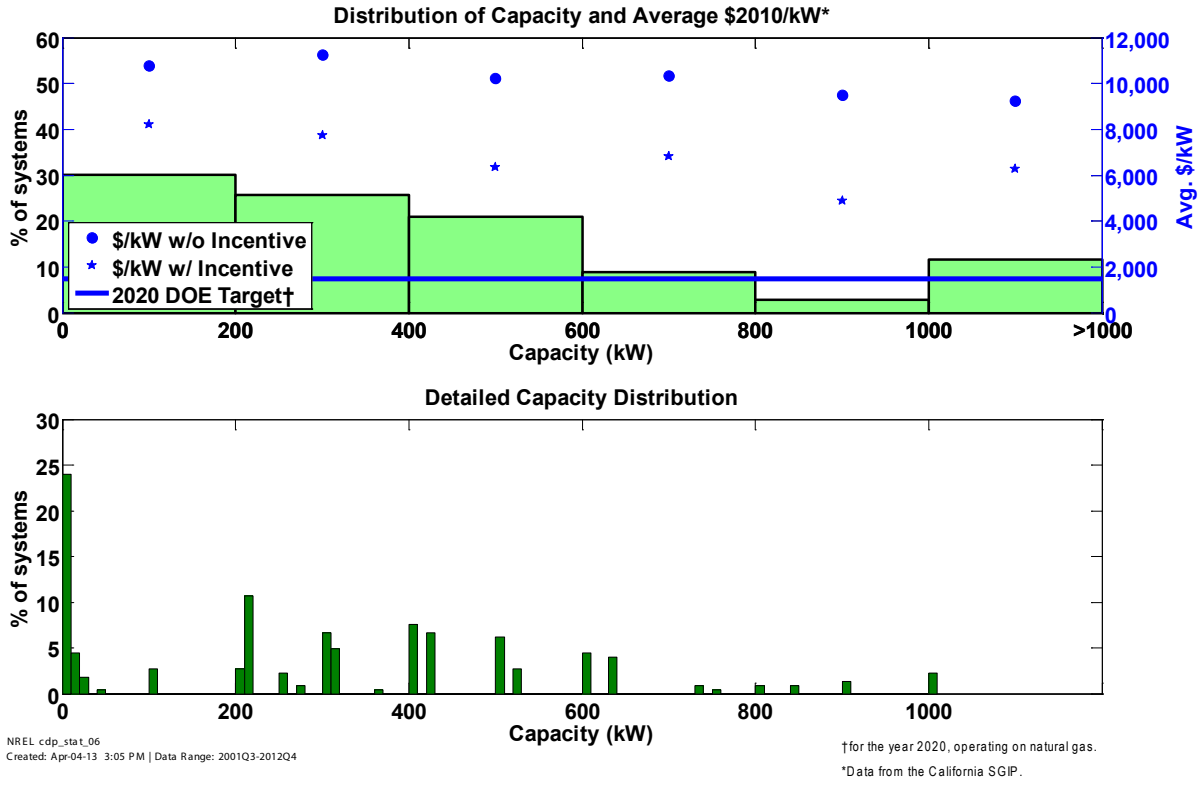

FIGURE 2. Distribution of capacity and average $/kW, relative to DOE 2020 targets running on natural gas.

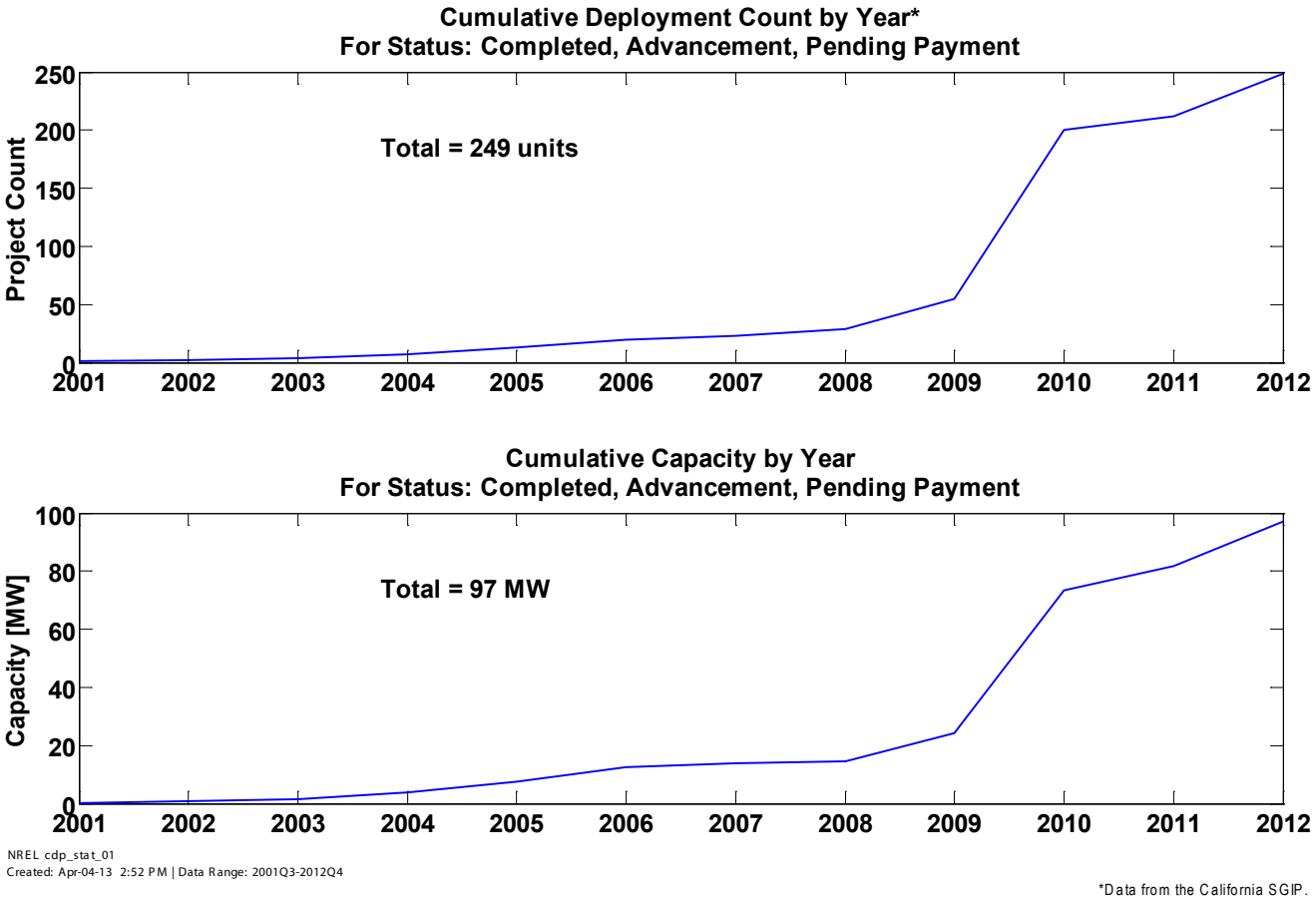

FIGURE 3. Total SGIP deployment count and kWh of installed capacity 2001-2012.

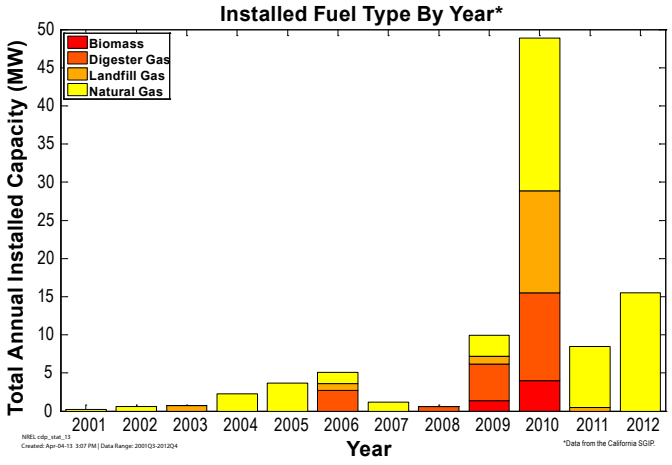

FIGURE 4. Installed fuel type by year which shows the recent domination of the market by natural gas installations.

During the 2009 program year, the incentive level for fuel cells operating on renewable fuels (biogas) was $4.5/W1, or 17% higher than the 2013 program year. Additionally, the fuel source was only required to be available for five years in 2009, as opposed to ten in 2013, and out-of-state directed biogas was not expressly forbidden. These reductions in the attractiveness of incentives, technical challenges related to reforming biogas, as well as the low cost of natural gas may contribute to the fact that from 2011 on, most systems are powered by natural gas, with all systems in 2012 falling into that category.

CONCLUSIONS AND FUTURE DIRECTIONS

Stationary fuel cells have seen wide deployments in the state of California sponsored in part by the SGIP. This program has deployed systems from 5 kW up to 2,800 kW in a variety of applications, using at least one system from each of the common commercially available fuel cell chemistries such as polymer electrolyte membrane, solid oxide, molten carbonate, phosphoric acid, and phosphoric acid doped polybenzimidazole (aka high-temperature polymer electrolyte membrane).

Despite the numbers deployed, total installed costs eligible for incentive dollars continue to rise in recent years, moving away from 2020 DOE targets, which they are already far from meeting. The causes of this trend are as yet unknown, and require further investigation.

Incentive spending by SGIP will continue to decline for fuel cells in the coming years. The effect that will have on deployments is uncertain, as the largest gains in total deployments have happened in the last five years, in a regime of declining incentives. It will be important to continue to analyze trends in California's SGIP as an indicator of larger national trends in the coming years and performance status as data are available.

For future work, this project aims to develop additional data sets to that available from SGIP, and continuing the regular cadence of results publication.

FY 2013 PUBLICATIONS/PRESENTATIONS.

1. Stationary Fuel Cell Evaluation, Annual Merit Review, Washington, D.C. May 2013.