
VII.B.3 Performance Evaluation of Delivered Hydrogen Fueling Stations

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Project End Date: April 30, 2018

Technologies Office Multi-Year Research, Development, and Demonstration Plan.

- (A) Lack of Fuel Cell Electric Vehicle and Fuel Cell Bus Performance and Durability Data
- (D) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

Contribution to Achievement of DOE Technology Validation Milestones

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

- Milestone 3.2: Validate novel hydrogen compression technologies or systems capable of >200 kg/d that could lead to more cost-effective and scalable (up to 500 kg/d) fueling station solutions for motive applications. The stations currently being constructed will incorporate Linde's patented ionic fluid compressor. This technology utilizes a liquid piston to compress gas rather than a diaphragm or metal piston used in conventional compressor technologies. Linde is optimistic that this technology can be cost effectively scaled to larger capacity stations in the future.
- Milestone 3.4: Validate station compression technology provided by the delivery team. See Milestone 3.2
- Milestone 3.8: Validate reduction of cost of transporting hydrogen from central production to refueling sites to <\$0.90/gge. This project will yield data directly aiding to develop baseline benchmarking and measure improved cost of delivery of liquid hydrogen to fueling stations in California.
- Milestone 4.4: Complete evaluation of 700-bar fast fill fueling stations and compare to SAE J2601 specifications and DOE fueling targets. This project will supply data to the National Fuel Cell Technology Evaluation Center that aid the program in the characterization of the stations' storage and delivery capacities, compression performance, fueling transactional data, operational cost, maintenance, and safety. Data supplied will provide points of direct comparison to SAE fueling standards and DOE fueling targets.

Overall Objectives

- Integrate non-intrusive data collection systems at five 100 kg/d delivered liquid hydrogen fueling stations located in California for a 24-month performance period.
- Submit complete sets of the National Renewable Energy Laboratory (NREL) Hydrogen Station Data Templates to National Fuel Cell Technology Evaluation Center.
- Provide useful data to accurately benchmark and characterize station capacity, utilization, maintenance, and safety.

Fiscal Year (FY) 2017 Objectives

- Installation and commissioning of the third and fourth systems in new Linde hydrogen fueling stations in San Ramon, California, and Mountain View, California.
- Produce the complete sets of data for the all active sites at the end of each quarter after startup and commissioning is completed.
- Monitor progress on final (fifth) planned hydrogen fueling station to ensure data acquisition systems are prepared for installation.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Fuel Cell

FY 2017 Accomplishments

- Completed installation of the GTI-designed data acquisition system at the San Ramon station. Station

opening is imminent; data collection to begin once open to public.

- Data submitted to NREL each quarter for West Sacramento and San Juan Capistrano stations.
- All equipment ordered and assembled for installation at the fourth station, Mountain View. The Mountain View station began construction in June 2017 and plans on commissioning by end of the year.



INTRODUCTION

The objective of this project is to collect, organize, and report on operational, transactional, safety, and reliability data for five hydrogen fueling stations located in California. Goals of the project are as follows. (1) The data collected will be statistically meaningful and the stations will have sufficient throughput and vehicle fueling frequency to minimize data aberrations. (2) The data collected will be accurate. (3) The data collected will be comprehensive and timely.

This project will directly assist DOE in assessing the readiness level of current infrastructure and state-of-the-art technologies utilized to support planned fuel cell vehicle deployment within the next five years. The data and observations collected during the performance period of this project will provide NREL with information detailing the operational costs, efficiencies, and reliability of the delivered hydrogen fueling station design. Furthermore, the Linde design utilizes the patented IC90 ionic fluid compressor package; through this project GTI will provide the performance data which will enable DOE and original equipment manufacturer to evaluate real world efficiencies further gauging the technology's adequacy in this application. This system is a first of its kind utilized for hydrogen fueling applications in the United States.

APPROACH

Hydrogen station data will be submitted quarterly to the National Fuel Cell Technology Evaluation Center at NREL using the appropriate Hydrogen Station Data Templates. GTI's project partner, Linde, is currently developing delivered hydrogen fueling stations under programs sponsored by the California Energy Commission. The sites will be accessible to the public for fueling consumer fuel cell vehicles, commercial vehicles, or government-owned vehicles. All five of the sites will be developed at existing or at new sites along with conventional gasoline stations operated by major, branded fuel providers. This provides the project with vehicle fueling data from a broad cross-section of real world vehicle applications. The station sites were selected to provide convenient, consumer-friendly

vehicle fueling for drivers of fuel cell vehicles. Development of each of these stations has the support of vehicle original equipment manufacturers and each site has passed stringent location selection requirements of the California Energy Commission to ensure the stations will be utilized by a high volume of fuel cell vehicle operators.

The data collection system will utilize a variety of methods in order to provide the entire data requirements set forth by NREL. This system will utilize the existing control architecture of the compressor and dispenser equipment as well as monitor and record signals from a set of installed instrumentation that will supplement information required that is not already captured inherently by the stations' operating system. There are multiple descriptive (opposed to measured data) deliverables that will be taken manually and submitted to GTI for processing and formatting prior to delivery to NREL. Manually collected data templates include:

- NREL Site Log: recording safety drills, training, or public meetings
- Storage and Delivery: compiling liquid hydrogen supplies delivery quantities and cost
- Fuel Log: transferring transactional data from monthly reports emanating from fuel management system
- Maintenance: station maintenance and operations reporting
- Hydrogen Cost: Collection of utility bills
- Safety: station environmental, health, and safety reporting
- Hydrogen Quality: SAE quality analysis completed annually and submitted

GTI will collaborate with Linde and create a reporting/submittal process to collect this type of data required to populate the NREL templates.

RESULTS

Installation of the San Ramon station was slow this year, partly due to the station being a green-field site, and not an addition to an existing gasoline station like other sites. The GTI data acquisition system has been installed and commissioned at the station. The San Ramon site will open for public use in the very near future and data collection will begin as soon as the station is open. Data collection continues for the two operational sites in West Sacramento and San Juan Capistrano. Figures 1 and 2 show the quarterly (Q) dispensed hydrogen data collected from these sites. The utilization of both of these sites has increased substantially over the past year. This is just a small subset of the large amount of data that is being reported to NREL each quarter. Other data collected includes the energy used in compression

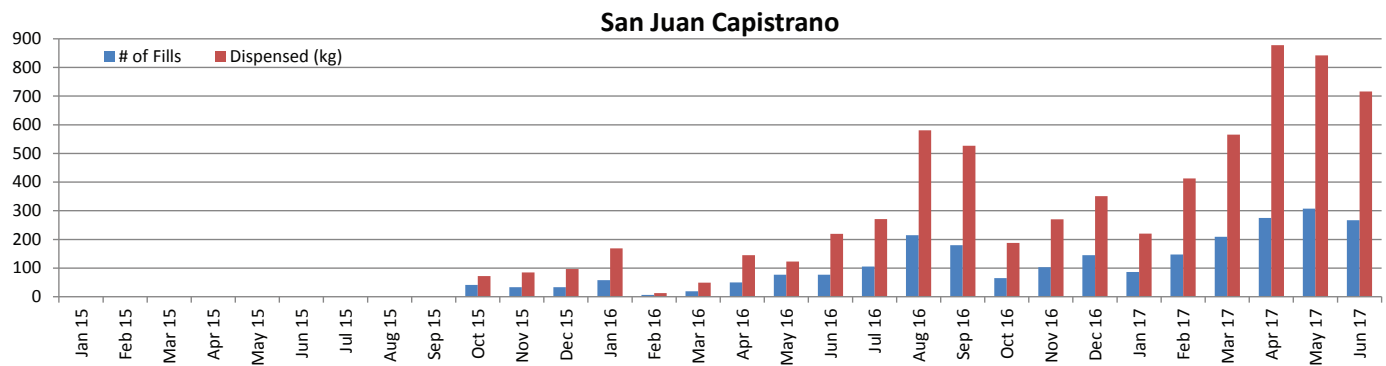


FIGURE 1. West Sacramento usage data

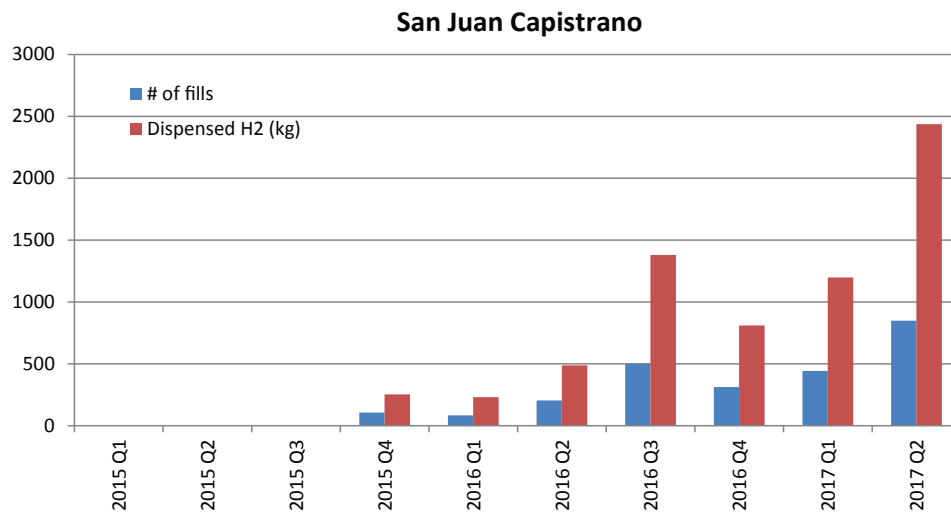


FIGURE 2. San Juan Capistrano usage data

and precooling of the hydrogen, maintenance and safety logs, and hydrogen control quality results.

The West Sacramento station was completed and commissioned in December 2014. The data collection portion of this project has continued and ten quarters of data have been collected from the site and submitted to NREL. The San Juan Capistrano station was completed and commissioned in September 2015. The data collection portion of this project has continued and seven quarters of data have been collected from the site and submitted to NREL. The Mountain View station began construction June 2017. Installation of the GTI panel will likely occur in September or October of this year. The GTI-supplied hydrogen gas flow meter for the system (longest lead item) has been delivered to the Linde staging area for integration into the compressor skid prior to the skid being installed at the site. The GTI data logger panel was assembled in early 2017 and is ready for installation whenever site construction progress allows. Lastly, progress continues to be made on the installation of the final station. A site has been proposed and is expected to be confirmed very

shortly. The major equipment for each site has already been built and is awaiting installation.

CONCLUSIONS AND UPCOMING ACTIVITIES

- Begin data collection at San Ramon station.
- Complete panel installation and commissioning at Mountain View site.
- Produce the complete sets of data for all active sites at the end of each quarter.
- Continue monitoring progress on final station site. Begin engineering review of site once documents are available.

FY 2017 PUBLICATIONS/PRESENTATIONS

1. “tv025_barnes_2017_p.pptx” – Poster Presentation 2017 AMR.