VII.7 Fuel Cell Electric Vehicle Evaluation

Jennifer Kurtz (Primary Contact), Sam Sprik, and Mike Peters

National Renewable Energy Laboratory (NREL)
15013 Denver West Parkway
Golden, CO 80401-3305
Phone: (303) 275-4061
Email: Jennifer.Kurtz@nrel.gov

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

Project Start Date: October 2012
Project End Date: Project continuation and direction determined annually by DOE

Overall Objectives

- Validate hydrogen fuel cell electric vehicles (FCEVs) in a real-world setting
- Identify current status and evolution of the technology

Fiscal Year (FY) 2014 Objectives

- Complete the first round of processing and analyses of data from all six FCEV original equipment manufacturers (OEMs)
- Identify the first three composite data products (CDPs) for the first publication
- Submit the first CDP set for initial review by the OEM partners
- Conduct reviews of the individual data analyses with the OEMs

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:

(A) Lack of Fuel Cell Electric Vehicle and Fuel Cell Bus Performance and Durability Data

Contribution to Achievement of DOE Technology Validation Milestones

This project contributes to the 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 2.3: Validate fuel cell electric vehicles achieving 5,000-hour durability (service life of vehicle) and a driving range of 300 miles between fuelings (4Q, 2019)

FY 2014 Accomplishments

- Completed processing and analyses for data from five out of six OEM partners; the topics included fuel economy, range, voltage degradation, driving behavior, and fueling behavior.
- Analyzed more than 26,000 files in calendar year 2013.
- Rebranded the Hydrogen Secure Data Center to the National Fuel Cell Technology Evaluation Center (NFCTEC).
- Conducted site visits with all six OEM partners.
- Finalized data collection and analysis plans.

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INTRODUCTION

Under FOA-625, the U.S. Department of Energy has funded projects for the collection and delivery of FCEV data to NREL for analysis, aggregation, and reporting. Multiple real-world sites and customers are included in this FCEV demonstration project. This activity addresses the lack of on-road FCEV data and seeks to validate improved performance and longer durability from comprehensive sets of early FCEVs, including first-production vehicles. NREL's objective in this project is to support DOE in the technical validation of hydrogen FCEVs under real-world conditions. This is accomplished through evaluating and analyzing data from the FCEVs to identify the current status of the technology, compare it to DOE program targets, and assist in evaluating progress between multiple generations of technology, some of which will include commercial FCEVs for the first time.

The project includes six OEMs: General Motors, Mercedes-Benz, Hyundai, Nissan, Toyota, and Honda. The latter three OEMs are part of one award managed by Electricore. Up to 90 vehicles are expected to supply data over potentially two phases, with particular attention on fuel cell stack durability and efficiency, vehicle range and fuel economy, driving behavior, maintenance, on-board storage, refueling, and safety.

APPROACH

The project's data collection plan builds on other technology validation activities. Operation, maintenance, and safety data for fuel cell system(s) and accompanying infrastructure are collected on site by project partners. NREL receives the data quarterly and stores, processes, and analyzes the data in NREL's NFCTEC. The NFCTEC is an off-network room with access provided to 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. Publications are uploaded to NREL's technology validation website [1] and presented at industry-relevant conferences. 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 and thousands of data records. A review cycle is completed before the CDPs are published. This review cycle includes providing detailed data products (DDPs) of individual system- and site-performance results to the specific data provider. DDPs also identify the individual contribution to the CDPs. The NREL Fleet Analysis Toolkit (NRELFAT) 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

The FY 2014 activities focused on integrating new OEM data into NRELFAT for processing and analyses. The analyses are built around the following topics: durability, deployment, operation, system specifications, range, fuel economy, efficiency, fill performance, reliability, drive and fill behaviors, power and energy management, transients, and benchmarking. Site visits were completed with all OEM partners and the frequency of data delivery has moved from start-up to regular.

In calendar year 2013 (Figure 1), more than 26,000 trip data files were analyzed. These data sets have been aggregated twice for internal NFCTEC review of the bulk performance data and in preparation of the first publication of CDPs in the fall of 2014. The cumulative data file size is nearly 5.5 GB. Because not all of the partners have supplied data and per NFCTEC process, the details of these analyses have not yet been published. Individual results have been reviewed at least once with the partners that have supplied data. In lieu of published results, Figure 2 is included as a snapshot of the processing user interface of NRELFAT for a fake partner called EcoCar. This interface includes the different processing options (right hand check boxes), archiving to store each data delivery and analysis cycle, and CDP setup and processing. Data from all six partners are expected to be integrated and working within NRELFAT by the end of FY 2014.
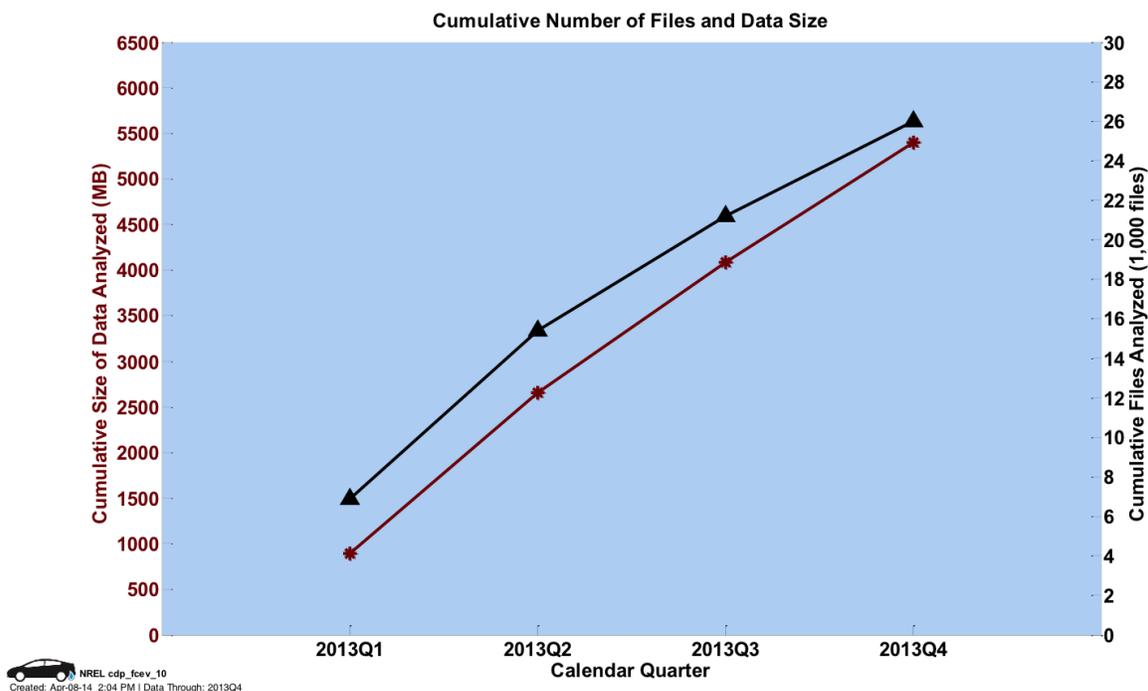

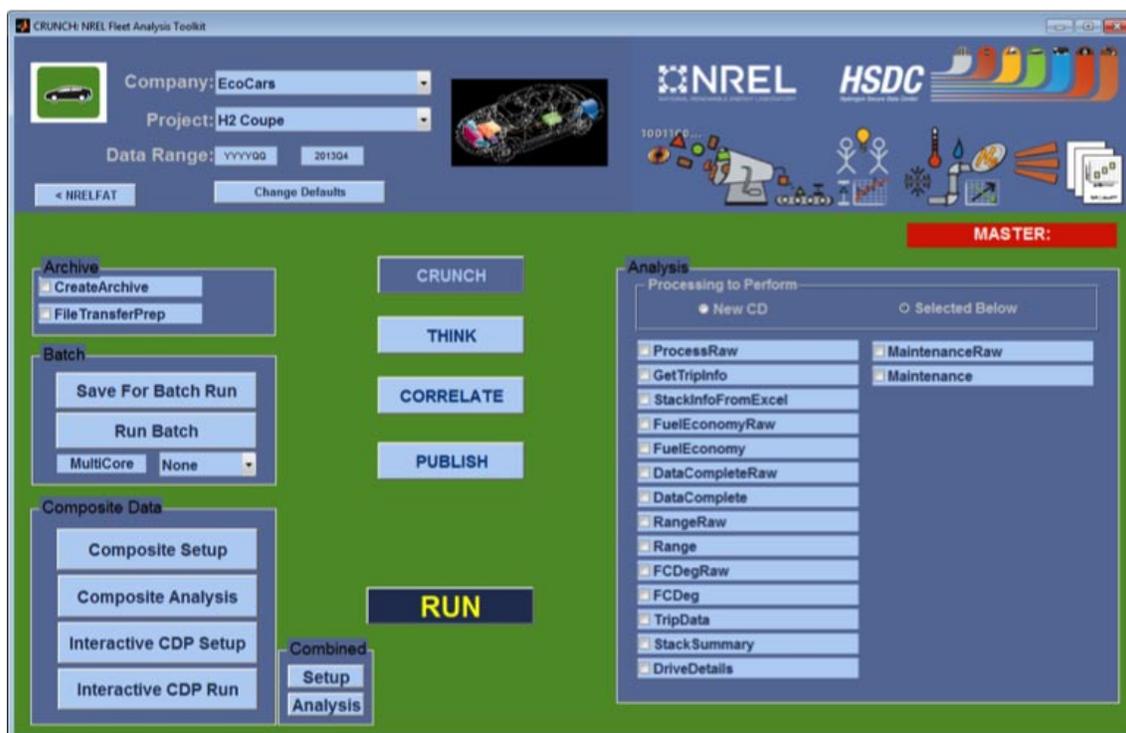**FIGURE 1.** FCEV Data File Count and Size Analyzed in 2013 by NFCTEC

FIGURE 2. NRELFAT Crunch NFCTEC User Interface for Example of Data Processed

NREL supported project kick-off and one-on-one meetings to gain consensus on the methods for data transfer and the steps for building and maintaining trust, such as test data transfers and review process and schedule.

The architectures for fuel cell hours, vehicle miles, calendar time between fills, distance between fills, and fuel economy CDPs were created. CDPs were created with fake data for the purpose of discussion prior to publication (Figure 3).

CONCLUSIONS AND FUTURE DIRECTIONS

- NREL has received and processed initial data from five out of six OEMs. The remaining OEM is expected to deliver the first data by August.

- The regular CDP publication schedule is anticipated to begin in the fall of 2014.

FY 2014 PUBLICATIONS/PRESENTATIONS

1. Kurtz, J.; Sprik, S.; Peters, M. "Fuel Cell Electric Vehicle Evaluation." 2014 DOE Hydrogen and Fuel Cells Program and Vehicle Technologies Office Annual Merit Review and Peer Evaluation Meeting, June 2014. (poster presentation)

2. Kurtz, J., Sprik, S. "National Fuel Cell Technology Evaluation Center." DOE webinar, March 11, 2014. (presentation)

3. Kurtz, J.; Sprik, S.; Wipke, K.; Saur, G. "Technology Validation of Fuel Cell Vehicles and Their Hydrogen Infrastructure." 2013 Fuel Cell Seminar, October 2013. (presentation)

REFERENCES

1. "Fuel Cell and Hydrogen Technology Validation." Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/hydrogen/proj_tech_validation.html.
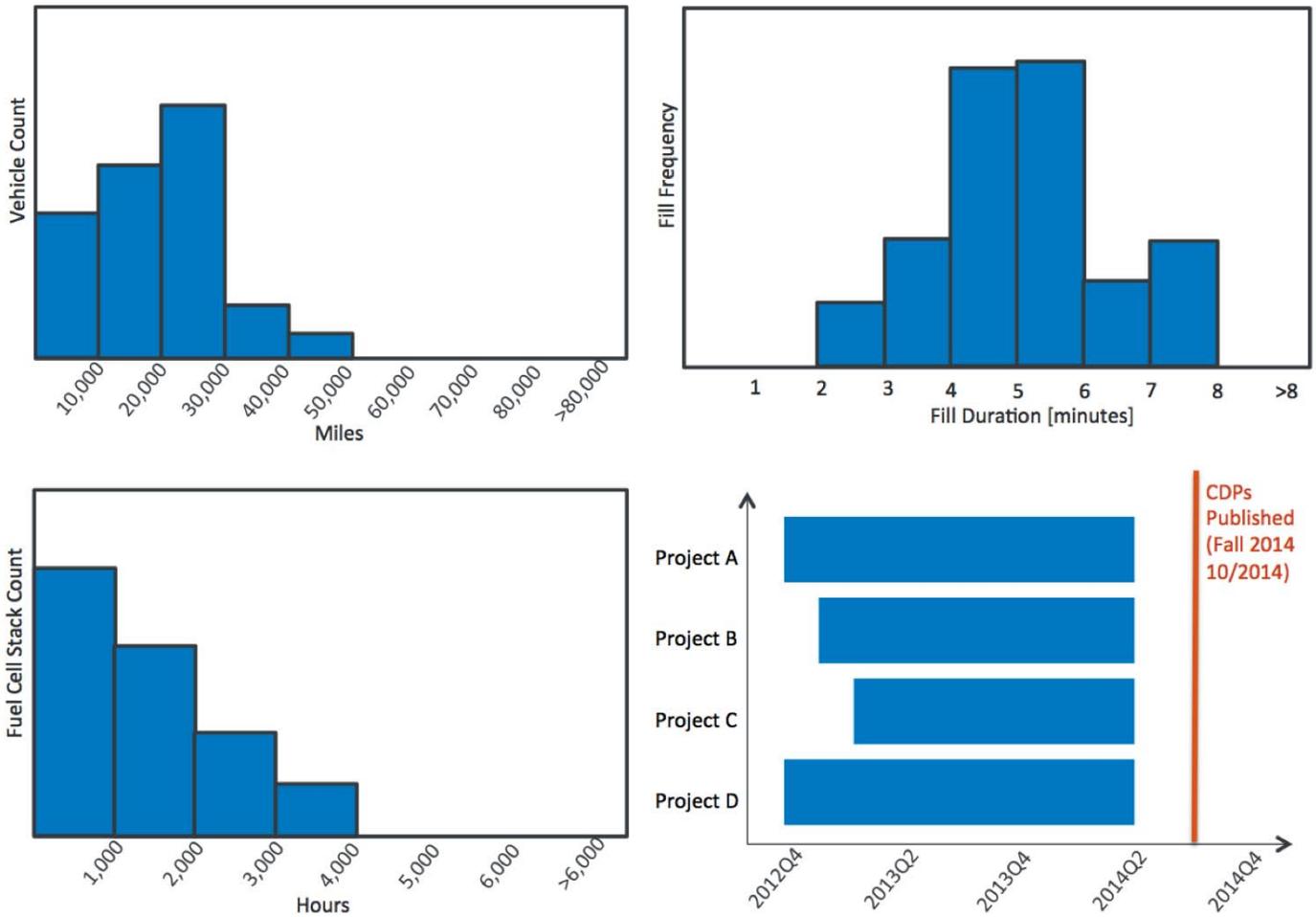
FIGURE 3. Fake CDP Examples for Metadata (e.g., start date), Fuel Cell Stack Hours, Vehicle Miles, and Calendar Days between Fills