XI.6 Employment Impacts of Infrastructure Development for Hydrogen and Fuel Cell Technologies

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Subcontractor:
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Project Start Date: October 2010
Project End Date: Project continuation and direction determined annually by DOE

Overall Objectives

- Facilitate early market deployment of fuel cells by developing a downloadable, user-friendly tool to estimate economic impacts.
- Identify opportunities for enhancing the economic impact of fuel cell production and deployment by better understanding where and how impacts occur and how infrastructure deployment produces economic benefits in addition to facilitating fuel cell market success.
- Meet stakeholder needs for estimating impacts of fuel cell and infrastructure deployment on state, regional, and national employment, earnings, and economic output.

Fiscal Year (FY) 2013 Objectives

- Quantify employment impacts of fuel cell deployment under the American Recovery and Reinvestment Act (ARRA).
- Update and validate the JOBS and economic impacts of Fuel Cells (JOBS FC) model.
- Initiate work to understand the effect of infrastructure development on job creation.

Technical Barriers

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

(B) Stove-piped/Siloed Analytical Capability

(C) Inconsistent Data, Assumptions and Guidelines

(D) Insufficient Suite of Models and Tools

Contribution to Achievement of DOE Systems Analysis Milestones

- 1.7: Complete analysis of job impact for fuel cell growth in material handling equipment sector through 2020. (4Q, 2013)
- 1.10: Complete analysis of job impact for fuel cell growth in distributed power generation sector through 2020. (4Q, 2014)
- 1.14: Complete analysis of the job impact from fuel cell growth in stationary power generation sector through 2020. (4Q, 2015)
- 2.2 Annual model update and validation. (4Q, 2011 through 4Q, 2020)
- 2.3: Complete development of job estimation model. (2Q, 2012)
- 2.4: Complete validation of job estimation model for material handling equipment sector. (4Q, 2013)
- 2.5: Complete validation of job estimation model for distributed fuel cell power generation. (4Q, 2014)
- 2.6: Complete validation of job estimation model for stationary fuel cell power generation. (4Q, 2015)

FY 2013 Accomplishments

- Continued close collaboration with stakeholders, fuel cell producers, and other researchers via a series of meetings, teleconferences, and webinars. Demonstrated beta versions of the JOBS FC model to this group to validate data and obtain feedback on desired functionality, granularity, and outputs. Added hydrogen producers to stakeholder group to gain further insight into infrastructure development cost, deployment, and other issues.
- Completed revisions to phosphoric acid fuel cells (PAFCs) and molten carbonate fuel cells (MCFCs), and launched version 1.1 of the JOBS FC model. That activity involved development of the following deliverables:
  - A user's guide.

  - A dedicated website for users to register and download the model and User's Guide.
  - A webinar introducing JOBS FC 1.1.
- Began initial design and development of JOBS and economic impacts of Hydrogen (JOBS H2) model.
- Analyzed the employment impacts of deploying proton exchange membrane (PEM) fuel cells in forklifts and for backup power applications with support from the ARRA. Issued a report documenting methodology and results.

INTRODUCTION

The project is developing and applying a computer model to estimate economic impacts of deploying fuel cells and associated infrastructure in early markets. Insights from the model will assist the Fuel Cell Technologies Office and its stakeholders in estimating employment and other economic impacts from DOE technology development and in identifying fuel cell markets and regions that are most likely to generate jobs and economic activity.

RESULTS

In FY 2011–2012, Argonne National Laboratory and RCF Economic and Financial Consulting designed and implemented a spreadsheet tool to calculate state, regional, and national economic impacts of fuel cell production, installation, and utilization in early markets (i.e., 2015–2020). Known as JOBS FC, that tool is a user-friendly, spreadsheet-based model. In FY 2013, an updated and expanded version of that tool, JOBS FC 1.1, was launched, and employment impacts associated with ARRA-funded fuel cell projects were examined using the same input-output methodology.

JOBS Model Development and Stakeholder Collaboration

A considerable portion of FY 2013 was devoted to enhancement and quality assurance of JOBS FC—including data validation, development of the user interface, and outreach. Supply chains were characterized using information from the literature, fuel cell suppliers, and stakeholders. Default values for fuel cell costs and operating parameters were obtained from these sources as well as through fundamental engineering design calculations.

Work also began on JOBS H2, a separate tool focusing specifically on hydrogen infrastructure. In its initial version, JOBS H2 estimates employment impacts associated with the deployment of hydrogen fueling stations for early markets. FY 2013 accomplishments include the formation of a stakeholder advisory group to guide model development, design of the conceptual model, and initial data collection.

For both JOBS models, the effect of fuel cell and hydrogen infrastructure deployment can be examined on any of 60 geographies—50 states, nine census regions, and the nation as a whole. The models estimate changes in employment, earnings, and economic output by adjusting the dollar flows among economic sectors within the relevant geography. As fuel cell systems (or H_2 infrastructure) are deployed, the purchases send dollars up the supply chain for PEM fuel cell, PAFC, or MCFC technologies or H_2 fuel as well as to the relevant supply chains for system integrators, installers, fuel suppliers, and businesses providing operation and maintenance services. These incremental purchases flow to other sectors which represent purchases from their supply chains. In the aggregate, the resulting web of transactions represents a nascent fuel cell industrial sector. Purchases include not only the fuel cell (or hydrogen) itself, but all transactions required to install, fuel, and operate the fuel cell system, as well as to build a facility to manufacture the fuel cell. To illustrate, a set of base or "reference scenarios" have been postulated and used to generate an initial set of JOBS FC results. Results for the MCFC prime power reference scenario are shown in Figure 1.

Employment Impacts of ARRA-Funded Fuel Cell Projects

In FY 2013, a detailed analysis of the employment impact of the ARRA-funded fuel cell program was completed. Data on DOE and industry cost-share expenditures under the program for 2009–2012 (Table 1) were obtained and allocated to industrial sectors. Results are shown in Figures 2 and 3.

For forklift applications, the ARRA program created or retained approximately 350 job-years of employment, approximately 56% of which occurred in the fuel cell and

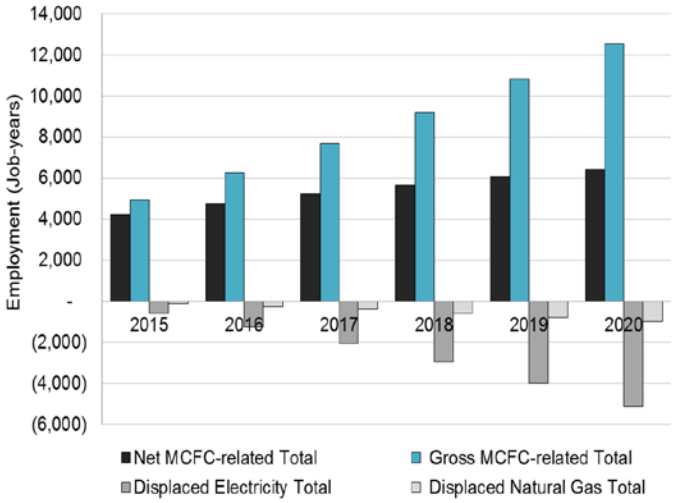

FIGURE 1. Gross and Net Employment Impacts of MCFC Fuel Cell Deployment under the Reference Case

TABLE 1. Expenditures under the ARRA-Supported Fuel Cells Program, 2009–2012

Expenditures (million $)	Forklift Projects	BUP Projects	Total
DOE	$9.7	$18.5	$28.2
Industry	$11.8	$30.8	$42.6
TOTAL	$21.5	$49.3	$70.8

BUP – Backup Power

infrastructure supply chain. The remainder, induced job-years, occurred from the ripple effect of re-spending in the economy by supply chain workers. Similarly, the ARRA program created or retained approximately 950 job-years of employment for backup power applications. Note that a job-year is one year of work by one person (e.g., 5 job-years can be 5 years of work by 1 person, 1 year of work by 5 persons or any person x year product equal to 5).

Note also that the estimates in Figures 2 and 3 do not include impacts from post-2012 fuel cell operation or from any (i.e., 2009–2012 plus post-2012) expenditures for hydrogen fuel. These expenditures are outside the scope of the ARRA program. In a separate analysis, impacts were estimated for these "out-of-scope" expenditures. The results suggest an additional 35 job-years per year are required to sustain fuel cell operation. Over five years, these activities result in over 150 additional job-years of impact associated with the ARRA-supported fuel cell program.

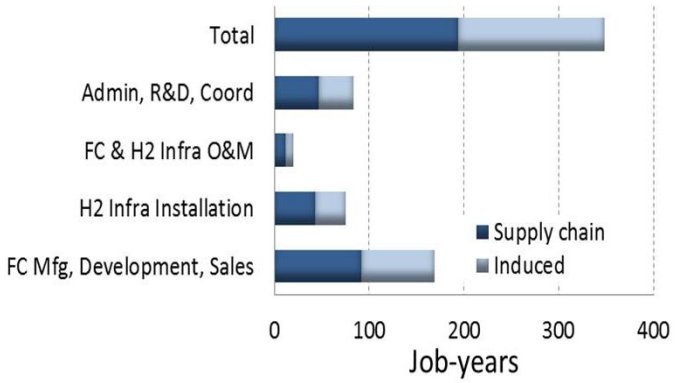

FIGURE 2. Domestic Employment from ARRA-Supported Deployment of Fuel Cells in Forklifts

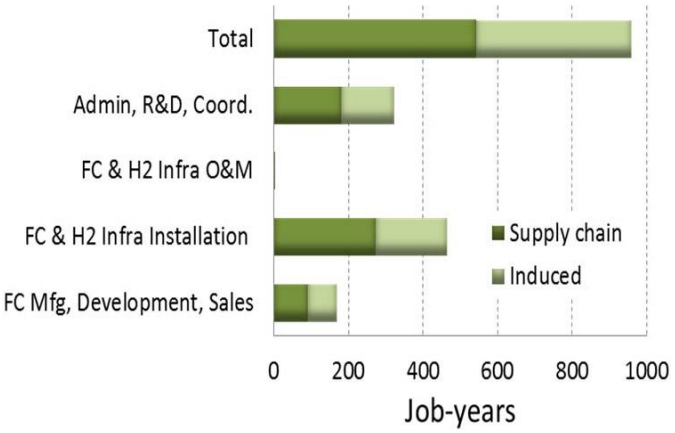

FIGURE 3. Domestic Employment from ARRA-Supported Deployment of Fuel Cells in Backup Power

CONCLUSIONS AND FUTURE DIRECTIONS

FY 2013 work focused on completion of the JOBS FC model, initial design and development of the JOBS H2 model, and analysis of the employment impact of the ARRA fuel cell program. Work on JOBS FC included outreach to industry and stakeholders to develop and validate input data and refine the user interface; model testing and quality assurance via a series of webinars, beta tests and sensitivity analyses; and model launch. Analysis of fuel cell deployments under the ARRA program produced a set of "top down" estimates based on total expenditures. FY 2014 work will build on these efforts, incorporating stakeholder recommendations for enhancements to the functionality and scope of both models, as well as developing estimates of employment impacts to support ongoing fuel cell deployment programs.

Potential future model enhancements include adding solid oxide fuel cell and high-temperature PEM technologies for prime power applications; distributed hydrogen production and biologically-derived hydrogen as options for fueling fuel cells in forklift, prime power, or vehicle applications; various options for delivering and dispensing hydrogen fuel to serve emerging vehicle markets; and analyzing the impacts of alternative hydrogen station rollout scenarios.

PUBLICATIONS

1. Mintz, M., C. Mertes, and E. Stewart, *Employment Impacts of Fuel Cell Deployment in Early Markets*, 92nd Annual Meeting of the Transportation Research Board, Washington, DC, January 16, 2013.

2. Mintz, M., J. Molburg, J. Gillette, C. Mertes, and E. Stewart, *JOBS FC 1.1 (JOBS and economic impacts of Fuel Cells)*, EERE webinar, December 12, 2012.

3. *JOBS and Economic Impacts of Fuel Cells (JOBS FC 1.1): User's Guide,* Argonne National Laboratory Report, ANL-12/24 Rev. 01, December 2012.

4. Mintz, M., J. Molburg, C. Mertes, and E. Stewart, *Employment Impacts of Early Markets for Fuel Cells: Initial Results of JOBS FC*, Fuel Cell Seminar and Exposition, Uncasville, CT, November 8, 2012.