XI.11 Employment Impacts of Early Markets for Hydrogen and Fuel Cell Technologies

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Subcontractor:
RCF Economic and Financial Consulting, Inc.

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

Fiscal Year (FY) 2012 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.
- Meet stakeholder needs for estimating impacts of fuel cell production and deployment on state, regional and national employment, earnings, and economic output.

Technical Barriers

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

(A) Lack of Readily Available, Objective, and Technically Accurate Information

(E) Regional Differences

(F) Difficulty of Measuring Success

Technical Targets

The project is using a computer model to estimate the impact of deploying fuel cells in early markets. Insights from the model will assist the Fuel Cell Technologies Program 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.

FY 2012 Accomplishments

- Initiated close collaboration with stakeholders, fuel cell market participants and other researchers via a series of meetings, teleconferences and webinars. Demonstrated beta versions of the JOBS and economic impacts of Fuel Cells (JOBS FC) model to this group to validate data and obtain feedback on desired functionality, granularity, and outputs.
- Completed characterization of supply chains (in terms of the dollar purchases from individual industrial sectors per fuel cell kW) for low-temperature polymer electrolyte membrane (PEM) fuel cells, phosphoric acid fuel cells (PAFCs) and molten carbonate fuel cells (MCFCs), and launched version 1.0 of the JOBS FC model. Launch required development of:
  - A user's guide.
  - A dedicated website for users to register and download the model and User's Guide.
  - A webinar introducing JOBS FC 1.0.
- Completed an initial analysis of employment impacts of select PEM fuel cell projects funded under the American Recovery and Reinvestment Act (ARRA).

Introduction

Section 1820 of the Energy Policy Act of 2005 (Public Law 109-58) directed DOE to assess the impact of a large-scale transition to hydrogen on U.S. employment. In response to that directive, RCF Economic and Financial Consulting, Inc., Argonne National Laboratory, and other partners undertook an in-depth analysis of the economic impacts of hydrogen deployment in the transportation sector. That study relied on input-output (I-O) analysis to estimate net employment changes at the national level and produced a final report which was submitted to Congress in July 2008. But the study did not address initial fuel cell

(FC) applications or issues associated with early markets. Neither did it develop a method to examine alternative deployment scenarios and their employment impacts. Now, however, it is increasingly important to understand and expand employment impacts associated with early FC market development. Developing that capability is the focus of this project.

Results

In FY 2011, Argonne National Laboratory and RCF Economic and Financial Consulting began work on the design and implementation of a spreadsheet tool to calculate the economic impact of fuel cell production, installation, and utilization in early markets (i.e., 2015–2020) at the state, regional, and national levels. Known as JOBS FC the tool is designed as a user-friendly, spreadsheet-based model. In FY 2012, development culminated in a series of beta tests, the May 2012 launch of JOBS FC 1.0, and the application of the model to examine employment impacts of ARRA-funded fuel cell projects.

Model Development and Stakeholder Collaboration

A considerable portion of FY 2012 was devoted to model development and quality assurance — including data validation, development of the user interface, and outreach. In order to provide users with unlimited, free access to the JOBS FC tool, the underlying I-O multipliers had to come from publicly available, unrestricted sources. Thus, Regional Input-Output Modeling System II multipliers – developed by the U.S. Department of Commerce – were secured and embedded in the model. 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 basic engineering design calculations.

For each FC application and technology in JOBS FC 1.0 default parameters include unit size (kW), capital and operating cost ($/kW), production location (domestic/import), installation location (domestic/import), utilization, fuel use, etc. The user can replace these values, thus defining a unique scenario, or use the default values embedded in the model.

For each of 60 geographies — 50 states, nine census regions, and the nation as a whole — JOBS FC estimates the effect of fuel cell deployments on employment, earnings and economic output. It does so by adjusting the dollar flows among economic sectors within the relevant geography. As FC systems are deployed, the purchases send dollars up the supply chain for PEMFC, PAFC, or MCFC technologies as well as to the relevant supply chains for FC 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 itself, but all transactions required to install, fuel and operate the fuel cell system. To illustrate, a set of base or "reference scenarios" (Table 1) were postulated and used to generate an initial set of results. Results for the forklift reference scenario are shown in Figure 1.

TABLE 1. "Reference Scenario" Input Assumptions

Reference Scenario Parameter	Forklifts		Backup Power	Prime Power	
	Class I/II	Class III		PAFC	MCFC
Capacity (kW)	10	2	5	400	1400
Installations: 2015	1,500	1,500	3,000	100	50
2016	3,000	3,000	6,000	125	60
2017	4,500	4,500	9,000	150	70
2018	6,000	6,000	12,000	175	80
2019	7,500	7,500	15,000	200	90
2020	9,000	9,000	18,000	225	100

Reference scenarios were also used to investigate model sensitivities to various input parameters. Figure 2 shows the effect of FC capacity, the cost of delivered hydrogen, the number of FC units deployed and annual operating hours on cumulative employment over the period 2015–2020. Figure 2 is limited to forklifts. Similar results were obtained for backup power and prime power applications. Note that job-years are defined as employment for one person for one year.

Figure 2 suggests that JOBS FC results are relatively sensitive to the number of units deployed and insensitive to annual utilization. Thus, scenarios with greater numbers of FCs deployed may be expected to yield larger increases

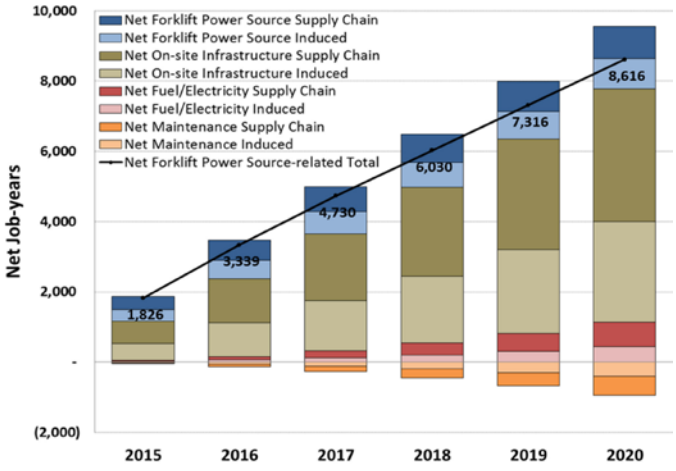

FIGURE 1. Employment Impact of Forklift "Reference Scenario"

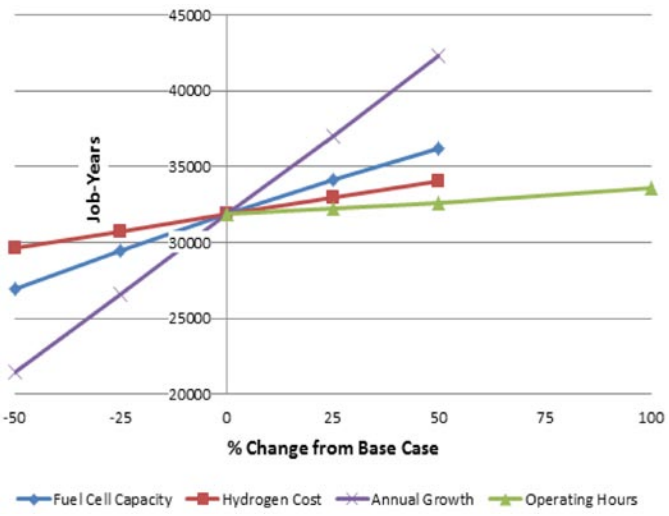

FIGURE 2. Sensitivity Analysis of Forklift Net Employment

in employment than those with increased operating hours or capacity.

Employment Impacts of ARRA-Funded Fuel Cell Projects

In FY 2012, JOBSFC 1.0 was used to develop an initial estimate of the employment impact of select ARRA-funded FC projects. Using data compiled for Fuel Cell Technologies Program market transformation sub-program, model inputs were developed for forklift and cell tower backup power systems placed in service under the ARRA program from 2009 through the end of 2011 (Table 2).

TABLE 2. Fuel Cells Deployed in Forklift and Cell Tower Backup Power, 2009–2011

ARRA Deployments, 2009-2011	Forklifts		Cell Tower Backup Power
	Class I/II	Class III	
Units: 2009	14	0	24
2010	122	172	166
2011	124	72	417
Total	260	244	607
Ave. capacity (kW)	8	2	2.1
Annual operating hrs	2,500	2,500	24
Fuel type	LH2/GH2	LH2/GH2	GH2
Operating hrs/fueling	4	4	72

LH2 - liquefied hydrogen; GH2 - gaseous hydrogen
Source: Kurtz, J., K. Wipke, S. Sprik, T. Ramsden and C. Ainscough, Early Fuel Cell Market Deployments: ARRA and Combined (IAA, DLA, ARRA) NREL Composite Data Products, March 8, 2012.

Results are shown in Figure 3 [1]. For both applications, H_2 infrastructure supply accounts for a large share of employment gains (note that the category "supply chain" = direct + indirect employment) because a relatively large number of job-years are associated with storage tank fabrication, installation and shipping. Note also that gross results are nearly equal to net results because a significant portion of FCs will displace imported batteries and diesel generators, and/or installation, fueling and operation and maintenance for the incumbent technologies (batteries and engines) are not very labor intensive.

[1] Since ARRA-funded projects are assumed to have been "shovel ready" initial numbers of FCs may be assumed to have come from inventory. Thus, shadows have been applied to the bars associated with FC production in Figure 3. By 2011 it may be argued that few (if any) FCs would still come from 2009 inventories.

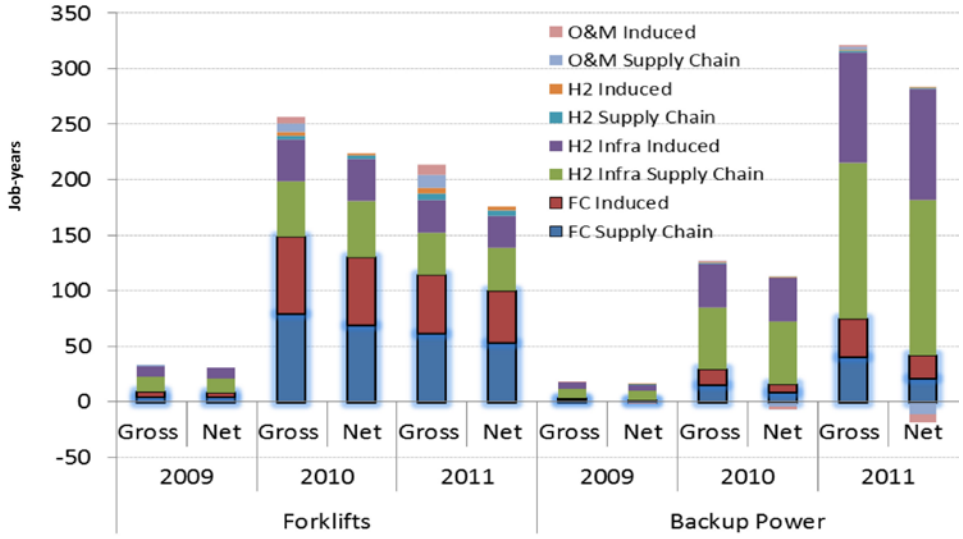

FIGURE 3. Preliminary Estimate of Employment Impact of ARRA Projects Deploying Fuel Cells in Forklift and Cell Tower Backup Power Applications

Conclusions and Future Directions

FY 2012 work focused on completion of the JOBS FC model to estimate gross and net economic impacts from the manufacture, installation, fueling, and operation of fuel cells in distributed prime power, backup power, and material handling (e.g. forklift) applications. That work included outreach to industry and stakeholders to develop and validate input and refine the user interface; model testing and quality assurance via a series of webinars, beta tests and sensitivity analyses; and model launch. The initial application of the model — to analyze the employment impact of fuel cell deployments under the ARRA — produced a set of preliminary "bottom-up" estimates which are being compared with "top-down" estimates based on total expenditures. FY 2013 work will build on these efforts, incorporating stakeholder recommendations for enhancements to the functionality and scope of the model, as well as developing estimates of employment impacts to support ongoing FC deployment programs.

Potential future model enhancements include adding SOFC and high-temperature PEM technologies for prime power applications, distributed hydrogen production and biologically-derived hydrogen as options for fueling FCs in forklift or prime power applications, and retail hydrogen fuel stations to serve emerging vehicle markets.

FY 2012 Publications

1. Mintz, M., J. Molburg, C. Mertes and E. Stewart, *Impacts of Non-Automotive Fuel Cells and Natural Gas Vehicles,* presented at the 91st Annual Meeting of the Transportation Research Board, Washington, DC, Jan. 23, 2012.

2. Mintz, M. *Employment Impacts of Early Markets for Hydrogen and Fuel Cell Technologies*, presented to the California Stationary Fuel Cell Collaborative, Sacramento, June 1, 2011.

3. *Job and Output Benefits of Stationary Fuel Cells (JOBS FC): An Economic Impact Tool Developed for USDOE*, Technology Transitions Corporation webinar *Where the Jobs Are: Hydrogen and Fuel Cells in Your Area,* July 19, 2011.

4. *Jobs and Output Benefits of Stationary Fuel Cells (JOBS FC): User Reference Guide for Beta Release 2.0*, draft report, Feb. 28, 2012.

5. *Jobs and Output Benefits of Stationary Fuel Cells (JOBS FC): User Reference Guide for Beta Release 1.0*, draft report, Dec. 15, 2011.