

Employment Impacts of Early Markets for Hydrogen and Fuel Cell Technologies

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Overview

Timeline

Start date: October 2010

End date: December 2012

Percent complete: 80%

Budget

Total funding: \$980k (FY09-11)

DOE share: 100%

- Funding for FY11: \$640k
- Funding for FY12: \$100k

Barriers

- Lack of Readily Available, Objective, and Technically Accurate Information (A)
- Regional Differences (E)
- Difficulty of Measuring Success (F)

Partners

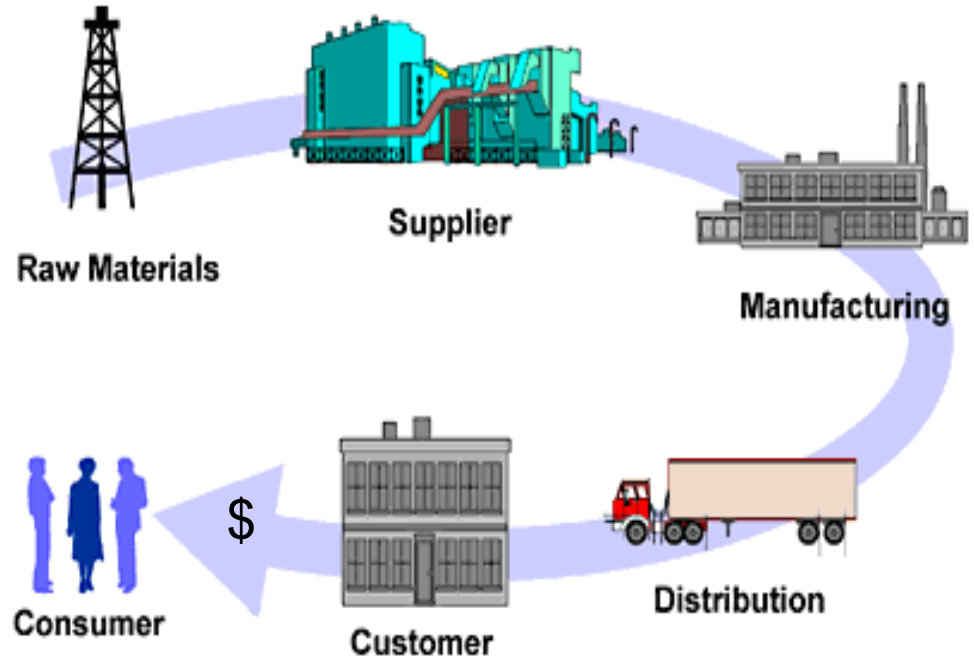
- Argonne National Laboratory
- RCF Economic & Financial Consulting
- Stakeholders:
 - Public agencies
 - Industry organizations
 - Manufacturers
 - Researchers

Relevance

- Provide a means for calculating employment and other economic implications of fuel cell investments. The Jobs and Output Benefits of Stationary Fuel Cells (JOBS FC) model translates investment and operations expenditures into direct, indirect and induced jobs and economic activity.
- Meet DOE and stakeholder needs to measure economic impacts of fuel cell technology deployment by region and application. This is essential information for local, state and national policy decisions, public and private investment decisions and program planning and analysis.
- Collaborate with stakeholders to create a user-friendly tool with appropriate functionality, to acquire/review input data and to validate results.

JOBS FC uses input-output approach to model FC deployment

- JOBS FC is a user-friendly **spreadsheet-based** tool that calculates direct, indirect and induced job creation, wages and sales resulting from FC production, installation, operation and fueling.
- JOBS FC uses Regional Input-Output Modeling System (RIMS II) **multipliers** to capture effect of expenditures on earnings, output and employment
- JOBS FC models **gross and net jobs** created by 3 technologies, 3 applications, multiple FC capacities (defaults shown)



Unit Capacity (kW)	LT PEM	PAFC	MCFC
Class I/II Forklift	10		
Class III Forklift	2		
Cell Tower Backup Power	5		
Prime Power (with CHP)		400	1400

Jobs are created at each stage in FC production, fuel infrastructure, O&M, and fuel supply chains (**direct + indirect jobs**), as well as from re-spending dollars in economy (**induced jobs**)

JOBS FC models expenditure flows through the supply chain



King, J. 2011, Fuel Cell-Powered Lift Truck FedEx Freight Fleet Deployment, DOE Annual Merit Review, 2011.



Courtesy of Ballard Power Systems.

Reforming
 Fueling Equipment
 Fuel Storage

FC Fueling

Maintenance
 Operating Labor

FC O&M

**Fuel Cell
 Application Cost
 Breakdown**

FC Manufacturing

FC Shipping

FC Installation

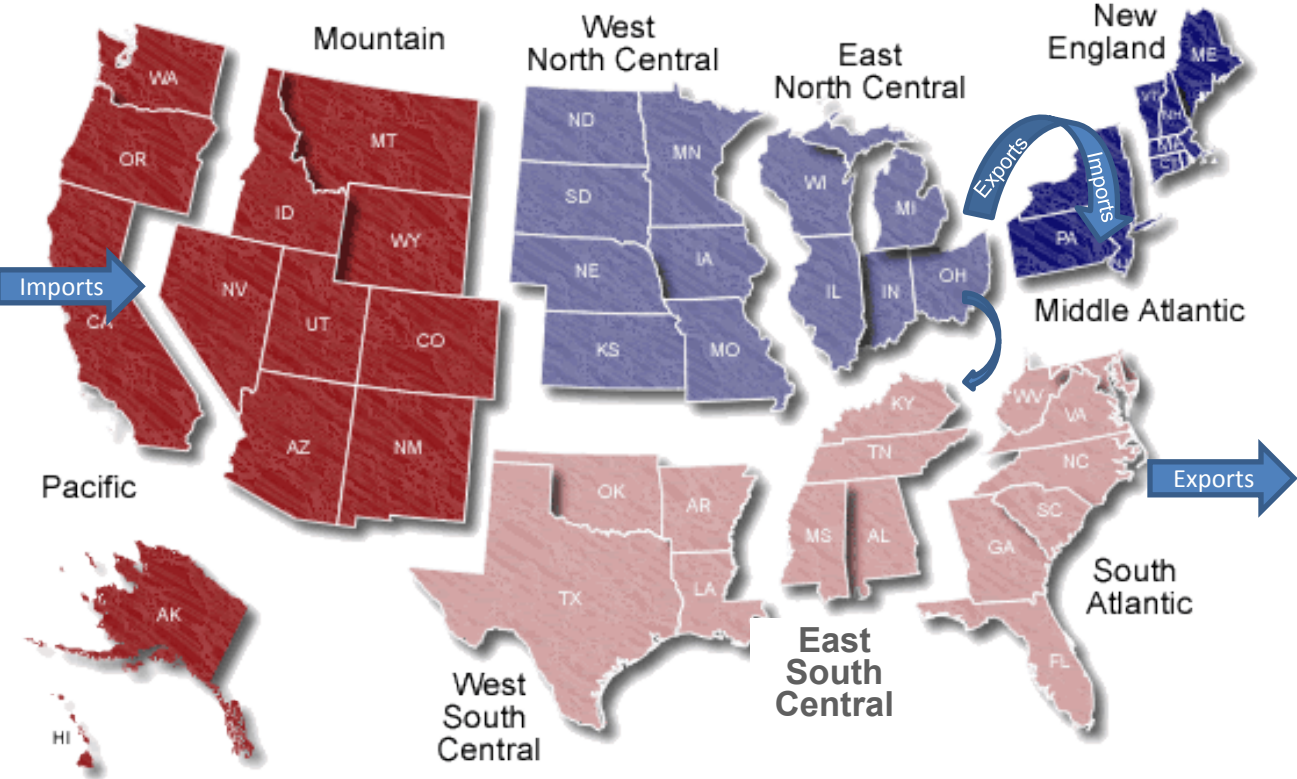


Courtesy of BMW Manufacturing Co., LLC

JOBS FC models expenditures for different geographies

Jobs occur where expenditures occur.
 Domestic manufacturing, installation and use create the most jobs, but imports and exports also create jobs

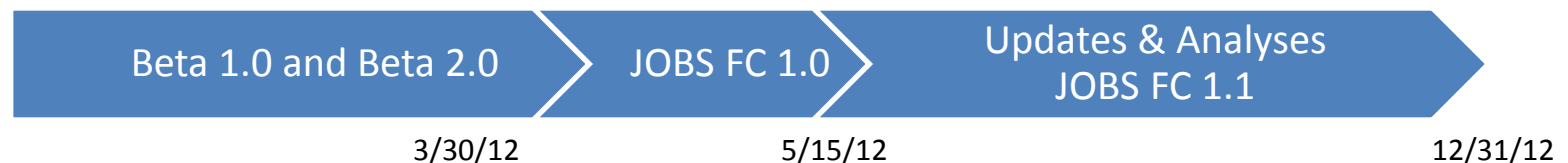
- JOBS FC use **RIMS II multipliers** for 61 different geographies to account for geographic variation
- Jobs are created from **imported** FCs installed and operated inside region (no manufacturing facility construction & FC production impacts occur).
- Jobs are created from **exported** FCs installed & operated outside region (no installation, O&M of FCs and fuel infrastructure & fuel purchase impacts occur).
- **Net effects** exclude jobs displaced by FCs (unless FCs displace imports)



Map by the Indiana Business Research Center, Kelley School of Business, Indiana University

FY 2012 Accomplishments

Due date	Milestone	Status
Dec. 2011	Beta 1.0 test	Complete
Feb. 2012	Beta 2.0 test	Complete
May 2012	JOBS FC 1.0 launch	Complete
May 2012	Initial employment estimates for forklift & backup power FCs deployed under American Recovery & Reinvestment Act (ARRA)	“High Level” Complete
Sept. 2012	Final employment estimates for forklift and backup power (BuP) FCs deployed under ARRA	Data collection/ validation
Dec. 2012	JOBS FC 1.1	Data collection/ validation



Completed beta tests and JOBS FC 1.0 launch

Products:

- JOBS FC Beta 1.0 (12/15/11)
- JOBS FC Beta 2.0 (2/28/12)
- JOBS FC 1.0 (5/15/12)
- Draft & Final Users' Guides
- JOBSFC.es.anl.gov portal and EERE link
- Web-based user training scheduled for 5/22/12

Comments on:

- User interface
- Default values/assumptions
- Functionality/usefulness
- Technologies/applications
- Operating system

JOBS FC Spreadsheet Tool User Reference Guide for Beta Release 1.0

Introduction

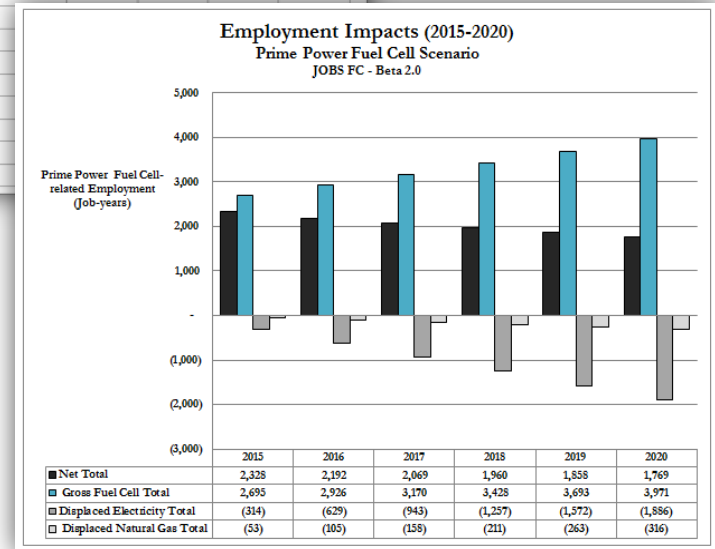
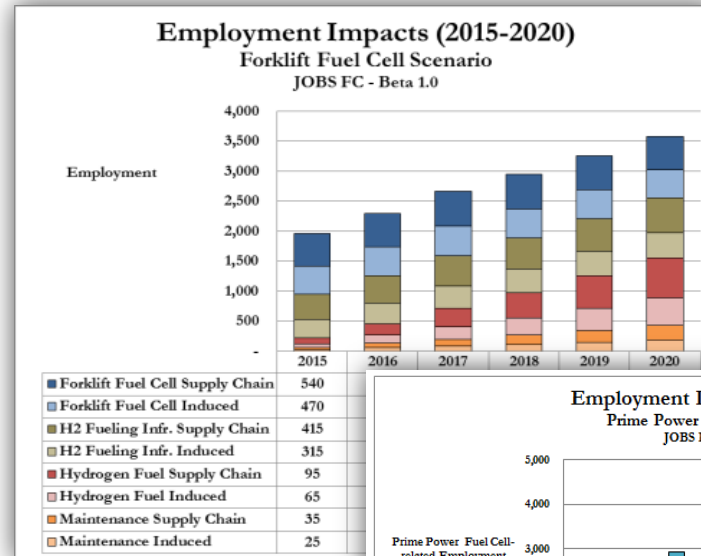
This reference guide has been developed to accompany the release of Beta Jobs and Output Benefits for Stationary Fuel Cells (JOBS FC) economic impact tool. The purpose of this reference guide is to provide an overview of JOBS users in performing scenario analyses. A comprehensive project report including methodologies and references will be prepared separately.

Jobs and Output Benefits for Stationary Fuel Cells (JOBS FC)

JOBS FC Spreadsheet Tool

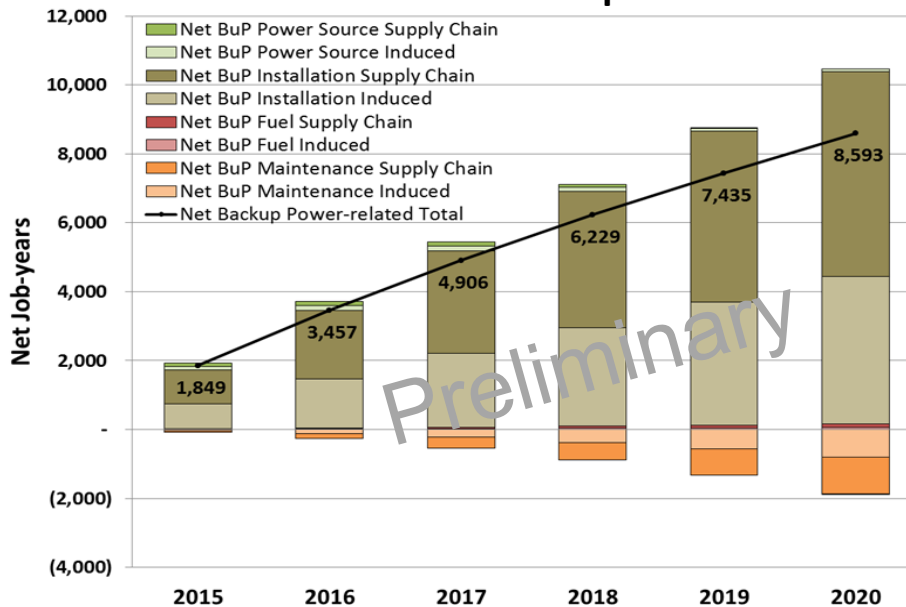
User Reference Guide for Beta Release 2.0

has been developed to accompany the release of Beta version 2.0 of the fits for Stationary Fuel Cells (JOBS FC) economic impact spreadsheet tool. This reference guide is to provide an overview of JOBS FC and to assist users in analyses. A comprehensive project report including methodologies and paired separately.

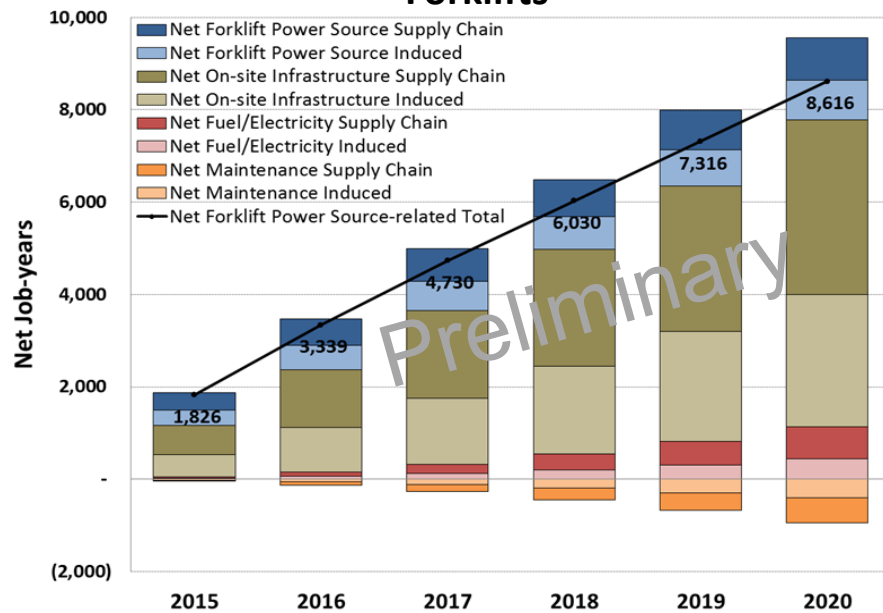


'Reference' scenarios show potential for thousands of net job-years*

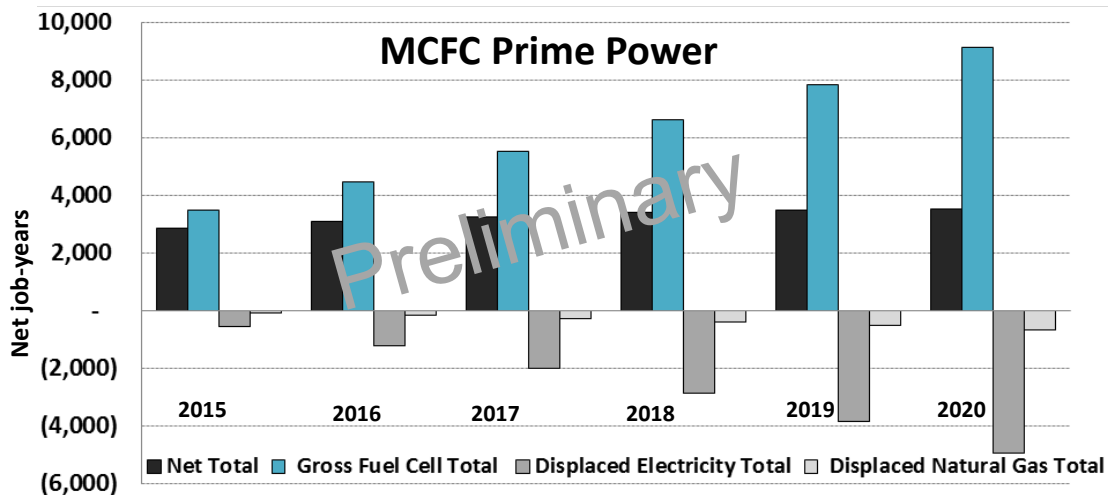
Cell Tower Backup Power



Forklifts



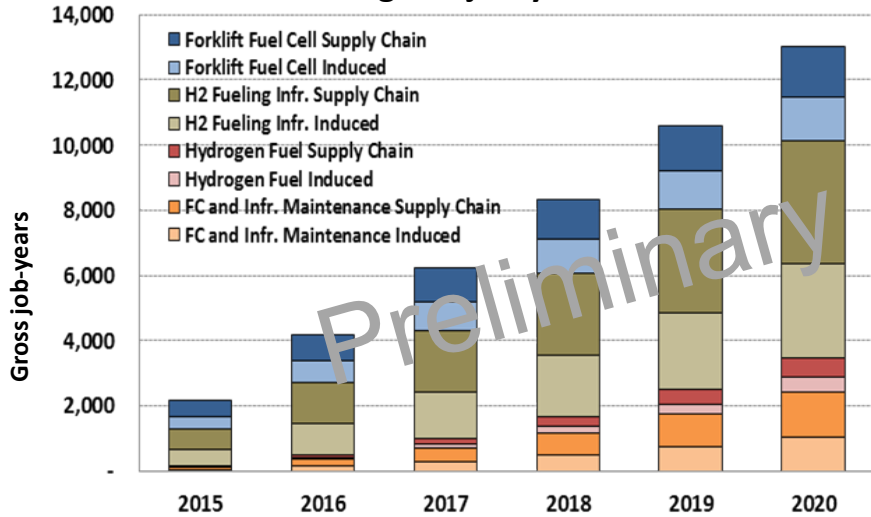
Reference Scenario Parameter	Forklifts		Backup Power	Prime Power	
	Class I/II	Class III		PAFC	MCFC
Capacity (kW)	10	2	5	400	1400
Installations:					
2015	1,500	1,500	3,000	100	50
2016	3,000	3,000	6,000	125	60
2017	4,500	4,500	9,000	150	70
2018	6,000	6,000	12,000	175	80
2019	7,500	7,500	15,000	200	90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



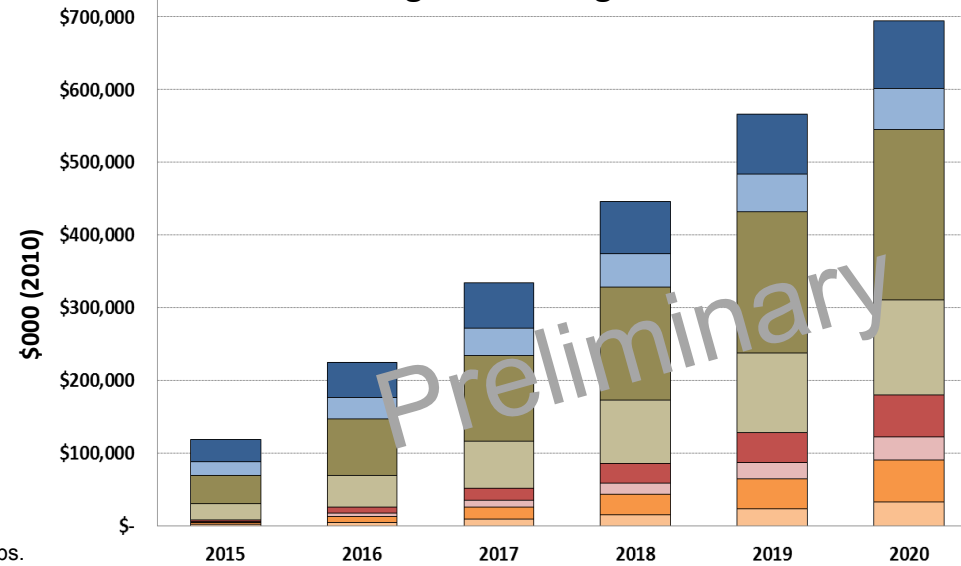
*One job-year = one year of work for one person. Results exclude manufacturing facility construction which could generate ≈ 800 additional job-years for PEM applications. Note, positive and negative values on stacked bar charts must be summed to yield total net effects (sum shown by line overlaid on chart).

Forklift FCs can add \$millions to gross earnings & \$billions to output

US gross job-years*

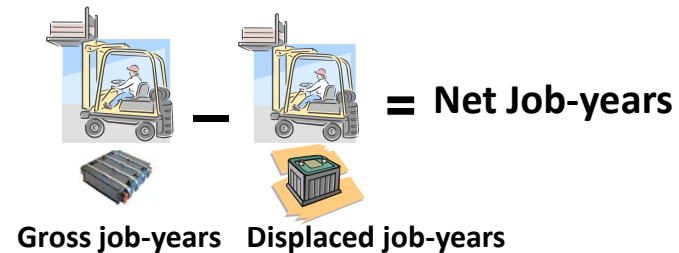
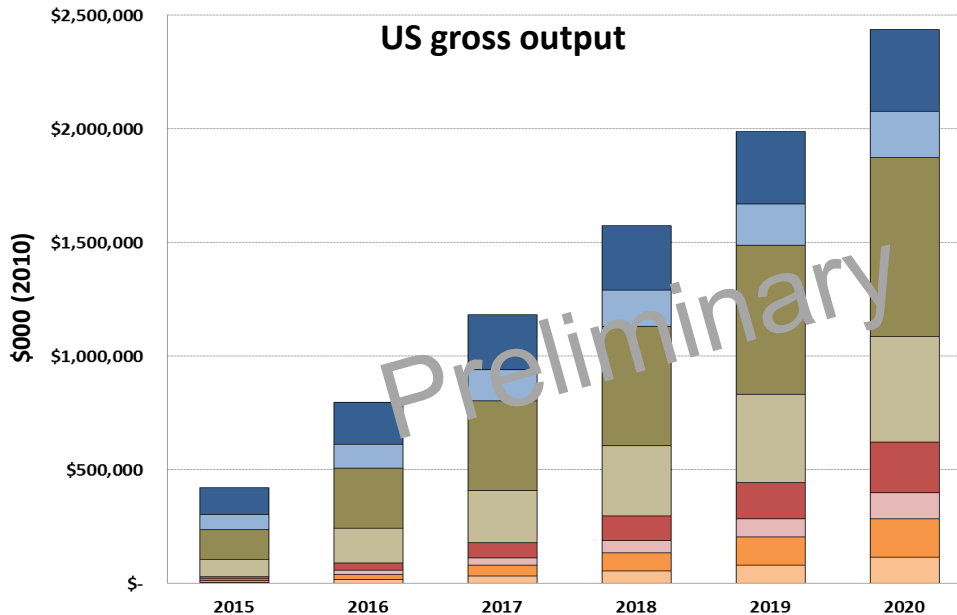


US gross earnings



*Excludes manufacturing facility construction which could generate ≈ 400 additional jobs.

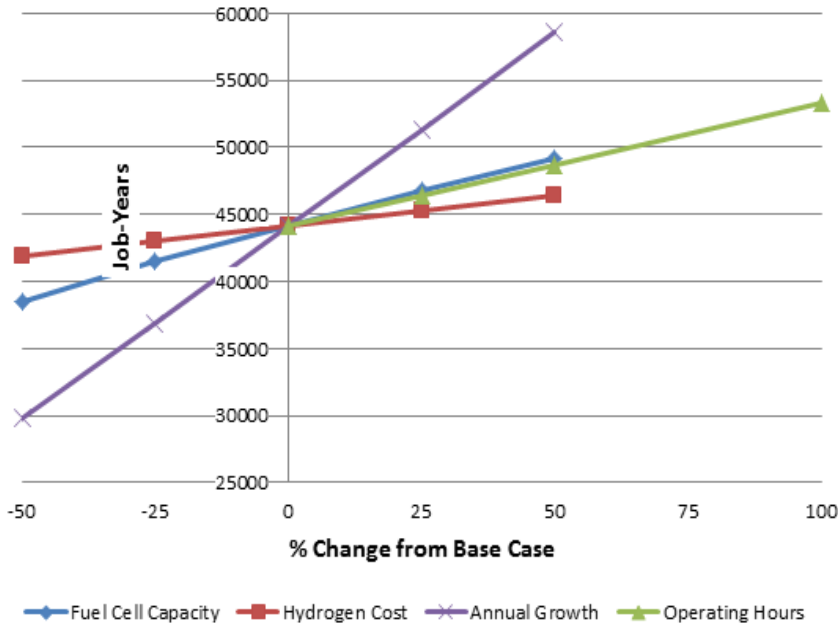
US gross output



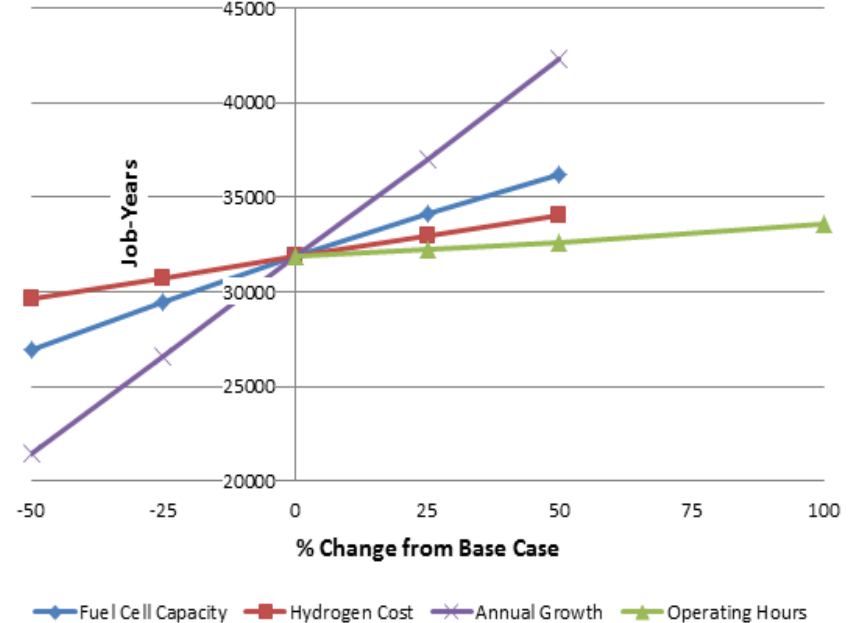
Accomplishments

Parametric analysis of forklift reference scenario shows high sensitivity to unit growth, less to capacity & operating hours

Forklifts: Gross Job-Years, 2015-2020



Forklifts: Net Job-Years, 2015-2020



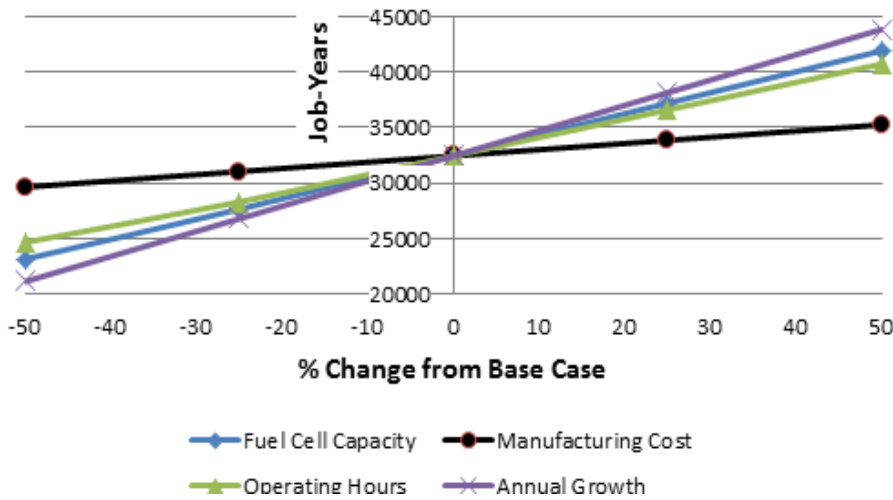
Values Modeled in Parametric Analysis

Parameter (% change)	-100%	-50%	-25%	Base	+25%	+50%	+100%
Capacity (kW):							
Class I/II	NA	5	7.5	10	12.5	15	NA
Class III	NA	1	1.5	2	2.5	3	NA
H2 molecule cost (\$/kg)	NA	2.75	4.12	5.50	6.87	8.25	NA
Growth (units/yr)	NA	1500	2250	3000	3750	4500	NA
Operating hrs/yr	NA	NA	NA	2500	3125	3750	5000

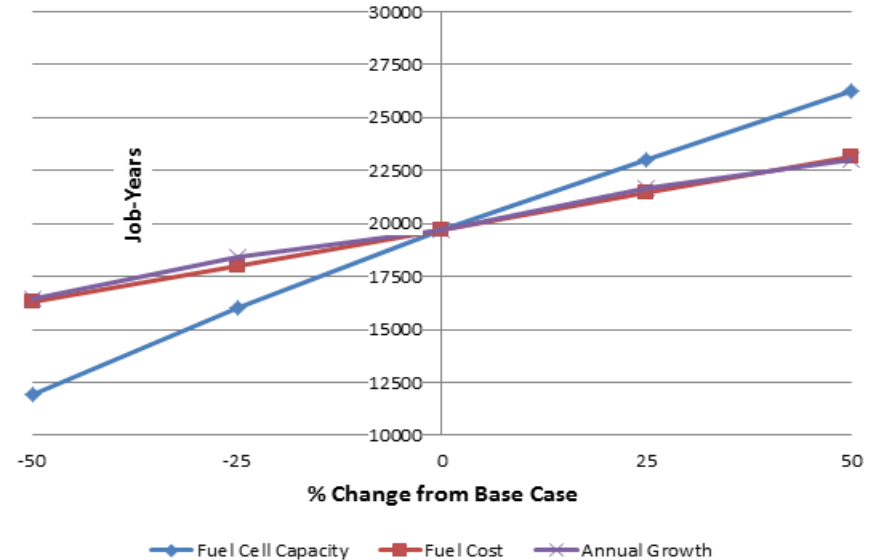
- Unit growth (2015-2020) produces biggest change in job estimates
- Gross results equally sensitive to FC capacity & annual operating hrs
- Net results least sensitive to operating hrs

Results for backup power and prime power applications are less sensitive to unit growth than are forklifts

Cell Tower Backup Power: Net Job-Years, 2015-2020



MCFC Prime Power: Net Job-Years, 2015-2020



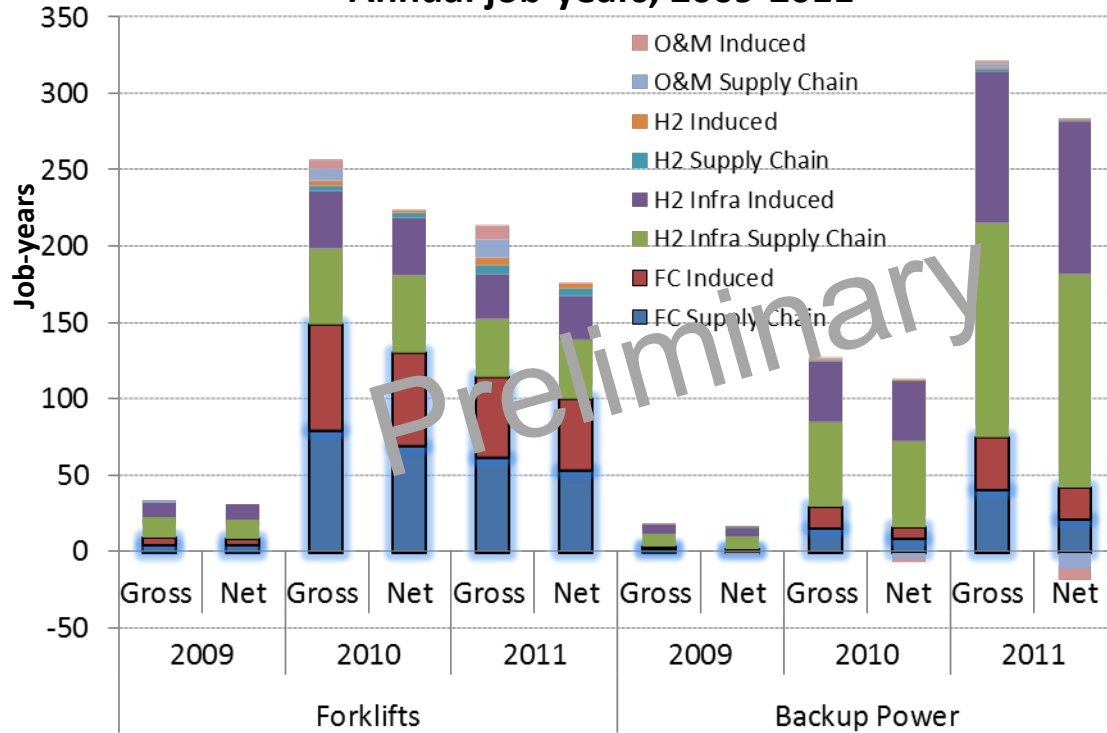
Values Modeled in Parametric Analysis

Parameter (% change)	-50%	-25%	Base	+25%	+50%
Capacity (kW): BuP (PEM)	2.5	3.75	5	7.5	10
Prime (MCFC)	700	1050	1400	1750	2100
Natural gas cost (\$/mcf)	4	6	8	10	12
Unit growth: Backup pwr.	1500	2250	3000	3750	4500
Prime pwr.	5	8	10	13	15
Operating hrs/yr (BuP):					
Required run time	24	36	48	60	72
Annual run time	12	18	24	30	36
2015 BuP mfg. cost (\$/kW)	550	825	1110	1375	1650

- Prime power estimates are most sensitive to capacity
- Gross & net (not shown) results for BuP equally sensitive to FC capacity & operating hrs, slightly more sensitive to unit growth, least sensitive to manufacturing cost
- H2 cost for BuP (not shown) not examined due to extremely low use

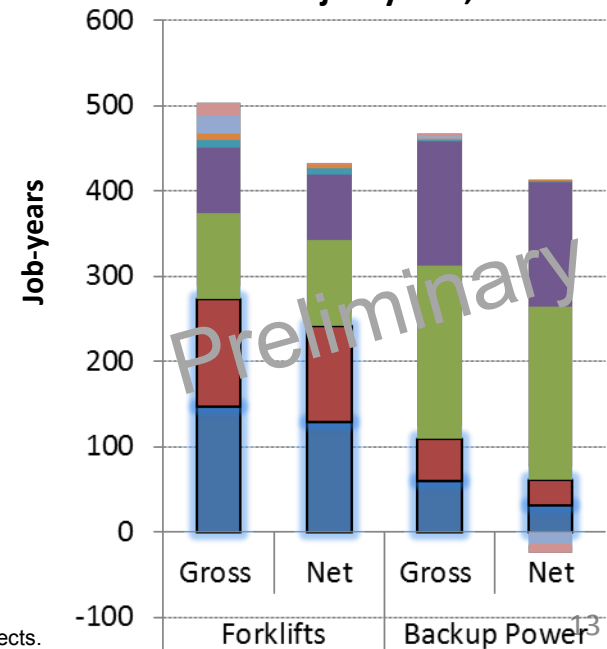
ARRA deployments resulted in 800–950 job-years to date (500–550 excluding FC manufacturing)

Annual job-years, 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.	2500	2500	24
Fuel type	LH2/GH2	LH2/GH2	GH2
Operating hrs./refuel	4	4	72

Cumulative job-years, 2009-2011*



- Initial results: ≈800–950 job-years to date
- Excluding jobs from
 - Financing, taxes
 - Remaining forklift and cell tower deployments
 - BuP in non-cell tower applications
 - Post-2011 fueling, FC & fuel infrastructure O&M, stack replacement

*Results on stacked bar charts appear deceptive. Negative values must be added to positive values to yield total net effects.

Stakeholders have been key collaborators for peer review, data collection/validation & beta testing Beta tester/Peer reviewer

Public Agencies:

- South Carolina Hydrogen and Fuel Cell Alliance
- California Stationary Fuel Cell Consortium
- Connecticut Center for Advanced Technology
- Ohio Fuel Cell Coalition
- NYSERDA
- Clean Energy States Alliance
- California Fuel Cell Partnership
- Virginia Clean Cities

Customers:

- Sprint-Nextel
- Metro PCS
- Whole Foods
- Sierra Nevada

Researchers:

- ORNL
- NREL
- PNNL
- Battelle

Trade Associations:

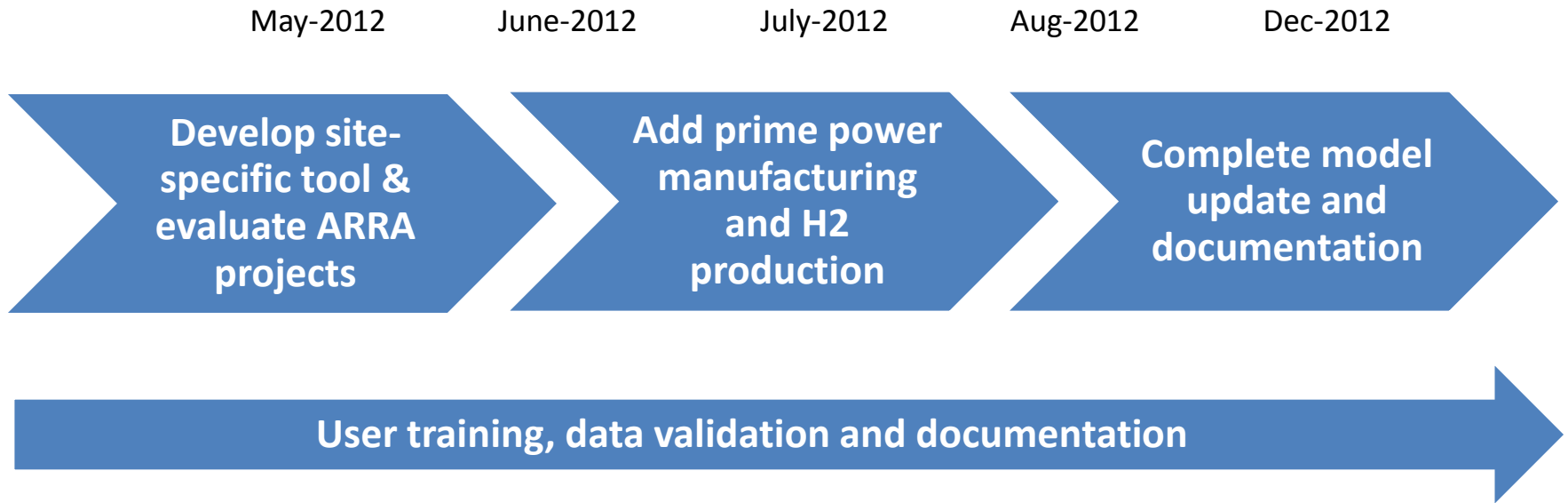
- FCHEA
- Fuel Cells 2000

Manufacturers:

- PlugPower
- ReliOn
- Idatech
- UTC Power
- Fuel Cell Energy
- Ballard

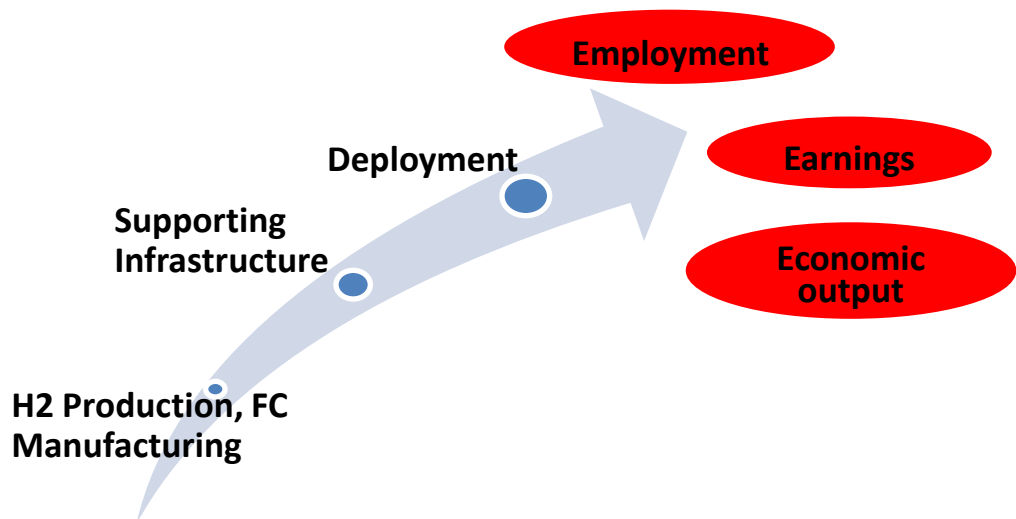


Tool expansion & analysis is focus of FY 2012 and beyond



Potential model expansion:

- Debt or other financing
- High temperature PEMFC
- Transportation applications
- SOFC
- CHHP



Summary

- **Relevance:** Provide a means for DOE and stakeholders to estimate employment and other economic impacts of deploying fuel cells in stationary, backup power and materials handling applications.
- **Approach:** Using input-output economic modeling within the context of a user-friendly tool to calculate direct, indirect and induced employment, earnings and economic output.
- **Collaborations:** Active partnership between ANL & RCF. Extensive stakeholder interaction.
- **Technical accomplishments and progress:**
 - Designed tool, conducted beta tests, developed users' guide and posted model at <http://JOBSFC.es.anl.gov> to calculate economic impact of FC production, installation and operation for early markets at state, regional and national levels (61 potential geographies).
 - Began analysis of employment impacts of ARRA forklift and cell tower backup power projects.
 - Conducted sensitivity analyses of selected parameters.
- **Future research:**
 - Conduct web-based user training for JOBS FC.
 - Add capability to model site-specific FC installations, H2 production and prime power FC manufacturing.
 - Validate and refine fuel cell operational and economic defaults.
 - Develop capability to model CHHP, debt or other financing, transportation applications, and high temperature PEMFC and SOFC technologies.