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Employment Impacts of Early Markets for Hydrogen and Fuel Cell Technologies

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ED 019

Argonne NATIONAL LABORATORY

RCF Economic & Financial Consulting, Inc.

Overview

Timeline:

Project start date: October 2010

Project end date: December 2011

Percent complete: 35%

Budget:

- Total project funding: $640k

  DOE share: 100%
- Funding received for FY10: $340k
- Funding for FY11: $300k

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:

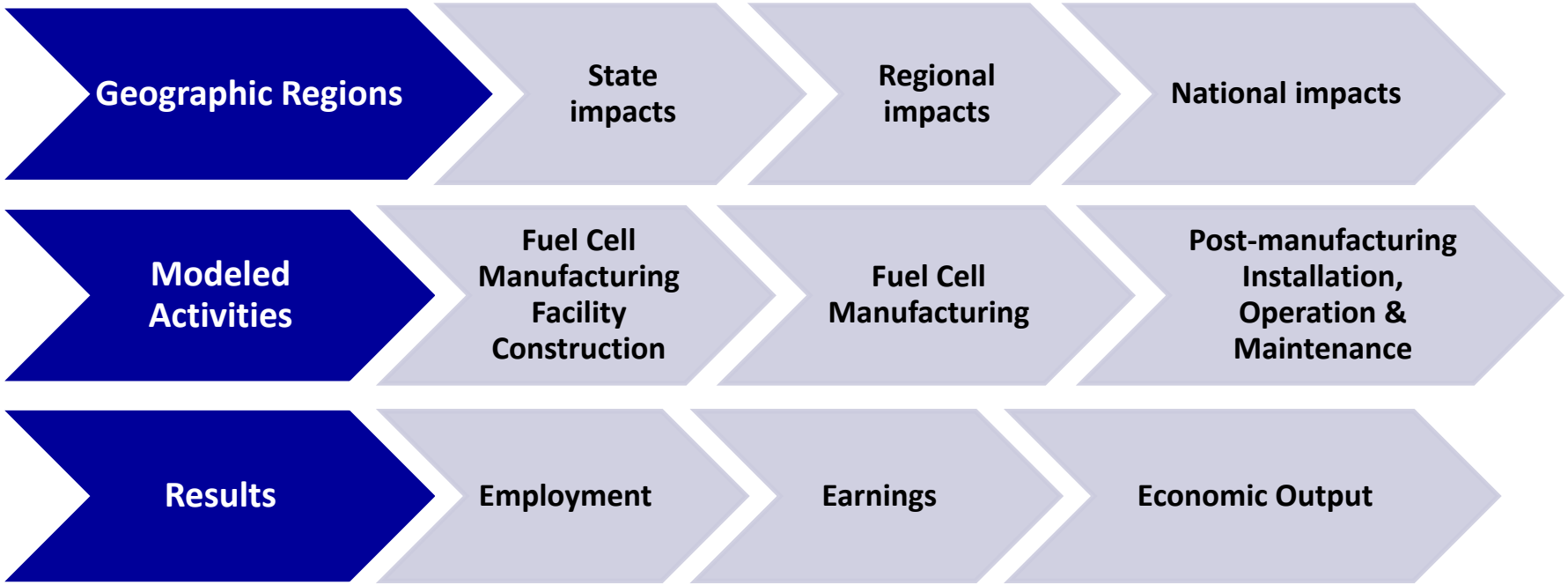
  California Fuel Cell Partnership

  SC Hydrogen and Fuel Cell Alliance

  CT Hydrogen Fuel Cell Coalition

Relevance

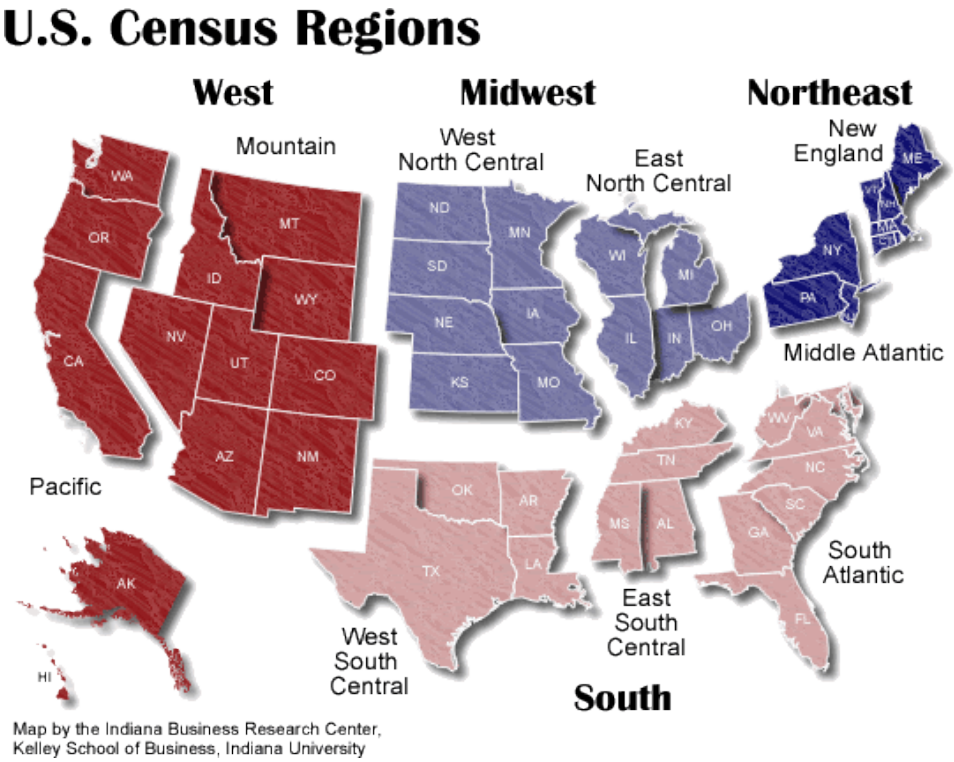
To facilitate early-market deployment of fuel cells in stationary, backup power and materials handling applications, by developing a user friendly tool to calculate economic impacts



Relevance, cont'd

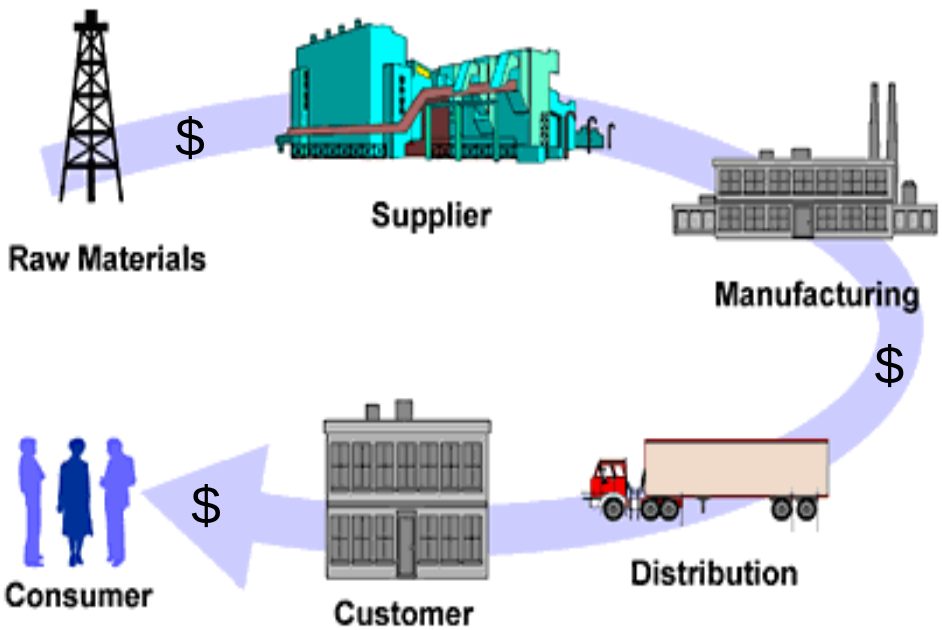
Tool designed to meet DOE and stakeholder needs

- Identifying industry sectors benefiting most from increased fuel cell production
- Determining impacts from constructing new facilities to achieve target levels of production
- Identifying indirect and induced effects of fuel cell deployment on state, regional and national economy



Approach

Tool calculates gross direct and indirect impacts of fuel cell expenditures by geographic area over time

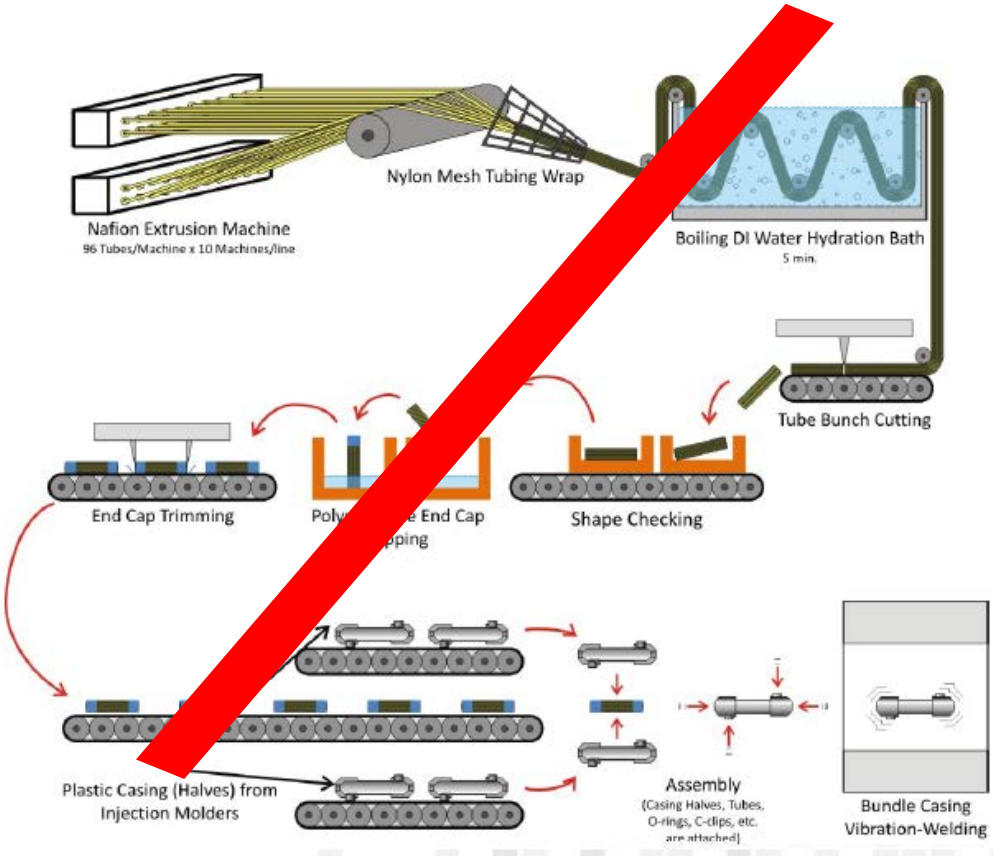


- Average manufacturing cost calculated over time period chosen by user (1-5 years)
- Indirect effects include supply chain spending and re-spending of income received by households
- Economic input-output model, the 440-sector IMPLAN model, provides platform for analysis

Approach, cont'd

Tool models dollar flows, not physical processes

- Inputs and outputs are dollar flows
- Tool does not model physical processes (e.g., membrane fabrication)
- Inputs (feedstock, fuel, components) are modeled as purchases via supply chain
- Unit of analysis is geographic (state, region or nation)
- Gross changes calculated for states and regions; net changes for nation as a whole

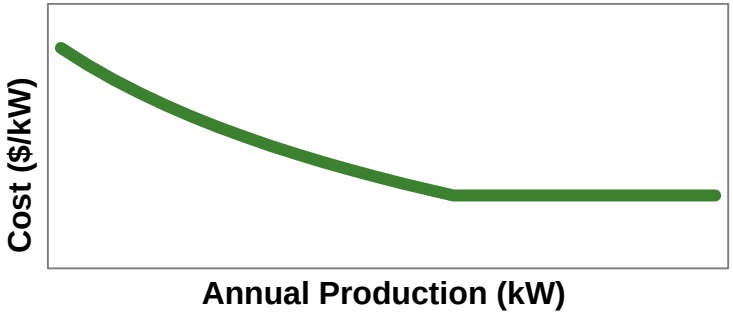


James, B. et al., Mass-Production Cost Estimation for Automotive Fuel Cell Systems, June 2010

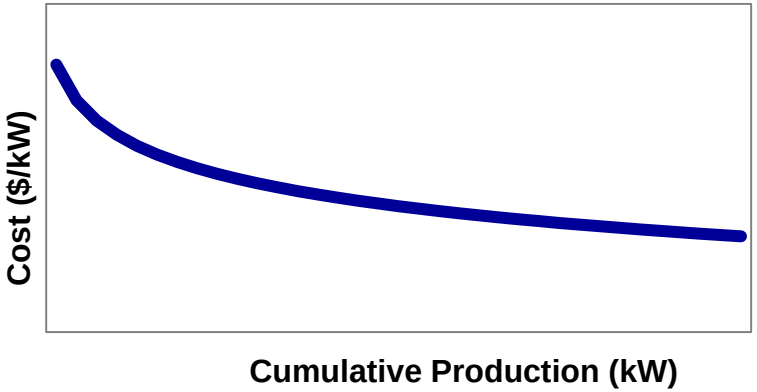
Approach, cont'd

Manufacturing costs include default dynamic factors that can be overridden by user

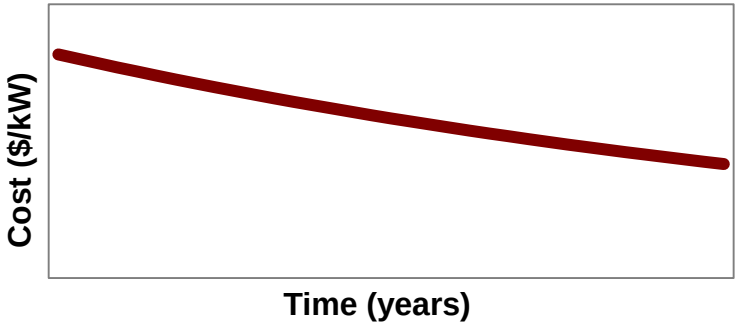
Economies of scale



Learning by doing*



Technology advancement



*Costs decline at a "progress ratio" from cumulative production experience

Approach, cont'd

Illustrations of possible uses

ACME Fuel Cell Co.

- Wants to build a new facility capable of producing 20,000 fuel cells (5kW) per year
- Knowing employment is important to communities and local purchasing will help lower costs, wants to site the facility where local employment will be maximized

Tool tells ACME how many jobs will be created

Newcity Development Corp.

- Wants to develop Newcity efficiently
- Has already decided to bring in a fuel cell company, but wants to know which fuel cell type will be best for Newcity

Tool permits analyst to compare effects of different fuel cell types to determine which is best for region

US Department of Energy

- Wants to compare alternative clean energy investments
- Already supporting R&D and deployment of different types of fuel cells in different markets, but wants to know which are likely to generate the most jobs

Tool permits analyst to compare effects of different fuel cell types on state, regional and national economy

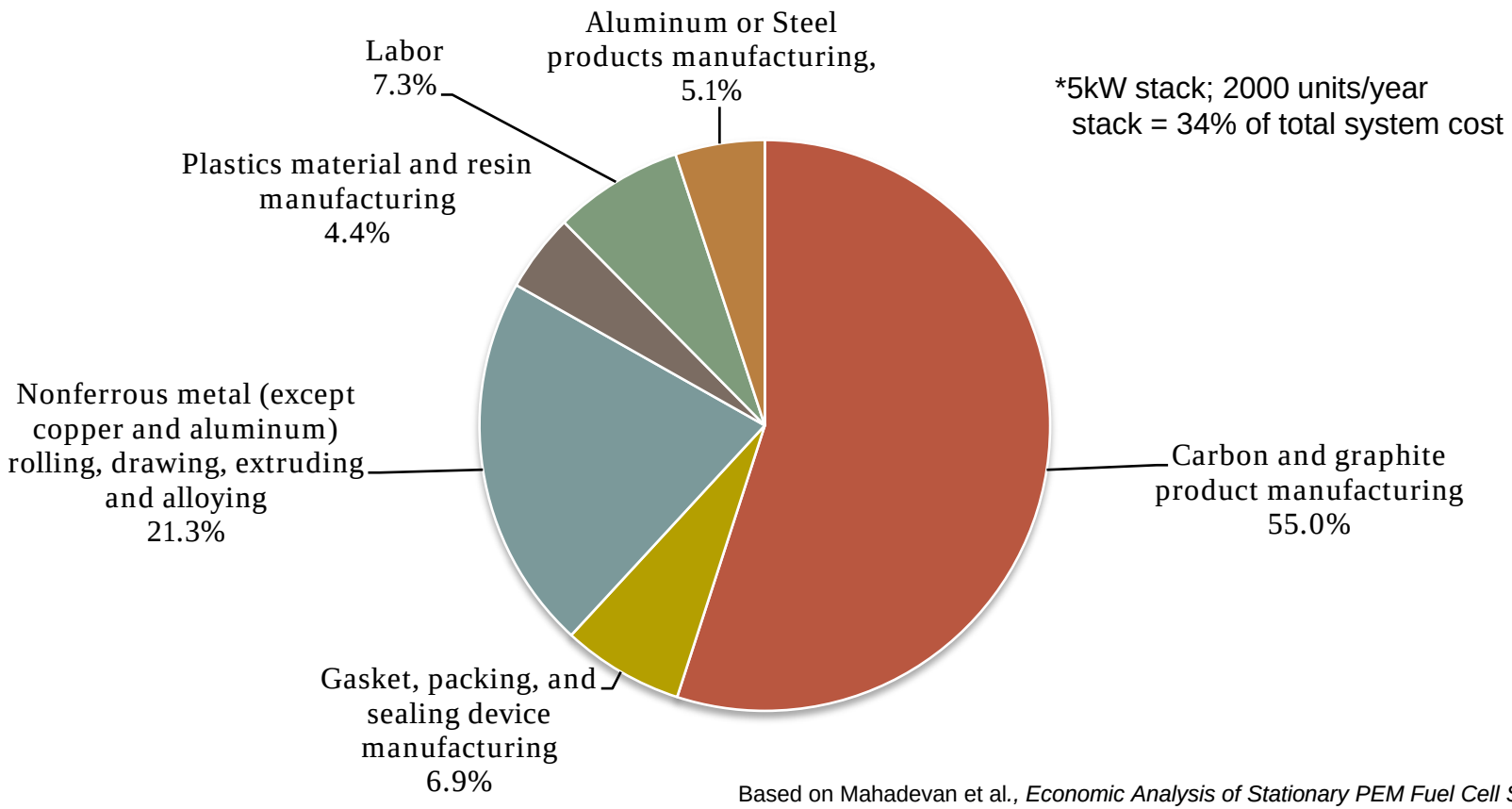
Progress

Preliminary results currently available for gross economic impact of PEMFCs at state or regional level

- Manufacturing cost module incorporated
- Supply chains identified
- IMPLAN model incorporated
- In working prototype, user supplies 6 required inputs (state/region, analysis timeframe, and fuel cell type, size, application and annual production)
- User can override default values for 11 other inputs
- Suggestions received in stakeholder webinar have been incorporated
- Data being validated by UTC Power

Progress, cont'd

Supply chain for PEM fuel cell stack*

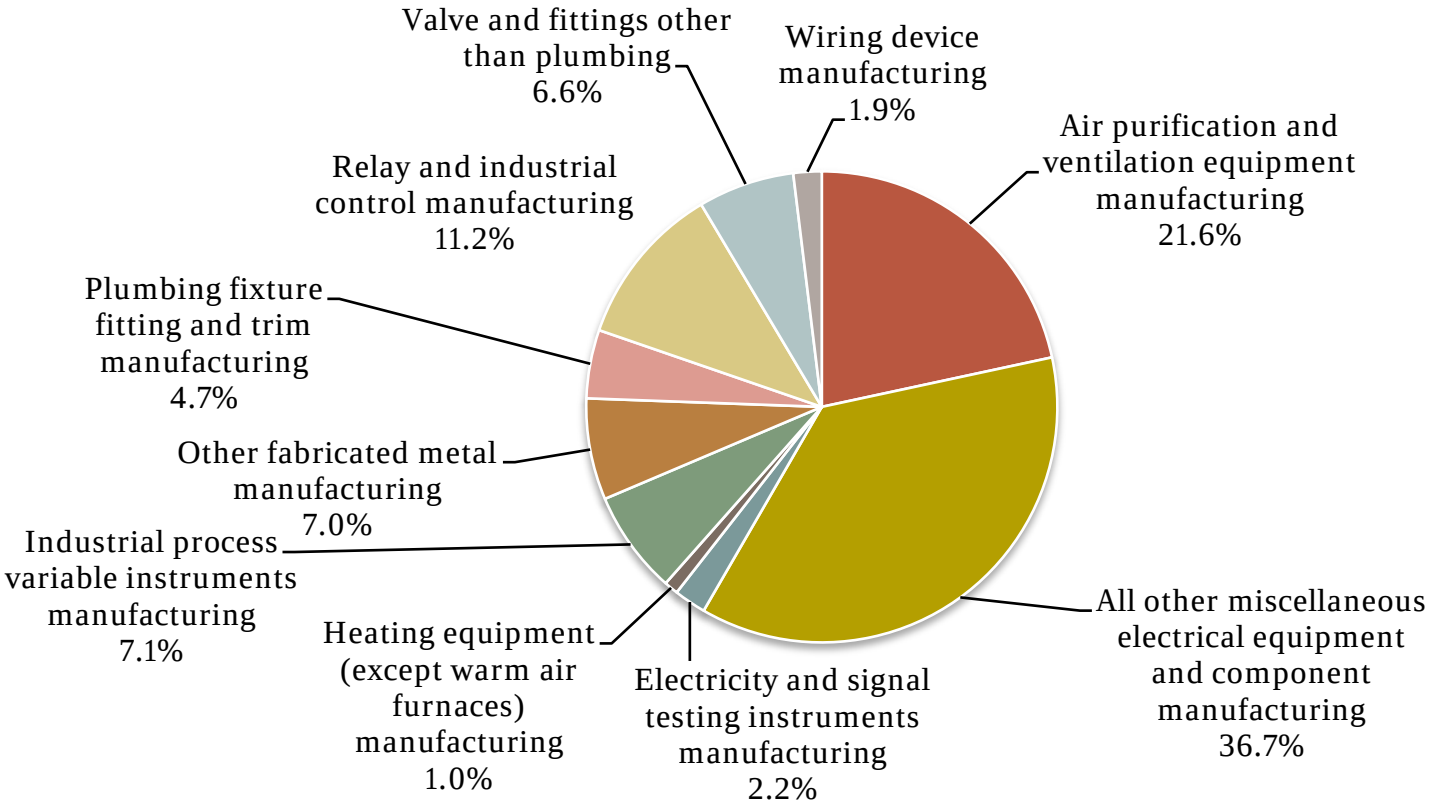


*5kW stack; 2000 units/year
stack = 34% of total system cost

Based on Mahadevan et al., *Economic Analysis of Stationary PEM Fuel Cell Systems.* Battelle, Presentation given at 2010 Hydrogen Fuel Cell Annual Merit Review. June 8, 2010.

Progress, cont'd

Supply chain for PEMFC balance of plant*



*5kW stack; 2000 units/year
BOP = 52.3% of total system cost

Based on Mahadevan et al., *Economic Analysis of Stationary PEM Fuel Cell Systems.* Battelle, Presentation given at 2010 Hydrogen Fuel Cell Annual Merit Review. June 8, 2010.

Progress, cont'd

User inputs

Required input fields:

- State or region
- Fuel cell type (PEMFC, MCFC, PAFC)
- Average fuel cell size (kW)
- Total annual FC production (kW/year)
- Time frame (1-5 years)
- Application

REQUIRED USER INPUT FIELDS	
Select State or Region:	NE
Type of Fuel Cell	PEMFC
Application	Stationary - Backup
Average Size of Manufactured Fuel Cell	5
Fuel Cells Manufactured per Year	2000
Annual Fuel Cell Production (kW/year)	10,000
Time Frame (years)	5
OPTIONAL USER INPUT FIELDS	
Existing Fuel Cell Production Capacity (kW/year)	0
Additional Manufacturing Capacity to be Constructed (kW/year)	10,000
Sales Price ($/kW)	*$2,000*
Production Cost ($/kW, initial)	$1,301
Progress Ratio	0.97
Production Volume for Initial Cost	10,000
Scale Elasticity	-0.2
Full Scale Production Level (kW/year)	25,000
Annual Rate of Technological Progress	2%
Average Production Cost Over Time Frame ($/kW)	$1,098
Installation Cost ($/kW)	*TBD*
Operations & Maintenance Cost ($/kW, annual)	*TBD*

Advanced input fields:

- Existing FC production capacity (kW/yr)
- 2015 retail price ($)
- 2015 manufacturing cost (and associated production to achieve that cost, $/kW)
- Progress ratio
- Scale elasticity
- Full scale production level (kW/year at which scale economy achieved)
- Rate of technological progress
- Installation cost ($/kW)
- Annual O&M cost ($/kW)

Progress, cont'd

Outputs

Economic impacts for NE resulting from one-time new manufacturing facility construction:

	Employment	Earnings ($M)	Output ($M)
Manufacturing Facility Construction	152.5	$7,024,566	$21,768,228
Direct	88.5	$4,364,070	$14,072,780
Indirect	64.0	$2,660,496	$7,695,448
Total:	152.5	$7,024,566	$21,768,228

Annual economic impacts for NE:

	Employment	Earnings	Output
Fuel Cell Production	54.2	$2,565,194	$10,172,144
Direct	2.7	$125,105	$846,925
Indirect	51.4	$2,440,089	$9,325,219
Fuel Cell Installation	*TBD*	*TBD*	*TBD*
Direct	*TBD*	*TBD*	*TBD*
Indirect	*TBD*	*TBD*	*TBD*
Operations and Maintenance	*TBD*	*TBD*	*TBD*
Direct	*TBD*	*TBD*	*TBD*
Indirect	*TBD*	*TBD*	*TBD*
Annual Total:	54.2	$2,565,194	$10,172,144
Cumulative total over time period:	270.8	$12,825,971	$50,860,719

Back to Input Screen

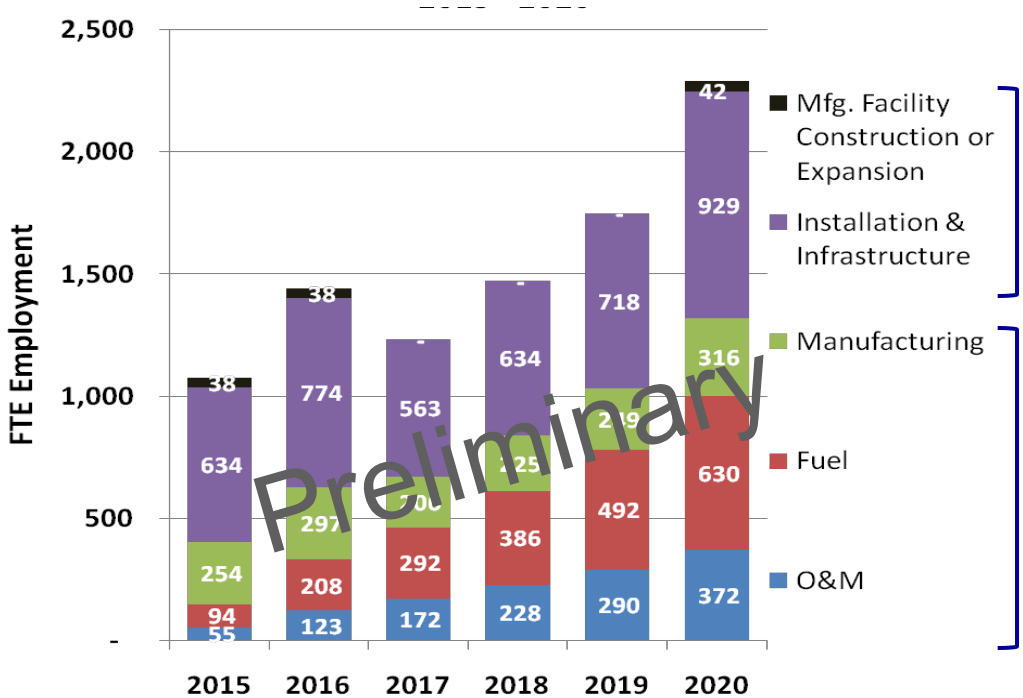
View Graphical Results

Direct, indirect and induced employment, earnings (wages + proprietor income) and economic output (revenue) from:

- Construction of fuel cell manufacturing facility
- Fuel cell production
- Fuel cell installation
- Fuel cell operation and maintenance (recurring)

Progress, cont'd

Example: Gross National Impact of PEMFCs in Forklifts



- ***Short-term jobs**:* Construction/ expansion of manufacturing capacity, installation and infrastructure.
- In this example, existing manufacturing capacity limits need for new construction/expansion.
- ***On-going jobs**:* Manufacturing, O&M and fuel production and delivery.
- O&M and fuel production/delivery jobs grow with cumulative fuel cell installations.
- ***Total Earnings (wages + proprietor income) in 2020 = $151 million***
- ***Total Economic Output (revenue) in 2020 = $539 million***

Technology/Market Assumptions:

- $1,300/kW initial manufacturing cost (*Battelle*), $4,200/kW retail price.
- Shipments reach 3,300 annually by 2020 *(Greene et. al.)*.
- 15,000 FC forklifts in operation by 2020 (<2 percent of Class 1-3 forklifts).
- Average of 60 fuel cells/site; investment tax credit expires in 2016.

Collaboration

Stakeholders:

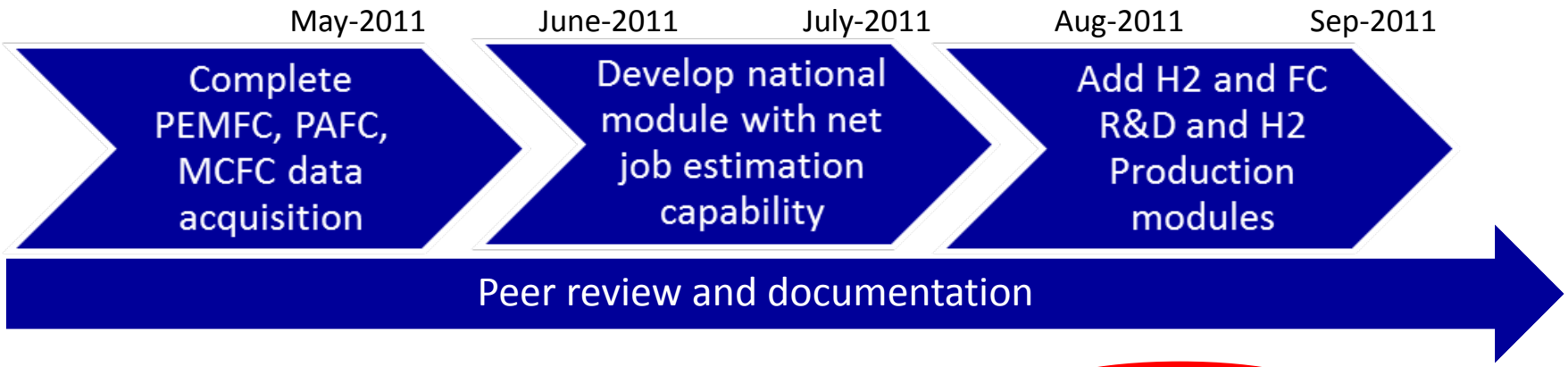
- South Carolina Hydrogen and Fuel Cell Alliance
- California Fuel Cell Partnership
- Connecticut Hydrogen Fuel Cell Coalition

Industry peer review:

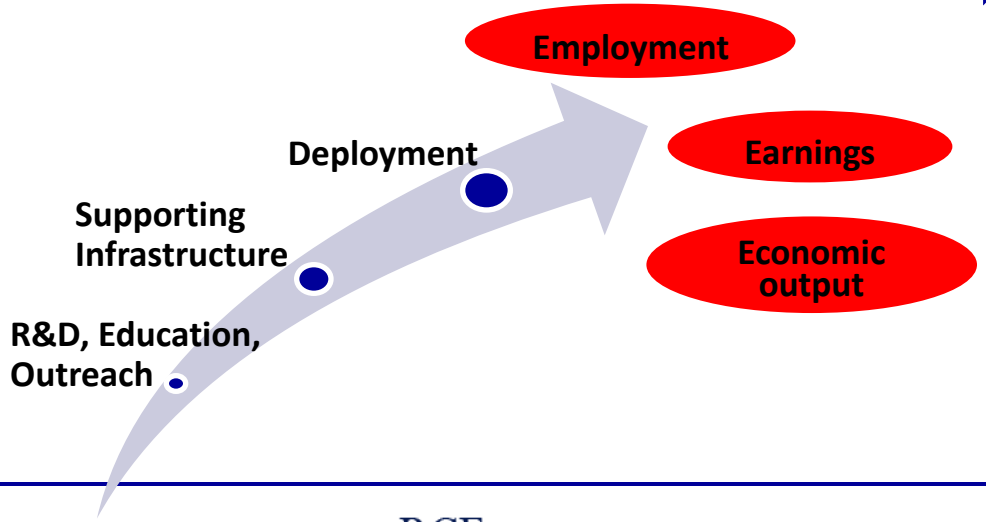
- Fuel cell producers
- Trade associations

Future Work

Tool completion and refinement



Potential follow-on work:
Capability to model economic impact of site-specific fuel cell installations



Summary

- **Relevance:** Developing a user friendly tool to meet DOE and stakeholder needs for estimating economic impacts of early-market deployment of fuel cells in stationary, backup power and materials handling applications.
- **Approach:** Using input-output economic modeling to calculate direct and indirect employment, earnings and economic output at state, regional and national level.
- **Collaborations**: Active partnership between ANL & RCF. Regular stakeholder interaction.
- **Technical accomplishments and progress:**
  - Design and implementation of spreadsheet tool to calculate economic impact of FC production for early markets (i.e., 2015–2020) at state and regional level.
  - Obtaining stakeholder input on tool features and requirements.
  - Acquired IMPLAN models and data to model PEMFCs; acquiring MCFC and PAFC data.
  - Developed working prototype in which user chooses geographic area, FC type, application, size, production quantity and analysis time (plus 11 optional inputs).
  - In process of adding MCFCs and PAFCs, and national module.
- **Future research**: Refine PEMFC and add PAFC and MCFC options. Develop modules to estimate economic impact of hydrogen production, and hydrogen and fuel cell R&D. Add capability to model economic impact of site-specific FC installations.

REVIEWER-ONLY SLIDES

Critical Assumptions and Issues

For Peer Reviewers Only

- Because PAFC and MCFC production are limited to single manufacturers, acquisition of supply chain data is hampered by confidentiality issues. UTC has been very helpful in dealing with this problem, supplying us with generic cost data that does not compromise proprietary concerns.
- Estimates for installation and operating and maintenance costs are being developed from actual FC installations. However, these costs are often bundled into contracts, along with capital and warranty costs. Warranties typically assume at least one FC stack replacement within the term of the contract, making it difficult to separate capital from O&M costs.
- State level IMPLAN models do not differentiate between out-of-state and out-of-country inputs. Thus, care must be taken in evaluating state level results in the absence of regional and national level results which are better able to capture these effects.

Critical Assumptions and Issues, cont'd

For Peer Reviewers Only

- State and regional models estimate gross changes in employment, earnings and economic output. The national model will account for industry displacement and thus estimate net employment, earnings and economic output, as well as gross values.
- IMPLAN reflects dollar flows and associated employment for 440 sectors of the US economy in 2009. In effect, IMPLAN is a snapshot of the economy's structure and the import and export patterns of individual industries. These patterns cannot be adjusted.