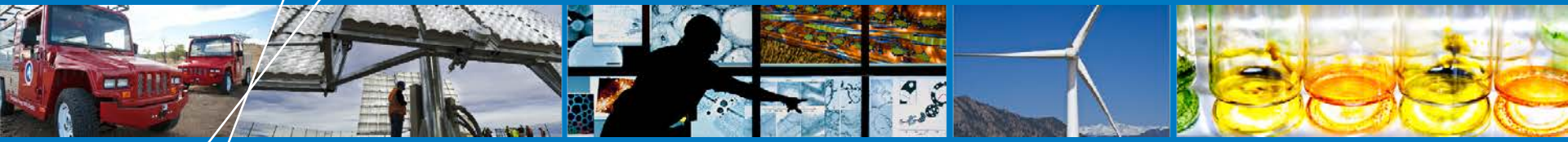
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Fuel Cell Technology Status
Cost & Price Status



2014 DOE Annual Merit Review

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Project ID# FC-081

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Overview

Timeline	Barriers
Project start date: July 2009 Project end date: October 2014[1] Percent complete: On-going	Lack of data for current fuel cell system cost and price
Budget	**Partners**
FY13[2] DOE Funding: $150k Planned FY14 Funding: $100k Total DOE Project Value: $550k	See collaboration slide

[1] Project continuation and direction determined annually by DOE

[2] FY09 – FY13 project objective focused on status of fuel cell durability

Relevance: Objectives

Benchmark current fuel cell system cost/price*

Utilize National Fuel Cell Technology Evaluation Center (NFCTEC)

- ***Leverage established fuel cell developer relationships***
- ***Leverage trust established in processing and publishing confidential data***

Collaborate with key fuel cell developers

*All data is supplied voluntarily, kept confidential, and published as aggregate results reviewed and approved by data providers.

Approach: NFCTEC Analysis and Reporting of Real-World Operation Data

Bundled data (operation & maintenance/safety) delivered to NREL quarterly

Internal analysis completed quarterly in NFCTEC

National Fuel Cell Technology Evaluation Center

Results

DDPs

Confidential

Public

CDPs

Detailed Data Products (DDPs)

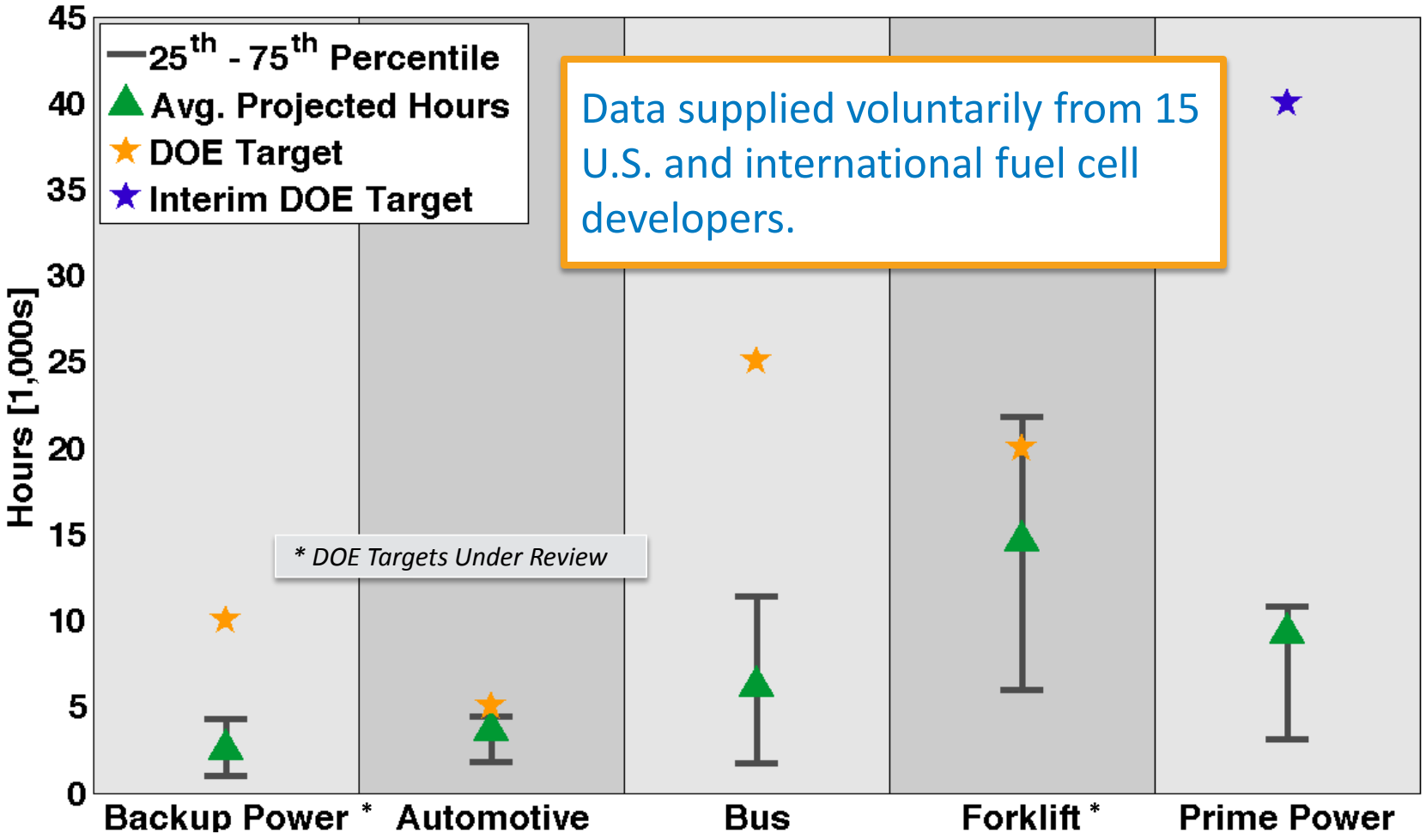
- Individual data analyses
- Identify individual contribution to CDPs
- Shared every six months only with the partner who supplied the data

Composite Data Products (CDPs)

- Aggregated data across multiple systems, sites, and teams
- Publish analysis results every six months without revealing proprietary data

www.nrel.gov/hydrogen/proj_tech_validation.html

Approach: FY13 Lab Data Fuel Cell Technology Durability Status *CDP Example*

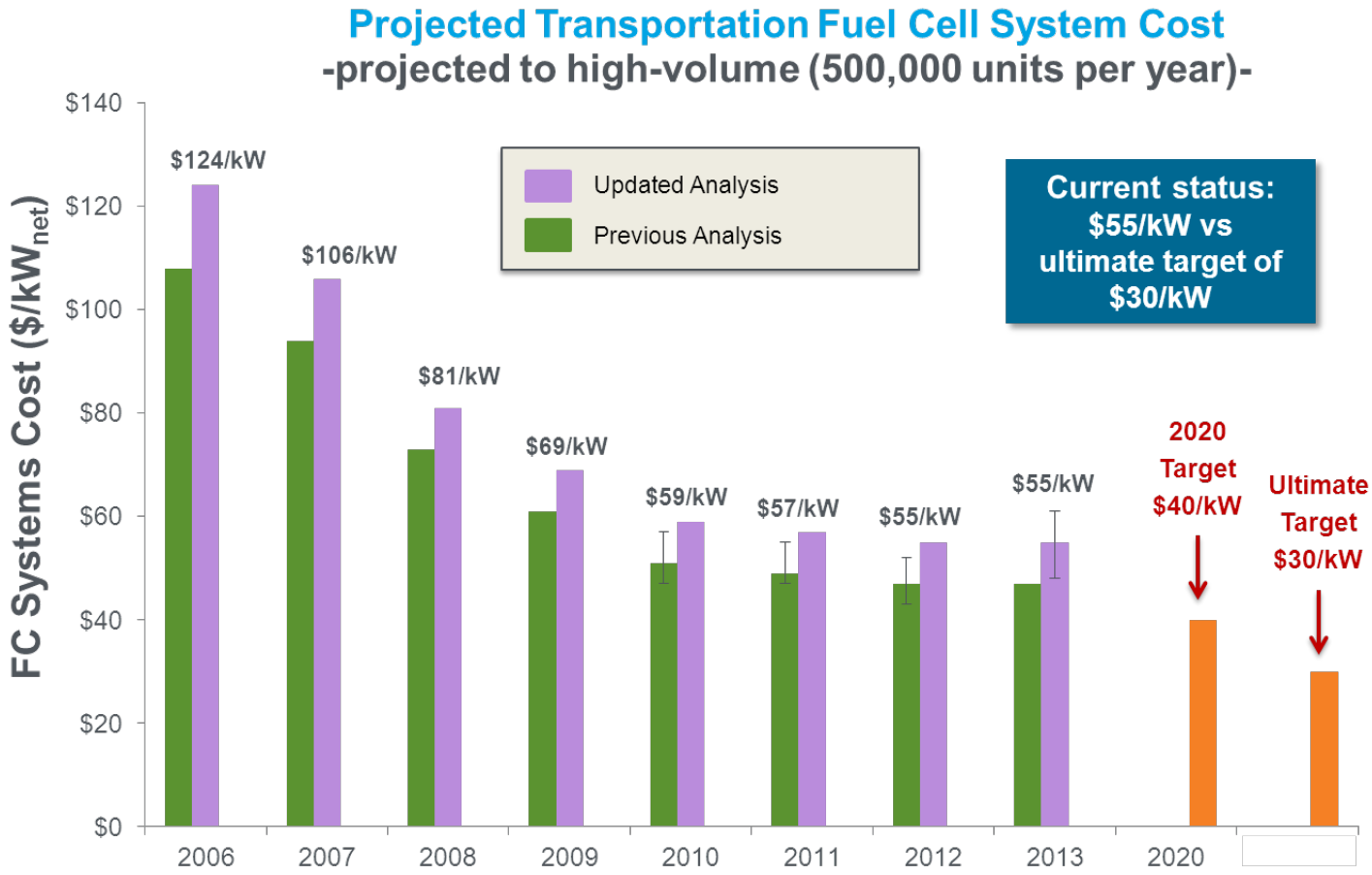


Data supplied voluntarily from 15 U.S. and international fuel cell developers.

Analysis – hours to 10% voltage degradation

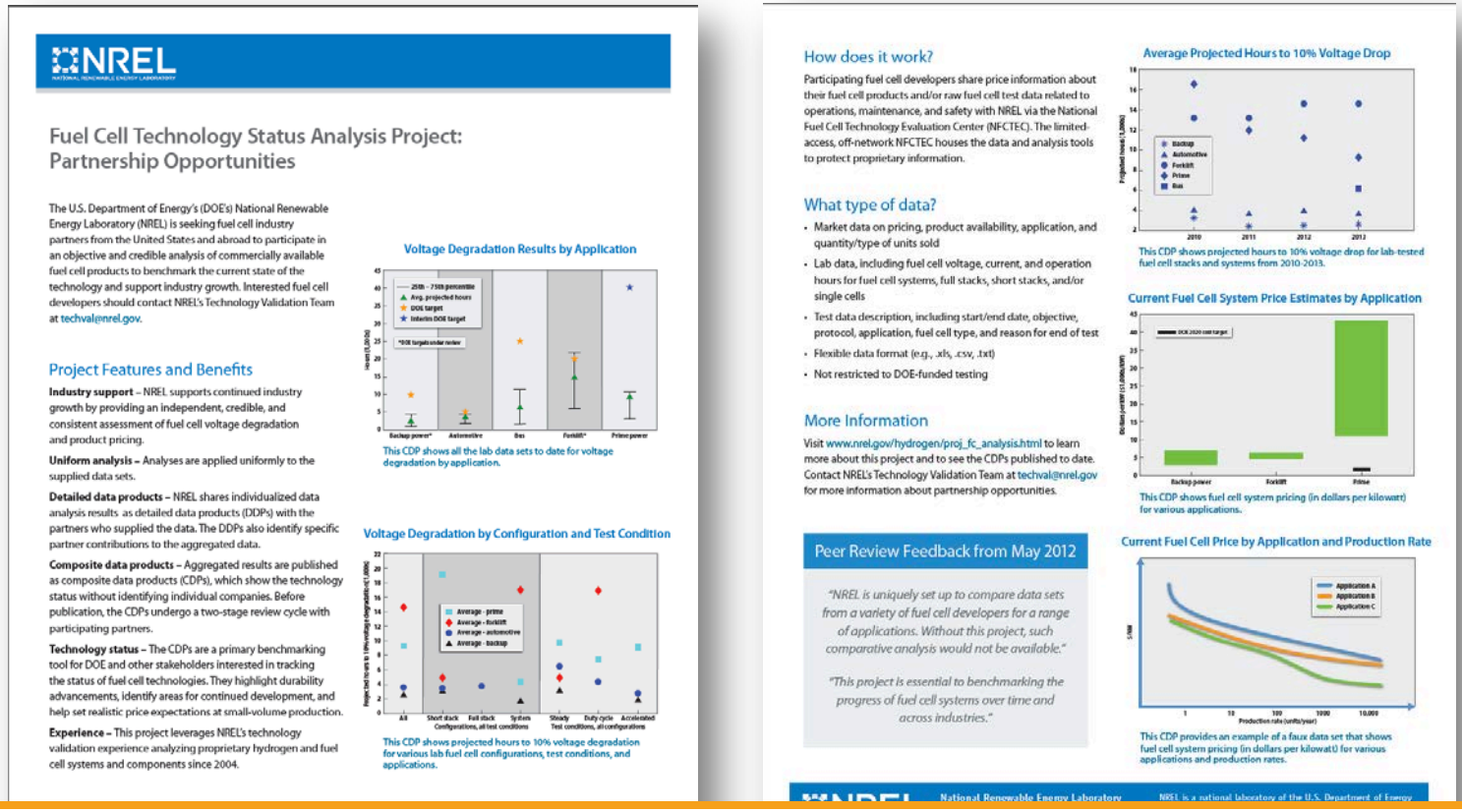
Data presented at 2013 AMR

Approach: Current Status to Complement DOE Fuel Cell System Cost Based on Models for High Volume



Record Source: http://www.hydrogen.energy.gov/pdfs/13012_fuel_cell_system_cost_2013.pdf

Accomplishment: Pamphlet with Participation Details and Benefits



NREL

Fuel Cell Technology Status Analysis Project: Partnership Opportunities

The U.S. Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) is seeking fuel cell industry partners from the United States and abroad to participate in an objective and credible analysis of commercially available fuel cell products to benchmark the current state of the technology and support industry growth. Interested fuel cell developers should contact NREL's Technology Validation Team at techval@nrel.gov.

Project Features and Benefits

Industry support – NREL supports continued industry growth by providing an independent, credible, and consistent assessment of fuel cell voltage degradation and product pricing.

Uniform analysis – Analyses are applied uniformly to the supplied data sets.

Detailed data products – NREL shares individualized data analysis results as detailed data products (DDPs) with the partners who supplied the data. The DDPs also identify specific partner contributions to the aggregated data.

Composite data products – Aggregated results are published as composite data products (CDPs), which show the technology status without identifying individual companies. Before publication, the CDPs undergo a two-stage review cycle with participating partners.

Technology status – The CDPs are a primary benchmarking tool for DOE and other stakeholders interested in tracking the status of fuel cell technologies. They highlight durability advancements, identify areas for continued development, and help set realistic price expectations at small-volume production.

Experience – This project leverages NREL's technology validation experience analyzing proprietary hydrogen and fuel cell systems and components since 2004.

Voltage Degradation Results by Application

This CDP shows all the lab data sets to date for voltage degradation by application.

Voltage Degradation by Configuration and Test Condition

This CDP shows projected hours to 10% voltage degradation for various lab fuel cell configurations, test conditions, and applications.

How does it work?

Participating fuel cell developers share price information about their fuel cell products and/or raw fuel cell test data related to operations, maintenance, and safety with NREL via the National Fuel Cell Technology Evaluation Center (NFCTEC). The limited-access, off-network NFCTEC houses the data and analysis tools to protect proprietary information.

What type of data?

- Market data on pricing, product availability, application, and quantity/type of units sold
- Lab data, including fuel cell voltage, current, and operation hours for fuel cell systems, full stacks, short stacks, and/or single cells
- Test data description, including start/end date, objective, protocol, application, fuel cell type, and reason for end of test
- Flexible data format (e.g., .xls, .csv, .txt)
- Not restricted to DOE-funded testing

More Information

Visit www.nrel.gov/hydrogen/proj_fc_analysis.html to learn more about this project and to see the CDPs published to date. Contact NREL's Technology Validation Team at techval@nrel.gov for more information about partnership opportunities.

Peer Review Feedback from May 2012

"NREL is uniquely set up to compare data sets from a variety of fuel cell developers for a range of applications. Without this project, such comparative analysis would not be available."

"This project is essential to benchmarking the progress of fuel cell systems over time and across industries."

Average Projected Hours to 10% Voltage Drop

This CDP shows projected hours to 10% voltage drop for lab-tested fuel cell stacks and systems from 2010-2013.

Current Fuel Cell System Price Estimates by Application

This CDP shows fuel cell system pricing (in dollars per kilowatt) for various applications.

Current Fuel Cell Price by Application and Production Rate

This CDP provides an example of a faux data set that shows fuel cell system pricing (in dollars per kilowatt) for various applications and production rates.

National Renewable Energy Laboratory

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The U.S. Department of Energy's National Renewable Energy Laboratory is seeking fuel cell industry partners from the United States and abroad to participate in an objective and credible analysis of commercially available fuel cell product cost/price to benchmark the current state of the technology and support industry growth.

Accomplishment: Benefits of Cost/Price Analysis

External

- Provide current cost status of fuel cell products
- Help set realistic price expectations at small volume production
- One source of realistic cost/price status for DOE from the leading fuel cell developers
- Highlights technology successes
- Helps adoption of fuel cell technology

Internal

- Provide independent, credible and consistent product cost/price information that is very useful for external partners (e.g. DOE and industry) without revealing proprietary information
- Benchmarking against CDPs
- Collaboration with NREL's technology validation team; dedicated analysis team with experience in multiple fuel cell applications

Provides DOE the actual price at low volume to complement the high volume model cost values.

Supports realistic expectations for current fuel cell system price.

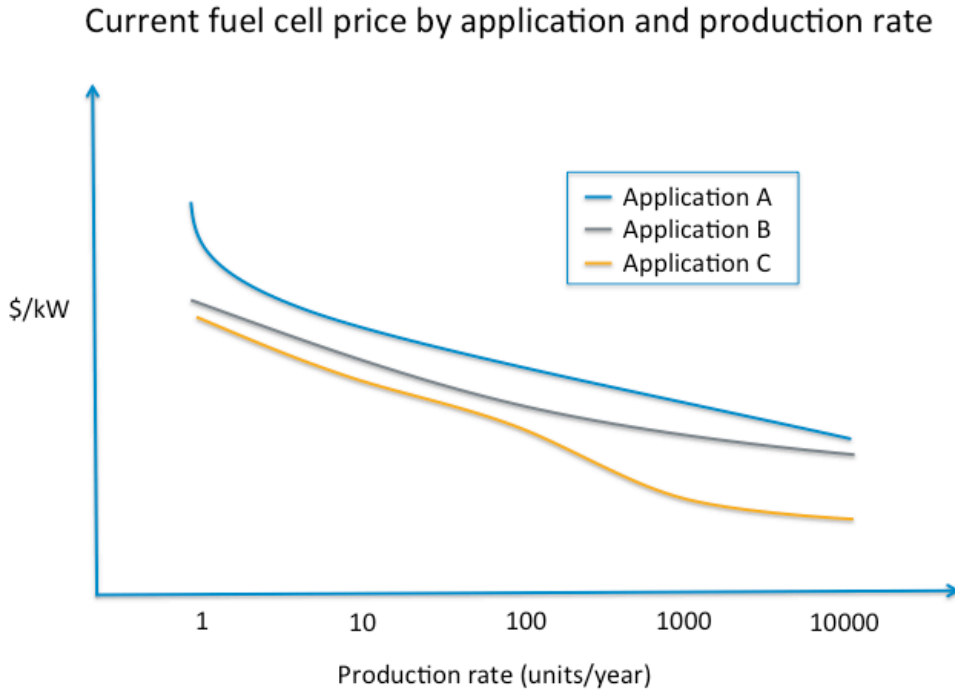
Participation and data share from developers critical for accurate status updates.

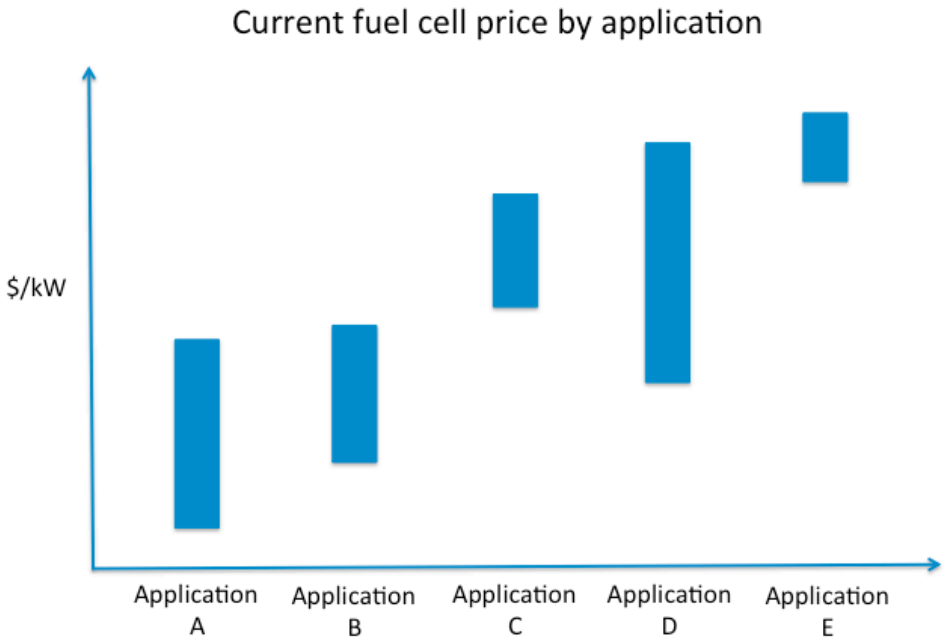
Accomplishment: Project Highlighted in NFCTEC DOE Webinar

Webinar covered NFCTEC overview, NFCTEC findings and benefits, and the the fuel cell cost/price aggregation project with 150 attendees.

Accomplishment: Example Results

Example results support conversations with developers on how data would be aggregated and published.





Accomplishment: Generic Cost/Price Template

4/7/14

Note: The information you provide here will be shared with the NREL National Fuel Cell Technology Evaluation Center for independent analysis and may be published as composite data products after a 2 stage review and concurrence process with the data providers. The information will be treated as confidential.

Instructions -

Please fill in applicable requested information for each available product, with each product entered as a new column. Some information may have been filled in based on an internet search of your available product. Please correct as appropriate.

System	ProductName1	ProductName2	ProductName32	ProductName4	ProductName5	ProductName6
Current Price (US $)						
Availability						
Market						
Application						
Fuel Cell Type						
Fuel						
Comments						
Power Rating (kW)						
Other features						
# systems sold to date						
2010 Price (US $)						
2012 Price (US $)						
2014 Price (US $)						
Current system cost (US $)						
Current fuel cell stack cost (US $)						
System efficiency						
Cell count						
Active area						
Turndown capability						
Spec sheet link or Product brochure PDF attached						

	Availability	Application	Fuel Cell Type	Fuel	Other features	Markets
	Available	Stationary Prime	DMFC	Hydrogen	CHP	Europe
	Future product	Stationary Residential	PEMFC	Methanol	CHHP	Japan
	No longer available	Stationary Backup	SOFC	Reformate	Other (Please specify)	United States
	Other (Please specify)	Forklift	MCFC	Other (please specify)		All
		Automotive	PAFC	Natural Gas		Other (please specify)
		Bus	AEM	Propane		
		Portable	Other (please specify)			
		Auxiliary				
		Other (Please specify)				

Example of generic form that would be filled out by a fuel cell developer.

Collaborations

- **Working with multiple fuel cell developers**
  - Developer names not released
  - 27 developers contacted
- **Data sharing is completely voluntary**
- **Ongoing effort to include additional fuel cell developers**

Future Work

- Publish a current cost/price aggregate CDP
- Alternate between a status update on fuel cell durability and system cost/price
- Update the lab fuel cell durability status (reviewed in 2013 AMR) planned for FY15
- Continue cultivating existing collaborations and developing new collaborations with fuel cell developers.

Summary

***Relevance*:** Independent aggregation of current fuel cell system cost/price complements high volume based model costs without revealing proprietary data.

***Approach*:** Leverage NFCTEC and prioritized industry collaborations.

***Accomplishments*:** Updated partnership pamphlet, project value and benefits, and example results.

***Collaborations and Future Work*:** Continue expanding analyzed data sets, including fuel cell developers, and results.