



**Clean Energy
Supply Chain
and Manufacturing
Competitiveness
Analysis
for Hydrogen
and Fuel Cell
Technologies**

US DOE Office of EERE
Fuel Cell Technologies Office
AMR, Washington, D.C., June 13-15, 2018

Project ID: MN012

Principal Investigator: Pat Valente, OFCC
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TIMELINE

- Start Date: Sept. 2015
- End Date: Aug. 2018
- Currently in Budget Year 3

BUDGET

- Start Date: Sept. 2015
- End Date: Aug. 2018
- Total Project Budget \$583,243
- Total Federal Share \$583,243
- Total Federal Funds spent: \$360,695.72 as of 4/30/18

BARRIERS

- Lack of standardization and cost of manufacturing
- Lack of national accessible database
- Lack of communication nationally between OEMs and suppliers

PARTNERS/COLLABORATORS

- Pat Valente, Ohio Fuel Cell Coalition (OFCC - project lead)
- Douglas Wheeler, DJW Technology (DJWT)
- Michael Ulsh, National Renewable Energy Lab (NREL)
- Jack Brouwer, National Fuel Cell Research Center (NFCRC) at UC Irvine
- Joel Reinbold, Connecticut Center for Advanced Technology (CCAT)

OFCC DJWT NREL NFCRC CCAT

- **DOE Hydrogen and Fuel Cells Program
Manufacturing Challenges Addressed:**
 - **Cost of Manufacturing** - The route to reducing manufacturing costs includes the development of a robust domestic supply chain.
 - Identified critical opportunities in the hydrogen and fuel cell supply chain between Original Equipment Manufacturers (OEMs) and Component Suppliers via Supply Chain Exchanges/Workshops/database research.
 - Present needs, capabilities and value proposition. Providing this outreach works toward filling supply chain gaps and promote competitive pricing.
 - Advance supply chain with respect to multiple applications – including stationary, transportation, commercial, utility, and infrastructure.
 - Additional information gained from research, mapping, and supply chain events are utilized in the national Hydrogen and Fuel Cell Nexus, which promotes business-to-business interaction and an expanded domestic supply chain. (Project MN-013)

➤ **Durability, Reliability, and Performance**

- The formation of supplier working group(s) to openly exchange and analyze specific needs of the OEMs with multiple suppliers. Concentration on including a number of domestic companies
 - Standardization of components work to address these issues, as well as promote competition and improve components reliability and efficiency.

➤ **Broad range of environmental benefits**

- Includes sustainability, clean energy and use of renewable power, reduced greenhouse gas emissions, improved air quality and energy conversion.

➤ **Barriers Relevance**

- Over 275 personal interactions facilitated through national and state events to improve communication between OEMs and component suppliers.
- Finalized PEM fuel cell OEMs/Integrators that have agreed to participate in The Working Group for standardization of BOP components and scored potential components for review.

Task #	Milestone and/or Deliverable	Description	Verification	Est. Quarter Completion	Planned Completion	Actual Completion
1.1	M1	Technical Exchange Centers Start-up and update of existing databases; JMU compatibility; Hold Supply Chain Exchange	2 Centers started, 2 converted; JMU compatibility verified, one supply chain event held in CT 10/2015	1	Mar-16	Sep-16
1.2	M2/D1	Creation of OEM needs brochure identifying components to be produced by suppliers	OEM needs to be determined with working group, but facing barriers of proprietary information and participation concerns	2	Sep-17	Sep-18
1.3/1.4	none	OFCC and subcontractors to hold Supply Chain Exchanges	Supply Chain Exchanges held in CA 5/2016 and OH 9/2016	4	Sep-16	Sep-16
2.1	none	Identification of working group participants	In progress but proceeding slower than expected due to OEM response times; include more domestic participants	4	Sep-17	Apr-18
2.2	M3	Identification of components and subsystems for standardization	In collaboration with MN014, GLWN, seven components are under consideration for standardization	4	Sep-17	Apr-18
Go/ No Go	none	Facilitate 200+ supplier and OEM interactions; 50 new contacts for national database	213 interaction facilitated; 476 contacts to national database	4	Sep-16	Sep-16

Future

In progress

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Approach – Milestones/Deliverables

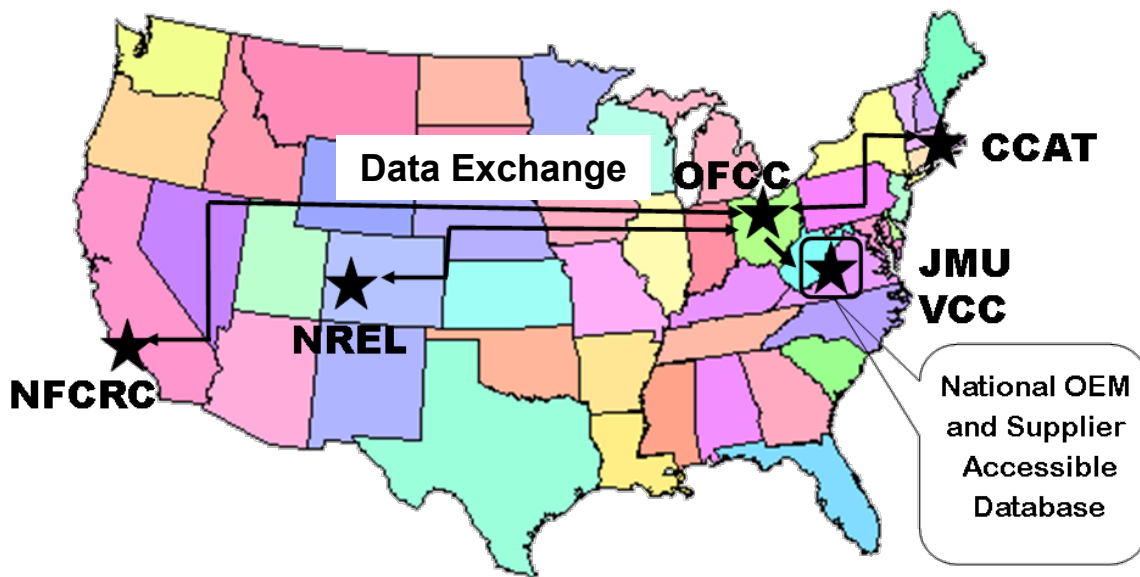
3.1	M4	Promote data exchange between OEMs and suppliers/provide progress report; hold Supply Chain Exchanges	Supply Chain Exchange in OH 3/2017; one to be held in CO 8/2017; progress report to be submitted	8	Sep-17	Sep-18
3.2	M5	National Supply Chain Exchange at FCS & EE	No national event in 2016; 2017 just announced for 11/2017	6	Nov-17	Nov-18
4.1	none	Working Group to identify components for standardization	In conjunction with GLWN (MN-014) suggested components identified	6	Aug-18	
4.2	M6/D2	Implement working group strategy for standardization; report on gaps, strategies, cost reduction	Team will work with suppliers/OEMs to identify topics and strategies for cost, performance, and durability improvements.	8	Aug-18	
Go/No Go	none	Facilitate 250+ supplier and OEM interactions; 50 new contacts for national database	To date - facilitated 247 interactions (one more event scheduled); 50 contacts to national DB	8	Sep-17	Sep-18
5.1	none	Establish national database	Working with MN-013 JMU/VCC and info transfer ongoing	12	Mar-18	
5.2	M7	Hold one national and several regional Supply Chain Exchanges and collect data and provide summary	Team will continue to plan and host events for interaction at both regional and national level	12	Aug-18	
6.1	M8/D3	Working group recommendations for specs and production processes for initial standardized component; report on such to DOE	Team will work with working group for recommendations and prepare report	12	Aug-18	
7	D4	Reports, AMR presentation and project results to DOE	Reports, other deliverables, and final report will be prepared	12	Aug-18	

Future In progress

OFCC DJWT NREL NRCRC CCAT

Any proposed future work is subject to change based on funding levels.

Operation of 4 Regional Technical Exchange Centers to transition to National Website Database



Due to the concentration and location of manufacturing facilities and number of states involved, four regional centers allow more thorough research, advanced interactions between OEMs and suppliers, and ability to build a quality supply chain database.

Promotion of Data Exchanges and Increased Collaboration between Suppliers and OEMs

- **August 17, 2017 – CleanTech Manufacturing Forum in Parker Colorado**
 - » Collaborators – National Renewable Energy Laboratory (NREL), Colorado Hydrogen Coalition (CHC), Colorado Cleantech Industries Association (CCIA) and the Colorado Advanced Manufacturing Alliance (CAMA)
 - » Focus: Tailored to the Rocky Mountain Region of manufacturers and suppliers for the clean energy technology industry
 - » Attendance: 89 participants
 - » Connections: informal opportunities during business to business networking session and reception, and electric and fuel cell vehicle ride and drives,
 - » Reach:

- **November 8, 2017 – National Supply Chain Exchange at Fuel Cell Seminar, Long Beach, CA**
 - » Collaborator – Ohio Fuel Cell Coalition (OFCC), U.S. DOE/EERE/FCTO, National Renewable Energy Laboratory (NREL), Connecticut Center for Advanced Technology (CCAT), DJW Technology (DJWT)
 - » Participants: 84 connections with 22 suppliers and 6 integrators
 - » Reach: 10 states represented – CA, CO, CT, MA, MD, MI, NC, NY, OH, PA, Vancouver, BC Canada, Horsham UK, Osaka, Japan
 - » Survey results : 75% made new contacts; 64% continuing dialogue

- **April 6, 2018– Northeast Hydrogen Highway Summit– Wallingford, CT**
 - » Collaborator – Connecticut Center for Advanced Technology/Proton OnSite
 - » Ribbon Cutting of first retail hydrogen refueling station on the East Coast.
 - » Panel discussion with government and industry leaders to explore how to lay the foundation for building the Northeast Hydrogen Highway.

- **October 2-3, 2018 - Ohio Fuel Cell Symposium, Stark State College, North Canton, OH**
 - » Planning has begun for this event
 - » A ribbon-cutting will take place for an LG 250kw SOFC fuel cell that was funded by the U.S. Dept. of Energy and will be located at Stark State College
 - » Speakers to include individuals from U.S. Dept. of Energy, LG Fuel Cell Systems, Plug Power, OFCC, and Stark State College
 - » The OFCC will host a supply chain event during the Symposium

- **Continue outreach efforts within the region to support and grow the Midwest Technical Exchange Center:**
 - » Edison Welding Institute (EWI), the premier materials joining center in the world
 - » American Electric Power (AEP) and LG Fuel Cell Systems re: micro grid supply chain
 - » Plug Power and Fast Lane MEP re: nozzle supply chain
 - » Plug Power re: component assistance for revised control panel, larger fuel cell tanks, improved ballast, flow-through plates.
 - » Eastern Michigan University to expand the Midwest TEC region and discuss a potential fuel cell conference there in 2019
 - » Eaton Corporation re: micro grids, hydrogen, and batteries

Events Relevance: DOE Manufacturing R & D activities for supply chain development.

- Initiate and promote communication between OEM's and integrators
 - Partner with different collaborators whose event focus has diverse participants = more information and contacts
 - Suppliers and OEMs matched based on their specified needs and capabilities
- Completion of the OEM needs-based brochure for use with potential suppliers
- Events in-progress align with project objectives for Tasks 1, 3 and 5, Start-up/Operation/Completion of Regional Technical Exchange Centers

Database Progress

- Continue to evaluate and research relevant companies for database info and events
- Completed identification and initial mapping of supply chain for hydrogen refueling.
- Identify opportunities for database management and integration
- Exploring opportunities to better inform related industries about the database

Standardization (tasks 2, 4, 6)

- With the assistance of the Fuel Cell Technologies Office (FCTO), eight PEM fuel cell OEMs/Integrators in the automotive and stationary sectors have agreed to participate in The Working Group for standardization of BOP components. These OEMs scored 45 Balance-of-Plant components to be of potential interest for standardization. Seven of these components received the highest cumulative scores and are identified in Table 1.

Table 1: PEM Highest BOP Components Cumulative Scores: Scored by OEMs/Integrators	Score
Humidifier	8
DC-DC Converter	8
Air Blower (higher pressure)	7
Air Compressor (highest pressure)	6
Air Filters	6
Pressure Regulator Fuel	6
Gas Sensor	6

Standardization (tasks 2, 4, 6)

- A report detailing the results of the scoring of the forty-five components identified by the Working Group was prepared without OEM/Integrator attribution. The report will be distributed to the Working Group upon approval by FCTO.
- This Working Group activity will include the following:
 - Review of results from questionnaire by OEMs and Integrators.
 - Meeting (telecom) to discuss pre-commercial BOP components with all eight OEMs/Integrators participating. This requires acceptance by OEMs/Integrators to be identified to each other and initiate pre-commercial component discussions and activities.
 - Working Group selects BOP components for standardization; up to three components are recommended to be selected.
- A list of potential suppliers was identified by the Ohio Fuel Cell Coalition and the National Renewable Energy Laboratory.

Reviewer's Comment from 2017	2018 Response/Action to comment
<p>Engagement is limited and should be expanded to a wider network of fuel cell representatives</p>	<p>Work has begun to broaden the Technical Exchange Centers reach by aligning Midwest and Northeast resources and building on manufacturing/related services expertise to be a dominant force in the sustainable energy market and create strong job growth in the process. A number of potential collaborations have been identified and will be evaluated for effectiveness.</p>
<p>Lack of OEM needs brochure</p>	<p>This brochure was designed and created for use at the 2018 Fuel Cell Seminar and Exposition and the National Supply Chain Exchange.</p>
<p>OFCC should place greater emphasis on creating and using the standardization working group.</p>	<p>This task took much longer than anticipated to move forward due to OEM reluctance to initially participate, caution with proprietary information, and slow response time. With concerted effort and the help of FCTO, participants have been identified, more domestic ones included, as well as potential standardized components.</p>

Collaborators (w/project budget after 11/2017 adjustment)	Relevance of Collaborators
Patrick Valente, Ohio Fuel Cell Coalition Prime (\$169,597)	Responsible for all programmatic and technical decisions for the project.
Joel Reinbold, Connecticut Center for Advanced Technology (CCAT); subcontractor (\$121,201)	Establish and coordinate the East Coast Technical Exchange Center; assist with supply chain mapping and standardization.
Douglas Wheeler, DJW Technology (DJWT); subcontractor (\$116,386)	Establish and coordinate the West Coast Technical Exchange Center at NFCRC; set –up working group; consulting.
Jack Brouwer, National Fuel Cell Research Center (NFCRC) at UC Irvine; subcontractor (\$46,059)	Establish and coordinate the West Coast Technical Exchange Center.
Michael Ulsh, National Renewable Energy Lab (NREL – Federal Lab); subcontractor (\$130,000)	Technical support and establish and coordinate Central Plain/Mountain Region States Technical Exchange Center; establish working groups.
Additional Collaborations	JMU/VCC MN-013 and GLWN MN-014

- Integration between Technical Exchange Centers database and national database (need API); ability to continue after funding ceases
- Lack of communication nationally between OEMs and suppliers
 - Supply chain event issues: with limited OEMs nationwide, frequency of exchanges/events create challenges; need to provide new and different suppliers to meet them.
 - Barriers in Mountain Region expansion with limited fuel cell supply chain and OEMs
- Lack of robust supply chain for fuel cell and hydrogen industry
 - High manufacturing cost of component and fuel cell systems
- Lack of component and system standardization
 - Working group and standardization barriers: release of proprietary information; hesitancy to participate
 - Fuel cell stack, carbon fiber composite, and fabricators of hydrogen storage tanks too proprietary to focus on standardization
- Integration of hydrogen fueling station components and their supply chain

FY 2018:

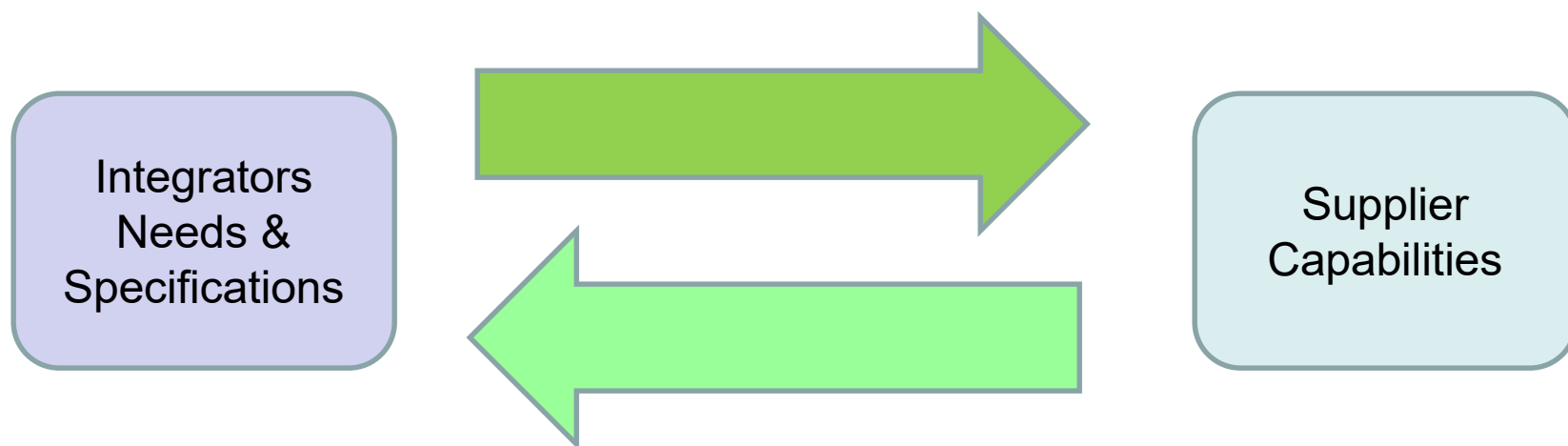
- Facilitate supplier and OEM interaction through the 2018 Ohio Fuel Cell Symposium, scheduled October 2-3, 2018 at Stark State College in North Canton, OH and a supplier event to be held during the Symposium
- Continue evaluation of organizations/companies for potential event participation and inclusion in the H & FC Nexus
- Explore and finalize seamless database integration and search capabilities
- Continue with Working Group and standardization tasks.

Future: (funding not secured as of this report)

- Expansion of the Midwest and Northeast regions to include reach into more states
- Focus on Hydrogen Roadmap for deployment and infrastructure
- Identify and assess advanced manufacturing resources for industry engagement
- Consensus on components and their specifications for standardization
- Identification of suppliers for standardized components
- Funding and management of supplier activities
- Evaluation of results of supplier standardization activities

Any proposed future work is subject to change based on funding levels.

Project focus is two way technology transfer between
Integrators and Suppliers



The Integrated Regional Technical Exchange Centers project is to facilitate the development of a robust supply chain for fuel cell and hydrogen systems that will accelerate mass production, reduce costs, and improve performance and durability of these systems by:

- Regional Technical Exchange Centers and nationwide supply chain exchanges provide increased communications between OEMs and suppliers, identification of needs and gaps in supply chain, contact and component information for web and public accessible national database.
- Working groups (supplier, OEMs and standardization) provide strategy for component standardization, recommendation for specifications and production processes leading to competitive cost reduction, more durable and better performing parts.
- Identification of critical opportunities in the hydrogen and fuel cell supply chain where the U.S. can achieve or maintain a competitive advantage.