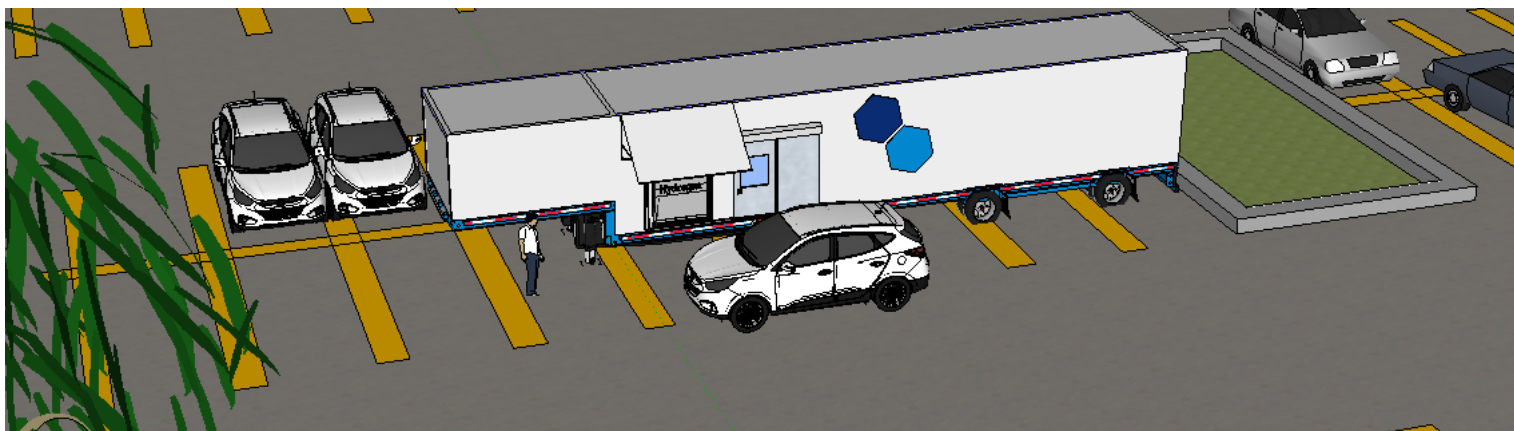


Innovative Advanced Hydrogen Mobile Fueler

Project ID: TV039



P. I.: Sara Odom

Presenter: Spencer Quong

Electricore, Inc.

June 13, 2018

Overview

Timeline and Budget

- **Project Start Date**— 07/01/2016
- **Project End Date** — 12/31/2019

* Schedule dependent on go/no-go approval of next phase

Partners

- **Electricore** – Federal Project Manager / PI
- **Air Liquide** – Design / Demonstration
- **HTEC** – Design & Fabrication
- **QAI** – Technical Lead
- **Manta Consulting** – Economic Analysis

Funding	
Total Project Budget	\$2,589,815
Total Recipient Share	\$1,301,033
Total Federal Share	\$1,288,782
Total DOE Funds Spent As of 3/31/18	\$449,377

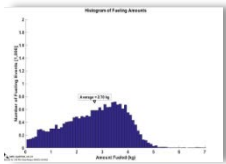
Barriers Addressed

- Lack of hydrogen refueling infrastructure performance and availability data
- Hydrogen storage
- Codes and standards

Relevance

Key Objectives

- ▶ Design and build an Advanced Hydrogen Mobile Fueler (AHMF)
- ▶ Deploy AHMF to support a network of H₂ stations and vehicles
- ▶ Gather and analyze fueling data for NREL Technology Validation Team



FCT Office Barriers	AHMF Impact
Mobile fueler performance and efficiency data	<ul style="list-style-type: none">• Designing liquid nitrogen cooling system to reduce on site energy consumption
Transportable hydrogen storage	<ul style="list-style-type: none">• Reduction of cost and setup time by obtaining special permit from DOT to allow transporting of H₂ at 95 MPa
Codes and standards for mobile fueling	<ul style="list-style-type: none">• Educating states with no experience in metering of hydrogen• Addressing issues of metering of hydrogen in multiple states

Approach

Current Activities - *Estimated Completion December 2018*



Next Steps - *Estimated Completion June 2020*



Approach

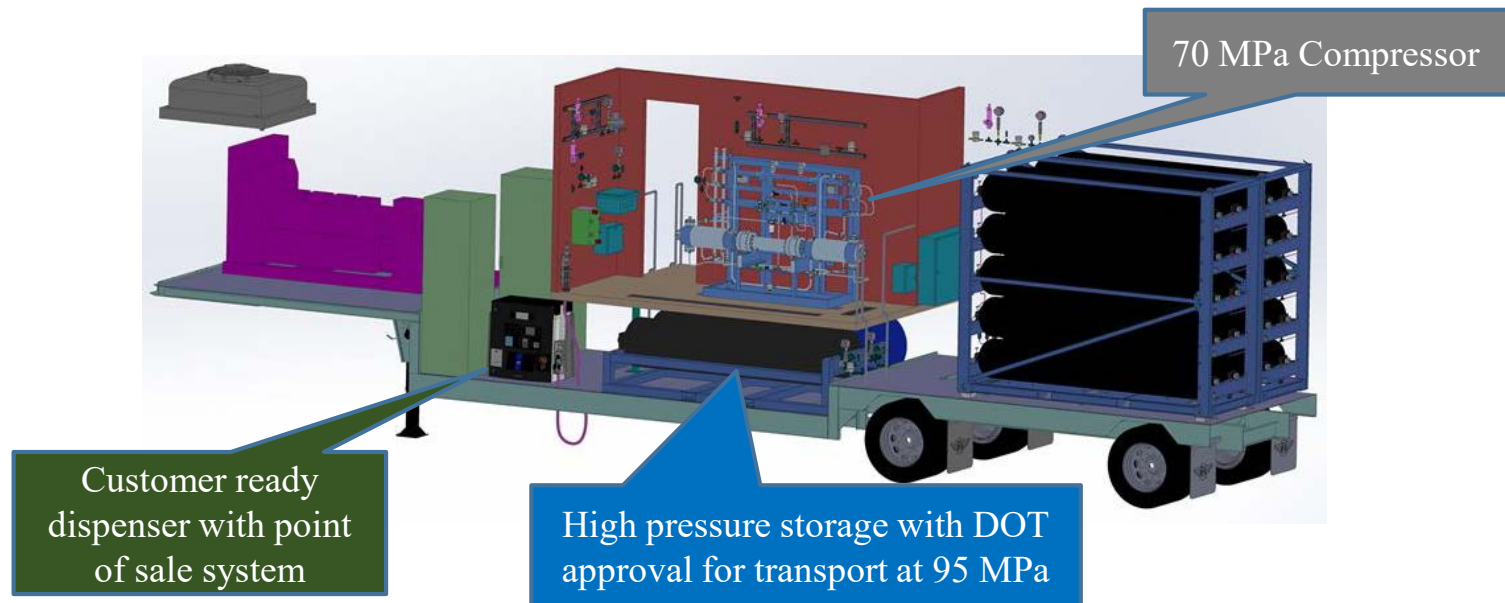
Previous Accomplishments

Task 1	Specifications	<ul style="list-style-type: none">• AHMF specifications finalized• Reviewed and approved by DOE
Task 2	Component Selection	<ul style="list-style-type: none">• Select major and time sensitive components and sub-systems• Long lead items ordered
Task 3	AHMF Design	<ul style="list-style-type: none">• Final design documents completed and submitted to DOE• Initial hazard analysis completed• Project reviewed by DOE H₂ Safety Panel

Approach

Specifications

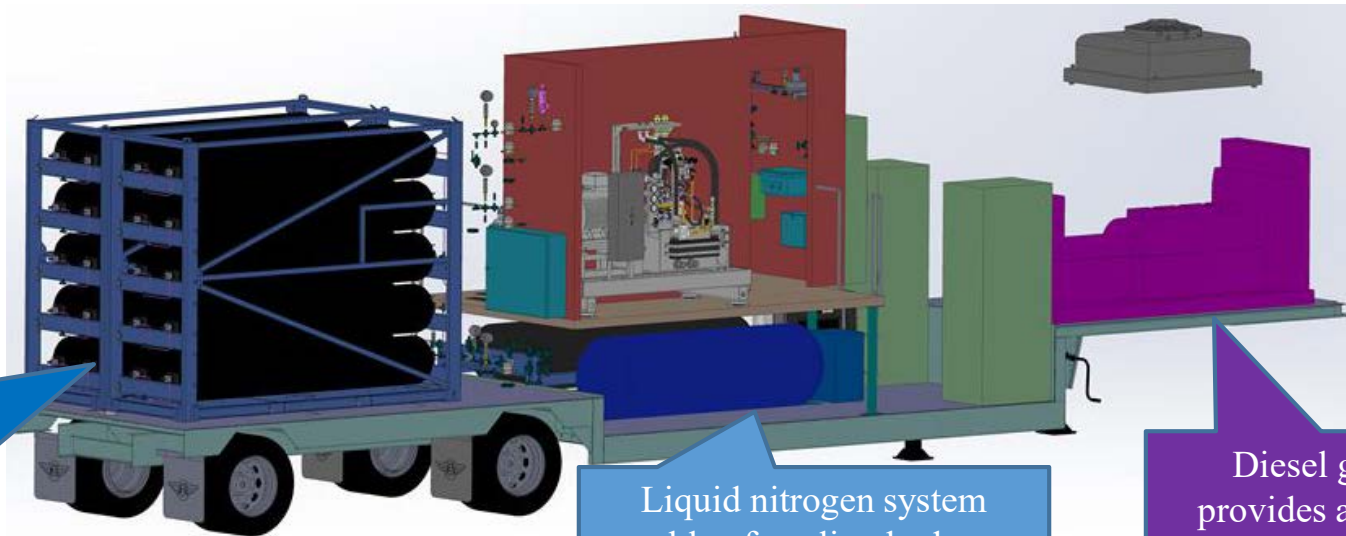
- ▶ Fully functional mobile fueller capable of filling vehicles to 95-100% in 3-5 minutes (SAE J2601 compliant H70 T40)
- ▶ 175 kg of storage. Can fill 3-5 cars in first hour, 20-40 cars daily
- ▶ Customer ready dispenser capable of retail sales
- ▶ Fully self contained with option for use of external power and hydrogen supply



Approach

Design Features

- ▶ AHMF based upon Air Liquide C100 (stationary) hydrogen station deployed in Northeast US
- ▶ AHMF fully contained in 45 foot trailer
- ▶ High and mid-pressure composite storage are DOT approved and can transport at full pressure
- ▶ Innovative liquid nitrogen system allows for cooling of hydrogen to -40C (T40)



Modular mid-pressure storage approved for transport at 45 MPa

Liquid nitrogen system capable of cooling hydrogen to -40C

Diesel generator provides all power to operate AHMF

Accomplishments and Progress



- ▶ **Bill of materials complete and all components identified for purchase**
- ▶ **Key components ordered (*delivered)**
 - ▶ Compressor *, dispenser*, MP storage, trailer, and electrical panel



- ▶ **Special permit from DOT to allow transport of hydrogen at full pressure in composite cylinders pending**
 - ▶ Eliminates need to vent and purge before/after transport
 - ▶ Composite tanks can be used with special permit used on other projects



- ▶ **Design of innovative liquid nitrogen system complete**
 - ▶ Significant reduction in power consumption, size and weight compared to conventional system
 - ▶ Based upon Air Liquide Blueeze™ refrigerated transport system (pictured on left)

Refrigerated truck with
Blueeze™ System

Accomplishments and Progress




- **Manufacturing site selected and construction plan started**
 - Develop both sub-system and full AHMF test plans to evaluate AHMF functionality and safety prior to field deployment
- **Packaging design complete and trailer 95% built**
 - The floor design and trailer packaging is complete and the trailer production complete
 - Includes access points, ventilation, and mounting points
- **Operational plan and safety review started**

Accomplishments and Progress

Responses to Previous Year Reviewers' Comments

Past Comments	Response
Concerns over physical size	AHMF will be mounted in a 45 foot trailer. A smaller trailer was impossible given the packaging constraints. The estimated weight of the AHMF is 60,000 lbs. which is legal to drive over unrestricted roads.
Concerns over transportation	The team is using a trailer design that has been used to transport fragile electronics. Many of the components will have anti-vibration protection. The team has also interviewed other mobile fueler manufacturers to capture their lessons learned.
Use of alternative fuels for generator	The operations team recommended the use of diesel in order to simplify logistics and reduce cost. The team will use a low emissions generator
Concerns over siting	The AHMF will be listed to NFPA2, NEC and other key codes/standards to assist in AHJ approval. The size of the trailer will limit its use at existing fueling stations, but the mobile nature will allow fueling at many other locations

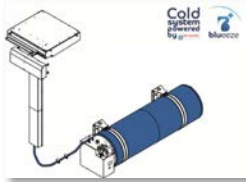
Collaboration and Coordination

Team Members		Role
	Air Liquide	Design/Operations Project Co-Funding
	HTEC Hydrogen Technology & Energy Corporation	Design and Fabrication
	Quong & Associates, Inc.	Technical Lead
	Manta Consulting	Economic Analysis

Collaboration	Role
National Renewable Energy Lab	Data Collection and Analysis
Multiple automotive companies	Advisor on Site Selection/Usage
US Department of Energy Hydrogen and Safety Panel	Safety Analysis
US Department of Transportation	High pressure special permit
Hexagon Lincoln LLC	Composite tank manufacturer

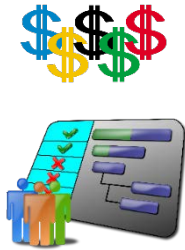
Remaining Challenges

Liquid Nitrogen Cooling



- **Challenge:** Build and calibration of LIN cooling system which will be the first to meet SAE J2601 fueling protocol
- **Solution:** Team will draw upon experience of Air Liquide's Blueze™ system and other H₂ fuelers which use LIN

Cost and Schedule



- **Challenge:** Cost and time of special permit for hydrogen storage and LIN system not factored into original plan
- **Solution:** The additional scope will reduce costs of future systems. The team is continuing work on other systems in parallel to reduce impact of schedule

Site Selection



- **Challenge:** Need to find sites to support fueling infrastructure and allow sale of hydrogen
- **Solution:** Team has already been working with NE states to sell H₂ at fixed stations. Team is integrating AHMF into network planning

Proposed Future Work

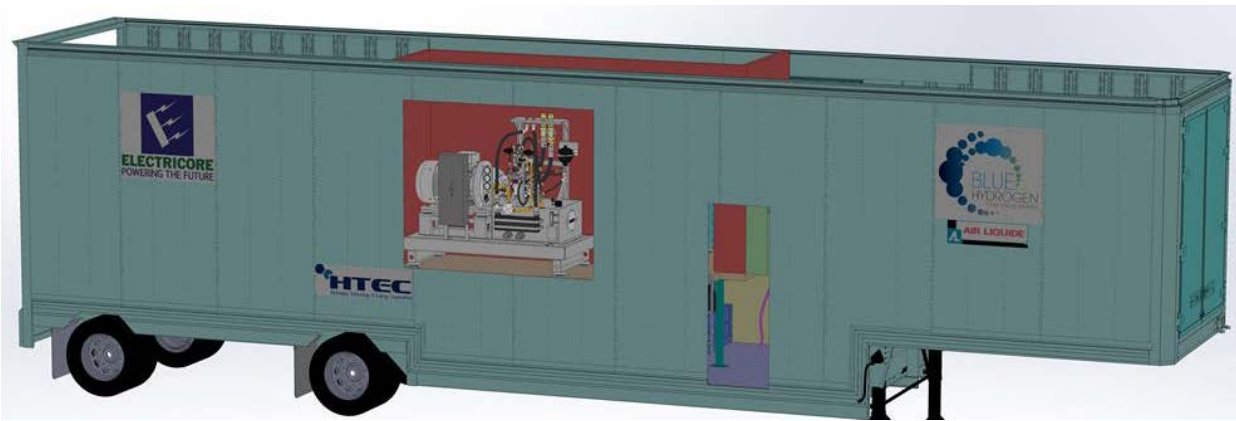
Goal	Dates	Tasks
Build AHMF	Current to Q4 2018	<ul style="list-style-type: none"> • Complete LIN system development • Purchase and receive remaining equipment • Implement manufacturing plan • Assemble components • Listing of AHMF • Sub-system and system testing
Site Selection		<ul style="list-style-type: none"> • Coordinate with auto companies to select 3 sites • Complete operations plan
Deploy AHMF	Q1 2018 to Q2 2020	<ul style="list-style-type: none"> • Approximately 6 months at 3 sites • Coordinate operations and maintenances support
Collect/Analyze Data		<ul style="list-style-type: none"> • Transfer data to NREL
Final Reporting		<ul style="list-style-type: none"> • Includes economic analysis
Beyond Project	Beyond Q2 2020	<ul style="list-style-type: none"> • Air Liquide plans to use AHMF beyond 2020 to support stations

Technology Transfer Activities

- ▶ **Special permit for transport of high pressure hydrogen can be used for other applications beyond AHMF**
 - ▶ Additional mobile systems considering use of same tanks
- ▶ **Team responding to inquiries for additional systems**
 - ▶ Public agencies
 - ▶ Private companies
- ▶ **AHMF facilitates establishment of new market areas and expansion of existing markets for hydrogen vehicles**

Summary Slide

- ▶ All major components ordered or received
- ▶ The team is ready to begin construction and will be ready for deployment in 2019
- ▶ The DOT special permit to transport high pressure hydrogen is pending, which will significantly reduce setup time and can be used on other systems
- ▶ The team is developing a first-of-its-kind liquid nitrogen cooling system which will significantly reduce size, weight and equipment costs
- ▶ The team is preparing sub-system and system test plans and reviewing the design internally and with a NRTL in preparation for listing



Technical Back-Up Slides

AHMF Block P&ID

