

# Innovative Advanced Hydrogen Mobile Fueler



PRESENTER – SPENCER QUONG

P.I. - SARA ODOM

ELECTRICORE, INC.

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PROJECT ID# TA017



Quong & Associates, Inc.

# Overview

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## Timeline

- Project Start Date: 07/01/16
- Project End Date: 09/30/2021
  - Phase 1 – Complete
  - Phase 2 (Demonstration) – anticipated start April 2020

## Budget

- Total Project Budget: \$2,971,537
  - Total Recipient Share: \$1,682,754
  - Total Federal Share: \$1,288,783
  - Total DOE Funds Spent\*: \$1,118,245
    - \* As of 12/31/2019

## Barriers

- H2 Codes and standards
- Hydrogen storage
- Lack of hydrogen refueling infrastructure performance and availability data

## Partners

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

# Relevance

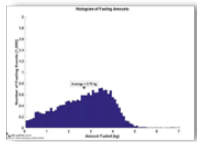
## Key Objectives



- Design and build an Advanced Hydrogen Mobile Fueler - **Complete**



- Deploy AHMF to support a network of H<sub>2</sub> stations and vehicles – *First Demonstration Site planned for Southern California*



- 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"><li>▪ Real world operations and maintenance data will be provided to NREL technology validation team</li></ul>
Transportable hydrogen storage	<ul style="list-style-type: none"><li>▪ Reduction of cost and setup time with special permit from DOT to allow transporting of H<sub>2</sub> at 95 MPa</li></ul>
Codes and standards for mobile fueling	<ul style="list-style-type: none"><li>▪ Educating states with no experience in metering of hydrogen</li><li>▪ Addressing issues of metering of hydrogen in multiple states</li></ul>

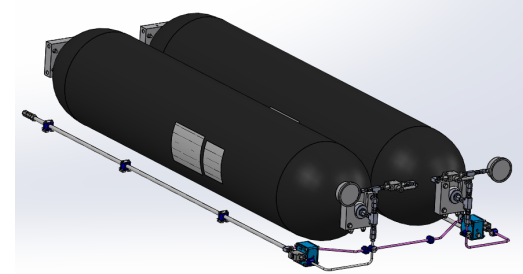
# Impact

Barrier: Codes and standards



Impact: First H70 mobile system with listing to assist in permitting

Barrier: Hydrogen storage



Impact: Received special permit for transport of H<sub>2</sub> at 95 MPa

Barrier: Lack of hydrogen refueling infrastructure performance and availability data



Impact: Will gather and analyze fueling data for NREL Technology Validation Team



Impact: AHMF will be deployed to support a network of H<sub>2</sub> stations and vehicles



# Approach

## Project Activities

### Phase 1 – Design & Development

#### Task 4 – AHMF Construction

- Procurement complete
- Subsystem assembly complete
- Final assembly complete

#### Task 5 – AHMF Testing

- Subsystem testing complete
- Functional and safety testing complete
- Intertek inspection complete

#### Task 6 – Site Selection

- First Site Selected – Sylmar, CA
- Additional demo sites proposed and in negotiations



### Phase 2 – Demonstration & Validation

#### Task 7 – Demonstration

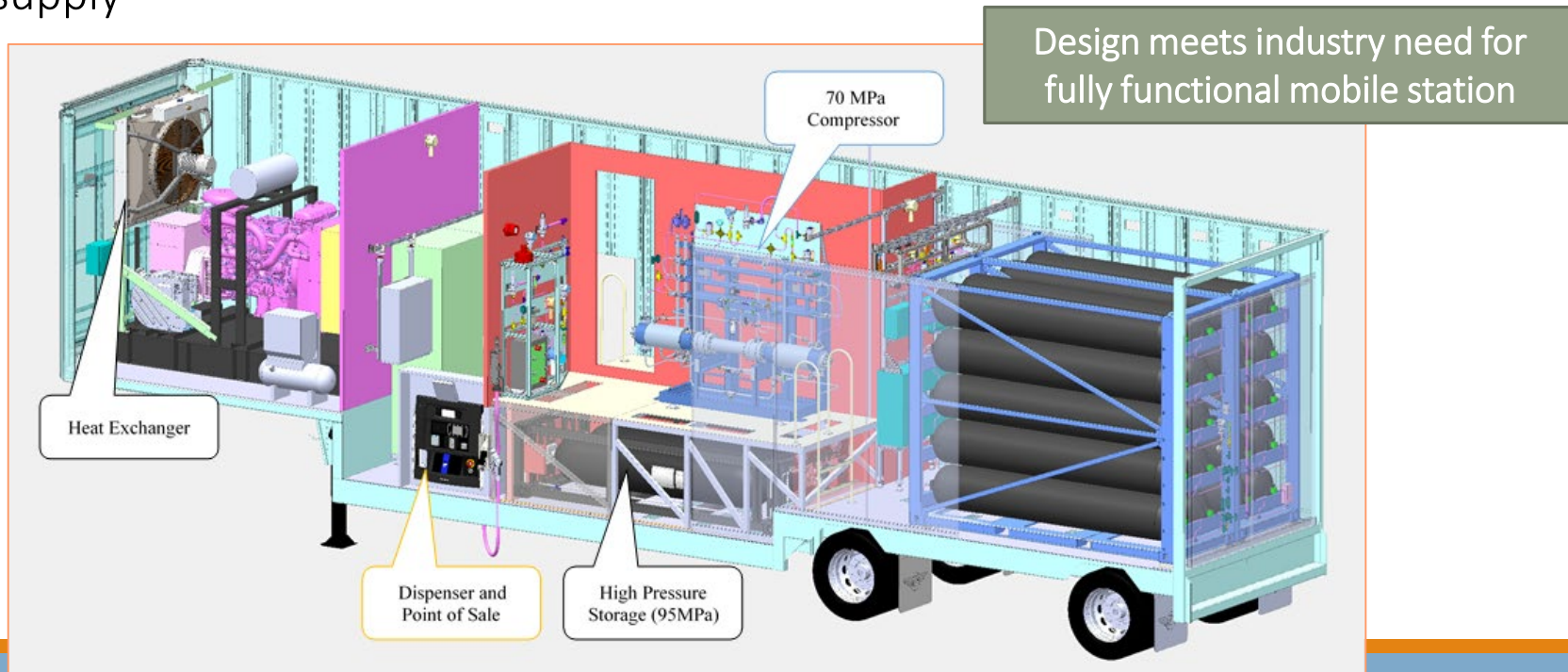
- Deployment at 3 demo sites over 18 months
- Provide operational and maintenance support
- Collect data for NREL Tech Val Team

#### Task 8 – Economic Analysis

- Conduct economic analysis
- Stakeholder meeting
- Reporting

# Approach

- First mobile fueler capable of filling vehicles to 95-100% in 3-5 minutes (SAE J2601 compliant H70 T40)
- Can fill 3-5 cars in first hour, 20-40 cars daily (175 kg of H<sub>2</sub> storage)
- Customer ready dispenser, capable of retail sales
- Fully self contained with option for use of external power and hydrogen supply



# Unique Aspects

- AHMF will use unique liquid nitrogen (LIN) cooling system; based upon Air Liquide's "Blueeze" refrigerated transport system.
- Special DOT permit acquired; allows transport of high pressure hydrogen at 95 MPa
- Fully self-sufficient: AHMF has 480V 3-phase plug-in capability, as well as CARB approved diesel generator for site operations.



# Accomplishments—Construction and Testing

- Completed final assembly of the AHMF in December 2019
- Passed electrical, software, pressure, leak, and safety testing.
- NRTL Listing inspection complete
- Initial fueling tests show stable temperature and pressure



**Dispenser (L) and High Pressure Storage (R)**

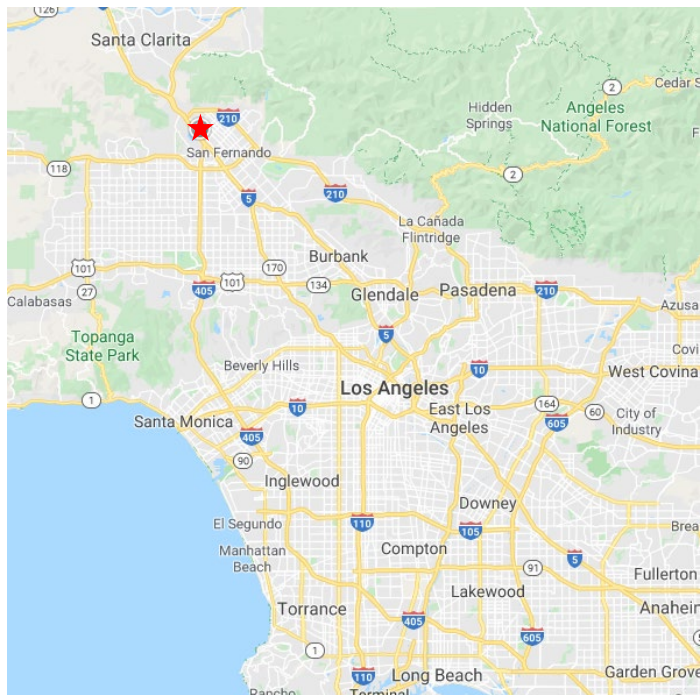


**Compressor**



**Installation of Powercubes**





# Accomplishments Demonstration Site

- Initial Demonstration Site Selected
  - Caltrans Facility in north Los Angeles
- Existing area designed and approved for CNG and hydrogen fueling.
- Site features: access to electrical power, grounding, and meets the required NFPA2 separation distances
- Use agreements being finalized but initial start delayed due to COVID-19



# Reviewer Comments

Past Comments	Response
Schedule delays associated with the DOT certification are going to put stress on the testing phase.	The functionality and safety testing phase is complete. The hydrogen quality and final protocol testing will be done on site
Running a generator on regular low-sulfur diesel using renewable diesel (not biodiesel) where possible instead would improve the selling point in emission sensitive areas where 480 V 3-phase is not available.	The generator is a California Tier 4 (cleanest) certified generator. The team will consider renewable diesel, but the availability and cost may be prohibitive. Where possible, the team will use shore power.
It would be helpful to see the system updated to address medium-duty vehicles.	The team is considering applying the new Category D fueling protocol, but the limited on-board storage may make its use for larger vehicles challenging.
The team should define station capacity using either the new draft CARB/CEC definition or a previously used CEC definition (pick any previous round of requests for proposals/GFO funding, as long as it is clear which definition was used).	The station capacity was estimated using CSA HGV 4.9.

# 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 and special permit
Kobelco Steel	Heat exchanger testing for use with LIN

# Remaining Challenges & Barriers

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- Challenge #1 - Site permitting and approvals for additional demonstration locations is difficult for all stations.
  - Solution – The team is finalizing the agreements for the first site, and initial discussions with the AHJ are positive since the site is already approved for gaseous fueling. The team has found second and third potential sites at key locations identified by stakeholders.
  
- Challenge #2 – Support and servicing is critical to ensuring AHMF is operational
  - Solution – The AHMF will be located in a region with existing hydrogen supply and Air Liquide technicians already supporting hydrogen stations
  
- Challenge #3 – The accuracy of the economic analysis on a pre-production system is problematic.
  - Solution – The team will work closely with DOE and the national laboratories to ensure that the cost estimates are useful for future analysis.

# Proposed Future Work

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- Remainder of FY2020
  - Deploy AHMF at 1<sup>st</sup> demonstration Site
  - Coordinate with Air Liquide for operations and maintenance support
  
- Future FY2021 Work
  - Continued operation and maintenance of AHMF
  - Deploy AHMF at 2<sup>nd</sup> and 3<sup>rd</sup> demonstration sites
  - Conduct Economic Analysis
  - Transfer data to NREL quarterly
  - Final reporting
  
- Work beyond the DOE Period of Performance
  - Air Liquide plans to use AHMF beyond 2021 to support stations throughout the U.S.

# Technology Transfer Activities

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- Special permit for transport of high pressure hydrogen can be used for other applications beyond AHMF.
  - The permit is available to any customers willing to use same tanks and frame/fire protection design
  
- The team is responding to inquiries for usage and additional systems.
  - Public agencies
  - Private companies
  
- AHMF facilitates establishment of new market areas and expansion of existing markets for hydrogen vehicles.
  
- Coordinating with automotive companies and nationally recognized testing laboratory for listing

# Summary

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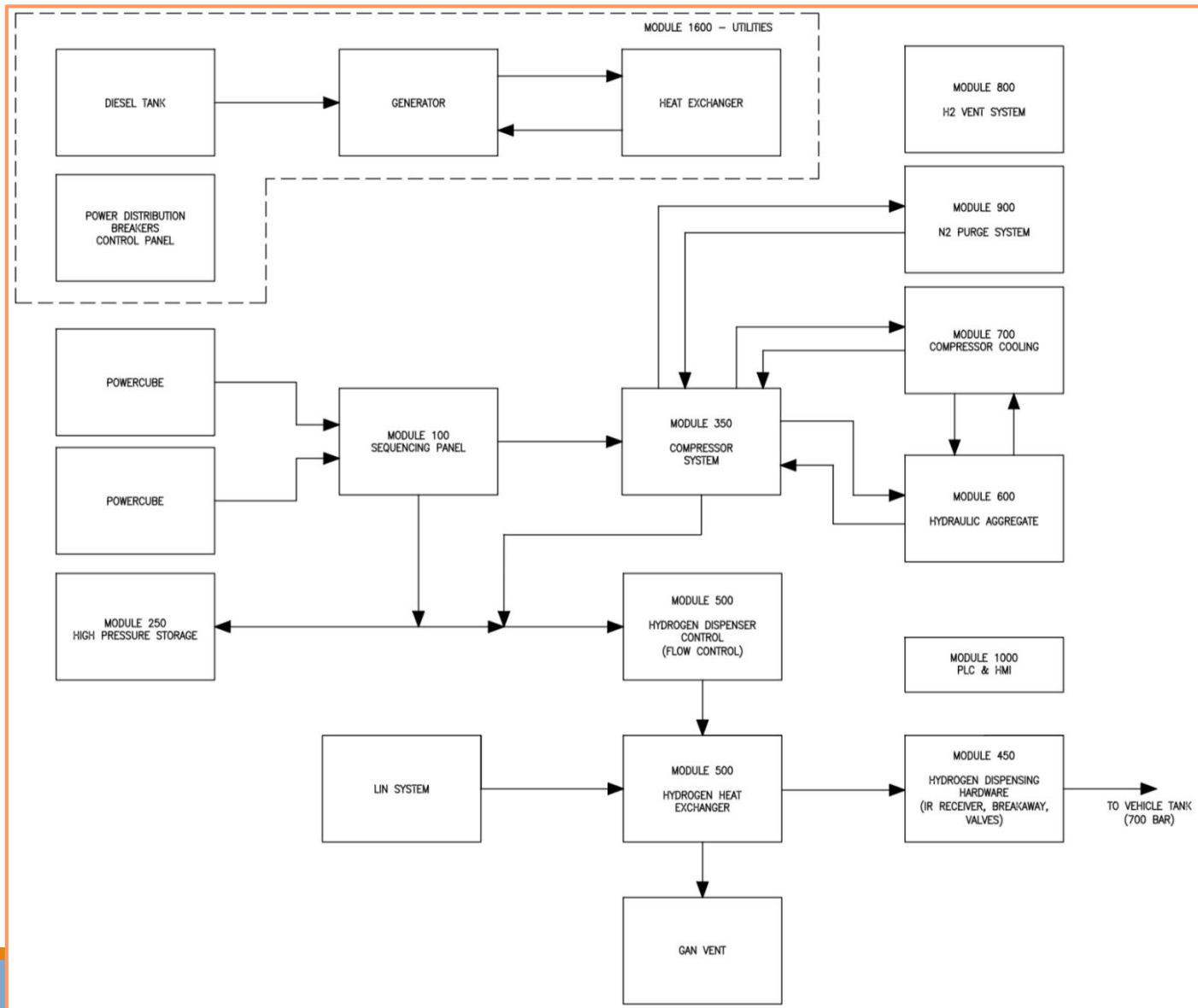
- **Objective**: The team has completed the design, build and testing of the AHMF. The team is in the processes of finalizing a site to support a network of H<sub>2</sub> stations and vehicles over an 18-month demonstration period. In addition, the team will gather and analyze fueling data for the NREL Validation Team.
- **Relevance**: In addition to fueling public owned vehicles, the project will gather real world operations and maintenance data. The project also developed a special permit for transport of high pressure storage which can be used by other programs.
- **Approach**: Deploy a fully self contained mobile fueler with option for use of external power and hydrogen supply that is capable of filling vehicles to 95-100% in 3-5 minutes (SAE J2601 compliant H70 T40).
- **Accomplishments**: The AHMF design, build and testing are complete. The AHMF is ready to be deployed to 1<sup>st</sup> demonstration site, capable of retail sale to the public.
- **Collaborations**: Strong team led by multiple key collaborators in the hydrogen industry.

# Technical Backup Slides

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# AHMF Block P&ID



# Publication and Presentations

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There are no publications or presentations to report.