Innovative Advanced Hydrogen Mobile Fueler

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Electricore, Inc.
Overview

**Timeline**
- Start Date: 07/01/16
- End Date: 12/31/19*
- *Schedule dependent on go/no-go approval of each phase

**Budget**
- Total Project Budget: $2,582,552
- Total Recipient Share: $1,293,769
- Total Federal Share: $1,288,783
- Total DOE Funds Spent*: $189,840
  * As of 3/31/17

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

**Partners**
- Electricore – Federal Project Manager / PI
- Air Liquide – Design / Demonstration
- HTEC – Design & Fabrication
- QAI – Technical Lead
- Manta Consulting – Economic Analysis
Objectives
Design, develop, deploy, and analyze an advanced hydrogen mobile fueler

Relevance

FCT Office Goals
- Reduced petroleum use
- Improved greenhouse gas emissions and air pollution
- Enabled widespread commercialization of H2 and fuel cell technologies

Results
- Increased use of hydrogen
- Expansion of fuel cell vehicles
- Reduced petroleum use
- Reduced emissions
- Permitting of hydrogen mobile fueler
- Collect hydrogen mobile fueling data

FCT Office Barriers
- Mobile fueler performance and efficiency data
- Transportable hydrogen storage
- Codes and standards for mobile fueling
## Approach and Strategy

### Key Objectives

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

### Unique Approach

- Based upon existing conventional station (reduced risk)
- Coordination with station provider and automotive OEMs

### Schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
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<tr>
<td>Specifications</td>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
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<tr>
<td>Component Selection</td>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
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<tr>
<td>Design</td>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
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<td>Go/No Go: Final Design</td>
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<td>Q1</td>
<td>Q2</td>
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<td>Construction</td>
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<td>Testing</td>
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<tr>
<td>Site Selection</td>
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<tr>
<td>Go/No Go: Assembled AHMF, Site selection</td>
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<td>Q1</td>
<td>Q2</td>
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<tr>
<td>Demonstration</td>
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<td>Economic Analysis</td>
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<td>Program Management</td>
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* Schedule assumes approval of First Go/No-Go in Q2 2017
Approach: Phase 1 Milestones

**Completed Milestones**

**Specifications**
- Submitted at kickoff meeting and design report
- Key components provided in design report
- Long lead item(s) ordered

**Component Selection**
- Design report submitted
- Initial hazard analysis completed
- Project reviewed by DOE H2 Safety Panel

**Design**
- Build subsystems
- Verify design
- Assemble AHMF
- Site Selection

**Testing**
- Create Test Plan
- Sub-system testing
- Safety & Functional testing

**Next Steps**
Accomplishments and Progress: Specifications

- AHMF Specifications Finalized

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
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<tbody>
<tr>
<td>Pressure Class</td>
<td>H70 (70 MPa) after compressing high bank storage</td>
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<tr>
<td>Pre-cooling</td>
<td>T30 (-30° C) or T40 (-40° C)</td>
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<tr>
<td>Performance</td>
<td>Up to 15 kg per hour, 100-120 kg in 8-10 hours</td>
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<tr>
<td>Fueling Protocol</td>
<td>SAE J2601-2014 table based for 2-7 kg tanks. SAE J2799-2014</td>
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<tr>
<td>Setup</td>
<td>One hour for limited performance, 8 hours for full performance</td>
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<tr>
<td>Storage</td>
<td>Up to 170 kg H2 at 45 MPa with ability to connect to external storage</td>
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<tr>
<td>Power</td>
<td>On-board 480VAC, low noise, low emissions diesel generator with option of using external power</td>
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</table>
| Usage               | Dispenser human machine interface allows fueling by minimally trained users.
Accomplishments and Progress: Design

Design Complete
- Final design report submitted to DOE
- Initial hazard analysis completed
- Project reviewed by DOE H2 Safety Panel
- Long lead items ordered

Key Design Features
- Based upon Air Liquide C100 H2 station design
  - Station being used around the world
  - Same user interface
  - Reduced risk to project
- Fully self contained
  - On-board compression, storage, dispensing and power
- Full performance station
  - Same fueling times (3-5 minutes on 25°C day)
  - Can fuel ~ 3 Vehicles in first hour, ~24 vehicles per day
- Compact heat exchanger
  - Reduces weight and size
- Multi-bank storage
  - Allows for reduced setup/teardown time

Equipment View
Includes: (1) High pressure storage; (2) Compression; (3) Electrical controls; (4) Genset; (5) H₂ gas chilling unit; (6) Equipment cooling; (7) Dispenser
This project was not reviewed last year.
# Collaborations

<table>
<thead>
<tr>
<th>Partner</th>
<th>Role</th>
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<tbody>
<tr>
<td><strong>Air Liquide</strong></td>
<td>Design Operations Project Co-Funding</td>
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<tr>
<td><strong>HTEC Hydrogen Technology &amp; Energy Corporation</strong></td>
<td>Design and Fabrication</td>
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<tr>
<td><strong>Quong &amp; Associates, Inc.</strong></td>
<td>Technical Lead</td>
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<td><strong>Manta Consulting</strong></td>
<td>Economic Analysis</td>
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<td>National Renewable Energy Lab</td>
<td>Data Analysis</td>
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<tr>
<td>Multiple automotive companies</td>
<td>Advisor on Site Selection/Usage</td>
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<tr>
<td>DOE Hydrogen and Safety Panel</td>
<td>Safety Analysis</td>
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Remaining Challenges and Barriers

High Pressure Storage

• **Barrier**: Can not transport AHMF with hydrogen fully pressurized. Will lead to long setup/teardown times.
  • **Solution**: Attempt to obtain US DOT special permit to allow for transport of H2 at full pressure

Retail Sale of Hydrogen

• **Barrier**: Regulations regarding retail sale (metering) not established by state regulators outside of California
  • **Solution**: Locate AHMF in one site that allows retail sale of H2. Work with other states to develop framework for sale of H2

Unattended Fueling

• **Barrier**: Unattended fueling requires significant design changes that would impact “mobile” aspect of AHMF
  • **Solution**: User interface requires minimal training. Select sites which have some supervision, but still public

Long Lead Items

• **Barrier**: Long lead time components may result in delays
  • **Solution**: Simplify the system architecture by using existing station design. Perform additional CAD efforts to avoid interferences in construction
Proposed Future Work

Buy, Build, Test and Deploy

2017
- Purchase components
- Assemble AHMF
- Test Sub-systems and full system
- Site Selection

2018/2019
- Deploy AHMF
- Gather and analyze fueling data

Future Decisions

Design Issues: Current design is conservative and any design changes will improve performance

Site Selection: Team will select multiple sites with public access; at least one site will allow retail sale of hydrogen.

Purchasing: Team has set up a purchasing committee to expedite process
Technology Transfer Activities

• Permitting of high pressure composite cylinder for transport
  – Facilitates industry-wide use of high pressure transportation systems for applications beyond the AHMF

• The market is already indicating interest for fast, full-performance mobile fueling
  – Public agencies
  – Private companies

• AHMF facilitates establishment of new market areas and expansion of existing markets
The AHMF is a self contained, full performance mobile hydrogen station.

The AHMF project has completed the design stage and is ready to begin construction.

The project has some barriers associated with operation and site selection.

Team has developed a plan with DOE and other stakeholders to reduce risk.