Maritime Fuel Cell Generator Project

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Photo by Young Bros, used with permission

Project ID # MT013

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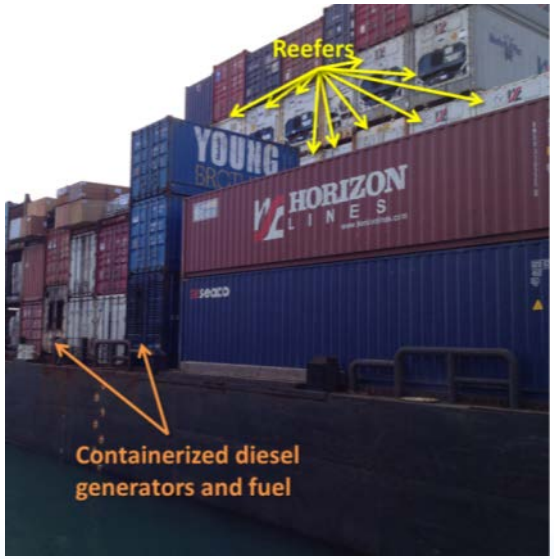
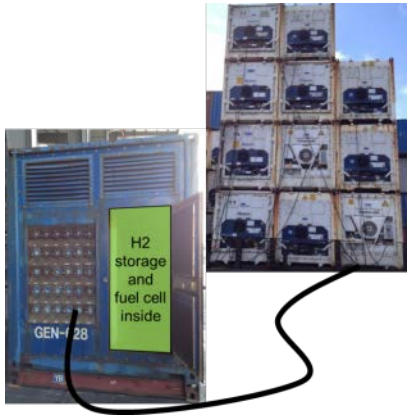
Project Background





Project Concept

PEMFC unit replaces diesel generators, saving fuel cost and emissions.

Project Scope

Design, build, and deploy a containerized fuel cell system to supply portable power for refrigerated containers ("reefers").

- **100 kW (net) PEMFC and H_2 storage inside a 20-foot container.**
- **6-month deployment on land and over the ocean.**
- **Strategic set of project partners, encompassing both the H_2-fuel cell and maritime communities.**

All photos by author

Project Overview

Timeline:

- Start: Sept. 2013
- End: Dec. 2015
- 25% complete

Budget:

- Total: $2.1M
  - DOE Share: $712k
    - $40k received in FY13
    - $672k received & planned in FY14
  - DOT/MARAD* Share: $700k
    - Received in FY13
  - Contractor Share (est.): $700k
- Cost share pct. (est): 66%

MT Barriers Addressed:

- A: Inadequate standards
- E: Financing mechanisms (Lack of cost and performance data)
- F: Inadequate user experience

Partners:

- Sandia *(project manager)*
- Young Brothers, Ltd.
- Foss Maritime
- Hydrogenics *(sub w/ cost share)*
- Hawaii Natural Energy Institute (HNEI)
- American Bureau of Shipping (ABS)
- US Coast Guard (USCG)
- Hydrogen Safety Panel

*DOT/MARAD: US Department of Transportation, Maritime Administration

Relevance – Overall Project Objectives

- ✓ **Lower the technology risk** of future port fuel cell deployments by providing performance data of H_2-PEMFC technology in this environment.
- ✓ **Lower the investment risk** by providing a validated business case assessment for this and future potential projects.
- ✓ **Enable easier permitting and acceptance** of H_2-FC technology in maritime applications by assisting USCG and ABS develop hydrogen and fuel cell codes and standards.
- ✓ **Act as a stepping stone** for more widespread shipboard fuel cell APU deployments.
- ✓ **Reduce port emissions** with this and future deployments.


Photo by author

Relevance – FY14 Impact as related to Project Objectives

- **FY14 Impact: Working alongside the code and safety officials from the beginning enables faster permitting and acceptance for this project and future maritime fuel cell deployments.**
  - ✓ Objective: Familiarize maritime code and safety offices with the project and concept of hydrogen fuel cells in maritime applications
  - ✓ Objective: Produce preliminary prototype design and review with ABS, USCG, and the Hydrogen Safety Panel
- **FY14 Impact: Enable technical and business case validation, lowering technology and business risk.**
  - ✓ Objective: Produce data collection and analysis plan

Photo by author

- **FY14 Impact: Maintain hydrogen infrastructure capability on Oahu in support of this and future strategic projects**
  - ✓ Objective: Develop hydrogen supply plan in close coordination with existing resources

Approach: Project Phases and Selected Milestones

1. Establish team and define prototype

(FY14 Q1)

- ✓ Team charter/MOU
- ✓ Agree upon prototype functional specifications
- ✓ Initial briefings with code/safety officials

2. Design prototype, H_2 supply logistics

(FY14 Q2-Q3)

- ✓ Preliminary prototype design
- ❑ Final prototype design
- ❑ Hydrogen supply plan
- ❖ Ongoing reviews with code/safety officials

3. Build prototype and site prep

(FY14 Q4 - FY15 Q1)

- ❑ On-site H_2 familiarity and safety training
- ❑ Site preparations complete
- ❑ Prototype FAT and on-site commissioning

4. Deploy on dock and on barge

(FY15 Q2-Q4)

- ❑ Operational control by host
- ❑ Technical and business case analyses

A complete project schedule and list of milestones and deliverables is given in the backup section

Accomplishment: Established partnership team and held project kick-off meeting / site tour

DOE: *Project Sponsor and Local H_2 Infrastructure*

Sandia: *Technology Support and Project Management*

DOT/MARAD: *Project Sponsor*

Young Bros. and Foss Maritime: *Deployment Partners*

Hydrogenics: *Prototype Production and Support*

HNEI: *Local H_2 Facilitator*

American Bureau of Shipping: *Maritime Product Certification*

Hydrogen Safety Panel: *Project and prototype safety review*

US Coast Guard and USCG Sector Honolulu: *Maritime codes and standards*

Photo by author

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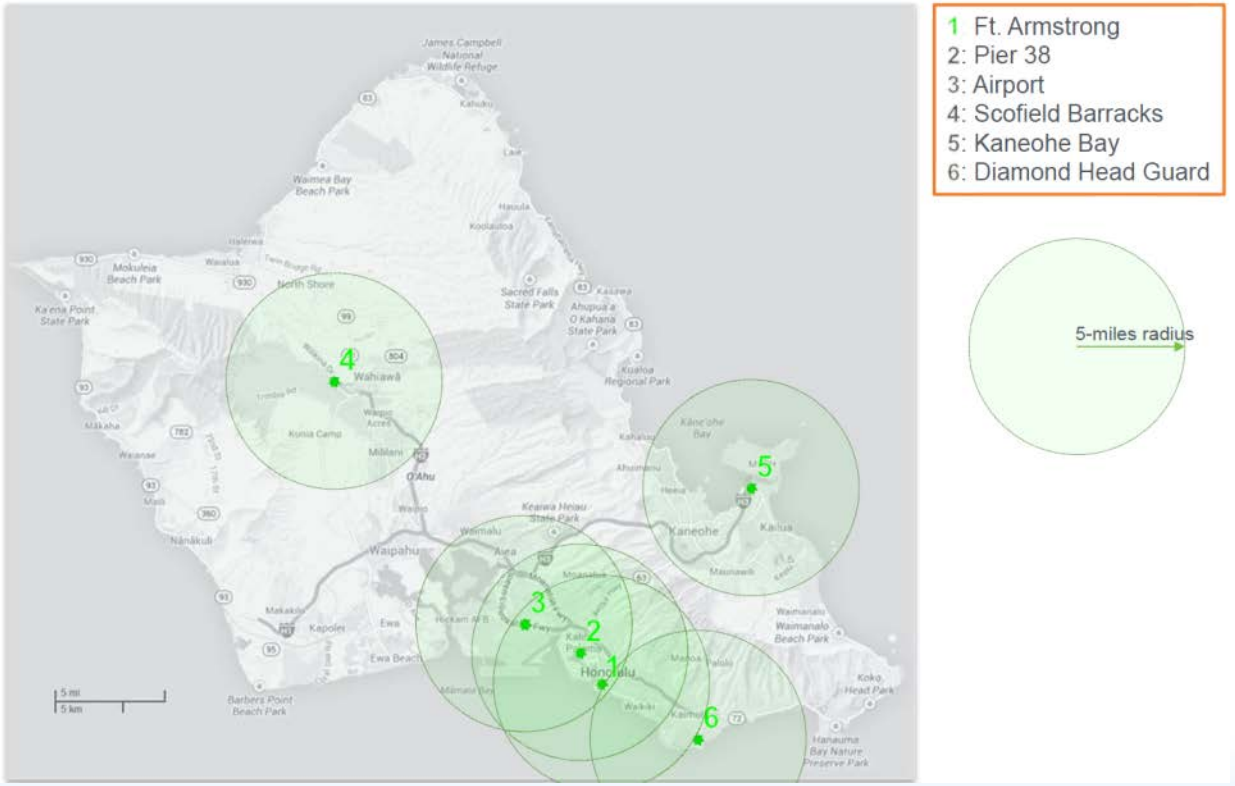
Accomplishment: Collaboratively determined prototype functional specifications

- **Performance**
  - At least 100 kW continuous at the plugs
  - 240 VAC, 3-phase
  - Hybrid battery/ultracap for inrush current
  - 10-12 hrs/day on the dock and 28 hr on the barge
  - 60-90 kg of H_2 stored at 5,000 psi
- **Size and Weight**
  - 20-foot Hi-cube ISO container; 81,000 lb max weight
- **Environmental**
  - Ambient temperature +2 C to +40 C
  - Tolerate rain, wave wash, salt water intrusion during operation
  - Tolerate side-to-side movement in 20-foot seas during operation
  - Handled as ordinary container (not operating when moved)

Photo by Young Bros, used with permission

Accomplishment: Progress towards hydrogen supply arrangements

- **Several options for H_2 supply on Oahu.**
- **Working to find the option that will:**
  - Be available for the project (timing and capacity)
  - Fit with DOE goal to maintain and grow H_2 infrastructure to support FCEV deployments
- **DOE is taking the lead on this task, working with DOD, HNEI, and others.**



Graphic from DOE presentation, "Fuel Cell Road Vehicles in Hawaii" by Pete Devlin and Greg Moreland, 11/15/2013. Used with permission.

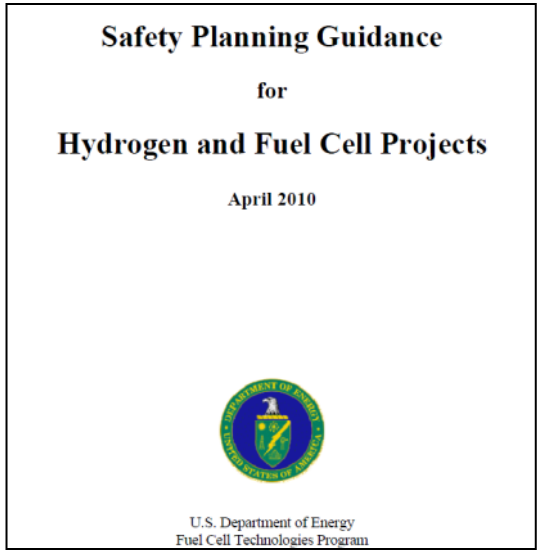
Accomplishment: Engaged maritime code and safety authorities and defined requirements

- **Initial briefings to US Coast Guard HQ, US Coast Guard Sector Honolulu, and American Bureau of Shipping in October/November 2013.**
  - USCG and ABS see the value of using the project to assist them in developing informed C&S for hydrogen and fuel cells.
  - DOT/MARAD, Young Bros, and Foss's partnership greatly facilitates this interaction.

- **Periodic follow-up meetings to keep them informed.**
- **ABS meeting Feb. 19 at ABS in Houston.**
  - Resolved jurisdiction question and agreed to work together on the project even though ABS certification is not required.
- **Design review May 9.**
  - 2-way information exchange and valuable prototype design feedback

Accomplishment: Ensuring safety is integrated into the project

- Began interaction with the Hydrogen Safety Panel (HSP) early: Nov. 2013.
- HSP has provided guidance on developing project safety plan.
- HSP involvement has “easing of the minds” effect: quicker acceptance of the technology and timely achievement of project milestones.
- Hydrogen safety and basic emergency response training will be provided to deployment personnel by PNNL’s Hydrogen Emergency Response Training for First Responders unit.


Safety Planning Guidance

for

Hydrogen and Fuel Cell Projects

April 2010

U.S. Department of Energy
Fuel Cell Technologies Program

Photo from DOE-EERE-FCTO publication “Safety, Codes, and Standards” available at http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/fct_h2_safety.pdf

Accomplishment: Preliminary prototype design review with all project partners

- May 9, 2014 with all project partners (verbal update)

A Collaborative Project

Partner	Project Roles
DOE	Sponsorship, steering, H_2 supply coordination
DOT/MARAD	Sponsorship, steering, and facilitation of maritime relationships
Young Bros. & Foss Maritime	Site preparations, prototype operation and routine maintenance
Hydrogenics *(sub w/ cost share)*	Design, engineer, build, commission, and support prototype unit
HNEI	Hydrogen supply logistics facilitation
ABS	Prototype design to maritime product standards
US Coast Guard	Review and acceptance of prototype design and operation
PNNL H_2 Safety Program	Prototype and project safety review by HSP; Hydrogen Emergency Response Training for First Responders
Sandia	Management and coordination, H_2 materials & systems expertise, tech/business data collection and analysis

Remaining Barriers and Challenges

- **Challenge**: Maintaining a planned deployment start date of May 2015 because of the late contract placement with Hydrogenics.
- **Planned Resolution**: The prototype fabrication delay caused by late contract placement can be made up for by the extra time built into the commissioning and training phase.

- All other prototype-related milestones and deliverables will be delayed by approximately three months.
- No other milestones or deliverables are at risk.

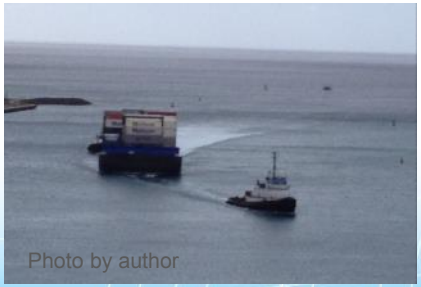
Proposed Future Work: Following the Plan

- **Remainder of FY14:**
  - Finalize prototype design with buy-in from code and safety officials.
  - Finalize hydrogen supply arrangements.
  - Finalize data collection and analysis plan.
  - Begin prototype build.

- **FY15 work to be accomplished:**
  - Finish prototype build, factory test, on-site commissioning, and training.
  - Finish site preparations and conduct on-site H_2 safety training.
  - Begin deployment testing and collect operational and cost data.
  - Continue to use the leverage for education and outreach both in HI and in the worldwide maritime/port community.

Summary: Addressing Several MT Program *Goals* and *Barriers*

- Enabling faster permitting and acceptance for this and future maritime hydrogen and fuel cell deployments.
- Enabling technical and business case validation, lowering technology and business risk.
- Maintaining hydrogen infrastructure capability in the State of Hawaii in support of future FCEV rollout.
- Direct and indirect user experience with hydrogen and fuel cell technology in the far-reaching maritime and port sector.



The Maritime Fuel Cell Project:
A wholly-collaborative effort with early and continuous stakeholders feedback that will successfully break down non-technical barriers to hydrogen and fuel cell use.

Thank you!

Technical Backup Slides

Project Schedule - Summary