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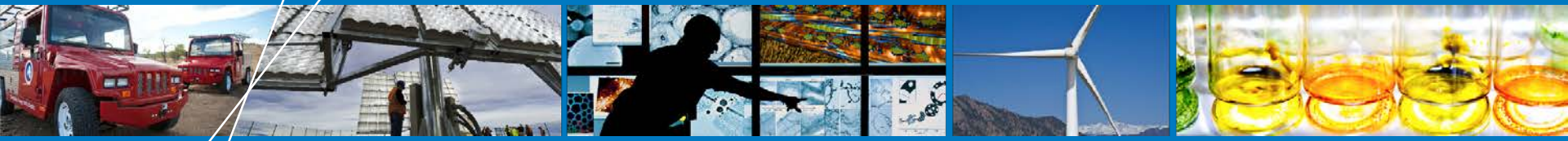
NATIONAL RENEWABLE ENERGY LABORATORY

Brentwood Case Study



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9 June 2016

Project ID TV033

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Overview

Timeline and Budget

- Project start date: 06/01/2015
- FY15 DOE funding $ 10,000
- FY16 planned DOE funding (if applicable): $50,000 (for lessons learned portion of the project that does not include subcontracting for design and construction work)
- Total DOE funds received to date: $60,000

Barriers

- Inadequate standards and complex and expensive permitting procedures
- Lack of knowledge regarding the use of hydrogen inhibits siting
- Inadequate installation expertise

Partners

- DOE, National Park Service (NPS), Proton Onsite, Werken, Anderson-Burton
- Project lead, Carl Rivkin

Relevance

- Objectives: This project will document lessons form the permitting and construction of a hydrogen fueling station to further reduce the time and costs associated with deploying hydrogen fueling technology. This work will address key barriers defined in the Market transformation Multi-Year Research, Development, and Demonstration Plan including
  - lack of knowledge regarding project siting,
  - inadequate installation expertise, and
  - high permitting costs.
- Since the 2015 AMR:
  - The fueling station permitting has been completed
  - The station design has been completed
  - Station construction has been completed and
  - The report documenting the lessons learned is drafted as an NREL technical report and will be published shortly.

Approach

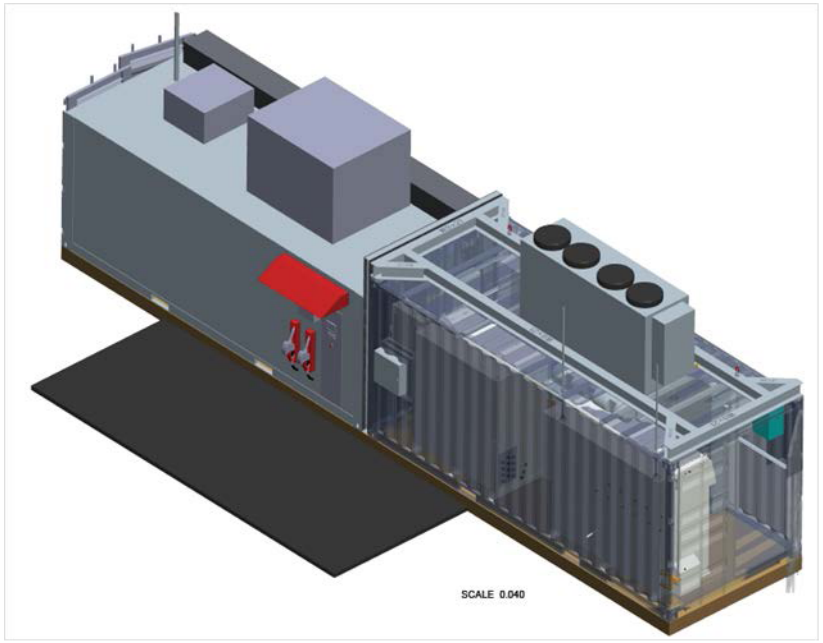
- **Overall technical approach:**
  - Collaboration leveraging strengths of the project partners.
  - Focused on lessons learned that could be applied to other hydrogen infrastructure projects and that were not unique to this project.
  - The lessons learned derived from this project have direct application in the Continuous Codes and Standards Improvement (CCSI) and Outreach project.
  - Example for CCSI is this project reinforced the need for restructuring part of NFPA 2 Hydrogen technologies Code to increase ease of application
  - Examples for outreach are thresholds for environmental permitting that this project fell beneath and that would likely provide exemptions for other similar projects.

Project overview

Install Fueling Station

- Move Proton's station from Connecticut to NPS Brentwood site in Washington, DC
- Proton's station design is packaged in site ready containers, which minimizes installation and commissioning requirements
- Site construction required consisted of station supports, trench for utility line from existing site building, storage shed, vehicle protection against impacting station equipment, and emergency shutdowns and alarms

Modular Fueling Station

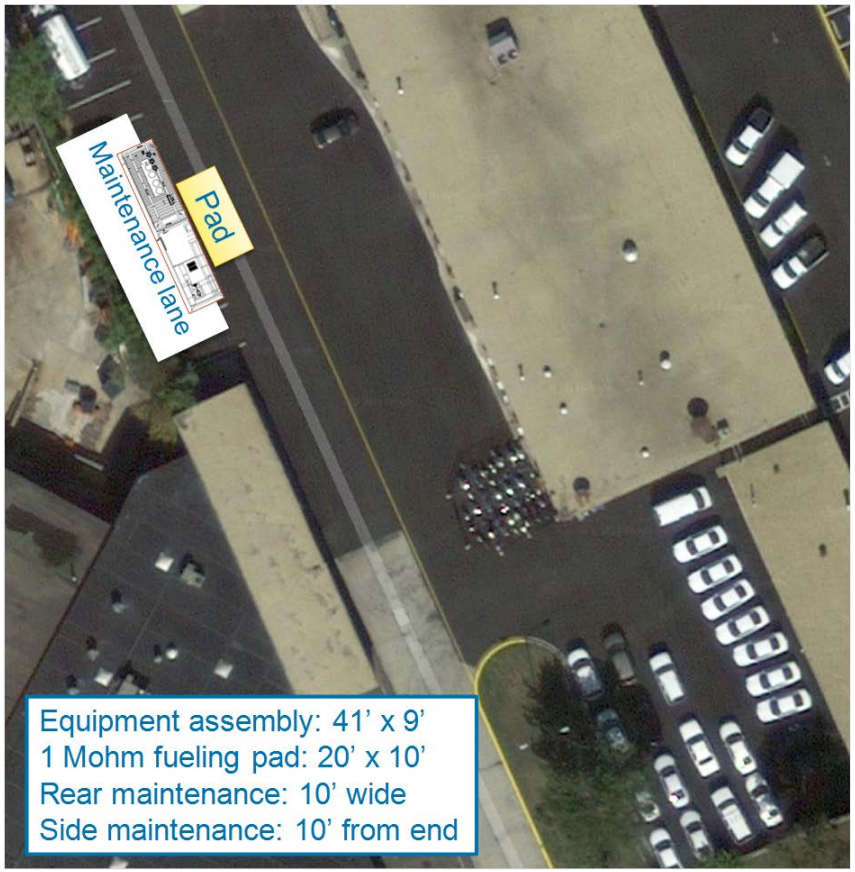


Washington, DC Site

Site Under NPS Jurisdiction

- Construction permitting is almost entirely under the jurisdiction of the NPS
- Only environmental permits such as soil erosion permit and air quality permit under District of Columbia jurisdiction
- Fire Service emergency response provided by District of Columbia

NPS Brentwood Repair Facility Site



Project Timeline

11/23/15 – Letter to FCTO & NPS for signature

11/25/15 – award and execute contract for design package

1/6/16 – Complete design package review (tentative)

1/26/16 – Release RFP for construction

- Proposals due 2/8/16

2/9/16 – review and select construction contractor (in process)

3/4/16 – execute contract for construction (or reissue RFP)

3/18/16 – begin site preparation

3/28/16 – ship equipment for delivery

4/4/16 – site preparation complete

4/5/16 – final inspections

4/6/16 – Proton work begins

4/27/16- Station operational and ready for OEM validation

XXX/ OEM Commissioning (not an NREL task)

5/21/16 Soft opening hopefully for the Bio Blitz on.

7/13/16 Official opening at Sustainable Transportation Conference

Accomplishments/Lesson learned

- **Lessons Learned from Project Components:**
  - Permitting
  - Project management
  - Site selection
  - Site utilization
  - Construction
  - Infrastructure deployment

Lessons Learned/Permitting

- **Multiple Authority Having Jurisdiction (AHJs) Create Issues**
- **AHJs may not be aware of the boundaries of their authority**

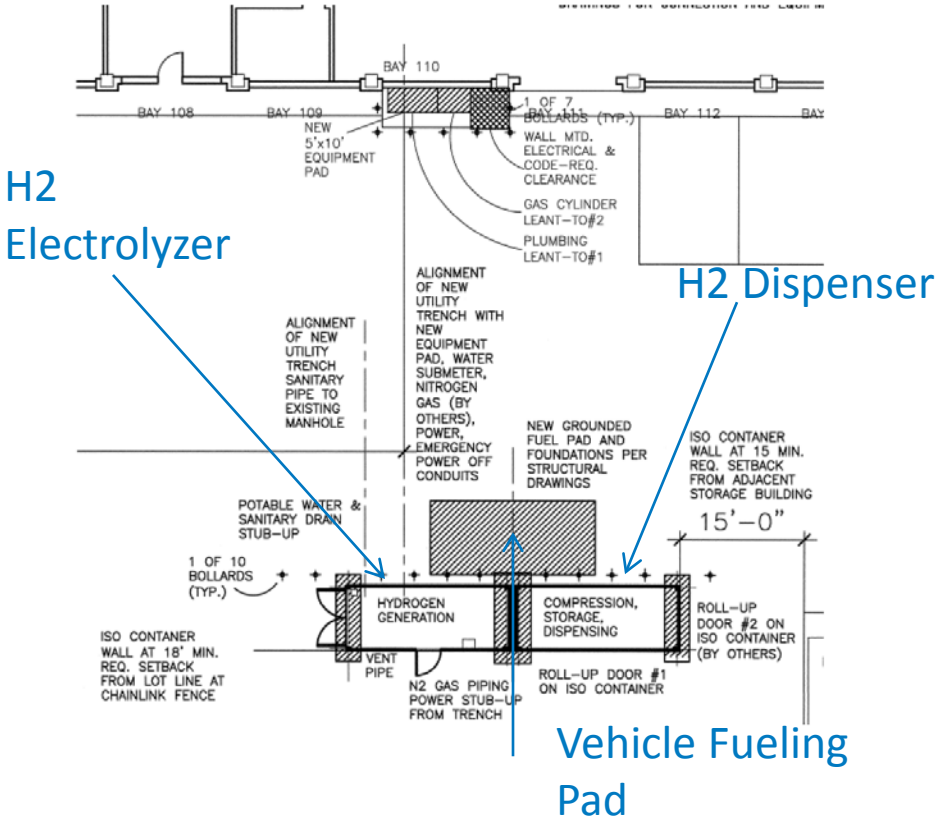
AHJ	Permitting /Operations Area
National Park Service	Construction
District of Columbia	Fire Service emergency response
District of Columbia	Environmental soil erosion
District of Columbia	Air quality impacts

Lessons Learned/Permitting

NPS Permit Process

- Employed Short Term Permit (NPS permit used for project with defined life)
- Somewhat different format from typical non-Federal jurisdiction
- Establishing agreement on respective roles of NPS and DOE through an Memorandum of Understanding (MOU) was critical step in the process
- Experience developed through this project would make it easier to construct hydrogen infrastructure projects at other NPS locations
- This experience includes knowledge of the NPS project review process, their general construction requirements, and how the NPS interacts with the jurisdiction in which the project located

Construction Schematic Submitted for Permit

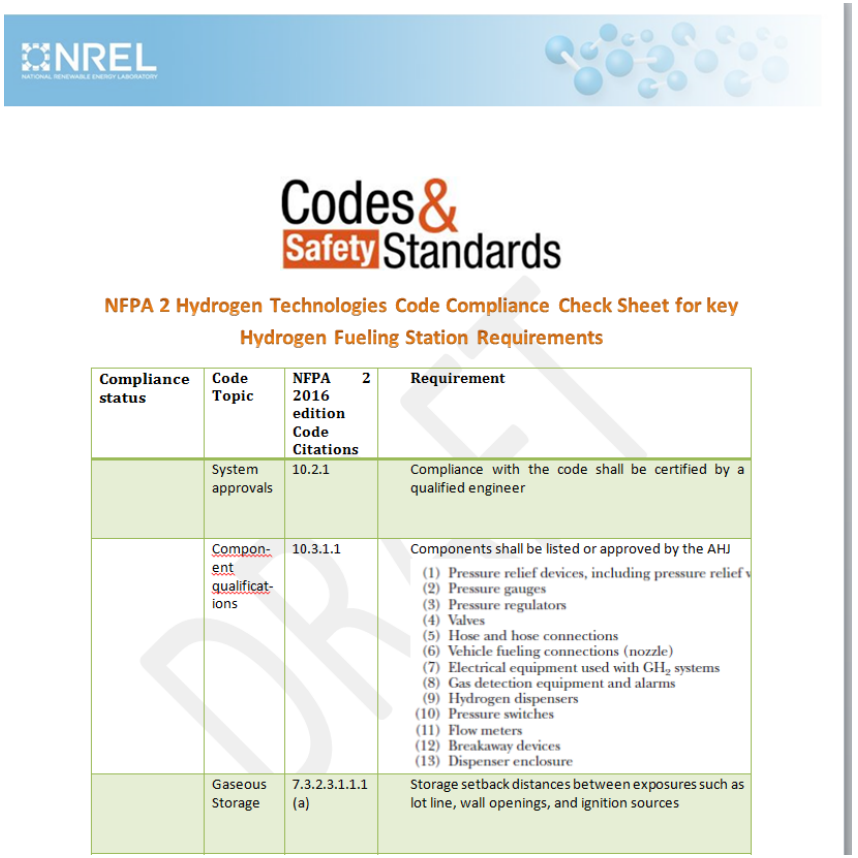


Lessons Learned/Permitting

NFPA 2 Hydrogen Technologies Code Compliance Check Sheet

- Site did not require compliance with building and fire codes through their short term construction permit
- Due diligence indicated a compliance evaluation against NFPA 2 Hydrogen Technologies Code (primary national code for hydrogen fueling stations)
- Compliance check sheet developed to facilitate NFPA 2 compliance analysis

Excerpt From NFPA 2 Check Sheet



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Codes & Safety Standards

NFPA 2 Hydrogen Technologies Code Compliance Check Sheet for key Hydrogen Fueling Station Requirements

Compliance status	Code Topic	NFPA 2 2016 edition Code Citations	Requirement
	System approvals	10.2.1	Compliance with the code shall be certified by a qualified engineer
	Component qualifications	10.3.1.1	Components shall be listed or approved by the AHJ (1) Pressure relief devices, including pressure relief v (2) Pressure gauges (3) Pressure regulators (4) Valves (5) Hose and hose connections (6) Vehicle fueling connections (nozzle) (7) Electrical equipment used with GH_2 systems (8) Gas detection equipment and alarms (9) Hydrogen dispensers (10) Pressure switches (11) Flow meters (12) Breakaway devices (13) Dispenser enclosure
	Gaseous Storage	7.3.2.3.1.1.1 (a)	Storage setback distances between exposures such as lot line, wall openings, and ignition sources

Lessons Learned/Project Management

- Multiple partners with different levels of project investment creates issues with synchronization
- First time nature of projects makes accurate cost estimates challenging
- Very limited construction contractor experience with hydrogen technologies although much of the construction work for a hydrogen project is not unique to hydrogen

Lessons learned/Site Selection

- **Site issues that should be considered in selecting a site include:**
  - Contamination, particularly from leaked hydrocarbon fuels
  - Construction impacts on existing utilities particularly buried lines
  - Setbacks for hydrogen storage
  - Neighboring properties and activities
  - Site history- do the neighbors consider the existing site activities to be a nuisance

Lessons learned/Existing Site Utilization

Site Upgrades

- Site may require upgrades such as:
  - A vehicle fueling pad that meets NFPA 2 resistance requirements
  - Electrical service for high demand equipment such as electrolyzers
  - Lighting to accommodate night time fueling

Steel Rod Cage for Concrete

12 Grounding bar attached to steel rod reinforcement.

Lessons Learned/Construction

Fitting New Projects Into Existing Construction

- Existing building where conduit needed to transit has likely asbestos containing materials
- Much of the site consisted of fill material that offered modest structural support
- Existing sites with heavy solvent usage or fueling operations may have soil contamination

Utility Run Through Existing Structure

10-11 Thursday, March 24, 2016

Pre-Core Drill Conference
Review of non-invasive imaging for locating rebars and conduits below floor slab.

Lessons learned/Infrastructure Deployment

Realistic Assessment of Construction Costs

- Hydrogen infrastructure is expensive
- More realistic cost assessment for hydrogen infrastructure, accounting for the cost of delays and routine activities that are part of construction projects, would be beneficial to planning and decision making
- For example, meeting the construction specifications that are part of any project is major effort that might not have been considered in what appeared to be a small construction project

Contributors to Construction Costs and Delays

Item	Routine/Non-routine
Asbestos tile in floor that required work around	Non-routine
Extensive construction specifications	Routine
Poor structural soil quality	Non-routine
Equipment not proximate to site	Routine
Lack of familiarity with technology	Routine

Lessons Learned Report

Report Elements

- Published as NREL technical report in FY16
- Available on H2Tools portal
- Will contain site evaluation checklist and NFPA 2 Hydrogen Technologies Code compliance checklist
- Will contain links to DOE permitting tools such National Permit Guide for Motor vehicle Repair Facilities, video "Permitting Hydrogen Fueling Stations," online code official training

Report Will Contain Site Checklist

- Identification of all applicable jurisdictions
- Listing of required permits
- History of site operations and hazardous material use/contamination
- Existing site drawings and other documentation
- Location of utilities

Collaborations

Collaborator	Project Role
US Department of Energy	Project management, coordination, and funding
National Park Service, National Capitol Region Brentwood Site	Fueling station location , security, emergency response, and regular site access
National Renewable Energy Laboratory	Project management and design, construction, and operations subcontracting
Proton Onsite	Hydrogen fueling station equipment, installation, and operations
Werken	Construction design and construction management
Anderson-Burton	Site construction

Remaining Challenges and Barriers

- Increased standardization of equipment will speed deployment but this project demonstrated that increased standardization of siting can be a large issue and will produce more efficient deployment processes
- Outreach to the construction industry supporting infrastructure deployment is needed to clarify basic concepts in hydrogen storage and dispensing technology
- Succinct targeted safety information is required to allow emergency responders to make quick correct decisions in the event of an emergency response action
- Outreach to the commercial fueling industry is required to move hydrogen fueling into the commercial fueling market

Proposed Future Work

- **The future:**
  - Complete the lessons learned report and share this report through the H2Tools portal to assist other hydrogen fueling station projects
  - Develop hydrogen fueling station projects at other NPS locations
  - Develop tool for siting hydrogen infrastructure that includes lessons learned from this project such as the impact of potential site contamination and the importance of a clearly delineated set of responsibilities for the AHJs
  - Work with key organizations involved in infrastructure deployment, such as National Association of Convenience Store Operators, to share the lessons learned from this project
  - Develop and deploy targeted outreach materials for emergency responders, project developers, and potential project investors

Summary

- **Key Points**
  - Although this project was a relocation of an existing modular station, there was significant effort and cost to perform the relocation
  - The lessons learned in permitting and subcontracting construction work can be applied to other similar sites and to commercial sites
  - Delineating the boundaries of the multiple jurisdictions that have authority over a project for all parties involved in the project is key to an efficient approval process
  - Site investigation is necessary when integrating a new project into an existing site, particularly an older existing site that may have limited documentation on the site history and operations