EVermont Renewable Hydrogen Fueling Station

Prepared for the 2004 DOE Hydrogen, Fuel Cells & Infrastructure Technologies Program Review

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This presentation does not contain any proprietary or confidential information.

Objectives

- Assist the DOE in the development of Hydrogen Production Technologies by building and testing a validation system
- Develop advanced PEM electrolysis fueling station that utilizes renewable electricity sources
- Reduce cost of hydrogen production
- Improve electrolyzer efficiency
- Improve fueling station integration and controls
- Utilize hydrogen fueled vehicles for testing and validation
- Show viability of distributed production pathway

Budget

- Total Budget: $1,246,258
- Total Cost Share: $309,430
- DOE Funds: $936,228

- FY04 Funding (projected)
  - Total: $500,000
  - Cost Share: $125,000
  - DOE Funds: $375,000

Technical Barriers and Targets for Hydrogen Generation by Water Electrolysis

- DOE Technical Barriers
  - Q. Cost (capital costs and O&M)
  - R. System Efficiency
  - S. Grid Electricity Emissions
  - T. Renewable Integration
- DOE Technical Targets for 2010
  - Cost ($/kg): $2.50
    - Includes all capital costs and O&M from power-in up to storage and dispensing at 5,000 psi for a 250 kg/day refueling station
  - Electrolyzer capital cost ($/kWe): $300
  - Energy Efficiency (%, LHV): 73%

Approach

- Develop advanced PEM electrolysis fueling station that utilizes renewable electricity sources
  - Advanced cell stacks designed for reduced cost and improved performance
  - Advanced power electronics that will improve controls functionality and efficiency – Power Card Technology
  - Improved H2 gas purification method to remove moisture
  - Integration of new H-Series Product Platform into fueling station
  - Modeling and design analysis of electrochemical compression at higher pressures
  - Analysis of wind and hydro resources and methods for utilization

Vision: Hydrogen Fuel From Renewables

Grid

Northern Power
wind turbine

Proton Energy
hydrogen generator

Air Products
fueling station

Sustainable "Hydrogen Highway"
-Non polluting
-Non depleting

Proton Product Platforms

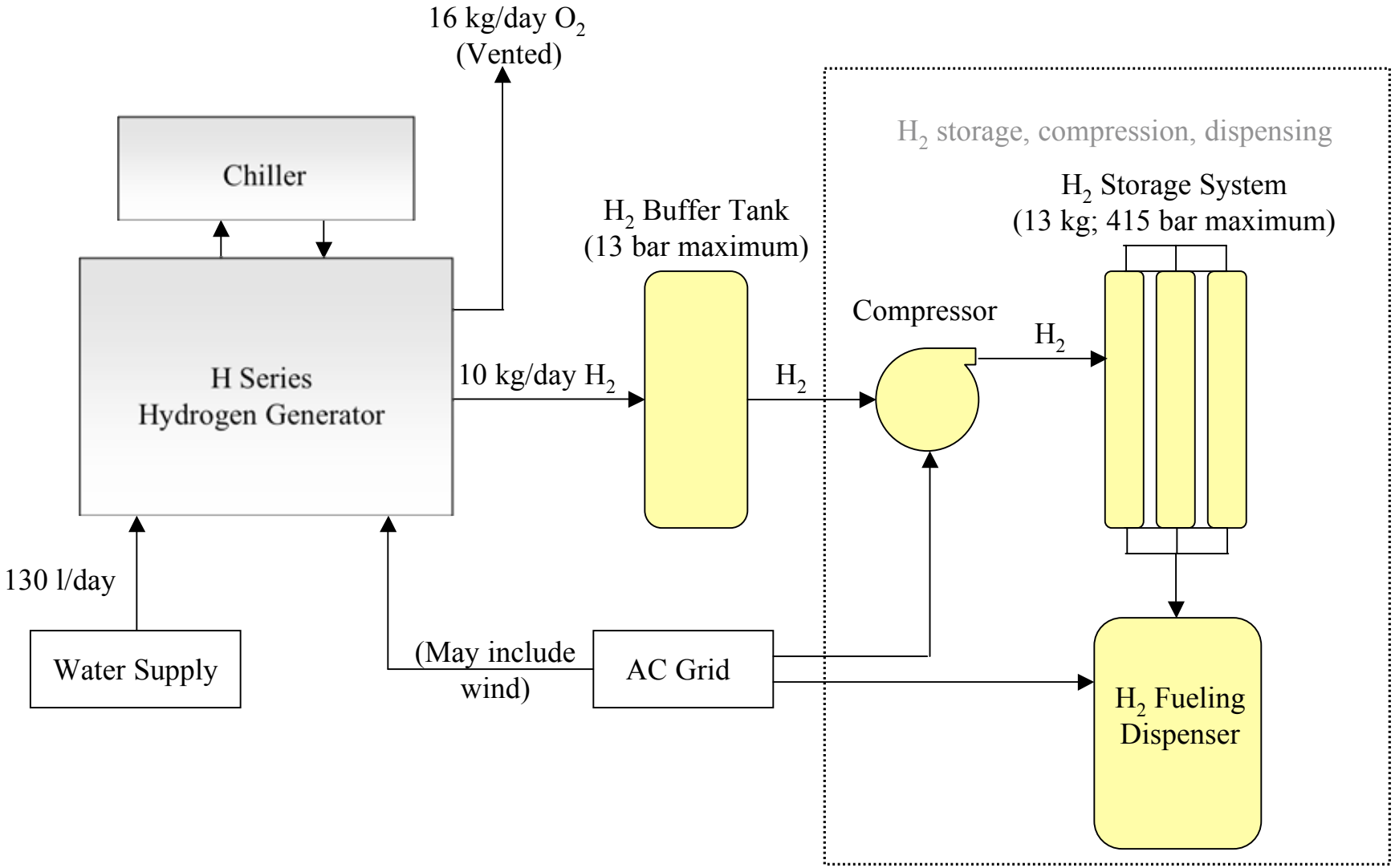
HOGEN 40

- Output: 20-40 SCFH (2.2 kg H2/day)
- Pressures up to 218 PSIG
- Ultra High Purity Hydrogen (99.999+%)
- Dimensions (L x W x H) – 38” x 31” x 42”
- Weight – 475 lbs
- Optional Renewable Interface

HOGEN H-Series

- Output: 80-240 SCFH (5-12 kg H2/day)
- Pressures up to 218 PSIG
- Ultra High Purity Hydrogen (99.999+%)
- Dimensions (L x W x H) – 78” x 32” x 78”
- Weight – 1750 lbs
- Outdoor all weather enclosure

Vermont Fueling System

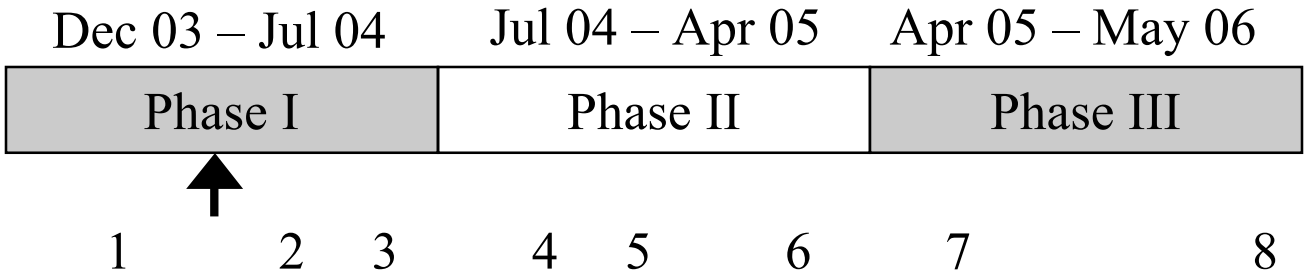


Project Safety

Potential Safety Hazards	Safety Precautions
Hydrogen Leaks	• Proper component selection: Components rated for hydrogen service, pressure and temperature. • Leak testing of the fueling system after onsite integration. • Combustible gas sensors to sense hydrogen leak and shutdown system on high LFL.
Storage of 430 bar Compressed H_2	• ASME approved storage tanks for hydrogen storage. • Approved pressure relief devices for the storage tanks.
Explosion Protection	• Eliminate the likelihood of an explosive gas atmosphere occurring around the source of ignition by diluting any hydrogen release to a concentration below LFL, or • Protect against ignition source by using explosion proof components.
Dispensing H_2 Fuel into Vehicles	• Follow Fueling procedures established by CaFCP and SAE

Follow appropriate Codes and Standards (NFPA 50A, NFPA 52, NFPA 70, ASME, NFPA 496)

Project Timeline



- Phase I – Project Definition
  1. Develop partnerships
  2. Site and vehicle selection
  3. Define scope of work
- Phase II – System Design and Build
  4. System design and permitting
  5. System fabrication and in-house testing
  6. System installation and commissioning
- Phase III – System Validation and Testing
  7. Testing, monitoring, and data collection
  8. Analysis and reporting

Technical Accomplishments/Progress

- This project is still in a preliminary project definition stage. Design and testing has not yet started. Final contract with DOE is still under development.

- Major Progress to date
  - Establishing project partnerships
  - Developing scope of work and budget
  - Narrowing site and vehicle options

Interactions and Collaborations

- **EVermont** – Contract recipient, vehicle experts.
  - Contact: Harold Garabedian (harold.garabedian@anr.state.vt.us)
- **Northern Power Systems** – Project management, systems integration, renewables
  - Contact: Chris McKay (cmckay@northernpower.com)
- **Proton Energy Systems** – Electrolyzer, H2 fueling station
  - Contact: Tom Maloney (tmaloney@protonenergy.com)
- **Vehicle partner options** – Texaco Ovonics, Solectria
  - Hybrid Prius with metal hydride storage
  - FC-Electric Hybrid Citi-Van
- **Host site options** – Burlington Department of Public Works, other?
  - Possible colocation with CNG fueling station
- **End user options** – BDPW, City of Burlington, Post Office, UPS, FedEx, other?
- **Congressman Bernie Sanders** – Project funding advocate

Future Work

2004

- Complete contract agreement
- Select host site and end-user
- Select vehicle
- System design and permitting
- Fabrication and In-house testing

2005

- Installation and commissioning
- Testing, monitoring, and analysis

EVermont

EVermont, started in 1993 by then governor Howard Dean, is a public-private partnership of entities interested in documenting and advancing the performance of advanced technology vehicles that are sustainable and less burdensome on the environment, especially in areas of cold climates, hilly terrain and with rural settlement patterns.

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