Ohio’s First Electrolysis-Based Hydrogen Fueling Station

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Fuel for Thought
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Project Background

• Efforts began in January 2009 with grant awarded to Ohio Aerospace Institute by the Cleveland Foundation to design a hydrogen fueling station

• OAI purchased hydrogen fueling station equipment from Burlington, VT
  - Equipment was decommissioned and shipped to Cleveland for refurbishing and installation

• Planning efforts began in 2011 to install a fueling station at Greater Cleveland RTA Hayden bus garage
Project Goals

• Install an operational hydrogen fueling station that demonstrates electrolysis as a safe and reliable means of H₂ generation
• Demonstrate the terrestrial benefits of NASA-developed space technologies
• Demonstrate the commercial reality of using H₂ in a fuel cell-powered bus
• Support clean energy efforts
Integration of NASA Space Technology

• NASA has developed fuel cell technology for space applications since Gemini and Apollo
  ◦ GRC currently focused on improving reliability and efficiency of fuel cells for space and terrestrial applications
  ◦ GRC currently develops advanced Non-Flow-Through PEM fuel cells and Solid Oxide Fuel Cells, and advanced electrolyzers
• Advanced hydrogen sensors developed & commercialized through SBIR and STTR programs with GRC, Makel Engineering and CWRU
Why Hydrogen and Fuel Cells?

• H₂ can be used as fuel to power fuel cell buses, passenger vehicles and stationary power systems

• H₂/O₂ or H₂/air fuel cells eliminate harmful emissions – they produce only water, electricity and heat

• Replacing diesel and gasoline-powered vehicles would reduce dependence on fossil fuels

But how do we get the hydrogen we need?
Why Electrolysis?

- Electrolysis is a safe, clean method of producing H₂ directly from water without harmful emissions.
- Allows for on-site H₂ generation, as opposed to delivered H₂, and eliminates the need to store large quantities of H₂.
- Generates quality H₂ at purity levels acceptable for use in fuel cell-powered vehicles.
- Compatible with renewable energy sources.
How Does a Fuel Cell Work?

• A Proton Exchange Membrane (PEM) fuel cell converts the chemical energy of reacting hydrogen and oxygen gases to electrical energy, with only heat and water as byproducts

• A fuel cell will run continuously as long as fuel is available
Fueling Station Equipment

• Originally installed in 2006 in Burlington, VT by DOE and BP

• Principal Components
  o PEM Electrolyzer from NASA KSC
  o Compressor
  o Storage tank array
  o Hydrogen dispenser
PEM Electrolyzer from Proton On-Site

• NASA KSC provided a newer electrolyzer from de-commissioned station in CA
• Electrolyzer uses city water and has internal de-ionization system to provide DI water to cell stacks
• Generates 0.99999 purity H₂
• Produces 12 kg/day (bus capacity 50kg)
  ○ Multiple units can be hooked up in parallel to increase output
Storage & Dispensing

• Generated H₂ is compressed to 6500 psi
• H₂ stored in 12-60 kg capacity modular storage tank array
• Stand-alone dispenser unit requires PIN input and dispenses H₂ fuel directly into tank on fuel cell bus
• H₂ production and compression is automatic, driven by the storage tank pressure
Installation Site

- GCRTA’s Hayden bus facility, E. Cleveland
  - Previously operated CNG buses
  - Infrastructure in place to house and maintain a fuel cell vehicle
- Located adjacent to Louis Stokes rapid station at Windermere, on the GCRTA’s red line
Ohio's First Electrolysis-Based Hydrogen Fueling Station
Hydrogen Dispenser

Hydrogen Fueling Station at GCRTA Hayden Bus Garage in East Cleveland, OH

Storage Tank Array and Compressor
Fuel Cell Bus Demonstration

• GCRTA leased a VanHool fuel cell bus from UTC Power (ClearEdge) through March 2013
  - Bus demonstrated the safe, efficient use of hydrogen as a fuel; generated data to determine the benefits of replacing a diesel bus with a fuel cell bus utilizing electrolysis-generated $\text{H}_2$
• Bus ran in revenue service roughly 60-80 miles/operating day, mostly on the #1 St. Clair route and other routes out of the Hayden garage
• GCRTA provided operational feedback to UTC/ClearEdge for Nutmeg Project under the FTA
• Bus was refueled as needed from $\text{H}_2$ station
- H₂ powered PEM fuel cells eliminate harmful emissions
- Only water and heat as byproducts
- Virtually silent bus operation due to replacement of diesel engine with fuel cell
- Reduction in moving parts means higher efficiency – less energy is lost as waste heat
- Helps to reduce America’s dependence on fossil fuels when H₂ fuel is generated via electrolysis combined with renewable energy sources
Project Challenges

• Public feedback to the project was a mixture of positive/negative prior to installation
  - Public meetings were held to educate the public and discuss safety concerns
• Permitting process and pushback from city offices and officials
• Technical issues experienced with equipment and fuel cell bus; unfamiliarity with fuel cell bus operations and reliance on external support
Project Successes

- Fueling Station successfully installed and operational in October 2012
  - Demonstrated the safe, efficient production of hydrogen via electrolysis and its use in a fuel cell to power a bus
- GCRTA operated fuel cell bus for approx. 300 miles in training and revenue service
- Positive feedback from GCRTA bus operators and mechanics
- Positive rider feedback and media coverage
Current Status

• GCRTA’s fuel cell bus lease expired and ClearEdge no longer supported mobile fuel cell applications – bus went to Flint, MI

• Fueling station equipment was shipping to NASA Kennedy Space Center for installation at Cape Canaveral
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Thank you for your attention

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