OBJECTIVE AND SIGNIFICANCE: HNEI has installed a 65kg/day hydrogen production and dispensing station on the Island of Hawai‘i at the Natural Energy Laboratory Hawai‘i Authority (NELHA) (Figure 1). The objective of the project is to evaluate the technical and financial performance, and durability of the equipment, and support a fleet of three hydrogen Fuel Cell Electric Buses (FCEB) operated by the County of Hawai‘i Mass Transit Agency (MTA). The knowledge gained in this project will inform the MTA on benefits and issues associated with transitioning from a diesel bus fleet to a zero emissions FCEB fleet in support of the State of Hawai‘i’s clean transportation goals. The knowledge will also be transferred to other counties to assist them in evaluating the deployment of zero emission buses for their public transportation fleets.

BACKGROUND: Development of hydrogen-based transportation systems requires hydrogen infrastructure to produce, compress, store, and deliver the hydrogen, a means to dispense the fuel, and vehicles capable of using high purity hydrogen. The HNEI hydrogen station at NELHA has been designed to dispense hydrogen at 350 bar (5,000 psi). Rather than use ground mounted permanent tank storage, HNEI will demonstrate centralized hydrogen production and distributed dispensing with a fleet of three hydrogen transport trailers (HTT). High purity hydrogen produced at the NELHA site will be delivered to the MTA base yard in Hilo to support deployment of heavy-duty FCEBs operated by the MTA Hele-On public bus service. The concept is illustrated in Figure 2.

In addition to the technical and cost analysis, HNEI is developing implementation plans to support the introduction of zero emission transportation systems. HNEI is coordinating with the University of Hawai‘i’s Hawai‘i Community College supporting the introduction of workforce development programs to train technicians to service the FCEBs and other battery electric vehicles.

PROJECT STATUS/RESULTS: Hydrogen Station

The site works as well as the hydrogen production and compression systems equipment have been installed at NELHA (Figure 3). The station is in the final stages of being commissioned by HNEI and Powertech, the equipment supplier. The station uses a Proton Onsite (now Nel) electrolyzer to produce 65 kg of hydrogen per day at an outlet pressure of 30 bar (440) psi. A HydroPak compressor (Figure 4) compresses the hydrogen to 450 bar (6,600 psi).
The system is powered by the HELCO grid which includes a substantial fraction of renewable energy including solar, wind, and geothermal.

**Hydrogen Transport Trailers**
Three trailers (Figure 5) are available for transport between the production and fueling site. The trailers were recently hydrostatically tested, pressure and thermal relief safety valves were upgraded, and the trailers were recertified by the Federal Transit Administration for use on U.S. public roads. The hydrogen cylinders must be recertified every five years.

![Figure 5: Hydrogen Transport Trailers.](image)

**Hydrogen Dispensing System**
The dispensing system consists of a dispenser (Figure 6) connected to a fueling trailer through a fueling post interface (Figure 7) that is connected to the dispenser via an underground hydrogen piping distribution system. The hydrogen dispenser is fully automated and programmed to “fail safe” for unattended operation.

![Figure 6: Hydrogen Dispenser.](image)

The fueling dispensers located at NELHA and at MTA are identical except for the addition of a boost compressor at the MTA site integrated into the MTA fueling post (Figure 8). The boost compressor system was developed by HNEI and Powertech to dispense up to 90% of the hydrogen stored in the HTT in order to reduce transportation costs by not having to return half-filled trailers to be refilled at NELHA.

![Figure 7: NELHA Fueling Post Interface.](image)

![Figure 8: MTA Boost Compressor Fueling Post.](image)

**Hele-On 29-Passenger Fuel Cell Electric Bus**
The Hele-On 29-passenger FCEB (Figure 9) was purchased with funds from the Energy Systems Development Special Fund. This bus, manufactured by Eldorado National and converted to a hydrogen-electric drive train by U.S. Hybrid is ADA-compliant. The fuel cell power system was recently upgraded by replacing the original 30 kW Hydrogenics fuel cell with a new state-of-the-art 40 kW U.S. Hybrid fuel cell.

![Figure 9: Hele-On 29-Passenger Fuel Cell Electric Bus.](image)
Onboard hydrogen is stored in composite carbon fiber cylinders located under the bus with a capacity of 20 kg. The fuel cell power system is integrated with two 11 kWh A123 Lithium-ion battery packs to provide motive power to a 200 kW electric drive system. U.S. Hybrid also replaced batteries with the new technology A123 batteries using U.S. Hybrid internal funding. At cruising speed, the fuel cell maintains the battery state of charge within a range that supports the long-term health of the battery. During deceleration, the electric motor acts as a generator sending power back into the battery (“regenerative braking”). This contributes to overall system energy efficiency and improves bus mileage. The bus has a range of approximately 200 miles depending on the route topography and driver skills.

**Bus Export Power Unit**
A 10 kW export power system (Figure 10) was installed in the 29-passenger bus to enable the bus to provide 110/220VAC electric power at full power for up to 30 hours as emergency power for civil defense resilience operations when the grid power is down. The bus can be refueled in 10 minutes providing an additional 30 hours of emergency power.

**Hele-On 19-Passenger Fuel Cell Electric Buses**
Two 19-passenger FCEBs (Figure 11) were also acquired by the MTA from Hawai’i Volcanoes National Park (HAVO). These buses were converted by U.S. Hybrid and are of similar design to the 29-passenger FCEB. Onboard hydrogen capacity is 10 kg giving a projected range of 100 miles. These buses are being upgraded with 40kW U.S. Hybrid fuel cells and A123 Lithium-ion batteries using funding from the County of Hawai’i.

**Publications**
This project has produced the following papers:


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