Hydrogen Utility Vehicle

Vehicle propulsion systems based on alternative energy sources have drawn much attention over the past decade. A hybridized vehicle structure has been proposed to take advantage of an alternative energy source to maximize the vehicle range with good overall system performance. The University of Texas at Austin Center for Electromechanics (CEM) in partnership with Gas Technology Institute (GTI) and Center for Transportation and the Environment (CTE), was funded by Defense Logistics Agency (DLA) to design, build, and deliver two extended range hydrogen fuel cell utility vehicles for a yearlong demonstration at the Defense Distribution Depot at Warner Robbins Air Force Base in Georgia (DDWG). The stock vehicle used for the retro-fit was a Columbia ParCar SUV-LN, which is powered by a 48 V lead-acid battery pack and 14 kW DC motor. A primary focus of this program was to assess different hydrogen storage technologies and maximize onboard hydrogen storage to maximize range without sacrificing vehicle cargo room.

PSAT (Power Train System Analysis Toolkit) was used extensively in the design phase to assess different hydrogen storage technologies, hybrid vehicle configurations, and battery/ultracapacitor options to determine the best design that could extend vehicle range and meet sponsor specifications. PSAT is a forward looking software package developed by Argonne National Laboratories which utilizes Matlab and Simulink. This vehicle modeling program allows the user to evaluate many different design configurations quickly and effectively.

Only increasing battery size to extend vehicle range is not as viable as using onboard fuel due to the increased weight and cost associated with the batteries. Hydrogen gas has a lower heating value of 120

MJ/kg which far exceeds the energy storage capability of the most advanced batteries, and is an attractive zero emission replacement for an all-electric vehicle. Based on the PSAT analysis, the design team chose a vehicle platform, which included an 8.5 kW fuel cell, ultracapacitors for load leveling, and 3.7 kg 350 bar compressed onboard hydrogen storage. This design predicted a vehicle range of 290 to 330 miles depending on cargo weight loading. A diagram of the fuel system integration on the vehicle is shown in Figure 1.

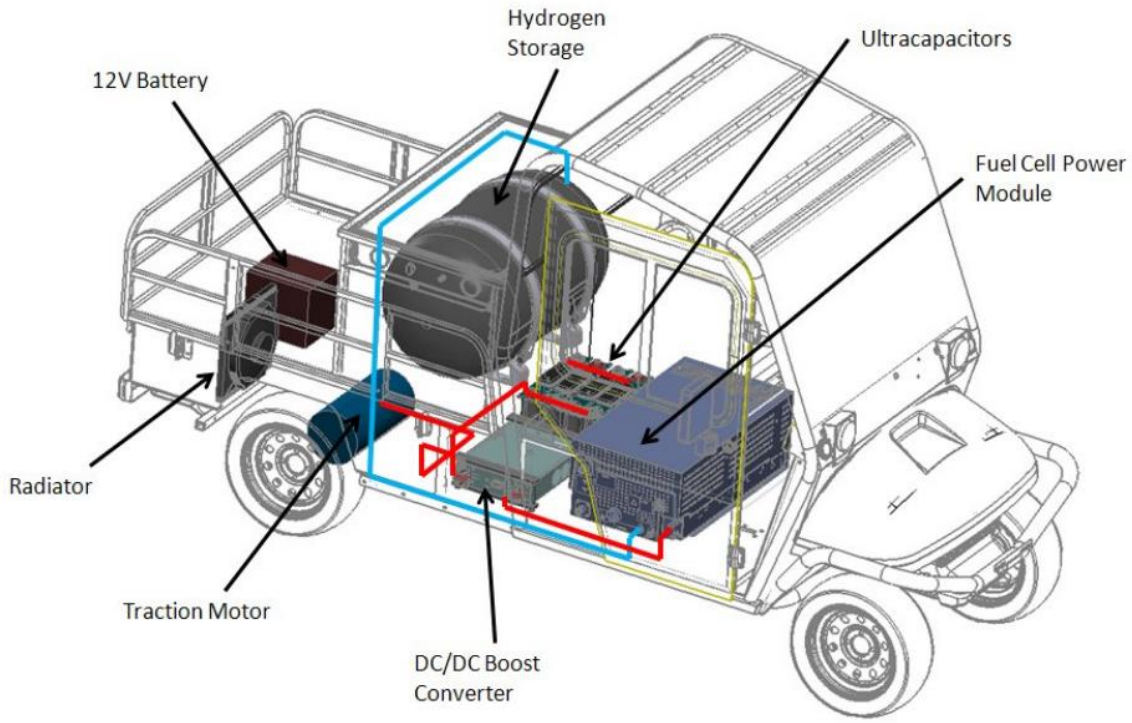

Figure 1. Layout of integrated components

Initial demonstrations to verify vehicle range were performed on the The University of Texas at Austin Pickle Research Campus (PRC) where CEM is located. This campus is relatively flat with speed limits up to 25 mph. One vehicle was filled with a full tank of hydrogen weighing 3.7 kg, and driven around the campus until the hydrogen tank pressure reduced to 100 psi. **At the end of the testing, the vehicle attained a final range of 309 miles, which agrees with the original PSAT analysis, and demonstrated an average vehicle efficiency of 90 mi/kg of hydrogen.**