Texas Commission on Environmental Quality

New Technology Research & Development (NTRD) Program

Monthly Project Status Report

Contract Number:	58211111463264		
Grantee:	Capacity of Texas, Inc.		
Report for the Monthly period:	August 2011	**Date Submitted:**	9/12/11

Section I. Accomplishments

Provide a bulleted list of project accomplishments as well as a description of their importance to the project.

- In light of the previous months listed focus points, a decision was made to focus attention this month on finalizing the appropriate fuel cell(s) for the Zero Emission Terminal Tractor (ZETT). One of the primary goals of the ZETT will be that the vehicle is charge sustaining. This means that no time will be required for the vehicle to be recharged via off-board charging. Naturally the vehicle will require time to refill the hydrogen fuel cells. The ultimate goal is for that other than the time necessary to refill the hydrogen storage tanks, the ZETT will be capable of operating virtually 24 hours per day.
- Per our initial research, the basis for the ZETT performance is determined by its ability to perform in a warehouse and distribution environment. With the experience Capacity of Texas has gained from the existing PHETT fleet, there is data to support the need for a charge sustaining system. The current PHETT architecture contains a 20 kW Gen-set onboard. Within the current fleet of 12-15 PHETT vehicles, it has been observed the 20 kW is enough to operate the vehicle in a warehouse and distribution facility for approximately 1-1/2 work shifts. This is not desirable in a warehouse and distribution operation because they are commonly operated on a 24/7 work schedule.
- With this knowledge base, the decision to pursue the utilization of two (2) 16 kW HyPM-HD fuel cell modules on-board was a relatively simple decision. Two 16 kW HyPM-HD fuel cell modules from Hydrogenics will power the yard tractor. This fuel cell module is a part of Hydrogenics' mobility line, which is specifically designed for rugged vehicle applications. The fuel cell stack is designed to operate without additional humidification and under low pressures, decreasing cost and increasing system efficiency and reliability. The fuel cells will be separated into two parallel circuits each located on either side of the vehicle in the existing PHETT battery bays.
- By having two 16 kW fuel cells operating in parallel, unique opportunities are available. For instance, reliability can be enhanced by keeping one fuel cell online if the second fuel cell system's operation is interrupted. Near full load duty could continue if sufficient idle time is available for the fuel cell to recharge the battery system to a high state of charge between events. Or, the single fuel cell system can be operated for continued lower-load duty, and for continued mobility. Figure 1 below shows a block diagram of the basic fuel cell architecture with the two fuel cells operating in parallel.

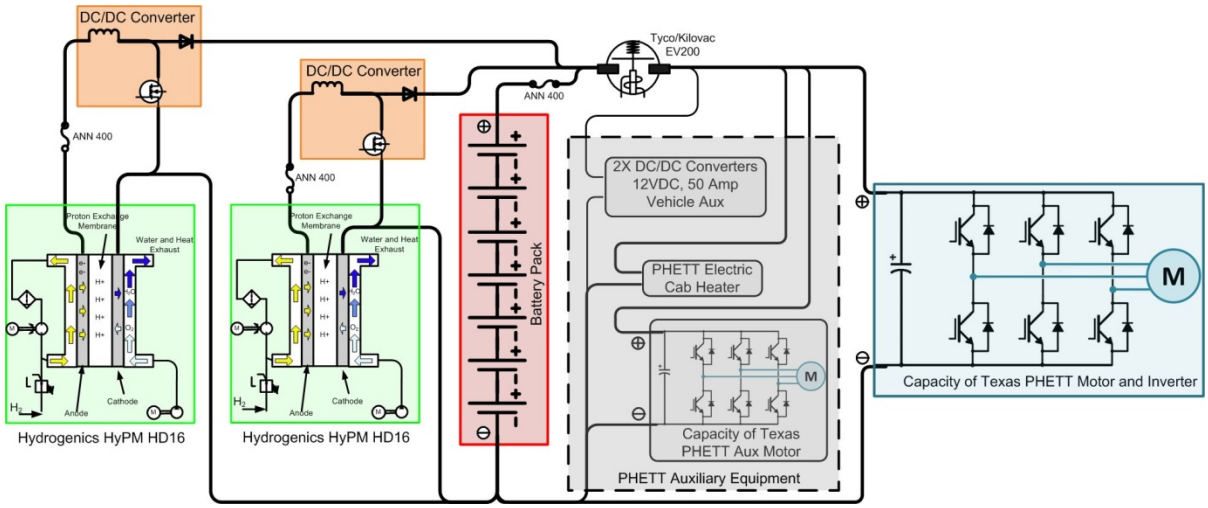

Figure 1: Fuel cell architecture with two fuel cells operating in parallel

- The Hydrogenics fuel cell operating temperature specification is a range of 2 ^{o}C to 40 ^{o}C. Through the addition of integrated strip heaters, the ambient temperature operating range will be expanded to -20 ^{o}C to 40 ^{o}C, encompassing most temperature extremes that could occur during the demonstration. A climate controlled enclosure around the fuel cell will be considered to both expand the fuel cell's ambient air operating temperature and to properly regulate the temperature for the cathode air intake. Ventilation for the fuel cell compartment will be provided via air intake vents and use of the coolant system's radiator fan.

- Thermal management controls will be integrated into vehicle operations to achieve correct operating temperatures to ensure fuel cell health and service life. This may include automated, background operation of the fuel cell and auxiliary heaters when the vehicle is exposed to freezing conditions in a non-operating mode. The auxiliary heaters would use onboard battery energy to provide initial freeze protection. If the battery state-of-charge (SOC) falls below a minimum set point during a freeze, the controller would prompt the fuel cell to turn on for additional heat and to recharge the batteries. Training and supplied operating manuals will fully address operating procedures to ensure safe and reliable operation of the yard tractor during and after the demonstration.

- Several vendors for the hydrogen yard tractor's DC-DC converter have been researched. Some of the vendors will provide a customized converter by leveraging past experience, while other vendors have designs that already meet the power system specifications. Each fuel cell power module will have its own DC-DC converter, and will provide the link between the fuel cell, batteries, and motor allowing for power flow between all devices. The DC-DC converter is designed to operate at 16 kW and boost the fuel cell stack voltage (40 – 80 VDC) up to the vehicle's nominal operating voltage of 310VDC. The DC-DC Converter vendor will be selected during the final design review.

Indicate which part of the Grant Activities as defined in the grant agreement, the above accomplishments are related to:

- Under Task 2, ZETT design, work continues on task 2.2.1. in the form of solid model design and determining packaging constraints.
- Under Task 2, ZETT design, work began on task 2.2.1.1. of the Capacity S.O.W. for the Hydrogenics fuel cell.

Section II: Problems/Solutions

Problem(s) Identified: Report anticipated or unanticipated problem(s) encountered and its effect on the progress of the project

a) Hydrogenics has been extremely supportive in helping to develop our new fuel cell configuration. No problems have been encountered other than the lead time that was stated once the design phase is complete and the need to actually purchase the fuel cell arises.

b) Many of the hydrogen storage tank manufacturers advertise certain size tanks, but no longer sell all of the advertised models. This item is carryover from the previous month.

Proposed Solution(s): Report any possible solution(s) to the problem(s) that were considered/encountered

a) None.

b) Through working with various tank suppliers, it has been determined that Dynetek has the most commercially available hydrogen storage tanks. Currently, the preliminary decision is to use the W150 model referenced in the July 2011 report.

Action(s) Conducted and Results: Describe the action(s) taken to resolve the problem(s) and its effect

a) An alternative supplier has been located for the Hydrogenics fuel cell, if needed.

Section III. Goals and Issues for Succeeding Period:

Provide a brief description of the goal(s) you hope to realize in the coming period and identify any notable challenges that can be foreseen

The goals for the next month include the following:

- Finalize the solid model of the base vehicle.
- Determine the space available for on-board hydrogen storage and batteries.
- Continue to finalize the selection of hydrogen fuel storage tanks.
- Begin to develop a decision matrix for on-board battery storage.

Date: 9/12/11

Authorized Project Representative's Signature

NOTE: *Please attach any additional information that you feel should be a part of your report or that may be required to meet the deliverable requirements for tasks completed during this reporting period.*