Efficiency analysis of battery management from improved Power Supply and Battery Management System (BMS), and more efficient Solar Cells

As we move forward in our efforts to become a more efficient and sustainable society, one of the biggest issues we have to face is transportation. Transportation in our society plays a vital role in ensuring that people are not only able to arrive where they need to be, but it is also the backbone of our society. Transportation of goods and products enables us to live the lifestyles that we choose to and makes the world “smaller”. However, all these vehicles need energy to keep them running. In 2013, over 95% of energy consumption in transportation was from fossil fuels, renewable energy sources such as biomass accounted for 4.6%, while electricity only accounted for 0.3% of consumption [1]. With the decreasing supply of fossil fuels and its environmental impact becoming an ever-larger concern, companies such as Tesla are focusing on developing cars that are powered using electricity, a much cleaner and more sustainable alternative energy source. With the recent launch of Formula E, Formula racing with electric cars, the racing world is also turning towards alternate energy sources. As we continue to develop our solar powered car, we need to consider the efficiency of energy conversion from solar energy to electric energy and how that translates to the actual performance of our vehicle. We also need to investigate the efficiency of our battery management and what solutions are more effective at providing a better performance.

Efficient Solar Cells

Currently, mass produced solar cells are capable of achieving an efficiency of 25.6%. The solar cells that we currently have installed on our car and have purchased have an efficiency of approximately 22.3%. The solar cells are installed on the top array of our car, with a total surface area of approximately 6.9 m², see figure 1. This allows us to generate a maximum output of 1.3KW of energy under good sunlight conditions. With this much energy generated from the solar cells, we can achieve a sustained speed of 30-35mph depending on road conditions. However, using our battery reserve, we can provide our motor with a maximum 7.5KW of power, allowing us to reach speeds of about 55-60mph.

The solar cells which we have purchased will be used to replace the damaged cells on our vehicle to improve overall power generation.

Figure 1 – NUSolar SC6 Solar Array
Power Supply and Battery Management System

At NUSolar, as we continue to build and improve our current car, SC6, we decided to purchase a new power supply and battery management system (BMS) to pursue a higher efficiency in our batteries.

The BMS balances the power pack using passive battery balancing. If one battery is discharging at a voltage higher than the other batteries, the BMS discharges that battery onto a resistor and brings the battery into a normal range. Although the act of discharging the battery onto a resistor causes a minor loss of charge, the overall system operates much more efficiently if all batteries are in the same voltage range.

The BMS also allows us to control the voltage at which our batteries discharge. This ensures that the batteries are not operating at levels that may cause damage to them. We currently have the voltage range set to 2.7V-4.2V, which is the range where lithium-ion batteries are safe to use. The BMS and passive battery balancing technique may allow batteries to run longer and have 5-10% increase in the number of charge cycles [2]. The protection of batteries is extremely important for the development and implementation of electric vehicles. By extending the life of batteries, consumers will not need to replace their batteries as often. This makes purchasing and maintaining an electric vehicle more inexpensive and allows greater access to people who previously may not have had the financial capability to own an electric vehicle.

The Acopian Power Supply allows us to charge our batteries more effectively. Previously, we had a 120V power supply, which was not enough to charge our entire battery pack at the same time and caused battery balancing issues. The new Acopian Power Supply has a 160V output which allows us to charge the whole battery at the same time.

In conclusion, these new additions are all important improvements that are much needed for the car. The new solar panels ensure that the entire outside of our car is used to collect solar energy efficiently. The Tritium Battery Pack Management Unit and Acopian Power Supply allow us to have much more control over our battery management. These purchases lay a solid foundation for us to further improve our battery management technique to achieve maximum efficiency and effectiveness at utilizing the energy that we harness from the sun.