Summary Report

Project Title: Design of Mobile Renewable Micro Power Grid for Vehicles.

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Summary: This research was conducted as an undergraduate design project, where two undergraduate students registered for the Senior Design course (EECE 4280) in the Spring 2022 semester at the University of Memphis. The goal of the project is to design a mobile renewable micro power grid that utilizes solar and wind energy to produce electricity in which the output power will be directly stored to an automotive vehicle's battery. The project makes renewable energy options more accessible to the population by increasing the efficiency of power generated by the dual use of solar and wind power. A solar-tracking car mount with a solar panel is fitted with wind turbines to generate additional power while the car is in motion. The power generated from the solar panel and the wind turbines charge a DC battery connected to an inverter that powers electronic devices. The mobile power station is an encapsulated device that produces and stores DC power as well as providing AC power to electronics. The station that we propose will contribute towards providing a cleaner source of energy for the population. Figure 1 shows the conceptual block diagram of the proposed mobile power grid for vehicles. The proposed mobile power grid will fit the roof of a small car and will rotate 180 degrees. The mobile grid can withstand outdoor temperatures and wind conditions. As such, because the device will be exposed to external elements of the weather, the system must be waterproof.

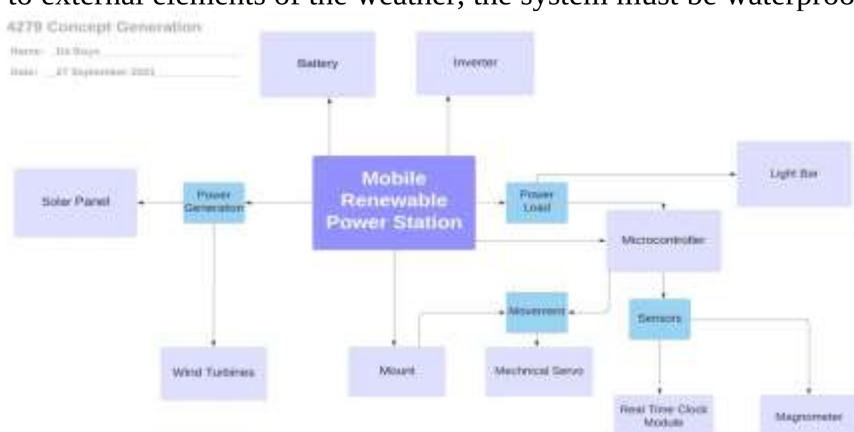

Figure 1: Conceptual block diagram.

Design Testing and Results: For this design project, an anemometer was used to test wind speeds. Upon installation of the inverter, it was used to power a lamp as during the unit testing phase. The batteries were individually tested with a multimeter to ensure their voltage was within the specified range, being 12.8V. A comparison of the battery bank connected in series and in parallel was conducted. The voltage of each setup was measured with a multimeter (shown in figures 2 and 3) to ensure it had been properly wired. The batteries were then used to power a DC light bar to drain some of the capacity. One battery in series had to be disconnected to power the light bar. This was to reduce its voltage. This was found impractical and parallel was decided on. The connection of the battery bank was compared in series and parallel. Series increases voltage to 53.2 Volts. Parallel increases the capacity to 200 amp-hours at 12.46 Volts.

Figure 2: Voltage Reading (Parallel Batteries).

Figure 3: Voltage Reading (Series Batteries).

The output voltage of the solar panel maximizes at 22V in direct sunlight. This varies greatly, as the output voltage will more realistically be lower as the amount of sunlight differs throughout the day. The batteries will not charge until their voltage drops below the solar panel or wind turbine voltage. The charge controller will boost or drop the voltage to maximize charging time. Settings on the charge controller allowed us to test different simulated voltages. A 180W light bar was powered by the batteries directly and through the maximum power point tracking (MPPT). The inverter was tested from both the battery bank and the MPPT. It was ultimately chosen to be used from the MPPT to monitor current draw as its load will change. The parallel connection was chosen due to the standardized operating specifications of the wind turbine and solar panel.

The hybrid wind and solar charge controller uses MPPT and PWM to boost or lower the voltage coking off the generators to that which matches the battery voltages. This ensures maximal charging time as the voltage coming off the generators depends on weather conditions. Figure 4 shows the MPPT system. A breaking resistor for the wind turbine, the wind turbine, the solar panel, the battery bank connected in parallel, and the inverter were connected to the hybrid charge controller with an additional DC light bar being powered directly from the battery bank. The parallel connection was chosen due to the standardized operating specifications of the wind turbine and solar panel.

Figure 4: Maximum Power Point Tracker (MPPT).

Conclusion: The proposed project has potential impact on the relevant field and application. In this project, power was generated in two ways: renewable solar and wind energy. A charge controller controls the voltage of both devices output by the generators, allowing them to charge the battery bank. The battery bank, composed of 4 $LiFeO_4$ batteries operating at 12V, 20Ah, features its own battery management system to keep its cells charging and discharging regularly. From the battery bank, an inverter is used to transform the power from DC to AC. The wired batteries functioned optimally – with longevity kept in consideration from being connected in parallel. The power from the batteries has been used to power both DC and AC electronics from entirely inside the vehicle successfully. The proposed mobile renewable micro power grid for vehicles does not require any additional inputs whether material or in labor after assembly relying completely on limitless and waste-free solar and wind energy.