2021 Capstone Design Project Fund

Application Form

Proposal Title: **Solar Powered Electric Capstone Project**

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1 Project Background

Number of Project Members: 7

Background: Canada recently passed the Canadian Net-Zero Emissions Accountability Act targeting 2050 as Canada's net-zero Green House Gas (GHG) emissions year. Transportation accounts for 30% of Canada's GHG emissions; therefore, to achieve this goal, substantial changes are needed in the transportation sector. Subsequently, the proposed project with 7 senior SREE students aims to develop a solar powered commuter vehicle capable of commuting to and from work, running daily errands such as grocery shopping, or even short off grid camping trips.

Project Status: The design allows the vehicle to generate and store its own power whilst also powering the electric DC motor to drive the vehicle making use of two batteries. A road legal dune buggy will be the base upon which the system will be constructed to serve as a proof of concept for the future development of a retail solar electric vehicle. Atop the vehicle a solar panel array will be mounted to a rotating base with a solar tracking device allowing the panels to track the sun while the vehicle is stationary. Additionally, the buggy will feature an electric DC motor to replace the gasoline engine.

MATLAB/Simulink has been used to scale the appropriate motor required for the vehicle to drive at regular commuting speed (100 km/hr) while carrying two people as well as a substantial load. The team is currently using MATLAB/Simulink to simulate PV power generation and storage through a DC-DC converter, as well as to simulate a battery discharge through a DC-DC converter to power the motor.

2 Project Need **(250 words max)**

This project is seeking $18,000 in funding to acquire all the required components to build the working solar vehicle.

The focus of this project is the power generation and storage system as well as the electric vehicle component. Thus, a dune buggy will be purchased to serve as the basis for the vehicle where components will be attached to create a vehicle which will be capable of creating and storing its own power using solar energy on the go and using that electrical power to drive a DC motor.

The solar panels will generate electrical power which will be scaled down with a DC-DC converter as required to charge one of the two Tesla Model S batteries. Furthermore, a second Tesla Model S battery will be used to drive the motor through another DC-DC converter. Multiple raspberry Pi's will be used as the battery energy management centre, power electronics controllers, solar panel position controller, and for maximum power point tracking.

3 Impact of Funding (250 words max)

The vehicle will serve as the starting point for a legacy project which will train students with solid hands-on experimental skills and deepen their multidisciplinary knowledge learned through their curriculum, including sustainable and renewable engineering, power electronics, and control engineering.

One of the goals of the Solar Powered Electric Vehicle Capstone Project is to leave behind a legacy project for future students to have the opportunity to gain hands on experience working on an electric vehicle which goes beyond the current features of retail electric vehicles. The vehicle encompasses efficient power generation, smart storage, and electric motor vehicles. Future students will have the opportunity to experiment and expand upon an electric vehicle which will also mimic a SCADA system. Integration of sensors will allow for data acquisition and analysis which is highly relevant to both the power generation and distribution sector. This will provide students valuable applicable experience which will put them at the forefront of students graduating in their field. Moreover, this vehicle can serve as a promotional tool for the Sustainable and Renewable Energy Engineering (SREE) program both on campus and around Ottawa to encourage students to enrolee in the SREE program.

4 Project Continuity (250 words max)

This vehicle would be designed such that it would allow future groups of students to contribute to an ever-evolving research and development learning experience.

The vehicle could be connected to Carleton's "Northern Nomad: Tiny House" to contribute to its overall power production. Alternatively, the vehicle could be connected to the grid to charge on cloudy days or sell excess power to the grid on very sunny days, otherwise known as a "Vehicle to Grid" connection.

Additionally, the vehicle could be outfit with a variety of sensors to create a fully off grid data acquisition system for data analysis along with graphical displays. For example, the vehicle could be outfit with DC current transformers which would be used to measure the power production of the PV cells and the power usage of the DC motor; furthermore, using a pyranometer, temperature sensor, and weather station could make the vehicle into a solar site evaluation vehicle. Where the vehicle could be driven to a remote location and could acquire data to evaluate the potential of that site for a solar far. Moreover, the addition of a cellular modem would allow all data acquired to be streamed to an online data base to automatically perform analytical and graphical displays all in real time akin to many SCADA systems.

Finally, the components mounted on the buggy could be removed then re-mounted to a retail electric vehicle such as a Nissan Leaf where the system could be re-integrated.

ANNEX A: FINANCIAL SUMMARY (2 pages max)

Part A. PROPOSAL COST ESTIMATE	
Equipment *- List the equipment that would be purchased for the project, if applicable.*	
Hammerhead GTS 150 (1)	4407.00
5 kW Brushless DC Motor 48/72/96V (1)	2437.41
Victron BMV-712 335 Watt RV Solar Kit (2)	3073.60
Canadian Solar Expansion Kit (2)	768.40
RBBA3000-50 DC-DC Converter (4)	2037.62
Tesla Lithium Ion Module (2)	4409.40
Raspberry Pi (3)	237.30
Morningstar ts-45 Charge Controller (1)	565.00
Grainer Battery Box (1)	226.00
Low Voltage PWM Speed Controllers (2)	31.62
Gear Reduction Motor (2)	320.90
Solarland Solar Panel 5W 12V – SLP005-12U (4)	103.24
Steel Tubing (25 ft)	282.50
Breadboard (1)	22.6
Electrical Wires (2 spools)	26.49
Moto Master Top Post Battery Terminal (2)	20.11
Southwire 6/19 T90 SIMpull Electrical Wire – Red (2 metres)	9.67
Southwire 6/19 T90 SIMpull Electrical Wire – Black (2 metres)	9.67
Contest, Competition or Race Costs *- List all expenses to participate in a conference, competition, or race, if applicable.*	
Administration Costs *- List all administrative expenses, if applicable.*	
PROJECT FULL COST ESTIMATE	***$18,988.52***

Part B. PROPOSAL FUNDING ESTIMATE	
C. OTHER FUNDING CONTRIBUTIONS *- List all other sources of funding for your proposal, if applicable.*	
D. REQUEST - Capstone Design Project Fund	
Requesting $5,000 to $18,000 towards project materials	
TOTAL FUNDING REQUEST	**$18,000**