Battery Bank for Wind Turbine

Project Proposal

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1.0 Introduction

1.1 Statement Of Purpose

1.1.0 Scope

We are part of a bigger project headed by Oscar Sida Bi and the WIDE Impact Development Engineering RSO. Their current project involves a wind turbine and generation of renewable energy used to power devices such as cars, phones, laptops, etc. One aspect of the overall scope of this project that has not yet been implemented is a way to store the energy efficiently. Thus, we have been tasked to design a storage unit which will act as the connection between the wind turbine and the user.

1.1.1 Purpose

The future of energy solutions points towards sources such as Solar and Wind. So far, wind energy has not been commercialized to the point where people can reliably harness and use it at their homes. We believe that this project is a great opportunity to start work in this field, and we hope it leads to further research and implementation.

1.2 Objectives

1.2.1 Goals and benefits

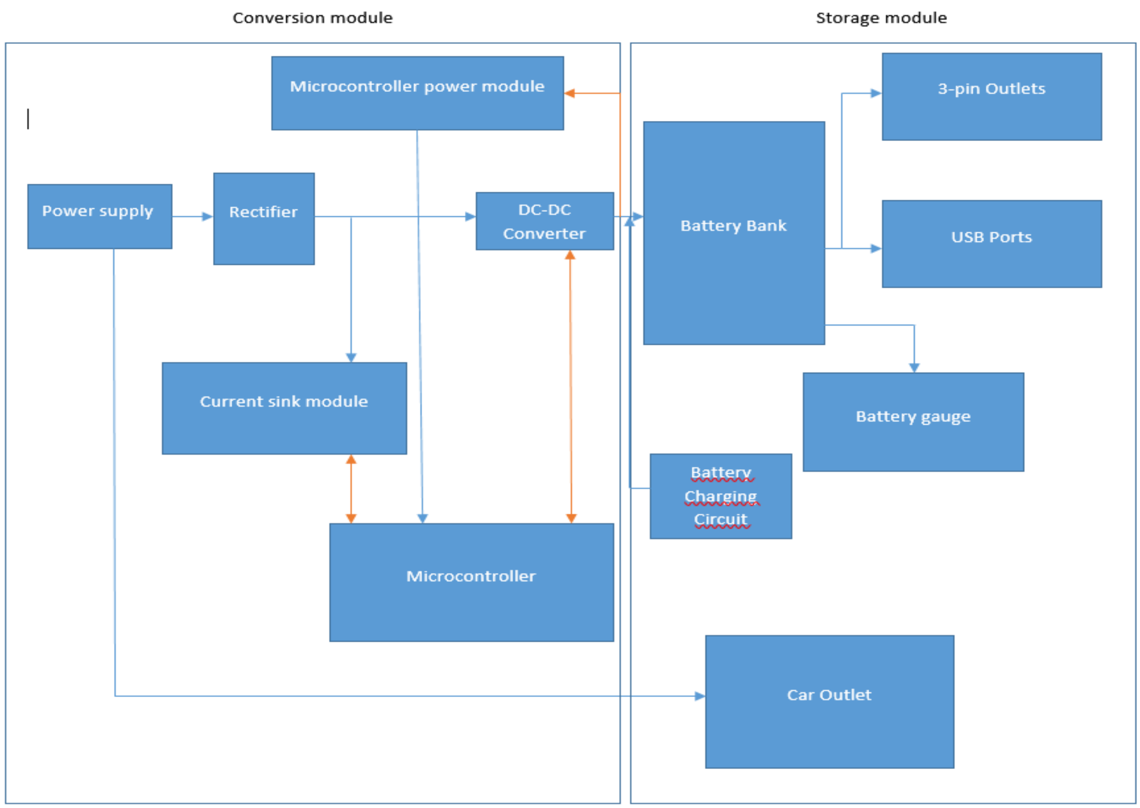
- Build a unit that successfully harnesses clean energy
- Must be inexpensive and user-friendly
- High efficiency for the life of the unit
- A stepping stone into the world of at-home wind energy usage

1.2.2 Functions and Features

- Rectifier to get to single phase
- Current sink module to regulate the current
- DC-DC convertor to get get to 12V DC power
- Microcontroller to control level of current regulation
- Battery Pack: Two 12V (35 A-h) Batteries
    - Only used to charge the basic electronics
- Outlets for the EV and the basic electronics
    - EV outlet is directly tied to wind generation (not batteries)
- Inverters to bring AC to the outlets
- Display to show level of charge

2.0 Design

2.1 Block Diagram



2.2 Conversion Module

2.2.1 Power Supply

The power is generated from the wind turbine. This turbine brings in 120 V, 3-Phase, AC power with a max current flow of 16-18 A. This will ultimately charge the batteries and/or the electric vehicle.

2.2.2 Rectifier

A 3-phase rectifier will be used to convert the AC power generated by the turbine into DC power that can be used to charge the batteries. We plan to use a rectifier rated at approximately 3 kW which will output 170 V DC and a max of approx 16-18 A

2.2.3 Current Sink Module

The current coming in from the turbine/rectifier may be too high to the point where getting from 120 V AC to 12 V DC is infeasible. Thus, a module must be created to remove some current from the system into a sink. It will consist of Nine 100 Ohm resistors in parallel, each leading to ground with a controlled switch. A microcontroller will control how many of these switches are triggered depending on how much current is flowing through. One voltage biasing resistor will allow the proper amount of voltage to enter the DC-DC converter.

2.2.4 Microcontroller

A microcontroller will be used to run the Current Sink Module and to get feedback from the DC-DC converter to make sure that the input and output of the converter is sufficient.

2.2.5 Microcontroller Power Module

This module is used to power the microcontroller. When there is sufficient charge in the battery bank, the MC will run off of this power. But, when charge in the batteries is low, a relay will allow the MC to run off of a back up Li-Po battery, that will be rechargeable from the battery bank during normal operation. This is a fail-safe so that the current sink module can always operate because if the module fails, the whole system fails.

2.2.6 DC-DC converter

The power coming from the rectifier will then go through DC-DC conversion, in order to produce the proper voltage needed to charge the batteries. The outputted voltage will be 17 V at approximately 7 Amps.

2.3 Storage and Usage Module

2.3.1 Battery Bank

The bank will be comprised of two 12 V, 35 A-h car batteries (lead acid). The energy stored will be used to charge/operate a variety of devices.

2.3.2 Battery Charging Circuit

To avoid unnecessary malfunctions during the charging process, a simple and low-cost chip will be located before the batteries to enable a softer charging

2.3.3 DC-AC Inverter

An Inverter will be used to convert the DC produced by the battery bank into 120 V AC power that electronics need to charge or operate. The inverter we use will have several outlets built in, such as 3 pin and USB ports that devices plug into to charge/operate.

2.3.4 Gauge

In order to give the user an accurate description of how much charge is left in the batteries, we plan to implement a gauge. This battery gauge will be able to sense the level of charge left in the batteries and display that to the user. It will act as a meter to show if the batteries are charging or discharging.

2.3.5 Car Outlet

Because an EV needs a large power source with a high current flow to charge in a reasonable amount of time, we made the decision to have this outlet only be fed by the Wind power source. So the power generated by the wind turbine will feed directly into an EV if an EV is plugged in, bypassing the conversion and storage modules. During periods of high wind, the EV can receive 120 V, 16 A, single phase power and could be charged as in as little as 8 hours, depending on the size of the vehicle.

2.4 Technical Analysis

We believe that this project has enough components to keep us busy semester. We plan on working every week to achieve certain goals necessary towards finishing the final project. Using diodes, resistors, and inductors, we will hand build the rectifier which will prove to be a challenging but rewarding task. Also, programming the microcontroller to control several switches will be a learning experience for us, because we do not have a programming background. To my knowledge, a low cost and portable solution to wind power has not yet been fully implemented and this is a great stepping stone into this field.

3.0 Requirements and Verification

Requirement	Verification	Points
1-. Rectifier **Output: 170V DC, 18 Amps** **Rated Power: 3kW**	a) Connect the rectifier to the grid b) Connect a load that draws 18 Amps DC at the output c) Measure output voltage across the load and check it is 170 V DC	**30**
2-.Sink module: It can draw up to 15 Amps **Rated power: 2.6kW**	a) Connect nine 100-Ohm resistors in parallel b) Connect also the rectifier to the grid as before c) Check the current at the output of the rectifier is 15 Amps	**5**
3-. DC-DC Converter: Buck-converter 50-17V DC **Rated Power: 150W** **Over 90% efficient** **3.1 Raux works (Raux stands for the auxiliary resistor located after the rectifier)**	a) Connect the rectifier and draw 3 Amps from the grid b) Check the voltage drop across Raux is 120 +/-1V being Raux 40 Ohms c) Measure the output current and ensure that output current is higher than 8 Amps which means that efficiency is over 90%	**15**

4-.Battery bank: Battery gauge works **4.1 It takes reasonable time to be charged**	a) With a backup battery we supply 17V and 9Amps (4,5 each) and check that the gauge reflects the battery is charging b) Fully charged, connect a load at the output of the batteries and check that the gauge reflects now they are discharging c) Measure the time it takes to charge a quarter of the battery and extrapolate for full-time charge to check whether is reasonable	**5**
5-.Outlets: USB Ports at 5 Volts DC **5.1 Three-pin outlets at 120 V AC**	a) Fully charged batteries connected to the inverter (for AC outlets) and buck-converter (for DC outlets) b) Measure voltage across USB ports and check it is 5V +/-0.2V DC c) Measure voltage across pin outlets and check it is 120V +/-2V AC	**5**
6-. Auto-supply microcontroller: check that even with no batteries the microcontroller is being supplied with 5V DC.	a) Disconnect the whole circuit b) Check that the buck-up battery supplies the microcontroller with 5V c) Connect only the batteries d) Check that now the relay makes its function and the batteries supply	**15**

	both the micro and the backup battery to recharge it. e) Measure input current to the auxiliary battery and the battery gauge to ensure it is discharging	
7-.Microcontroller: Everything is well-programmed and 3 Amps flow through Raux at any time, regardless of the input current. **Input: voltage at the input of DC-DC** **Output: Required voltage at the input of DC-DC (feedback)**	a) Connect the rectifier, Raux and a load that draws up to 18 Amps at 50 volts b) For diverse values of the current drawn from the grid, measure current flowing through Raux and make sure it is always 3 Amps c) Measure the current drawn to the sink module and verify Kirchhoff's law at the intersection node	**25**

3.1 Tolerance Analysis

The block we are analyzing is the rectifier. The main reason is that it is the principal part of the project, the connection between the wind turbine and the electrical applications that can be used with its energy. The input will ideally be 120 V AC and 6 Amps per line whereas the output will be designed to achieve 162.35 V +/- 1V and 18 Amps +/-0.5Amps DC current. The tolerance used for the output is adequate because the rectifier output must be filtered with an inductor connected in series with the load and the resulting wave ends up being exactly 170V DC. Due to the accuracy of the voltage, the current is also affected, but we estimate only a tolerance of +/-2.77%.

On the other hand, we are planning to use six Schottky diodes, being their reverse voltage drop only 0.7V which also influences the tolerance of the output voltage of the rectifier. In addition, the inductor that we will use for the filter will also affect the output.

4.0 Cost Analysis and Schedule

4.1 Cost Analysis

4.1.1 Labor Costs

NAME	**HOURLY RATE**	**HOURS INVESTED**	**TOTAL = RATE * 2.5 * HOURS INVESTED**
Prash	$30	150	$11,250
Marcos	$30	150	$11,250
		300	$22,500

4.1.2 Parts Costs

Item	Quantity	Total Cost
Rectifier:	1	$ 34.20
-Diodes	6	$ 3.00
-PCB	1	$ 30.00
-Load Resistor	1	$ 0.20
-Inductor	1	$ 1.00
Current Sink	1	$ 32.00
-Resistors	10	$ 2.00
-PCB	1	$ 30.00
DC-DC Buck Converter (Linear Technology LTC381)	1	$ 10.00
Battery Pack	1	$ 119.78
-Batteries (12V 35 Ah from BatterySharks)	2	$ 89.78
-Charging IC	1	$ 10.00
-Gauge (Powermax 12/24V battery gauge	1	$ 20.00
Microcontroller Module		$ 66.00

-Arduino	1	$ 22.00
-200mA Relay	1	$ 4.00
-PCB	1	$ 30.00
-Charging IC (LT1505)	1	$ 10.00
Inverter (Bestek 300W Power Inverter)	1	$ 27.00
Switches + LiPo battery		$ 30.00
TOTAL		$ 318.98

4.1.3 Total Costs

SECTION	**COST**
Labor	$22,500
Parts	$318.98
TOTAL	$22,818.98

4.2 Schedule

Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday			
7-Feb										NO WORK
14-Feb										RECTIFIER
21-Feb		RECTIFIER			ORDER PARTS	SINK				SINK
28-Feb										PROGRAMMING
6-Mar					PROGRAMMING					DC-DC+ BATTERIES
13-Mar						DC-DC+BATTERIES				MICRO POWER
20-Mar										FINAL REVIEW
27-Mar										
3-Apr						MICRO POWER				
10-Apr										
17-Apr										
24-Apr	REVIEW									

* This Proposal is subject to change based on more research and better verification of our math/process.