Group 9 EEL 4914
2/12/2021

Initial Project Document

High Capacity Solar Powered Lithium Iron Phosphate Battery (Solar LIP Battery)

UNIVERSITY OF CENTRAL FLORIDA
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Senior Design 1

GROUP 9

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Project Narrative:
As civilization progresses, and pollution becomes more rampant, the world struggles with the same problem day to day with little in terms of an affordable long term solution. While there are several different energies that are considered “renewable”, the problem continues to center around affordability and efficiency. The one source of energy that is quite possibly the easiest to use is solar. While solar is still far from being fully efficient, it can be utilized more practically by the everyday person. As it stands, hydro and wind energies can require sources out of your control, while solar energy is typically abundant for many hours of the day. What is even more difficult is a solution that is not only clean, but portable. What we aim to accomplish is an affordable and easy to use solution to portable solar energy.

Our project aims to create a high-capacity solar-powered lithium-iron phosphate (LiFePO4) battery that can be used in situations where standard power is not readily available. Whether this be when you’re camping or if you’re unlucky enough to have your power knocked out by a catastrophic event, our device offers a convenient and affordable solution. We estimate achieving a 280 Ah battery by connecting multiple cells to create this high storage capacity.

The battery will be monitored by a charge controller that is based on a microcontroller. The charge controller will control and display the battery’s state on a touchscreen LCD screen. This will help preserve the life span of the battery and improve efficiency. The LCD will display information regarding the battery using graphics that is easy to understand. Many smartphones display charge levels by representing that information using a filled battery icon as well as including the numerical level. We will be using that design philosophy when creating the graphical user interface.

Though there are other high capacity batteries that can be charged with solar, their price points are not affordable for many households. An equivalent capacity battery with solar charging capabilities can be up to $4000! For most people this is not an option. We want to demonstrate that affordability in this design IS possible, while also adding a feature that no other battery assembly has at our price point...an LCD touchscreen display as explained above.

In the solar industry, there are two types of charge controllers. Pulse Width Modulation (PWM) driven charge controllers and Maximum Power Point Tracking (MPPT) charge controllers. MPPT charge controllers are more efficient and can offer up upto 80 amps. PWMs can only provide upto 60 amps. However, for this project, we will be creating a PWM charge controller. Our goal for this project is to provide an affordable and robust solution. PWM charge controllers have been around much longer compared to MPPT controllers and are generally cheaper. They are well established and simpler to implement. The charge controller will also monitor the temperature of the battery. Lithium-iron phosphate batteries are safer compared to other lithium based batteries due to the fact that it is very unlikely for LiFePO4 batteries to be subjected to thermal runaway. LiFePO4 batteries are more desirable for use in high temperature environments due to their stability. For safety reasons, it would still be a good idea to monitor the battery's state in the unlikely possibility of it overheating.

In terms of the solar panel, we will be using a polycrystalline panel. Though this panel is not as efficient as monocrystalline in high sun, it is more efficient in lower light if there is significant cloud coverage. Because one of the utilities for our project is producing power if power had been cut off by a storm event, this would be important. Not all days after a hurricane will be sunny, so it's imperative that the solar panel still charges the battery in these circumstances.

In terms of functionality, our solar powered battery assembly will have the capacity to charge phones, computers, and other small devices, alongside running energy efficient fans or other energy efficient devices in times of need. No one wants to sleep when it's 90 degrees without AC or fans or have to deal with loud generators that release gaseous fumes, guzzle gas, and malfunction consistently. Our affordable green solution will remedy each of these problems, while keeping money in the customer's wallet.

Requirements Specifications:

General/Hardware Requirements

- Simple install and assembly for the customer
- Total price should be less than $800
- Easy to use/understand touchscreen LCD interface
- Weight of the assembly > 60 lbs excluding the solar panel
- Solar panel must be rated to output 100 watts with 80% efficiency
- Battery assembly must adhere to at least IP54 water resistance
- Assembly will have 4 AC outlets
- Battery capacity will be 280 Ah
- Temperature sensor to trigger voltage cut-off to stop charging battery if extreme temperatures are reached
- A sensor such that the solar panel stops driving voltage into the battery when the battery is fully charged
- The solar charge controller will have built-in polarity protection
- The assembly will have a heat sink

Software Requirements

All specifications below will be for the software of the solar charge controller/BMS (Still deciding which features we want to add to each of them)

- The application shall route charge.
- The application shall measure the charge of the battery.

- The application shall measure voltage from the battery.
- The application shall measure current.
- The application shall measure temperature from the battery.
- The application shall measure power consumption.
- The application shall measure voltage from the solar panels.
- The application shall control the heat sink.
- The application shall disconnect the output from the battery based on the charge level of the battery.
- The application shall reconnect the output to the battery based on the charge level of the battery.
- The application shall display the information on a display.

Constraints:

The main constraint that may cause issues is price. Other than this, we won't know further constraints until more research is done. We would like to keep the project budget under $800 in order to keep it affordable. This is important because our goal for this project alongside providing clean energy, is to provide an affordable solution. Most solar powered battery systems with equivalent amp hour capacity can be up to $3000. Based upon the proposed budget we should be able to meet this, but due to shipping costs/tariffs from China, which is where a lot of the materials will come from, this may be difficult.

Budget and Funding:
Our budget will be self funded, excluding malfunction of equipment and breakage, the cost of materials can be found below in tabular format**:**

Item	Quantity	Price Estimate	Place of origin
Solar Panel	1	$70	Windy Nation
Charge Controller	1	> $50	Custom Made (TBD)
Battery Cells	4	$430	Alibaba
Voltage Regulator	1	> $25	TBD
Microcontroller	1	$11.00	JEDEC TRAY
Custom PCB	1	$50	TBD
LCD Display	1	$10.00	Adafruit
Relay	TBD	$30	TBD
Custom Enclosure	1	$25	Friend's 3D Printer

Different gauge wiring	**TBD**	**> $50**	**Amazon**
Soldering materials	**TBD**	**$15**	**Amazon**
Outlets	**4**	**> $25**	**Amazon**
Temperature Sensor	**1**	**$5.00**	**Adafruit**
Total	**N/A**	**$796**	**N/A**

Project Milestones SD1:

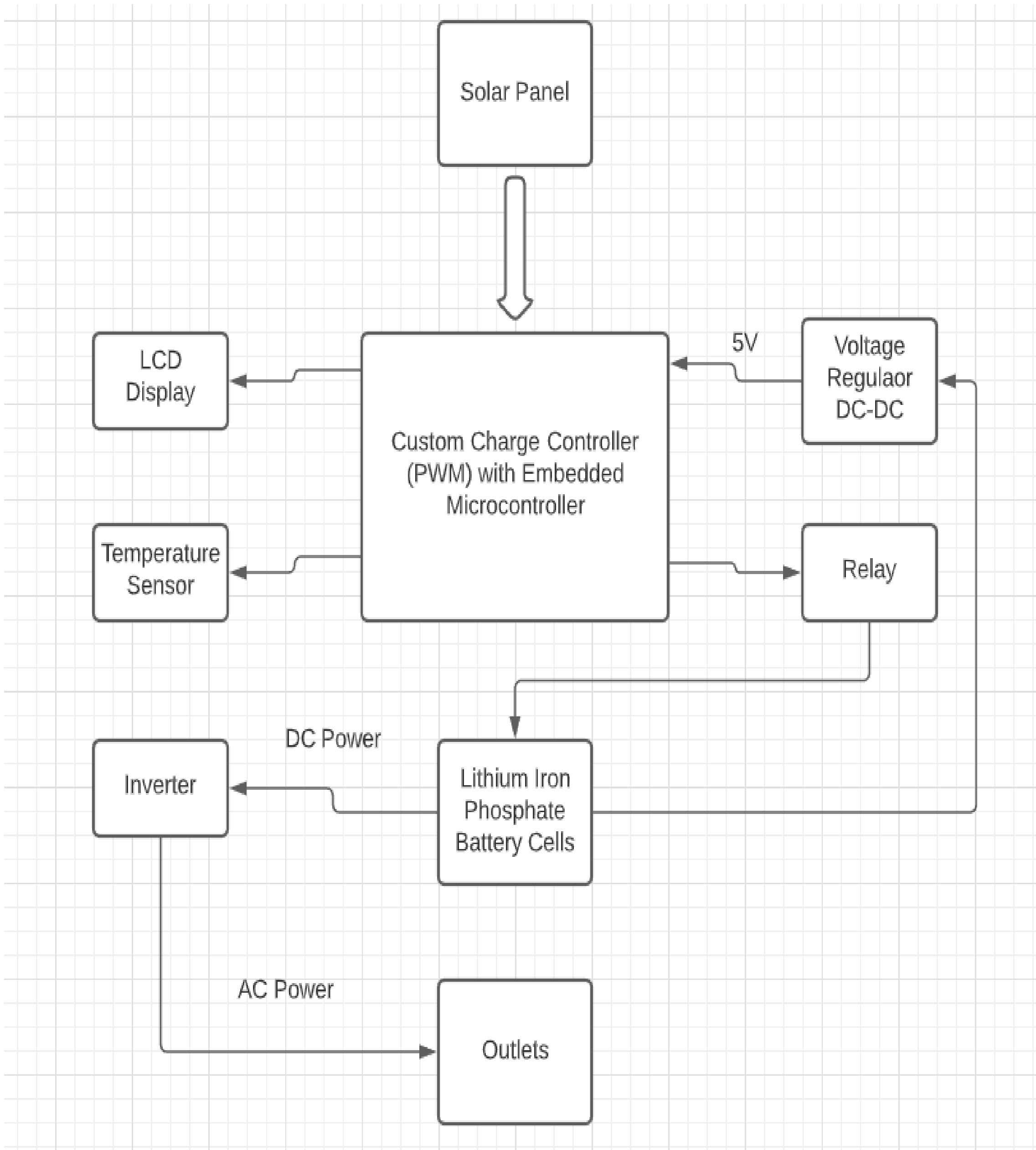
Description	**Timeline**	**Completion Date**
Senior Design Grouping	1 week	1st week (1/14/2021)
Project Idea Brainstorming	1 week	2nd week (1/21/2021)
Divide and Conquer 1.0	1 week	3rd week (1/29/2021)
Divide and Conquer 1.0 Meeting	1 week	4th week (2/1/2021)
Divide and Conquer 2.0 (Project Locked in)	1 week	5th week (2/12/2021)
Initial Project Research/60 Page Draft	7 weeks	12th week (4/2/2021)
100 Page Draft	2 weeks	14th week (4/16/2021)
Final Document	2 weeks	16th week (4/27/2021)

Project Milestones SD2:

Description	**Timeline**	**Completion Date**
Project prototype build	4 weeks	4th week (6/4/2021)
Testing and fixes	2 weeks	6th week (6/18/2021)
Finish prototype based on fixes	2 weeks	8th week (6/29/2021)

In class presentation	TBA	TBA
Final document for turn-in	TBA	TBA
Final presentation	TBA	TBA

Block Diagram:



From the block diagram above we have summarized our project into blocks where the flow is indicated by the arrows. To help make the user understand how our product operates we can elaborate upon this diagram. First, the solar panel that we decide will convert the sun's energy into electrical energy which will then be passed into our custom PWM charge controller working alongside a microcontroller. Branching off of this, a relay will be closed and opened depending upon how charged the batteries are as we want to prevent overcharging and undercharging. Next the energy brought in from the solar panel will be contained within Lithium Iron Phosphate Battery Cells. From here we will have a branch where some of the energy is directed to a voltage regulator to power the microcontroller and the rest of the energy in the batteries will be put through a DC to AC converter (inverter) to multiple outlets to power external devices. The LCD display and temperature sensor will be controlled by the microcontroller whereby it will display information such as battery levels, incoming and outgoing energy, temperature of the system for safety purposes and possibly other functionalities.

Division of Labor:

Team Member	**Primary Task(s)**	**Secondary Task(s)**
Josiah Best	• Constructing Custom Charge Controller (schematic) • PCB Design • Simulations • Voltage Regulator	• Assist Jason with any software tasks • Assisting Eduard and Mike on inverter • Ordering parts
Mike Howell	• PCB Design • Simulations • Battery Assembly • Inverter	• Assist Eduard with voltage regulator • Ordering parts • Soldering
Jason Rodriguez	• PCB software • Microcontroller software	• Assist with any hardware Josiah, Mike or Eduard

	● LCD Display/Temp Sensor software	need ● Ordering parts
Eduard Meighan	● Constructing Custom Charge Controller (schematic) ● PCB Design ● Voltage Regulator ● Inverter	● Soldering ● Assist Mike with battery assembly ● Assist Mike and Josiah with any simulations

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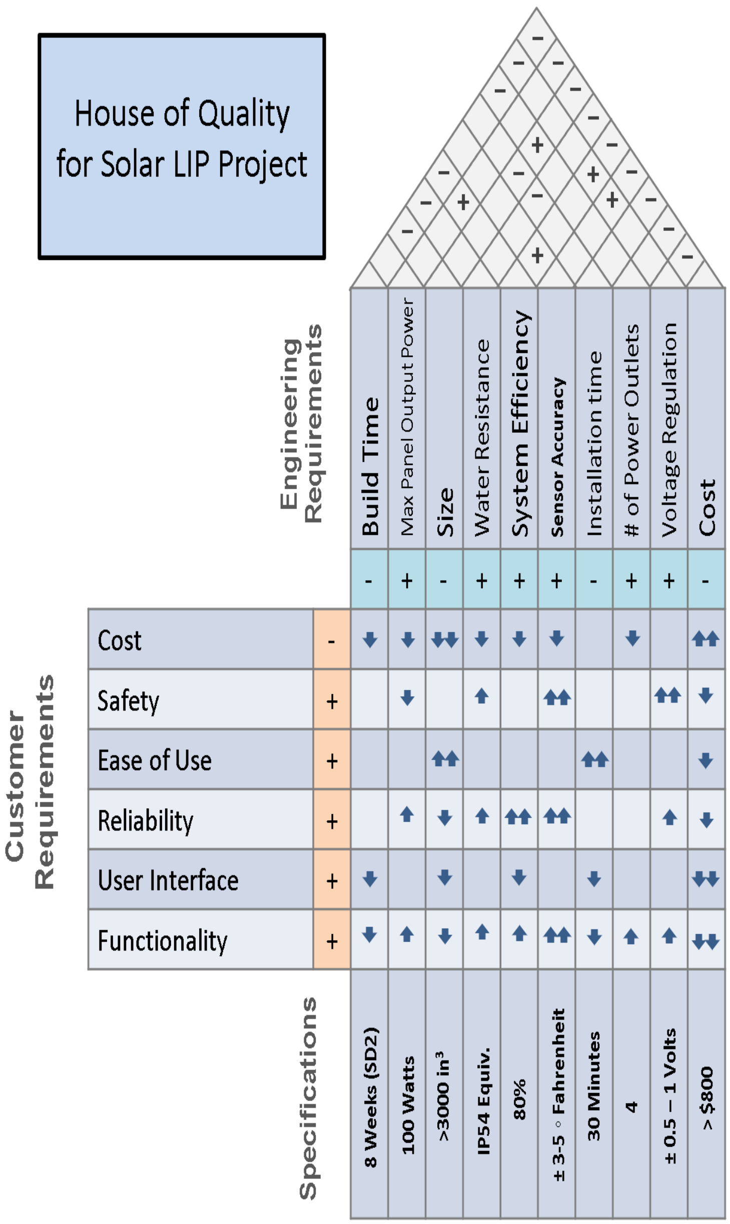

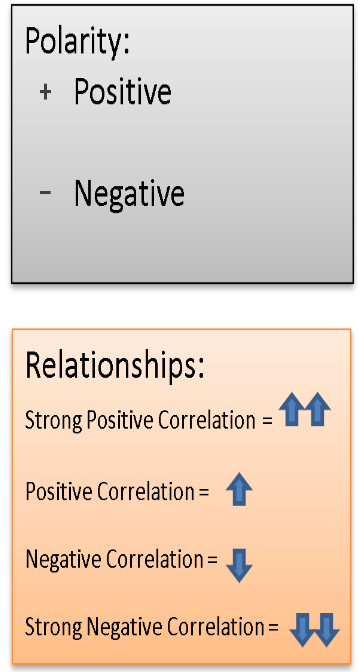

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ENG Requirement	Value
Build time	8 weeks (SD2)
Max panel output power	100 watts
Size	> 3000 inches^3
Water resistance	IP54 Equiv.
System efficiency	80%
Sensor accuracy	± 3-5 ◦ Fahrenheit
Installation time	30 Minutes
# of power outlets	4
Voltage regulation	± 0.5 – 1 Volts
Cost	> $800