GNG1103

Final Design Report

Solar #1

Submitted by

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Abstract

In this project, we provided solar energy to a modular home that is easily assembled, disassembled and is safe for families to live with. Our solution is for women and children seeking refuge from their homes and it involves a solar panel charging a DC battery and then that battery providing the necessary energy for a home like heating through detachable wiring.

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Introduction

The problem is that there is not enough sustainable living for people to be moved from their homes immediately so we need to provide temporary relief. These are women fleeing from sexual or domestic abuse in the VAW program at the Eastern Ottawa Resource Center [1]. That is why we need to provide a renewable energy to these temporary homes for people fleeing from other people in their former homes. Since the users are small groups of people for a temporary amount of time, the product doesn't need to generate a lot of power. Since there may be children it needs to be safe. This is why everything must be hidden or not exposed in the wiring department.

The reason our product stands out is that it is basically already built when the home is built, whoever is setting it up just needs to connect the circuit at certain junctions and then it is free to run smoothly.

2 Need Identification and Product Specification Process

Problem Statement:

To design a net zero modular house that can temporarily house a small number of people (including children) and can be easily assembled and disassembled in order to allow it to be transported easily and efficiently while also meeting safety standards.

Benchmarking

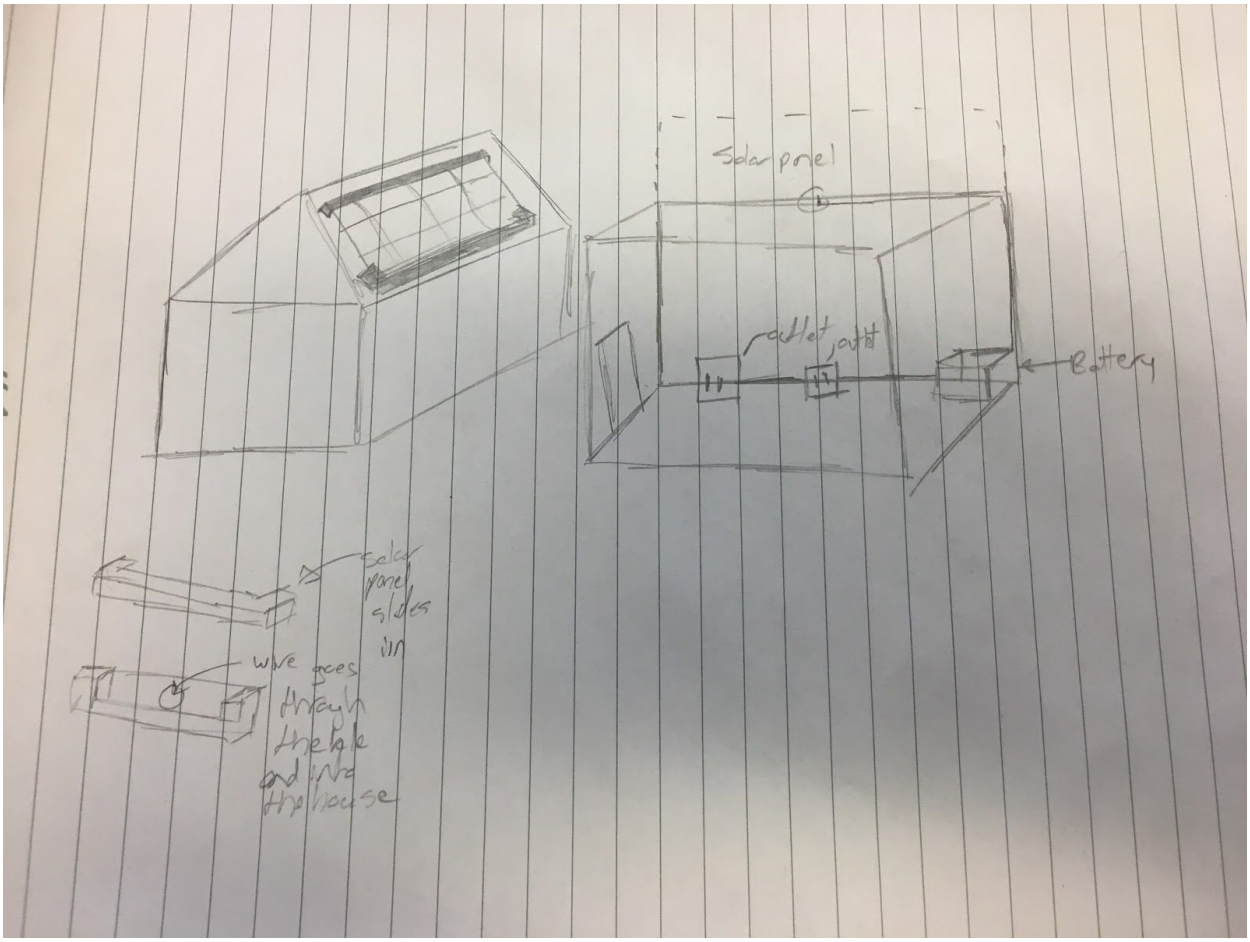
Specifications	**Average Canadian Household**	**Miniature Homes (condos, small townhouses, etc)**
Electricity usage	~11 879 kWh per year	~6000 kWh per year
Outlets	1 per 12 feet	1 per 12 feet
Safety	Plastic covers over outlets, GFCI-protected (prevent shock hazards)	GFCI-protected (prevent shock hazards)
Voltage	120V	120V
Heat	2200 square feet	1200 square feet
Costs	Hydro (141$ per month)	Hydro (50-90$ per month)
Lighting	26 light bulbs	13 light bulbs
Aesthetic	Wiring kept inside walls	Wiring kept inside walls
Setup	Done by professionals	Done by professionals
Amperage	100A	100A

Needs and Specifications

Target Needs	Target Specifications
Amperage	~9A
Voltage	120V
Safety	Child Safe/No Fire Hazards
Cost	≤$100 (After solar panel, battery, inverter)
Lighting	1-2 light bulbs
Heating	Heat 32 square feet
Outlets	2-3 outlets, 120V
Tidiness	Not Exposed/Close to Walls
Setup Difficulty	Very Easy
Aesthetic	Clean

3 Conceptual Designs

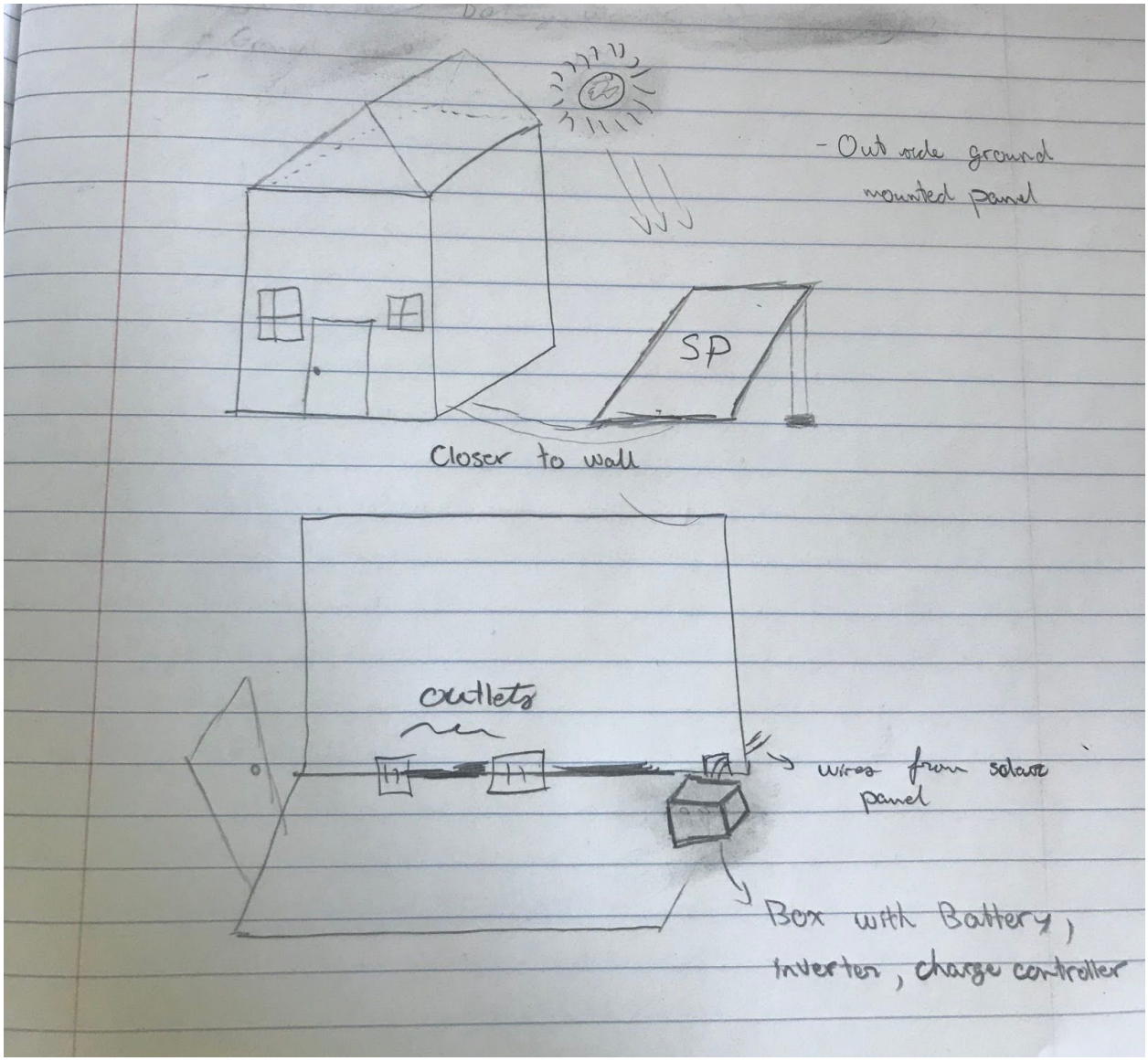
Concept 1:



For this concept, the solar panel is mounted onto the roof. The panel just needs to slide into its lower and upper mount to be stable. Cables run to the battery that is stored inside a rubber

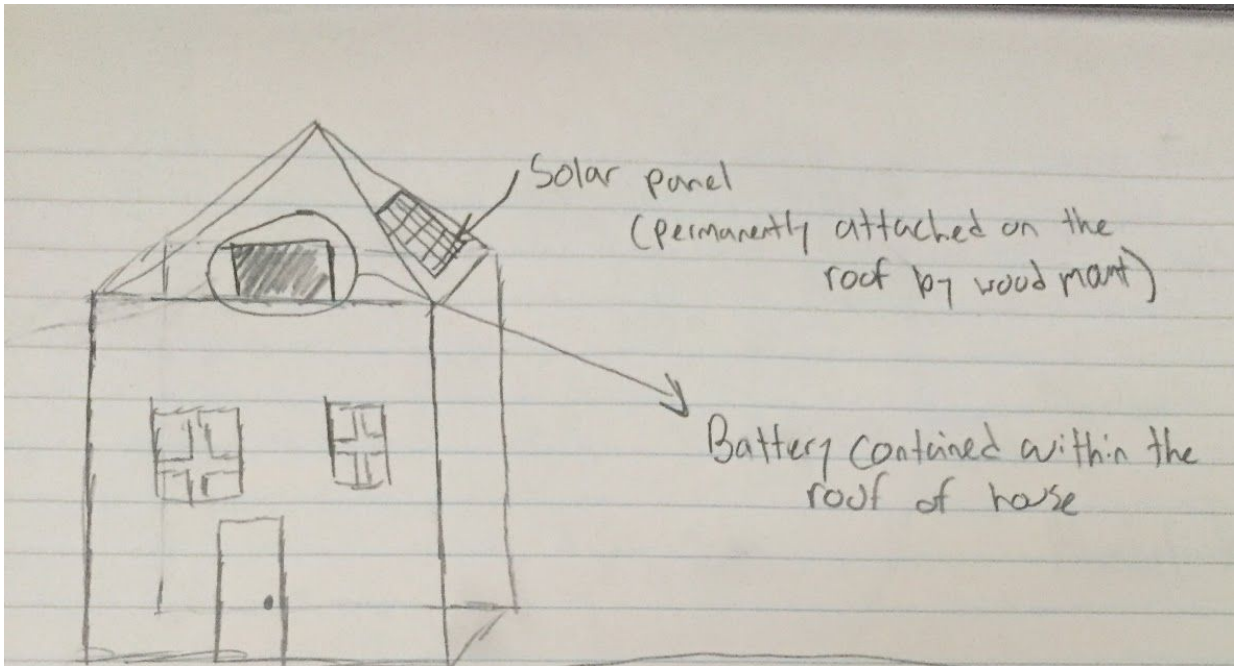
bin, containing our controller and inverter. Electricity runs through the home on detachable wiring with outlets.

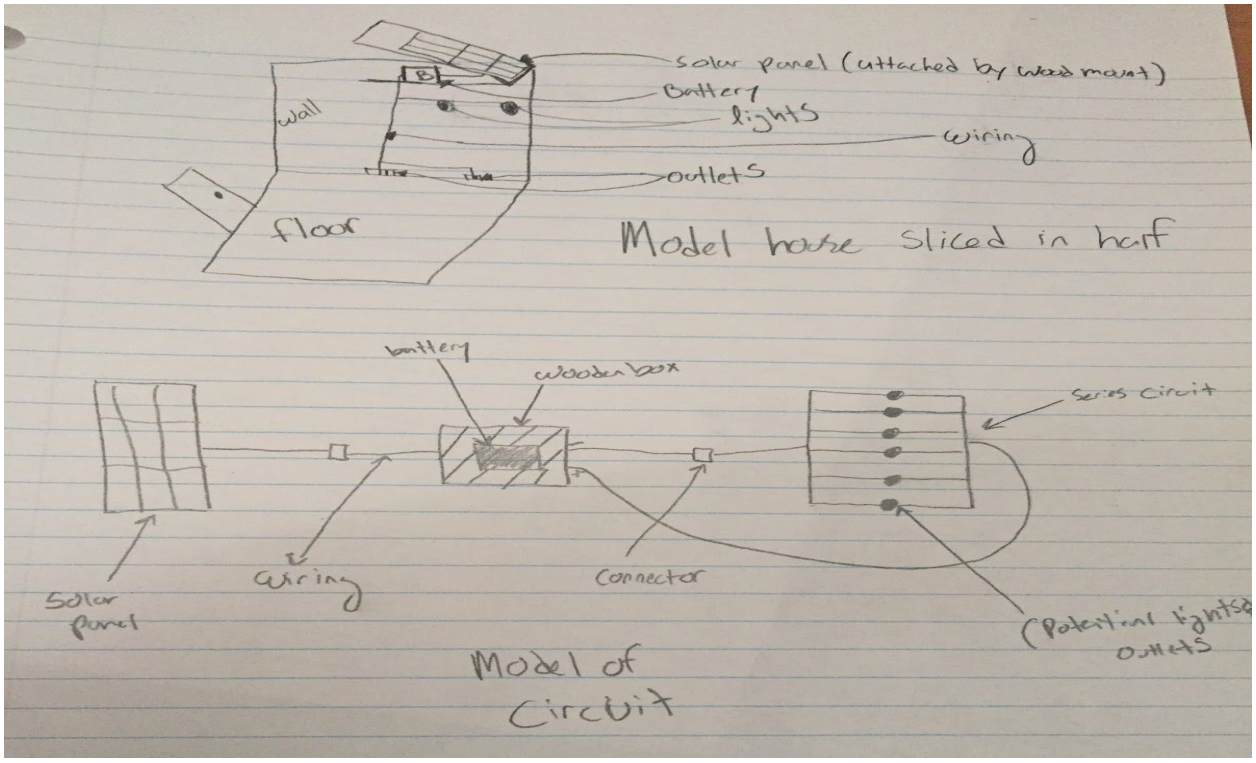
Concept 2:



In this design, the solar panel is placed outside the home but close to the outer wall. Wires run through a small hole on the outer wall, connecting to the battery which is in the house. The battery is inside a small box placed in the corner of the home, containing the battery, inverter and charge controller. We also use wires and extension cables to connect outlets, lights and heater.

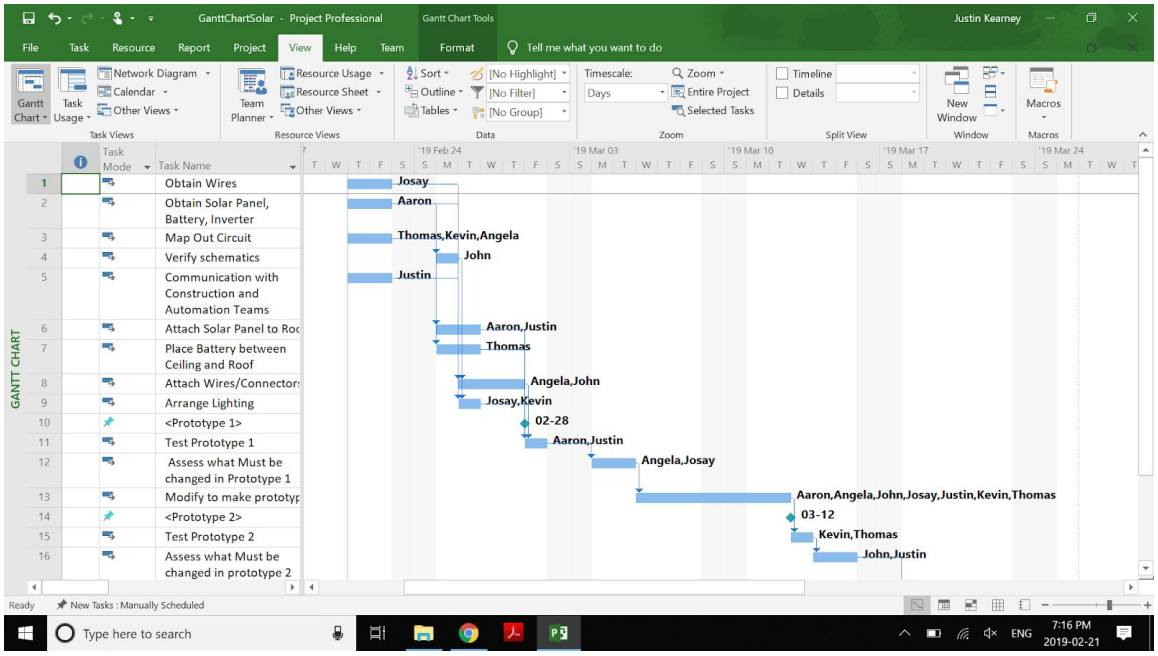
Concept 3:

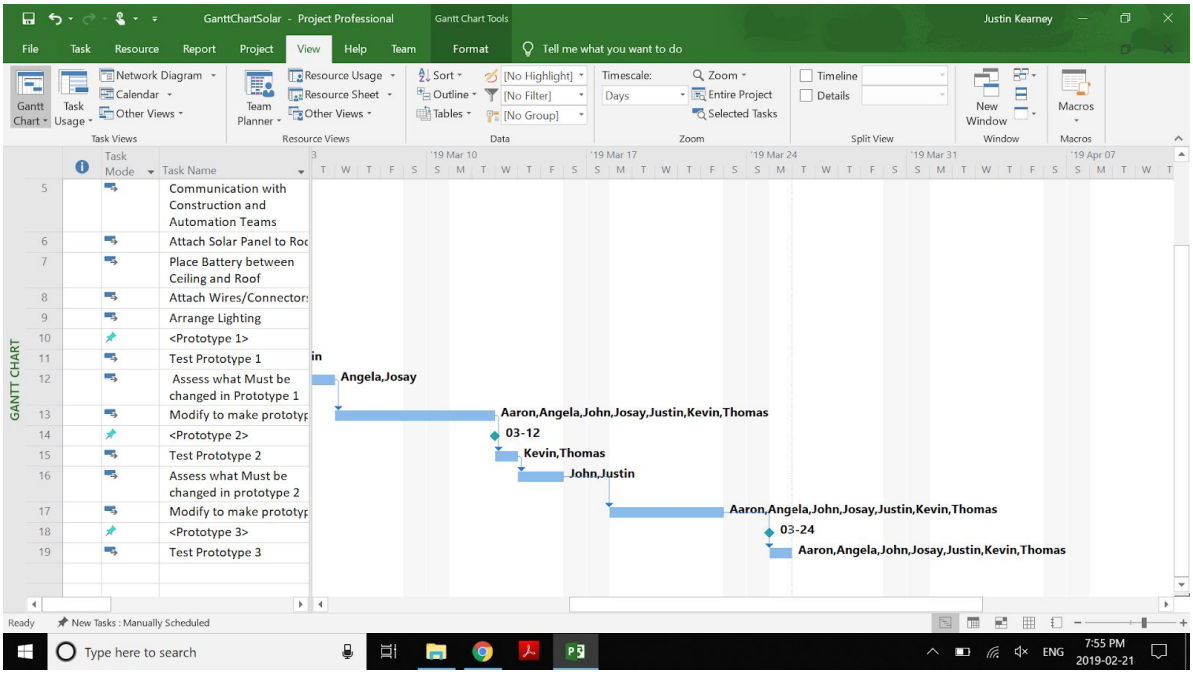




For this system, we placed the battery inside a wooden box to protect it from potential damage, which would be stored in the roof of the house. Our solar panel would also be mounted onto the roof via wood mounting so that we can maximize potential energy consumption. The circuitry for our lights, outlets, cooling and heating will be connected in parallel to avoid all electricity being futile. The wires will run down the wall that does not contain the door or windows, to best avoid external weather damages from rain or snow. The wires will have specified places where it can be connected and disconnected easily to allow the house to be taken apart easily and with no complications.

4 Project Plan, Execution, Tracking & Bill of Materials





Bill Of Materials

Item	Unit Cost	Quantity	Cost
Solar Panel	Provided	1	$0.00
Battery	Provided	1	$0.00
Inverter	Provided	1	$0.00
Connecting Wires 10 m	$27.00	1	$27.00
Heating Unit	$25.99	1	$25.99
Connectors	$2.50	5	$12.50
Outlets	$0.99	2	$1.98
Outlet boxes	$5.00	2	$10.00
Outlet Covers	$5.00	2	$6.00
Total			$87.47

Analysis:

When making the circuit, we want all the outlets to work with the same voltage, so we run everything in parallel.

Vtotal = V1 = V2 = … in parallel

This leaves us with the current. The output of the inverter is 1000W, and at 120V throughout the entire circuit

P = IV

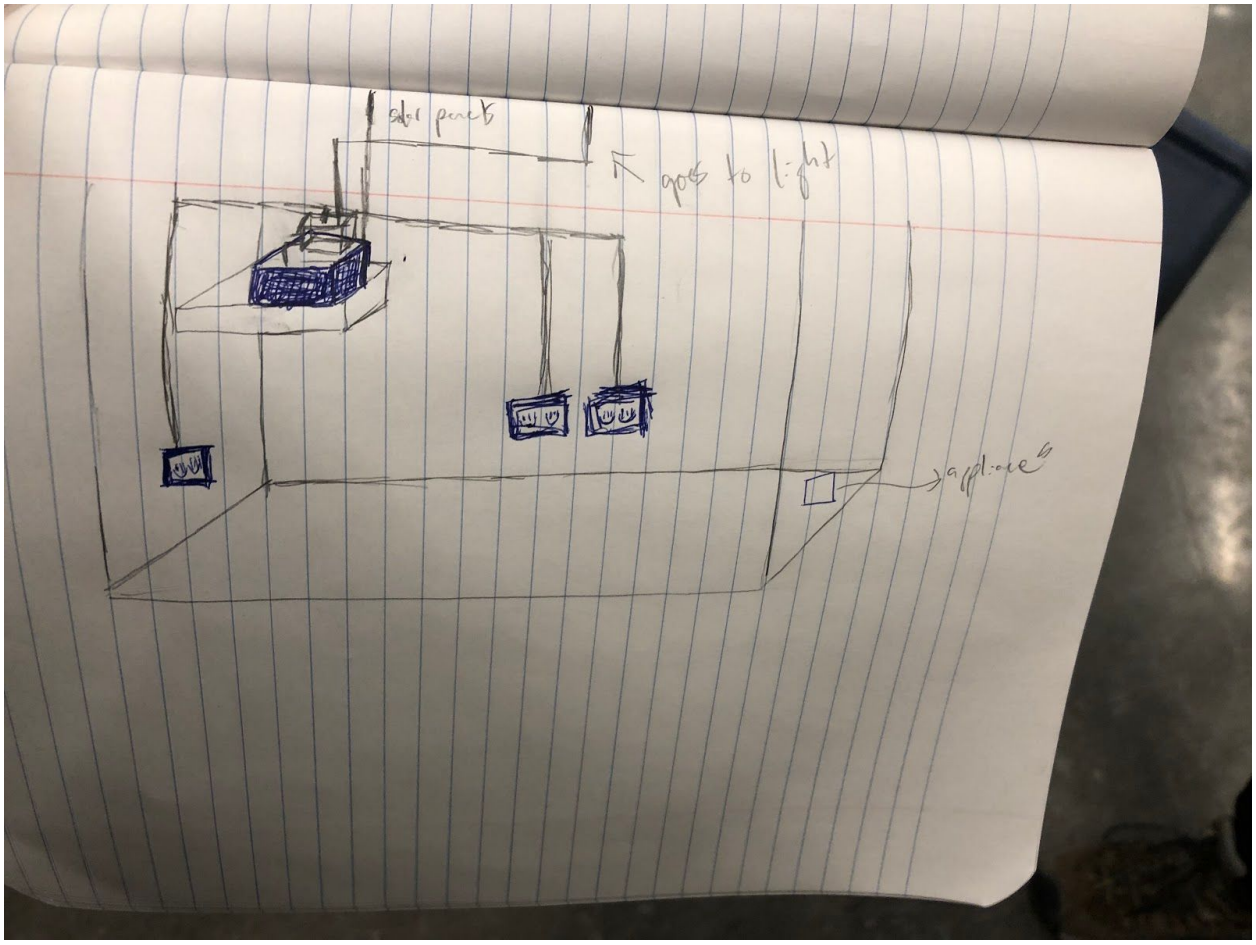
I = P/V

I = 1000W/120V

I = 8.33A so we have 8.33 amperes of current to go around to all the electrical products combined, which is a very small amount so we will have to be conservative on the power that we use.

Prototyping, Testing and Customer Validation.

Prototype 1

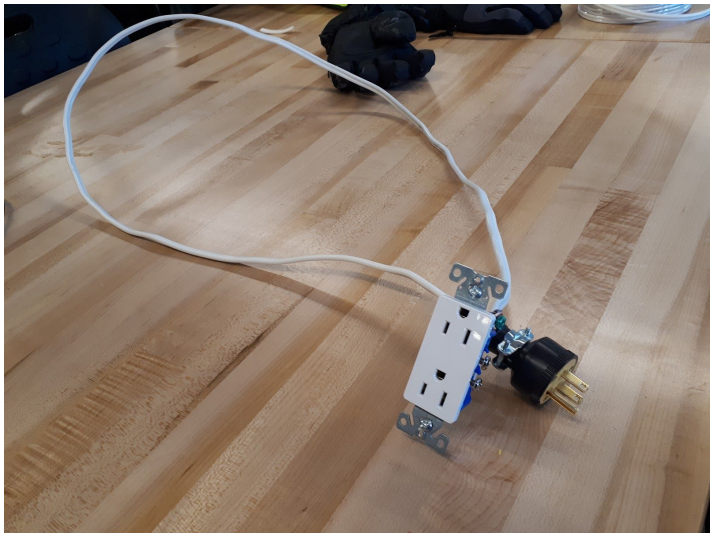


The rope will simulate wires, prototype 1 is created to ensure that the placement of the wires in the future will not obstruct any key appliances, will be neat and optimizes the amount of wiring used for the entire portable house, and also create a guideline to map the path of the circuits. To test, the members will analyze the circuit made of rope visually and will modify and adjust the components according to the placement of the rope to the rest of the house. This can also pinpoint more precisely the overall price of the optimized circuit.

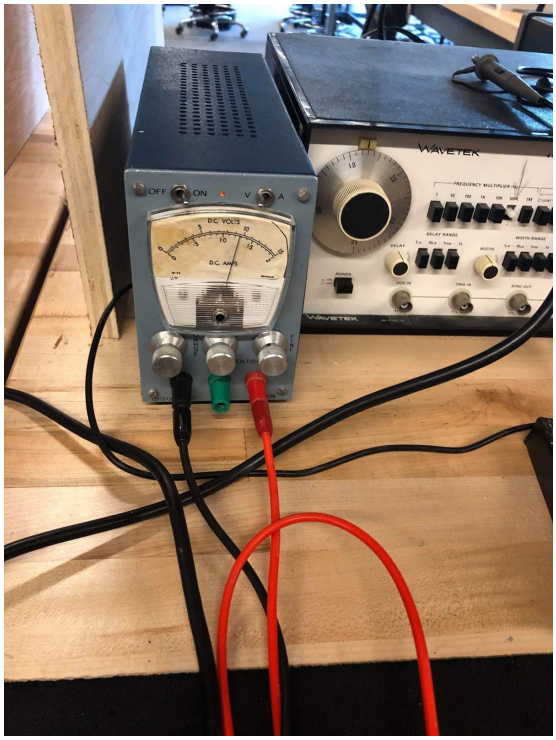
As a result of our client meetings and discussions with the project manager, we were able to acquire feedback and formulate solutions based on their needs. For instance, we had initially sought out to use a multi-purpose box where we would keep our battery and power inverter. At the same time, we intended on using it as a possible nightstand or bench. However, after consulting with our project manager and client, we concluded that because of shortages in space in the shed we were to install the box containing our battery and inverter in the attic space.

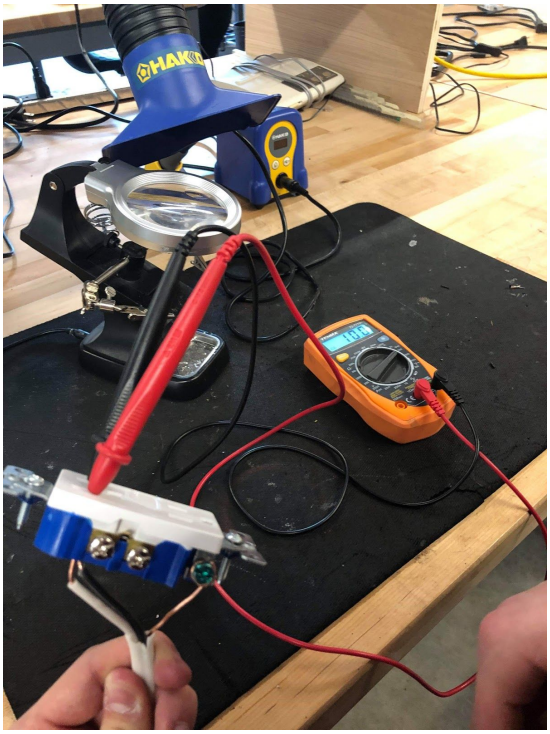
Conclusions were also made on the topic of whether or not we were going to permanently attach the solar to the roof panel or not.

Prototype 2



Testing



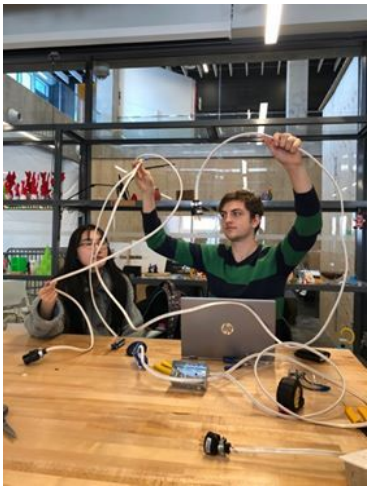


For this prototype, we tested for faulty wiring, as well as ensuring that there was no resistance in our prototype. We used a DC power supply to provide power to our outlet for preliminary testing. The stopping criteria for this prototype were to ensure that each separate part was working before we moved on to the assembly portion of our project, which is in our next prototype.

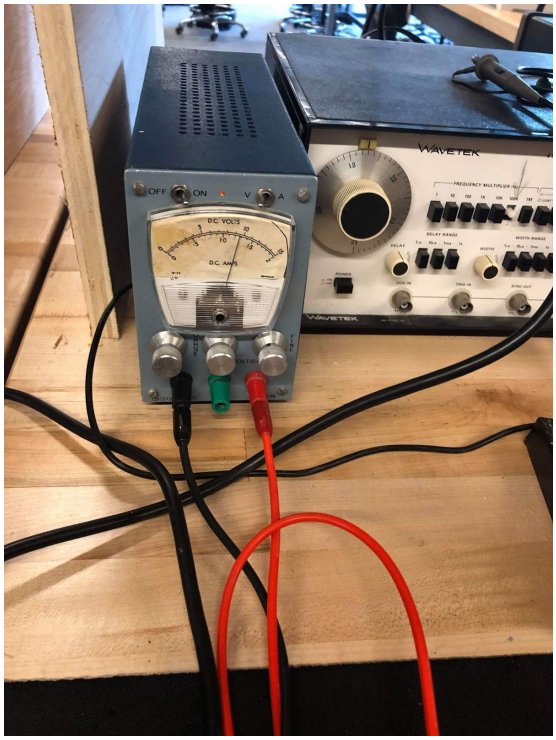
The client informed us to avoid putting an outlet on the wall where the window was to be placed to avoid leakage issues. Other than that, the client was in full support of our design ideas. The professor mentioned that the connectors that we will be using do not meet proper safety standards in a regular home, however, we were given the approval to use them anyways. We can use this feedback to adjust our design measures and use it as a guideline for the next prototype to improve the safety of the wire setup.

Prototype 3





Testing



For this prototype, we tested for faulty wiring, as well as ensuring that there was no resistance in our prototype. We used a DC power supply to provide power to our outlet for preliminary testing. The stopping criteria for this prototype were to ensure that each separate part was working and it still worked when we combined all the components. We also needed to test the battery/inverter/solar panel set-up. This caused problems as an unforeseen error came up with

the inverter. Whenever it was connected to the battery, the screen would flash red. This was not in the troubleshooting guide, and I assume that it means that we are dealing with a faulty inverter. We will continue the installation and see if we can fix this problem along the way.

There was a change in how we were setting up for design day, now all the sheds will be put together and ours will be in the middle. Since this is the case, we needed to change the locations of our outlets. We needed to adapt t the situation at hand because we need to put the outlets in the corner. This requires different lengths of wires in the ceiling. The professor mentioned that the connectors that we will be using do not meet proper safety standards in a regular home however, we were given the approval to use them anyways. We now have all the connectors ready to go and we didn't change our design.

Final Solution

For our final solution, we attached the outlets onto the house walls about 2 feet off the ground to save costs on wiring. Then, we ran each wire up towards the ceiling where they could be connected to the circuit by a simple connection. This simple connection allows for the easy mounting and dismounting of the circuit because it is already put in place when the home is constructed, it just needs to be connected, and the parts are moved when the wall panels are moved. This circuit connects to the inverter which is being given energy from the battery. The battery is being trickle charged by the solar panel witht the use of a solar controller.

We also propped up the solar panel at ground level to collect energy instead of putting it on the roof. This allows the solar panel to be placed in an optimal sunlight position in case the modular home was built in full shade or any other unfortunate and unpredictable situations.

Conclusions and Recommendations for Future Work

As a result of this project, we've learnt several principles when it comes to making a design for a specific client. Lessons that were learned and can be taken away from this experience and applied in future work are:

- How to budget, where to cut costs
- Good scheduling makes good projects
- Open discussions and listening to everyone eliminates conflicts
- Working with a client in the real world, receiving feedback

In the future, with a larger scale, there come multiple specializations that would need to be upgraded. We believe this to include:

- Additional solar panels
- An increase in power storage
- Have a higher power output
- Provide more outlets for extra appliances

Bibliography

1. https://www.wocrc.ca/violence-against-women/vaw-counselling-program

APPENDIX: Design Files

1. Need Identification and Problem Statement

https://docs.google.com/document/d/13Z3yO0wmswdOW5m4YtM3rlyXWbzMSNjV-h1x2AzRWA8/edit?usp=sharing

2. Design Criteria and Target Specifications

https://docs.google.com/document/d/1GR0IaBMI3m8TOY3YcfwUkDh1mkaGRVw1eskbBvYXZ3U/edit?usp=sharing

3. Conceptual Design

https://docs.google.com/document/d/1QDI8ejnExbaocgg9DDfwEl-SjN7hlqs8tRm32ZiUTmE/edit?usp=sharing

4. Project Schedule and Cost

https://docs.google.com/document/d/1sAdLWcVaOK_Rs7OC9NzIzsB8uDt-TT-higj3jfCgDiI/edit?usp=sharing

5. Prototype I and Customer Feedback

https://docs.google.com/document/d/1JBzmbN_XFKdPjzY0CzCloxoXVtDS7MJVJdgKCtPSsNo/edit?usp=sharing

6. Prototype II and Customer Feedback

https://docs.google.com/document/d/1kqYwUr28i5OIuocSG-2suO2aL6mL3CVu51qv7htQF_0/edit?usp=sharing

7. Prototype III and Customer Feedback

https://docs.google.com/document/d/1kqYwUr28i5OIuocSG-2suO2aL6mL3CVu51qv7htQF_0/edit?usp=sharing

MakerRepo: https://makerepo.com/JKear016/gng1103-d1-solar