Veggielution Solar Panel Project Report

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Abstract

In this project, we cooperated with Veggielution to build a solar panel project to provide electricity for the kitchen in Veggielution. We searched online for information about solar panels, solar generators, the best angle to put, the calculation of the charge time, etc. Then, we designed the circuits and built them on-site by ourselves. We found that our solar generator and panel work well in Veggielution to supply enough power to the lights to brighten the whole kitchen room and last enough time for the whole night. Finally, we hope this project will be improved in the future to achieve the goal of providing hot water using solar panels.

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1. Introduction

In this section, we will provide background information about our project. First, we will introduce our community partner, their mission, and some of the programs they offer. Next, we will go into detail about some of the background influences for both our partner's motivation as well as our team's motivation. Then, we will discuss the project itself, including our goals for the project, budget, and critical customers. Finally, we will lay out a roadmap for the rest of this report.

1.1 Community Partner

For our community-based engineering project, we are partnering with Veggielution. Their mission is to connect people from diverse backgrounds through food and farming to build a community in Eastside San José. One of the major programs Veggielution offers is the Eastside Grown program. This program includes voluntary sessions for children aged 5 to 10 to play in the garden and learn to cook every Saturday. Our critical customers are those children and staff members of Veggielution.

1.2 Background/Motivation

The greatest social challenge our partner Veggielution faces is people's lack of perception of children's need to thrive outside of the classroom (Bento & Dias, 2017). Most people find it hard to understand why children should acquire knowledge not immediately of use (such as recognizing different kinds of plants or cooking) and participate in group activities outside of primary school. However, Veggielution fulfills children's natural curiosity which they cannot achieve in classes, and equips them with crucial life skills in an early stage. Veggielution's commitment to children's well-being solidified our determination to succeed in the project. Moreover, our motivation comes from our wish to serve the community and our burning desire to apply our theoretical knowledge to tackle real-world problems. Although more effort is needed to address this social problem, we hope our project could be the first step in making a difference.

1.3 Project Specifications

Currently, Veggielution's kitchen lacks a reliable source of power for appliances, so it cannot be used during nighttime and weather without natural light. Therefore, Veggielution employees, their volunteers, and the local community need renewable energy for lights/hot water because it will greatly improve the efficiency and comfort of their kitchen. The top priority for this project is to use solar panels to provide electricity for lights in the kitchen, which is our short-term goal and key success metric. We also have a stretch/extension goal: trying to design a water heating system and or ventilation system to supply hot water and air conditioning in the kitchen, and leaving instructions for the next ENGR 110 class about what's left to implement.

Since Veggielution is a nonprofit organization, it lacks the funding that other organizations might have. Moreover, due to the aforementioned problem of lack of public perception of the necessity of Veggielution's deeds, it is not receiving enough donations from the public. This means our biggest challenge in the project is the budget constraint. Veggielution wants the most effective and cost-efficient solution within the $600 budget they can provide. Additionally, the Santa Clara University Engineering Department can provide an additional $100 budget, making our maximum budget $700. Our plans to complete this project are to only purchase raw materials, utilize our knowledge from previous classes to formulate a sketch of our design, use online simulation software to test out the feasibility of our design, and then go on-site to implement it.

Our product will enable Veggielution employees and customers to safely and comfortably use their kitchen anytime without being limited by natural lighting. This will also assist Veggielution in their mission to help educate children with crucial life skills at an early age, since the cooking lessons for children on Saturdays can last longer until night time, and no longer have to be canceled because of bad weather. Furthermore, our use of solar panels and renewable energy is in line with Veggielution's mission to improve and educate the community.

1.4 Roadmap

The rest of this report will show details about the project. Firstly, the "Discussion" section covers detailed project specifications, the solutions we used, and our unique approaches compared to other existing findings and solutions. It also includes the civic considerations that shaped our

project or solution design. Secondly, the "Results and Analysis" section presents the explanation of our solution including product specifications, physical sketches, relevant figures, and tables (the long ones will be shown in the appendix). This section also shows the process of implementation, testing, and the budget for our project. Thirdly, the "Conclusions and Recommendations" section provides a summary of primary issues, a judgment about the project, and a recommendation for future improvements. Finally, the "Bibliography" lists references and the "Appendices" section includes supplementary materials such as sample calculations, full testing results, data tables for charts, assembly instructions, bill of materials, and team-related information.

2. Discussion

In this section, we are going to discuss certain specifications of our project and aspects of civic engagement. First, we will compare our project to an online guide about implementing solar panels, and analyze the similarities as well as our novel approaches in the project. Second, we will state two design ideas altered during the process, and specify the reasons. Third, we will discuss organizations that play a role in our project. Fourth, we will discuss the civic issues our project addresses. Finally, we discuss policies and regulations and their impact related to our project.

2.1 Comparison with Online Guide

In order to make sure that our design ideas are professional, we decided to compare our processes to a well-recognized online guide about implementing solar panels. Compared to expert opinion: *RV Solar Panels: A Beginners Guide To Going Solar* (Stuart, 2022), our procedures are very similar, from selecting a portal solar panel instead of a stationary one to calculating Watt usage to adding an inverter and checking the battery bank to ensure there's enough voltage. What we didn't use is a charge controller, which creates a one-way path for energy, and monitors potential issues like overcharging or discharging. However, this device is not completely necessary, because our charger shows exactly how many hours for the battery to be fully charged. As long as Veggielution's staff members set an alarm to pull the charger off, it will not do any damage to the life of the battery. Compared to the guide, we made some innovations. We checked the tilt depending on the sunlight in different seasons and wrote it down

on the user manual for Veggielution to reference. In addition, we paid attention to shadows from buildings or trees in the area, which could potentially affect the efficiency of solar charging.

2.2 Design Ideas Changed During the Process

Some initial design ideas were modified during the design process. It was said during the partner presentation in week 1 that having our solar panels mounted to the roof was not a viable idea, since the roof might not withstand the pressure of the solar panel. Thus, we have to seek an alternative place to put our solar panel. We decided that the best option was to make it portable to protect it from damage from extreme weather. Secondly, we assumed that 300W would be enough to power the A/C, lights, fridges, and other appliances. However, after further research, we found that to deliver a sustainable amount of power, we need roughly 1000W to power just the lights with some leeway for a few other appliances.

2.3 Organizations that Influence Our Project

Because Veggielution is a non-profit public organization, it needs permission to continue receiving budget and operating on public land. Therefore, the San Jose City Council plays the most vital role in Veggielution's development. Fortunately, the city council recognizes the value of Veggielution and supports its efforts. The city council has approved a 25-year extension with Veggielution in November 2021 (Alaban, 2021). Mayor Sam Liccardo openly expressed gratitude for Veggielution and claimed he is a bit disappointed that there aren't more non-profit organizations in San Jose like Veggielution participating in farming and cooking education for the youth. Working closely with the city council, the city's Park Department is providing support for Veggielution's programs and also advocating more parks throughout the city to follow in the footsteps of Veggielution to hold similar food and farming activities, which Veggielution spread its social influence and goodwill.

Besides government agencies, Veggielution is also working with other organizations. It forms the Si Se Puede collective with four other nonprofit organizations to serve the San Jose community. Among them, Veggielution can formulate deep cooperation with Grail Family Service to learn about professional child care, as their main customers are the parents of children aged from 5 to 10. Members of the community are involved, as some professors and program coordinators at

San Jose State University and Santa Clara University are serving on the board of Veggielution. These close connections enable Veggielution to cooperate with nearby universities to address its various technical problems. These corporations also offer students like us to transform theoretical knowledge into practice to gain hands-on technical experience, creating a win-win situation.

2.4 Civic Issues Addressed by Our Design

The civic issue directly addressed by our design is not so apparent at first sight, since the lights we will implement will mainly benefit Veggielution's staff members and the children taking cooking classes. However, our design idea of using a solar panel instead of thermal power to generate electricity sets a good example for the community and other non-profit organizations to develop environmentally friendly solutions to generate energy. The world is deeply troubled by the emission of greenhouse gasses nowadays. As greenhouse gas emissions blanket the Earth, they trap the sun's heat. This leads to global warming and climate change. The world is now warming faster than at any point in recorded history. Warmer temperatures over time are changing weather patterns and disrupting the usual balance of nature since humans and other organisms are really sensitive to even a slight change in temperature (United Nations, n.d.). CO2 accounts for 80 percent of greenhouse gasses. Using a solar panel to generate electricity will reduce CO2 emissions by 20 times compared to burning coal, and 10 times compared to burning gas (Wigness, 2023). We are seeking not only to contribute to the community but also to protect the environment and achieve sustainable development.

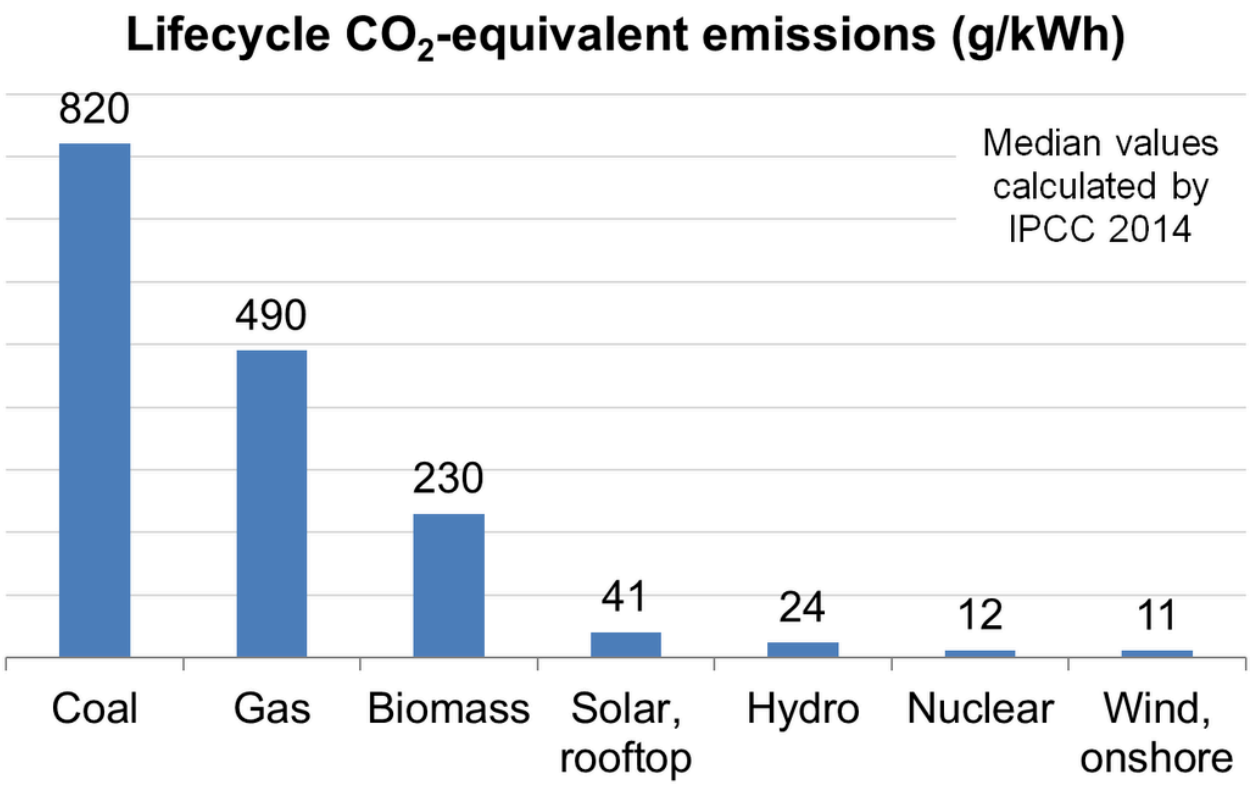

Figure 5. Lifecycle CO2 equivalent emissions (g/kWh) by different energy sources.

2.5 Policies and Regulations

Our project must abide by all regulations about "Batteries and Battery Charging" written in the US Department of Labor Part Number 1926. One of the most related clauses to our project is that battery charging installations shall be located in areas designated for that purpose (*1926.441 - batteries and battery charging.*). Moreover, our project supports California's policies in achieving carbon neutralization. Senate Bill No.1020 states that zero-carbon resources should supply 90% of all retail sales of electricity to California end-use customers by 2035, the figure will increase to 95% by 2040, and 100% by 2045. To ensure its enforcement, the California Solar Mandate that came into effect in January 2023 requires newly-built single- and multi-family homes up to three stories high to have a solar photovoltaic (PV) system as an energy source. Although the target building on which we are building the solar panel is not a family home, we still appreciate the fact that our project goes along with California's mission of achieving a 100% zero-carbon supply of electricity by 2045. We have found a new source of motivation for our project besides helping to equip children with essential life skills, which is serving mankind to achieve sustainable development.

3. Results and Analysis

In this section, we will present all the results, including tables and figures of our final design, and analyze them. First, we will include two sketches of our final design. Second, we will demonstrate tables showing the key data about the features of the battery, lights, and solar panels, and also a table showing the total budget. Third, we will show two pictures of our finished design. Fourth, we will add explanations to the tables and figures. Finally, we will present the results of our final testing, point out the deviations from our expectations, and analyze the underlying reasons.

3.1 Sketches of Our Design

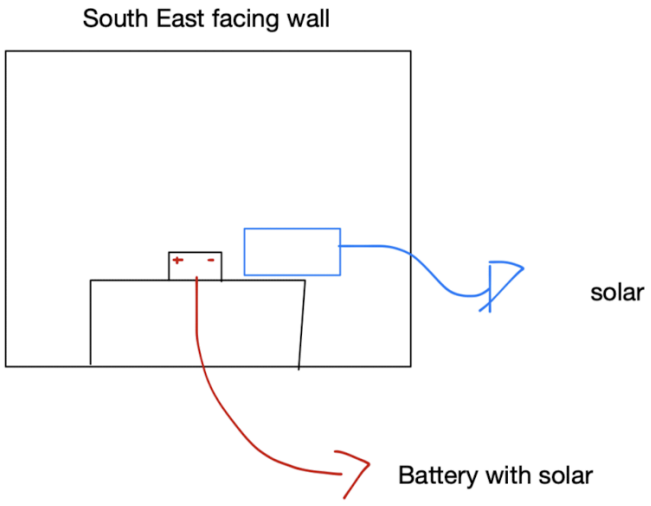

Figure 1: Diagram of Solar Panel and Battery Setup Outside Southeast Wall of Cocina

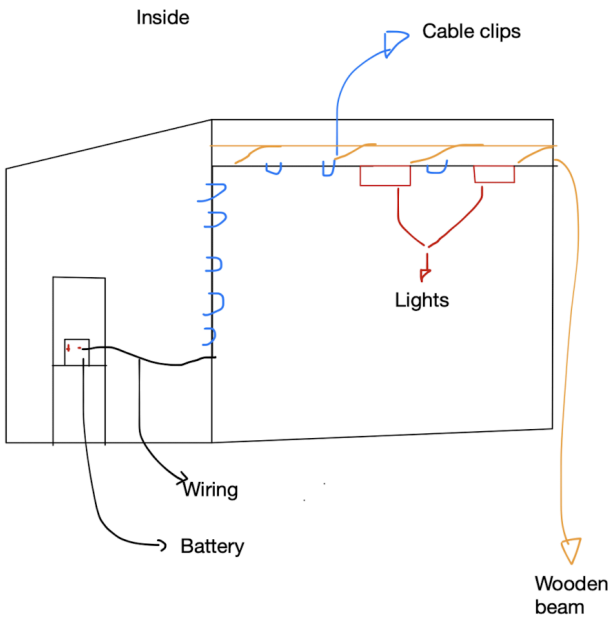

Figure 2: Diagram of Battery and Lighting System Inside the Cocina

3.2 Tables about Key Data of Equipment and Budget

Table 1.1: Battery Usage and Duration for Different Loads and Charge Levels (Tested)

Battery Level	100% (100ah)	50% (50ah)
1 Light (41W)	12 hrs	6 hrs
2 lights (82W)	6 hrs	3 hrs
3 lights (123W)	3hrs	1hrs

Table 1.2: Battery Charge Time for Different Methods of Charging

Battery charge time (outlet) (120 V)	5.3 hrs
Battery charge time (solar) (10-20V) (Tested)	20-45 hrs

Table 1.3: Materials and Specifications With Minimum and Maximum Cost

Items	Important Values	Cost	Link to buy
Lights	Size: 47.36"L x 5.48" W x 2.58"H Power: 41W Weight: 4.4 pounds Number: 2(4)	Each(+tax): $42 Total for 2: $84 Total for 4: $168	Light
Solar panel with removable battery	Delivers 1000w Has solar to charge If we order arrives in a week	Single: 399-699 plus tax (currently on sale)	Solar
Wire/Extension cord/Surge protected	Essential for delivering power to lights and kitchen	$10-50 Readily available	Wire
Maintenance cost	Lights: $0	Solar and wires: $0	Current total: **684**.00
Total (possible):	Max: $700.00	Min: $550.80	Goal: $**684**

Total for our partner 700 limits: $644 (lights, and Solar) Better light?**(2pk) &** Solar

Total for us 100 limits: 40 (power strip and wall cable) Wire & Power Strip

Total 684.

3.3 Figures of Completed Project Implementation

Figure 3. Cocina with Installed and Connected Lights

Figure 4. Solar Battery In Use on Cocina Shelf

3.4 Explanations of Tables and Figures

In Table 1.1 we calculated the efficiency of the battery and light system, deciding that our main goal for this project was to be able to provide and deliver power for at least 4 hours to sustain 2-3 lights as shown in Fig 3. After doing further testing we were able to ensure that the solar battery in Figure 4 chosen for the project will be able to support two lights for at least 8-6 hours on a full charge. Knowing this, the battery itself has a timer to let the consumer know when the battery will be depleted based on the connected appliances. Our testing indicated that the battery would be able to provide power to additional appliances, and was not limited to solely the light fixtures.

Being able to provide power beyond just lighting is a big goal we were hoping to achieve and addressing table 1.2 we were able to do so just under our budget at 684.00 plus tax. We took into account different lights and wiring as well and found these to be the most efficient.

3.5 Implementation and Testing

After fully installing the lights, battery, wiring, and cable clips we were able to gain a deeper understanding of how it would perform. After preliminary testing, we were able to deduce that it would last about 8 hours on a full charge and 4 on half a charge. Which was a little lower than our expected values. After diving into the issue, we found out that the lights themselves pulled about 150w each, compared to their advertised 81w. This caused an error in the calculations. Regardless, the lights will still have enough charge to last well beyond their needed time frame.

Our consumers had the safety manuals, the maintenance, and the storage instructions all laminated for future use. We also created a user manual to inform the consumer how to use and clean the device when needed.

4. Conclusions and Recommendations

The Veggielution Solar Panel Project, conducted in collaboration with Veggielution and Santa Clara University’s ENGR 110 class, aimed to provide a sustainable energy solution for Veggielution’s kitchen. Focused on meeting the immediate need for lighting, our project navigated challenges such as budget constraints, leading to the development of a cost-effective

solar panel system within the allocated $700. Through planning and discussion, our initial design underwent several revisions, such as moving away from roof-mounted panels due to cost and regulatory considerations. The project is successful because of its adaptability to budget limitations and the ability to meet our goal of powering kitchen lights.

Furthermore, the social impact of the project aligns with Veggielution's mission to provide non-traditional education for children. By introducing environmentally friendly energy solutions, the project not only addresses Veggielution's immediate needs but also sets an example for the community, promoting sustainability.

Looking forward, future improvements include expanding the use of solar power to heating systems or additional appliances, as well as providing user-friendly guides for Veggielution staff to manage energy consumption effectively, and monitoring the system's performance. In conclusion, the Veggielution Solar Panel Project demonstrates the feasibility of community-driven, environmentally friendly solutions in renewable energy, laying the foundation for potential future enhancements and broader community impact.

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