Team 306: Leon County Energy Sustainability Final Report

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Abstract

Leon County is facing concerns about rising energy use. The county has set a goal of reducing their greenhouse gas emissions by 30 percent by 2030. Leon County commits to decreasing the impacts of climate change. They are teaming up with us to explore how renewable technology helps the public and the environment. There are many ways to meet their goals. However, all had required a feasibility study, analysis, and simulation. Solar technology was chosen to be the focus for our project as it was the best fit based off of Leon County's goals.

This project has three different stages. Using different software and tools, we have built models that showed the overall performance from adding solar generation. This provided a look at how such equipment fits into their renewable energy goals. In the economic stage of the project, research was done into costs of various systems. Additionally, tax requirements, funding opportunities as well as the return on investment were analyzed. This provides Leon County with a snapshot of their costs and returns given the different options. The final stage provides a set of designs with which Leon County can build. We determined that the best way to use the available resources was to build solar charging stations for parks. The station results in low running costs, low maintenance, and a reduction on the load power for conventional grids.

The result of this project is both a detailed analysis and design. This provides many beneficial options to be considered for the Leon County's Office of Resource Stewardship to choose from. As time progresses, the County can use any number of our options given their available funding.

Disclaimer

This report contains model data and load assumptions that may not actually reflect realized conditions. All modeling and assumptions (see Results) has been done with the utmost care to ensure an accurate picture of what the options discussed herein are capable of.

Acknowledgement

We would like to thank the Leon County Office of Resource Stewardship, in particular our sponsor, Shelby Green and Sustainability Manager Tessa Schreiner for assisting in providing a plethora of technical data concerning Woodville Park, and allowing us to be a part of building the county's sustainable future.

We would also like to thank Dr. Md. Omar Faruque, PhD for assisting us in understanding the technical aspects of renewable energy systems. Also, few would thank him for providing us the necessary background information into using the NREL SAM Modeling Software and putting this data into a presentable format for the customer.

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Notation

NREL: National Renewable Energy Laboratories

SAM: System Advisory Model

GFI Outlet: Ground Fault Interrupting

NEC: National Electric Code

NESC: National Electric Safety Code

COTE: City of Tallahassee Electric Utility

kWh: Kilowatt-hour, unit of energy

W: Watt, unit of power

Chapter One: EEL-4914

Project Scope

Project Description

In order for the Leon County Board of Commissioners to fulfill their goals described in the Integrated Sustainability Action Plan (ISAP), the Office of Sustainability has requested the use of Team 306 to analyze and submit a turn-key design for possible sites for a pilot solar generation project for Leon County facilities and parks. In addition, to gain greater operational understanding of solar as a means of power generation, a prototype solar plant will be constructed by the Team.

Market

While the goal of this project is to provide designs for Leon County, this project has the opportunity to be applied to multiple markets, due to its nature of community exposure and government propensity toward the advancement of renewable generation:

1. Other Government Facilities: whereas this project provides means of implementing solar generation in public places, other government organizations who share Leon County's vision for solar generation in their facilities could make use of our designs to both lower their operational electric costs and to increase public exposure to solar generation.
2. Commercial Facilities: whereas many commercial organizations in the same spirit as the Leon County Commissioners want to increase their use of renewables in their own facilities, this project can and may be applied toward not only government facilities but their private counterparts, as the difference is slim between the load required in a corporate office versus that required for a courthouse.
3. State and National Parks: whereas the facilities required in operation of a county recreational park will be similar in scope to those required by State and National Parks. This will allow these parks to reduce dependence on conventional sources of power and allowing for further exposure to the uses of solar power.

Private Communities: whereas many subdivision communities and homeowners' associations share the same views toward increasing use and public exposure toward solar energy as the Leon County commissioners, they can benefit immensely from making use of our findings as a means of beginning their own pilot projects toward integrating solar energy in their offices, parks, or any other facilities.

Assumptions

For this project, a number of assumptions in regard to the nature of solar generation and the nature of energy development must be made prior to the commencement of any and all work by the Team:

1. Safety will be the overarching design factor for any and all designs, testing measures and recommendations for both the pilot project as well as the prototype.
2. This will be a pilot project, and will not be overly ambitious, insofar that we are not looking to completely alter or remove conventional electrical utility connection from any of the facilities.
3. This project will be for facility-sized solar generation and will require appropriate output voltages for service.
4. As per Leon County, the construction of this project will be handled by the Leon County.
5. As per Leon County, any and all project documentation and implementation will be reviewed by the Office of Sustainability and will submit recommendations in regard to the design prior to implementation.

The prototype will be implemented such that it is in conjunction with the scope of the Leon County Study

Stakeholders

This project will entail multiple stakeholders in its implementation:

1. Whereas we are representing the College of Engineering before Leon County, all faculty taking part in this project (instructors, advisors, reviewers) are stakeholders in its entirety.
2. Whereas the Leon County Office of Sustainability is sponsoring this project from start to finish, and our product will be put to use by them, they are regarded as stakeholders in its entirety.

Most importantly, this project is for the greater benefit of the public, and are the most crucial stakeholder in this project. All analyses, designs, and decisions will be made in regard to public trust and effective use of their tax dollars.

Customer Needs

Initial Sponsor (Customer) Meeting Questions

We began our Needs Analysis with our initial Sponsor meeting, with the intent to establish the 5 W's (Who, What, When, Where, Why,) and How of this project. We worked through gathering enough data to have a good understanding of what they are looking for in this project. Overall, the project stems from the Leon County Office of Sustainability's Growing Green Initiative to incorporate sustainability and furthermore renewable energy into the county. The questions we asked were as followed:

1) Why do they want this project?
    a. Use this project for reference in future renewable energy projects.
2) What all do they want with the project?
    a. Focus on Renewable Energy in Leon County
    b. Creative ideas for renewable energy sources
    c. Have something that can be viewed or accessed by the public to raise awareness of solar energy in Leon county.
    d. Look for ways to address social issues.
    e. Look for public feedback and see how we can address some of those issues.
    f. A concise plan of action.
3) Is the project Solar-based?
    a. Yes, but with more creativity.
    b. Consider hydroelectric within areas such as parks
4) Where will the project be located?
    a. Possible facilities and parks are listed where potential is greatest for impact
5) What exactly is the design powering?
    a. Seeking self-sustainability in low income areas
6) How do they want this project completed?
    a. Include a site analysis
    b. Include economic impact
    c. Include cost analysis
    d. Include Return on Investment
    e. Include design
    f. Report will be presented to Leon Cunty officials and will be implemented
7) Who exactly is the project to affect?
    a. Lower Income neighborhoods in Leon County
8) What is the budget?
    a. 50-100 Thousand

Customer Statement of Needs

With an initial interview done, we were able to have a good idea of what exactly was wanted by this project. Overall, it is an analysis and design of a project to be implemented after we finish that would utilize Leon County facilities or parks as an avenue to integrate renewable energy as a means of increasing their sustainability and the public's exposure to renewable energy. Therefore, we could tabulate the customer's need statements as followed:

Table 1: Customer Needs

No.	Statement of Need	Source
1	Must be creative	Cust.
2	Must promote self-sustainability	Cust.
3	Must promote renewable energy	Cust.
4	Must be implementable	Cust.
5	Must include a concise plan of action	Cust.
6	Must make use of Leon County facilities and parks	Cust.
7	Must adhere to all NEC requirements	NEC
8	Must adhere to all Electric Utility Interconnection Requirements	Electric Utility
9	Must conform to budgetary restrictions	Cust.

Interpreted Needs and Requirements

Although a number of these aforementioned needs can be subjective, we began to look into how we could make them less so. We arrived at these in two ways, the first and main source being what we knew from working with the customer. That would meet their requirements. The second was from what we had researched what all was required to potentially integrate renewables alongside a utility service. Those two needs (7 and 8) stem from there. The issue however we continued to run into is that due to the broad scope of what can be done for the project, our interpreted requirements cannot be too precise. In addition, due to these unprecedented times and multiple scheduling conflicts, we are not able to actually tour the sites to better understand what it is we could do and better grasp our limitations before we the Customer Needs were required to be submitted. We were, however, able to interpret these statements we do have into guiding requirements going into the facilities tour:

Table 2: Interpreted Customer Requiremetns

No.	Interpreted Requirement	Corresponding Need
1	Will make use of Leon County facilities and parks	6
2	Will adhere to NEC standards	7
3	Will include approved Transfer Switch if utility connected	8
4	Total cost will be less than $50,000	9
5	Will use appropriate voltage outputs	7, 8
6	Will be able to power at least 20% of site's total load	2, 3, 4
7	Will include site analysis and selection justification	5
8	Will include economic feasibility analysis	5
9	Will include design plans with drawing package	4, 5
10	Will include load survey/analysis	5
11	Will include return on investment analysis	5
12	Will be designed to be viewable from site entrance	1, 2, 3

These requirements will greatly help guide us in how we can pick a site that will best allow us to meet them. When looking at these we can discuss why we decided on them. Whereas one of, if not the most important, of our assumptions is to provide a plan that makes effective use of tax dollars, we are going to stay on the lowest end of the budget that we can, as shown in Requirement 4. Another of our assumptions was that this project would not be overly ambitious, which is our guiding idea behind Requirement 6. If we can do over 20% of the total load, all the better. But our biggest requirement is to present a useable and effective analysis and plan to the Leon County Office of Sustainability to be implemented. Requirement 12 stems from the difficulty in having something objective from something as subjective as creative, which is something we still have room to incorporate. However, since one of the needs is to be viewable by the public and in the public sphere, the part of the park where we know everyone will see is the entrance, ergo, we can ensure maximal viewership.

Summary

After meeting with the sponsor she described the different locations that Leon county is looking to implement solar or renewable energy. The sponsor is focused on the analysis and turn key design. We will share our findings with the sponsor at the end of the year so that they can present those findings to the county commissioner to receive funding to begin building the design. On top of presenting a key turn project the project should also promote solar energy usage in Leon county to the public by being in a public and easily seen area. The key turn project that will be turned over to Leon county needs to be within the budget of $50,000-$100,000. The sponsor will be giving tours of the 12 locations to team 306 to give more details and visual aid on what each location will entail when creating our design.

Functional Decomposition

Introduction

Team 306 has to look into the best way to improve sustainable energy and energy efficiency for a selected site. The goal is to reduce gas emissions by 30% by 2030, while raising awareness of solar energy within Leon county. The function tree located in the Decomposition Chart Catalog provides a breakdown and the decomposition levels of the analysis and planning portion of this project. The modules portion provides a description of the major tasks of this project.

Module Breakdown

Table 3: Site Plan Module Decomposition

Module:	Plans for selected site
Inputs:	Relating Information and External Resources
Output:	Finalized Plan
Tasks:	Get information from Leon County Tour sites Do background research Perform Assessments Consider Optimizations Power Consumption/Absorption Power system additions/subtractions Finalize Plans Submit & Present plan to Leon County's Assessment board

Table 4: Prototype Module Decomposition

Module:	Possible Prototype
Inputs:	Relating Information and External Resources
Output:	Small Solar Hookup
Tasks:	Conduct Background Research Estimate costs Finalize Plans Submit & Present plan to Leon County's Assessment board

Summary

The Functional Decomposition will typically provide a clear path for designing prototypes in projects of which this is the main deliverable. However, our project's deliverable is a design and a plan for Leon County, with a prototype not being necessary. The issue we as a team had to sort through was how to accommodate the requirements for the Functional Decomposition with what we were working on. So instead of thinking in terms of what we would develop, we looked more into functionally decomposing the process for which we would provide the analysis and plan. We began with working on how we would arrive at what we could do, as well as what we would do.

The project could go two ways, towards a facility enhancement or a park design for the community. The decision will be made by our team agreeing on the best idea for Leon County. After careful observation and evaluation, the path will be chosen by our team. Our team will then execute the tasks listed in the Functional Decomposition to the best of our ability.

Target Summary

Our biggest problem we have had with this project is in a lot of ways is that our deliverable is not a prototype for the county, but a plan that can be put into action at the end of this. Whereas our peer groups will design and build prototypes to complete a function, Team 306 has a broad range of possibilities, all with different functionalities, to meet Leon County's objective of implementing sustainable practices and renewable energy within the county. In addition to this, due to pandemic restrictions, we have only recently been able to meet with them to see the parks and facilities that we could do this project on. So it is because of this that our targets do appear to be broad in scope, because the objective is also broad in scope.

With each target, we have added multiple sub-targets, checklists of sorts that can tell where we are at and if we are on track to meet them. The first two targets, being most critical, are the ones we aim to meet by this method. For instance, Target 2 includes six sub-targets that we aim to meet when we present this plan to Leon County. Our goal here is that we can directly see how we are doing on meeting these targets by which of these sub-targets we can check yes to and no to those which we cannot yet check yes. This allows us to better measure our success on this project when we do not have a great deal of numerical metrics to work with.

Many of these targets were derived after seeing what we could do during our first visit to possible sites on 9/25/20. This allowed us to better grasp ideas that could guide both our concept generation as well as fulfilling the designs. Following this trip, we brainstormed these ideas for targets and most importantly how we would measure our success of them. We discussed as well what warrants a successful project and a failure, and that is where we arrived at the critical targets and the range of importance of our targets. For Targets 1 and 2, we need them to 100% complete to be considered successful, and the rest at minimum 67% for success. We gather those answers through continual review from our stakeholders including our advisers, our reviewers, and our customer. They have the final word on whether these targets are met.

We arrived at these targets more through synthesizing our customer's needs over our functional decomposition. This is especially key here, as our design is not decomposed the way other electrical engineering projects are. Instead, we focus on meeting the requirements that are set forth by us from Leon County. Referencing that, we see they want this project to be implementable and under budget, which is why those two are our most critical.

The final note here is that these are the highest-level targets we could arrive at. Because of the fact we have a broad function for the project and a broad range of possibilities for implementing it, as we pursue one avenue over another these can be adjusted to be more geared to the proposed design itself. The same here can be said of the functional decomposition once we have an idea of the overall function of our design in place.

Concept Generation

Summary of Methods

We began working on our Concept Generation following the conclusion of our first Virtual Design Review. We had the plan in place to use resources provided by our sponsor, and other background research findings all of which point toward numerous actions other counties, municipalities, and even businesses have done to meet similar requirements.

Following a couple days of reviewing our findings we spent a couple of hours brainstorming, making exceptional use of the Crap-Shoot methodology, going down the line, discussing ideas, and building off of previous ideas. We would jot these down, which is the reason for the abbreviations used in the descriptions, with the goal of generating 100 ideas. In our minds, we had already come up with a number of ideas prior to generation and been given these ideas by our sponsor and advisor, so these were our starting out points.

After we had written these down our next job was to assign our confidence levels to these. This was in essence our highest level of concept selection criteria. The criteria for that confidence level, which is congruous with fidelity in this instance, would be a few questions:

1. Is this doable by us as a team?
2. Would this increase sustainability for the county?
3. Would the public be able to see it?
4. Most importantly, is it a good use of county funds?

With this in mind, we went back through our list of concepts and answered these and other questions to give us our confidence level. Obviously, the ones we had initially thought about and worked over in our minds met these criteria and were our “high” confidence levels. The majority were “low” confidence levels however the “med” levels were interesting because many of these were ones we had not even considered until we had begun concept generation. Thus, with our target of having multiple tiered proposals in mind, these are some that could very well play a role going forward.

Table 5: Concepts Generated with Initial Confidence

No.	Concept Description	Confidence Level
1	Pavilion charging station	high
2	Interactive renewable “instructable”	high
3	Hydroelectric powered water testing lake Munson	high
4	Irrigation controller	med
5	Hydroelectric charging station lake Munson	med
6	Renewable benches w/ charging station and Wi-Fi	med
7	Solar power trash cans	med
8	Solar power county events bulletins	med
9	Solar on county owned lakes	low
10	Windmills on city owned lakes	low
11	Workout station powered by renewables	low
12	Integrated solar panels on courthouse	low
13	Building material replacement	low
14	County fleet replace w/ electric	low
15	Window replacements on county bldgs.	low
16	HVAC regulators on facilities	low
17	Population sensor for HVAC	low
18	Population sensor for lighting	low
19	PV cell upgrades for park lighting	low
20	LED replacements for park lighting	low
21	Solar power net garbage collector for lakes	low
22	Solar powered porta-potties at park	low
23	Complete renewable rebuild of park restroom	low
24	Solar power fire/smoke detector	low
25	Solar power air quality detector	low
26	Solar power water quality detector	low
27	Wi-Fi canopy for parks	low
28	Renewable integrated water fountain pumps	low
29	Solar power clocktower	low
30	Coastal wind turbine integration county connect	low
31	Tidal turbine connect to county	low
32	Geothermal integration for utility connect	low
33	Spring-fed hydroelectric turbine	low
34	Automatic operating blinds for bldg. HVAC	low
35	HVAC upgrades across all facilities	low

36	Natural lighting integration for ceilings	low
37	Natural lighting design for walls	low
38	LED replacements for facility lighting	low
39	Rainwater reuse	low
40	Renewable integrated hurricane sensors	low
41	Renewable integrated weather stems	low
42	Wi-Fi areas for all parks	low
43	Renewable implemented pavilions	low
44	Solar power hot water heaters	med
45	Renewable benches w/ charging station	med
46	Renewable benches w/ Wi-Fi connectivity	med
47	Biomass integrated generating station	low
48	Renewable integrated billboards	med
49	Methane harvesting at landfill	low
50	County maintained electric vehicle charge stations	low
51	E-bike charging station	low
52	Landfill solar farm	low
53	Solar power water purifier	med
54	Solar power hydration stations	med
55	Renewable integrated UV index detector	low
56	Renewable power population detectors	low
57	Solar power handwashing station	low
58	Solar power temperature scans	low
59	Solar power digital bulletin boards	low
60	Electrify county owned heavy equipment	low
61	Public Wi-Fi canopies at all parks	low
62	Solar power lighting for all remote parks	low
63	Solar power lighting for all future parks	low
64	Solar power facility water heaters	low
65	Solar power microwaves for parks	low
66	Solar power refrigeration for parks	low
67	Solar power fans in existing pavilions	med
68	Solar charging stations on bike trails	low
69	Hydration stations for bike trails	low
70	Solar power air pump for bikes on bike trails	low
71	Security lighting for bike trails	low
72	Hydroelectric power lighting for lake Munson	low
73	Hydroelectric power for stormwater runoff	low
74	Solar security lighting for all county boat ramps	low

75	Solar integrated porta johns for boat ramps	low
76	Sustainable design bldg. for county example	low
77	Solar powered county owned parking gates	low
78	Moveable solar handwashing stations	low
79	Solar power animal feeding station	low
80	Solar power dog feed/water station	low
81	Solar power tennis ball launcher for parks	low
82	Renewable powered vending machines	med
83	Renewable powered occupancy sensors	low
84	Wearable human proximity sensors	low
85	Repurpose park for large scale solar integration	low
86	Solar powered fire starter for park cooking stations	low
87	Solar lawn care tools for county parks management	low
88	Solar powered playgrounds	low
89	Solar powered receptacles for county vehicles (outlets)	low
90	Large scale coastal wind integration for county connection	low
91	Airflow upgrades for parks and facilities	low
92	Wholesale purchase of solar integrated power	low
93	Solar powered shaded picnic tables for parks	low
94	Solar power bug zappers for parks	low
95	Solar powered compost collector	low
96	Solar powered security cameras for parks	med
97	Solar powered alarm systems	low
98	Solar powered PA systems	low
99	Solar powered park lockers	low
100	Solar powered radios for parks	low

Concept Selection

Summary of Methods

We began by going back through our list of 100 concepts generated and discussed them more in depth. Specifically, we discussed the feasibility of these options. Assigning a feasibility rating ranging from 0-5, we rated each option as a means of cutting off concepts that would not be feasible enough for pursuing any further. Ideally, we knocked it down to our top eight concepts to pursue. The majority of these concepts we had already considered and brainstormed following our visits to the parks and facilities, as well as multiple discussions with the Leon County Office of Sustainability.

Going forward, our next means selecting our concepts was to specialize our ratings based on our targets and based on what our goals are for the project. To implement this, we made use of the House of Quality as a means of modeling our goals of the project. We considered our requirements and considered how they stack up comparatively. This provided us with a guide for which requirements were more important than others.

Following the House of Quality, we went through and plotted our top eight concepts into an AHP Decision Matrix. This was another means of narrowing our field further with what we could do, with what met our requirements. Finally, we compared the highest scoring concepts with each other through the Pugh Comparison Matrix.

Our goal with doing these methods was to reach the best one or two concepts that met our goals and could be done. With our project, we have the option to proceed with multiple concepts as a means of providing Leon County with multiple plans and designs that they could pursue.

Concept Feasibility: Baseline Selection

The initial plan of action was to narrow our field of concepts initially with a feasibility ranking. This was done shortly after brainstorming the concepts and acted as our baseline for establishing higher feasibility concepts. We did this by ranking each concept from 0 to 5, 0 being not feasible at all, and 5 being exceptionally feasible and would be an excellent fit given our scope. Most of the concepts ranked 5 actually stemmed from ideas and miniature brainstorm sessions we had while we were touring the parks and facilities. The following pages show the concepts we had established, as well as their associated feasibility rankings.

Table 6: Concept Baseline Feasibility

No.	Concept Description	Feasibility
1	Pavilion charging station	5
2	Interactive renewable "instructable"	5
3	Hydroelectric powered water testing lake Munson	5
4	Irrigation controller	5
5	Hydroelectric charging station lake Munson	5
6	Renewable benches w/ charging station and Wi-Fi	5
7	Solar power trash cans	5
8	Solar power county events bulletins	5
9	Solar on county owned lakes	1
10	Windmills on city owned lakes	0
11	Workout station powered by renewables	3
12	Integrated solar panels on courthouse	2
13	Building material replacement	0
14	County fleet replace w/ electric	0
15	Window replacements on county bldgs.	0
16	HVAC regulators on facilities	3
17	Population sensor for HVAC	2
18	Population sensor for lighting	2
19	PV cell upgrades for park lighting	4
20	LED replacements for park lighting	3
21	Solar power net garbage collector for lakes	2
22	Solar powered porta-potties at park	2
23	Complete renewable rebuild of park restroom	0
24	Solar power fire/smoke detector	3
25	Solar power air quality detector	3
26	Solar power water quality detector	3
27	Wi-Fi canopy for parks	4
28	Renewable integrated water fountain pumps	3
29	Solar power clocktower	0
30	Coastal wind turbine integration county connect	0
31	Tidal turbine connect to county	0
32	Geothermal integration for utility connect	0
33	Spring-fed hydroelectric turbine	1
34	Automatic operating blinds for bldg. HVAC	3
35	HVAC upgrades across all facilities	0

36	Natural lighting integration for ceilings	0
37	Natural lighting design for walls	0
38	LED replacements for facility lighting	2
39	Rainwater reuse	2
40	Renewable integrated hurricane sensors	3
41	Renewable integrated weather stems	2
42	Wi-Fi areas for all parks	0
43	Renewable implemented pavilions	4
44	Solar power hot water heaters	4
45	Renewable benches w/ charging station	4
46	Renewable benches w/ Wi-Fi connectivity	4
47	Biomass integrated generating station	2
48	Renewable integrated billboards	4
49	Methane harvesting at landfill	2
50	County maintained electric vehicle charge stations	0
51	E-bike charging station	3
52	Landfill solar farm	4
53	Solar power water purifier	3
54	Solar power hydration stations	3
55	Renewable integrated UV index detector	3
56	Renewable power population detectors	2
57	Solar power handwashing station	1
58	Solar power temperature scans	0
59	Solar power digital bulletin boards	3
60	Electrify county owned heavy equipment	0
61	Public Wi-Fi canopies at all parks	1
62	Solar power lighting for all remote parks	4
63	Solar power lighting for all future parks	3
64	Solar power facility water heaters	2
65	Solar power microwaves for parks	1
66	Solar power refrigeration for parks	1
67	Solar power fans in existing pavilions	2
68	Solar charging stations on bike trails	4
69	Hydration stations for bike trails	3
70	Solar power air pump for bikes on bike trails	3
71	Security lighting for bike trails	2
72	Hydroelectric power lighting for lake Munson	2
73	Hydroelectric power for stormwater runoff	2
74	Solar security lighting for all county boat ramps	3

75	Solar integrated porta johns for boat ramps	1
76	Sustainable design bldg. for county example	0
77	Solar powered county owned parking gates	0
78	Moveable solar handwashing stations	1
79	Solar power animal feeding station	1
80	Solar power dog feed/water station	2
81	Solar power tennis ball launcher for parks	1
82	Renewable powered vending machines	3
83	Renewable powered occupancy sensors	3
84	Wearable human proximity sensors	0
85	Repurpose park for large scale solar integration	0
86	Solar powered fire starter for park cooking stations	1
87	Solar lawn care tools for county parks management	0
88	Solar powered playgrounds	2
89	Solar powered receptacles for county vehicles (outlets)	0
90	Large scale coastal wind integration for county connection	0
91	Airflow upgrades for parks and facilities	2
92	Wholesale purchase of solar integrated power	0
93	Solar powered shaded picnic tables for parks	1
94	Solar power bug zappers for parks	2
95	Solar powered compost collector	2
96	Solar powered security cameras for parks	1
97	Solar powered alarm systems	1
98	Solar powered PA systems	0
99	Solar powered park lockers	0
100	Solar powered radios for parks	1

House of Quality

After analyzing the customer requirements, we developed these technical requirements needed to complete our project. Each technical requirement has its own associated target. We also developed the interaction between the engineering requirements and identified how both our customers and the technical requirements impacted each other. The house of quality below shows the project planning matrix (Engineering matrix), which was designed to demonstrate how the customer needs related directly to the technical requirement that our designed will be depending on.

Quality Function Deployment (House of Quality)

Team 306:
Leon County Energy Improvements

Correlations:
⊕ Strong Positive
+ Positive
⊖ Strong Negative
- Negative

Customer Requirements	Customer Priority or Weight	Energy Storage	Output Power	Sunlight needed for PV system	Area usage	Budget
Be used in Leon County facilities and parks	9				+	
Promotes Sustainability & Renewable Energy	10	⊕	⊕	⊕		
Adheres to Electric Utility Interconnection Requirements	9.5		⊕			
Implementable Design	8.5				+	+
Conform to budget	6					⊕
Follows a concise plan of action	8					
Targets		30	20	4	150	$50
		%	%	hours	ft^2	thousand

Technical Requirements — Technical Assessment — Customer Assessment/ Competitive Evaluation

Figure 1: House Of Quality

AHP Decision Matrix

The AHP tabulates criteria needed for the project along with the top eight different design options pulled from the initial feasibility matrix. Each design option is given a score on how effectively it meets each criterion. A summation of these scores is then displayed on the bottom of the AHP decision matrix to rank the different design options. For our project, our team decided on utilizing a local park as our location.

Table 7: AHP Decision Matrix

	Pavilion charging station	Interactive renewable instruction	Hydroelectric powered water testing	Irrigation controller	Hydroelectric charging station	Renewable benches with charging station and Wi-Fi	Solar powered trash cans	Solar powered county event bulletin
Budget	5	3	2	2	1	5	5	5
Sustainable	5	3	3	2	3	4	5	5
Promotes renewable energy	5	5	3	2	4	5	5	5
Public exposure	5	5	1	3	5	5	5	5
Public use	5	5	0	0	5	5	5	5
Score	25	21	9	9	18	24	25	25

After evaluating all the designs and criteria, the pavilion charging station, solar powered trash can, Charging and Wi-fi benches and solar powered county event bulletin board were the projects that had the highest scores. We decided on these after careful consideration of the criteria. Each of them scored well in the budget category because they are realistic in terms of meeting our goals for the set budget. We also figured each of them were sustainable in that they would be regulated without the need of someone controlling them, and they would not use anything outside of renewable energy. Since our project needed to promote renewable energy to the public, we figured that these projects would best suit that requirement. With that, we also figured that the four would favor well in public exposure and public use. Each of these projects could be used by the community. In order to rank these four designs from best to worst we will need to put them in a Pugh Matrix where the criteria will be weighted.

Pugh Comparison Matrix

At this point of the concept selection process, we had narrowed down our 100 initial ideas into four high feasibility options that met all of our requirements in essentially the same manner. In addition, we also have established which of our requirements correlate between technical targets and customer needs, as well as which are most important. Going forward, our last step is to compare these top scoring decision matrix concepts with each other on the basis of our requirements. For this, we are making use of the Pugh Comparison Matrix. The following tables will show how each concept under scrutiny stacks up when compared to the other concepts.

Table 8: Pavilion Charging Reference

	Pavilion Charging Station (ref)	**Solar Power Trash Cans**	**Solar Powered Event Board**	**Solar benches w/ charging and Wi-fi**
Budget	-	0	0	0
Sustainable	-	+1	-1	0
Promotes renewable energy	-	0	0	+1
Public exposure	-	-1	+1	0
Public use	-	+1	-1	+1

Table 9: Solar Trash Cans Reference

	Solar Power Trash Cans (ref)	**Solar Powered Event Board**	**Solar benches w/ charging and Wi-fi**	**Pavilion Charging Station**
Budget	-	-1	-1	-1
Sustainable	-	0	-1	0
Promotes renewable energy	-	0	0	+1
Public exposure	-	+1	0	0
Public use	-	-1	+1	0

Table 10: Event Board

	Solar Powered Event Board (ref)	Solar benches w/ charging and Wi-fi	Pavilion Charging Station	Solar Power Trash Cans
Budget	-	0	+1	+1
Sustainable	-	0	-1	-1
Promotes renewable energy	-	+1	+1	0
Public exposure	-	-1	-1	-1
Public use	-	+1	+1	0

Table 11: Wi-Fi and Charging Benches Referenced

	Solar benches w/ charging and Wi-fi	Pavilion Charging Station	Solar Power Trash Cans	Solar Powered Event Board
Budget	-	+1	+1	+1
Sustainable	-	+1	+1	0
Promotes renewable energy	-	0	0	-1
Public exposure	-	-1	-1	+1
Public use	-	+1	0	-1

So, the question is what do these tables show? From the comparison matrices a number of points arise. It shows that the Bulletin Board concept is definitely the cheapest option and the Wi-Fi integrated park benches concept is the most expensive in comparison. However, while it is the cheapest option, the bulletin board does not promote renewable energy as greatly as other concepts do. This is due to the fact that while they would make use of solar panels for energy, it may not be a great amount due to the light load the board pulls compared to the other concepts. It does, however, have the added benefit of public exposure, due to the function of a bulletin board in of itself. As far as sustainability, it is not exactly an easy thing to compare objectively, but the powered waste bins have the added benefit of compacting waste as well as using solar energy to do so, it stands to reason it has double benefit in terms of sustainability.

These matrices have in total given us a greater understanding for how our top concepts stack up when related to each other. For our final concept selection, this will be the biggest assistance in determining not only what we want to pursue going forward, but to also justify why we want to pursue them.

Load Study Concept Selection

The Load Study is one of the key components in presenting our product. Whereas not only are we providing a product design, but also showing how it will function and taking a holistic approach into seeing what Leon County's parks look like as far as loading, modeling this, and presenting options to tackle these. We began this component by looking at decomposing some of the functions of it, as shown in the Functional Decomposition Chart Catalog under Load Study Functional Decomposition.

Going forward we had a better idea of what design alternatives we could do to tackle each function of the Load study, which are the lowest level on the functional decomposition. These all tackle what needs to be done. From here we worked on how we could tackle these and began brainstorming. These figures are following the Load Study Functional Decomposition in the Functional Decomposition Chart Catalog.

After we generated the concepts for each component of the Load Study we began to think about the selection process. At this point, we really did not have 100 concepts for this the way we had for the actual design, so we looked at our selection process a little differently. In lieu of tabulating and draw houses and such we just discussed the options. We began by looking at what we knew we could not do.

Since safety is going to be paramount in what we did (referencing our Project Scope) We knew we could not go directly test live currents in the equipment, therefore our best option there was going to be using manufacturer's estimates, because it would give us the safest means of estimating. This took off the alternatives of doing direct probes and even setting up time integrating amp and voltage recorders for new and currently installed equipment.

The other aspect of this how best we could go about establishing accurate models for both generation capacity and load requirements. This we knew would be affected by both weather and park attendance, so models of these would need to be added. Luckily, we had a starting point using the NREL Atlas and PV Watts tools, this would provide us a baseline estimate prior to more in depth manufacturer research and forecast modeling. This would be the jumping off point by which we would compare our findings to. Our goal then too would be to better understand the relation between cloud cover and PV generation. We had three options, to build a model of historical daily data, average cloud cover, daylight, and precipitation on a month to month basis, or aggregate it into a factor for annual weather effects. We knew that the annual weather diversity factor would probably be easiest to calculate, but would not be nearly as effective. Alternatively, a daily model would be most specialized, using the most data from the National Weather service for historical models. This would be a precise, yet not necessarily accurate, given year to year fluctuations in weather. We decided our best option is to calculate our load generation factors based on month to month data and work from there, given that months typically have similar weather and daylight patterns year to year, but will differ month to month.

Following this, we needed to model also the park usage, and the park attendance, to best relate them. The selection for these would be served based upon what data Leon County could provide us. At best, we would have attendance data monthly with trendlines, as well as month to month load data. At worst, this data could be estimated given typical Florida load distribution over the course of a year and typical park attendance statistics. With this complete, we could then recompose our decomposition with our selected design alternatives going forward. This can be found in the Final Load Study Concept Selection Diagram in the Functional Decomposition Chart Catalog. With this, for all of our modules, we now have associated a concept to tackle each of these. If more than one, there will be all of these concepts in combination.

Economic Analysis Concept Selection

The economic analysis section is one of the most important part in our project, since it decides how to stay within the budget limit, and it gives us an idea on what the return on investment is going to be. This is going to guide us in what all we need to include in providing a useable model for costs and benefits going forward. We graphed this shown in the Functional Decomposition Chart Catalog under Economic Analysis Concepts, as a basic outlook on what all would be required.

This generation helps our team connect the dots on how to reduce the costs on the Leon County parks, and at the same time reduce the gas emission by at least 20%. Based on the economic assumption, the Bulletin Board would be the cheapest concept selection to choose in order to use as a renewable energy project and it is also within the budget limit, however, it does not work enough in reducing the gas emission and at the same time does not provide much in return on investments. The same problem occurs with the other concept selections, is the lack of reducing the gas emission by at least 20% and some are off the budget limit. However, based on the beginning of an economic analysis selection looking forward, the solar- powered compaction Garbage Bins would be one of the best economically selection, since it does fit perfectly within the budget limit and it does reduce the gas emission by at least 20%, which have a big impact on the return on investment as well.

We came up with many ideas on how this concept selection can be perfect for the Leon county's return on investment, due to the fact that this selection can economically reduce the collection of the waste in a good way, since it is going to have a built-in features that help in saving the use of the Leon County waste-carry vehicles. This decision was based on the clear starting economic view on how this selection can meet the Leon County budget requirement and at the same time save the environment form the dangerous gas emission. Looking forward to the future of the economic analysis that our group is going to work on, it will include at least two quotes for both the materials and the labor cost, include an expected return on investment analysis report, expected energy saving analysis, and reports how power system contributes to environmental pollution and reducing gas emission.

Final Decision and Justification

As we rounded up our decision-making matrixes and charted our comparisons between the best concepts, we began working on which concept we would pursue. This was not an easy task. Multiple options could and would work out to meet Leon County's requirements, and the majority of these were not large-scale projects. This made us begin to think about how we could combine them to work to our advantage. The beauty of the project we are working on is that we can make use of a number of these options to meet our targets of tiering projects.

To put it differently, we began to question why would need small, medium, and large sized projects when we could use different aspects and different smaller projects combined to account for these. For example, our smaller projects could incorporate a design and feasibility analysis of a charging station bench or a solar power trash compactor. Then, as we move into potentially larger options, we could combine these, such as a pavilion in which there is a charging station on the tables as well as Wi-fi connectivity and trash compactors.

The idea that guided us to this goes back to one of our assumptions: one big project will not attain Leon County's sustainability goals, but in the same manner that an ant eats an elephant, a number of smaller to medium sized projects can be applied to a number of locations to build up their renewable portfolio. This would allow Leon County's Office of Sustainability to have the chance to present multiple options to the Commissioners dependent upon what the budget was. Our goal is to present lower and higher cost options alike for their parks and even in some cases facilities that would continually push toward their goals.

So what does this look like? We decided on using our top three concepts, and work on how we could potentially combine these into their own projects. These included the Solar Power Trash Compactor, the Charging Station Bench, and the Pavilion. The compactor can be a unit on its own, an addition that can be done. Our plan is to provide a feasibility analysis for one with no communication capabilities, as well as one that can communicate its fill level. Additionally, the charging station bench would be a singular unit, one in which we could provide feasibility analyses for Wi-Fi connectivity as well as with just charging capabilities. In addition, the pavilion could encompass benches as well as trash compactors. Our goal with this is to provide a small, medium, and large pavilion option, and the feasibility analysis for all three.

By the end of this project, our goal now is to provide these options for the Office of Sustainability's consideration. Out analyses ought to be full breadth, including costs associated with them, and using solar power, how long it will take to pay for each of these. In addition, we plan on providing design packages for each that will allow Leon County to construct these with as minimal questions as possible.

With the conclusion of concept selection, we now have our plan in place. In the coming days and weeks our goal is to zero in on what all needs to go into these feasibility analyses and designs and begin our pursuit compiling these plans. As stated in earlier sections, our project is different than others, but we are excited to begin working on this multi-faceted project.

Vendor Decision Process

Once we had in mind that we wanted to consider vendor devices as a means of best meeting our, and more importantly, Leon County's goals. This began with determining what products we would look for, done previously. The benefit then of the selected concept was that the products had already been widely used in similar applications: schools, parks, and other such functions.

We first began this process by looking into which was characteristics were most important. These traits were tabulated below in a Comparison Matrix:

Table 12: Vendor Decision AHP Matrix

	Appeal	Price	Durability	Promotes Renewable energy	Battery Storage	Charging Power	Total
Appeal	1.00	0.25	0.25	0.20	0.33	0.33	2.37
Price	4.00	1.00	0.50	0.25	0.33	0.50	6.58
Durability	4.00	2.00	1.00	0.25	3.00	3.00	13.25
Promotes Renewable energy	5.00	4.00	4.00	1.00	4.00	4.00	22.00
Battery Storage	3.00	3.00	0.33	0.25	1.00	3.00	10.58
Charging Power	3.00	2.00	0.33	0.25	0.33	1.00	6.92

Following this, we met and discussed with a number of different vendors for both the charging station and trash compactor. We gathered data on each of these and attached to them rankings based on the above traits. We then again tabulated this in order to best make our decision going forward.

Table 13: Vendor Charging Station Comparison Matrix

	Enerfusion Solar-Powered Dok	Enerfusion Solar-Powered Canopy	Kay Park	Sitescapes	GoCharge!
Appeal	5	4	2	5	1
Price	1	4	5	3	4
Durabilty	5	3	2	4	2
Promotes Renewable energy	5	4	5	2	5
Battery Storage	5	3	1	1	3
Charging Power	5	4	3	2	4
Total	26	22	18	20	19

As evident from the table, the most apt to meet our traits was the Enerfusion Solar-Powered Dok, over the other four options. The reasonings for this will be discussed at greater length in the justification portion of the Results.

Table 14: Trash Compactor Comparison Matrix

	CleanCube	Big Belly
Appeal	5	5
Price	4	5
Promotes Renewable energy	5	5
Battery Storage	5	5
Wifi Connection	Yes	Yes
Capacity	4	5
Total	23	25

As shown in the table, we determined that the Big Belly Compactor slightly had an advantage over the CleanCube compactor. This is due to the lower price but greater capacity. Other reasons for this, including the provided case studies provided that added to the usefulness of the compactor, will be discussed at greater length in the Results portion of the report.

Prototype Design Set Decision Process

Due to the decision of pursuing the prototype design not taking place until the beginning of Spring semester, doubled with the lack of funding to construct a prototype we approached the decision process here with different requirements needed for this to work. Since we were unable to have a prototype to determine whether or not the equipment would properly function, there became a large requirement of compatibility among our components. Firstly, we decided on what exactly we wanted to do. To best meet the goals of the County, in which they could implement it at the park for a low price with great usership, we decided to go with a charging station. This was taken from inspiration of other solar powered charging stations. Whereas many of these companies designed smaller charging stations for large events such as concerts or sporting events, we looked to instead use what parks already had.

As such, we developed a design that would be composed of a self-contained solar energy generating and storage unit complete with inverter to output typical 60 Hz GFI Outlets for cell phone and laptop charging. This would be fastened to a normal wooden park bench, situated in an optimum location in the Park. The design required two components: a fabricated metal frame on which the components and wiring could be mounted as well as the solar system itself. For the solar powered system we are designing, we considered how best to approach the components. Since we are unable to do testing on it to determine its compatibility, we decided the best approach was to consider a kit that would include all of the required components. This actually ended up being the most cost-effective option that still met all of our requirements. Going this route, we determined that the Nature Power 410-W system best met all of our needs, as shown in the Appendix under Vendor Data Sheets.

The other part of this design was the mechanical frame. This would be done by the Leon County Personnel, therefore what was required of us was the mechanical assembly in addition to a Bill of Materials of the project. Both of these can be found in the Appendix under Bill of Materials and Engineering Drawings Respectively.

Spring Project Plan

Following this semester, we have going forward all of our planning aspects taken care of. We have our project, we have discussed and confirmed the deliverables as well as means to make them. As a team, we have set forth goals which will govern our work going forward into the spring semester. Our work will encompass three phases. Phase one will be data acquisition. From January through the middle of February we will gather all of equipment costs and specifications that we will be looking to implement. For each of our selected concepts, the target is to have 3-5 different options in terms of manufacturers for which we will make recommendations, and Leon County can select.

Phase Two will consist of building our models, based on the data we have gathered. This is the meat of the project, to provide Leon County with a good idea of how different design options will affect the final outcome, as well as what is to be expected as far as generation ability, load draw, and recommendations. This will finalize the Load Study portion as we move on to Phase 3 in which we will develop the economic model and final report preparation.

The Economic portion will require research as far as funding options and incentive programs as well as developing the models for return on investment, payback period, and expense budgets. This will require further research into tax requirements and other permitting costs for implementing any of the solutions.

On the following pages, the tasks themselves will be described in further detail, including start and end date targets, as well as the lead team member for each task. For those with TBD, the lead team member will be discussed as time progresses. After the task descriptions, the Gantt chart visualizing this tasking and the outlook over the course of the semester. Our goal is to have the majority of the work complete by the first part of April, allowing us with plenty of leeway to make adjustments, make changes, and prepare presentations with plenty of time for Engineering Design Day and Graduation with minimal late nights at the College of Engineering.

Table 15: Spring Project Plan Task Set

TASK #	TASK NAME	TASK DESCRIPTION	START DATE	DUE DATE	LEAD
SD1	UPDATED RISK ASSESSMENT	If necessary update risk assessment to reflect any new activities	1/22/2021	1/29/21	GRP
SD2	DESIGN REVIEW 1	Presentation: Completed design and progress report	1/22/2021	2/5/21	GRP
SD3	TESTING AND VALIDATION	Report entry showing results of testing. Use targets to define tests	2/26/2021	3/5/21	GRP
SD4	DESIGN REVIEW 2	Presentation: Status update and module demo	3/12/2021	3/12/21	GRP
SD5	SCHOLARSHIP IN PRACTICE	Report entry detailing suggested design changes and lessons	3/19/2021	3/26/21	GRP
SD6	OPERATION MANUAL	Instructions to accompany project	3/26/2021	4/9/21	GRP
SD7	FINAL PRESENTATION	Details TBD	4/2/2021	4/16/21	GRP
SD8	PROTOTYPE DEMO (?)	Details TBD	4/16/2021	4/23/21	GRP
SD9	FINAL REPORT	Details TBD	4/2/2021	4/23/21	GRP
LS1	ESTABLISH WEATHER MODEL	Generation diversity due to monthly weather	1/8/2021	1/22/2021	Jacob
LS2	ESTABLISH PARK USAGE MODEL	Load diversity due to park attendance model	1/8/2021	1/22/2021	Jacob
LS3	SAM MODEL	NREL tool used to develop economic and load model	1/8/2021	1/28/2021	Samantha
LS4	PV WATTS MODEL	NREL tool to estimate generation capacity for grid connected PV installations	1/8/2021	1/28/2021	Chris
LS5	RESEARCH CHARGING STATIONS	Gather quotes and data specifications on charging station benches and associated costs and load requirements	1/15/2021	2/12/2021	Sean
LS5A	FINALIZE CHARGING STATION	Identify top contenders, and tabulate all specifcations and quotes	2/12/2021	2/19/2021	Sean
LS6	RESEARCH WIFI CONNECTIONS	Gather quotes and data specifications on Wi-Fi canopies and associated costs and load requirements	1/15/2021	2/12/2021	Marwan
LS6A	FINALIZE WIFI CONNECTIONS	Identify top contenders, and tabulate all specifcations and quotes	2/12/2021	2/19/2021	Marwan
LS7	RESEARCH PAVILION CONSTRUCTION	Gather quotes and data specifications for park pavillion construction, load requirements, and building process	1/15/2021	2/12/2021	Jacob
LS7A	FINALIZE PAVILION CONSTRUCTION	Identify top contenders, and tabulate all specifcations and quotes	2/12/2021	2/19/2021	Jacob

LS7B	RESEARCH TRASH COMPACTOR	Gather quotes and data specifications on Trash compactor and associated costs and load requirements	1/15/2021	1/15/2021	TBD
LS7C	FINALIZE TRASH COMPACTOR	Identify top contenders, and tabulate all specifications and quotes	2/12/2021	2/12/2021	TBD
LS8	RESEARCH PARK EQUIPMENT USAGE	Using Leon County data, identify highest usage equipment at Woodville park and possible solutions to reduce energy consumption	1/15/2021	2/12/2021	TBD
LS8A	FINALIZE HIGHEST USAGE EQUIPMENT	Identify top contenders for addressing equipment usage	2/12/2021	2/19/2021	TBD
LS8B	DETERMINE SOLNS FOR EQUIPMENT	Identify and model means of addressing equipment's high energy usage	2/19/2021	3/12/2021	Jacob
LS9	RESEARCH SOLAR EQUIPMENT	Gather quotes and data specifications on multiple manufacturer's PV generation equipment including material quotes, data sheets, and installation costs	2/12/2021	3/12/2021	Marwan
LS9A	FINALIZE SOLAR EQUIPMENT QUOTES	Identify and tabulate top contending PV generation equipment quotes and data	3/12/2021	3/19/2021	Marwan
LS10	RESEARCH ENERGY STORAGE	Gather quotes and data specifications on multiple manufacturer's energy storage equipment including material quotes, data sheets, and installation costs	2/12/2021	3/5/2021	TBD
LS10A	FINALIZE ENERGY STORAGE QUOTES	Identify and tabulate top contending storage equipment quotes and data	3/5/2021	3/12/2021	TBD
LS11	DEVELOP TOTAL LOAD REQUIREMENTS	Using all data from equipment research, develop final load requirements for all equipment to be installed	2/19/2021	2/26/2021	Jacob
LS12	DEVELOP GENERATION CAPACITY MODEL	Using all data from equipment research, develop final capabilities for generation equipment to be installed.	3/12/2021	3/19/2021	Chris
LSF	FINALIZE LOAD STUDY	Record all findings into Load Study section	3/19/2021	3/26/2021	Marwan
EC1	RESEARCH FUNDING OPPORTUNITIES	Research all local, state, and federal government monetary incentives able to be used in cost offsets.	1/15/2021	2/12/2021	Samantha
EC2	FINALIZE EQUIPMENT QUOTES	Record and tabulate equipment costs determined from equipment quotes, identify most cost effective equipment options	2/19/2021	2/22/2021	Jacob

EC3	DEVELOP EXPENSE BUDGET	Determine a cost model for expenses in accordance with Leon County Facilities personnel, including manhour costs, permitting costs, taxes, and administrative expenses.	2/22/2021	3/8/2021	Marwan
EC4	RESEARCH TWO-WAY METERING	Research requirements for two-way metering service with electric utility, and determine costs associated with it, in addition to install requirements	1/15/2021	1/29/2021	Samantha
EC5	DEVELOP RETURN ON INVESTMENT MODEL	Using finalized expense budget, determine return on investment analysis, including breakeven time	3/8/2021	3/15/2021	
EC6	FINALIZE BILL OF MATERIALS	Tabulate all final selected options for equipment to be installed and all necessary material needed to complete installation	3/15/2021	3/22/2021	Marwan
MD1	REVIEW FINDINGS WITH LEON COUNTY	Review analysis with Leon County personnel, note any additions or other final topics to address	3/22/2021	3/29/2021	GRP
MD1A	MAKE FINAL CHANGES ALTERATIONS	Using feedback from Leon County and Sponsor, make all final additions, including devloping evidence book, and ensuring all requirements for final report are met	3/29/2021	4/1/2021	Jacob
MD2	FINALIZE ANALYSIS	Submit finalized report to Leon County.	4/1/2021	4/2/2021	Jacob

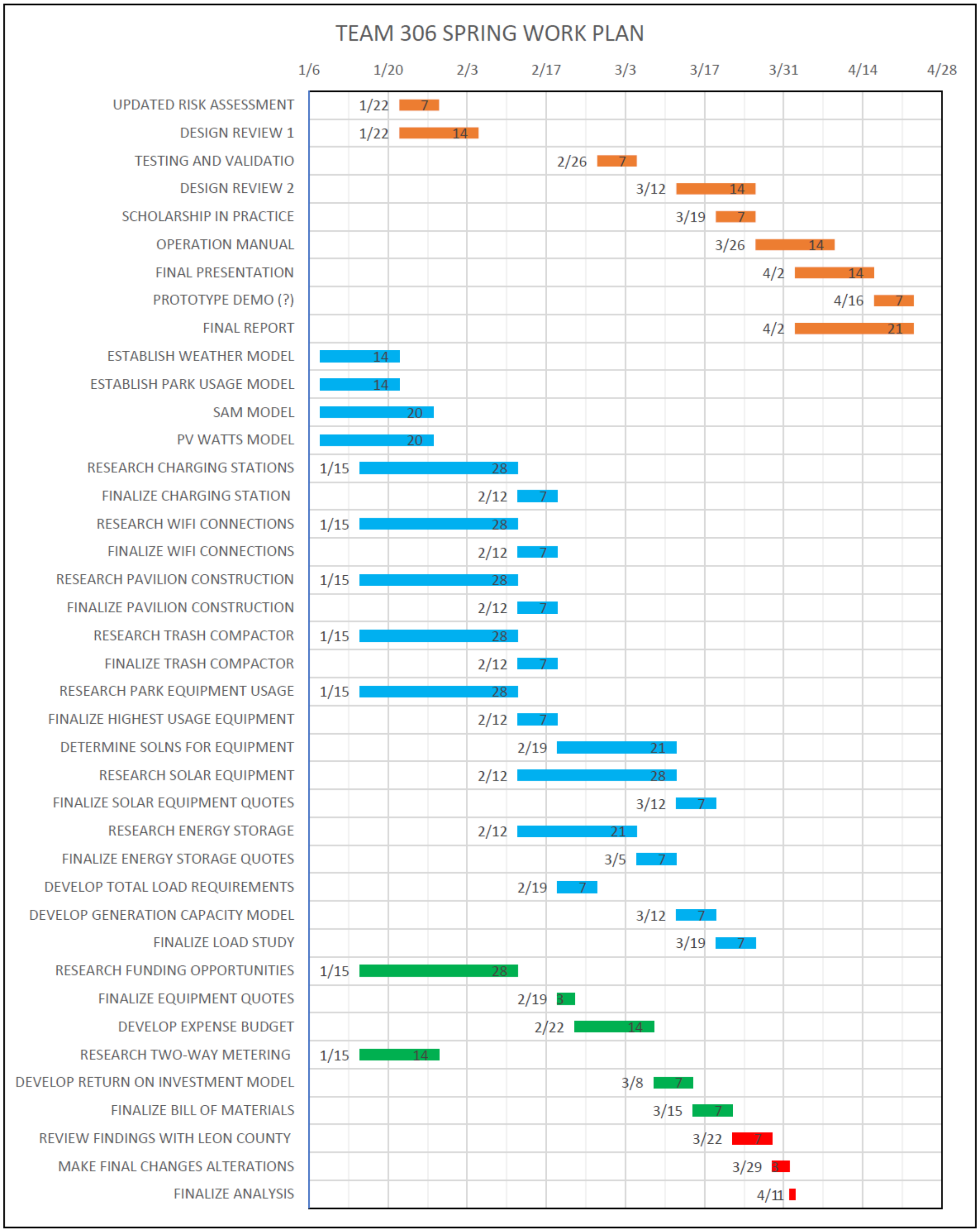


Figure 2: Spring Project Plan Gantt Chart

Chapter 2: EEL-4915

Restated Project Definition and Scope

Project Description

In order for the Leon County Board of Commissioners to fulfill their goals described in the Integrated Sustainability Action Plan (ISAP), the Office of Sustainability has requested the use of Team 306 to analyze and submit a number of different turn-key designs for possible sites for a pilot solar generation project for Leon County facilities and parks. These projects will range in scale so as to coincide with any differing county budgets. In addition, to gain greater operational understanding of solar as a means of power generation, a set of designs for a prototype solar plant will be constructed by the Team.

Market

While the goal of this project is to provide designs for Leon County, this project has the opportunity to be applied to multiple markets, due to its nature of community exposure and government propensity toward the advancement of renewable generation:

1. Other Government Facilities: whereas this project provides means of implementing solar generation in public places, other government organizations who share Leon County's vision for solar generation in their facilities could make use of our designs to both lower their operational electric costs and to increase public exposure to solar generation.
2. Commercial Facilities: whereas many commercial organizations in the same spirit as the Leon County Commissioners want to increase their use of renewables in their own facilities, this project can and may be applied toward not only government facilities but their private counterparts, as the difference is slim between the load required in a corporate office versus that required for a court house.
3. State and National Parks: whereas the facilities required in operation of a county recreational park will be similar in scope to those required by State and National Parks. This will allow these parks to reduce dependence on conventional sources of power and allowing for further exposure to the uses of solar power.

Private Communities: whereas many subdivision communities and homeowners' associations share the same views toward increasing use and public exposure toward solar energy as the Leon County commissioners, they can benefit immensely from making use of our findings as a means of beginning their own pilot projects toward integrating solar energy in their offices, parks, or any other facilities.

Assumptions

For this project, a number of assumptions in regard to the nature of solar generation and the nature of energy development must be made prior to the commencement of any and all work by the Team:

1. Safety will be the overarching design factor for any and all designs, testing measures and recommendations for the pilot projects as well as the prototype.
2. This will entail a number of pilot projects, and will not be overly ambitious, insofar that we are not looking to completely alter or remove conventional electrical utility connection from any of the facilities.
3. This project will be for facility-sized solar generation and will require appropriate output voltages for service.
4. As per Leon County, the construction of this project will be handled by the Leon County.
5. As per Leon County, any and all project documentation and implementation will be reviewed by the Office of Sustainability and will submit recommendations in regard to the design prior to implementation.
6. The prototype will be implemented such that it is in conjunction with the scope of the Leon County Study.

Stakeholders

This project will entail multiple stakeholders in its implementation:

1. Whereas we are representing the College of Engineering before Leon County, all faculty taking part in this project (instructors, advisors, reviewers) are stakeholders in its entirety.
2. Whereas the Leon County Office of Sustainability is sponsoring this project from start to finish, and our product will be put to use by them, they are regarded as stakeholders in its entirety.
3. Most importantly, this project is for the greater benefit of the public, and are the most crucial stakeholder in this project. All analyses, designs, and decisions will be made in regard to public trust and effective use of their tax dollars.

Summary of Charter Updates

The charter changed very little save for the addition to the scope of the prototype we decided to go with. Even with this addition, the overall goal remained the same: have a number of different options that Leon County could go with.

Results: Modeling

Modeling Background

The System Advisory Modeling (SAM) software created by the National Renewable Energy Laboratory (NREL) is used to compare different renewable energy projects, build finical models, and show the effectiveness of a renewable energy project. The user will input data pertaining to their given project including; geographical location, direction that the solar panels will face, angle of the solar panels, conversion efficiency, energy production, load consumption, and local utility information. The user then has a wide variety of graphs to choose from to display how effective their system will run and compare those graphs will other possible systems.

After implementing the desired information for Woodville park team 306 used SAM to display four different graphs for each system we recommend to Leon County. The first graph for each system is the monthly energy vs monthly load. This allows Leon county to easily see the access energy being produced compared to the load of each system. The second graph shows the annual energy production. This graph shows a twenty-five-year long analysis on the energy production of each system. The third graph shows the value of the energy produced over the next twenty-five years. The final graph shows Leon County's debt balance for the next twenty-five years.

Load Assumptions

For the Modeling, there would need to be a load requirement to compare the generated capacity against. This was subjective, and had to stem from some basis of understanding of what load would be required, We decided that in general there would two main sources of load draw: cell phone and laptop chargers. We assumed two cell phone chargers and one laptop charger would be operated for on average four hours a day. From this we developed a model of what the energy consumption would look like, as found in the Calculations portion of the Appendix. The result of this was that on average, the charging stations would draw 8.7 kWh/month.

Additionally, the same analysis was required for the compactor., albeit far simpler. We assumed that with its main load draw component being a 20 W motor, operated on average for a total of one hour a day, this would result in 0.62 kWh/month being drawn.

With these assumptions made, we could feed into the SAM Model to show how well the generation would meet these load requirements, and then based on the costs associated, how the payoff could be implemented. The results are shown in the following figures.

From all of the graphs offered through SAM team 306 believed showing these four different graphs was the most effective way to show Leon county more information regarding system operation and system cost for the recommended prototype and vendor systems.

Enerfusion Charging Station

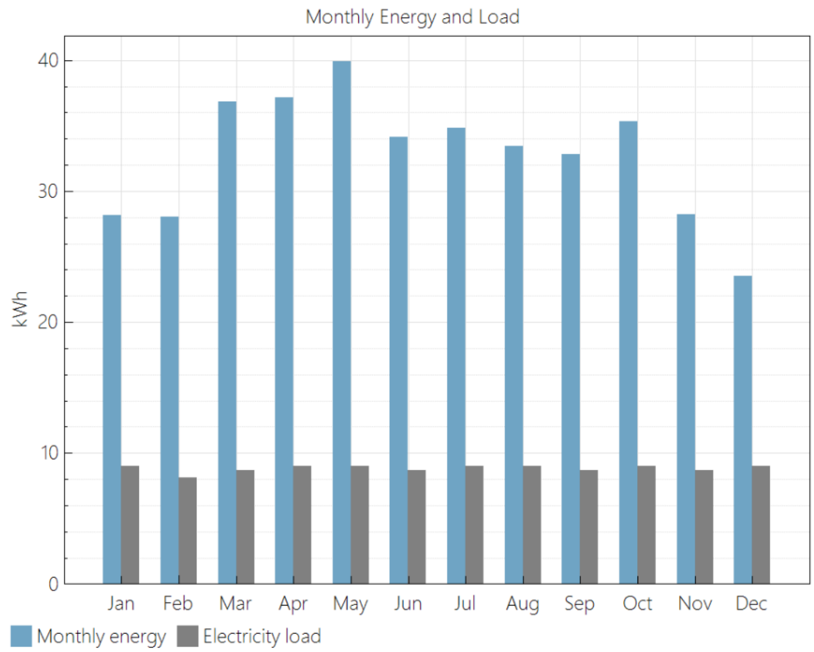


Figure 3: Enerfusion Load Generated vs. Consumed

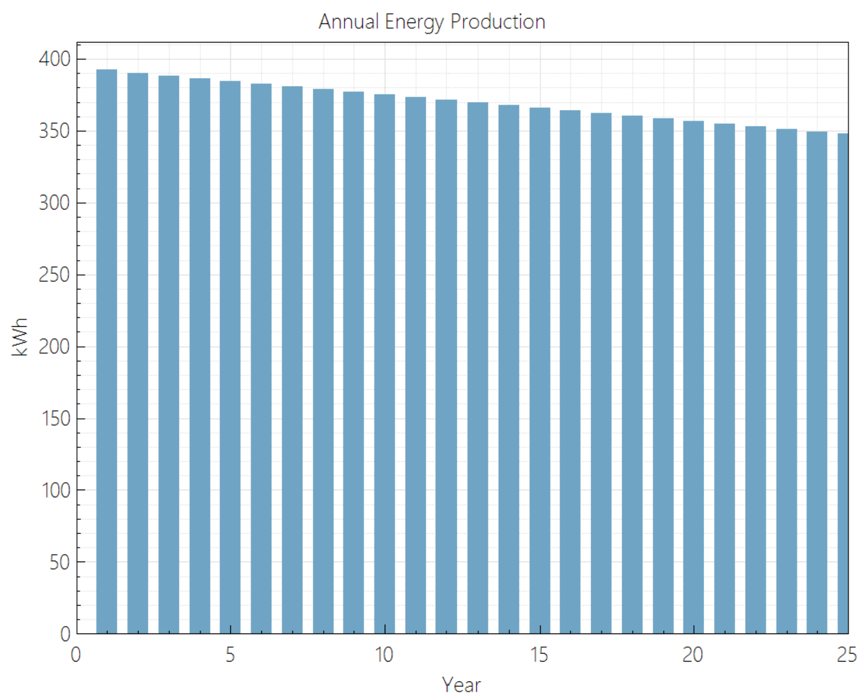


Figure 4: Enerfusion Annual Energy Production (kWh)

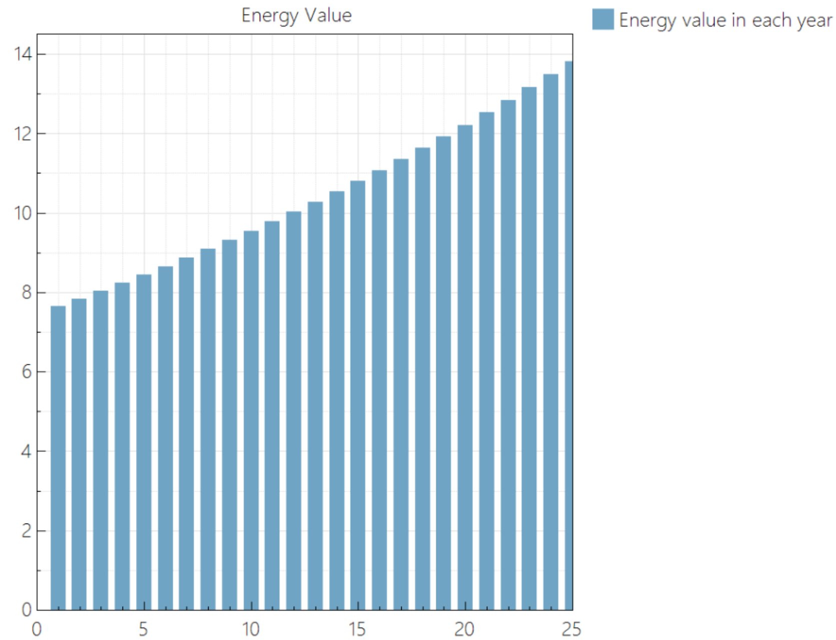


Figure 5: Enerfusion Energy Annual Value

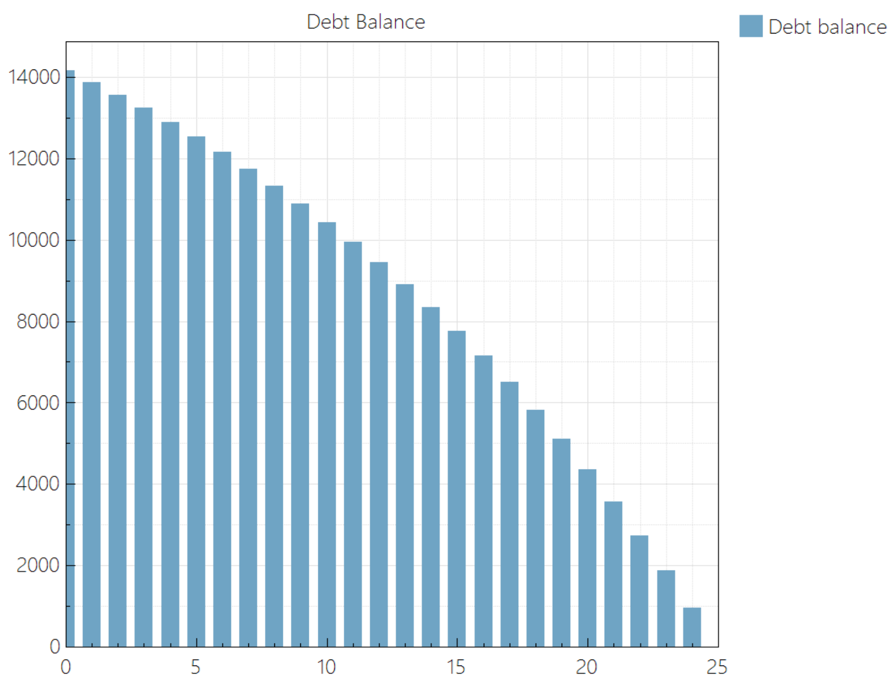


Figure 6: Enerfusion Cost Debt Balance

Prototype

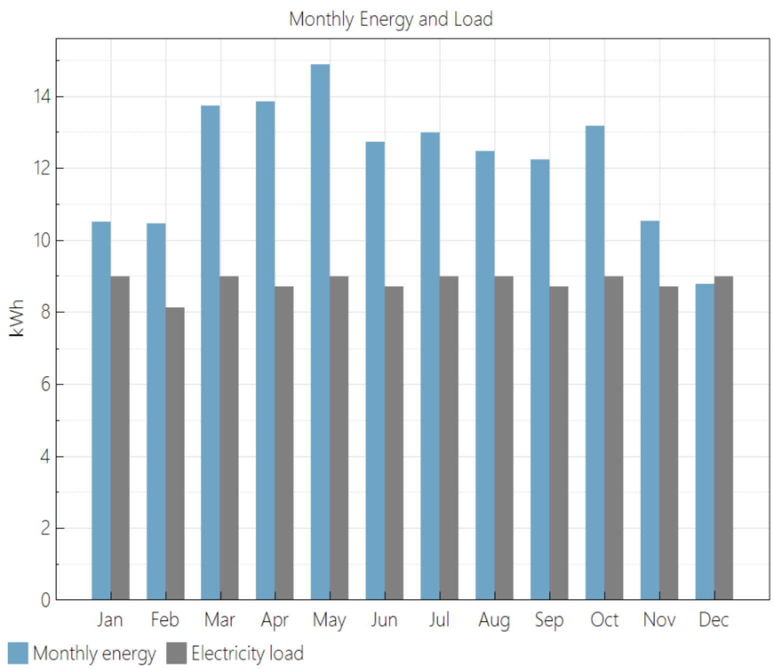


Figure 7: Prototype Load Generated vs. Consumed

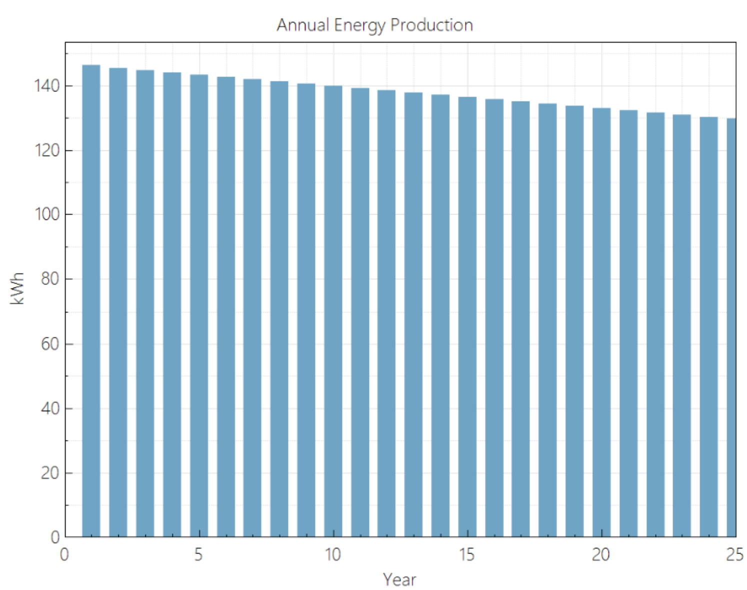


Figure 8: Prototype Annual Energy Production (kWh)

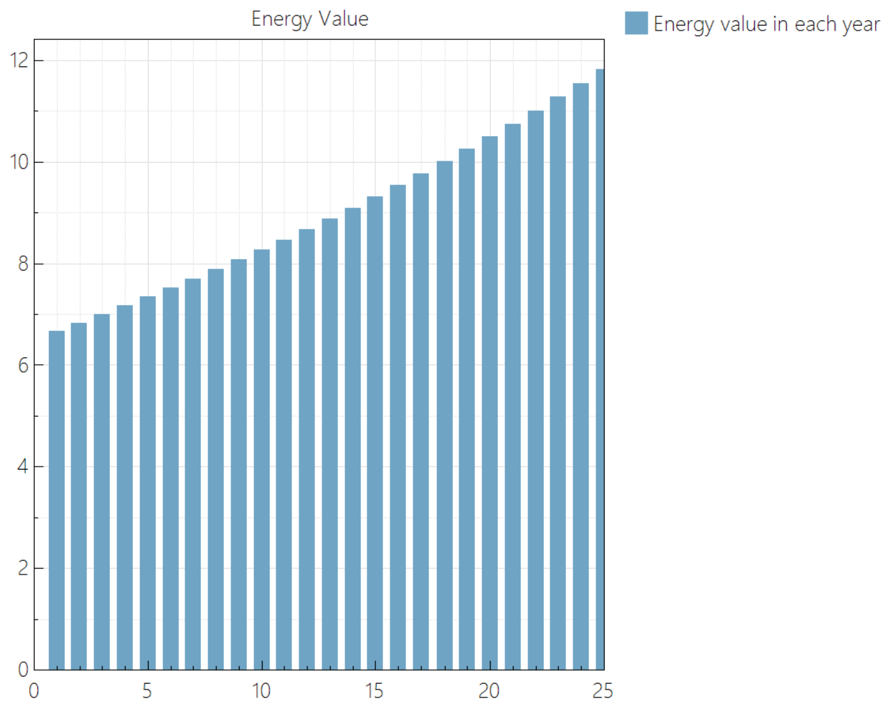


Figure 9: Prototype Energy Annual Value

Figure 10: Prototype Cost Debt Balance

Big Belly Trash Compactor

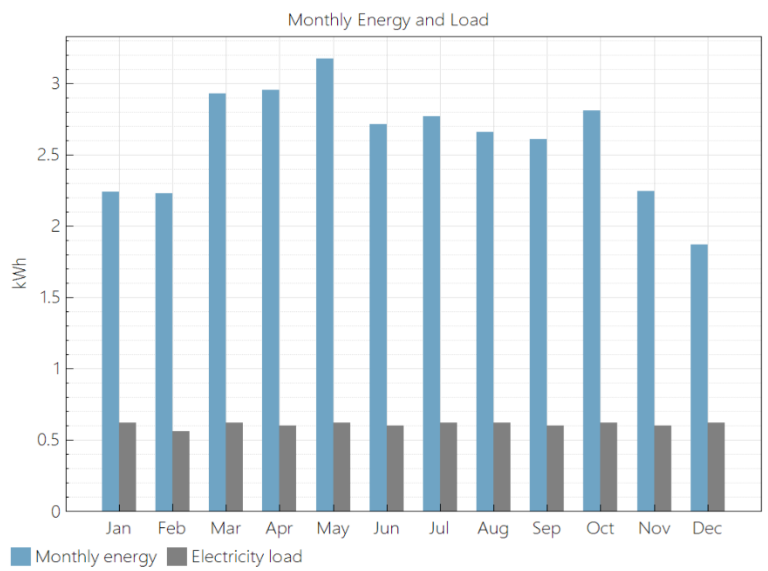


Figure 11: Big Belly Load Generated vs. Consumed

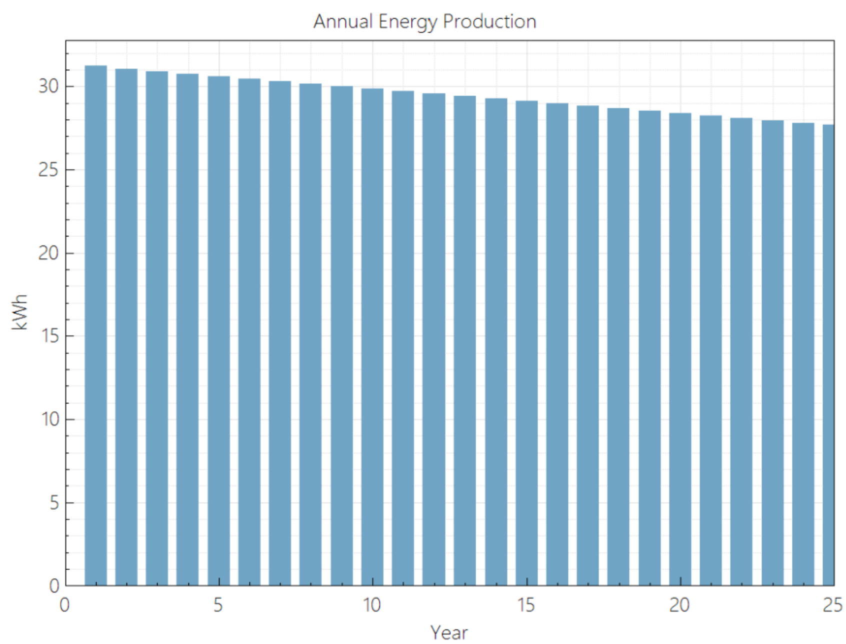


Figure 12: Big Belly Annual Energy Production (kWh)

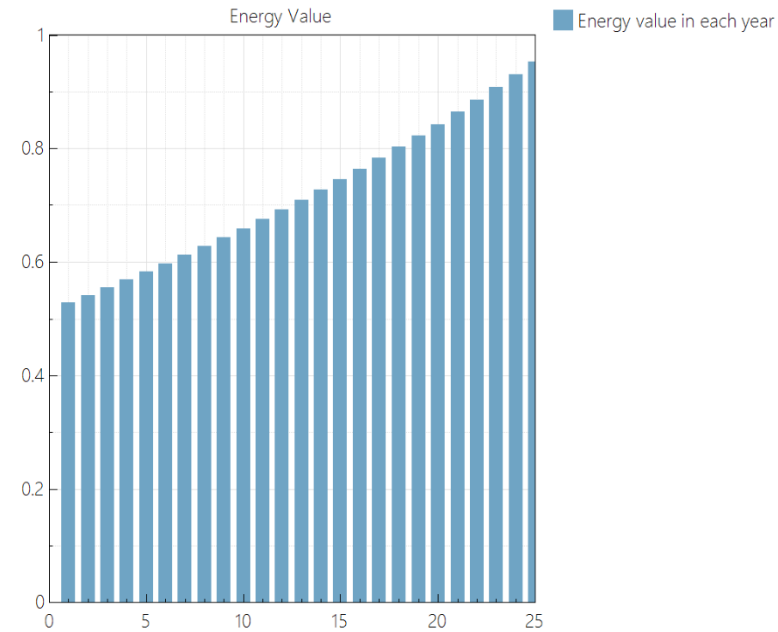


Figure 13: Big Belly Energy Annual Value

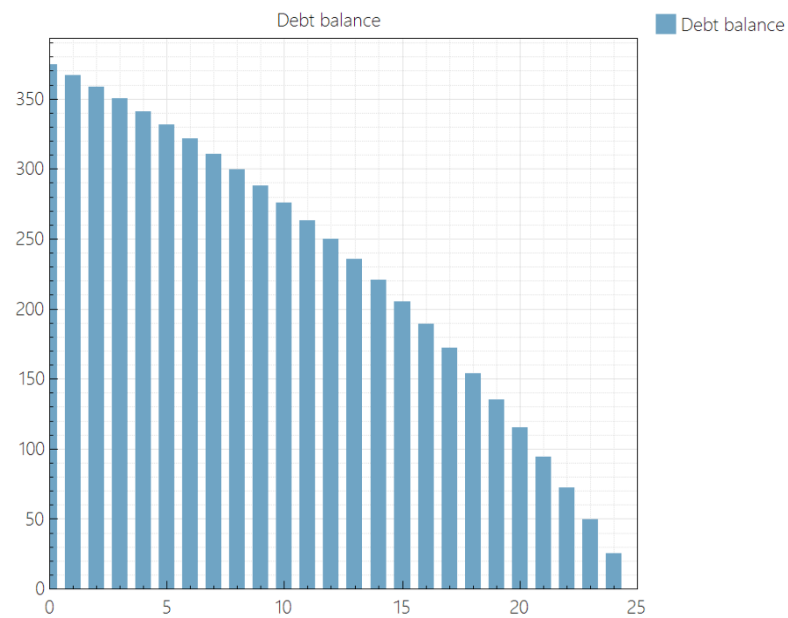


Figure 14: Big Belly Cost Debt Balance

Results: Prototype Implementation

Prototype: Material Acquisition

This manual will be used to construct and assemble the charging station prototype as outlined. The first step is procurement of the necessary materials. This is outlined below in the Bill of Materials table.

Table 16: Bill of Materials

Part #	Vendor/Supplier	Description	Qty	Units	Picture	Unit Cost	Cost
53110	Nature Power	110W Panel kit w/ Charge Controller, Panel, mounting z-brackets, and inverter	1	1		$ 220.00	$ 220.00
RBT100G	Renogy	Hybrid GEL battery 12V, 100Ah	1	1		$ 246.00	$ 246.00
2HGR7	GRAINGER	Aluminum Plate 24"x24"	1	1		$ 295.80	$ 295.80
5GUL0	Rigid	Aluminum Conduit 3" Diam 10' length	1	1		$121.28	$ 121.28
67312	Hillman	1/2" x 5" Hex Bolt	4	1		$2.07	$ 8.28
67342	Hillman	1/2" Hex Nut	4	1		$0.41	$ 1.64
63449	Hillman	0.531" Flat Washer	4	1		$0.36	$ 1.44
61817	Hillman	1/2" Split Lock Washer	4	1		$0.28	$ 1.12
20670	Aluminum Bar	1/2" x 8" Aluminum Rectangle Bar 3'	1	1		$87.00	$ 87.00
1171	Aluminum Bar	1/2" x 4" Aluminum Rectangle Bar 6'	1	1		$ 76.49	$ 76.49
	Total		**22**				**$ 1,059.05**

All materials save for the Solar Kit and Battery are referenced to Grainger Industrial Supply, found at https://www.grainger.com/ . The Solar Kit can be found on its respective website, or at hardware stores such as Home Depot, Lowes, and Northern Tool and Equipment. The battery can be found on its website at https://www.renogy.com/deep-cycle-hybrid-gel-battery-12-volt-100ah/ . All have been confirmed to have the products upon the writing of this manual.

Prototype: Base Construction

This section pertains to the construction of the base frame below, including the hardware used for mounting, and the framing to facilitate the electrical components. To construct, there is required a welder for attaching the conduit, a drill press for hardware mounting points, and a band saw for cutting out the aluminum framing.

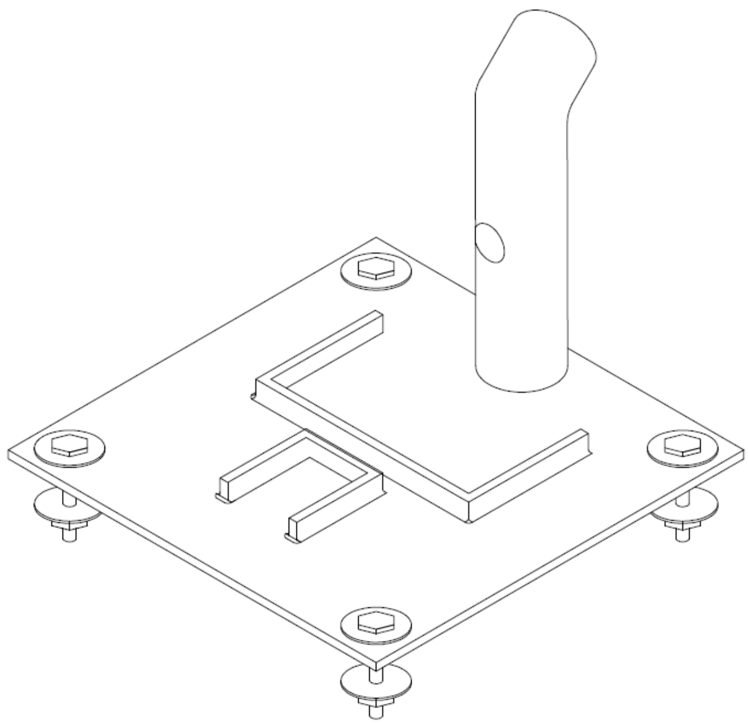


Figure 15: Base Frame Isometric

Upon procurement of all of the components, work can be started on assembling the base frame. This will begin with the 2’ x 2’ 6061 Aluminum plate. Any cutting edges are rounded off to ensure safe operation when applied to park location. Following this, Assemble the base frame in accordance with the mechanical drawings below. Lastly, drill a 0.5” radius hole 2” from each of the four corners to facilitate the mounting hardware.

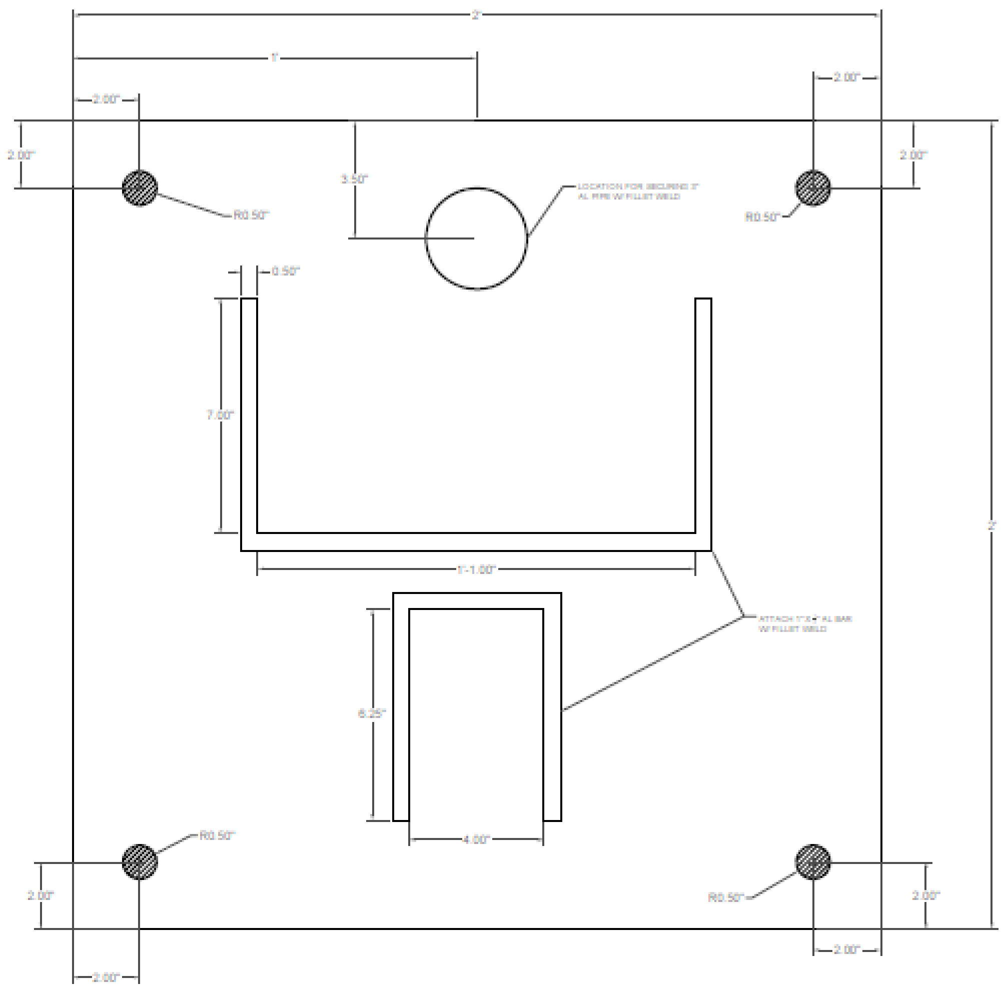


Figure 16 Base Frame Top View

To construct the component framing, use a band saw to slice the 0.5” aluminum bar into 1” wide pieces, and then cutting them to the specified length in the layout above Following cutting, round off all edges again for safety. Attach these using fillet welds.

Cut conduit to 24” length, and bend 60˚ at 4” from the top. This will ensure that once mounted, the panel will have a tilt at 30˚. Drill a 1” radius hole approximately 8” from the base. This will facilitate the entry and exit for the panel wiring from the charge controller to the battery.

Prototype: Panel Mount

This section will pertain to the construction of the crossmember used to hold the panel and charge controller, as shown below:

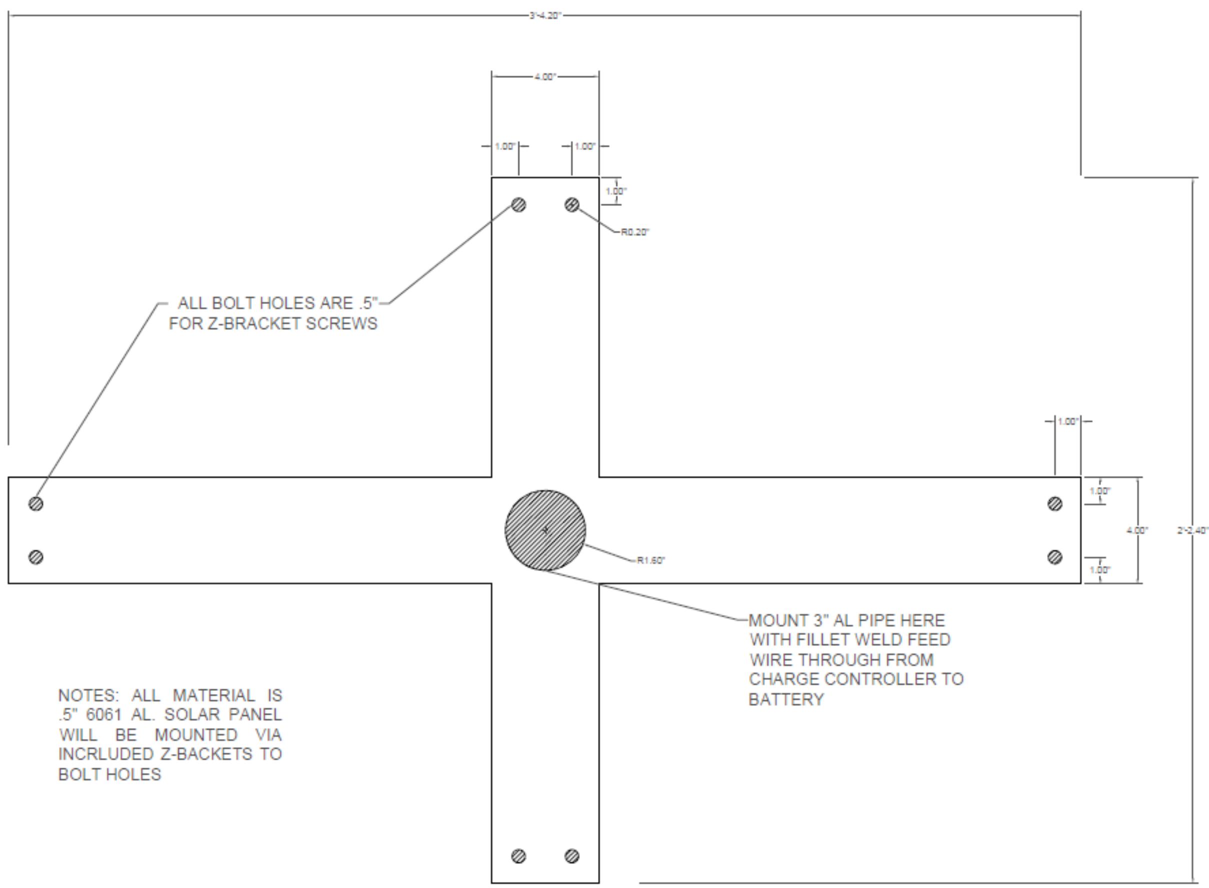


Figure 17: Mounting Bracket Front View

Construct the crossmember using 4” wide slices of 0.5” Aluminum bars at 26.4” and two at 18.1”. Attach together using Fillet Weld such that the dimensions in the mechanical drawing are met. Drill a 1.5” radius (3” diameter) hole into the center. This will be the location to mount the conduit to, and will be the entryway for the wiring coming from the charge controller to the battery. Round off all edges to ensure safe operation.

For the screw holes, note that these are designed using Z-Bracket models found in the kit. However, these are possible to have changed in the design itself. This will likely be a point of modification going forward due to the Solar Kit changing its specifications.

Following completion here, mount the crossmember to the bent conduit and the base of the conduit to the base frame via fillet weld.

Prototype: Final Assembly

The wiring for the Solar Kit is shown below in the included wiring diagram, derived from its operation manual. Note that the clips in which to mount to the battery will instead use screw terminals with battery covers. This was not included in the initial Bill of Materials, but is a potential safety modification going forward.

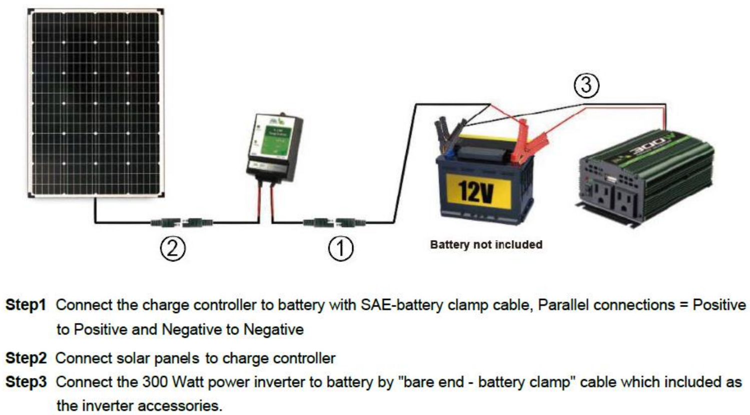


Figure 18: Wiring Diagram from Nature Power Generation System

Place the battery in the area closest to the conduit, it should fit and have terminals pointed outward (away from the conduit). The converter will be placed at the front, with outlets pointed outward. Wire it according to that shown above. Any particulars in reference to the components can be found in the Operation Manual of the Solar Kit, which is included with the kit.

Once all is fixed into place and wired accordingly, the station can then be mounted onto a typical wooden picnic table using the Hex Bolts. The Final Assembly ought to resemble the Design below:

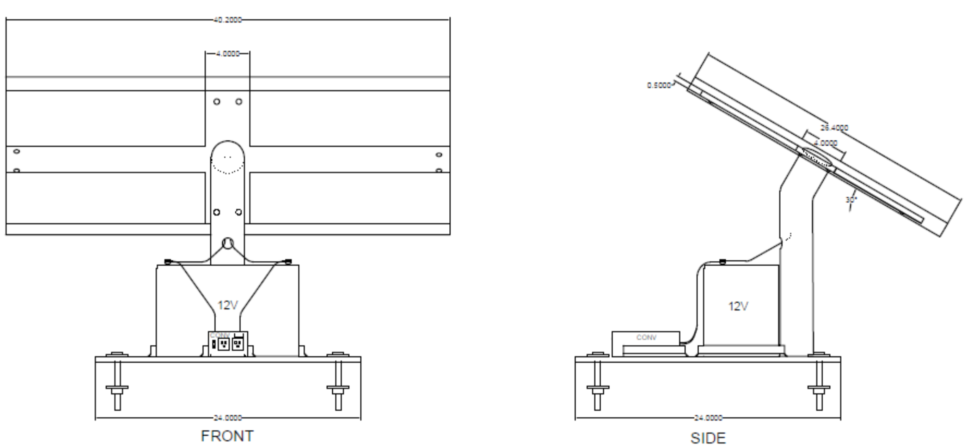


Figure 19: Prototype Finalized Concept Front and Side View

Prototype: Orientation and Location

Orient the Charging Station to the south, ideally in a location with high sunlight penetration. After noting locations, the likely candidates for placement of the prototype charging station, as well as the Enerfusion Charging Station were added below on an Overhead Map shown below with our locations noted by stars. We decided that these marked stars would be the most ideal for social interaction.

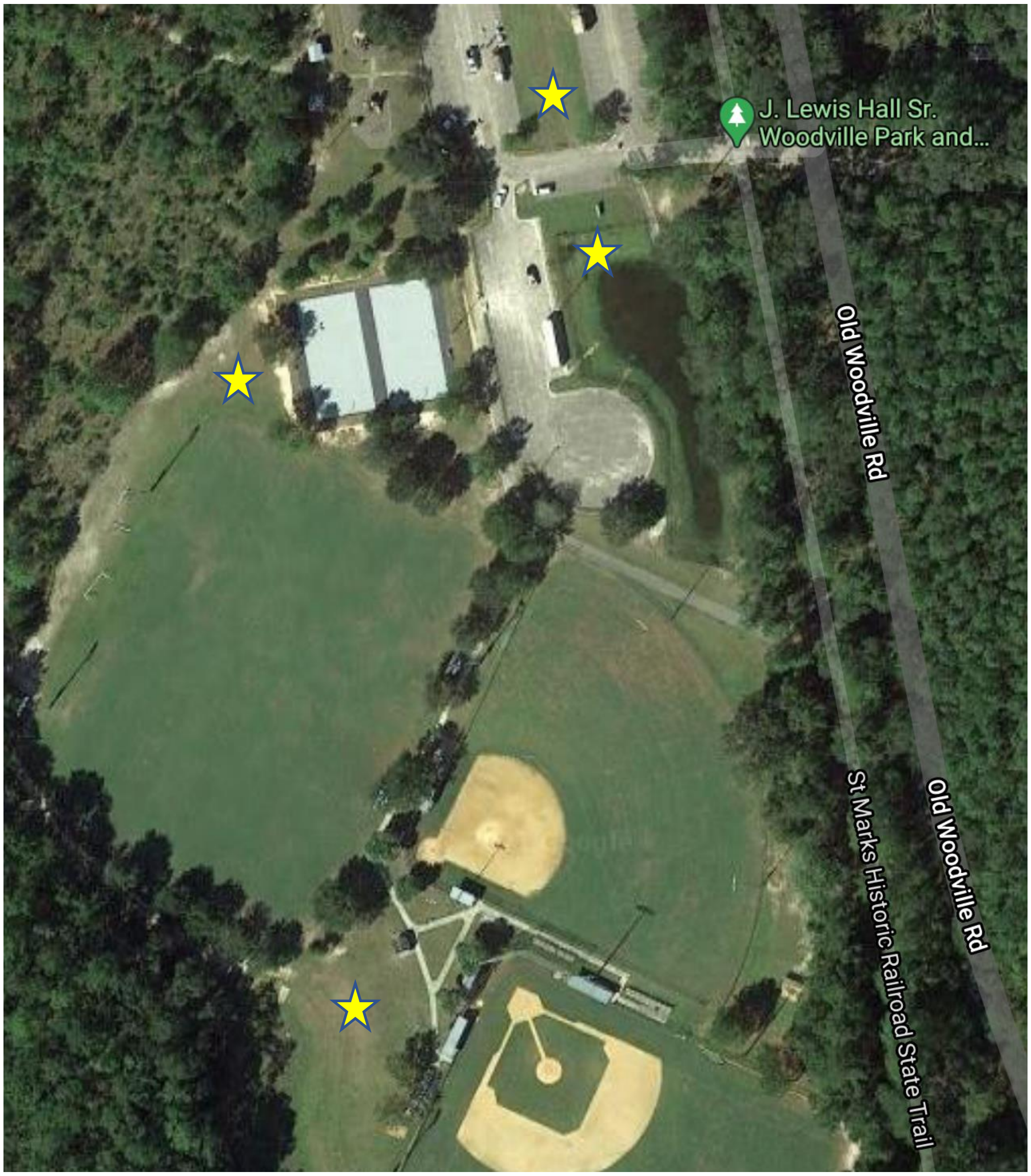


Figure 20: Implementation Locations

Results: Vendor Product Implementation

Justification of Devices

We chose the Big Belly trash compactor and the Enerfusion charging station because they matched the criteria we were looking for, for our project design. We made a list of needs and requirements at the beginning of this park development entailing what all we thought the park would need. The needs and requirements were then taken and concatenated into a AHP matrix where the most important criteria were then decided out of all the needs and requirements considered. This process enabled us to focus on what devices would hit on the most important criteria and further narrowed our selection pool for things that would not be considered. After the most important criteria was decided, we then started to look for devices that aligned with what our criteria. After selection of different devices, all of them were put into another AHP Matrix and ranked in each area (our different criteria) from 1-5; with 1 being a device that did not rank well for a certain criterion. From then, we recognized the devices that scored the highest overall (Enerfusion Charging station & Big Belly trash compactor) and chose these as our final selections.

The two main vendors we considered for work in the Park were Big Belly and Enerfusion. Both were proven to be easy to work with, helpful in data acquisition, and had useful products that would exceptionally benefit Woodville Park going forward.

In regard to the implementation of these products, the majority will be contacting the vendors and their representatives. For Big Belly, they will do all of the construction, maintenance, and will coordinate the connectivity. Enerfusion will require assembly of their charging station product, after being shipped. The Assembly instruction will be included in the shipment.

The Enerfusion charging station is a very stable, efficient, and appealing product. The charging station consists of 4 solar panels (1 100W and 3 60W panels), an umbrella at the top for shade from the sun, seating for multiple people, charging outlets, and a sturdy and reliable structure. The structure is built with aluminum and uses stainless steel fasteners to avoid rusting. The umbrella at the top of it blocks sunlight very well. It also allows for custom labelling on the cloth of the umbrella. The seating can be customized to fit other seating arrangements that the company has, that is, single seating arrangements, multiple seating arrangements, or even handicap adjustments. The chargers on the station have a GFCI outlet that provides ample charging amps/voltage to fit whatever device you want to plug up to it. The outlets are also surge protected to prevent device damage or a shortage in the outlet. In addition to the outlets, the table contains wireless charging areas for devices that can use that feature. Overall, the Enerfusion charging station is a highly capable and efficient device that allows for modularity so that the buyer can design it how they want.

The Big Belly solar-powered trash compactor is a very dependable device. The device is a trash compactor that has an integrated 4G LTE wireless link to communicate to its hosts servers. Although this device is a trash compactor, it has a lot of features that can enhance its use. For instance, the 4G LTE network can be set up to provide wifi to anyone around the device. The wireless connection allows for the trash compactor to communicate to the hosts of the device that it is nearing capacity so that someone can collect the waste from it. This allows for the host to make less frequent trips to collect the garbage from the compactors and in turn reduces carbon emissions produced by garbage trucks. The trash compactors also do not require high maintenance, so they do not need to be monitored heavily. Another feature on the device that results in an increased sustainability is the filling sensor, which communicates to the compactor component when to compact the trash. With the device also being high in capacity, the need to pick up garbage becomes much less frequent than say if a regular trash can was in its place. The device has saved many customers more money, time, and increased the sustainability of their organizations by increasing recycling and reducing carbon emissions. FAMU is one of the customers of the product and they have saved money and increased sustainability around their campus. An article/case study done on the trash compactors was done emphasizing on how the compactors have impacted the campus, noting that the compactors help keep the campus beautiful. Another study was done on Manatee County also commenting on how beneficial the compactors have been for them.

Vendor Contact Information

The Information for contacting these vendors are shown in the tables below.

Table 17: Enerfusion Contact Information

Enerfusion Inc: Joe Kobus, President	
Work Phone:	(844) 876-9378
Mobile Phone	(517) 525-0368
Email:	joe@enerfusioninc.com

Table 18: Big Belly Contact Information

Big Belly: Mike Phillips, Regional Sales Manager	
Phone:	(978) 460-1977
Fax:	(781) 444-5651
Email:	mphillips@bigbelly.com

Funding Sources

While most grant funding was not in its application stages for those with the highest possibility of usership. However, after discussing with the Florida Department of Agriculture and Consumer Services (FDACS) we found that there were grants that could potentially be helpful for funding these projects. We have listed them below as well as the links to their respective information webpages:

- Florida Small Community Energy Efficient Lighting Grant Program:
  - https://www.fdacs.gov/Energy/Energy-Programs/Florida-Small-Community-Energy-Efficient-Lighting-Grant-Program
- Florida Counties Low-Income Residential Energy Efficient Grant Program:
  - https://www.fdacs.gov/Energy/Energy-Programs/Florida-Counties-Low-Income-Residential-Energy-Efficient-Grant-Program
- Florida Renewable Energy Tax Incentives:
  - https://www.fdacs.gov/Energy/Energy-Programs/Florida-Renewable-Energy-Tax-Incentives

Additionally, we found a great deal of usage in the DSIRE database (https://www.dsireusa.org/) which lists all possible grants and funding sources. We also are including the link to the City of Tallahassee's Net Metering information, with the knowledge that this could reap the greatest economic benefits from renewable implementation should it be considered in the future:

https://www.talgov.com/you/you-products-home-solar-net-metering.aspx

Results: Summary

As part of our requirements, we set out to provide a number of options that had the capability to increase Leon County's renewable generation portfolio, while also providing increased social interactivity in a park setting. As part of this, we wanted to included multiple options, given a number of different options of varying costs and benefits. To best show these results, a table was created to show the different benefits and costs.

Table 19: Summary of Recommendations

	Enerfusion Power Dok	**Prototype Station**	**Big Belly Compactor**
Associated Cost	$14,174.59 per unit	$1059.05 per unit	$2400-$4800 per year
Covered Maintenance?	No	No	Yes
Covered Installation?	No	No	Yes
Custom Wrapping?	Yes	No	Yes
Wi-Fi Hotspot Option?	No	No	Yes
Ambient Lighting?	Yes	No	No
ADA Accessible?	Yes	Varies	N/A
Average Annual Solar kWh Generated	392 kWh	146 kWh	31 kWh
# People able to Use	4-6	2-3	N/A
# USB Chargers	4	1	N/A
# 120VAC GFI Outlets	4	2	N/A
# Wireless Chargers	4	0	N/A

Discussion

As shown above in the summary table, our findings showed the wide swath of available options for Leon County to meet their goals. Looking back, our goal was not to completely change the outlook on the county, but to provide small options that could be pilot projects for a place that does not oftentimes see Renewable energy in use.

We knew going in that analyzing potential vendor solutions was atypical of most senior design projects, but our goal for this was to ensure that any option we suggested would be useful, and most importantly, beneficial. As discussed, each of our two vendor options were extensively researched. We interviewed vendors in search for the best options, and the two we chose we felt not only met our goals but were proven through multiple case studies to have been beneficial to the universities, municipalities, and other entities with the same goals in mind as Leon County.

In regard to the prototype portion of our project we fet, after discussing with charging station vendors, we could bring a much lower cost option to the table with similar capability. With that in mind we designed the system with a signle kit to ensure component compatibility, minimizing the amount of materials required, and focusing on the applicability of it. This was not without its problems. The mechanical side of the design work proved to be one of the greatest lynchpins in the project, as few in the group had experience in mechanical drafting. This obstacle however was overcome. Looking back, we knew we probably could have started the prototype earlier and had a far greater opportunity for success, but in doing so we were worried that if we focused too much on a prototype, we would neglect the importance of determining the vendor options best suited for their needs.

Another tradeoff we had to work through was in the design itself. It is likely there were better options as far as components were concerned, yet we knew with the mismatch of these there ran the risk of incompatible components, which could very well ensure the prototype a critical failure. It was for this reason that we elected to use the kit as a means of assuring there would be no issue.

As a whole however, we felt this project was without any serious problems. While we could critique every decision we made along the way, and many of these were worthy of criticism, we are confident that with this report, we will meet Leon County's requirements set forth this past Fall.

Conclusions

This project from the beginning proved to be an exceptional opportunity to develop multiple technical and nontechnical skills. This project revlved around using our engineering background to meet a societal goal that Leon County wanted to address. While we discussed initially the goals as a whole that Leon County has in regard to their Integrated Sustainability Action Plan, we wanted to be able to deliver the a project with options to begin that trek toward these goals, in an outside of the box means of thinking.

While the project was not necessarily technically strenuous, the most important skill we acquired throughout this past year was communicating with entities and their employees nontechnical in nature. This was most critical in working for the county government, as this project would ultimately be decided by the county commissioners, and therefore our justification would have to be from a social aspect. This too proved to be critical as we communicated with representatives from the different vendors, oftentimes nontechnical people, as we were trying to determine technical information so to feed into our modeling systems.

Additionally, we had the opportunity to learn about the ever growing realm of renewable energy. We went so far as to be able to design these power systems based off of gathered load data. Our own load assumptions showed the difference in value between the two charging statons under consideration, and noted again the benefit of our own design in comparison, with its meeting the majority of its modeled requirements while being only about 7% of the cost of the Enerfusion station. The potential for useability in the Enerfsuin cannot however be stressed enough, as our own load assumptions were small in comparison to the Power Dok's delivery capability, as shown in its excess generation.

As we look forward, we are excited to see the project potentially come to fruition in Leon County' shands. Of course with our options, such are determined based on their own budgetary allocations, again giving reason to why we presented the tiered level of options that we did. We are proud of the work we have accomplished with the conclusion of this project, and hope it paves the way for further work to be done in the area.

Future Work

Looking forward there are a number of options Leon County can take with this project. As previsiously discussed, our project was not able to really bring a great deal of data to the table concerning the funding side of these options, due to the grants that would be most applicable not accepting applications currently. Going forward, this is one avenue that would be most helpful in assisting in funding these possible projects. Details were all included pertaining to the specific grants that would be most useful toward the Project's goals.

There was then another point that could be discussed, in regards to the prototype itself. Following our submission of the preliminary designs to the sponsor, one thing they would want to do was reexamine the safety features as well as weatherization.

The challenging aspect of this project was that our designs could not come to fruition so that we could make iterative modifications. However, we knew that once done there would be ways to better our work; specifically those pertaining to safety. This design after all is going to be used by the public. This could include containerizing the battery, wiring, and inverter to ensure that no contact could be made with any electrical devices.

Nother potential improvement would be weatherizing the equipment, whether that be protectively coating the components or putting them all into a weatherproof container, not unlike Enerfusion's station. This however is something that must be discussed at greater length with understanding the possible tradeoffs including added costs incurred.

These modifications and options are all things that could be undertaken by Leon County to really make this design and make this project their own, as we finish up our part of it.

References

Leon County Integrated Sustainability Action Plan

NREL System Advisory Model Home Page and Information

Note: for The above link, this page has all of the required information necessary to further utilize SAM as a means of modleing further renewable generation implementation

Appendix

Code of Conduct

Mission Statement

Team #306 is committed to ensuring a positive work environment that supports professionalism, integrity, respect, and trust. Every member of this team will contribute a full effort to the creation and maintenance of such an environment in order to bring out the best in all of us as well as this project

Roles

Each team member is delegated a specific role based on their experience and skill sets and is responsible for all herein:

Team Leader: Jacob Moore

Manages the team as a whole; develops a plan and timeline for the project, delegates tasks among group members according to their skill sets; finalizes all documents and provides input on other positions where needed. The team leader is responsible for promoting synergy and increased teamwork. If a problem arises, the team leader will act in the best interest of the project.

He keeps the communication flowing, both between team members and Sponsor. The team leader takes the lead in organizing, planning, and setting up of meetings. In addition, he is responsible for keeping a record of all correspondence between the group and 'minutes' for the meetings. Finally, he gives or facilitates presentations by individual team members and is responsible for overall project plans and progress.

Lead ECE: Christopher Gibson/Sean Fisher

- Responsible for the EE, IE, or CE design part in support of the project.
- Keeps line of communication with the team members.
- Responsible for knowing details of the design, and presenting the options for each aspect to the team for the decision process.

Co-Lead ECE/Project Secretary: Samantha Lafrance

- Maintains a line of communication with team members
- Keeps all design documentation for record
- Act as Webmaster for project website
- Maintains written records of information, meeting minutes, etc.

Financial Advisor: Marwan Kamleh

Manages the budget and maintains a record of all credits and debits to the project account. Any product or expenditure requests must be presented to the advisor, who is then responsible for reviewing and the analysis of equivalent/alternate solutions. They then relay the information to the team and if the request is granted, order the selection. A record of these analyses and budget adjustments must be kept. Will finalize bill of materials and maintain record of all quotes obtained

All Team Members

- No role is set in stone
- Work on certain tasks of the project
- Buys into the project goals and success
- Delivers on commitments
- Adopt team spirit
- Listen and contribute constructively (feedback)
- Be effective in trying to get message across
- Be open minded to others ideas
- Respect others roles and ideas
- Be ambassador to the outside world in own tasks

Communication

The main form of communication will be via GroupMe and through regular Zoom Meetings. Email will be a secondary form of communication for issues not being time-sensitive, in addition to correspondence with advisor, sponsor, instructor(s), and any resource outside of the College of Engineering. If Direct Messaged via GroupMe, the recipient should respond to questions in a timely manner not to exceed eight hours, except during holidays. For the passing of information, i.e. files and presentations, email will be the main form of file transfer and proliferation. For any calendar event, Microsoft Outlook will be the means of scheduling, and the Team Leader will create and forward all calendar updates and meeting requests as they arise.

Each group member must have a working email for the purposes of communication and file transference. Members must check their emails at least twice a day to check for important information and updates from the group. Although members will be initially informed via a phone notification, meeting dates and pertinent information from the sponsor will additionally be sent over email so it is very important that each group member checks their email frequently.

If a meeting must be canceled, a notification must be sent to the group at least 24 hours in advance. Any team member that cannot attend a meeting must give advance notice of 24 hours informing the group of his absence. Reason for absence will be appreciated but not required if personal. Repeated absences in violation of this agreement <u>will not</u> be tolerated and instructors will be notified after two consecutive absences from meetings without notification.

Team Dynamics

The students will work as a team while allowing one another to feel free to make any suggestions or constructive criticisms without fear of being ridiculed and/or embarrassed. If any member on this team finds a task to be too difficult it is expected that the member should ask for help from the other teammates. If any member of the team feels they are not being respected or taken seriously, that member must bring it to the attention of the team in order for the issue to be resolved. We shall NOT let emotions dictate our actions. Everything done is for the benefit of the project and together everyone achieves more.

Ethics

Team members are required to be familiar with the NSPE Engineering Code of ethics as they are responsible for their obligations to the public, the client, the employer, and the profession. There will be stringent following of the NSPE Engineering Code of Ethics. Whereas this project deals exclusively with public property and with the public trust, the Team will make all analyses, designs, and recommendations with the public trust of Leon County in mind.

Dress Code

Team meetings will be held in casual attire. Sponsor meetings and group presentations will be business casual to formal as decided by the team per the event. Zoom presentations will not require such attire below camera view.

Weekly and Biweekly Tasks

Team members will participate in all meetings with the sponsor, advisor and instructor. During said times, ideas, project progress, budget, conflicts, timelines and due dates will be discussed. In addition, tasks will be delegated to team members during these meetings. Repeat absences will not be tolerated

Advisor and sponsor updates will take place Fridays on a biweekly basis, at 1:30 P.M. via Zoom beginning September 18, 2020 for the duration of the Fall Term. For the Spring term, advisor updates will take place on a biweekly basis beginning at 11:00 A.M. on January 13, 2021. The purpose of these meetings are to maintain correspondence between the sponsor, the team, and the advisor as work progresses. All meetings are subject to cancellation at the behest of the advisor or sponsor.

If there are any agenda items requiring discussion, or action items requiring completion by the group, these will be addressed in a weekly meeting held Wednesday's at 6:30 P.M. via Zoom if possible or in person at the College of Engineering, if necessary, for the Fall term. For the Spring term, all meetings will be held via Zoom Monday's at 11:00 A.M. All group meetings are subject to rescheduling or cancellation if necessary.

Decision Making

Decision Making is conducted by consensus and majority of the team members. Should ethical/moral/public trust reasons be cited for dissenting reason, then the ethics/morals shall be evaluated as a group and the majority will decide on the plan of action. Individuals with conflicts of interest should not participate in decision-making processes but do not need to announce said conflict. It is up to each individual to act ethically and for the interests of the group and the goals of the project. Achieving the goal of the project will be the top priority for each group member. Below are the steps to be followed for each decision-making process (as applicable):

- Problem Definition – Define the problem and understand it. Discuss among group.
- Tentative Solutions – Brainstorms possible solutions. Discuss amongst the group most plausible.
- Data/History Gathering and Analyses – Gather necessary data required for implementing Tentative Solution. Re-evaluate Tentative Solution for plausibility and effectiveness.
- Design – Design the Tentative Solution product and construct it. Re-evaluate for plausibility and effectiveness.
- Test and Simulation/Observation – Test design for Tentative Solution and gather data. Re-evaluate for plausibility and effectiveness.

Final Evaluation – Evaluate the testing phase and determine its level of success. Decide if design can be improved and if time/budget allows for it.

Conflict Resolution

In the event of discord amongst team members the following steps shall be respectfully employed:

- Communication of points of interest from both parties which may include demonstration of active listening by both parties through paraphrasing or other tool acknowledging clear understanding.
- Administration of a vote, if needed, favoring majority rule.
- Rock Paper Scissors
- Team Leader intervention.
- Instructors will facilitate the resolution of conflicts.

Statement of Understanding

Name	Signature	Date
Samantha Lafrance	Samantha Lafrance	9/9/20
Jacob Moore	[illegible]	9/9/20
Christopher Gibson	[illegible]	09/09/20
Marwan Kamleh	[illegible]	09/09/20
Sean Fisher	[illegible]	9/9/20

Functional Decomposition Chart Catalog

Figure 21: Primary Functional Decomposition

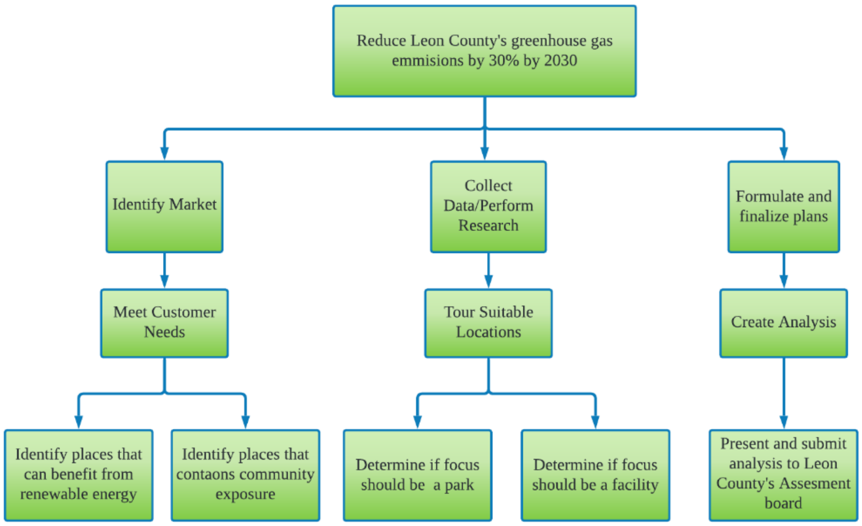
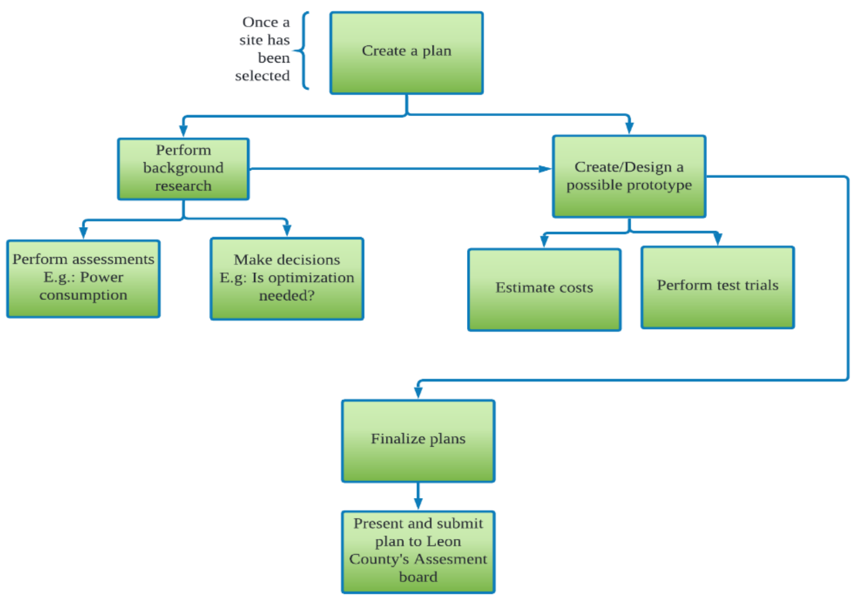
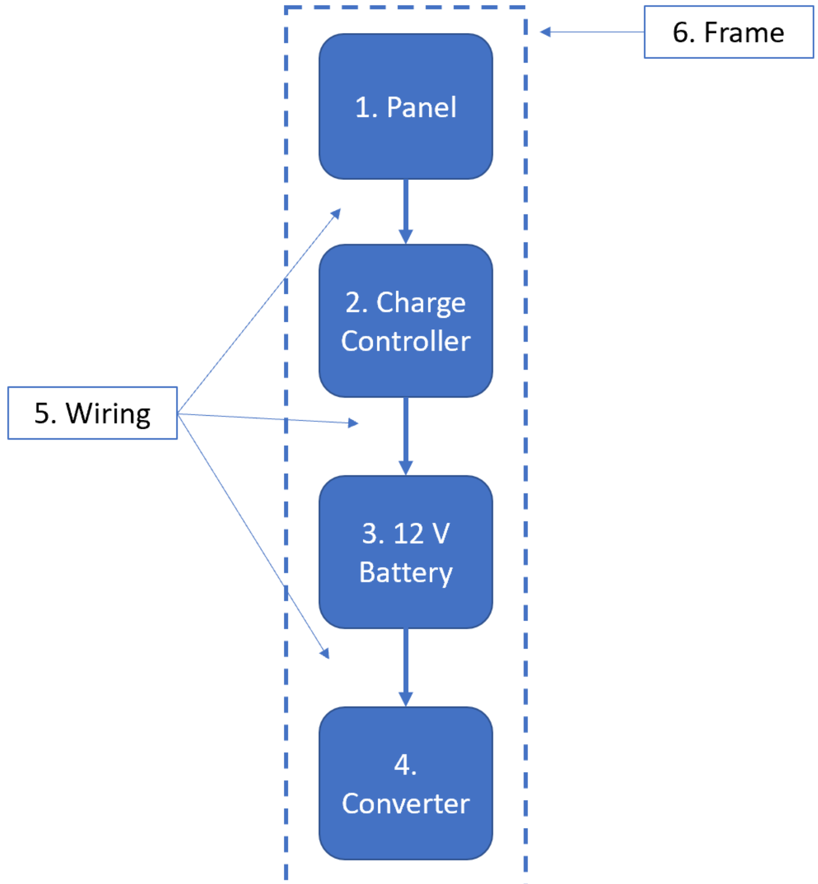


Figure 22: Primary Functional Decomposition Continued




6. Frame
1. Panel
2. Charge Controller
5. Wiring
3. 12 V Battery
4. Converter

Target Catalog

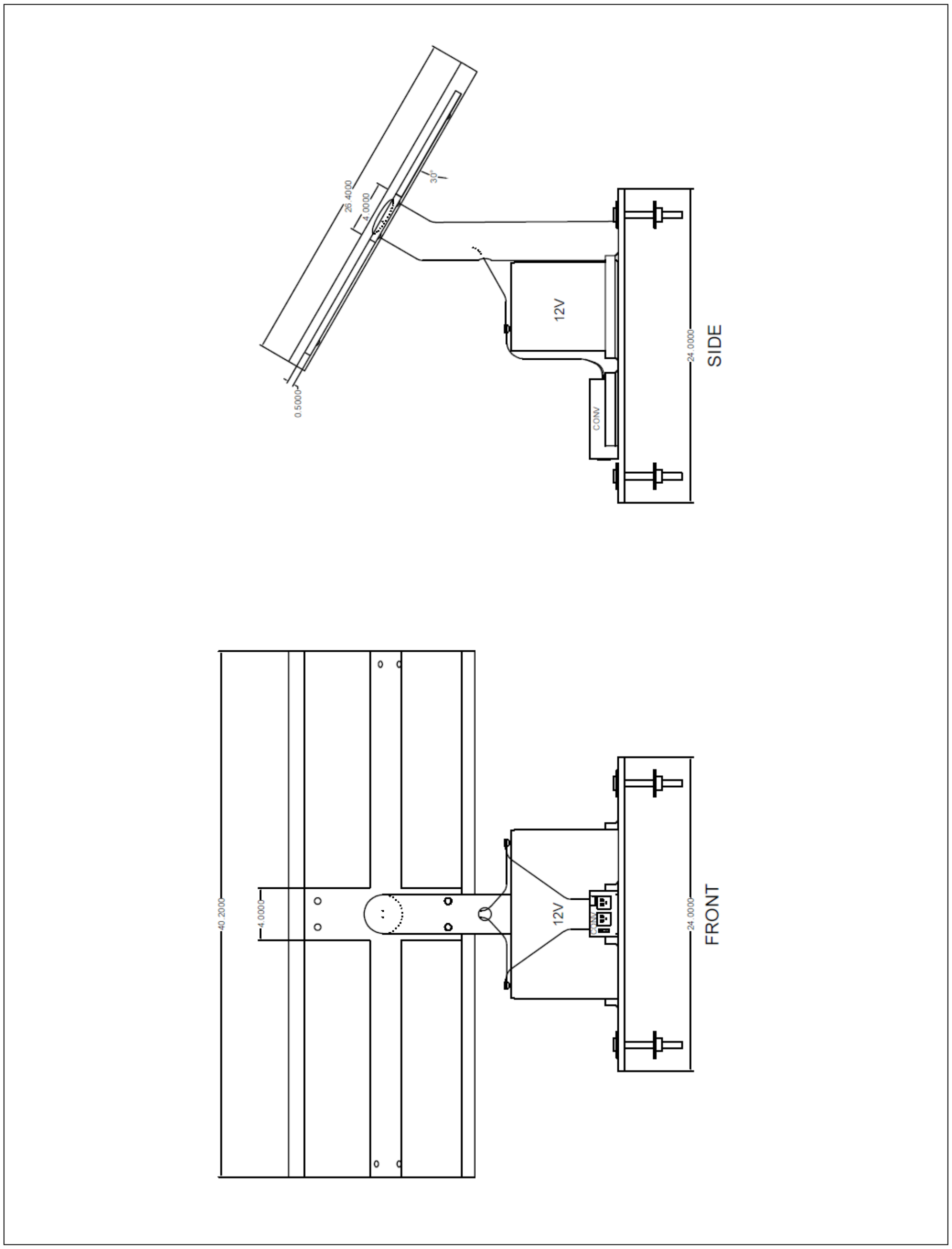
Table 20: Target List

No.	Target Description	Metric of Success	Associated Function/Req
1*	Total cost of $50,000 or less	1. Finalized feasibility cost <$50,000	Estimate Costs
2*	Directly implementable (turn-key)	1. Designs meet all associated standards 2. Proposal includes full economic feasibility analysis 3. Proposal includes Return on Investment 4. Proposal includes complete design package 5. All analyses include justifications 6. Design has been reviewed for completeness	Site Plan/Proposal
3	Complete Design package	1. Includes finalized wiring diagrams 2. Includes finalized panel schedules 3. Includes finalized physical layouts 4. Includes finalized bill of materials 5. Includes justification for design choices 6. Designs are reviewed for completeness and accuracy	Site Plan/Proposal
4	Complete Economic Analysis	1. Includes at minimum 2 quotes for all material 2. Includes at minimum 2 quotes for all labor costs 3. All renewable implementation is modeled for annual load 4. All renewable generation includes expected energy savings 5. Includes Return on Investment analysis and calculation 6. Includes bottom-line costs for implementation 7. Uses diversity factorization for labor and material costs	Perform Assessments, Estimate Costs

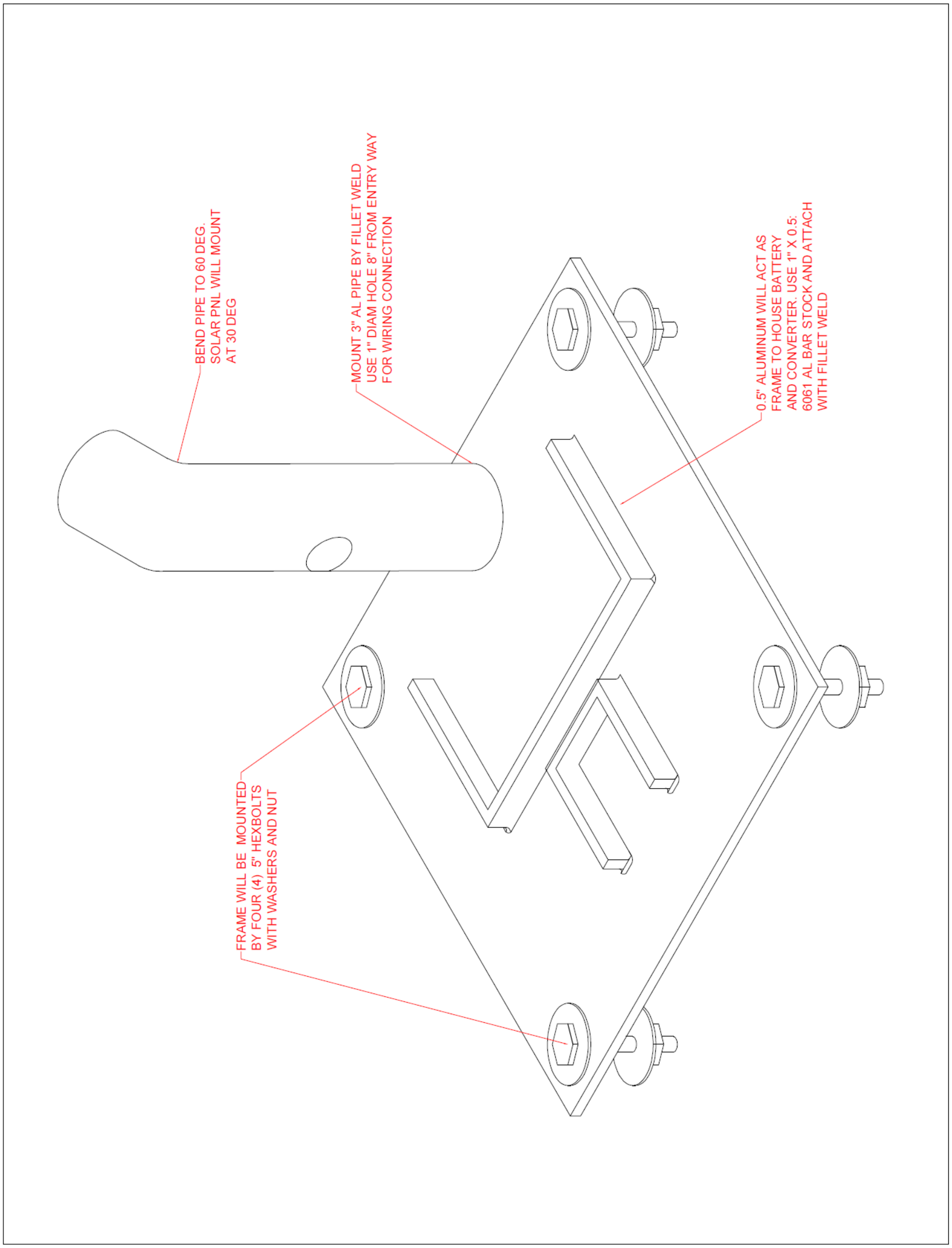
		8. Includes justification for all analyses and calculations	
5	Design completely self-powered	1. Renewables implemented do not require utility interconnection for continual usage 2. Designed such that no limits to time of operation 3. Design makes use of solar PV and storage elements 4. Minimal (<1 s) transition between storage and active PV	Site Plan/Proposal
6	Multiple tiered proposals	5. Includes proposals for multiple designs based on different budgets. 6. Includes high level proposal for $100,000 budget 7. Includes high level proposal for $20,000 budget 8. Include justifications for proposals	Site Plan/Proposal
7	Proposed design has public exposure	1. Design must be viewable to all entrants at park/facility 2. Design makes use of signage in at minimum 2 areas 3. Signage notes renewable energy to public 4. All solar PV devices are in public view	Public Exposure to Renewables
8	Proposed design is interactive for public	1. Accommodate up to 4 people at minimum 2. Implements exercise, crank system, other activity for public usage 3. Exhibits usage of renewable energy	Public Exposure to Renewables
9	Proposal is replicable	1. Design package can be used in multiple parks/facilities 2. Budget is below $50,000 target 3. Space used is minimal (<150 ft^2)	Site Plan/Proposal
10	Proposal has avenue for public feedback	1. Makes use of surveys of proposal's usefulness 2. Proposal package includes survey responses	Public Exposure to Renewables

Engineering Drawings

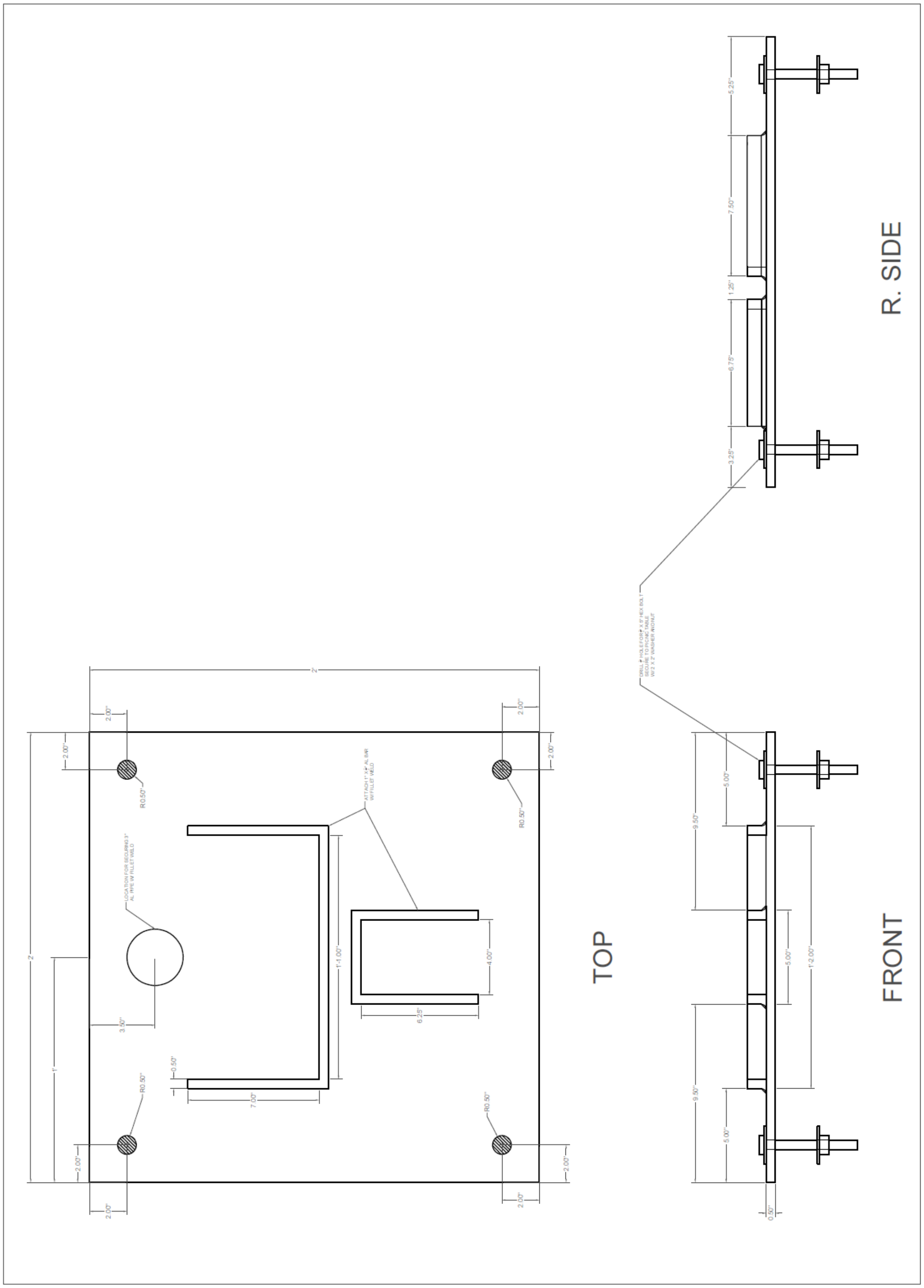
Finalized Concept Prototype



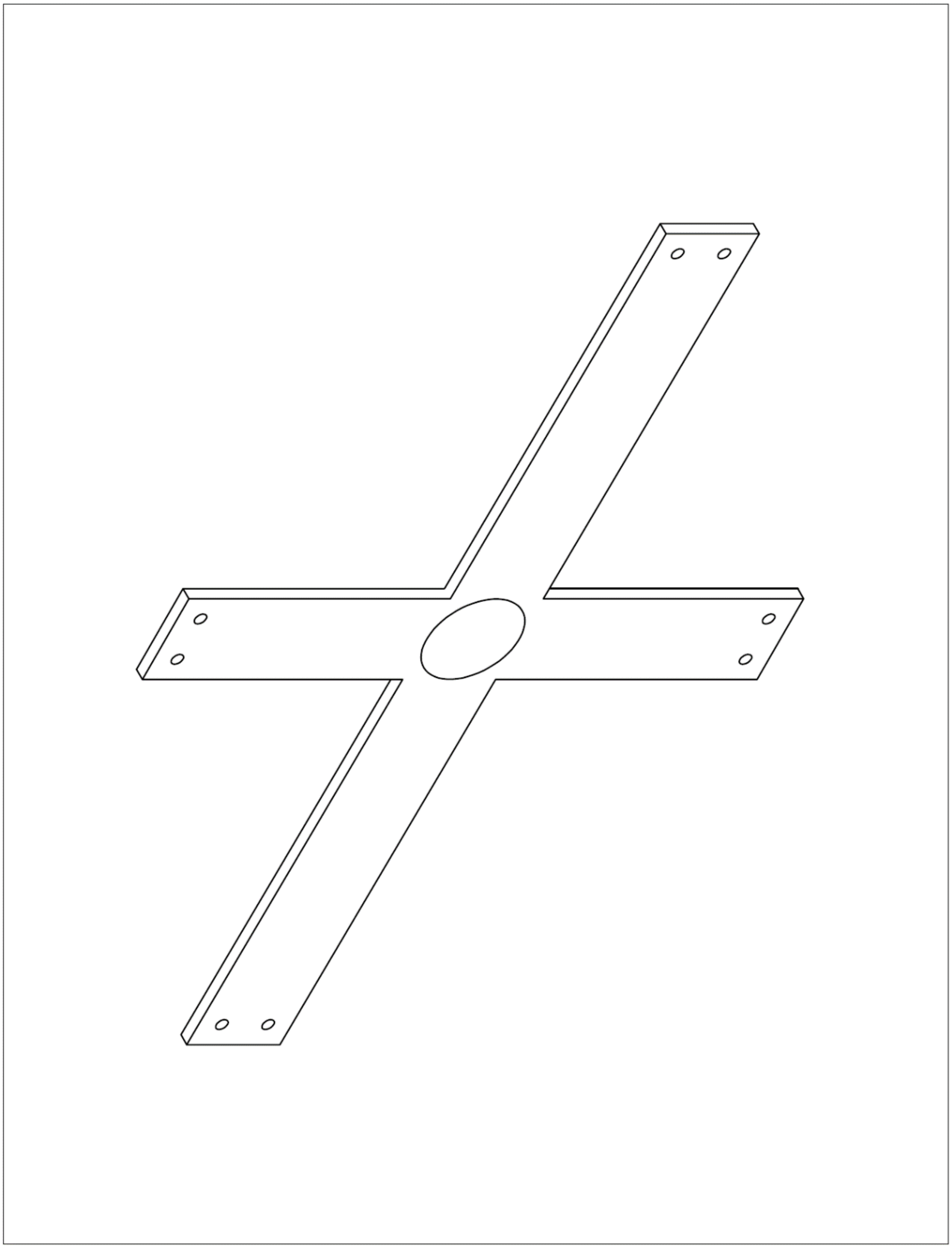
Base Frame Isometric



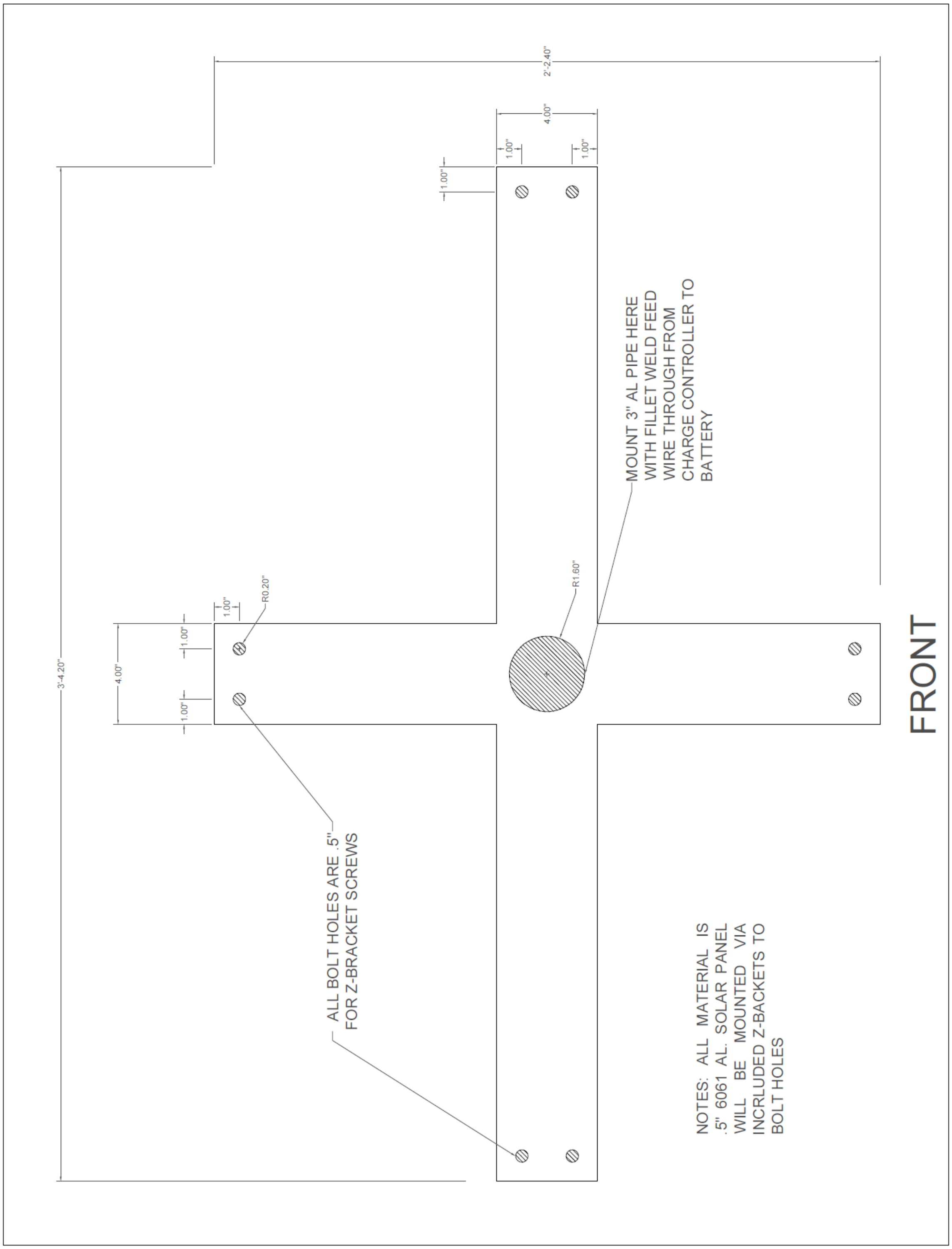
Base Frame Three Side



Panel Mount Isometric



Panel Mount Side View



Bill of Materials

Part #	Vendor/Supplier	Description	Qty	Units	Picture	Unit Cost	Cost
53110	Nature Power	110W Panel kit w/ Charge Controller, Panel, mounting z-brackets, and inverter	1	1		$ 220.00	$ 220.00
RBT100G	Renogy	Hybrid GEL battery 12V, 100Ah	1	1		$ 246.00	$ 246.00
2HGR7	GRAINGER	Aluminum Plate 24"x24"	1	1		$ 295.80	$ 295.80
5GUL0	Rigid	Aluminum Conduit 3" Diam 10' length	1	1		$121.28	$ 121.28
67312	Hillman	1/2" x 5" Hex Bolt	4	1		$2.07	$ 8.28
67342	Hillman	1/2" Hex Nut	4	1		$0.41	$ 1.64
63449	Hillman	0.531" Flat Washer	4	1		$0.36	$ 1.44
61817	Hillman	1/2" Split Lock Washer	4	1		$0.28	$ 1.12
20670	Aluminum Bar	1/2" x 8" Aluminum Rectangle Bar 3'	1	1		$87.00	$ 87.00
1171	Aluminum Bar	1/2" x 4" Aluminum Rectangle Bar 6'	1	1		$ 76.49	$ 76.49
	Total		**22**				**$ 1,059.05**

Calculations

Load Assumptions

The Charging Station assumes to provide power for 1 laptop charger (rated at 19V and 3.42A) and 2 cell phone chargers (rated at 5V and 1A). We are assuming 4 hours operation for the Laptop charger and 3 hours for the cell phone charger:

$$P_{LAPTOP} = 19\,V_{DC} * 3.42 \quad = 64.98\,W$$

$$E_{LAPTOP} = 64.98\,W \; * 4\,\frac{hr}{day} = 260\,\frac{Wh}{day}$$

$$\mathrm{P}_{CELL} = 5\,\mathrm{V_{DC}} * 1\,\mathrm{A_{DC}} = 5\,\mathrm{W}$$

$$E_{CELL} = 5\,W \; * 3\,\frac{hr}{day} * 2 = 30\,\frac{Wh}{day}$$

$$E_{TOTAL} = E_{LAPTOP} + E_{CELL} = 260\,\frac{\mathrm{Wh}}{\mathrm{day}} + 30\,\frac{\mathrm{Wh}}{\mathrm{day}} = 290\,\frac{\mathrm{Wh}}{\mathrm{day}} \approx 8.7\,\frac{kWh}{month}$$

The trash compactor operates using a 20W motor. According to case studies done, the typical operation shows to be about 1 compaction per day or about 1 hour a day. These results are shown below:

$$E_{COMP} = 20\,\frac{W}{day} * 1\,hr = 20\,\frac{Wh}{day} \approx 0.62\,\frac{kWh}{mo}$$

Risk Assessment

Project Narrative

Name of Project: T306 Leon County Energy Efficiency		**Date of submission:** 18 November 2020
Team member	**Phone number**	**e-mail**
Sean Fisher	(850) 673-7550	sean1.fisher@famu.edu
Christopher Gibson	(850) 673-7550	cag16f@my.fsu.edu
Marwan Kamleh	(850) 673-7550	msk13b@my.fsu.edu
Samantha LaFrance	(850) 673-7550	samantha1.lafrance@famu.edu
Jacob Moore	(850) 673-7550	jtm17f@my.fsu.edu
Faculty mentor	**Phone number**	**e-mail**
Omar Faruque	(850) 212-0493	faruque@caps.fsu.edu

Rewrite the project steps to include all safety measures taken for each step or combination of steps. Be specific (don't just state "be careful").

For all work requiring group collaboration at the College of Engineering (COE), Team 306 will adhere to FSU COVID-19 guidelines to minimize risk of potential transmission, in addition to to adhering to COE Emergency Action Plans during facility emergencies. While we are working on site analysis and planning out at Hall Park in Woodville there are multiple low level potential hazrds that arise typically associated with outdoor work including but not limited to heat, sun, and insects, with added cautions of COVID-19, these were addressed with added PPE of insect repellent and sunscreen as well as taking water breaks as the weather warms up again. If any analysis requires opening of energized panels or equipment, we will schedule a time with qualified Leon County Facilities employees to do so.

Thinking about the accidents that have occurred or that you have identified as a risk, describe emergency response procedures to use.

Our risks for emergency are minimal. However, should an emergency arise at the COE, 911 will be called immediately and faculty will be notfied. While at Woodville Park, any emergency will be addressed by a 911 call. For the sake of record, the nearest Hospital to Woodville Park is Capital Regional Healthcare Southwood at 2674 Capital Cir SE, Tallahassee, FL, should 911 be unable to be reached.

List emergency response contact information:

- Call 911 for injuries, fires or other emergency situations
- Call your department representative to report a facility concern

Name	Phone number	Faculty or other COE emergency contact	Phone number
		Omar Faruque	**(850) 212-0493**
		Oscar Chuy	**(850) 410-6468**

Safety review signatures

Team member	Date	Faculty mentor	Date

Report all accidents and near misses to the faculty mentor.

Project Hazard Assessment Worksheet				
PI/instructor: **Oscar Chuy**	Phone #:	Dept.: **ECE**	Start Date: **18 Nov 2020**	Revision number: **1**
Project: **Senior Design T306 Leon County Energy Sustainability**			Location(s): **College of Engineering; Hall Park, Woodville, FL**	
Team member(s): **S. Fisher, C. Gibson, M. Kamleh, S. Lafrance, J. Moore**			Phone #: **850-410-6468**	Email: **chuy@eng.famu.fsu.edu**

Experiment Steps	**Location**	**Person assigned**	**Identify hazards or potential failure points**	**Control method**	**PPE**	**List proper method of hazardous waste disposal, if any.**	**Residual Risk**	**Specific rules based on the residual risk**
Group Work	College of Engineering	N/A	1) Potential Close Proximity workspace during pandemic 2) Facility Emergency	1) Adhere to University COVID-19 Guidelines 2) Adhere to COE Emergency Plan	- Masks (potentially)	N/A	HAZARD: CONSEQ: Low Residual: Low	N/A
Site Work/Visits	J. Lewis Hall Woodville Park	N/A	1) Working in Heat 2) Working in Sun 3) Proximity to energized equipment 4) Insect/Bug bits 5) Potential close proximity 6) Tripping hazard	1) Regular water breaks in heat 2) Sunscreen as required 3) Adjust work plan to not require access to energized equip., let Leon Co. employees operate equipment 4) Avoid wasp nests, spray down with repellent if necessary 5) Maintain Social distancing measures 6) Pay attention to path	- Water bottles - Sunscreen - Insect Repellent - Masks (potentially)	N/A	HAZARD: CONSEQ: Low Residual: Low	N/A

Principal investigator(s) PHA certification: I certify that I have reviewed and approved the PHA worksheet and will ensure the control measures are available and implemented in the laboratory.

Name	**Signature**	**Date**	**Name**	**Signature**	**Date**

Team members' certification: I certify that I have reviewed the PHA worksheet, am aware of the hazards, and will ensure the control measures are followed.

Name	**Signature**	**Date**	**Name**	**Signature**	**Date**

Vendor Data Sheets

Prototype Supplier Data: Solar Kit

https://www.naturepowerproducts.com/product-details.php?id=269

Prototype Supplier Data: Battery

https://www.renogy.com/deep-cycle-hybrid-gel-battery-12-volt-100ah/

Enerfusion Power Dok

Enerfusion Data Sheet

Big Belly Trash Compactor

Big Belly Data Sheet

Testing and Validation Sheet

Test Writer	Team 306						
Test Case Name	Load Requirement Checkouts					Test ID #:	
Description	Test the efficacy of implementing Prototype and Vendor Charging Station to model the load delivery performance					Type	
Name of Tester	Chris Gibson, Marwan Kamleh, Jacob Moore					Date	3/1/21
Hardware/Software Ver.	NREL System Advisory Modelling (SAM) Software ver. 2017.9.5					Time	1530
Setup	We began with modeling the load requirements. This was done with looking into the requirements for what the charging station is geared toward—cell phone and laptop chargers. We modeled the same load requirements as a means of noting the difference. We assumed 4 hrs of operation of the laptop charger at rated load and 3 hrs operation for two cell phone chargers at rated load resulted in on average 8.7 kWh/month. This was fed into the SAM Model as a means of knowing the charging station generation capacity. A pass result would mean that for all 12 months, the supplied load met its demand assumptions, a fail would constitute it not doing so.						

Step	**Actions**	**Expected Results**	**Pass**	**Fail**	**N/A**	**Comments**
1	Using the generation capacities from Enerfusion and the demand assumptions calculated, use the SAM model to ensure requirements are met	Load Generated would meet Demand	X			The supply far exceeded demand assumptions, showing the demand can be increased
2	The same process was conducted with the prototype and the load assumptions	Load Generated would meet Demand		X		There was one month that generation was not modeled to meet demand. We addressed this using a large capacity gel-cycle battery and rechecked it to ensure the battery could meet the excess demand.
3	We retested it with a 1.2 kWh battery to test that the	Load Generated or stored would meet Demand	X			The Model showed that the energy consumption for the month of December was within the storage capabilities of the battery.
Overall Test Result			X			We are confident in our selected vendor charging station and prototype to meet assumed load demands