January 31, 2018

Mr. Steve Whitmore
School of Engineering Science
Simon Fraser University
Burnaby BC
V5A 1S6

Re: ENSC 405 Capstone Project Proposal: EnerTree

Dear Mr. Whitmore,

The following document outlines our project proposal of a hybrid renewable energy production system for ENSC 405W (Project Documentation, User Interface Design, and Group Dynamics). The project will involve constructing a faux tree in order to harvest different types of renewable energy.

Although it is early in the stages of research and development, this proposal will include a summary of the intended product, the risks and benefits of taking on this ambitious project, and the current market and competition for such a product. After that, further sections include cost considerations and project planning.

PNW Energy consists of three 5th year engineering students. Each of whom are eager and motivated to start working on this project.

If you have any questions about this proposal, please contact Cole Patterson by email at colep@sfu.ca.

Thank you,

Cole Patterson
Sam Swerhone
Jacob Cheng

2018

EnerTree Proposal

HARNESSING ENERGY USING SMALL SCALE HYBRIDIZED SYSTEMS

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PNW ENERGY CO.

PNW Energy

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Executive Summary

Solar roof tiles, solar garden lights, solar phone chargers and even plain old solar panels... With renewable energy growing as an industry and with the desire to install these photovoltaic energy systems everywhere, the technology continues to improve. People living in places like Arizona and California love this advancement in technology. In addition to enjoying the technology, they are also loving the endless days of sun. The same cannot be said for the residents of the Pacific Northwest, who rather than having endless days of sun, ‘enjoy’ endless days of rain. With that being said, even with all this rain, some residents of Vancouver, Portland and Washington are willing to install solar panels for the rare appearances of sun.

The objective of EnerTree and PNW Electric is to provide the residents of the Pacific Northwest and other similar regions a chance to have a hybrid, renewable energy system that will function in any climate. EnerTree will collect rain water, store it, and produce energy through a micro hydroelectric turbine found in the base of the trunk. The leaves will be fabricated as a photovoltaic system and will harness the sun's energy during the sunny days. Meanwhile, wind energy will be collected through micro wind turbines and PVDF technology. With all these technologies combined and integrated together EnerTree will be an all-around hybrid renewable energy system that can function in any weather.

The majority of people installing solar panels on their property are placing them out of sight. The idea behind the tree-like structure is to have a product that is both appealing to the eye and has a natural look to it. The hope is to have this beautiful, realistic looking tree as the focal point of gardens, an attractive element of cities and be the epicenter of renewable energy for consumers in the Pacific Northwest.

PNW Energy consists of three highly motivated and enthusiastic 5th year engineering undergraduates from SFU. The members have a wide variety of industry experience, including but not limited to: mechanical design, embedded systems, electronic simulation, electrical assembly and soldering/machining.

A working prototype of EnerTree will be completed by August 6, 2018. Our tentative budget is set to $705 CAD but will hopefully grow with additional corporate sponsorships. Understanding the various electronic systems and fabrication will take up the majority of this time, whereas the remaining time will be focused on research.

Introduction

With the effects of climate change becoming more apparent each year, there is a massive worldwide trend away from greenhouse gases, as countries move toward sustainable and renewable energy sources. As we continue to burn fossil fuels, the risk of permanent and irreversible damage to our planet continues to grow. Luckily, scientific advancements are being made at an unprecedented pace, allowing us to move toward a world where renewable energy is the primary source of electricity. Whether it is harnessed through solar power, hydropower or wind power, the energy sources are abundant.

Large photovoltaic and solar thermal power stations are being constructed in many areas worldwide as the technology of solar panels evolves and their efficiency increases. The majority of these power plants are showing up in climates where extreme heat and countless days of pure sunlight is the norm.

Wind power is another popular source of renewable energy, and wind farms are being installed worldwide. Large agricultural areas and other wide open plains are an excellent spot to build wind turbines. These locations are ideal because of the need for constant winds, since large wind turbines require a minimum speed of 3m/s in order to generate electricity [1].

The largest source of renewable energy comes in the form of hydropower. This should come as no surprise, as the Earth's surface is 71% water [2]. Energy is collected either through dams, pumped storage, run-of-the-river or by the change in tides. The optimal location for hydropower plants is quite obvious. These locations require access to large bodies of water and an abundance of mountainous terrains and flowing rivers.

Renewable energy is being harvested all over the world, but there are obvious 'hot spots'. The Pacific Northwest is a great example of this. This region is bounded by the Pacific Ocean on the West and the Cascade mountain range on the East. More specifically; Oregon, Washington and British Columbia [3]. With some cities in this area averaging upwards of 135 inches of rain in a year and 235 days of rain, the amount of sunlight is limited [4]. Although these areas have enough wind to generate wind power, the mountainous and dense forest regions make finding optimal areas for wind farms difficult. Since the Pacific Northwest is in abundance of mountainous regions and flowing rivers, Oregon, Washington and BC lead their respective countries in production of hydroelectric energy [5]. With that, there is still a great amount of energy yet to be harvested in these regions from the rainfall, wind and sun.

The idea of EnerTree is simple, a hybrid renewable energy system specifically targeted at locations with low sun, high rains and moderate winds. EnerTree, as the name implies, is a tree like structure designed to be installed individually or in clusters, in a variety of sizes, in either residential or urban locations. The design will take advantage of the ever-growing technology of piezoelectrics (such as Polyvinylidene fluoride or polyvinylidene difluoride (PVDF)) to generate electricity from the vibrations of raindrops on the leaves and through the bending and twisting of the stems due to the changes in wind direction and speeds. Not only will EnerTree collect energy from the vibrations of the raindrops, it will also collect said raindrops through the leaves down the stem and into the trunk where that water will then be released to create hydroelectricity. Although these regions may not have an abundance of sun, there remains a sufficient number of sunny days that warrant installing solar panels on EnerTree. The main focus of the design will be to make an aesthetically pleasing tree shaped design that will seamlessly integrate these technologies while maintaining a natural and realistic look.

This proposal is designed to identify and highlight the key concepts of the renewable energies and technologies that this product will be implementing. It will also provide a detailed explanation of the challenges that will be faced, the different competition of similar systems and an in-depth look at the project plan and budget.

Scope/Risks/Benefits

Daily living in the Pacific Northwest sparked the vision of creating a small scale power generation system that will produce energy on any day of the year. The microclimate that drives the region’s high variety of weather makes traditional, private-sector renewable systems ineffective and costly. The first steps will be to survey the most efficient and feasible methods of renewable energy, then combine them into a hybrid system that targets the private consumer. Initial research has directed us toward three renewable energy harvesting technologies: photovoltaics, hydro, and wind power. The proposed design is a hybrid system using all three energy sources. The scope of the project is quite broad, since each harvesting technology needs to be examined. This section will try to focus on each individual technology, and close with an explanation of the risks and benefits of combining the three technologies.

Photovoltaic energy harvesting systems have been around for a long time. The initial discovery of light’s impact on electricity came in the mid 1800’s, but in recent years dramatic improvements have been made with respect to cost and efficiency [6]. Photovoltaics primarily revolves around taking advantage of the freely moving electrons in semiconductors and the movement of millions of photons (high energy subatomic particles, that compose solar radiation). Photons are emitted from the sun and hit valence electrons in the outermost shell of a semiconductor, usually silicon. When these semiconductors are configured into a circuit, their electrons will leave their initial atom and bounce to the next atom. This movement of electrons, or current, can be used to power the rest of the circuit [7]. This technology separates itself from other energy generation methods by being a purely electrical system, thus, avoiding mechanical components which can wear down over time.

The project would likely take the form of incorporating a pico-solar system. These systems are more feasible to design in the 6-8 month duration, and provide an excellent proof of concept or prototype that could be ideally scaled up. Pico solar systems provide 0.1 to 15 Wp (Wp is Watts during peak solar radiation), as compared to the significantly larger systems used by off grid homes (50Wp+) [7]. They require smaller components and lower power ratings, which lowers project prices. It would also be easier to combine with the other harvesting systems, due to small system area.

As photovoltaic systems are now cheaper and more efficient than ever, they make an excellent energy harvesting method to include in the hybrid system. They are fairly easy to wire up, but can require complex circuitry when used to charge a battery, and often present other engineering challenges. The premier design challenge is the maximization of solar insolation, the measure of solar energy received over specified area over a specified duration. The solar incident angle is also extremely important, keeping a solar module perpendicular to the sun's rays, thereby maximizing the solar irradiation (the amount of solar radiation actually striking a surface, which is the key factor in maximizing solar insolation). Lastly, solar systems require protection from shading, overheating, and collisions. When the module is partially shaded, the shaded cells will produce less current than other cells, due to fewer photon/electron collisions. Since these cells are in series, the shaded cells will start to absorb the current of the unshaded neighbor cells. This absorption produces heat, and can damage cells or circuitry (often protection diodes) [6]. Solar cells are designed to absorb as much solar radiation as possible, this will inherently generate heat which can damage the cells or circuitry even under normal operating conditions. The heat needs to be exhausted and the cells need to be cooled. Not only is this a concern for longevity of photovoltaic systems, but also an efficiency concern. Photovoltaic cells are known to be considerably less efficient when exposed to high heat, falling in power by 0.5% per degree centigrade [7]. High temperatures significantly reduce the open circuit voltage, and therefore can either reduce power or damage devices downstream from the photovoltaic module. Photovoltaic modules are also brittle and can break due to hail or other falling objects, since, they are often layered with glass that can crack and expose the circuitry to water damage.

Fortunately there are alternative cell materials; crystalline silicon cells have the highest efficiency but the worst issues with shading, overheating, and collision induced damages. Thin film, or amorphous silicon, is flexible and also has significantly less shading issues. For a small scale hybrid system, amorphous silicon is a good option. It can be partially covered or bent without damage [6]. Amorphous silicon is also the cheapest option. Figure 1 depicts an amorphous silicon module.

Figure 1: Thin Film Photovoltaic Module [8]

The risk of using photovoltaic cells has been covered, but it is important to understand the locational downside of this technology. Vancouver, Seattle, and Portland are the major northwestern cities in North America, and on average have cloud/rain over half of the year. As stated earlier, up to 100% of solar radiation can be diffused on cloudy days and diffused radiation is 10% as powerful as direct radiation. Solar cells range from 10-20% in energy conversion efficiency, from solar to electrical [7]. This calculates that for half the year in these cities, a well designed, meter by meter sized, high solar incidence system will only take 10% of 10% of the 1000W/m² from the sun [7]. This comes to only 10W. These cities are also further from the equator, so they can have shorter days and less solar radiation, so that 10W becomes even smaller when averaged. This is why a photovoltaic system in the Pacific Northwest should be hybridized and harvest other energy sources on low yielding days.

The next surveyed energy harvesting system is hydro. Hydro power is generated by using the kinetic energy present in falling or fast running water to spin a turbine that is connected to an electric generator. That electrical energy can be stored or used instantaneously. In the EnerTree, this will be incorporated by collecting water in the trunk or base of the tree above a water turbine, and once enough potential energy is stored, the water will be released. This will cause the turbine to spin and generate electricity.

A simple calculation can be made to find the available output power. In order to calculate the available power, certain variables are necessary. Firstly, we must discuss hydraulic head. Head is the amount of energy a certain amount of water can produce. The head is proportional to the height of the stored water (distance from intake) and the velocity upon contact with the intake [9].

Equation Set 1: Power of Hydro Turbine System

Power(W) = $n\rho Qgh$

n = dimensionless efficiency of turbine

ρ = density of water in kilograms per cubic metre

Q = flow in cubic metres per second

g = acceleration due to gravity (9.8 m/s^2)

h = height difference between inlet and outlet in metres

In the base of the trunk a reaction water turbine will spin due to Newton's third law generating the energy to be stored in a battery for later consumption. When water acts on a reaction turbine, the turbine changes internal pressure, which in turn generates electrical energy. Figure 2 below shows an example of a water reaction turbine that could be used for this application.

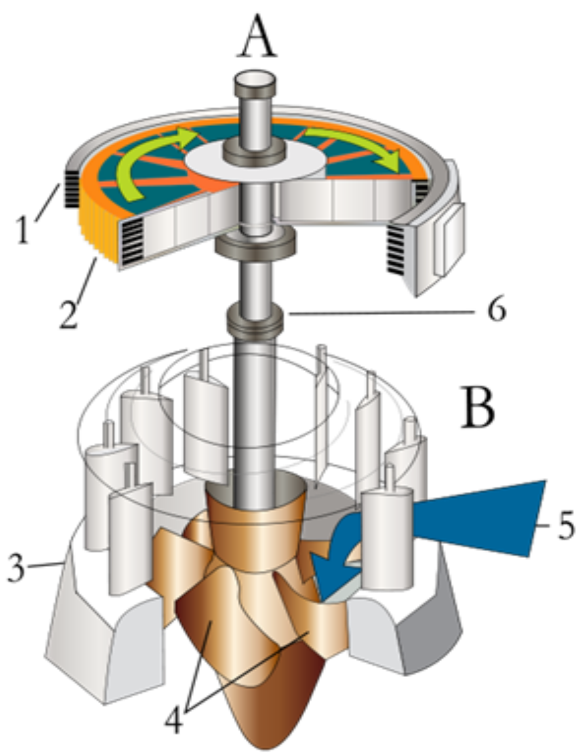

Figure 2: Hydro Generator [10]

For a scalable unit based on our budget constraints and due to the hybridization of the system as a whole, mini hydropower converters can be purchased online for around $15 CAD. These are small and cheap, but they are less efficient than large scale generators. The image below shows a mini hydropower converter. The device is made up of a simple input and output tube with an encased hydro turbine wheel. This generator has a 12V DC output, which is perfect for charging batteries and to power lighting. This device would be excellent for a proof of concept or prototype.

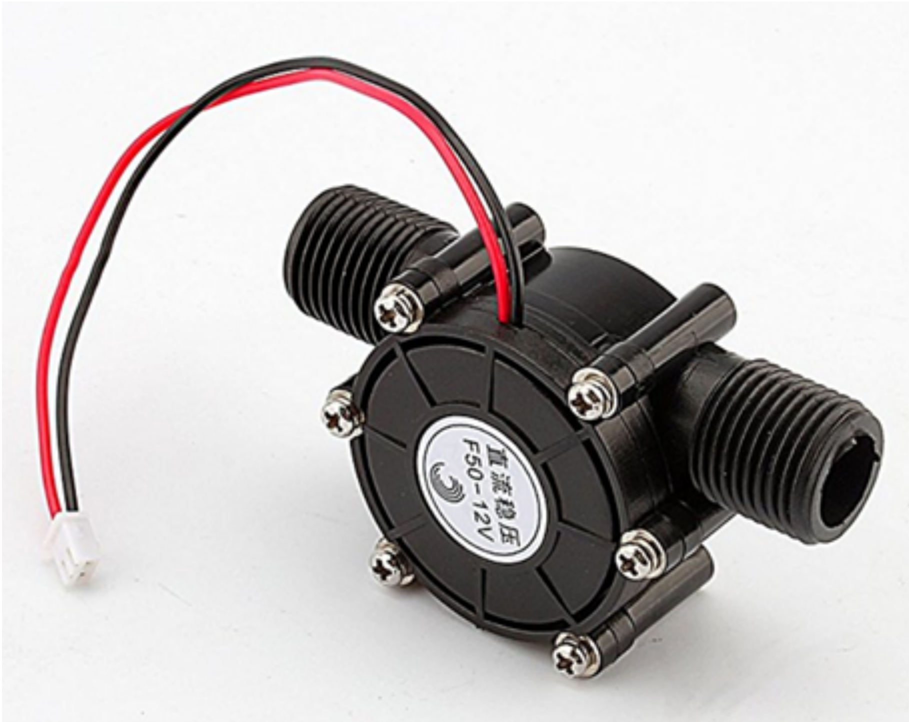

Figure 3: Mini Hydropower Converter [11]

The benefit from hydropower is in the abundance of running water and cost efficiency. Hydropower has been proven to work well because of the kinetic energy via running water in some parts of the world. EnerTree will take advantage of the abundance of rain in the Pacific Northwest. Hydro is seen as the cheapest energy proposed in this project, and BC is almost completely run off of hydropower. For EnerTree our main concerns are that: the water collector might be too short to generate enough electricity, our design may lack enough surface area to collect an appropriate volume of water, and the intermittent nature of the design will produce spiking voltages instead of level outputs. The electrical issues can be mitigated by the use of capacitors to help stabilize and level the spiking output of the mini hydropower converter.

Wind power is another type of renewable energy. In the last 20 years, turbines have become 200 times more efficient [12]. Although wind is often intermittent, the increase in efficiency of turbines will allow us to overcome this issue. Although it may seem different from hydropower, wind turbines use the same method of electricity generation as a hydroelectric dam. Clearly, the major difference is the input method of energy. On most wind turbines, the blades are connected to a generator and provide rotational input to the system.

The main issue seen with wind power is the inconsistency of the wind. There are few locations that experience consistently high amounts of wind. The lack of wind results in an idle turbine. With regards to electricity production, it is desirable to be producing 24/7. Although the wind may not always be blustering, wind power cannot be forgotten about. Incorporating wind will ensure that EnerTree utilizes all available forms of energy.

EnerTree's, wind power can take one or two routes. The first option is the traditional wind turbine. This option can be implemented by using a cup design seen on weather monitoring stations (shown in image below). This option can be built into the trunk of the tree, or multiple smaller turbines can be placed on branches throughout.

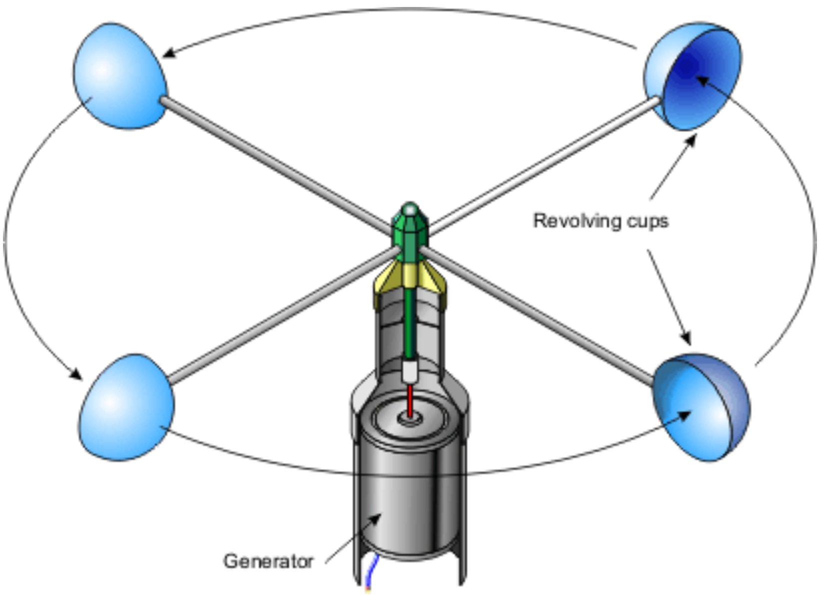

Figure 4: Small Wind Turbine [13]

The second option with regards to wind power, is the use of a piezoelectric material. The current identified piezoelectric material is called PVDF, or Polyvinylidene Difluoride. A piezoelectric material elicits an electrical response to an applied mechanical stress. Strands of PVDF would be arranged on branches or leaves of the tree in an effort to collect energy from wind and falling rain drops. Whether the mechanism is rain or wind, the goal is to create a setup that maximizes all types of stress on a piece of PVDF. The resulting electrical response would be stored by the system's main battery.

Current research shows that PVDF is not particularly efficient, and requires perfect conditions to receive minuscule amounts of electricity. Michael McCloskey states that "extracting 10W from piezoelectrics botanic mimics of practicable size is not a near-term reality" [14]. Even with this being said, there still is no harm in researching its capabilities when combined with other types of renewables.

One of the main risks to a hybrid system involves designs that hinder or reduce efficiency of one energy generator in order to improve that of another. The goal is to get maximum output from each source, not to settle for low outputs from each. Since the tree will not specialize in any one area, the mechanisms responsible for producing energy will not be optimized for any one particular method. This can become an issue when designing the structure of the prototype, as solar and wind power may inhibit the other forms of energy production. There is also the risk that the design will be overly specific to the Pacific Northwest, and therefore miss potential consumers from other parts of the world. It is undeniable that solar energy would work best for equator centered locations, but there are many other areas in the world that also have intemperate climates. These places have heavy rainfall seasons as well as sunny seasons, which why is it important for the design to be efficient at each form of energy harvesting. There are also issues protecting each independent module. For example, solar cells need to be protected from collisions or high winds, yet wind harvesting is inherently subject to the kinetic forces of the wind. These are a few of the design challenges that can be seen as daunting, but PNW Energy is eager to embrace the challenges and overcome them.

When it comes to energy production, the main worry is the lack of energy available on mild weather days. On a cloudy day with minimal wind, the tree is not expected to produce any electricity. The piezoelectric method may combat this, but hasn't been tested enough to be proven in large scale energy production.

The benefits of each system have been independently stated. Solar power provides a simplistic approach with zero mechanical components. The potential of piezoelectric components combined with the efficiency of traditional wind turbines are great reasons to implement them in a hybrid system. Lastly, hydro is the cheapest harvesting solution of the three. The real benefit of the proposed design is the combination of the three, which would overcome the variability of each independent source: solar, wind, and rain. The vision is to provide electrical energy on any given day, in any given location. The target of this design is for climates that are more variable and for consumers that desire a consistent energy output. The belief is that the control circuitry can be mostly combined into a single module, and the generators can be used simultaneously.

Unlike other renewable energy harvesting techniques, the tree will be able to produce on the majority of the days in BC. It is estimated that Vancouver gets 161 days of rain a year, which are mostly days where solar power is producing suboptimally [15]. This project is a unique approach to small scale renewable energy production available to consumers that can work during any type of weather. The Government of British Columbia has a yearly goal with regards to sustainability: The goal is to have 93% of the province's electricity gathered from renewable energy sources [16]. With respect to this number, British Columbia has one of the highest percentages in the world 97% in 2014 [17]. This design will contribute to this goal.

Market/Competition/Research Rationale

The majority of products designed for energy generation focus on mass producing, usually as a means to supply a city's electricity needs. There is a very large market for supplemental power generation using renewable hybrid energy sources and biomimicry. It is important to understand that in British Columbia, there is no product that will compete with BC Hydro to supply large amounts of electricity to cities using renewable energy. With this in mind, EnerTree's goal is to be a supplemental renewable energy product. Our tree aims to supply a homeowner with enough power to run backyard irrigation systems, small garden lights or serve as an emergency backup power source. Another market for this product is for remote or disaster locations. Portable electricity is key in these areas since there may not always be power. This is a growing niche in the energy production sector, where portability and versatility are very important. EnerTree could be implemented in locations such as Puerto Rico, where recently floods due to Hurricane Maria have caused over 400,000 people to be without power for upwards of 4 months [18].

We identified the three main renewable energy options as wind power, solar power, and hydro power in the Pacific Northwest. Understanding this, and by analyzing current small scale options, it became clear that a hybrid system would be very useful in addressing supplemental electricity generation using renewable methods.

Currently, solar power is an expensive option to generate any amount of useful power in BC, partly because of the climate. This is the reason that very few people opt to completely turn to solar power in rainy climates [19]. CBC states that in BC, it would cost $1M just for the batteries to be completely self sufficient using solar power [19].

Private hydroelectric dams are not an option for the vast majority of residents in the Pacific Northwest. A hydro system would only work for properties in which there are rivers and creeks. There is virtually no competition in this area.

Hybrid systems are a relatively new design, and have yet to be realized in the form previously described. The tree like structure has been seen before for solar and wind power exclusively, however this hybrid system is the first of its kind available to consumers. This is because of the specialization theory. This states that by focusing on the production of a limited scope of products, the resulting efficiency within an overall system will increase. However, without a clear and efficient source of renewable energy available to consumers in the Pacific Northwest, this hybrid system might be the exception to this theory.

Project Planning

The general schedule is constructed to follow the ENSC 405W deliverable date, see Table 1. The Gantt Chart, in Appendix I, depicts a broken down weekly schedule. The team's plan emphasizes testing and debugging, these processes should reserve the most time.

Table 1: ENSC 405W Deliverables

	Deliverables	Work Week to Finish	Actual Date	Percentage
1	Proposal	4	Web, Jan 31, 2018	10%
2	Design Review 1	7	Mon, Feb 19, 2018	5%
3	Requirements Specs	7	Wed, Feb 21, 2018	15%
4	Design Review 2	12	Mon, Mar 26, 2018	5%
5	Design Specs	12	Wed, Mar 28, 2018	15%
6	UI Design Specs	12	Wed, Mar 28, 2018	10%
7	440 Planning	12	Wed, Mar 28, 2018	10%
8	Poster Presentation	14	Mon, April 9, 2018	10%

Cost Considerations

Budget

Table 2 below shows a detailed breakdown of the approximate budget for the project. EnerTree has the potential to be a massive product as it should resemble an actual tree (8-15 feet tall), which will require a very large budget. The budget below is tailored to an initial prototype for proof of concept. Although the design will be implemented with the general structure of a tree, the final project will lack some of the aesthetics required to resemble a natural living tree. This sacrifice is being made to accommodate our low budget and focus of the technical details rather than the appearance. With EnerTree implementing three different types of renewable energy it will require three separate energy generating systems wired together. With that in mind, only one battery is required but the necessary electrical components will be increased to account for the need to wire the three systems together.

Table 2: Estimated Budget

Material	**Costs (Canadian Dollars)**
PVC piping*	100
Mechanical Components*	100
Electrical Components*	150
Testing Material*	100
Solar Cell	30
Test Battery	30
Micro Hydroelectric Turbine	25
Micro Wind Turbine	20
Under Budgeting Buffer	100
PVDF System	50
Total	**705**

**PVC piping includes: 6” pipe for trunk, connectors, glue, attachments, 1” pipes for branches; *mechanical components includes: brackets, tools, screws; *electrical components includes: wires, resistors, capacitors, switches, relays; *testing material includes: anemometer, solar power meter, etc.*

Funding

The funding will heavily impact the size and deliverables of this project. With so many variables and the scalability of this project, going beyond a proof of concept and small scale design will be difficult without the proper funding. As stated above, the budget is for a small scale design. With the desire to go bigger with our project, PNW Energy is reaching out to other renewable energy and energy companies for funding, namely BC Hydro, Fortis BC, Vancouver Renewable Energy, Canadian Energy, and Rev Engineering. The hope is to acquire either full funding for the project, partial sponsorship or donation of parts and components necessary for the design. As well as reaching out to some big companies for sponsorship, we will be applying for the ESSS Endowment fund and the Wighton Endowment fund.

As our project will grow with the funding, PNW Energy is fully aware that it is possible that we will receive no additional funding. For that reason, our initial budget is set within a range that our founding members are willing to split evenly amongst ourselves. However, if a substantially large company is willing to invest, we hope to expand our company and move in the direction of mass fabrication and retail sales.

Company Details

Bios:

Sam Swerhone is a systems engineering undergraduate at Simon Fraser. His engineering interests range from robotics and embedded systems to aerospace. Sam has worked as an intern at Indro Robotics and Intel, and is hoping to break into the aerospace industry after graduating in 2019. Sam enjoys competitive sports and board games in his spare time.

Jacob Cheng is an electronics engineering undergraduate at Simon Fraser University. His engineering interests are mostly in electronics, however his focus is shifting toward mechanical and civil in order to be able to combine his work and integrate it seamlessly with other streams of engineering. Jacob has competed in several engineering competitions and hopes to continue competing until he graduates in 2019.

Cole Patterson is a systems engineering undergraduate student at SFU. He has an interest in mechanical design, software and digital system design. Cole has his sights set on a career involved in renewable energy after graduation. Outside of school, Cole enjoys playing varsity football and rugby.

Conclusion

This proposal is the first step of PNW Energy's commitment to solve small scale hybrid energy systems. The EnerTree is a marketable product targeting a growing demand. The product has great benefit to those who wish to reliably power small appliances, as well as governances that would scale the design for powering the grid. A green cradle to cradle design has a good chance of external funding as well as future patents. As the global community increasingly puts more emphasis into renewable energy, there is a bright future ahead of PNW Energy.

As a capstone project, the EnerTree presents an excellent design challenge. It will take full effort from all team members and push each member to grow as design engineers. The project requires knowledge in a handful of engineering disciplines, and will require continued learning over the course of the next seven months. There is plenty more research to be done, but the proposal has enough foundation to move forward.

Although challenging, the team believes that this is a feasible project. Without any external funding, the team is confident it can self-fund. The gantt chart in Appendix I, outlines a schedule that provides plenty of testing and debugging periods to ensure a quality prototype. Above all else, the team is excited to tackle a project that is fundamental to the longevity of life on Earth. The ultimate goal is a prototype that will contribute new ideas and methods of hybridized energy harvesting.

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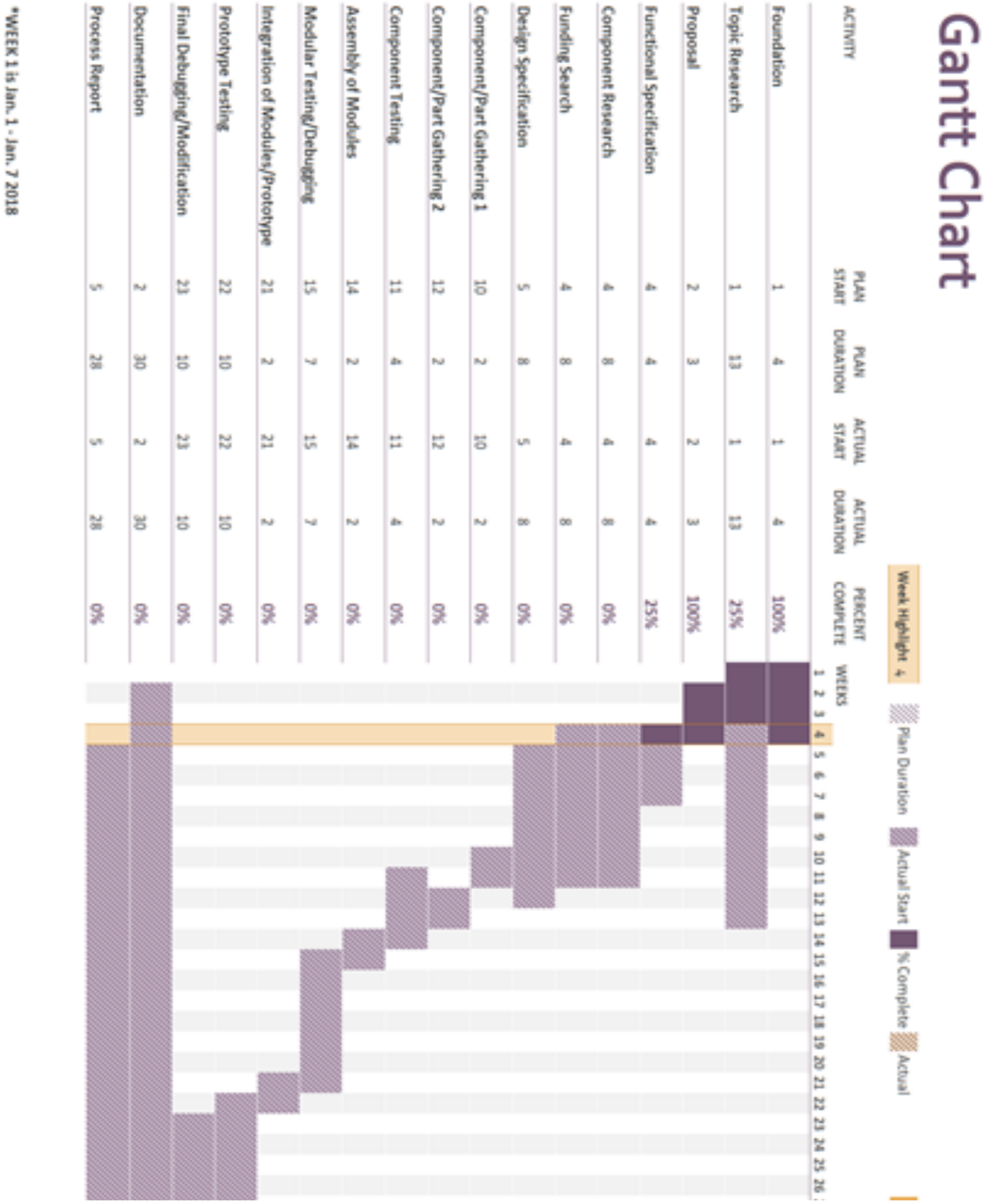
Appendix I



ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Foundation	1	4	1	4	100%
Topic Research	1	13	1	13	25%
Proposal	2	3	2	3	100%
Functional Specification	4	4	4	4	25%
Component Research	4	8	4	8	0%
Funding Search	4	8	4	8	0%
Design Specification	5	8	5	8	0%
Component/Part Gathering 1	10	2	10	2	0%
Component/Part Gathering 2	12	2	12	2	0%
Component Testing	11	4	11	4	0%
Assembly of Modules	14	2	14	2	0%
Modular Testing/Debugging	15	7	15	7	0%
Integration of Modules/Prototype	21	2	21	2	0%
Prototype Testing	22	10	22	10	0%
Final Debugging/Modification	23	10	23	10	0%
Documentation	2	30	2	30	0%
Process Report	5	28	5	28	0%

*WEEK 1 is Jan. 1 - Jan. 7 2018